



SUPPLY AND PRICING STRATEGIES OF INFORMAL RURAL TRANSPORT PROVIDERS: FINAL REPORT

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This project was funded by the Africa Community Access Programme (AFCAP) which promotes safe and sustainable access to markets, healthcare, education, employment and social and political networks for rural communities in Africa.

Launched in June 2008 and managed by Crown Agents, the five year-long, UK government (DFID) funded project, supports research and knowledge sharing between participating countries to enhance the uptake of low cost, proven solutions for rural access that maximise the use of local resources.

The programme is currently active in Ethiopia, Kenya, Ghana, Malawi, Mozambique, Tanzania, Zambia, South Africa, Democratic Republic of Congo and South Sudan and is developing relationships with a number of other countries and regional organisations across Africa.

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ABSTRACT

This study was aimed at developing an evidence-based understanding of the factors determining the service and pricing patterns of informal public transport operations in rural areas of South Africa. The informal modes include minibus-taxi services, as well as supplementary services operated with pickup trucks ("bakkies") and smaller sedan taxis ("4+1s"). We examine three rural districts as case studies, using a mix of quantitative service data collection, regression analysis, and informant interviews.

The ultimate objective was to strengthen government decision making around the planning, regulation, and promotion of rural public transport services, with a view to promoting rural mobility in Africa.

The final deliverables take the form of three documents: this final report detailing process and outcomes; a student's Master's thesis; and an academic paper highlighting the main approach and findings. The three documents should be read together.

The findings largely confirm previous research on the factors driving transport supply in rural Sub-Saharan Africa, but adds significant new insights that can help shape more effective responses to the rural mobility challenge. A key determinant of the quantity and quality of service is the condition of roads (both paved and unpaved), suggesting that judicious infrastructure investment can be used to leverage better and more affordable private sector responses. We also describe the emergence of a differentiated service hierarchy involving a greater variety of vehicle types suited to different operating conditions, and based on intentional coordination among operators of minibus and bakkie services.

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INTRODUCTION

The University of Pretoria was appointed by Crown Agents under the African Community Access Programme (AFCAP), funded by the UK government's Department for International Development (DFID), to commission a research project on "Supply and Pricing Strategies of Informal Rural Transport Providers" to increase knowledge in the area of affordable rural transport services in sub-Saharan Africa.

The contract was signed in May 2011. In terms of the contract a number of progress reports were completed during the course of the project. This document serves as the **Final Report** for the project, and aims to demonstrate that the aims and deliverables of the project were achieved.

This project was undertaken primarily as an academic research project, with one of the stated aims being the training of a postgraduate student in rural transport issues. The main output of the project is thus an academic thesis, supported by a conference paper. The thesis contains a complete record of the scientific activities, findings and recommendations of the project. The paper is a shorter version of the thesis, aimed at publication in the academic literature. To avoid unnecessary duplication, this report only focuses on providing a brief description of the process followed, deliverables produced, and outcomes of the project, from a project management perspective. For the scientific content the other two documents should be consulted.

STUDY OBJECTIVES

The purpose of the study was to develop an evidence-based understanding of the factors determining the service and pricing patterns of informal public transport operations in rural areas of South Africa. The informal modes include minibus-taxi services, as well as supplementary services operated with pickup trucks ("bakkies") and smaller sedan taxis ("4+1s"). A further aim was to promote the adoption of this knowledge among government planners and regulators to improve decision making and planning.

More specific objectives included the following:

- To identify the factors determining the service patterns (including routes served, frequencies, fares charged, and vehicle sizes to be used) of rural informal public transport operators, and to quantify the strengths of these relationships;
- To develop models (both conceptual and quantitative) that can be used to estimate the likely impact of a limited set of regulatory or government interventions (such as road upgrading) on taxi supply patterns;
- To provide feedback to decision makers and planners and to demonstrate the use of the findings; and
- To create opportunities for training in rural transport issues at tertiary education and at community level.

STUDY TEAM

The study was undertaken by the following team members:

Principal investigator: Associate Professor **Christo Venter**, Department of Civil Engineering, University of Pretoria, Pretoria, South Africa. Responsible for project management, recruitment of graduate student, quality control, and academic supervision.

Student researcher: As per the Technical Proposal, a post graduate student from a previously disadvantaged community in South Africa with a Bachelor's Degree in Civil Engineering, Economics or Town and Regional Planning had to be identified, to receive support to complete his/her Master's Degree research project at the University of Pretoria. The University identified **Mr Malesela Johannes Molomo** as a student to undertake this project as part of his research project for the MSc: Applied Science: Transportation Planning degree in the Department of Civil Engineering at the University of Pretoria. The student had previously completed a B.Sc (Hons): Applied Science and B.Tech degrees in the field of transportation planning. He had been involved professionally in rural transport planning, had worked in the transport department of a rural district in South Africa, and assisted in the preparation of various transport plans in these areas.

The student's tasks were to complete a literature review, undertake preliminary research design, experimental design, instrument design and testing, help with the field work, and undertake the data analysis and academic report writing, under supervision of the Principal Investigator.

Advisor and Field Supervisor: Mr **Mac Mashiri**, of Gwarajena TRD, a rural development consulting firm. Mr Mashiri has 20 years' experience in transport research, including rural issues. His responsibilities were to assist with conceptualising the study, coordinating the field workers (research assistants), designing and providing training as needed, and supervising data collection (together with the research student). He also assisted with setting up meetings for qualitative interviews and workshops, as needed.

Field work facilitator: Mr **Ishmael Adams**, from the Kgautswane Community Centre, Limpopo, participated by recruiting community youth to act as research assistants; assisting in training, translation, and testing of the data collection instruments; assisting in logistic arrangements for field workers; and helping with verification and capturing of the field data.

ACTIVITIES UNDERTAKEN

This section briefly described the activities that were undertaken. More detail on many of these is provided in the student thesis.

1. Identification of the postgraduate student (Reported above).
2. Preliminary data collection and selection of case study areas

Three rural districts were selected as case study areas. The following factors informed the selection of the case study areas:

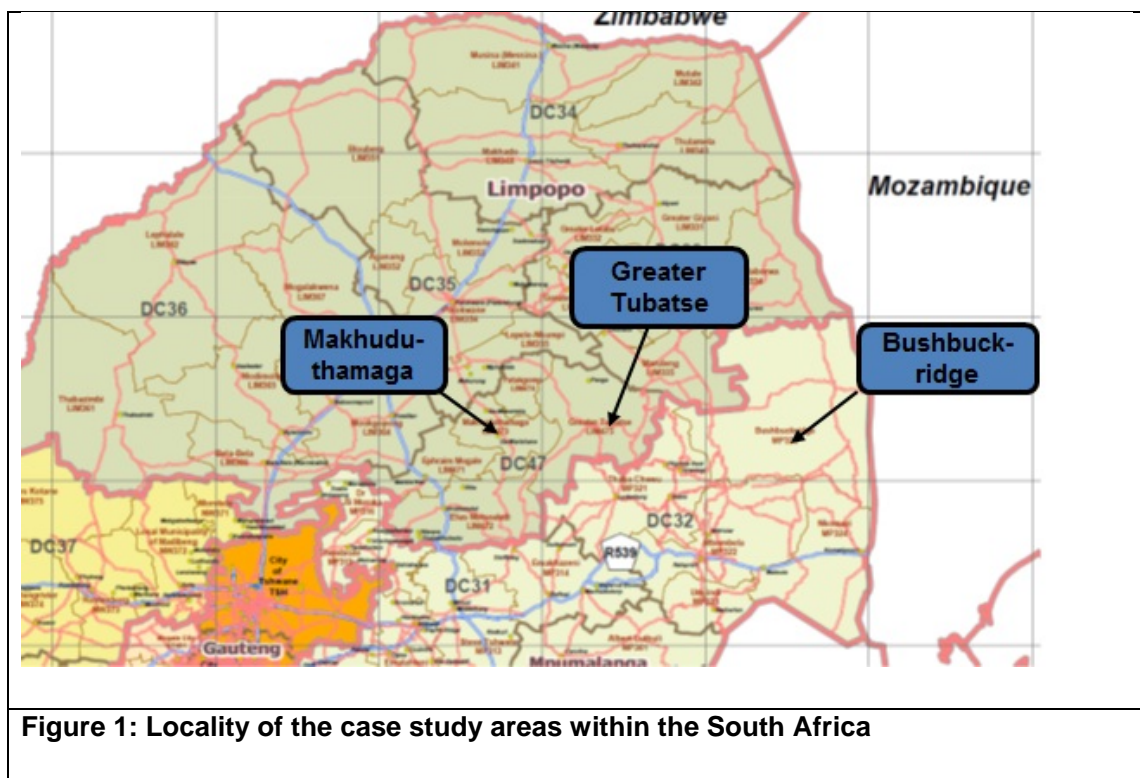
- **Representivity:** The rural districts were considered representative of the variation of rural transport conditions found across Southern Africa. The areas cover a range of rural conditions, including deep rural/isolated, small/secondary town, commercial agriculture, and mining economy areas. Demographic and demand patterns are typical of rural areas, including low average incomes and low demand levels. The transport services are largely

similar and typical of transport supply nationally, including a range of informal modes (minibus-taxi and pickup/bakkie), formal modes (buses), and non-motorised modes.

- Convenience: Prior knowledge about the area, and existing contacts with stakeholders in the areas, enabled the research team to mobilise the study effectively.
- Feasibility and budget limitations: All three areas are within reasonable proximity to the University of Pretoria.

Preliminary data collection proceeded with the collection of government reports (Integrated Development Plans, Current Public Transport Records and Spatial Development Frameworks) on rural services in the proposed case study areas. Eleven reports were sourced from the relevant authorities.

The case study areas were located in the Limpopo and Mpumalanga Provinces of South Africa, predominantly rural provinces. The location of the districts is shown in Figure 1.



The areas included in each of the case study areas are summarised in Table 1 below.

Table 1: Summary of the Case Study Areas Selected	
Study Region	Case Study Sub-Areas
Greater Tubatse Area	Burgersfort, Orighstad, Phiring, Kgotlopong, Taung, Mafarafara, Penge, Makofane, Maakubu, Ga-Riba, Maandashoek, Ga-Masha, MaSeven, Ngwaabe, Leporogong
Makhuduthamaga Area	Jane Furse,Apel Cross, Masemola, Malope, Mamatsekele, Mashwanyaneng, Ga-Mampana, Schoonoord, Dlamini/Ga-Sekele, Tsopaneng, Malegale, Madibaneng, Dinotsi, Phokwane, Molepane, Ga-Malaka, Thoto, Leeukraal, Vleeschboom, Maserumule, Glen Cowie, Marishane, Mathapisa/Soetvelden, Machacha, Thabampshe
Bushbuckridge Area	Bushbuckridge, Mariti, Madrass, Tsakane, Hoerskom, Marongwane, Thekamahala, Macia, Mpyenyatsatsi, Matengteng, Casteel, Chochocho, Majembeni, Hlamalani, London, Zuknog, Mokhululine, Moreka, Buyelani, Buffelshoek, Orinoco, Merry Pebble Stream, Angin Court, Belfast, Cork, Hluvukani, Manyeleti, Masakeng, Shatale

3. Engagement with Stakeholders in Case Study Areas

Initial meetings were held with representatives of the local authorities and taxi associations within each of the study areas. The objectives were:

- To secure the cooperation of the roleplayers during data collection, and
- To explore local knowledge about taxi supply patterns and institutional relationships in the areas.

A list of meetings and dates are provided on page 10 below.

4. Questionnaire Design

The following survey types were conducted:

- Route Utilisation – To collect frequency data during peak period, including vehicle capacities, occupation, taxi association, fares etc.
- Infrastructure Survey – To collect data relating to conditions of the public transport infrastructure, GIS information, routes lengths etc.
- Qualitative Surveys – Interviewing the taxi and LDV transport operators.

Questionnaires and survey instruments were developed for each of these. Examples of the instruments are provided as annexures to the Master’s thesis.

5. Field data collection

This process entailed the following:

- Training of community youths at Kgautswane Community Centre to act as data collection assistants in all case study districts. One Supervisor and 12 survey assistants from Kgautswane Community Center were identified and trained on 19th November 2011.
- Kgautswane youth were used for the data collection in both Greater Tubatse and Makhuduthamaga areas, which are adjacent. However, in Bushbuckridge (which is about 100km away and in another province), local stakeholders insisted on the use of local youths from that area. This resulted in additional recruiting and training being conducted in Bushbuckridge
- Recording of data on taxi service patterns (including routes, association affiliations, frequencies, ranks used, vehicle types used, road conditions, and fares charged) in all case study areas. The data was captured in Excel spreadsheets and on paper maps by the assistants themselves, and thoroughly checked by the field supervisor.
- Collation of additional spatial and demographic data from secondary sources (e.g. population data from census, economic activity within certain buffer distances from surveyed routes, and distance measures to major towns and villages). The help of a GIS supplier was enlisted to prepare this data, which was later used during the quantitative analysis.
- Qualitative data was collected directly from taxi operators and associations in each area. An informant interview approach was followed, where the associations visited before were asked to nominate chairpersons or delegates to attend a focus group or individual meeting with the researchers. The objectives of the field work were to develop an understanding of the factors affecting the decision of individual associations to operate a service on a particular road in a particular market – including factors such as travel demand (how do they assess it?), cost factors (how is it affected by operating conditions such as road quality?), trip distances, and competition from buses, bakkies, and other taxi operators. We also explored how decisions are made regarding service quantity (e.g. what frequencies to operate at, which vehicles to use on a particular route) and pricing (how are fare levels determined; is there any evidence of collusion with up or downstream providers such as last-mile ‘bakkie’ operators?).

6. Data Analysis and Modelling

This activity entailed statistical analysis and modelling of the quantitative data, in order to examine the quantitative data for the strength of relationships between transport supply and potential explanatory factors.

Two link-level linear regression models of taxi supply were developed. The dependent variables were the daily frequency of (i) all informal public transport, and (ii) only minibus service, on each route during the morning and afternoon periods. Twenty-three potential explanatory variables were tested, including variables describing the quality of road and rank infrastructure, route lengths, population densities within various buffers from the route and the origin and destination, the extent

of economic activity within these buffers, competition from other modes, and location effects related to each study area (captured as dummy variables).

Another set of price models were estimated, in order to test the effect of the same set of explanatory variables on the average fare per kilometre of each route. The regression methods and results are described in detail in the thesis document.

The quantitative model results were then cross-checked with the insights obtained from the qualitative interviews, to try to form a coherent picture of the drivers of supply and pricing patterns in the areas. In most cases the two data sources reinforced each other very well, which speaks to the quality of the data.

REPORTS, MILESTONES AND DELIVERABLES

The following reports were prepared during the course of the project:

- Inception Report – June 2011
- First Progress Report – September 2011
- Second Progress Report – January 2012
- Third progress report – July 2012
- Fourth progress report – November 2012
- Final report (this document) – March 2013

Key milestones specified in the terms of reference were reached on the following dates:

- MS1: Student identified and inception report completed (Completed June 2011)
- MS2: Primary data collection in case study areas completed (Completed August 2012)
- MS3: Analysis completed and preliminary results shared with institutional/government stakeholders in workshop session (Completed March 2013)
- MS4: Student research report/thesis completed, final study report completed and submitted (Completed March 2013)
- MS5: Conference paper presented and published (Completed March 2013)

KNOWLEDGE TRANSFER AND TRAINING

A key component of the project was to facilitate knowledge transfer and training to improve the practice of rural transport service planning. The following activities were specifically aimed at this objective:

1. A postgraduate student (from a previously disadvantaged community in South Africa) received financial support to complete his Master's degree research project at the University of Pretoria. The completed thesis is submitted as a separate document. Examination of the thesis is not

yet complete. Once the student has been awarded the degree, the thesis will be available through the University of Pretoria's open access repository: <http://www.library.up.ac.za/openup/index.htm>

2. Capacity building of research assistants from two rural communities, who received training in research techniques, map reading, and communication. They gained hopefully valuable experience in participating in a research project and data collection. The original goal of training perhaps ten youth from Kgautswane was exceeded. We trained and deployed 12 youths from Kgautswane, and an additional ten from Bushbuckridge. The youths were all matriculants (i.e. had completed a high-school education), but were unemployed.

3. Workshops and interactions with local officials and operators in the case study areas.

During lead-up to study, casual discussions and meetings were held with key planners and officials in the institutions dealing with rural transport planning and regulation, both in the case study areas, and at provincial government level in Limpopo and Mpumalanga Provinces. This helped to generate interest in, ownership of, and support for the project, and also helped to promote awareness of and problem identification in the general area of rural transport services. The following workshops were conducted:

- Makhuduthamaga Local Municipality on the 21st June 2011;
- Greater Tubatse Local Municipality on the 22nd June 2011;
- Bushbuckridge Local Municipality on the 07th July 2011;
- Sekhukhune District Taxi Council on the 03rd October 2011;
- Greater Tubatse Taxi Associations on the 11th October 2011;
- Makhuduthamaga Taxi Associations on the 26th November 2011; and
- Bushbuckridge taxi Associations on the 19th January 2012

Contact with the relevant taxi associations was continuous in the lead up to the field data collection, in order to keep them informed of the data collection programme, and to facilitate informal contact and discussions during this time. The relationship was cordial and very cooperative; all taxi associations agree to participate and in only one case could one route not be surveyed due to conflict between taxi associations in the area.

Follow-up visits were made to the taxi associations during the qualitative interview phase in November 2012. The main purpose of the meetings was to collect data on taxi decision making (see Activity 5 above), but as the project was already far advanced we found opportunities for discussing some of the initial findings, and prompting self-reflection among the participants. The following meetings were scheduled:

Makhuduthamaga Associations – Jane Furse(Wednesday, 28th Nov 2012):

- Masemola Taxi Association
- Jane Furse / Polokwane TA
- Sekhukhune Taxi Association
- Nebo Taxi Association

Greater Tubatse Taxi Associations – Burgersfort (Thursday, 29th Nov 2012):

- Eastern Leolo Taxi Association
- DRUDTA
- Tubatse Taxi Association
- Origstad Taxi Association

Bushbuckridge Taxi Associations – Bushbuckridge (Friday, 30th Nov 2012):

- Thabakgolo Taxi Association
- MUBTA Taxi Association
- Bohlabela Taxi Association
- Bushbuckridge Taxi Association
- THATA

4. Final feedback workshop

After completion of the study a final feedback workshop was held, to provide feedback to the various study participants around the methodology, findings and recommendations. Emphasis was placed specifically on the actions that operators and local authorities can take to improve rural mobility services, following from the study findings. The workshop took place on Wednesday 13 March 2013, at the Makhuduthamaga Local Municipal Offices in Jane-Furse.

A list of attendees is attached in Appendix A. The workshop presentation is attached as Appendix B.

To assess whether the participants found the workshop useful, they were asked to complete a brief questionnaire. The results are summarised in Appendix C. It showed that the workshop achieved its aim of providing useful feedback to the roleplayers.

5. Conference paper

A conference was prepared describing the project, its main results and recommendations. The final version, titled

Vehicle differentiation in informal rural transport services: New evidence from South Africa, (M Molomo, C Venter and M Mashiri)

was submitted to the AFCAP technical advisor on 25 February 2013. The paper is attached as Appendix D to this report.

The paper was due to be presented at the ASAUK Conference in Leeds University from the 6th to the 8th September 2012, but due to scheduling problems could not be presented by this team. The paper is now due to be submitted to the World Transport Policy and Practice journal, for possible inclusion in a special issue.

To ensure that the work and its outcomes also receive wider circulation within the Southern African community of transport practitioners, we intend to deliver the paper at the annual Southern African

Transport Conference, taking place in Pretoria in July 2013. The completed version will then also be disseminated via the conference proceedings (open access online: www.satc.org.za).

ASSESSMENT AGAINST LOGICAL FRAMEWORK

This section assesses the outcomes of the project against the logical framework prepared during the proposal stage of the project. The table below indicates that:

- 100% of output level indicators were met, and
- Achievement of purpose level indicators could not be clearly assessed due to the fact that the project ended before new transport plans were compiled for the case study areas. However the outcomes from the knowledge transfer activities of the project suggest that the purpose of the project will likely be met in due course.

PROJECT NAME	SUPPLY AND PRICING STRATEGIES OF INFORMAL RURAL TRANSPORT PROVIDERS					
GOAL	Indicator	Baseline	Target (2012)	Outcome (2013)		
Increase affordable motorised mobility (for longer distance trips) in rural areas	Per capita trip rates on public transport in rural districts	2003 average trip rates	Increased average trip rates in 2012 survey	Unknown		
		Source				
	National Household Travel Survey - summaries of mode use per capita					
	Public transport expenditure/income ratio in rural districts	2003 average cost/income ratio, normalised per trip	Decreased average cost/income ratio (normalised per trip) in 2012 survey	Unknown		
		Source				
	National Household Travel Survey - summaries of expenditures and income					

PURPOSE	Indicator	Baseline	Target (2012)	Outcome (2013)	Assumptions
Improve evidence-based decision making in government planning and regulation of informal rural public transport	No of public transport plans and operating licensing strategies in rural areas referencing this work	(2010) - almost no references to research findings	At least one strategy document per rural district references this study and its findings	No new rural transport plans have been prepared in this period, but engagements with planning officials during the course of the project raised awareness of the project and of the role of research. All participants at final workshop indicated they would apply the findings in future projects (either fully or partially).	- Government planners and regulators have control over planning studies and strategies in their areas
		Source			
	Public Transport Plans and Operating licensing strategy documents in rural districts				
	Vehicle-kilometers of daily taxi services per capita in rural districts	To be established during project	To be established during project	Baseline data was established during survey.	- This study succeeds in deriving valid relationships between supply and explanatory factors, that are potentially under the control of government
		Source			
	Mapping of taxi routes and frequencies during this project				

OUTPUT 1	Indicator	Baseline	Target (end of analysis)	Outcome (2013)	Assumption
Conceptual and statistical models of taxi supply in case study areas	Goodness of fit statistics of estimated cross-sectional models	n/a	Meets generally accepted goodness of fit thresholds	Achieved: see regression statistics of models (including R-squared, t-statistics and F statistics)	- Data collected of sufficient quality - Sufficient participation of taxi association officials
		Source			
	Output from statistical estimation exercises				
	Feedback from potential users regarding clarity of conceptual model	Baseline	Target (Jun 2012)	Outcome (2013)	
		n/a	75% of participants find it clear	83% of participants found it clear; remaining found it partially clear	
		Source			
Feedback/assessment forms filled in at workshop(s) with officials					

OUTPUT 2	Indicator	Baseline	Target (Jun 2012)	Outcome (2013)	Assumption
Enhancement of local capacity to plan for better taxi services in rural areas	Feedback from potential users regarding usefulness of results	n/a	75% of participants find it useful	50% of participants found it definitely useful; remaining found it partially usefully	- Data collected of sufficient quality - Sufficient participation of local planners and officials in workshops
		Source			
	Feedback/assessment forms filled in at workshop(s) with officials				

OUTPUT 3	Indicator	Baseline	Target (Jun 2012)	Outcome (2013)	Assumption
Enhanced skills of rural youth to participate in team work, work with data, & communicate	Number of youth trained and deployed as research assistants	zero	10 youth successful trained and deployed	20 youth successfully trained and deployed	- Able to identify youth with sufficient interest and time in participating - Cooperation of Kgautshwane Community Centre in recruiting youth and facilitating training 100%
		Source			
	Field supervision reports				

OUTPUT 4	Indicator	Baseline	Target (Jun 2012)	Outcome (2013)	Assumption	
Research thesis by master's student	Research thesis completed, externally examined, and submitted to University.	zero	Research thesis completed by end of project.	Completed	<ul style="list-style-type: none"> - Master's student is identified to undertake this project as research project - Master's student able to allocate sufficient time; 	
		Source				
		Academic records				

CONCLUSIONS

It is concluded that the project achieved its aims of developing an evidence-based understanding of the factors determining the service and pricing patterns of informal public transport operations in rural areas of South Africa. Participation was successfully secured from government officials in three case study areas in rural district in South Africa, as well as from local taxi and pickup (“bakkie”) operators. Both quantitative and qualitative data was collected, enabling the estimation of a set of cross-sectional regression models to examine the factors driving supply and pricing variables in the areas. The results corresponded well with the insights obtained during qualitative interviews and workshops with operators.

In terms of substantive findings, the research provided confirmation of previous findings around the factors driving transport supply in rural areas of Sub-Saharan Africa, but adds significant new insights that can help shape more effective responses to the rural mobility challenge.

In agreement with previous research, we found that the condition of roads (both paved and unpaved) is a very important determinant not only of the quantum of service, but also the quality of vehicle used. Minibus vehicles are not likely to be deployed on badly maintained or unpaved roads, even if taxi associations have legal permits/operating licenses for operating along a certain route. Thus minibus-taxi services are predominantly deployed on surfaced roads, and offer higher frequencies on surfaced roads with better conditions. The situation is being exacerbated by government-driven efforts to upgrade and renew the minibus vehicle fleet through the South African Taxi Recapitalisation Programme. While there is an improvement in vehicle and service quality, operators are hesitant to deploy newer (more expensive) vehicles on poor quality roads, leading to a reduction in supply of quality rural transport services.

The research also showed that poor quality gravel roads increase average fares by a third. Operators pass the extra vehicle operating costs on to passengers. While road condition is not the only factor driving supply and pricing, there remains a strong rationale for using (appropriate) infrastructure improvement strategies as a way to leverage better and more affordable private sector transport services in rural areas. It appears that upgrading gravel roads from poor to good condition can have a greater incremental impact on service availability and fares than upgrading them to a paved road standard. Operators avoid or reduce frequencies on overly long routes – the research suggested a threshold route length of around 30km (one-way). Judicious road investments would focus on missing links to reduce dead-ends and detours.

The research also found that minibus operators are attracted to routes with formalized ranks at their end points – ranks generate other economic activity such as trading, which increases transport demand. This lends support to the provision of rank infrastructure as a way to promote private sector transport supply.

On gravel roads and (to a lesser extent) some surfaced roads in poor condition, the mobility gap is often bridged by 'second tier' operators providing services with pickup trucks ('bakkies'), old low-quality minibus vehicles, or sedan taxis. Although these operators are often ignored by government, they provide a significant amount of transport – almost a third of public transport supply in the case study areas. We also found evidence of intentional coordination between bakkie and minibus operators, leading to a rational organization of routes and vehicle types where bakkies and smaller

vehicles provide feeder services along poor quality local roads up to main roads, and minibuses serve major routes to district centres.

Thus a differentiated service hierarchy is emerging involving a greater variety of vehicle types suited to different operating conditions. This is encouraging, as it presents evidence of the kind of local innovation that has been called for by previous studies. While we found some evidence of uncompetitive pricing resulting from such self-organisation in rural transport markets, it seems equally clear that rural mobility benefits significantly from this differentiated approach, especially the most isolated communities who would otherwise have no motorized transport option available.

Lastly, informal rural transport operators indicate that they are operating at very low profit margins. Many do not perceive their businesses as sustainable. Rural mobility would certainly benefit, in the long run, from active government involvement in the promotion of sustainable business practices through information provision, training, and corporatization of informal transport providers.

Although the study was not intended to examine demand patterns in detail, the data did highlight the extent to which both the usage and the supply of informal rural public transport is gendered. Firstly, the transport supply market is highly dominated by men: none of the taxi associations were represented by a woman during the interviews. Furthermore, 7 out of 9 associations have between 4.5% and 18% women taxi owners, with the other 2 associations indicating 30% ownership. The situation is much worse when it comes to drivers, of which less than 3% are women. When prompted for the reason for this situation, the common response was that the industry is perceived to be rough, with driving activities dominated by young men. There appears to be significant scope for expanding women's ownership of and employment in the rural transport industry.

Recommendations flowing from the study include:

- Government actors should prioritise selective upgrading of rural roads to a good gravel condition, as this can do much to attract not only more public transport supply, but also transport of a higher quality (minibuses instead of bakkies);
- Provision of formal taxi rank facilities at important nodes and interchange points seem to explain some favourable supply reaction, and can thus be used to leverage better public transport provision in an area;
- Government actions should also enable and support innovation and coordination of a variety of vehicle sizes (including non-motorised modes), as this appears to promote higher mobility directly;
- Governments should tread lightly with regard to regulating competition and vehicle quality in thin rural transport markets. While there is definitely scope for improving the robustness and user friendliness of vehicle designs, the research found anecdotal evidence that government-driven efforts at recapitalizing minibus fleets are having counterproductive impacts in terms of the amount of taxi transport available in deep rural areas. Self-organising tendencies between operator associations are by and large working to produce a rational service under marginal economic conditions; yet the equilibrium it produces is fragile and might easily be upset by insensitive or heavy-handed intervention, to the detriment of the user.
- Further research is needed on the operating cost and financial situation of informal public transport suppliers, to enable better identification of cost drivers and potential remedies.

Promising remedies might include the use of information technology to improve information among providers, and between users and providers.

Finally, the study set out to achieve certain knowledge transfer and training objectives in the area of rural transport services, and achieved this by supporting one postgraduate student (who undertook this study as a Master's degree research project); by conducting several workshops and meetings with operators and officials in the case study areas and working closely with them to expose them to the research process; by training local youths to participate as research assistants; and by disseminating the findings through a conference and an academic publication.

A more complete description of the conclusions and recommendations are provided in the thesis document.

Appendix A

List of attendees at final feedback workshop, 13 March 2013



UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

ATTENDANCE REGISTER FOR THE RURAL TRANSPORT SERVICES AFCAP RESEARCH PROJECT FEEDBACK WORKSHOP
HELD AT MAKHUDUTHAMAGA LOCAL MUNICIPALITY OFFICES ON THE 13TH MARCH 2013, AT 11H00

NAME AND SURNAME	ORGANISATION	TELEPHONE	CELLPHONE	FAX NUMBER	EMAIL	SIGNATURE
MALEELA Molemo	UNIVERSITY OF PRETORIA	—	0722999540	081 6669540	maleela-m@webmail.co.za	<i>[Signature]</i>
Albert Segale	Makhuduthamaga Municipality	013 265 8642	07882 44359	086555 2448	albertsegale@imga.lc.mn	<i>[Signature]</i>
Ramashala Moloko	Dept of Roads & Transport	015 294 8239	076521 6660	0866055604	ramashalalaund@lmp.gov.za	<i>[Signature]</i>
Skanyama Samuel	Roads & Transport	015 295 1262	078920 4944	0866078183	skanyama@lmp.gov.za	<i>[Signature]</i>
Matlulodi Nkomo	Makhuduthamaga Municipality	013 265 8669	0723412236	086 6335861	nkosonatin@makhuduthamaga.gov.za	<i>[Signature]</i>
Mphethi Tshepo	Makhuduthamaga Municipality	013 265 8610	081 744 0377		mphethi@makhuduthamaga.gov.za	<i>[Signature]</i>
SKOSANA KN	MKN	013 265 8611	0829387481	0132657975	k.skosana@yahoo.com	<i>[Signature]</i>
Lekwadu MV	Greater Tlokoetse Municipality	013 231-1000	082 305981	0865649286	ulekwadu@tlokoetse.gov.za	<i>[Signature]</i>

Appendix B

Workshop presentation containing overview and findings and recommendations



SUPPLY AND PRICING STRATEGIES OF INFORMAL RURAL TRANSPORT PROVIDERS

STAKEHOLDER FEEDBACK WORKSHOP PRESENTATION

Date: 13 March 2013

Venue: Makhuduthamaga Local Municipal Offices (Jane-Furse)

Time: 11h00

Presented by: Malesela Molomo
University of Pretoria



OUTLINE OF THE PRESENTATION

1. INTRODUCTION
2. PURPOSE OF THE PRESENTATION
3. RESEARCH METHODOLOGY
4. FINDINGS: QUANTITATIVE ANALYSIS
5. FINDINGS: QUALITATIVE ANALYSIS
6. CONCLUSIONS AND RECOMMENDATIONS



1. INTRODUCTION

► Background

- University of Pretoria (UP) was appointed by Crown Agents under the African Community Access Programme (AFCAP).
- Research project on ***“Supply and Pricing Strategies of Informal Rural Transport Providers”***
- To increase knowledge in the area of provision of affordable rural transport services in sub-Saharan Africa
- Funded by the UK government’s Department for International Development (DFID).



1. INTRODUCTION Cont.

► Research Overall Goal

- promote AFCAP’s stated purpose of:

“supporting sustainable rural road provision and affordable rural transport services, by promoting evidence-driven decision making among government planners and regulators that will result in improved mobility for rural people making longer (motorised) trips”



1. INTRODUCTION Cont.

► Research Objectives

- To examine the extent and characteristics of public transport supply in selected rural areas of SA;
- To identify the factors determining the service patterns (including routes served, frequencies, fares charged, and vehicles to be used) of informal rural public transport operators, and to quantify the strengths of these relationships; and
- To develop evidence-based recommendations on how rural mobility may be strengthened, with specific reference to informal modes.



2. PURPOSE OF THE PRESENTATION

“To provide feedback to rural transport decision makers and planners and to demonstrate the use of the findings”



3. RESEARCH METHODOLOGY

Case Study Areas

- ▶ Makhuduthamaga Local Authority;
 - ▶ Greater Tubatse Local Authority; and
 - ▶ Bushbuckridge Local Authority
- ▶ Case study areas considered as representative of the variation of rural transport conditions in Southern Africa (i.e. deep rural/isolated, scattered settlements, lack of infrastructure, small/secondary towns, commercial agriculture, mining economy, and etc).



3. RESEARCH METHODOLOGY Cont.

Case Study Areas

- ▶ ISRDS Rural Development Nodes, 2000





3. RESEARCH METHODOLOGY Cont.

- ▶ Data Collection: Desktop
 - ▶ Initial meetings with the reps of local authorities.
 - ▶ Official documentation:
 - ▶ *National Strategies*
 - ▶ *Provincial Strategies*
 - ▶ *IDPs, CPTRs, ITPs, SDFs, and*
 - ▶ *etc.*
 - ▶ Initial engagements with the taxi associations (to ensure buy-in, access, and obtain initial operational understanding).



3. RESEARCH METHODOLOGY Cont.

- ▶ Data Collection: Sample Size

Summary of the sample sizes per case study area			
Case Study Area	No of taxi associations covered in quantitative surveys	No of routes covered in quantitative surveys	No of taxi associations covered in qualitative interviews
Bushbuckridge	5	23	3
Makhuduthamaga	4	29	3
Greater Tubatse	4	23	3
Total	13	76	9



3. RESEARCH METHODOLOGY Cont.

- ▶ Data Collection: Quantitative Surveys
 - ▶ Local youth (12) and a supervisor from Sekhukhune area were identified and trained as data collectors.
 - ▶ Types of surveys undertaken:
 - ▶ *At Rank Route Utilisation;*
 - ▶ *Cordon Route Utilisation; and*
 - ▶ *Route Infrastructure Inventory.*
 - ▶ Surveys were undertaken for AM (06:00 – 09:00), Midday (09:00-12:00), and PM (15:00 – 18:00) peaks



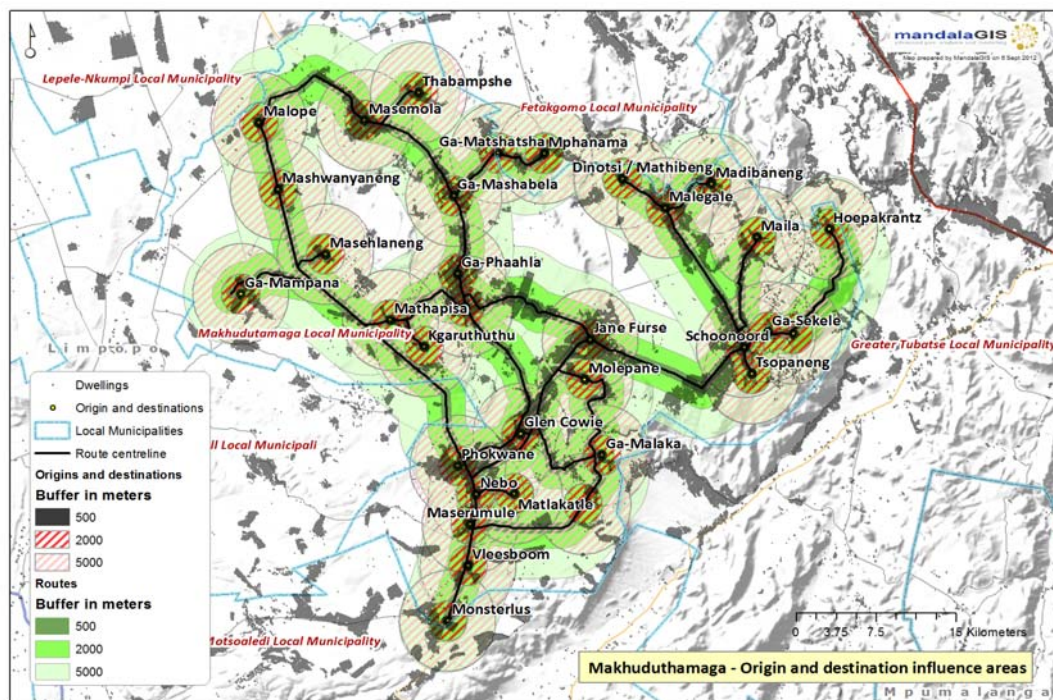
3. RESEARCH METHODOLOGY Cont.

- ▶ Data Collection: Spatial & Demographic Data
 - ▶ Spatial and demographic data was collected from secondary sources (CSIR meso data), and include:
 - ▶ *Gross Value Added Data, 2009;*
 - ▶ *Population Data, 2010;*
 - ▶ *Gender Data, 2010; and*
 - ▶ *Age structure Data, 2010.*
 - ▶ The data was obtained for 500m, 2000m and 5000m buffers.



3. RESEARCH METHODOLOGY Cont.

Data Collection: Spatial & Demographic Data



3. RESEARCH METHODOLOGY Cont.

Data Collection: Qualitative Interviews

- ▶ Qualitative interviews undertaken with 9 associations (3 per case study area).
- ▶ Interviews were in a form of a questionnaire on a one to one basis on issues around:
 - ▶ *Frequencies of operations;*
 - ▶ *Travel Demand;*
 - ▶ *Pricing (Fare setting) & profit margins;*
 - ▶ *Effect of roads infrastructure;*
 - ▶ *Competition with other modes: and etc.*
- ▶ The qualitative findings were used to develop conceptual understanding of the rural informal PT operating factors, and to check on the findings of the quantitative analysis.



3. RESEARCH METHODOLOGY Cont.

- ▶ Statistical Analysis and modelling
 - ▶ Step 1 – We analysed correlations between informal public transport supply & environmental factors; and
 - ▶ Step 2 – Estimation of cross-sectional regression models for:
 - ▶ *Taxi Supply;*
 - ▶ *All Informal Transport Supply;*
 - ▶ *Average Taxi Pricing; and*
 - ▶ *Average Informal Transport Pricing.*



4. FINDINGS: QUANTITATIVE ANALYSIS

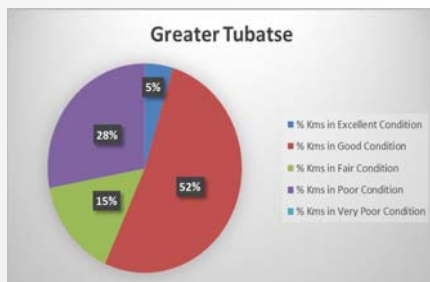
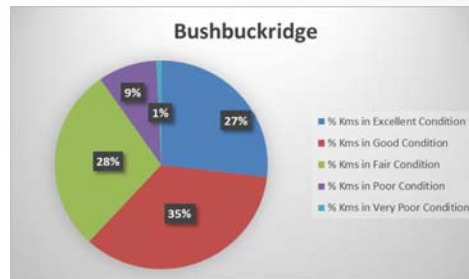
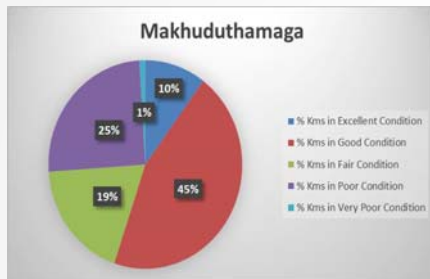
- ▶ Rural Public Transport Routes & Infra. Conditions

Summary of route lengths per case study area					
Local Authority	No. of Routes	Kms of Routes Surfaced	Kms of Routes Gravel	Total Route - Kilometres	Average Route Length (Km)
Bushbuckridge	23	183.3	183.9	367.2	15.9
Makhuduthamaga	29	292.6	246.1	538.7	18.6
Greater Tubatse	23	574.9	160.2	735.1	31.9
Overall	76	1050.8	590.1	1640.9	21.9



4. FINDINGS: QUANTITATIVE ANALYSIS Cont.

Rural Public Transport Routes & Infra. Conditions



4. FINDINGS: QUANTITATIVE ANALYSIS Cont.

Rural Public Transport Routes & Infra. Conditions

Typical infrastructure used by informal rural public transport



Minibus taxi in Kgautswane offloading passengers at a muddy cul de sac without proper infrastructure (e.g Shelter)



An interchange point between minibus taxis, bakkies and private cars in Motlolo village



An area used as a Bakkie rank in Burgersfort town







Typical rural road infrastructure used by rural public transport operators observed in Makhuduthamaga area



4. FINDINGS: QUANTITATIVE ANALYSIS Cont.

Characteristics of Informal Public Transport Supply (Modes)

Examples of types of public transport modes observed in the study areas

 <p>Minibus Taxis</p>	 <p>One of the Busses operating in the area</p>
 <p>Kartjiebans / Old Minibus Taxis</p>	 <p>Bakkie (pickup truck) with passengers</p>



4. FINDINGS: QUANTITATIVE ANALYSIS Cont.

Characteristics of Informal Public Transport Supply

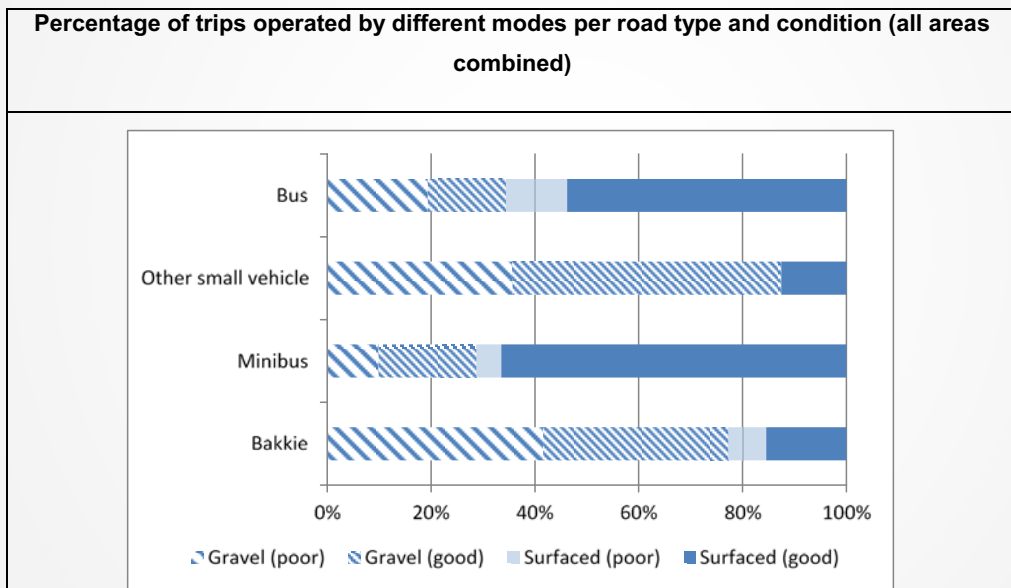
Public transport supply per mode in case study areas				
Vehicle type (Service type)	Road type	Total daily vehicle frequency (vehicle trips per 9-hour day)		
		Makhuduthamaga	Bushbuckridge	Greater Tubatse
Bakkie (Informal)	Gravel	138 (16.9%)	103 (10.9%)	130 (20.8%)
	Surfaced	35 (3.5%)	28 (3.0%)	55 (8.8%)
	ALL	203 (20.4%)	131 (13.9%)	185 (29.6%)
Minibus (Informal)	Gravel	98 (9.8%)	163 (17.3%)	97 (15.5%)
	Surfaced	645 (64.9%)	594 (63.1%)	295 (47.1%)
	ALL	743 (74.8%)	757 (80.5%)	392 (62.6%)
Other small vehicle* (Informal)	Gravel	17 (1.7%)	17 (1.8%)	15 (2.4%)
	Surfaced	2 (0.2%)	5 (0.5%)	0 (0%)
	ALL	19 (1.9%)	22 (2.3%)	15 (2.4%)
Bus (formal)	Gravel	10 (1.0%)	10 (1.1%)	12 (1.9%)
	Surfaced	18 (1.8%)	21 (2.2%)	22 (3.5%)
	ALL	28 (2.8%)	31 (3.3%)	34 (5.4%)
ALL TYPES	ALL	993 (100%)	941 (100%)	626 (100%)

*Other informal include Kartjiebans (old minibuses and vans) and private cars operating for-hire public transport services, i.e. smaller vehicles with capacities of between 6 and 12 passengers.



4. FINDINGS: QUANTITATIVE ANALYSIS Cont.

Characteristics of Informal Public Transport Supply



4. FINDINGS: QUANTITATIVE ANALYSIS Cont.

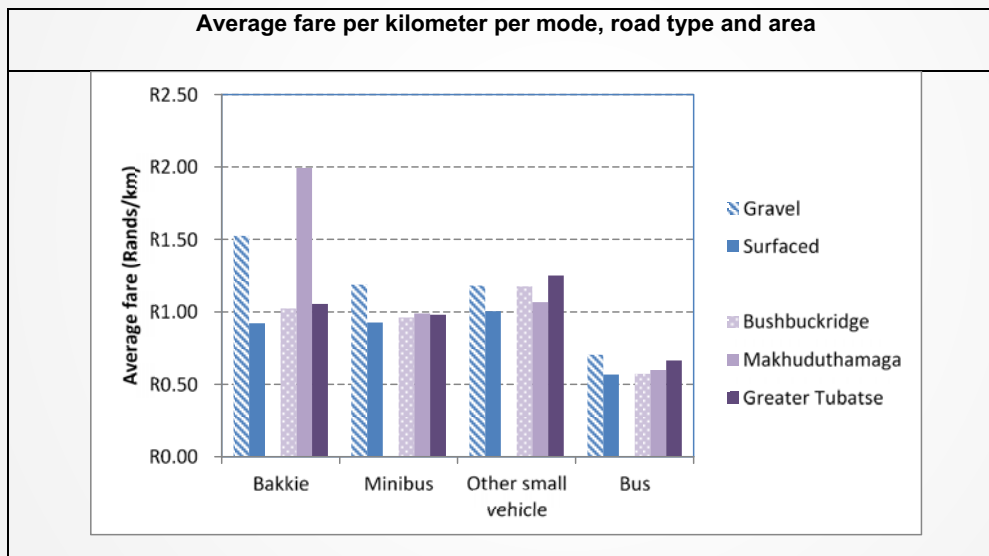
Characteristics of Informal Public Transport Supply

- Taxis & Busses tend to operate predominantly on surfaced roads
- In all areas bakkies, minibuses and kartjebans provide more than 95% of public transport service,.
- Despite their precarious legal status, bakkies contribute a sizable 14%, 20% and 30% of public transport in Bushbuckridge, Makhuduthamaga and Greater Tubatse respectively.
- Limited information is available in the ITPs regarding usage of bakkies/kartjebans/"4+1" as public transport mode.



4. FINDINGS: QUANTITATIVE ANALYSIS Cont.

► Pricing of Informal Public Transport



4. FINDINGS: QUANTITATIVE ANALYSIS Cont.

► Pricing of Informal Public Transport

- There is a strong relationship between road type and condition, and the average fare charged by informal operators
- Bakkie fares are on average 65% higher on gravel than on surfaced roads; for minibuses the figure is 28%
- Makhuduthamaga has the worst case, where average bakkie and minibus fares per kilometer on the gravel road are between 103% and 150% more than on the surfaced route sections
- This could be attributed to poor conditions of the road infrastructure, as the average fare per kilometer by the bakkies and taxis on the very poor routes in this area is indicated as R3.77 per kilometer
- Specific area in question is Leolo area, where “there is serious lack or no transport in areas of Leolo due to poor and dangerous state of roads (Makhuduthamaga IDP, 2011)”



5. FINDINGS: QUALITATIVE ANALYSIS.

► Respondents

Minibus-taxi associations that took part in the qualitative interviews	
Case Study Area	Association Name
Bushbuckridge	Thabakgolo Taxi Association
	MUBTA
	Bohlabela Taxi Association
Makhuduthamaga	Sekhukhune Taxi Association
	Nebo Taxi Association
	Masemola Taxi Association
Greater Tubatse	Origstad Taxi Association
	Tubatse Taxi Association
	Eastern Leolo Taxi Association



5. FINDINGS: QUALITATIVE ANALYSIS Cont.

► Minibus Taxi Supply & Operational Strategy

- Associations allocate taxis on rotational system.
- AM trips originate at the villages to economic centres.
- Taxis arrange themselves in to feeders & main services.
- Bakkies also provide feeder services from deep gravel routes.
- On taxi to taxi transfer, passengers normally pay once.
- For bakkie to taxi transfer, passengers pay twice.
- Different headways are set for different routes/associations.



5. FINDINGS: QUALITATIVE ANALYSIS Cont.

- ▶ Minibus Taxi Supply & Operational Strategy
 - ▶ During off-peak, some associations “tout”, and other operate in longer headways (e.g. every hour).
 - ▶ In the PM peak, operations are from economic centres to the villages.
 - ▶ Taxis only leave when they are full.
 - ▶ Some associations take bakkie/kartjieban operators as their members.
 - ▶ However, should the roads be upgraded associations will take over the operations.
 - ▶ Bakkie operators who can afford taxis will be incorporated in to the associations.



5. FINDINGS: QUALITATIVE ANALYSIS Cont.

- ▶ Minibus Taxi Supply & Operational Strategy





5. FINDINGS: QUALITATIVE ANALYSIS Cont.

- ▶ Minibus Taxi Fare Setting Strategy & Business Viability
 - ▶ Fuel price, spares & tyres prices, vehicle price, and inflation are considered when setting fares.
 - ▶ Only 33% of the associations highlighted considering infrastructure when setting fares, contrary to quantitative results.
 - ▶ General sense of business confidence among rural PT operators is low.
 - ▶ Low profitability of the business is attributed to high veh costs, low densities, over-saturation, competition form subsidized busses, and poor road conditions.



5. FINDINGS: QUALITATIVE ANALYSIS Cont.

- ▶ Minibus Taxi Fare Setting Strategy & Business Viability
 - ▶ Operators estimated the average age of minibus taxis at less than 6 years – indication of the success Taxi Recap Programme.
 - ▶ However an unintended consequence of this success appears to be a gradual withdrawal of minibus services from lower quality rural roads.
 - ▶ The gap is clearly being filled by bakkies and, to a lesser extent, kartjebans.



5. FINDINGS: QUALITATIVE ANALYSIS Cont.

- ▶ Competition with other rural PT modes
 - ▶ Bus operators are seen as the biggest competition, as they are subsidized.
 - ▶ 50% of the taxi association take bakkie/kartjieban operators as their members.
 - ▶ There generally a spontaneous coordination between taxis & bakkies/karjiebans.
 - ▶ Where coordinated, bakkies/karjiebans provide feeder service to the taxis.
 - ▶ Conflicts between associations and attempts to resolve them is a further factor driving supply patterns.



5. FINDINGS: QUALITATIVE ANALYSIS Cont.

- ▶ Government interventions: Taxi operators perspective
 - ▶ Upgrading and maintenance of roads & internal streets within the villages.
 - ▶ Provision & upgrading of public transport facilities.
 - ▶ Subsidization of the taxi industry.
 - ▶ Assist with conflict resolution within the industry;
 - ▶ Provision of dedicated loading & offloading facilities within the centres of economic activities.
 - ▶ Government to purchase vehs directly from the factory & sell them to the industry at low interest rates.
 - ▶ Removal of illegal operators.



6. CONCLUSIONS AND RECOMMENDATIONS

- Condition of roads is a very important determinant of quantum of service, and quality of vehicle.
- Minibus taxis operators are generally hesitant to deploy taxis to badly maintained and poor gravel roads (leading to low levels of supply).
- The situation is exacerbated by renewed fleet from Taxi Recap programme.
- Poor quality gravel roads increase average fares by a third.
- Upgrading of gravel roads from poor to good conditions can have greater incremental impact on service availability and fares.



6. CONCLUSIONS AND RECOMMENDATIONS Cont.

- It was also found that minibus taxis are attracted to formalized ranks, and trading.
- This lends support to the provision of rank infrastructure as a way to promote private sector transport supply.
- Second tier operators (i.e bakkies, kartjebans and sedan (4+1) taxis) provide mobility gap on gravel poor roads.
- These operators provide almost a third of the public transport supply in the case study areas.
- This demonstrate the need for differentiated, robust vehicle designs that are better suited to difficult operating conditions.



6. CONCLUSIONS AND RECOMMENDATIONS Cont.

- Informal rural transport operators indicated that they are operating at low profit margins.
- Rural mobility would benefit from active government involvement in the promotion of sustainable business practices through:
 - *provision,*
 - *training and*
 - *corporatization of informal PT will benefit rural mobility.*
- The estimated models for supply and pricing of the informal would be crucial for rural transport planning.



Estimation of Cross-sectional Regression models (Supply)

Regression results: Factors explaining frequency of public transport vehicles per route during AM and PM peaks					
Type of factor	Variable	All informal modes		Minibus mode	
		Estimate	T statistic	Estimate	T statistic
Infrastructure	%GRAVPOOR: Percentage of route that is gravel and in poor condition	-3.194	-1.117	-4.838**	-2.011
Infrastructure	FORMALRANK: 1 if formal rank is used at route origin	2.646	1.307	4.196**	2.464
Demand	POPDENS: Average population density (persons/ha) within 0.5km of route	0.279**	2.193	0.289**	2.698
Demand	ECONACT: Average GVA ⁽¹⁾ (Rands/ha) within 2km of route	0.032	1.501	0.038**	2.104
Route	ROUTELENGTH: 1 if route is longer than 30km (one-way)	-3.997	-1.429	-2.250	-0.957
Competition	BUSTRIPS: Number of daily bus trips on same route (AM & PM peaks)	2.379**	3.402	2.407**	4.093
Constant	CONSTANT	4.838**	2.159	0.745	0.395
N =		151		151	
Adjusted R² value =		0.201		0.307	
F statistic (p-value) =		7.282** (0.000)		12.056** (0.000)	

Notes: 1 GVA = Gross Value Added, a measure of all economic output generated within buffer zone around route.

AM peak refers to the morning peak period between 06h00 and 09h00.

PM peak refers to the afternoon peak period between 15h00 and 18h00.

*Significant at 90%

**Significant at 95%



Estimation of Cross-sectional Regression models (Pricing)

Table 4.9.2: Regression results: Factors explaining average fare per kilometer of informal transport services

Type of factor	Variable	All informal modes		Marginal effects ⁽³⁾	
		Estimate	T statistic	Marginal fare effect	% of average fare
Infrastructure	%GRAVPOOR: Percentage of route that is gravel and in poor condition	0.245**	2.672	+R4.22	+31%
Demand	POPDENS: Average population density (persons/ha) within 0.5km of route	0.006*	1.689	+R0.11	+1%
Demand	ECONACT: Average GVA ⁽¹⁾ (Rands/ha) within 2km of route	0.001	0.952	--	--
Route	ROUTELENGTH: 1 if route is longer than 30km (one-way)	-0.241**	-2.826	-R4.14	-30%
Competition	BUSTRIPS: Number of daily bus trips on same route (AM & PM peaks)	-0.038*	-1.811	-R0.66	-5%
Vehicle mix	%NONTAXI: Percentage of informal PT ⁽²⁾ trips by bakkie or other small vehicle	0.364**	4.062	+R6.28	+46%
Constant	CONSTANT	0.711**	9.025	+R12.26	+90%
N =		151			
Adjusted R ² value =		0.295			
F statistic (p-value) =		9.976** (0.000)			

Notes: 1 GVA = Gross Value Added, a measure of all economic output generated within buffer zone around route.

2 PT=Public transport

3 Marginal effects calculated as increase in fare associated with one unit increase in independent variable. Based on average fare in the sample (R13.58). Only calculated for significant variables.

*Significant at 90%

**Significant at 95%

"We've loaded everything on the segwaigwai, including beds, kitchen units, coffins, groceries, bricks and roofing materials. Even though we have a modern bridge, I will never forget those difficult days," Herbert Maphoru". sanews.gov.za





Thank You!!!

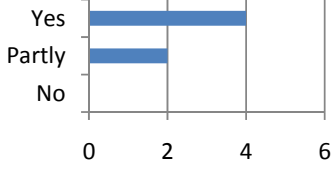
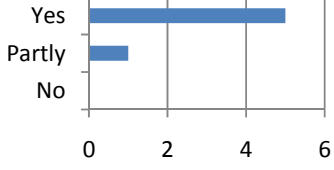
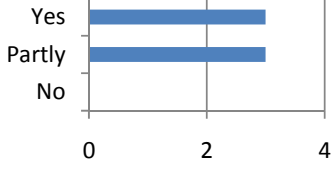
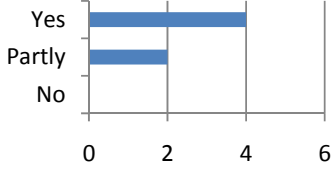
Appendix C

Summary of feedback questionnaire results: final workshop

EVALUATION FORM: Stakeholder Feedback Session

SUPPLY AND PRICING STRATEGIES OF INFORMAL RURAL TRANSPORT PROVIDERS

Please rate the following regarding the research outcomes. Please mark with X on your answer

<p>1) Did the research findings meet your expectations?</p>		
<p>2) Are the research findings clear to you?</p>		
<p>3) Do you find the research findings useful?</p>		
<p>4) Would you apply the research findings in your future projects?</p>		

5) Any other Comments: *"This research met my expectations because the municipality are working on rural areas, and some of the presentation is affecting us as the department of traffic. And as such it is our responsibility to see to it that LDV operators and taxi operators should sit together and discuss this problems and come out with solutions."*

Appendix D

Conference paper

VEHICLE DIFFERENTIATION IN INFORMAL RURAL TRANSPORT SERVICES: NEW EVIDENCE FROM SOUTH AFRICA

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ABSTRACT

The paper examines the characteristics of supply and pricing strategies of informal rural public transport operators in South Africa. The research provides statistical and qualitative confirmation of previous findings around the factors driving transport supply in rural areas of Sub-Saharan Africa, but adds significant new insights that can help shape more effective responses to the rural mobility challenge. A key determinant of the quantity and quality of service is the condition of roads (both paved and unpaved), suggesting that judicious infrastructure investment can be used to leverage better and more affordable private sector responses. We further describe the emergence of a differentiated service hierarchy involving a greater variety of vehicle types suited to different operating conditions, and based on intentional coordination among operators of minibus and pickup trucks ('bakkies') services. We discuss ways in which governments might promote such coordination and innovation in rural transport markets.

1. INTRODUCTION AND BACKGROUND

Over the last decades the notion that a more holistic approach is needed towards rural transport than just focusing on roads or infrastructure has become embedded in research and practice. Lebo and Schelling (2001) argued that the approach towards improving rural mobility should consider three elements, namely transport services and intermediate modes, the location and quality of services, and transport infrastructure.

In what is probably the most comprehensive study on rural transport services in Africa to date, Ellis and Hine (1998) noted that rural Africans make very little use of motorized transport, and that they face much higher transport costs, lower service frequencies, and more unreliable services than do rural people elsewhere in the developing world. Observing that large investments in road building do not always result in the expected increases in road traffic and economic activity (Howe, 1981), they argued for a better

understanding of the links between infrastructure provision and transport services to allow planners and project implementers to leverage real livelihood benefits more effectively.

Most research activity in this field has focused on the impacts of road investment on transport demand and livelihoods (e.g. Hettige, 2006; Davis, 2000), and not on understanding the business practices of rural transport operators as the providers of mobility. This research was aimed at exploring these practices, in terms of operators' decisions around supply, vehicle deployment, network organization, and pricing. The focus is on informal paratransit services provided by private operators using a variety of vehicle types and sizes.

The minibus-taxi is the main mode of motorised transport in rural areas of Sub-Saharan Africa: in South Africa about 15% of work trips are made by taxi-- more than by any other mode except walking (DoT, 2004). About 20% of taxi users pay more than R300 per month¹ to use taxis, imposing severe affordability constraints on users.

There is a growing scholarly interest in the quality and supply problems in the informal public transport industry in developing countries (e.g. Barret, 2003; Boudreaux, 2006; Gwilliam, 2006; Venter, 2013). What these studies highlight, more than anything else, is the shortage of knowledge that exists in academic and government circles about exactly how the industry operates: how decisions are made, for instance about which routes to operate; what drives the entry decision for individual operators, what kind of vehicle to use, and at what level to set fares. Furthermore, most studies have focused on urban conditions. This knowledge gap often reflects in the public transport plans prepared by consultants for rural areas, which tend to be based on urban practices, but ignore rural realities such as the widespread use of pickup trucks ("bakkies"), the considerable impact of bad road conditions on transport operating costs, and taxi associations' practice of using old vehicles retired from urban areas for rural services.

Accordingly, the objectives of this work were:

- To examine the extent and characteristics of public transport supply in selected rural areas of South Africa;
- To identify the factors determining the service patterns (including routes served, frequencies, fares charged, and vehicle sizes to be used) of informal rural public transport operators, and to quantify the strengths of these relationships; and
- To develop evidence-based recommendations on how rural mobility may be strengthened, with specific reference to informal modes.

We take a case study approach, focusing on three typical rural districts within South Africa. While the focus is primarily on motorized (thus longer-distance) passenger transport, linkages to Intermediate Modes of Transport (IMTs) and freight movement are

¹ Amounts in South African Rand in this paper can be converted to US dollars using an average current exchange rate of R8.00 per dollar.

identified. We do not examine the demand for rural transport or any particular mode in detail, focusing instead on supply and supply-demand interactions.

The paper firstly provides a brief overview of relevant literature on rural transport services, followed by a description of the study methodology and data collection. We then discuss findings, including qualitative analyses and statistical modeling of supply and pricing patterns. Lastly, we identify measures that could increase supply, affordability, and use of motorized transport services in rural Africa.

2. RURAL TRANSPORT SERVICES IN THE LITERATURE

Various studies have demonstrated the strong link between poverty and rural isolation (e.g. Barwell, 1996; Gannon and Liu, 1997). People who cannot move cannot move out of poverty (Banjo et al., 2012). Barwell (1996) noted that poor transport options in Sub-Saharan Africa makes walking by far the most common means of transport. Although people spend roughly similar amounts of time daily on travel as do people in industrialised countries, excessive walking impacts rural households in two ways: firstly, transport efficiency is much lower – the time and effort spent walking achieve little besides basic subsistence. Excessive walking is also a drain on labour, the chief production input of rural households.

What passenger transport services do exist, households typically have poor access to. Bus services, where they exist, are commonly restricted to main roads only. Informal services, typically provided by private, small-scale operators using pickup trucks, small buses or tractors, are more widely available across Africa (Barwell, 1996).

Poor road conditions are often cited as the most important or the only reason for the lack of transport services in certain areas. Ellis and Hine (1998) however argued that many other factors also act as obstacles to the greater availability and reduced cost of Rural Transport Services (RTS). Foremost amongst these are low demand densities. Coupled with low cash incomes, sparse demand creates conditions where operators fail to operate effectively, leading to a mismatch between demand and supply. Ellis and Hine (1998) further argued that transport services are usually regarded as the domain of the private sector, and have been largely ignored by transport planners, governments and donor agencies.

Some of the problems facing informal rural transport services sprout from their informal business model; while these problems are common to urban and rural operators, the effects may be magnified in rural areas due to more financially marginal operations. Unprofessional management practices and poor access to credit leads to the use of old and unreliable vehicles and poor maintenance practices (Gwilliam, 2006). Providers are usually organized into informal associations or unions, which exercise *de facto* control over fares, route allocation, and the quantity of service. This often leads to uncompetitive practices and pricing at higher than competitive market levels (Ellis and Hine, 1998; Gwilliam, 2006). The user experience is often one of low service quality, erratic availability, high prices, and poor road safety (Gilbert, 2008). Efforts by

governments to regulate informal public transport suppliers have generally failed, due to a combination of limited implementation capacity, and active resistance from the informal industry itself (Schalekamp et al. 2009; Venter, 2013).

The result is that there is often a strong unmet demand for better transport services in rural areas, provided they are efficiently managed and moderately priced (Davis, 2000). Ellis and Hine (1998) identified a number of strategies that might promote more efficient services, including provision of basic access on as much of the road network as possible through spot improvement strategies and appropriate standards; consolidation of demand through rural markets and brokering; and correction of market distortions by increasing competition in the market. They decry the lack of diversity in vehicle types and sizes, arguing that a diversity of vehicle types is important to keep transport costs to a minimum and ensure that all transport needs are met. There is a particular problem with access to vehicles which are suitable for transporting smaller loads over relatively short distances.

Ellis and Hine's review of transport services in Sub-Saharan Africa showed that service frequencies are a function of (i) density of demand, (ii) road quality, and (iii) ability of the population to pay. Recent qualitative research of minibus-taxi patterns in South Africa (Venter and Cross, 2011) confirmed the importance of road quality -- especially the existence of paved roads with sufficient quality to attract motorized transport -- and population and job densities, and also indicated that competition from other modes (such as government-provided bus services) might help explain taxi service patterns.

It is the aim of this study to further explore these factors in the context of newly emerging service patterns in rural transport markets.

3. DATA COLLECTION

A mixed mode data collection strategy was used, including both quantitative and qualitative components. Quantitative cross-sectional data on the extent and characteristics of a representative sample of rural public transport (including bus, minibus-taxi and 'bakkie' services) are used to examine supply and pricing patterns under actual operating conditions. This is supplemented with qualitative data, collected via in-depth semi-structured interviews with operators, managers and government role players, to investigate perceptions and strategies affecting taxi/bakkie supply.

3.1 Selection of the case study areas

Three rural districts considered representative of the variation of rural transport conditions found across Southern Africa were selected. The areas cover a range of rural conditions, including deep rural/isolated, district centre, commercial agriculture, and mining economy areas. Located in the Mpumalanga and Limpopo Provinces of South Africa, they include:

- Bushbuckridge Local Authority

- Makhuduthamaga Local Authority
- Greater Tubatse Local Authority

Bushbuckridge Local Authority was declared a presidential nodal point by the president of the republic in 2001 (Bushbuckridge LM, 2010a). The 2007 estimated population was 509,967 and the number of households was 153,839, equating to an average household size of 3,84 persons. Only about 9% of the municipality's population lives in district centres. Small rural villages comprise 29% of the population, while dense rural villages represent the remaining 61% (Bushbuckridge LM, 2010b). The local economy of Bushbuckridge depends on agriculture and tourism. However, the fragmented settlement pattern prevents a "critical mass" from being achieved in order to boost and sustain economic growth. Very little commercial farming takes place in Bushbuckridge and several orchards and plantations are currently lying dormant due to limited access to water and numerous land claims on agricultural land (Bushbuckridge LM, 2010b).

Makhuduthamaga Local Authority covers a large area of approximately 2,096 square kilometers, made up of 146 settlements with a population of 300,206 people and 56,642 households (Makhuduthama LM, 2010). Yet economic activity is sparse: two minor places contain most services (namely Jane Furse and Monsterlus, which is located on the edge of the municipal area). There is an unemployment rate of between 60% and 75% in the area, and hence high dependency rate on government grants. Government is the largest contributor to employment in the area at 46%, and the sector provides public and social services such as health and education as well as investment in infrastructure development.

The Greater Tubatse Local Authority is highly mountainous, thus development occurs mostly in valleys where settlements are small and scattered. Development potential and spatial patterns are determined by the location of steep ridges (Greater Tubatse LM, 2010). The estimated 2007 population is 343,468 with 66,611 households. Greater Tubatse Municipality has significant mining and manufacturing (ferrochrome smelters) sectors concentrated near district towns; yet unemployment is still significantly above the provincial average. Information from different sources suggests that new mining developments could reduce unemployment to 44% (Greater Tubatse LM, 2010).

3.2 Data

Background data was obtained from government reports and plans such as Integrated Development Plans and Current Public Transport Records. Demographic data such as population and economic activity came from public databases. Consultations with local authority officials helped identify the taxi associations in each district, with whom informal meetings were held to explain the project, to obtain buy-in and access, and to generate an initial understanding of taxi and bakkie operations in each area.

Many taxi services stage at formal and informal ranks in towns and at major transfer points (see Figure 1). Quantitative data collection included drunk surveys where data was

collected on routes served, vehicle types, departure frequencies, fares, and rank facilities. Cordon surveys at key points along routes provided a 9-hour frequency count (per vehicle type), and all routes were driven by researchers to visually assess road conditions and collect GPS coordinates. Maps of all informal public transport routes were identified with the operators. A total of 76 routes were identified for all three areas. By differentiating between the forward movement in the morning peak (06h00 to 12h00) and the reverse movement in the afternoon peak (15h00 and 18h00), we obtained a total of 152 routes. (The final sample contained 151 routes as one reverse route could not be surveyed due to conflict within one of the associations.)

We recruited and trained 24 local youths -- twelve from the Kgautswane Community Centre and twelve from Bushbuckridge -- to act as data collection assistants. A supervisor was also appointed and trained to assist with logistical arrangements and data capturing. Most of the youths from both areas had finished high school but were unemployed.

In-depth interviews were then conducted with managers of three taxi associations in each district, to understand what factors affect the decision of individual associations to operate a service on a particular road in a particular market. The open-ended interview covered broad issues around service quantity (e.g. how do they decide what frequencies to operate at, or which vehicles to use on a particular route?), pricing (how are fare levels determined?), travel demand, cost factors (profit margins and the effect of road conditions), trip distances, and competition from other operators.

The findings of the interviews were presented to the institutional stakeholders in order to strengthen their own understanding of the private sector transport operating environment. The qualitative findings also act as a check on the findings of the quantitative cross-sectional analysis.

4. FINDINGS

The quantitative and qualitative data covered a wide range of issues relating to the supply of informal transport in the case study areas. We focus here only on analyses of the relationships between informal transport and road quality; vehicle types and their organization into networks; and factors affecting the frequency and pricing of these various informal services.

4.1 Public transport routes and road infrastructure

Figures 2, 3 and 4 show the spatial patterns and public transport routes for Bushbuckridge, Makhuduthamaga and Greater Tubatse local authorities. The manner in which local topography affects network patterns is evident when comparing Greater Tubatse -- with its long routes along narrow valleys -- with the denser coverage of Bushbuckridge and Makhuduthamaga. The many dead-end routes and lack of

Figure 1: Examples of operating conditions in case study areas



Minibus-taxi in Kgautswane offloading passengers at a muddy cul-de-sac without formal infrastructure



An interchange point between minibus taxis, bakkies and private cars in Motlolo village



An area used as a bakkie rank in Burgersfort town



Typical rural road infrastructure used by rural public transport operators in Makhuduthamaga area

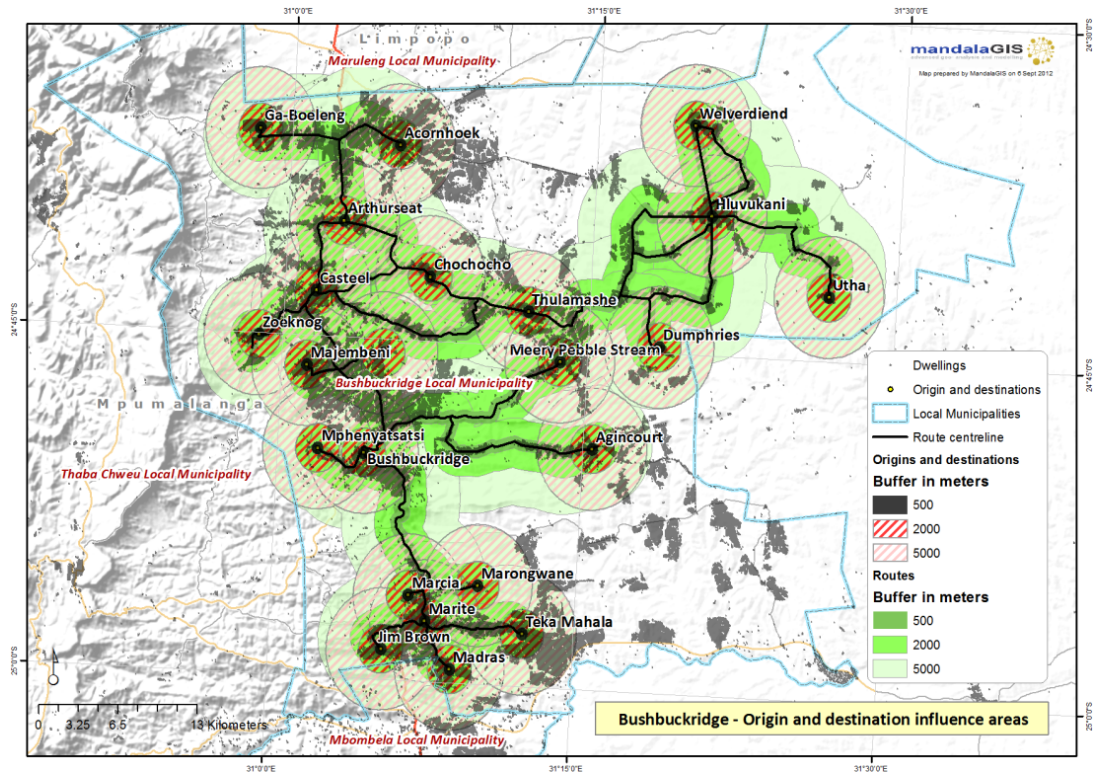


Figure 2: Bushbuckridge Local Authority spatial pattern and public transport corridors

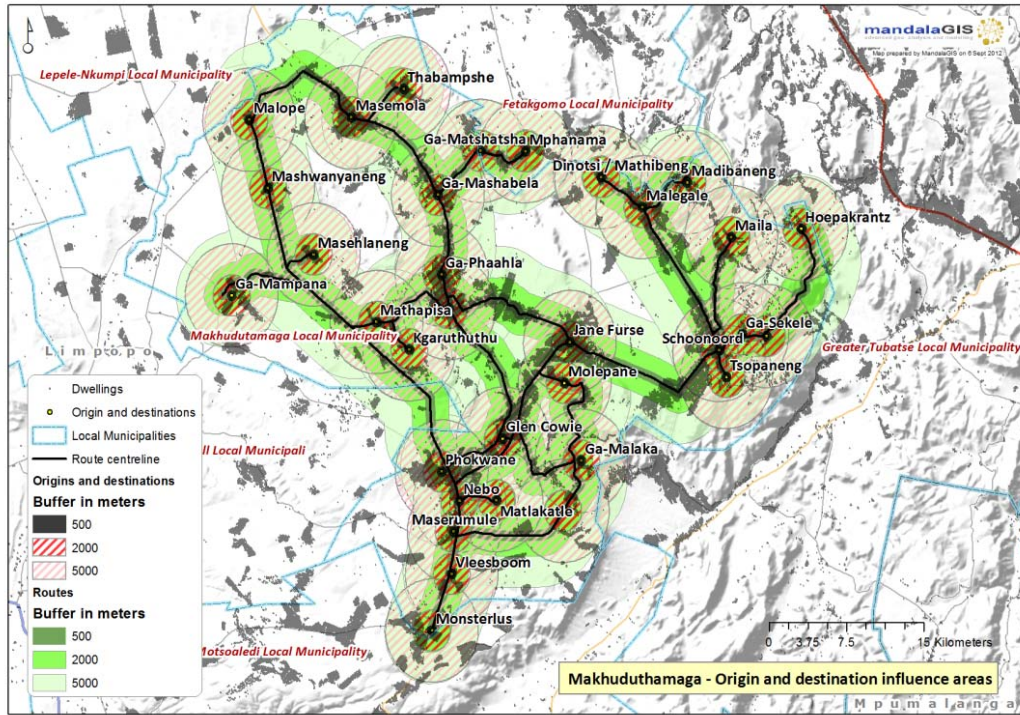


Figure 3: Makhuduthamaga Local Authority spatial pattern and public transport corridors

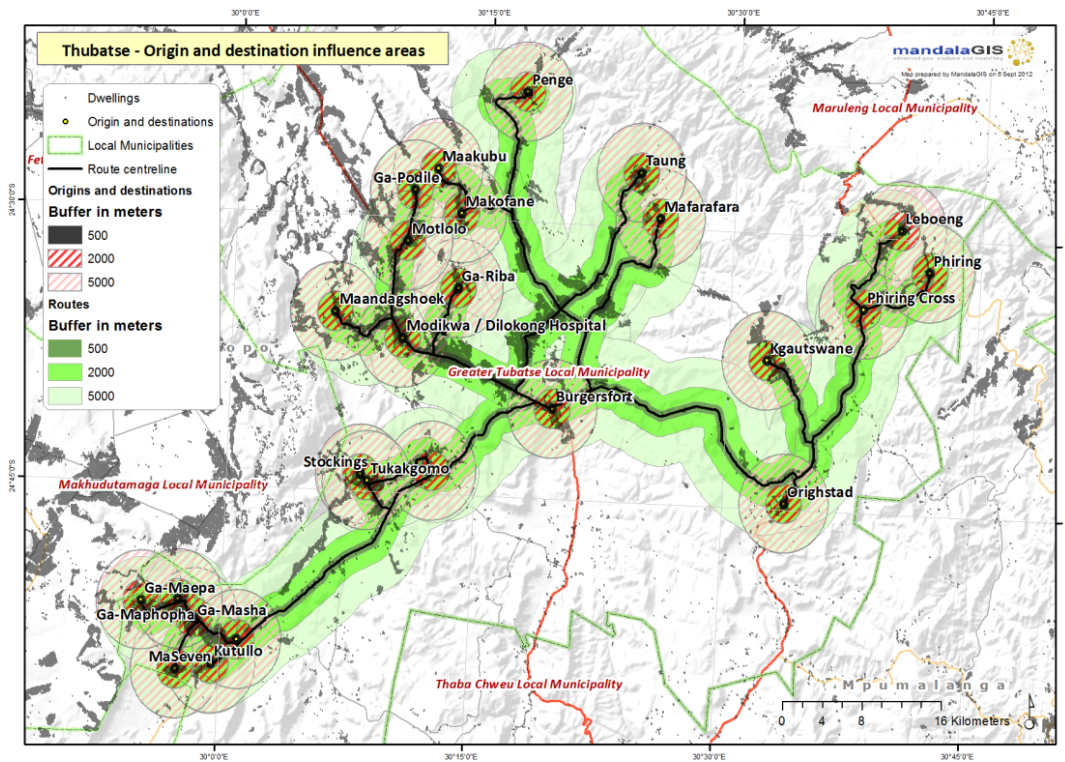


Figure 4: Greater Tubatse Local Authority spatial pattern and public transport corridors

connectivity in Greater Tubatse can be expected to raise fares or depress frequencies, due to the greater risk operators bear under such conditions (Ellis and Hine, 1998).

Routes are also much longer in Greater Tubatsethan in the other two areas. Table 1 shows that the 23 routes surveyed in Greater Tubatse cover 735 route-kilometres, at an average of 31.9km – much longer than the averages of 18.6km and 15.9km in Makhuduthamaga and Bushbuckridge respectively. These longer routes result in more route-kilometers per capita being operated in Greater Tubatse, but at a lower frequency (as will be shown below) and thus lower availability.

Differences in government capacity between the areas are also evident when comparing road conditions. Table 1 summarizes road conditions for all public transport routes in the three case study regions. Road conditions were classified using visual inspection using standard classification procedures while being travelled by a researcher in a probe vehicle.

Table 1: Summary of route lengths by road condition

Local Authority	No. of Routes	Route length (km) per road type		Total route length (km)	Route-km per 1,000 people	% of route-km per road condition*			
		Surfaced	Gravel			Excellent	Good	Fair	Poor/Very poor
Makhuduthamaga	29	292.6	246.1	538.7	1.794	10.2%	45.0%	18.7%	26.1%
Bushbuckridge	23	183.3	183.9	367.2	0.720	26.9%	35.0%	28.5%	9.7%
Greater Tubatse	23	574.9	160.2	735.1	2.140	4.7%	52.0%	15.3%	28.0%
ALL	75	1050.8	590.1	1640.9	1.422	11.5%	45.9%	19.4%	23.3%

Note: *Road condition based on visual assessment

Approximately 26% of the surveyed routes in Makhuduthamaga are in poor and very poor condition, 28% in Greater Tubatse, and only 10% in Bushbuckridge. Only 10% and 5% of the Makhuduthamaga and Greater Tubatse networks, respectively, are in excellent condition, as compared to 27% in Bushbuckridge. Since the areas are broadly similar in climate and traffic conditions, we could attribute this difference mostly to differing capacities of the three local authorities to manage and maintain their road infrastructure, as well as the extent of historical backlogs. Furthermore both Makhuduthamaga and Greater Tubatse fall within the same district administration, which struggles to manage its district roads. Bushbuckridge, on the other hand, has been designated a presidential nodal point, which has given it access to preferential budgets and technical expertise from national government.

The impact of poor road conditions on transport supply and prices is examined later.

4.2 Vehicle differentiation and network organization

Four vehicle types operate passenger services in these areas: buses, minibuses, bakkies, and a collection of other small vehicles. Figure 5 shows examples of different modes observed in the study areas.



Figure 5: Examples of types of modes observed in the rural areas

Bus services are the only formal, scheduled services, operated under contract to the provincial authorities and subsidized by government. The typical vehicle is a rugged 65-seater high-floor bus.

Minibus-taxi services are operated with 16 or 18-seat vehicles. A large proportion of minibuses observed here are new vehicles, partially funded in terms of the South African government's Taxi Recapitalisation Programme which provided legal taxi owners with an incentive to scrap and replace old vehicles with newer models with enhanced safety and passenger comfort features. 'Bakkie' services use pickup trucks or light delivery vehicles (LDVs), with or without canopies for passenger protection. A variety of other passenger vehicles, collectively called 'Kartjiebans', include old taxi vehicles or small Venture vans. Both have a typical seating capacity of about 6 to 12 passengers. In Tubatse old sedan vehicles (called "4+1"s) were also observed.

Although minibus-taxi operators are legally required to possess operating licences and thus fall within the ambit of government regulation, we found that many do not operate with licenses, making them *de facto* informal operators with internal control over all aspects of their service. Bakkies and kartjebans do not have permits or operating licenses, and are not formally acknowledged as passenger vehicles by law. All informal operators tend to operate on fixed routes, but with flexible schedules, typically departing only when full.

Despite their precarious legal status, bakkies contribute a sizable 14%, 20% and 30% of public transport in Bushbuckridge, Makhuduthamaga and Greater Tubatse respectively (Table 2). In all areas bakkies, minibuses and kartjebans provide more than 95% of public transport service, making them by far the most important mobility provider.

Table 2: Public transport supply per mode in case study areas

Vehicle type (Service type)	Road type	Total daily vehicle frequency (vehicle trips per 9-hour day)		
		Makhuduthamaga	Bushbuckridge	Greater Tubatse
Bakkie (Informal)	Gravel	138 (16.9%)	103 (10.9%)	130 (20.8%)
	Surfaced	35 (3.5%)	28 (3.0%)	55 (8.8%)
	ALL	203 (20.4%)	131 (13.9%)	185 (29.6%)
Minibus (Informal)	Gravel	98 (9.8%)	163 (17.3%)	97 (15.5%)
	Surfaced	645 (64.9%)	594 (63.1%)	295 (47.1%)
	ALL	743 (74.8%)	757 (80.5%)	392 (62.6%)
Other small vehicle* (Informal)	Gravel	17 (1.7%)	17 (1.8%)	15 (2.4%)
	Surfaced	2 (0.2%)	5 (0.5%)	0 (0%)
	ALL	19 (1.9%)	22 (2.3%)	15 (2.4%)
Bus (formal)	Gravel	10 (1.0%)	10 (1.1%)	12 (1.9%)
	Surfaced	18 (1.8%)	21 (2.2%)	22 (3.5%)
	ALL	28 (2.8%)	31 (3.3%)	34 (5.4%)
ALL TYPES	ALL	993 (100%)	941 (100%)	626 (100%)

*Other informal include Kartjebans (old minibuses and vans) and private cars operating for-hire public transport services, i.e. smaller vehicles with capacities of between 6 and 12 passengers.

The manner in which the services of minibus-taxis, bakkies and kartjebans are differentiated becomes obvious when one examines the road types used by each (Figure 6 and Table 2). Minibuses tend to operate predominantly on surfaced roads; the higher the road quality, the higher the taxi frequency. For instance, in Bushbuckridge, 78% of minibus-taxi supply is on surfaced roads; of this 9 out of 10 taxis ply on roads with an excellent or good condition. Average frequencies (in terms of vehicles per hour) are about ten times higher than on roads in fair or poor condition. This was confirmed during the qualitative interviews where the operators indicated that they do not prefer to deploy their vehicles on gravel roads as it reduces the life-span of a vehicle. They indicated that vehicles operating on gravel roads would typically break down within two

years of purchase, leaving them with high maintenance and capital repayment costs for the duration of the contract.

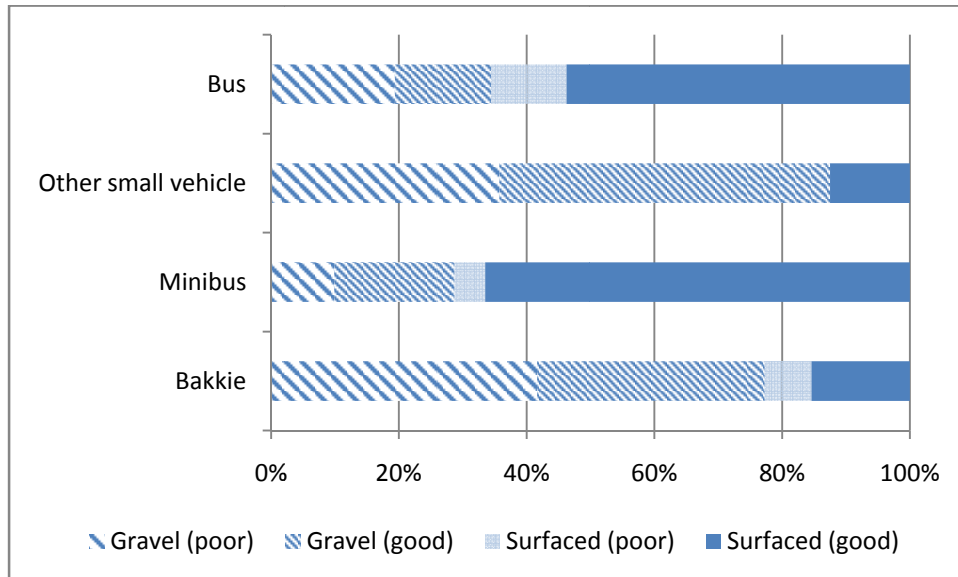


Figure 6: Percentage of trips operated by different modes per road type and condition (all areas combined)

Operators estimated the average age of minibus taxis at less than 6 years – an indication of the success of government’s Taxi Recapitalisation Programme. However an unintended consequence of this success appears to be a gradual withdrawal of minibus services from lower quality rural roads.

The gap is clearly being filled by bakkies and, to a lesser extent, kartjebans. Overall, 78% of bakkie supply is on gravel roads (Figure 6). About half of this is on gravel roads in poor condition. Kartjebans and other small vehicles are lowest in the hierarchy, with almost 90% of their routes restricted to gravel roads.

The allocation of vehicle types to routes is the result of careful and rational decision making on the part of associations. Firstly, associations of minibus operators dominate route allocation; they would normally deploy their vehicles on busier corridors with proper infrastructure. By mutual consent the potential market is divided up between associations into non-overlapping geographical areas. This avoids direct competition on the route. Incursion of these informal “property rights” is often met with violence.

Associations then allocate specific minibus-taxis to specific routes, using a rotational system to ensure all members get equal exposure to profitable corridors. Figure 7 shows an example of the simple boards that are used to manage the rotation system.

Although bakkie and minibus operators are traditionally in conflict over the right to operate, we found evidence of emerging coordination between them. Most operators of

bakkies and kartjebans are not formal members of taxi associations, but are coopted to provide feeder services along low quality local roads, but only up to the main road network where passengers have to transfer to a minibus for the last leg of the trip to town. This arrangement clearly benefits the minibus operators by consolidating demand. It also benefits bakkie operators, many of whom are aspirant minibus owners, who now have an entry point into the association. It can however be said to disbenefit passengers, who incur sometimes lengthy waits and discomfort at the transfer point. However, associations indicated that, without the lower-quality bakkie and kartjeban vehicles, they would not be willing to penetrate as deeply into rural areas.



Figure 7: Example of board used by minibus associations to manage rotation system for members

4.3 Factors affecting service frequencies

In order to further examine the factors affecting the quantity of service by different vehicle types deployed on specific routes, we estimated two linear regression models. The dependent variables were the daily frequency of (i) all informal public transport, and (ii) only minibus service, on each route during the morning and afternoon periods. Twenty-three potential explanatory variables were tested, including variables describing the quality of road and rank infrastructure, route lengths, population densities within various buffers from the route and the origin and destination, the extent of economic activity within these buffers, competition from other modes, and location effects related to each study area (captured as dummy variables).

Table 3 shows the results of the best two models, containing only significant effects of non-correlated independent variables. The R-squared values for the two models are fairly low (0.20 and 0.30 respectively), indicating that the decisions around service frequencies are complex and only partially explainable by indicators measured at the route level; nevertheless the results confirm previous research and shed further light on supply processes.

Table 3: Regression results: Factors explaining frequency of public transport vehicles per route during AM and PM peaks					
Type of factor	Variable	Model 1: All informal modes		Model 2: Minibus mode	
		Estimate	T statistic	Estimate	T statistic
Infrastructure	%GRAVPOOR: Percentage of route that is gravel and in poor condition	-3.194	-1.117	-4.838**	-2.011
Infrastructure	FORMALRANK: 1 if formal rank is used at route origin	2.646	1.307	4.196**	2.464
Demand	POPDENS: Average population density (persons/ha) within 0.5km of route	0.279**	2.193	0.289**	2.698
Demand	ECONACT: Average GVA ⁽¹⁾ (Rands/ha) within 2km of route	0.032	1.501	0.038**	2.104
Route	ROUTELENGTH: 1 if route is longer than 30km (one-way)	-3.997	-1.429	-2.250	-0.957
Competition	BUSTRIPS: Number of daily bus trips on same route (AM & PM peaks)	2.379**	3.402	2.407**	4.093
Constant	CONSTANT	4.838**	2.159	0.745	0.395
N=		151		151	
Adjusted R ² value=		0.201		0.307	
F statistic (p-value) =		7.282** (0.000)		12.056** (0.000)	

Notes: 1 GVA = Gross Value Added, a measure of all economic output generated within buffer zone around route.

*Significant at 95%

**Significant at 99%

The models firstly confirm Ellis and Hine's (1998) finding that service frequencies are related to both the demand density (indicated by the population per hectare resident within 500m of the route) and the users' ability to pay (indicated by the Gross Value Added (GVA) per hectare within 2 kilometers of the route). The 500m buffer for demand density worked much better than larger buffers, suggesting that transport service frequencies respond to the immediate catchment area around a route.

More interesting is the way in which infrastructure, route length, and competition affect supply. As hypothesized, poor quality gravel roads clearly depress minibus frequencies,

but not those of other informal modes such as bakkies and kartjebans (note the insignificance of the %GRAVPOOR variable in Model 1). Taxis are more likely to increase frequencies where formal taxi ranks are supplied, as these also attract other economic activity such as informal trading and increase potential transport demand. ROUTELENGTH is only marginally significant, indicating that there may be a tendency among informal operators to avoid long routes, especially those longer than 30km (one-way), as it becomes impossible to make more than one trip in the peak hour.

Lastly, the strongest explanatory variable (with the highest T statistic) is the number of bus trips operating along the same route. This suggests that formal and informal public transport services are complementary rather than substitutes for each other. Bus services tend to operate mostly on higher volume corridors, but have insufficient capacities to satisfy all demand, leaving a large market for informal modes. Previous research has also indicated that busses typically serve commuters with repetitive daily travel patterns, whereas informal transport suits passengers in need of flexibility (Venter and Venkatesh, 2009) – thus the markets are not perfectly overlapping. In fact most associations felt their relationship with the bus industry to be generally healthy.

4.4 Pricing of informal public transport

Figure 8 shows the average fare per unit distance charged by public transport operators in the case study areas. Bus fares are significantly lower than those of other modes, mainly due to the fact that busses are subsidized. This was reiterated by the informal transport providers, who felt that subsidies were the biggest competitive advantage of the bus mode.

On average, bakkies and kartjebans charge a slightly higher fare than taxis, but Figure 8 shows that this is mostly due to road conditions as bakkies and kartjebans operate primarily on gravel roads. There is a strong relationship between road type and condition, and the average fare charged by informal operators. Bakkie fares are on average 65% higher on gravel than on surfaced roads; for minibuses the figure is 28%. Operators pass the extra operating costs associated with bad road conditions on to users. There might also be an element of monopoly pricing involved, as the bakkies tend to operate in areas with no other services. Surprisingly, though, none of the associations cited infrastructure as a determining factor when setting fare levels.

The general sense of business confidence among rural public transport providers is quite low. During engagements with the operators and management, it was indicated that many do not perceive their business as profitable or sustainable, but since economic opportunity is limited they do not leave the industry.

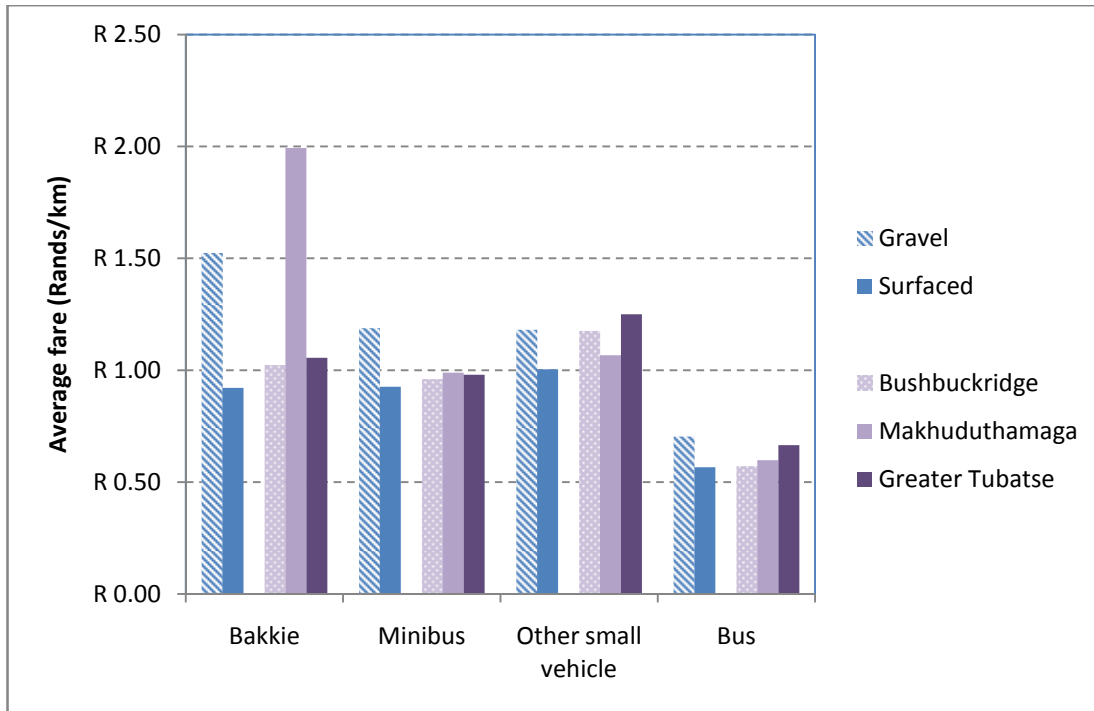


Figure 8: Average fare per kilometer per mode, road type and area

To determine the relative contribution of various factors to the price of informal public transport, we estimated a third regression model taking the average per-kilometer fare as the dependent variable. A similar set of explanatory variables was tested as in the frequency models described above. We also estimated the marginal effects of each significant variable to indicate the effect on the average fare of a unit increase in the independent variable. Results are given in Table 4.

Prices are most strongly influenced by the type of vehicle (%NONTAXI), route length, and road condition (%GRAVPOOR). (Route length is endogenous as it is used to determine the dependent variable.) Everything else being equal, bakkie or kartjieban services add almost 50% to the price *regardless of the road condition*, indicating that a measure of monopoly pricing is indeed at play. Across all informal modes, operating only on poor gravel roads adds about 31% to the price. Less significant effects are population density (taxi operators seem to charge slightly more on denser routes) and the frequency of bus trips on the same route (higher bus frequencies depress the fares of informal modes slightly). There is thus a competitive effect of the lower-priced buses on informal mode pricing.

Table 4: Regression results: Factors explaining average fare per kilometer of informal transport services

Type of factor	Variable	Model 3: All informal modes		Marginal effects ⁽³⁾	
		Estimate	T statistic	Marginal fare effect	% of average fare
Infrastructure	%GRAVPOOR: Percentage of route that is gravel and in poor condition	0.245**	2.672	+R4.22	+31%
Demand	POPDENS: Average population density (persons/ha) within 0.5km of route	0.006*	1.689	+R0.11	+1%
Demand	ECONACT: Average GVA ⁽¹⁾ (Rands/ha) within 2km of route	0.001	0.952	--	--
Route	ROUTELENGTH: 1 if route is longer than 30km (one-way)	-0.241**	-2.826	-R4.14	-30%
Competition	BUSTRIPS: Number of daily bus trips on same route (AM & PM peaks)	-0.038*	-1.811	-R0.66	-5%
Vehicle mix	%NONTAXI: Percentage of informal PT ⁽²⁾ trips by bakkie or other small vehicle	0.364**	4.062	+R6.28	+46%
Constant	CONSTANT	0.711**	9.025	+R12.26	+90%
N =		151			
Adjusted R ² value =		0.295			
F statistic (p-value) =		9.976** (0.000)			

Notes: 1 GVA = Gross Value Added, a measure of all economic output generated within buffer zone around route.

2 PT=Public transport

3 Marginal effects calculated as increase in fare associated with one unit increase in independent variable. Based on average fare in the sample (R13.58). Only calculated for significant variables.

*Significant at 95%

**Significant at 99%

5. CONCLUSIONS: IMPLICATIONS FOR RURAL TRANSPORT SERVICES

The paper describes the characteristics of supply and pricing strategies of informal rural public transport operators in South Africa. The research provides statistical and qualitative confirmation of previous findings around the factors driving transport supply in rural areas of Sub-Saharan Africa, but adds significant new insights that can help shape more effective responses to the rural mobility challenge.

In agreement with previous research, we find that the condition of roads (both paved and unpaved) is a very important determinant not only of the quantum of service, but also the quality of vehicle used. Minibus vehicles are not likely to be deployed on badly maintained or unpaved roads, even if taxi associations have legal permits/operating licenses for operating along a certain route. Thus minibus-taxi services are predominantly deployed on surfaced roads, and offer higher frequencies on surfaced

roads with better conditions. The situation is being exacerbated by government-driven efforts to upgrade and renew the minibus vehicle fleet through the South African Taxi Recapitalisation Programme. While there is an improvement in vehicle and service quality, operators are hesitant to deploy newer (more expensive) vehicles on poor quality roads, leading to a reduction in supply of quality rural transport services.

The research also showed that poor quality gravel roads increase average fares by a third. Operators pass the extra vehicle operating costs on to passengers. While road condition is not the only factor driving supply and pricing, there remains a strong rationale for using (appropriate) infrastructure improvement strategies as a way to leverage better and more affordable private sector transport services in rural areas.

What is appropriate? It appears that upgrading gravel roads from poor to good condition can have a greater incremental impact on service availability and fares than upgrading them to a paved road standard. Operators avoid or reduce frequencies on overly long routes – the research suggested a threshold route length of around 30km (one-way). Judicious road investments would focus on missing links to reduce dead-ends and detours. The research also found that minibus operators are attracted to routes with formalized ranks at their end points – ranks generate other economic activity such as trading, which increases transport demand. This lends support to the provision of rank infrastructure as a way to promote private sector transport supply.

On gravel roads and (to a lesser extent) some surfaced roads in poor condition, the mobility gap is often bridged by 'second tier' operators providing services with pickup trucks ('bakkies'), old low-quality minibus vehicles, or sedan taxis. Although these operators are often ignored by government, they provide a significant amount of transport – almost a third of public transport supply in the case study areas. We also found evidence of intentional coordination between bakkie and minibus operators, leading to a rational organization of routes and vehicle types where bakkies and smaller vehicles provide feeder services along poor quality local roads up to main roads, and minibuses serve major routes to district centres.

Thus a differentiated service hierarchy is emerging involving a greater variety of vehicle types suited to different operating conditions. This is encouraging, as it presents evidence of the kind of local innovation that has been called for by previous studies (e.g. Barwell, 1996; Ellis and Hine, 1998). Perhaps governments' role in this regard should be to find ways of enabling and supporting such innovation and coordination, while treading lightly with regard to promoting competition. While we found some evidence of uncompetitive pricing resulting from such self-organisation in rural transport markets, it seems equally clear that rural mobility benefits significantly from this differentiated approach, especially the most isolated communities who would otherwise have no motorized transport option available.

Lastly, informal rural transport operators indicate that they are operating at very low profit margins. Many do not perceive their businesses as sustainable. Rural mobility would certainly benefit, in the long run, from active government involvement in the

promotion of sustainable business practices through information provision, training, and corporatization of informal transport providers.

ACKNOWLEDGEMENTS

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