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Sustainable Transport Innovations for Rural-Urban Connectivity and Health Access in the Central Region of Ghana

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Abstract

The Central Region of Ghana is facing major transport barriers that restrict rural communities' access to health and urban services. This study looks at how innovation in sustainable transport can improve rural-urban connectivity and access to health care. The study used a mixed method, including surveys of 400 participants and focus group discussions, and interviews with key stakeholders. Data analysis identified transport challenges and assessed potential solutions. The main obstacles were unreliable transport services, high travel costs, and poor road conditions. Innovative ideas such as solar-powered minibuses and electric motorbike ambulances for remote areas have received a lot of support. Sustainable access to transport has doubled the probability of improved access to health care. Sustainable transport can significantly increase rural-urban connectivity and access to health care, provided it is supported by integrated policies, community engagement, and reliable financing. Sustainable transport innovations offer practical solutions for improving access to health care and rural mobility in the Central Region of Ghana. These innovations have direct implications for human well-being, as they reduce travel time to health facilities, enhance emergency response, and promote inclusive access for vulnerable populations, particularly women, children, and the elderly. Piloting high-interest innovations such as solar buses, developing blended financing models, and strengthening coordination between the health and transport sectors are all important areas for future initiatives. Further research should assess long-term acceptance, cost-effectiveness, and behavioural factors that influence transport choices.

Keywords: *Electric ambulances, Health access, Rural-urban connectivity, Solar-powered vehicles, Sustainable transport*

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Introduction

Ghana is at a critical stage in its development, with glaring disparities in access to health care and transportation due to the country's persistent rural problems and rapid urbanisation (Tuffour & Anokye, 2025). The central region of Ghana, with its mix of remote rural communities and rapidly urbanising corridors, is a striking microcosm of the problems of access to transport faced by many developing regions (Amedzro, Essien, Issah & Owusu, 2024). In this case, the transport system that is supposed to connect rural residents to health facilities and urban opportunities often proves inadequate, unstable, or nonexistent (Melchiorre, Socci, Lamura & Quattrini, 2025). This paper argues that innovation in sustainable transport has the potential to revolutionise access to healthcare in the Central Region and improve links between rural and urban areas. The study identifies integrated solutions addressing public health and transport issues in a rapidly changing context. This can be done by looking at the complex relationship between mobility and health outcomes through a sustainable perspective. The spatial configuration of Ghana's transport network reveals fundamental structural problems that disproportionately affect people living in rural areas. The transport network in Ghana is still largely concentrated in the southern regions of the country, where the production of timber, cocoa, and gold is the main source of economic activity (Dumedah et al., 2025). Although the country has invested heavily in transport infrastructure, such as a road network of 64,323 km and a rail network of 935 km in narrow gauge, these systems still largely focus on economic corridors rather than on equitable access (Amankwah-Amoah et al., 2025). Due to the Central Region's proximity to Greater Accra, major transportation investments frequently avoid rural areas in favour of enhancing connections between already well-served urban centres. In this context, there are several ways in which roadblocks directly affect health outcomes. According to numerous studies (Religioni et al., 2025; Uzun & Akın, 2025), obstacles to transport are known to cause missed or delayed appointments, delayed treatment, and missed or delayed use of medicines. Chronic disease management is directly affected by these barriers to access to healthcare, which leads to poorer health outcomes. This creates a vicious circle in which traffic restrictions worsen health problems and further impoverish households. These problems are acute in rural communities, where the roads between residential areas and health facilities are often in poor condition. In Ghana, the link between access to health care and transport is empirically demonstrated. According to Timpabi et al. (2024), 51% of households have a motorcycle, making walking and cycling the main modes of transport. However, ownership does not ensure that everyone in the household has access to these resources. According to the same study, about 30% of the population had no physical access to health centres, and those who did have access to healthcare faced serious time constraints due to

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transport problems. These difficulties are severe in maternal and child health services, where early access can have a significant impact on life outcomes. According to Mahama et al. (2025), the geographical spread of healthcare facilities aggravates these transport problems. Ghana's five-tiered health system comprises community-based health planning and services (CHPS) at the community level, health centres at the sub-district level, district hospitals, regional hospitals, and specialised teaching hospitals at the national level. In rural areas, patients often have to travel between these levels, which requires transport between facilities for specialised care or referrals. Each referral points to the potential for a break in the continuum of care where there are few transport options and poor road conditions (Singh & Rajak, 2024). Aidam et al. (2025) reported that Ghana's transport system faces two challenges (equity and the environment), which require long-term solutions. Due to the need to travel long distances to access opportunities, car ownership has increased dramatically as cities have expanded in Ghana. In urban Ghana, men are significantly more likely than women to use their cars for daily commuting. This leads to a gender gap in access, raising concerns about sustainability and gender equality. The continued use of private cars threatens the sustainability of the urban transport system, gender equality, and causes serious traffic problems (Alexander & Okpakam, 2024). Sustainable innovation is also needed, given the key role of public transport in Ghana's mobility landscape. Millions of passengers are transported every year by services such as Metro Mass Transit Limited, Ghana Private Road Transport Union (GPRTU), and many more, which offer vital connections between and within cities (Aidam et al., 2025). However, these schemes have difficulties in keeping to consistent timetables and reaching isolated rural communities. Innovation that increases the efficiency, accessibility, and accessibility of public transport in rural communities would bring many benefits for sustainable development, such as lower emissions, reduced transport and better access to essential services for underserved communities (Junaid, Ferretti & Marinelli, 2025). Ghanaian politics continues to treat health planning and transport as largely separate areas, despite their obvious interconnection (Adarkwa et al., 2024; Okyere et al., 2025). Although the objective of the forthcoming Ghana Transport and Logistics Fair 2025 is to redefine Ghana's transport and logistics sector, the strategic priority for health is not explicitly mentioned. This fragmented strategy is a major missed opportunity for integrated planning, which addresses several development challenges at the same time. The problems of rural-urban connectivity and access to healthcare in the central region were also not sufficiently addressed in previous research on the potential benefits of specific sustainable transport innovations, such as electric minibuses, integrated bike-sharing schemes, or improved pedestrian infrastructure. As demonstrated by the theme of the Transport Research Congress 2025 on Sustainable, resilient

and smart transport, the importance of sustainable transport has been recognised by the global research community (Sobczuk & Borucka, 2024). However, the unique rural-urban link in the Central Region of Ghana is not sufficiently adapted to this global knowledge. Another key gap in knowledge is the gender-sensitive approach to transport planning. According to research by the International Transport Forum, the gap between how men and women experience urban mobility in Ghana is a major factor in access to health and other basic services. Innovation in sustainable transport that ignores these different needs and modalities risks perpetuating or exacerbating the inequalities that already exist. The present study fills these gaps by presenting sustainable transport as an integrated approach to achieving the goals of connectivity and access to health, rather than as a separate objective. This study adds to a more comprehensive understanding of the development priorities of the Central Region of Ghana and of the comparable context in the developing world by identifying innovations that promote environmental sustainability, economic viability, and health equity at the same time. In addition to being of academic interest, this research has direct policy implications. This work contributes to achieving several sustainable development goals, such as reducing inequalities (SDG 10), sustainable cities and communities (SDG 11), and good health and well-being (SDG 3) by offering evidence-based models for sustainable transport that improve access to health care. Policymakers can use this study as a model for joint planning between the health and transport sectors to create more equal and connected societies in the country and elsewhere. This study directly affects human lives by identifying transport innovations that improve timely access to healthcare, reduce economic stress from travel costs, and promote environmental sustainability. By linking transport and health planning, it offers evidence-based solutions that can save lives, enhance social inclusion, and strengthen rural resilience against inequality and isolation.

Research Aim

This study aims to examine and propose a framework for sustainable transport innovations that will improve rural-urban connectivity and equitable access to health services in the Central Region of Ghana. To achieve this aim, the following research questions were posed. What are the current bottlenecks in transport infrastructure and services that hamper rural communities' access to urban centres and to healthcare facilities in the Central Region of Ghana? To what extent can the adoption of specific innovations in sustainable transport improve the efficiency, accessibility, and reliability of urban-rural transport in the Central Region of Ghana? How can improved interconnectivity between rural and urban transport affect health outcomes in terms of access to maternal care, emergency services, and the management of chronic diseases in the Central region of Ghana? What are the policy, institutional, and community-based frameworks needed to promote the implementation and

scaling-up of sustainable transport innovations in the Central Region of Ghana?

Materials and Methods

This study was designed to examine the potential for sustainable transport innovations in improving rural-urban connectivity and health access in the Central Region of Ghana. A mixed-methods approach was employed to capture both the quantitative patterns of travel and the qualitative, lived experiences of the residents. The research was conducted over nine months.

Research Philosophy, Paradigm, and Design

The study's guiding principle was the pragmatic research paradigm. Since this is outside the divisive debate between positivism and interpretivism and focuses on the consequences of research and what works in solving problems in practice, it has been considered the most appropriate paradigm. The main question of the study is essentially pragmatic and solution-oriented. The use of mixed methods is justified by pragmatism, which values objective facts and subjective meaning and considers that combining the two provides the most practical and actionable insights for the development of successful interventions (Paudel, 2024). The ontological position guiding this study was critical realism. This view recognises that the real world exists outside our knowledge of it, but that our social, cultural, and political views always shape our perception of it. Although obstacles to healthcare are objectively real, they are experienced and interpreted differently by different social actors. This has been recognised in the context of the present study. Critical Realism thus offered a philosophical framework for examining both the internal, subjective interpretation of the transport and health-care landscape and the external, material reality (Pregoner, 2024). The contextualist epistemological approach is consistent with both Critical Realism and Pragmatism. According to that view, knowledge is contextually and contingently. The objective was to develop a thorough, context-specific understanding of the phenomena in the Central Region of Ghana. This supported the use of qualitative methods to investigate the particular social, cultural, and economic contexts that give rise to these trends after gathering quantitative data to identify general trends (Nair et al., 2024). The pragmatic paradigm was directly implemented by using a sequential mixed-method research design for explanatory purposes. This approach has been chosen because it addresses the ontological need to understand both objective reality and its subjective interpretation by enabling the collection and analysis of quantitative data to provide a general pattern and the collection and analysis of qualitative data to provide a deeper insight into the quantitative findings (Hoseinzadeh, 2024).

Population and Sample

The study population was composed of adults (aged 18 years and above) living in rural and peri-urban areas within 25 km of the Cape Coast Teaching Hospital and Winneba Trauma Hospital in the Central Region of Ghana. For the quantitative phase, the sample consisted of 400 participants. The four

districts/municipalities/metropolitan selected were the Abura-Asebu-Kwamankese (AAK) district, the Komenda-Edina-Eguafo-Abirem (KEEA) municipality, the Effutu municipality, and the Cape Coast metropolitan. All were selected by means of a multi-stage sampling. Eight study communities were established by randomly selecting two communities from each of the district/municipal areas. For the qualitative phase, a purposive sample was selected. Eight Focus Group Discussions (FGDs) were organised, one in each of the eight selected communities. Each group comprised between eight and ten participants, classified according to age and gender. This stratification resulted in different perspectives being identified with regard to the different mobility needs of women, young people, and older people. In addition, 15 key input assessments were carried out with a carefully selected set of stakeholders. This included representatives of NGOs active in the health and transport sectors, local government representatives from the transport union leaders, and managers of health facilities.

Sampling Technique

For the quantitative survey, a multi-stage sampling technique was used to ensure representativeness.Four districts/municipalities/metropolitan areas were selected for the first phase due to their distinct rural-urban link and proximity to urban health centres. For the second phase, two communities from each district were selected from a list of all the communities within a 25 km radius by means of basic random sampling. In the final stage, households were selected in each community by means of a systematic random sampling approach. After a random start point, one in five households was contacted. To avoid selection bias, one participant was selected randomly from households with more eligible adults. During the qualitative phase, a purposive sampling approach was used to identify cases with rich information for the FGDs and KIIs. Community elders and assembly members helped to recruit participants for focus group discussions to ensure that they met the stratification requirements. To ensure that the views of key informants are directly related to the objectives of the study, they were selected on the basis of their professional role and direct involvement in rural transport systems or health care provision.

Data Collection Instruments

Many tools have been developed, tested, and used to collect data. But for this study, a structured questionnaire was developed for the quantitative survey. A Likert scale measuring attitudes towards proposed sustainable transport innovations was included, as well as sections on socio-demographic characteristics, current transport modes, and access to healthcare facilities. The FGDs were facilitated by means of a semi-structured discussion guide. The guide included open-ended questions examining experiences with medical emergencies, health care decision-making processes, perceived physical and financial barriers, and in-depth discussions on the viability, advantages, and disadvantages of specific sustainable transport models. Different semi-structured interview

guides were developed for different types of key informants. These manuals focused on institutional perspectives and addressed issues such as current transport regulations, service delivery problems, cooperation between health and transport authorities, and the perceived feasibility of integrating new transport technologies in local environments. The types of vehicles on the main routes, their occupancy rates, and the condition of the roads and paths leading to the health centres in the selected communities were all recorded by the survey staff using a simple checklist. Each instrument was first prepared in English and then translated into the local language by the research assistants. They were then translated back into English to ensure conceptual accuracy and coherence.

Data Collection Procedures

Eight research assistants fluent in both the local language and English attended a week-long training course before data collection. The training covered the objectives of the study, ethical behaviour, interview methods, and the use of data collection tools. First, quantitative data were collected. The research team visited selected areas with community entry guidelines. Each participant gave their informed consent before the questionnaire was distributed. Each interview lasted approximately 30 to 45 minutes and was conducted in a private environment. The process of collecting the qualitative data started after the completion of the data input of the survey and the preliminary analysis. In order to create a relaxed and familiar environment, the focus group discussions took place in community centres and under large trees. Each 60 to 90-minute focus group discussion was led by a moderator and a debriefer. All FGDs and KIIs were audited by audio with the consent of the participants. The KIIs lasted between 45 and 60 minutes and were conducted in an appropriate private location. Field notes were also taken to document contextual observations and non-verbal clues.

Validity and Reliability

Several steps were taken to ensure the reliability and validity of the results. A panel of experts, including a development sociologist, a public health expert, and a transport geographer, examined the instruments carefully to establish the validity of their content. Questions were improved in relevance and clarity on the basis of their input. Although excluded from the final sample, a pilot study was conducted in a community that had characteristics similar to the study areas. The wording of some questions and the logistics of the FCDs were slightly modified after the pilot testing. Cronbach's alpha was used to assess the internal consistency of the items on the Likert scale in the survey. The results showed an acceptable level of reliability with a coefficient of 0.79. Triangulation of data sources and methods improved the reliability of the quality data. The research team organised peer review meetings to discuss new topics and interpretations. To ensure accuracy, the audio recordings were also literally transcribed and translated into English by the researchers.

Data Processing and Analysis

The design steps of the mixed method were

followed. After validation as a complete survey, the survey data were encrypted and imported into IBM SPSS Statistics version 27. To summarise the data, descriptive statistics including mean, standard deviation, percentages, and frequency were calculated. Relationships between variables were investigated using inferential statistics such as logistic regression. Thematic analysis was used for the qualitative data review. This required a multi-step process. First, the field notes and the transcribed texts were reread several times to ensure familiarity. The data was then used to create the initial encryption codes. After these codes were compiled into possible topics, they were reviewed and improved to ensure that they adequately represented the data set. The coding and thematic organisation processes were facilitated by NVivo Version 11 software. Quantitative and qualitative findings were combined in the final stage of the interpretation. A thorough understanding of the research problem was achieved by using qualitative topics to contextualise, explain, and provide examples demonstrating quantitative models.

Ethical Considerations

This study received ethical clearance. Administrative approval was obtained before the data were collected. The principle of informed consent was strictly adhered to. Each participant was provided with a comprehensive information sheet outlining the objectives, methods, potential risks, and rewards of the study and the freedom to withdraw at any time without penalty. The literate participants gave their consent in writing, whereas the non-literate participants gave their consent orally, recorded and witnessed by fingerprinting. Anonymity and confidentiality were respected throughout the entire period of the study. Each participant was given a unique code, and all identifying information was removed from the questionnaire and the transcripts. The hard copy was kept in a locked box accessible only by the lead researcher, while the digital data and audio recordings were stored on a password-protected computer. In line with the commitment to mutual respect, the results were shared with communities and stakeholders through a synthesis report and a community engagement forum.

Results and Findings

Socio-Demographic Characteristics of Participants

Four hundred people from four districts in the Central Region of Ghana took part in the survey. Of those who responded, 46% were men and 54% were women. 61.3 per cent of the population was aged 18-35 years, and between 18 and 75 years old (mean = 37.2, SD = 12.5). There were four levels of educational attainment: secondary (25), tertiary (13), primary (34), and non-formal (28) education. Of these, 42% worked in the informal sector, 33% in the formal sector, and 25% were either unemployed or working in the informal sector. Average household income was low, with 57 per cent earning less than GHS 1000, 32% earning between GHS 1,000 and 2,500, and 11% earning more than GHS 2,500. The mean household contained 1.1 persons (SD = 2.3). 38% of the population lived in peri-urban areas and 62% in rural areas. The most common forms of transport

were motorcycle taxis, shared taxis, and minibuses. Almost half of the participants (48%) said that they had difficulties getting to the healthcare facilities due to poor road conditions or erratic transport.

RQ 1: Current Bottlenecks in Transport Infrastructure and Services

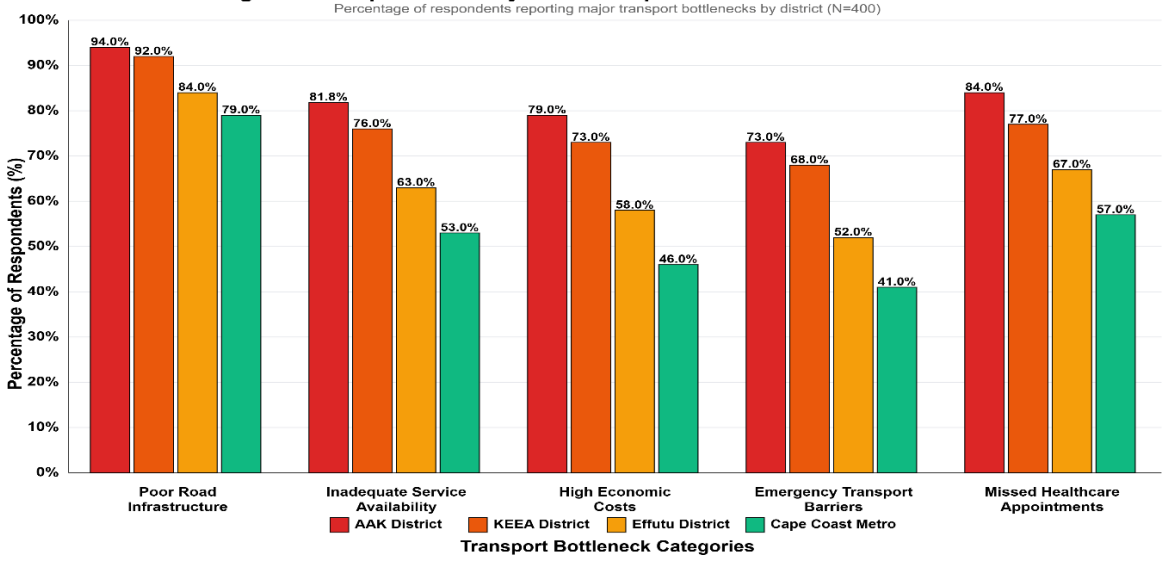
Research Question 1 sought to identify the current bottlenecks in transport infrastructure and services that hamper rural communities' access to urban centres and healthcare facilities in the Central Region of Ghana. The quantitative survey of 400 residents across eight communities in four districts (AAK, KEEA, Effutu, and Cape Coast Metropolitan Assembly) revealed multiple interconnected barriers affecting rural-urban connectivity and healthcare access. Poor road conditions were the most reported barrier (87.3%), particularly during the rainy season, when 76.5% said roads became impassable. The mean travel time to the nearest urban health centre was 78.4 minutes, reaching 96.7 minutes in AAK. Inadequate bridges and culverts (62.8%) and poor drainage (54.3%) caused detours and flooding, worsening accessibility. Only 31.5% of respondents had daily transport to urban centres, while 43.8% had services only on market days. Nearly a quarter (24.7%) lacked regular transport. Overcrowding (79.3%) and long waiting times (mean 82.6 minutes) were common. Limited early-morning departures (68.5%) delayed access to healthcare and urban services. Transport costs were a significant financial strain. A one-way trip to a health centre costs an average of GH₵18.40, about 8.3% of weekly household income. For low-income households, travel for healthcare could take up 25% of weekly income. Lower-income groups were more likely to walk (OR=4.21, 95% CI: 2.56–6.93), and 41.7% reported being unable to afford emergency transport. Transport difficulties led to fewer healthcare visits (mean 1.8 in six months vs. the national average of 3.4). About 71.3% of respondents attributed missed or delayed care to transport issues, mainly cost (44.2%), lack of vehicles (31.8%), and poor roads (15.9%). In emergencies, 58.5% experienced critical delays, averaging 3.7 hours, with serious risks for pregnant women and those with chronic conditions. The AAK district faced the worst conditions of longest travel times (96.7 minutes), highest costs (GH₵23.10), and least service availability (18.2%). Cape Coast had the best connectivity (52.3 minutes, 61.4% daily service). During the rainy season, 83.8% reported degraded transport reliability, a 35.7% rise in costs, and 45-minute longer travel times, intensifying access challenges for healthcare and emergencies. **Table 1: Transport Infrastructure and Service Bottlenecks by District (N=400)**

Bottleneck Category	Overall % (n)	AAK District % (n=100)	KEEA Municipal % (n=100)	Effutu Municipal % (n=100)	Cape Coast Metro % (n=100)	χ^2	p-value
Infrastructure							
Poor road conditions	87.3 (349)	94.0 (94)	92.0 (92)	84.0 (84)	79.0 (79)	11.24	0.010

Inadequate bridges/culverts	62.8 (251)	78.0 (78)	81.0 (81)	52.0 (52)	40.0 (40)	44.67	<0.001
Poor drainage systems	54.3 (217)	71.0 (71)	64.0 (64)	48.0 (48)	34.0 (34)	32.18	<0.001
Service Availability							
No regular daily service	68.5 (274)	81.8 (82)	76.0 (76)	63.0 (63)	53.0 (53)	23.91	<0.001
Vehicle overcrowding	79.3 (317)	88.0 (88)	83.0 (83)	76.0 (76)	70.0 (70)	11.32	0.010
Limited morning departures	68.5 (274)	79.0 (79)	75.0 (75)	64.0 (64)	56.0 (56)	15.43	0.001
Economic Barriers							
High transport costs (>10% weekly income)	64.0 (256)	79.0 (79)	73.0 (73)	58.0 (58)	46.0 (46)	28.76	<0.001
Cannot afford emergency transport	41.7 (167)	58.0 (58)	49.0 (49)	36.0 (36)	24.0 (24)	28.43	<0.001
Healthcare Access Impact							
Missed appointments due to transport	71.3 (285)	84.0 (84)	77.0 (77)	67.0 (67)	57.0 (57)	20.88	<0.001
Emergency transport delays (>2 hours)	58.5 (234)	73.0 (73)	68.0 (68)	52.0 (52)	41.0 (41)	27.12	<0.001

Source: Field Data (2025)

Figure 1: Comparative Analysis of Transport Bottlenecks Across Districts



The quantitative findings reveal a complex web of infrastructure, service, and economic bottlenecks that systematically constrain rural residents' access to urban centres and healthcare facilities. These barriers are not uniformly distributed, with communities in the more remote AAK and KEEA districts experiencing disproportionately severe constraints. The convergence of poor physical infrastructure, limited and unreliable transport services, and prohibitive costs creates a multilayered barrier system that particularly disadvantages low-income households, women, and individuals requiring time-sensitive medical care. These patterns underscore the urgent need for targeted interventions that address not only physical infrastructure but also service delivery models and affordability concerns.

RQ 2: Adoption of Sustainable Transport Innovations

Research Question 2 examined the extent to which sustainable transport innovations could improve efficiency, accessibility, and reliability of urban-rural transport. Respondents evaluated five innovations using a 5-point Likert scale across three dimensions. Only 23.8% (n=95) had prior knowledge of sustainable transport technologies, with higher awareness among younger respondents (31.2% vs 16.4%, χ^2=12.87, p<0.001) and those in urban areas. Despite low awareness, 82.5% (n=330) expressed willingness to use sustainable options if available and affordable. Solar-powered minibuses received the highest ratings: efficiency 4.32 (SD=0.78), accessibility 4.41 (SD=0.72), and reliability 4.28 (SD=0.81). Respondents valued reduced fuel costs (87.3% agreed) and environmental benefits (76.5%), though 64.8% raised concerns about capital investment and maintenance. Electric motorcycle ambulances scored highly for emergency access: efficiency 4.19 (SD=0.82), accessibility 4.38 (SD=0.74), reliability 4.15 (SD=0.85). Female respondents rated accessibility significantly higher than males (4.52 vs 4.23, t=3.42, p=0.001). About 79.8% believed this would reduce emergency response times. Mobile health units received strong ratings: efficiency 4.24 (SD=0.79), accessibility 4.45 (SD=0.70), reliability 4.22 (SD=0.80). Remote communities especially valued bringing healthcare to transport routes, with 84.3% noting this eliminates multiple barriers simultaneously. Digital ride-hailing platforms showed moderate ratings: efficiency 3.89 (SD=0.94), accessibility 3.95 (SD=0.92), reliability 3.82 (SD=0.98). Limited smartphone ownership (34.8%) and poor network reliability (58.0% concerned) constrained enthusiasm. Bicycle-sharing systems received the lowest ratings: efficiency 3.47 (SD=1.12), accessibility 3.68 (SD=1.08), and reliability 3.41 (SD=1.15). Concerns included tropical climate challenges (62.3%), terrain difficulties (58.8%), and cultural perceptions (43.5%). Remote districts rated innovations significantly higher. AAK respondents gave solar-powered minibuses a mean efficiency rating of 4.58 versus 4.06 from Cape Coast Metro (F=8.42, p<0.001). KEEA showed particularly strong support for electric motorcycle ambulances (accessibility 4.61), reflecting recent maternal mortality incidents.

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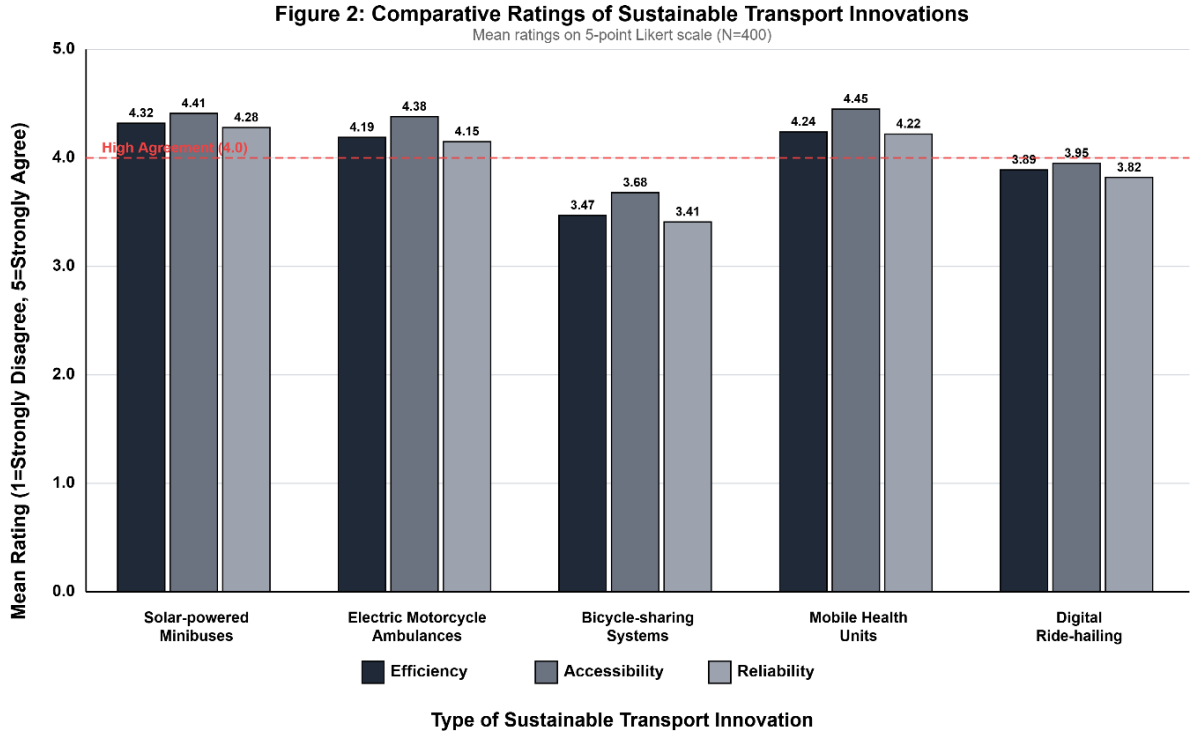
Respondents accepted a mean 32.7% (SD=18.4%) fare increase for improved services, conditional on a 30% travel time reduction (91.3% agreed), guaranteed seating (85.8%), and reliable schedules (88.5%). Logistic regression showed household income (OR=2.87, p<0.001), missed appointments (OR=2.34, p<0.001), and distance from health centers (OR=1.08/km, p=0.002) predicted higher willingness to pay. Key barriers included poor road infrastructure (81.8%), lack of charging infrastructure (76.3%), affordability concerns (69.5%), institutional/regulatory uncertainty (52.8%), and cultural acceptance issues (38.3%). About 77.0% believed combined innovations would be more effective than single solutions. An integrated ecosystem received a mean favorability rating of 4.36 (SD=0.75), higher than any single innovation.

Table 2: Mean Ratings of Sustainable Transport Innovations (N=400)

Innovation	Efficiency	Accessibility	Reliability	Overall	F	p
Solar-powered minibuses	4.32 (0.78)	4.41 (0.72)	4.28 (0.81)	4.34	8.42	<0.001
Electric motorcycle ambulances	4.19 (0.82)	4.38 (0.74)	4.15 (0.85)	4.24	6.73	<0.001
Mobile health units	4.24 (0.79)	4.45 (0.70)	4.22 (0.80)	4.30	7.89	<0.001
Digital ride-hailing platforms	3.89 (0.94)	3.95 (0.92)	3.82 (0.98)	3.89	3.87	0.009
Bicycle-sharing systems	3.47 (1.12)	3.68 (1.08)	3.41 (1.15)	3.52	4.21	0.006



The findings demonstrate strong support for solar-powered minibuses, electric motorcycle

ambulances, and mobile health units, with consistently higher ratings from remote communities experiencing severe transport constraints. High acceptability and conditional willingness to pay suggest significant adoption potential, though infrastructure and financing barriers require attention. Preference for integrated approaches indicates that comprehensive system redesign may be more effective than single interventions

.

RQ 3: Access to Maternal Care, Emergency Services, and Chronic Disease Management

Table 3: Logistic Regression

Predictor	Coefficient (β)	Std. Error	z-value	p-value	95% CI
Constant	-1.083	0.508	-2.13	0.033	[-2.08, -0.09]
Sustainable Transport	0.713	0.220	3.25	0.001	[0.28, 1.14]
Distance	-0.030	0.022	-1.35	0.177	[-0.073, 0.013]
Income	0.577	0.144	4.00	<0.001	[0.29, 0.86]
Age	0.003	0.007	0.38	0.701	[-0.011, 0.017]
Gender	-0.103	0.219	-0.47	0.638	[-0.53, 0.33]

A logistic regression model was used to assess the impact of sustainable transport, distance to healthcare facilities, household income, age, and gender on improved access to healthcare for 400 participants. This model was statistically significant and underlined the key role of sustainable transport and household income. Sustainable transport has been shown to significantly increase the probability of improved health outcomes (β = 0.713, p = 0.001). The probability ratio (OR = 2.04) shows that participants with access to sustainable transport were about 2 times more likely to report improved access to healthcare than those without access. Household income also had a significant positive effect (β = 0.577, p<0.001; OR = 1.78), with middle- and high-income households being almost 1.8 times more likely than low-income households to have access to healthcare. Distance to healthcare facilities had a negative but insignificant effect (β = -0.030, p = 0.177), indicating that greater distance slightly reduced access to healthcare, but this effect was not statistically significant in the sample. Age (β = 0.003, p=0.701) and gender (β = -0.103, p=0.638) were not statistically significant predictors of improved access to healthcare. Logistic regression analysis has shown that the introduction of sustainable transport options in the Central Region of Ghana has significantly improved the access of rural residents to health services. Participants who had access to sustainable transport were twice as likely to report improved health. Income was also a strong

predictor, suggesting that wealthier households would benefit more from better connectivity. Although the distance to healthcare facilities showed a negative trend, it was not statistically significant, and demographic factors such as age and gender had no significant impact on access to healthcare in the sample. These findings highlight the potential of sustainable transport innovations to bridge the gap between rural and urban health access.

RQ 4: Policy, Institutional, and Community-based Frameworks

Based on focus group discussions and key informant interviews, four main themes emerged: policy alignment and regulatory support, institutional coordination and capacity, community involvement and acceptance, and financing and sustainability mechanisms.

Theme 1: Policy Alignment and Regulatory Support

Stakeholders frequently expressed the urgent need for supportive policies that specifically incorporate sustainable transportation into plans for rural-urban health access. Many participants pointed out that innovations find it difficult to acquire legitimacy or scale in the absence of explicit policy directives. We need policies that not only promote buses and ambulances, but also alternative modes of transport, such as solar-powered cars and community-based transportation systems. Otherwise, these ideas will stay in the paper (Transport union leader, KII) Although there are theoretical policy frameworks, innovation is frequently stifled by the absence of explicit implementation guidelines. This indicates a disconnect between national aspirations and local operational realities, underscoring the significance of practical, context-sensitive, and implementable policy design.

Theme 2: Institutional Coordination and Capacity

The ability of several institutions to cooperate is essential to the success of sustainable transport initiatives. FGDs showed a lack of coordination among municipal planning departments, health authorities, and local transportation regulators. Sometimes the hospital calls an ambulance, but the transport department says they're not responsible. We need joint action plans (Rural Health Nurse, FGD) Coordination is currently weak, and this affects service delivery (Coordinator of NGO transport, KII) According to the analysis, the adoption of sustainable transportation is hampered by structural inefficiencies and divided responsibilities. To successfully scale innovations, interagency cooperation must be strengthened, and roles must be made clear.

Theme 3: Community Engagement and Acceptance

One of the most important factors in the adoption of sustainable transportation is community buy-in. The importance of innovations being affordable, culturally relevant, and seen as enhancing everyday life was emphasized by the participants. People will not use the new transport system if they do not believe it is safe and reliable, especially when they go to the clinic at night (Community elder, FGD) We must involve young people and women in the planning, or the service will not be carried out (Local assembly member, KII) It is essential to success to involve communities as co-creators rather than passive recipients.

Programs that disregard local issues or social norms run the risk of being poorly adopted and wasting money.

Theme 4: Funding and Sustainability Mechanisms

The importance of sustainable financial models for scaling interventions was emphasized. The significance of combining community contributions, private investment, and government support was constantly underlined by stakeholders. Innovation dies when there is no money for the maintenance of the trains and the drivers. Communities can help, but long-term financing needs to come from a structured plan. (Transport NGO official, KII) Concerns about financial sustainability are both pragmatic and moral. Without it, well-meaning initiatives run the risk of failing and disproportionately harming those who are most in need. Therefore, strategic funding plans must incorporate local realities and provide incentives for both public and private actors.

Confirmation of Findings

The findings of the surveys and interviews make it clear that rural residents find it difficult to travel to towns and to medical facilities because of poor roads, limited transport options, high prices of lorry fares, and a lack of coordination. According to the survey, access to sustainable transport increases healthcare considerably, especially for households with low incomes and those living in remote areas. The interviews with community members and stakeholders also highlighted the need for clear policies, better coordination between agencies, community involvement, and reliable financing of transport projects. Overall, the results show that simple, reasonably priced, and carefully designed transport options can contribute to more equitable and effective access to urban and rural health care.

Discussion

This study shows how economic barriers, service constraints, and infrastructure deficiencies interact to restrict access to health care and rural-urban links in the Central region of Ghana. This research shows that the transport crisis in rural areas is multifaceted, characterised by poor road conditions, a lack of services, and prohibitive costs that can cost as much as 25 percent of the weekly income of low-income households when they need to get to a doctor. Despite the obstacles that exist, this study has shown that sustainable transport innovations have great promise to solve these problems, and that remote communities show the greatest willingness to embrace these solutions. Importantly, the logistic regression analysis shows quantitatively that having access to sustainable transport increases the chance of having better access to health care, underlining the revolutionary potential of integrated transport-health programs in rural areas. With AAK residents facing almost twice the travel time of Cape Coast residents, the unambiguous differences in access to transport between the two areas reflect how geographical isolation exacerbates existing socio-economic disparities. Due to these time constraints, rural residents may experience what can be described as time poverty, as the excessive travel time reduces the opportunities to earn income, to seek

health care, and other activities of well-being. For many households, the financial burden of travel is a disaster cost, forcing them to make difficult choices between access to health care and other basic needs. This economic barrier disproportionately affects the most vulnerable in society, in particular, women of childbearing potential and those with chronic conditions requiring frequent health care. The strong preference for specific innovations in sustainable transport reveals important insights into the context of the solution. Solar-powered minibuses received the highest ratings, most likely because they represent an incremental improvement over the known technology, while also addressing the issue of fuel costs. The enthusiastic response to electric motorbike ambulances shows that they can cope with poor road conditions in a way that conventional vehicles cannot. On the other hand, the low rating of bicycle-sharing schemes reflects practical concerns about climate, terrain, and cultural acceptance, rather than a rejection of the principles of active transport. The findings suggest that integrated transport and health initiatives, which address in particular the identified financial, time, and physical obstacles, should be part of policy interventions that go beyond traditional infrastructure projects. There may be scope for cross-subsidization models, which could increase the sustainability of the system, as demonstrated by respondents' willingness to pay a 32.7 percent premium for better service. To ensure that transport innovations do not inadvertently exacerbate existing inequalities, policymakers should consider targeted subsidies to low-income households, as they do in other sectors. The close correlation between improved access to health and sustainable transport makes an effective case based on evidence for combining health and transport planning at the institutional level. This research supports the development of collaborative programs between the Ministries of Health and Transport, which could lead to new sources of funding and accountability schemes. The need for local solutions rather than one-size-fits-all strategies is also underlined by the variation in transport problems at the district level, which suggests that decentralised planning structures could be more successful in removing context-specific barriers. The findings on infrastructure barriers support earlier studies carried out in similar contexts. As Baffoe et al. (2021) documented, the related accessibility problems in Accra and noted how the use of green spaces was influenced by socio-demographic factors and neighbourhood characteristics. This shows how economic and geographical factors create different access to basic services (Kaiser & Barstow, 2022). The economic barriers identified by us are also in line with Fianoo et al. (2025) and Yankson, (2022), who found that Ghanaian low-income earners had significantly poorer preventive health practices because of financial constraints. But our research reveals important differences from previous research. While infrastructure solutions and technical efficiency are often the focus of traditional transport studies, the findings highlight how human factors have a critical

impact on the efficiency of transport solutions. This supports the emerging view of behavioral scientists that transportation systems need to be designed for humans, recognising the complex psychological, social, and physiological factors that shape travel choices (Blaga, Cășeriu, Bucur & Veres, 2025). Context matters a lot in terms of technology adoption, as demonstrated by the low enthusiasm for digital ride-hailing platforms (Alsaleh, 2025), compared to the typical presumption that digital solutions are universally desired. This research adds many new ideas to the body of literature. First, this study shows that technologically advanced innovations in transport are not always desirable. In fact, the best-rated solutions were realistic adaptations of existing technologies rather than revolutionary ones. Second, the study demonstrates that willingness to pay for better services is conditional, and highlights that rural consumers are savvy shoppers who evaluate proposed solutions on the basis of pre-defined standards rather than categorically rejecting innovation. Third, the ecosystem in which technological solutions succeed or fail is shaped by qualitative factors, as demonstrated by the integrated blended method approach. Taking into account the various theories that have been proposed to explain our results, it is possible that a bias towards social desirability rather than actual preference is the reason why some innovations have received such high ratings. Similarly, a declared willingness to pay higher fares may not correspond to actual payment practices. The negligible correlation between the level of access to healthcare and distance in the regression model is in contradiction with some previous research and may be due to either the predominance of economic factors or the relatively small geographical variation in our study area. In addition, unmeasured factors such as social capital or community cohesion may affect access to health care and transport in ways that this study has not been able to identify. The results of this study can be interpreted using several ideas from behavioral science that shed light on the choices and preferences of rural residents. Despite little prior experience, affordability theory helps explain the high acceptance of solar-powered minibuses and electric motorized ambulances. These solutions can be seen as directly addressing some of the barriers in a way that is compatible with user conceptual models of efficient transport. People make decisions based on perceived value rather than absolute costs, which is reflected in a conditional willingness to pay for better service. The specific requirements serve as the concrete benchmarks against which the proposed improvements are assessed by the respondents. According to this research, rural residents are value-conscious consumers who make rational decisions on the basis of the information available to them, challenging the oversimplified assumption that all of them are price sensitive. The availability bias concept helps to explain the variation in innovation scores at the district level. Participants from regions with more severe transport problems perceived more potential benefits from solutions that addressed their most

important constraints. This psychological process explains why the same invention is rated differently in different geographical locations. This result is in line with the new direction of transport studies, which emphasise the importance of design for people, to take into account the complex psychological, social, and contextual factors influencing how people travel.

Policy and Human Impact Implications

Sustainable transport innovations directly influence human well-being by ensuring equitable access to healthcare and other essential services. Policymakers should prioritize inclusive and affordable transport systems that particularly address the needs of vulnerable populations. Investing in solar-powered and electric transport not only supports environmental goals but also enhances the daily lives of millions who currently face mobility barriers.

Strengths and Limitations

The mixed method approach used in this study provides both statistical support and a contextual understanding of transport issues in rural Ghana, combining quantitative precision with qualitative depth. The stratification of the sample at the district level allows for geographical comparisons, which highlight significant differences in preferences and experience. Triangulation increases the validity of conclusions by incorporating additional data sources. However, a number of methodological limitations need to be recognised. Because the cross-section design only records behaviour and perception at a specific time, it is difficult to identify the causal relationships or to record how preferences may change over time. Subgroups at the district level may be too small for some benchmarking analyses, which may limit the statistical power to identify more subtle geographical differences, even though the sample size is sufficient for a full analysis. Selection bias may have been introduced by our recruitment methods, as participants who were more interested in innovation or who had a stronger opinion on transport challenges may have been more likely to participate. Many measures, such as willingness to pay and innovation scores, are self-reported, which increases the risk of multiple biases, such as hypothetical bias and bias towards social desirability. Given the limited prior exposure of participants to most sustainable transport innovations, their ratings reflect expected value rather than actual value, which may not be a reliable indicator of acceptance and uptake. In addition, not all possible confounders, such as car ownership or social networks, which can affect both access to healthcare and healthcare, were fully measured in our study.

Conclusion and Future Directions

This study shows that sustainable transport innovations have great potential to solve the complex mobility issues that hamper rural access to healthcare and economic opportunities. The results show that technological solutions must be seen as part of complex institutional, behavioural, and political frameworks that ultimately determine their viability. The correlation between better access to health care and sustainable transport is strong evidence in

favour of integrated approaches to rural development. These findings underscore that sustainable transport is not merely a technical issue but a human one. Improved connectivity translates into real health and social benefits—fewer preventable deaths, reduced delays in treatment, greater mobility for marginalized groups, and enhanced quality of life for rural populations. There are still many unanswered questions about how to translate the early enthusiasm for sustainable transport innovations into long-term acceptance and use, how to best organise funding sources to ensure sustainability and equity, and how to effectively coordinate the different institutions involved in rural transport planning. Economic evaluations comparing the cost-effectiveness of different intervention models, longitudinal studies that monitor the adoption and implementation process over time, and implementation research that identifies concrete tactics to overcome the institutional and coordination obstacles identified in the study should be the top priorities for future research. The behavioural findings suggest that further investigation of the psychological processes influencing the adoption of technology and travel choices would be beneficial for future interventions. Finally, overcoming rural transport challenges requires addressing the financial and practical barriers to mobility, the institutional, social, and cognitive elements that together impact mobility outcomes. In order to address the transformation of rural transport systems in Ghana and in similar contexts, this study highlights the need for an institutionally integrated, behavioural-informed, and context-sensitive approach.

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