

SMART SUSTAINABLE RURAL MOBILITY SOLUTIONS FOR SOUTH AFRICA: CLOSING THE URBAN-RURAL GAP

NB MUDAVHI

University of Venda, Private Bag X5050, Thohoyandou, Limpopo 0950; Mentor:
Ms. Funani Tshivhase; Tel: 071 989 6866; Email: brianmudavhi4@gmail.com;

ABSTRACT

South Africa's rural transport fraternity faces challenges. About a third of the population lives in areas where infrastructure is crumbling, public transport is scarce, and long walks are a norm as mobility is a daily struggle. These hardships don't just make mobility difficult, they also create barriers to education, healthcare, and economic opportunities, trapping communities in cycles of poverty. This essay looks at how smart, technology-driven, and community-led mobility solutions can assist to close the gap between rural and urban mobility. Drawing on examples from South Africa and the wider Southern African region, it highlights the exigency for sustainable, smart solutions that empower rural communities, fix infrastructure gaps, and make the most of the new technologies. The essay explores key areas where real change is possible. Digital tools are proving to be powerful from SMS-based ride-hailing services and mobile money systems to digital maps that chart informal transport routes. Projects such as bicycle distribution programs and the rollout of solar-powered electric micro-vehicles offer practical, scalable options designed specifically for rural life. Building better rural roads, creating pedestrian-friendly infrastructure, and even testing drone-based services are all critical steps to back up these mobility solutions. Using GIS technology for smarter, data-driven planning while making sure communities have a say ensures that investments meet local needs. The essay proposes alternative recommendations to making mobility a right for every South African which should not just be a dream but a necessary step to a more connected, inclusive, and sustainable mobility future.

1. SETTING THE SCENE

South Africa's transport landscape reflects a dual reality. Urban residents typically enjoy better access to reliable transport options, from tarred roads to buses, taxis and trains. Mobility is defined in this essay as the ability of South Africans to move easily and freely. In contrast, rural areas often suffer from limited transport access which severely affects their daily life. One-third of South Africans live in rural areas which are often those that had been historically marginalized under the apartheid regime and in these areas roads are poor in condition, public transport is inaccessible, and essential services such as schools and clinics are often distant.

According to the National Planning Commission, (2012) over a quarter of students in rural areas walk more than 30 minutes to school each day, with around 5% walking more than an hour. These mobility challenges are not merely inconvenient; they are structural barriers that restrict access to education, healthcare, and employment, perpetuating cycles of poverty. Bridging the urban-rural mobility gap is essential for national development and equality. This essay explores how smart, technology-driven, and community-led mobility solutions can help bridge this disparity.

In this context “Smart” as the thoughtful use of technology alongside practical and sustainable innovations. The discussion draws from South African and broader Southern Africa examples to present realistic, people-centered interventions that can transform rural mobility. The essay is structured as follows; Section 2 (two) provides a background on the urban rural mobility divide. Section 3 (three) discusses sustainable smart mobility solutions. Section 4 (four) outlines recommendations for transport planners, policymakers and other relevant stakeholders who are entrusted with the responsibility to make mobility easier and safer, and the preceding section offers concluding remarks.

2. BACKGROUND OF THE URBAN-RURAL MOBILITY GAP

The mobility gap between urban and rural South Africa remains critical and stark. While cities like Johannesburg and Cape Town have extensive transport networks and various travel modes, rural residents usually rely on walking or informal taxi transport modes to move between clustered and dispersed settlements. Poor gravel roads become a problem in times of heavy rains, leaving communities isolated. Formal public transportation systems, such as trains and buses, rarely extend into rural areas (Tao, 2024). Even where minibuses operate, their coverage is limited/minimal. Rural residents frequently walk for kilometres to reach pick-up points.

Women, children, the elderly, and those individuals with special needs suffer the most from this inaccessibility. Several learners at different educational levels face exhausting journeys to reach their respective schools, and pregnant women risk the possibility of complications due to delayed access to healthcare facilities (Hussain *et al.*, 2023). The consequence of limited mobility extends beyond inconvenience, it contributes to educational dropouts, missed healthcare appointments, restricted economic participation, and social exclusion.

Rural farmers and entrepreneurs face particular challenges in transporting their goods to markets, limiting their economic potential. Without reliable transportation, these rural areas remain locked out of the broader development opportunities. The expansion of mobile network coverage across rural South Africa and new innovations in mobility technologies can offer a refreshing hope. Strategic interventions that bring together technology, appropriate transport solutions, and smart infrastructure investments could finally bridge this gap.

3. SUSTAINABLE SMART RURAL MOBILITY SOLUTIONS

To effectively address rural mobility challenges effectively, a multi-faceted approach is necessary. Solutions must blend technology, appropriate vehicle designs, upgraded infrastructure, and new service models that are all designed to meet the needs of rural communities.

3.1 Digital Connectivity and Mobility Services

One of the most powerful tools for improving rural mobility is leveraging mobile connectivity to coordinate transport. In the Western Cape province, a pilot project introduced an SMS hotline allowing villagers to request minibus taxis on demand (Mutopo, 2014). This model filled the service gaps by allowing informal transport operators to efficiently pool ride requests and optimize routes. Mapping informal transport routes, as undertaken by initiatives like “WhereIsMyTransport” (2020), also opens new possibilities. Developers can create navigation apps specially made for rural users. A simple SMS-based alert system informing passengers about transport schedules can transform

accessibility and make mobility much easier. Digital payment systems using mobile money platforms further enhances rural mobility by making payments safer and cashless. This integration of digital tools does not only bridge information gaps but also empowers rural residents to take control of their mobility options while enhancing their sense of belonging in the transport industry.

3.2 Innovative Rural Transport Modes

Transport innovation extends beyond digital platforms to include practical vehicle solutions. Bicycles are also a significant contributor to rural accessibility. Organizations like Qhubeka (2022) have distributed thousands of bicycles to rural school children, cutting travel times and opening new horizons. Electric micro-vehicles present a significant next step. In countries like Zimbabwe, the Mobility for Africa initiative leases solar-powered electric tricycles often referred to as “Hambas” to groups of rural women (Mazele, 2022). These vehicles have made mobility simple, allowing women to efficiently ferry their goods and passengers while building new multiple income streams.

A key feature of this model is sustainability, these tricycles use swappable batteries that are charged by solar panels, ensuring environmental friendliness. South Africa could replicate and scale up this model by establishing rural cooperatives that own and manage fleets of shared electric vehicles. These types of initiatives would not only solve mobility challenges but also generate jobs and stimulate the rural economy. Alternatively, the exploration of creative modes such as community-operated shuttles and even, in the future, small cable cars in mountainous areas would really work in trying to bridge this gap.

A one-size-fits-all solution is unlikely, a diverse ecosystem of transport options tailored for the local terrain and distances is essential. Other promising innovations include but not limited to community-owned mobility cooperatives that are supported by micro-financing and blockchain-based ticketing systems that allow for transparency in fares and subsidies. This technological interventions could significantly enhance rural transport planning and build trust among users and those who are service providers especially when designed with user simplicity in mind.

3.3 Bridging Infrastructure and Services Gaps

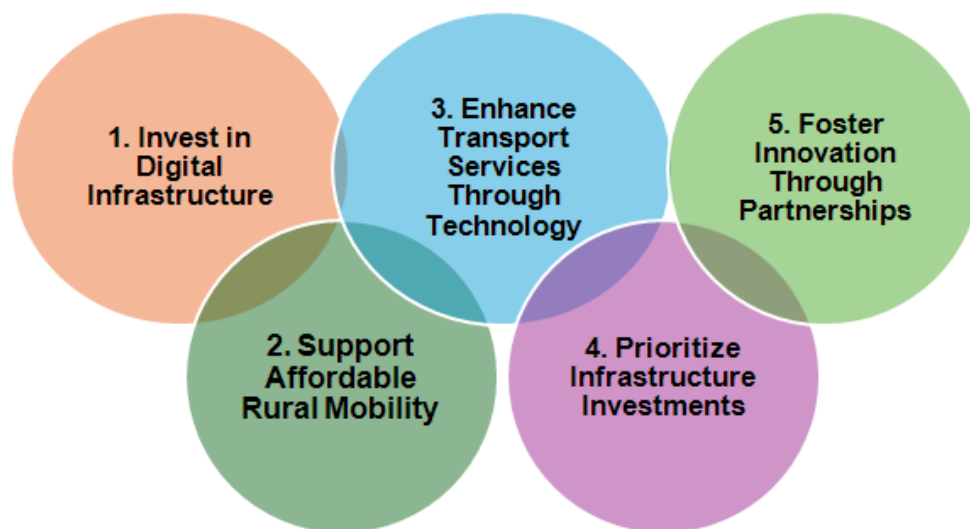
Innovative vehicles and digital platforms require a solid physical infrastructure foundation. Upgrading roads in rural areas, particularly key access collectors, must be a national priority. Lucas (2021) suggested that future investment should focus on all-weather surfacing, building pedestrian bridges, developing safe bicycle lanes, and maintaining existing gravel roads through labour-intensive programs that create local jobs. Data-driven planning is important. GIS mapping tools such as ArcGIS software can assist in identifying the most isolated communities and guide future investment to maximize the impact (Booth *et al.*, 2023). Small interventions, like installing solar lighting along the rural footpaths or constructing the basic transport hubs, can also make a significant difference. Bringing essential services closer to rural populations while essentially reducing the need for travel. Mobile clinics, satellite schools, and mobile government units can reach communities rather than coercing villagers to take a journey to distant towns.

Drone-based service models offer a viable approach with proven impact. The World Economic Forum that took place in 2022 made emphasis on Rwanda’s Zipline program, which delivers blood and medicine to remote clinics through drones, creates a powerful example of how innovation can leapfrog poor infrastructure. South Africa can explore these similar models for sparsely populated areas. Strong policies and partnerships are

very important. Governments could subsidize rural mobility programs, recognize and integrate informal transport providers, and foster partnerships between public authorities, technology startups, and rural communities.

4. RECOMMENDATIONS

To make room for improvement and ensure that there are more solutions to the rural-urban mobility gap, a set of recommendations are presented in the Figure 1 below. These recommendations highlight the need to prioritise mobility as it affects daily livelihoods of people and their economic well-being. Implementing these solutions requires a vision, funding, and collaboration. But the payoff of a connected, unified, and inclusive South Africa is well worth the effort. Mobility is not a luxury. It is a right and realizing it for all South Africans must be a national priority (The South African Constitution enshrines the right to freedom of movement and residence in Section 21).



Source: Author's constructs

Figure 1: Smart rural mobility recommendations

The above key recommendations (shown in Figure 1) are further simplified and expanded respectively below.

1. Expand mobile network coverage and support the creation of rural mobility platforms (mobile apps and SMS services).
2. Scale up bicycle programs like Qhubeka's and pilot electric micro-vehicle initiatives with accessible financing and maintenance systems.
3. Informal operators into formal mobility planning using GPS tracking and digital ride-scheduling tools.
4. Upgrade critical rural roads using GIS planning tools; construct pedestrian bridges, bicycle lanes, and sheltered stops.
5. Establish public-private-community partnerships to pilot drone-based delivery systems, solar-powered hubs, and other transformative projects.

4.1 Implementation Challenges and Considerations

While these proposed solutions are promising, their implementation could have its own challenges and anticipated possible constraints. High infrastructure costs, ongoing maintenance, and limited local capacity could cause critical barriers towards implementing these proposed solutions to rural mobility. Policy fragmentation and slow adoption to

technological innovations by public institutions could further delay any progress being made. To succeed in the long-term, coordinated policies, sustainable funding, training programs, and robust institutional support are required elements. Addressing these issues in a way that is inclusive and follows transparent planning is important in ensuring that the interventions are scalable and remain community driven.

5. CONCLUSION

Smart and sustainable mobility solutions are both feasible but important for South Africa's mobility future. Rural communities face severe transport disadvantages that entrench social and economic inequalities. Addressing these barriers is both a moral imperative and an opportunity for national progress. Technology can be a game-changer because digital platforms can be used to connect communities to transport services, electric micro-vehicles can provide affordable mobility, and drone networks can bring services to the people's doorstep. However, these innovations must be embedded within a broader framework of infrastructure upgrades, supportive policies, and, most importantly, community participation. Successful rural mobility solutions must be people-centred and context specific while combining high-tech and low-tech solutions thoughtfully and sustainably. If South Africa embraces this opportunity, it can build a future where every citizen regardless of their location have equal access to mobility and the opportunities it brings.

6. REFERENCES

Booth, L *et al.* 2023. 'Anticipated Transport Choices in a World Featuring Autonomous Transport Options', *Sustainability*, 15(14):11245.

Hussain, S *et al.* 2023. 'Sustainability of smart rural mobility and tourism: A key performance indicators-based approach', *Technology in Society*, 74.

Lucas, K, Philips, I & Verlinghieri, E. 2021. 'A mixed methods approach to the social assessment of transport infrastructure projects', *Transportation: Planning-Policy-Research -Practice*, 49(1):271-291.

Mazele, O & Amoah, C. 2022. 'The causes of poor infrastructure management and maintenance in South African municipalities', *Property Management*, 40(2):192-206.

Mutopo, P. 2014. *Women, mobility and rural livelihoods in Zimbabwe: experiences of fast-track land reform* (1 online resource vol). Boston: Brill (Afrika-Studiecentrum series; v. 32; volume 32).

National Planning Commission (NPC). 2012. National Development Plan 2030: Our Future-Make it Work. Pretoria: The Presidency.

Tao, S, Kamruzzaman, L & Ma, J. 2024. 'Transport disadvantage and social inclusion: Exploring the role of smartphone use for transport purposes', *Transportation Research Part A*, 189.

World Economic Forum (WEF). 2022. How drone deliveries are boosting healthcare for rural communities.

ANNEXURE A: TURNITIN SIMILARITY REPORT



2% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.

Filtered from the Report

- ▶ Bibliography
- ▶ Quoted Text
- ▶ Cited Text

Match Groups

- 4 Not Cited or Quoted 2%**
Matches with neither in-text citation nor quotation marks
- 0 Missing Quotations 0%**
Matches that are still very similar to source material
- 0 Missing Citation 0%**
Matches that have quotation marks, but no in-text citation
- 0 Cited and Quoted 0%**
Matches with in-text citation present, but no quotation marks

Top Sources

- 1% Internet sources
- 0% Publications
- 1% Submitted works (Student Papers)

Integrity Flags

0 Integrity Flags for Review

No suspicious text manipulations found.

Our system's algorithms look deeply at a document for any inconsistencies that would set it apart from a normal submission. If we notice something strange, we flag it for you to review.

A Flag is not necessarily an indicator of a problem. However, we'd recommend you focus your attention there for further review.



ANNEXURE B: TURNITIN AI REPORT



*% detected as AI

AI detection includes the possibility of false positives. Although some text in this submission is likely AI generated, scores below the 20% threshold are not surfaced because they have a higher likelihood of false positives.

Caution: Review required.

It is essential to understand the limitations of AI detection before making decisions about a student's work. We encourage you to learn more about Turnitin's AI detection capabilities before using the tool.

Disclaimer

Our AI writing assessment is designed to help educators identify text that might be prepared by a generative AI tool. Our AI writing assessment may not always be accurate (it may misidentify writing that is likely AI generated as AI generated and AI paraphrased or likely AI generated and AI paraphrased writing as only AI generated) so it should not be used as the sole basis for adverse actions against a student. It takes further scrutiny and human judgment in conjunction with an organization's application of its specific academic policies to determine whether any academic misconduct has occurred.

Frequently Asked Questions

How should I interpret Turnitin's AI writing percentage and false positives?

The percentage shown in the AI writing report is the amount of qualifying text within the submission that Turnitin's AI writing detection model determines was either likely AI-generated text from a large-language model or likely AI-generated text that was likely revised using an AI-paraphrase tool or word spinner.

False positives (incorrectly flagging human-written text as AI-generated) are a possibility in AI models.

AI detection scores under 20%, which we do not surface in new reports, have a higher likelihood of false positives. To reduce the likelihood of misinterpretation, no score or highlights are attributed and are indicated with an asterisk in the report (*%).

The AI writing percentage should not be the sole basis to determine whether misconduct has occurred. The reviewer/instructor should use the percentage as a means to start a formative conversation with their student and/or use it to examine the submitted assignment in accordance with their school's policies.

What does 'qualifying text' mean?

Our model only processes qualifying text in the form of long-form writing. Long-form writing means individual sentences contained in paragraphs that make up a longer piece of written work, such as an essay, a dissertation, or an article, etc. Qualifying text that has been determined to be likely AI-generated will be highlighted in cyan in the submission, and likely AI-generated and then likely AI-paraphrased will be highlighted purple.

Non-qualifying text, such as bullet points, annotated bibliographies, etc., will not be processed and can create disparity between the submission highlights and the percentage shown.

