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RESEARCH ARTICLE

RURAL ROAD INFRASTRUCTURE AND ACCESS TO SOCIAL SERVICES: IMPLICATIONS FOR LIVELIHOOD OUTCOMES AMONG SMALL-SCALE FARMERS

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ABSTRACT

Rural road infrastructure is a crucial component in promoting economic growth, especially in rural economies characterized by small-scale farming. These roads are vital for connecting isolated communities to crucial social services, including education, healthcare, and markets, which support enhanced livelihood outcomes. In Kenya, rural regions are inadequately developed in terms of road infrastructure, which may hinder access to social services and perpetuate cycles of poverty among agricultural households. This study investigates the effect of access to social services due to rural road infrastructure on the livelihood outcomes of small-scale farmers in Upper Eastern Region, Kenya. This study examines the relationship between enhanced rural road networks and access to education, healthcare, and markets, and how this affects the livelihood outcomes of small-scale farmers. The research employed a descriptive survey approach based on positivist philosophy. Data was obtained from a stratified random sample of 395 households spanning Meru and Embu Counties. Reflexive comparison and correlational analysis were utilized to assess the impacts of road infrastructure pre- and post-construction. Regression analyses were performed to ascertain the relationship between social service access and livelihood outcomes, informed by the Sustainable Livelihood Framework and the Welfare Pentagon. Research indicated enhanced physical accessibility to educational institutions, particularly privately-owned primary schools, and an increase in private healthcare services subsequent to rural road construction. Market access markedly enhanced, decreasing journey duration and augmenting interaction with buyers. Nonetheless, despite these advancements, regression analysis revealed that enhanced access to education ($\beta = -0.187$), health services ($\beta = -0.094$), and markets ($\beta = 0.148$) exerted no statistically significant impact on livelihood outcomes ($p > 0.05$). Challenges including the affordability and quality of private services, low quality, and postponed socio-economic gains from education were recognized as constraining factors. While rural road infrastructure has facilitated access to social services, it is inadequate to substantially improve the livelihood results of small-scale farmers. Affordability, service quality, and socio-economic factors influence the advantages of access. The report advocates for cohesive development strategies that merge infrastructure investments with specific policies to enhance service affordability and pertinence. Prolonged investigation is essential to evaluate deferred effects and identify indirect advantages. Holistic approaches are crucial for converting rural road development into concrete and sustainable enhancements in rural livelihoods.

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INTRODUCTION

Rural road infrastructure is a critical component of development, particularly in agricultural economies where small-scale farmers form the backbone of rural livelihoods (Dorosh, Wang, You, & Schmidt, 2022). Roads serve as conduits for connecting remote communities to essential social services, such as education, healthcare, and markets, which are vital for improving living standards and fostering economic growth. However, in many developing countries, poor road networks isolate rural populations, limiting their access to

these services and perpetuating cycles of poverty (Kesterton, Cleland, Slogget, & Ronsmans, 2019). Access to social services is a key determinant of livelihood outcomes for small-scale farmers. Education enables rural households to acquire knowledge and skills that improve agricultural productivity and diversify income sources. Healthcare access ensures that farmers and their families remain healthy and productive, reducing the economic burden of illness. Markets provide opportunities for farmers to sell their produce, purchase inputs, and access consumer goods, directly influencing household income and food security. Despite their importance, these

services are often inaccessible to rural communities due to inadequate infrastructure, high transportation costs, and poor service delivery. Livelihood outcomes, such as food security, household health, and income stability, are closely tied to the availability and accessibility of social services. Improved rural road infrastructure has the potential to bridge the gap between rural communities and essential services, enabling small-scale farmers to achieve better economic and social outcomes (Tsikata & Torvikey, 2021). However, the relationship between road infrastructure, access to social services, and livelihood outcomes is complex and influenced by other factors such as affordability, service quality, and market dynamics. This study therefore, explores the role of rural road infrastructure in enhancing access to social services and its implications for the livelihood outcomes of small-scale farmers. By examining the experiences of banana farmers in Meru and Embu Counties, Kenya, the study aims to provide insights into how improved road networks can contribute to sustainable rural development. This study was based on the Sustainable Livelihood Framework and the Welfare Pentagon framework.

Sustainable Livelihood Framework: The Sustainable Livelihood Framework (SLF) is a tool used to understand and analyze the factors that influence people's livelihoods, particularly in rural areas. It focuses on how individuals and households utilize their assets and capabilities to achieve positive livelihood outcomes while coping with external shocks and stresses (FAO (2019)). The framework emphasizes the interconnectedness of resources, strategies, and outcomes, providing a holistic view of rural development.

Key components of the framework include

Livelihood Assets: These are the resources people use to build their livelihoods, categorized into five types:

- **Human capital:** Skills, knowledge, health, and education.
- **Social capital:** Networks, relationships, and social support.
- **Natural capital:** Land, water, forests, and other environmental resources.
- **Physical capital:** Infrastructure, tools, and equipment.
- **Financial capital:** Savings, credit, and income.

Vulnerability Context: This refers to external factors that affect livelihoods, such as economic shocks, climate change, and political instability. These factors can either enhance or undermine people's ability to achieve sustainable livelihoods.

Transforming Structures and Processes: These include institutions, policies, and social norms that shape access to resources and opportunities. They influence how people use their assets and interact with the broader environment.

Livelihood Strategies: These are the activities and choices people make to achieve their livelihood goals, such as farming, wage labor, or diversification into non-farm enterprises.

Livelihood Outcomes: These are the results of livelihood strategies, such as improved food security, better health, increased income, and reduced vulnerability. The SLF highlights the importance of resilience, equity, and sustainability in rural development, emphasizing the need for integrated approaches that address both immediate needs and long-term goals. By utilizing the Sustainable Livelihood

Framework, this study methodically assesses how different livelihood components (education access, health facilities access, and market access) interact with rural road infrastructure to affect the livelihood outcomes of small-scale farmers.

The Welfare Pentagon Framework

The Welfare Pentagon, developed by Neubourg, illustrates the five key institutions that individuals and households rely on to meet their needs and achieve well-being. These institutions are interconnected and collectively contribute to livelihood security, especially in rural areas. The pentagon emphasizes the importance of access to resources and support systems for sustainable development (Neubourg, Cebotari, & Karpati, 2021)

The five institutions are

- **Markets:** Provide opportunities for individuals to buy and sell goods, access services, and earn income. Efficient markets are essential for economic growth and livelihood improvement.
- **Family:** Acts as a primary support system, offering emotional, financial, and social assistance. Families play a crucial role in ensuring basic needs are met, especially during times of crisis.
- **Social Networks:** Include community relationships and informal connections that provide mutual support, information sharing, and access to resources.
- **Public Authorities:** Represent government institutions that deliver essential services such as education, healthcare, infrastructure, and social protection. They play a critical role in reducing inequality and ensuring equitable access to resources.
- **Membership Institutions:** Include organizations such as cooperatives, unions, and religious groups that provide collective support, advocacy, and access to shared resources.

The Welfare Pentagon assumes that households maximize their well-being by leveraging these institutions, depending on their access to resources such as human, social, financial, and physical capital. If one institution fails, others can substitute its role, though this may increase risks and burdens for individuals. For example, if public authorities fail to provide healthcare, families or social networks may step in, but with limited capacity. The model underscores the need for balanced and integrated support across all five institutions to ensure sustainable livelihoods and resilience against shocks (Neubourg, Cebotari, & Karpati, 2021)

MATERIALS AND METHODS

The study used positivism philosophy, since the study involved description of a real phenomenon, without altering the phenomenon being studied as suggested by Fischhoff & Broomell (2020). The study used a descriptive survey design that was described by Mugenda & Mugenda, (2019) as the process of collecting data, with the aim of answering questions about the subject of study as it is. This study relied largely, on descriptive survey-based data and quantitative analysis using cross sectional data as suggested by Bordens and Abbott (2021). The study used reflexive comparison, which compared

the treatment area before and after the road project intervention, since there is no control area for the study (Ide & Beddoe, 2024). This method was used by Irandu, (2022) when they conducted an impact analysis of Ndomba-Makete road in Tanzania. This study also applied correlational design, to determine the relationship between rural road infrastructure and agricultural practices. The target population of this study was be 324,326 households living in Meru and Embu Counties in Kenya. Despite being an agricultural area, these areas have been relatively neglected in terms of roads construction and maintenance. The population was distributed in eight (8) Sub Counties, thus a proportionate stratified random sampling technique was used to obtain a sample size of 395 respondents.

RESULTS

This study examined whether rural road infrastructure, through its facilitation of social service access, contributes meaningfully to livelihood improvements such as food security, household health, and income stability.

Access to Education: The analysis began by examining the influence of rural road construction on educational infrastructure. Empirical findings showed that the number of educational institutions; primary, secondary, and tertiary schools increased after the construction of rural roads. Notably, primary schools experienced the most significant growth, and most of the new institutions were privately owned. This aligns with findings by Adukia et al. (2020), which suggested that road development in rural settings spurs investment in education.

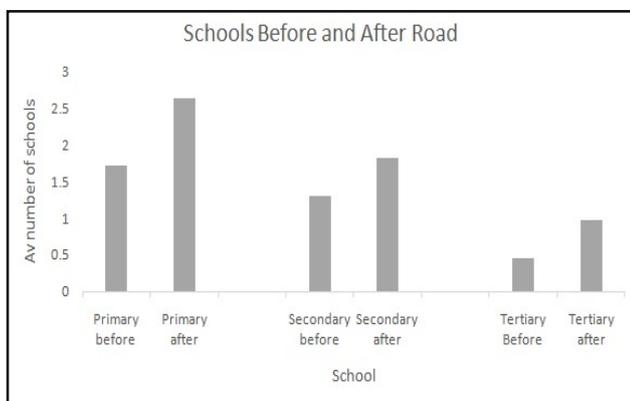


Figure 1. Schools Before and After Road

Moreover, the data indicated that many households perceived positive changes in school access. For example, respondents agreed with statements such as their children reaching school in good time and the reduced time required for commuting. However, there was some ambivalence regarding whether children could return home early after school, hinting at potential challenges in the return journey, possibly due to unreliable transport or after-school activities.

Despite these developments, the regression analysis revealed that improved access to education had an insignificant and weak negative impact on livelihood outcomes, such as household health and income security ($\beta = -0.187$). This suggests that while roads improved physical access to education, the quality, cost, or relevance of that education may not have significantly influenced farmers' economic resilience in the short term

Health Facility Accessibility

The study also explored access to health services post-road construction, measuring changes in availability and cost. The number of private hospitals increased significantly, while public health facilities declined. Mission hospitals experienced marginal growth. This dynamic suggests a shift towards privatized healthcare, possibly due to road access attracting private investment.

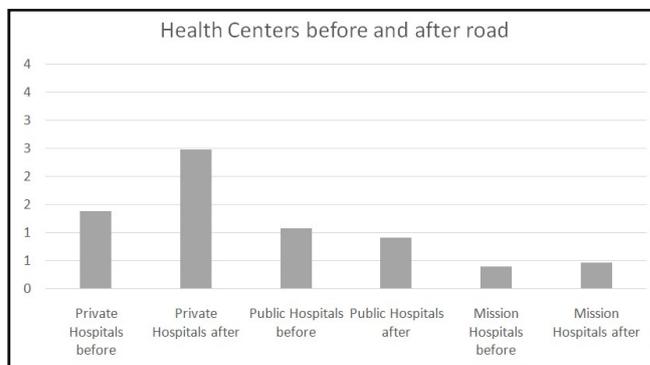


Figure 2. Health Centers before and After Road

However, the affordability and utility of these health services remained questionable. Most respondents were undecided on whether it was now less costly or easier to access health centers. Statements about reduced transport fare and expenses to health facilities yielded neutral responses, pointing to ongoing challenges in affordability or satisfaction with healthcare services. This perceived ambivalence translated into empirical findings: regression results showed that improved access to health facilities had a statistically insignificant and weak negative ($\beta = -0.094$) effect on household health and income stability. The findings suggest that while physical proximity to health services may have improved, the services themselves may not be of adequate quality or financially accessible to rural households.

Market Access as a Social Service: Another key component analyzed was access to markets. The construction of rural roads led to shortened travel times and greater ease in transporting produce. Respondents expressed strong agreement that it now takes a shorter time to reach markets, and that round-trip durations had decreased significantly. The benefits included not only time savings but also increased opportunity for timely market engagement.

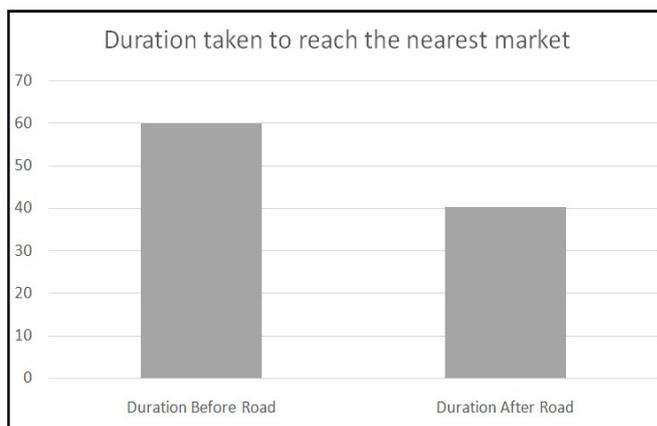


Figure 3. Duration to reach Market Before and After Road

Table 1. Regression Analysis of Access to Social Services and Livelihood Outcome

Coefficients					
Model	Unstandardized B	Coefficients Std. Error	Standardized Coefficients Beta	T	Sig
Constant	9.955	.897		11.096	.000
Education	-0.187	.203	-0.049	-0.922	.357
Health	-0.094	.093	-0.055	-1.013	.312
Market Access	0.148	.170	.048	0.870	.385

Table Error! No text of specified style in document.2. Model Summary

Model Summary									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	Df1	Df2	Sig. F Change
	0.073	0.005	-0.003	1.474	0.005	0.643	3	363	.588
Predictors: (Constant, Access to Market, Education, Health)									
ANOVA									
Model	Sum of Squares	Df	Mean Square	F	Sig				
Regression	4.189	3	1.396	0.643	0.588				
Residual	788.739	363	2.171						
Total	792.428	366							

Despite these qualitative improvements, the regression results indicated that market access though positively associated with livelihood outcomes ($\beta = 0.148$) was statistically insignificant ($p = 0.385$). This suggests that improved physical access alone may not be enough to yield tangible economic benefits unless complemented by favorable market conditions such as fair prices, adequate demand, and reliable infrastructure like storage and transport systems

Factor Analysis and Component Loadings: Through factor analysis, the study identified three main components of access to social services: education, health, and market access. Variables associated with each were loaded onto these three distinct components. The reliability analysis (Cronbach's Alpha) showed high internal consistency for all three (education = 0.87, health = 0.90, markets = 0.93), confirming the robustness of the constructs. Interestingly, the mean response scores indicated that while farmers generally agreed that access to schools and markets had improved (mean scores: 3.59 and 3.99, respectively), they were undecided about improvements in health services (mean score: 3.08). The Regression Summary of this study showed the following: According to the results, market access has a non-significant positive relationship with livelihood outcomes ($\beta = 0.148$; $p = 0.385 > 0.05$), while access to education and health facilities have non-significant negative relationships with livelihood outcomes ($\beta = -0.187$; $p = 0.357 > 0.05$; $\beta = -0.094$; $p = 0.312 > 0.05$), respectively. Since livelihood outcomes and access to health and educational facilities have a negative relationship, livelihood outcomes tend to decline as education levels rise.

This conclusion is corroborated by the findings that the development of rural roads, as argued by Adukia et al. (2020), led to a rise in private investment in education in rural regions, including the number of schools. As a result, the majority of small-scale farmers still cannot afford education, despite the rise in private schools. Furthermore, the expansion of postsecondary educational institutions in rural regions resulted in a delayed entry into the workforce and a rise in youth migration to urban areas, which in turn had a detrimental impact on livelihood outcomes (UNICEF, 2020). Similarly, the study found that a decrease in public facilities like dispensaries and a rise in private health facilities had the biggest effects on the expansion of health facilities. This has an impact on health care affordability. Private schools have a crucial role in determining the livelihood outcomes of rural

households since they have a direct impact on household financial decisions, long-term economic mobility, and future livelihood possibilities. Despite their importance to health, private hospitals do not directly generate revenue, and their influence is frequently constrained by intermittent use and the availability of substitute medical care. Investments in private healthcare and education therefore place a long-term financial strain on households, which has a detrimental impact on the livelihood results of small-scale farmers (RHI, 2024). However, the positive relationship among livelihood outcomes and market access indicates that livelihood outcomes improve as market access rise. In other words, better livelihood outcomes result from easier access to markets brought about by the improved road, as evidenced by (Ewnetu, 2023). A significant coefficient of determination is indicated in the model summary ($R^2 = 0.05$; $p = 0.588 > 0.05$). This demonstrates that the livelihood outcomes of small-scale farmers are not statistically affected by access to social services. The findings indicate that just 5% of the livelihood outcomes of small-scale farmers can be explained by access to social services due to rural road infrastructure. The F statistic is 0.643 according to the ANOVA statistic of the effect of rural road infrastructure on social service access on small-scale farmers' livelihood outcomes. Given that the computed F-statistic (0.643) is less than the critical value of 2.46 and the p-value (0.588) is greater than 0.05, it can be concluded that the livelihood outcomes of small-scale farmers are not statistically significantly impacted by access to social services because of rural road infrastructure. Therefore, as indicated by (Ewnetu, 2023), the findings demonstrate that while improved rural road infrastructure improves small-scale farmers' access to social services, it has no significant effect on livelihood outcomes. The hypothesis testing confirmed the above descriptive and regression findings. Specifically, the null hypothesis (H_0): that access to social services does not have a significant effect on the livelihood outcomes of small-scale farmers, was not rejected.

DISCUSSION

Access to Education: The study revealed an increase in the number of schools after the construction of rural roads, particularly private primary schools. However, the affordability of private schools remained a challenge for small-scale farmers, limiting their access to quality education.

Access to Healthcare. The findings showed a significant increase in private healthcare facilities after road construction, while public health facilities declined. Despite improved physical access, affordability and quality of healthcare services remained barriers to better health outcomes.

Access to Markets: Improved rural roads reduced the time taken to reach markets by an average of 20 minutes. Farmers reported increased access to consumers, leading to higher demand for their produce. However, the study found that increased competition among farmers led to fluctuating prices, affecting income stability.

Livelihood Outcomes: Access to social services had a non-significant positive effect on food security, household health, and income security. While improved market access enhanced food security and income security, the affordability of education and healthcare services limited their impact on livelihood outcomes. The study highlighted the complex relationship between rural road infrastructure and access to social services. While improved roads enhance physical access to schools, healthcare facilities, and markets, the affordability and quality of these services remain critical determinants of their impact on livelihood outcomes. For instance, the proliferation of private schools and healthcare facilities after road construction underscores the need for policies that ensure equitable access to affordable and quality services. Improved market access due to better roads positively influenced food security and income security by enabling farmers to sell their produce directly to consumers. However, fluctuating prices and increased competition among farmers highlight the need for market regulation and support mechanisms to stabilize income. In summary, this study provided a nuanced analysis of how access to social services, facilitated by rural road infrastructure, relates to the livelihood outcomes of small-scale farmers in Kenya. While there are perceptible improvements in access to education, health, and markets, these improvements have not translated into statistically significant changes in livelihood indicators such as income stability, food security, and health outcomes. This disconnect underscores the need for policymakers and development planners to adopt an integrated approach enhancing not just access but also the quality, affordability, and responsiveness of social services. Investments in rural infrastructure must be matched with reforms in education and health systems, as well as market regulations, to realize meaningful impacts on rural livelihoods. The findings suggest that rural road infrastructure alone is insufficient to significantly improve household level livelihood outcomes. Complementary interventions, such as subsidies for education and healthcare, and investments in market infrastructure, are necessary to maximize the benefits of improved road networks.

CONCLUSION

Rural road infrastructure enhances access to social services, but its impact on livelihood outcomes of small-scale farmers is limited by affordability and quality of these services. While improved market access positively influences food security and income security, the benefits of better access to education and healthcare are constrained by household-level financial barriers. Policymakers should prioritize integrated approaches that combine road infrastructure development with measures

to improve the affordability and quality of social services. Future research should explore the long-term effects of rural road infrastructure on social service delivery and its implications for sustainable livelihoods. The lack of statistically significant effects raises important questions about the efficacy of rural infrastructure projects in improving social service delivery. While rural road infrastructure undoubtedly enhances physical accessibility, the study suggests that this is not a sufficient condition for livelihood transformation. Several explanations were proposed:

- **Quality and Affordability of Services:** Merely having access to schools and hospitals does not guarantee meaningful outcomes if those services are of poor quality or unaffordable. The study cited cases where increased access led to greater privatization (in both education and health), potentially excluding low-income farmers.
- **Delayed Impact:** Some benefits, particularly from education, may manifest only in the long term. The lag between investment in education and measurable outcomes like income or food security may account for the statistically insignificant short-term effects observed in the study.
- **External Influences:** Cultural, economic, and political factors may mediate or suppress the benefits of improved access. For example, reports emerged of increased dropout rates due to early pregnancies and lure of quick income through informal employment like motorcycle transport (bodaboda business) among youth—especially boys—following road construction
- **Mismatch Between Access and Utilization:** Despite better roads, utilization rates of health services or schools might remain low due to distrust in quality, economic constraints, or sociocultural barriers.
- **Indirect Benefits Underexplored:** The study emphasized that indirect or synergistic benefits, such as social cohesion, time savings for caregivers, and improved teacher retention were not fully captured in the measurement framework. These could have long-term effects that are not immediately quantifiable.

CONFLICT OF INTEREST STATEMENT

The authors assert that there exists no conflict of interest pertaining to the publishing of this paper. The research was carried out autonomously, and no financial, institutional, or personal affiliations affected the findings, interpretations, or conclusions within. The authors have followed ethical norms throughout the research procedure

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GLOSSARY OF ABBREVIATIONS

ANOVA Analysis Of Variance
FAO Food and Agriculture Organization
RHI Rural Health Information
SLF Sustainable Livelihood Framework
UNICEF United Nations International Children's Emergency Fund

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