

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 study were to:

- Examine the extent and characteristics of public transport supply in selected rural areas of South Africa;
- 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
- 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 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

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.

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. Quantitative data collection included rank 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

It is evident from the study that local topography affects network patterns, for example, comparing the spatial pattern and public transport corridors in 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 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 Tubatse than 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.

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.

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 1 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.

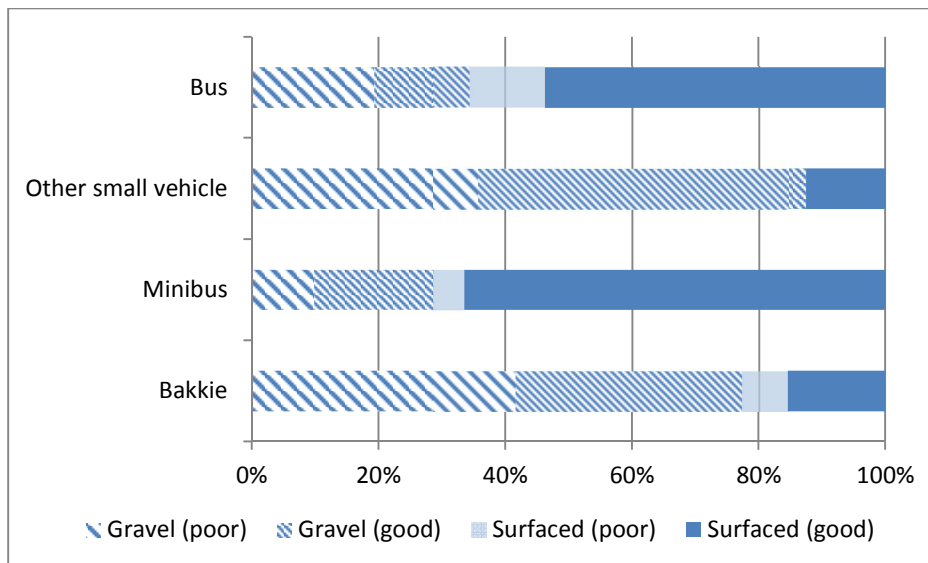


Figure 1: Percentage of trips operated by different modes per road type and condition (all areas combined)

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, kartjiebens. Overall, 78% of bakkie supply is on gravel roads (Figure 1). About half of this is on gravel roads in poor condition. Kartjiebens 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 kartjiebens 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 kartjieban vehicles, they would not be willing to penetrate as deeply into rural areas.

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.

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 2 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.

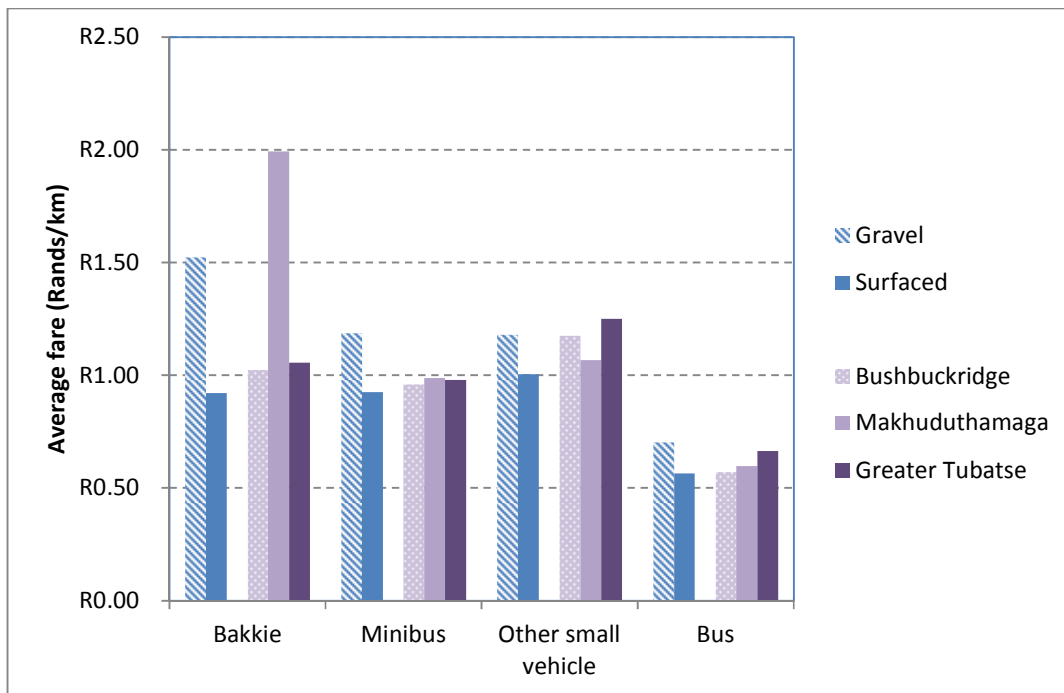


Figure 2: Average fare per kilometer per mode, road type and area

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.

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.

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