APPROACHING RURAL ROAD INVESTMENTS WITH A TRANSPORT SERVICES PERSPECTIVE

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ABSTRACT

The 'Interactions: Maintenance-Provision of Access for Rural Transport Services (IMPARTS)' research project is studying how the provision and maintenance of low-volume rural roads impact rural transport services and the mobility of people and their goods. The road provision-preservation-services continuum requires an integrated approach to ensure road investments are well-planned, cost-effective and appropriate to rural communities.

Rural people are diverse, with different transport needs to access markets, healthcare, education, livelihood opportunities and other facilities. Transport services are essential for rural mobility in low-income countries with low vehicle ownership. Road investment proposals often assume that rural mobility will be enhanced as transport services respond by reducing tariffs and improving vehicle capacities/frequencies. However, based on literature and contacts with road authorities in seventeen countries, there appears little objective evidence to support this. Few rural road initiatives have conducted baseline, post-investment and follow-up surveys related to transport services. Roads authorities generally use traffic count information and not transport services data in prioritising investments. Rural road asset management should involve managerial, technical and socio-economic issues, but political considerations may divert resources from maintenance to road provision.

The literature reports many beneficial correlations between road investments and socio-economic development. Negative developmental correlations may occur as roads fail due to poor maintenance. Better roads can lead to higher agricultural production, higher attendance at schools and health facilities, and more economically-important trips. However, few research papers have reported on the enabling transport services, relying instead on socio-economic, GIS or other data sources for the correlated outcomes.

Rural transport services include minibuses, taxis, trucks and motorcycles, with different advantages, disadvantages, price-ranges and infrastructure needs. Many operate to-and-from small town hubs, providing mixed passenger-freight transport services, often using old, over-loaded, vehicles. On many rural roads, motorcycle taxis are the most common vehicles and may serve off-road villages.

Traffic count analyses illustrate how some road investments led to more vehicle movements, with some price effects (highly dependent on vehicle type and distances). However, some investments produced unexpected results due to externalities unrelated to asset management (including climate, national issues and traffic diversions from/to other roads). Some poor transport services responses related to alternative (preferred) routes and

insufficient transport demand, suggesting insufficient stakeholder consultation prior to investments.

The paper outlines deficiencies in rural road planning procedures and guidance from rural road impact studies for developing countries. A particular weakness is when major changes in modal composition occur following road investment. For example, when new road access is established or when vehicle impassability is substantially reduced throughout the year. Although calls for a more integrated approach between road investment and different sectors of the economy are frequently made, in practice, this rarely happens. To address the issue, the paper draws on recent research from Ethiopia, Liberia, Kenya and Tanzania to show how transport services data can help provide a bridge between rural road investment, and different sectors of the economy. It is argued that, if funds are limited, motorcycle trails can be an effective solution to help people access markets, schools and health care. However, conventional vehicle access is required if substantial volumes of agricultural produce need to be moved. A more comprehensive use of transport services data, is advocated, and this should help improve the prediction of sectoral outcomes following rural road investment.

Road authorities should become proactive in developing innovative provision-preservation-services approaches, with more attention to transport services. This may require inter-disciplinary approaches, capacity building and active cooperation (or integration) with transport authorities.

1. INTRODUCTION

The impacts of road investment are often categorised in terms of the effects on different sectors, for example on agricultural production and marketing, on health services and on education. As a result, to make the case for road investment there have long been calls to integrate the planning of rural roads with other sectors. It is argued that other sector specialists would support the case for better road access if they could see more clearly the links between road standards and the success of their own sector. Unfortunately, the detailed connections are rarely made. For most locally financed rural road investment in low-income countries, road planners and road engineers usually just rely on road condition data and sometimes traffic flows to make their decisions. These decisions may be backed up by generalised arguments from impact studies. There is usually little information to integrate the demands of different sectors into meaningful flows of vehicles.

Donor supported investment programmes may require formal traffic based prioritisation procedures (based on say traffic flow, population and investment costs) or simple transport cost-benefit analysis (for example using the Road Economic Decision (RED) model [1] in which traffic flow data is combined with vehicle operating cost coefficients to calculate a rate of return [2]). Even here there is little connection between the road investment and the sectoral use.

While the standard approaches may work for incremental improvements of rural roads with high traffic flows, it is not so useful when traffic flows are low, subject to major interruption, and there are major changes in transport mode, or substantial new investments or new links are proposed. Another issue that needs to be considered is the development of low-cost motorcycle trails for remote communities. There has recently been a huge growth in motorcycle use in many developing countries, yet until now, it has been difficult to assess how effective these would be to meet the needs of the rural population.

A possible approach to help address the problem is to use transport services data as a bridge between different sectors and road investment planning. Although there is no fixed definition of 'transport services' it usually relates to the different modes of transport that are used, their carrying capacity, typical journey distances, journey purposes, freight characteristics, patterns of operation and the fare and freight tariff levels incurred.

In this paper, the use of transport services data is examined to show how it may relate to the availability of roads and road condition, provide connections to different sectors, and provide new approaches to road investment. Data from recent research undertaken by the authors in Liberia, Kenya and Tanzania is presented. This is supplemented by other research findings on the planning and impacts of rural roads.

The paper examines three interrelated issues:

- Current deficiencies in guidance for rural road planning. This relates both to findings from impact studies and the use of appraisal models
- The relationship between the composition of transport services and their relationship with different sectors of the economy
- Predicting changes in transport services following major changes in road investment

2. IMPACT OF RURAL ROAD INVESTMENT – HOW TRANSPORT SERVICES, AND ROAD DESIGN ARE MISSED OUT

2.1. Impacts of rural road investments

A lack of rural transport is recognised to be a major constraint to development and an important contributor to poverty in many regions. A disproportionate proportion of poor people live in rural locations. While 58% of the population of low-income countries live in rural areas, 78% of the extreme poor [3], and 85% of the multidimensional poor, measured by the Multidimensional Poverty Index (MPI), are located in rural areas [4].

There is a substantial volume of literature that examines the impacts of rural roads. A recent systematic review of the impact of rural roads [5] was carried out that initially screened 5,500 references, based on titles and abstracts. Of these, 120 references were examined in detail of which 56 studies were analysed and the findings presented. Overall, it was found that rural road investment had important positive impacts on rural incomes and consumption, agricultural output, marketing and employment. Health and education were also positively affected although there was also some evidence of an increase in communicable diseases. Despite the volume of literature, only a few studies provided hard evidence on transport costs (7 studies) and traffic volumes (5 studies).

An important finding of the systematic review was that the studies were very weak in their analyses of different engineering solutions, road standards and the effects of road length in relation to the provision of transport services. As a result, the studies are of little use as a guide to the prediction as to how transport services will respond following a road investment or, more importantly, to an engineer looking for guidance to optimise the design of the road [5].

Only two studies provided guidance as to the standard of road interventions that would maximise income generation and reduce poverty. Fan, Zhang and Rao suggested that

money spent in Uganda on feeder roads (i.e. basic access roads) would lift three times as many people (per unit of investment spent) out of poverty compared with building higher standard gravel ('murram') or sealed roads [6]. The other analysis related to China [7] and suggested that lower-quality roads would be much more effective (per unit of investment spent) in reducing poverty than higher-standard ones. However, in both these cases, the function of roads cannot be separated from their engineering design. Escobal explored the effects of improving trails as well as low volume rural roads (LVRRs) in Peru. In this case both types of infrastructure provided positive effects on incomes, but the change was only statistically significant for the rural roads [8].

Many of the studies examined in the systematic review [5] considered that transport costs and traffic volumes were the main indicators of the means by which road improvements affect the rural economy and social outcomes. However, the actual mechanisms by which road investments lead to the improved outcomes (such as the roles of transport services) were not explored.

2.2. Deficiencies in rural road appraisal models

The most common economic model used to appraise rural road investment and plan maintenance interventions is the Highway Development and Management model, HDM-4, [9] and its derivative, the Road Economic Decision model, RED [1]. The latter model is more specifically designed for low volume rural roads, while the former can also be used for major highways. The models are widely used in low and middle income countries, particularly to appraise specific donor funded investments, and to provide a framework for prioritising road investment and maintenance.

Although there is no absolute consensus on deficiencies, perhaps the most important weaknesses of the economic component of the models are:

- The vehicle operating cost relationships are largely based on research that is now 30 to 40 years and have not been updated. In addition, in many developing countries, the majority of the conventional vehicle fleet is composed of imported second-hand vehicles which has caused unresolved complications in the prediction of vehicle maintenance costs. The default relationships (which can be adjusted in HDM-4, but not in RED) tend, in many instances, to substantially over-predict vehicle operating cost savings. In fact a very wide response in vehicle maintenance costs with roughness has been observed. [10].
- The transport cost savings approach to estimating benefits assumes a competitive economy and full employment of resources (perhaps not the most realistic assumption of rural areas of developing countries). There is no facility to introduce 'wider economic benefits' or the 'economies of agglomeration' [2].
- The models give little or no guidance in predicting a response in traffic and transport services following a major change investment or a likely major change in transport mode.

It is beyond the scope of this paper to investigate the first two issues, which tend to counteract each other. However, a greater examination of transport services, particularly examining predicted running and maintenance costs against actual maintenance costs and gross revenues may improve the realism of the data and coefficients employed.

One way to predict a response from improved infrastructure on travel patterns is to make use of known transport price elasticities, which relate a change in travel volume to a change in the price of travel. Transport price elasticities are defined by a proportionate change in transport demand divided by the proportionate change in the transport price. These ratios

can be used to predict how the volume of travel and transport may respond to a predicted change in fares and tariffs (or to the cost of running privately-owned vehicles). A study of high-income country data, found that the elasticities for cars ranged between -0.1 to -1.1 and for buses from -0.1 to -1.3. For aggregated commodities carried by truck, the range was -0.7 to -1.1 [11]. To interpret these figures, if an elasticity was -0.7 then a 10% decline in fares and tariffs brought about by a road investment should be consistent with a 7% rise in traffic volume.

It is sometimes suggested that a modelled decline in transport costs, (as opposed to a decline in transport fares or charges) for a given road investment can be used to predict increase in traffic volumes using a transport elasticity. However, care needs to be taken with this approach because the section of road being upgraded may only be a small part of the total journey. The elasticity of demand relates to the price of a complete journey. So for a given elasticity, improving a 50 km road section will give a much larger response if the total journey is only 60 km, in comparison with the situation when the 50 km improvement is part of a 200 km journey, even though of course, the change in costs, (which may be calculated via HDM-4, or RED) is the same. This is another example where a more complete understanding of transport services will lead to better predictions rather than just mechanistically relying on vehicle operating cost modelling.

It is also important to realise that price elasticities are not necessarily fixed, although they will tend to lie within a certain range. The elasticities can vary from case to case, according to the composition and patterns of travel and the local economy, and the responses can change over time.

Lipmann has pointed out that a particular price increase (or decrease) is likely to have very different effects on people of different incomes [12]. There is reason to suspect that price reductions for lower income people will generate a higher response (i.e. give a higher elasticity) than for richer people. It is argued that where different modes of transport are in play, higher elasticities may result.

Another issue that needs to be addressed is when a substantial change in transport mode is forecast to occur, as for example when new vehicle access is provided when previously people had to walk, for all or part of a year. Not only is there difficulty in predicting the scale of response in traffic volumes, the whole basis of valuation may become suspect particularly when considering the effects on medical emergencies. Medical emergencies are usually of major interest when access and mobility issues are discussed with women in rural areas. When a road is impassable to conventional motorised vehicles then patients have to be manually carried (or transported on a motorcycle, if it can reach the village). Valuing time savings, of for example, not being carried by neighbours for two hours, is completely inappropriate when lives may be at stake. If one is inclined to include the ‘value of life’ in the calculations, there is little data on the probability of dying in such situations, or being seriously incapacitated for life. It is for this reason that ‘social benefits’ are sometimes recommended, based on providing year-round vehicle accessibility for the population, as an alternative planning approach [13, 2].

3. TRANSPORT NEEDS AND RELEVANT MODES OF TRANSPORT

3.1. Trip destinations and modal composition examples from Ethiopia and Ghana

For rural people, their choice of transport mode will depend on many factors, notably the journey purpose, trip length and availability of means of transport. Unfortunately, there is relatively little published data on rural trip destinations or on trip length. However, a recent source from Ethiopia provides this data [14]. Table 1 summarises the data from studies in four regions of Ethiopia: Amhara, Benishangul-Gumuz, Tigray and Southern Nations, Nationalities, and Peoples' Region (SNNPR). Most rural residents lack personal means of wheeled transport and tend to depend on walking (for shorter journeys) and transport services (for longer trips). Most journeys started in their home villages, and Table 1 illustrates people's most frequent destinations, modes of transport used, trip distance and journey times. The data derives from an ongoing study investigating the outcomes and impacts of a rural road investment programme.

Table 1 - Data on trips, relative frequency and mode of transport in four regions in Ethiopia [14]

Destination	**Relative frequency %**	**Means of transport used**			**Distance *km***	**Time taken *minutes***
		Walking %	**Motorcycle Bajaj %**	**Bus/ minibus %**		
Most visited market	15.8	56	16	14	7.7	70
Nearest hospital	3.6	17	14	67		
Nearest clinic	3.6	56	23	15	8.2	70
Nearest health post	6.2	97	1.3	0	1.9	18
Nearest health centre	6.8	59	18	9.9	6.8	58
Farm land	9.6	99	0	0		
School	5.7	96	1.8	1.4	1.5	16
Safe water	8.6	97	0	0	1.2	13
Religious centre	11.2	98	0.9	0.5	1.5	16
Recreation place	2.4	67	12	13	4.8	44
Most visited relatives	7.7	60	12	24	19	
Village (*kebele*) centre	8.9	88	4.2	5.1		
District (*woreda*) centre	8.1	29	25	35		
Regional centre	1.7	6.3	7.8	84		

Table 1 shows that for the shortest journeys (e.g. to collect water, go to the farm, school, religious centre or health post), people in the study areas overwhelmingly walked. For intermediate distance journeys (i.e. health centre, market, district centre), motorcycles and three-wheelers were more frequently used. While some of the motorcycles would have been for personal or family transport, most would have been informal sector motorcycle taxis, particularly in the south. The motorised three-wheelers (known locally as Bajajs after the brand name of a major Indian manufacturer) provide informal public transport services. For the longest journeys (to hospital or regional cities) people tend to use minibuses and larger buses, with much of this travel on the national road network.

Another example of different frequencies of travel by journey purpose is given in Figure 1 for rural Ghana. In Ghana, motorised trips are predominantly made to markets, hospitals or visiting friends and relatives. Short-distance trips tend to be for visits to school, market, grinding mill and for religious purposes.

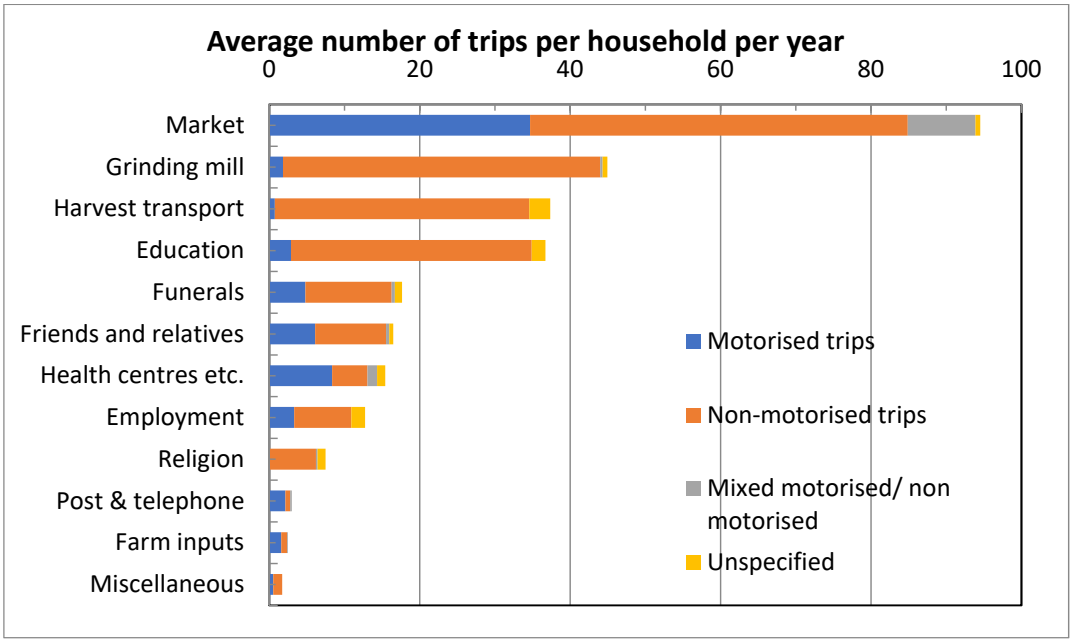


Figure 1 – Out-of-village travel patterns by trip purpose and mode for rural Ghana [15]

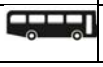
Both the Ethiopian and Ghana studies confirm that visits to markets and health centres are major journey destinations where motorised trips are used. To reach the roads that had bus or minibus services, many people would have used another mode of transport (walking, or motorcycle/Bajaj). This exemplifies comparable situations in many countries where, transport services are stratified, with 'conventional' bus and minibus services operating along main roads from regional hubs. There may be complementary 'feeder' services using smaller capacity vehicles (motorcycles, three-wheelers and rural taxis) operating from smaller district hubs or village hubs or hubs located at road junctions [16, 17, 18].

The stratification of transport services is often necessary on low volume roads, as transport demand is insufficient to justify regular bus or minibus services. Smaller-capacity vehicles such as motorcycles, three-wheelers or rural taxis may be able to provide transport services on narrow rural roads, although, without the economies of scale of larger vehicles, they are likely to charge more per passenger kilometre and per tonne-km. Other widely-adopted strategies to make rural transport services profitable include maximising loading (waiting for a full load and/or over-loading) and using older vehicles of low capital cost [17]. However, one of the main changes in rural access in recent years has been the huge increase in the number of motorcycles on rural roads, whether operated for personal transport or operating as transport services [19].

3.2. The influence of markets on travel patterns in Liberia

Attending markets is an important reason for travel, and markets can be a major source of traffic. This is shown in traffic data (Table 2) collected from four locations in rural Liberia. Markets appear to have been a major influence in pedestrian, motorcycle, pick up and truck traffic.

Table 2 - Traffic count summaries on rural roads in Liberia on market and non-market days [20]

	Pedes-trian	*Bicycle*	*Motor-cycle*	*Car*	*Jeep, pickup*	*Mini bus*	*Bus*	*2-axle truck*	*3+ axle truck*	*Tractor / other*
										
Zuatuo–Graie										
Market	413	5	203	18	47	0	0	25	13	6
Non-market	291	3	98	22	17	13	0	11	6	14
Bahn–Saclepea										
Market	446	5	609	19	36	12	0	13	14	16
Non-market	415	4	161	9	23	7	0	14	5	35
Gbalorkpala-Botota										
Market	171	0	314	9	11	0	0	1	5	0
Non-market	27	2	23	13	17	0	0	2	17	0
Wohn-Gibi–Kakata										
Market	217	0	145	1	12	0	0	0	1	5
Non-market	37	0	38	0	4	0	0	0	0	0

However, markets are not the only source of traffic shown in Table 2. The various large trucks were associated with mining enterprises and Liberia's substantial rubber plantations. The Wohn-Gibi–Kakata road had no nearby mines or rubber plantations, and hence few large trucks.

Stallholders, wholesalers and other visitors were also interviewed at the market to determine their means of transport, travel time and costs. The data is shown in Table 3.

Table 3 - Modes of transport used to access markets in Liberia [20]

	Jennepleta	Graie	Saclepea	Gbalorkpala
People Interviewed No. (Nº)	48	50	34	50
Women %	67%	60%	65%	56%
Stallholders (Nº)	38	31	30	35
Visitors looking to buy (Nº)	8	17	1	11
Wholesalers (Nº)	3	2	3	4
Mean travel time to market (mins)	16	49	58	34
Transport means				
Taxi/car (%)	77 %	50 %	50 %	52 %
Motorcycle (%)	6 %	28 %	38 %	40 %
Walking (%)	5 %	22 %	12 %	8 %
Bicycle (%)	2 %	0 %	0 %	0 %
Travel Cost				
Mean total cost (US $)	$ 1.73	$ 3.68	$ 4.39	$ 4.16
Mean Passenger cost (US $)	$ 1.11	$ 2.62	$ 1.91	$ 2.38
Mean Freight cost (US $)	$ 0.86	$ 1.64	$ 2.48	$ 2.21
Mean cost by taxi (US $)	$ 1.73	$ 4.42	$ 5.71	$ 5.42
Mean Cost by motorcycle (US $)	$ 1.75	$ 2.01	$ 2.65	$ 2.52

Over half the people interviewed were women, reflecting the importance of women as market sellers and buyers. More than half of the respondents came by car taxis, with motorcycles the second most important form of transport. This is also reflected in the breakdown of their travel costs, with 38-56% of people's travel costs being for freight. As noted, if the survey had concentrated on people coming to buy produce and goods for the household, there would have been a much higher percentage of people travelling on foot and by motorcycles.

There are important differences, between markets, in the average and maximum travel time and costs involved, and some of this can be related to the market location. Jennepleta market is on the main Ganta-Gbarnga highway, with many traders travelling by taxi from Gbarnga, which is reflected in the highest use of taxis and the relatively low travel times and

travel costs. The high travel times and costs of the large Saclepea and Graie markets are considered to be a reflection of the wide catchment area of these markets, with traders travelling large distances to attend. Compared to the large markets, Jennepleta had less use of motorcycles and had lower average and maximum travel times and costs, but a greater use of car-taxis, than the other markets and appeared to draw from a smaller catchment area than the other markets. Gbalorkpala is a medium size market, with fewer people travelling in from other districts. This is reflected in the shortest average travel times and the highest percentage use of motorcycles. Nevertheless, some traders travel there from Gbarnga and further afield, and this is reflected in the high average and maximum travel costs.

3.3. Accessibility and modal choice for education

In most low income countries going to primary school is overwhelmingly undertaken on foot or by bicycle. Even if a motorised transport service is available it would usually be too expensive to use to go to primary school [21]. Studies in Ghana and South Africa show it is common for children to walk an hour or more to school. Distance to school can be a major factor in preventing girls from attending school. In South Africa the Shova Kalula (Ride Easy) National Bicycle Programme, which commenced in 2001, aimed to provide one million bicycles to disadvantaged groups in rural and peri-urban areas. The objective was to help both school children get to school and for farm workers [22].

Motorised transport is more likely to be used for attendance at secondary schools, but often not on a daily basis. Due to long distances and high costs, it is common for pupils to board at school, or in houses near the school, travelling on a weekly or half-termly basis. In middle and high income countries it is common for governments to provide subsidised or free school transport. Extra help is also given to children with disabilities who find it difficult to use buses, to enable them to use private mean of transport or taxi services. In contrast, in most low-income countries, rural transport subsidies are rare, and it is generally only the more expensive private schools that arrange school bus services.

A recent survey was carried out on school transport in rural Liberia, which covered three senior schools and one primary school. As can be seen in Table 4, the most frequent means of transport was by walking, particularly for the primary school and one secondary school. However, for two secondary schools a large minority of children (38% and 42%) travelled to school by motorcycle. No other means of transport (e.g. bicycles, taxis or minibuses) were identified. Liberia is unusual in Africa for its relatively low use of bicycles. However, motorcycle use in rural areas is now very common.

Mean motorcycle fares (US 41 cents, and US 25 cents) are relatively expensive compared with average per capital incomes of around US$ 700 at the time of the survey in 2016. Hence it is likely that only the richest sections of the rural population could afford the daily use of motorcycles for school children. It is believed that the high use of motorcycles for secondary school attendance is unusual in low income Africa, although the authors have observed a high degree of motorcycle secondary school use in rural areas of middle-income Malaysia.

Table 4 - A survey of school transport in rural Liberia [20]

	St Francis High School, Tappita	Johnny Voker High School, Saclepea	Zokeseh Public School, Ganta	Jennepleta Primary School, Jennepleta
% Walking Mean distance km.	62% 1.5 km	58% 0.7 km	95% 5.1 km	98% 1.7 km
% by motorcycle Mean distance, km	38% 3 km	42% 2 km	5% 12 km	2% 7 km
Mean motorcycle fares (US cents)	41 cents	25 cents	90 cents	58 cents

Infrastructure can play a role in education. In the systematic review of rural road impacts it was found that in three out of five studies (in Morocco, Vietnam and Nigeria) a beneficial effect of rural road impacts on educational outcomes was found. However, two studies (Ghana and another study for Vietnam) found no beneficial impact [5]. In Morocco, road improvement has been reported to improve school enrolment rates and educational attainments through reduced absenteeism (of both teachers and pupils), easier recruitment of teachers, better supply of teaching materials, and through the increased construction of primary schools where the presence of a road was a key planning criterion [23].

3.4. Access to health centres and hospitals

When discussing accessibility and mobility issues with the rural population, the most important concern raised by women is usually ‘How do we get to hospital in times of an emergency?’ Complications in childbirth tend to be the biggest fear. To properly address this issue requires both passable roads and an available means of transport. Discussion on planning issues for emergency transport is given in Section 2.2 on the deficiencies of rural road appraisal models.

An example of the connections between the importance of timely transport and healthcare has been demonstrated by the link between obstetric fistula (a highly debilitating condition resulting from complications in childbirth) and poor transport access in Ethiopia. Success in treating obstetric fistula is highly dependent on minimising the length of time between the onset of the condition (i.e. childbirth) and getting to hospital. As a result, staff at the Fistula Hospital in Addis Ababa have taken a particular interest in improving rural transport access in Ethiopia [24].

There have been a number of transport service initiatives to help get people to hospital. In Malawi and Zambia, Transaid has been working with local communities to provide bicycle and motorcycle ambulances. Riders for Health, which works in seven African countries, provides specialised training in the maintenance of vehicles for health staff. Likewise, the Partnership for Reviving Routine Immunization in Northern Nigeria, Maternal, Newborn and Child Health Initiative in association with Transaid, has been working with the National Union of Road Transport workers to provide elementary training for taxi drivers, in the emergency transportation of women in labour to the closest hospital. Compensation is paid to the driver for the cost of fuel only. The driver also gets the advantage of going to the front of the taxi queue, when he next reports for duty. Between January 2010 and May 2012, 5,515 emergency transfers were recorded [25].

A survey of transport to health centres and hospitals was carried out in rural Liberia. The results are shown in Table 5. What is particularly interesting is the high degree of the use of motorcycles. Although it is often stated that pregnant and nursing mothers find it difficult to use motorcycles, in fact 74% of women attending the CB Dunbar Maternity Hospital in Gbarnga were recorded as using motorcycles to get to hospital with only 2% using taxis.

Table 5 - A survey of transport to health centres and hospitals in rural Liberia [20]

	Botota Health Centre	CBD Maternity Hospital	AFBM Health Centre	E & J Medical Centre	Saclepea Health Centre	JFD Referral Hospital
Location	Botota	Gbarnga	Gbarnga	Ganta	Saclepea	Tappita
Patients surveyed	41	54	51	50	47	60
Percent women (%)	95 %	100 %	71 %	88 %	57 %	83 %
Means of Transport						
'Only walking' (%)	85 %	24 %	27 %	18 %	6 %	22 %
Motorcycle (%)	15 %	74 %	71 %	68 %	55 %	43 %
Motorcycle and Taxi (%)	-	-	2 %	8 %	28 %	7 %
Taxi (%)	-	2 %	-	6 %	38 %	13 %
Jeep, Minibus or Bus (%)	-	-	-	-	-	9 %
Ambulance (%)	-	-	-	-	-	3 %
Private Car (%)	-	-	-	-	-	3 %
Journey time (minutes)	82	13	24	46	57	150
Maximum (Hours-mins)	4-0	0-45	1-45	8-0	2-45	8-0
Mean Fare (US$)	$ 1.31	$ 0.41	$ 0.73	$ 1.73	$ 4.05	$ 5.94
Maximum Fare (US$)	$ 3.00	$ 3.75	$ 5.00	$16.00	$15.00	$20.00

Obviously there can be major issues carrying sick people to hospital by motorcycles. Frequently, a sick or frail person will be held on by another passenger. Where they are available, motorcycle 'ambulances', involving a side car, can be used.

3.5. Modal choice and 'first mile' access to farms for commercial agriculture

Under the UKAid-funded African Community Access Programme (AFCAP) a series of studies were undertaken investigating how 'first mile' access problems affect the evacuation of produce from farm to the first collection or buying point. Pilot studies were undertaken in Nyeri County of Kenya [26] to investigate the movement of onions and Kilolo District Tanzania to investigate tomatoes [27]. These were followed up with a larger study of green beans in the Machakos and Meru areas of Kenya, and studies of potatoes in Matola and pineapples in Madeke areas of Tanzania [28].

The first two pilot studies showed how 'first mile' transport problems severely affected farmers' incomes. The initial transport is by far the most expensive. A lack of road access prevents the majority of produce being taken from farm straight to market. For onion farming in Kenya, the cost of the initial stages of transport accounted for between 10% to 20% of the net incomes that farmers would derive from their produce sale. Around 43% of onions were evacuated by head or backloading, 17% by animal transport, 7% by motorcycle, 5% by tractor, and 2% by wheelbarrow. In addition, 26% of onions were picked up by truck, straight from the farm and delivered to market. For the tomatoes, 88% were first transported by head/back load to the first buying point. The cost of this first movement was equivalent to 40% of the value of the tomatoes at the farm gate. The tomatoes would eventually be sold in Dar es Salaam for 250% more than the farmer received.

First mile transport data relating to the later surveys is given in Table 6, for Kenya, and Table 7 for Tanzania. The tables show that a diversity of modes were used in Machakos and Matola, but only head/back loading was used for 'first mile' transport in Meru and Madeke. The latter two areas had steeper terrain and much poorer vehicle access, making it more difficult to use other modes. The cost of transport, expressed per kg/km, is most expensive by head/backloading. The difference in transport charges between modes depends on trip distance and load. For short distance movements in the same location, the charges of motorcycle transport ranged between 36% to 68% of the charges of head/backloading, expressed per kg/km. Animal transport appears cheaper still ranging from 16% to 33% of head/backloading charges per kg/km. Note that the mean load is for the consignment, which

may be carried in several trips (for head loading or backloading it would be extremely unlikely to carry 90 kg in one trip).

Long distance movements enable far cheaper transport. The long distance movement of pineapples by truck (with a trip distance of 195 km) gives charges that are a tiny fraction of the costs of moving by head/backload (i.e. just 0.12 of one per cent per kg/km) while for motorcycles (with a trip distance of 31.5 km) it is just 1.44% of the costs per kg/km.

Table 6 - Transport survey data for first mile transport of green beans in Kenya [28].

	Machakos Farmers survey				Meru Farmers Survey	Meru Transporters survey
	Headload	Motor-cycle	Animal cart	Donkey	Headload	Motorcycle
Observations	50	23	11	7	82	8
Mean load kg	52.8	141.3	231.3	112.5	65	130
Mean distance km.	1.43	1.8	1.35	2.2	1.53	5.9
Mean US cents/kg	1.49	1.14	0.74	1.2	1.11	0.82
Mean US cents/ kg-km	2.03	1.39	0.65	0.63	0.95	0.35

Table 7 - Transport survey data for first mile transport of pineapples and potatoes in Tanzania [28].

	Matola Farmers Potatoes				Madeke Farmers Pineapples	Long Distance Transport of Pineapples	
	Head load	Motor - cycle	Donkey Cart	Ox Cart	Headload	Truck	Motor cycle
Observations	53	34	30	14	126		
Mean load, kg	91.9	85.7	101.9	123.4	37.1	3,505	103
Mean dist. km	0.67	1.44	1.78	2.15	0.34	195	31.5
Mean US cents/kg	0.84	1.04	1.11	1.11	1.51	5.05	9.5
Mean US cents/kg-km	5.38	1.95	1.79	0.88	20.9	0.026	0.3

To help put the different modes into relative context, Table 8 provides a rough outline ranking of characteristics of different loads. Head-loading and back-loading are the most flexible, able to work in almost any terrain. However, it is the most expensive (per kg/km). A large truck, potentially the lowest cost, but it is obviously less flexible in use, requiring a wide right of way, good alignment, and strong structures. With large wheels a truck can go through deep water which may defeat a saloon car or minibus. The ranking will not be uniform in all situations. An individual donkey may provide relatively expensive transport. However, a group of donkeys will provide much cheaper transport, as the main cost is the human attendant.

Table 8 - Characteristics of different modes

Flexibility in being able to work in different terrain and road conditions		Transport Costs (when fully loaded, and travelling reasonable distance)	
Most flexible	Head/backloading	Lowest Cost	Large truck
	Donkey		Medium truck
	Motorcycle		Large bus
	Tractor		Animal cart
	Animal Cart		Tractor and trailer
	4-wheel drive pick-up		4-wheel drive pick-up
	Medium truck		Small truck
	Small truck		Minibus
	Large truck		Saloon car
	Large bus		Motorcycle
	Minibus		Donkey
Least Flexible	Saloon car	Highest cost	Head/backloading

The effects of 'first mile' transport on net farmers' incomes are shown in Table 9. Here estimated crop losses associated with first mile transport (i.e. loading, unloading, bruising during transport) are given together with the transport costs as a proportion of net farmers' incomes. It can be seen that the total negative effect of first mile transport on farmers' incomes is around 15% for Machakos, 12% for Meru, (for green beans); and 33% for Matola potatoes and 39% for Madeke pineapples. There would obviously be huge advantages if produce could be collected by truck close to the farm and taken direct to a market, avoiding the costs of intermediate handling, and associated crop losses, at local collection points. Of course, to take advantage of the lower costs, substantial load consolidation is required, possibly through operating a 'milk round' approach whereby different smaller loads are picked up one by one, close to the farm, before the truck undertakes the longer journey to market or processing factory.

Table 9 - Effect of 'first mile' crop losses and transport costs on net farmer's incomes [28]

	Kenya		Tanzania	
	Machakos (green beans)	Meru (green beans)	Matola (potatoes)	Madeke (pineapples)
Estimated crop losses related to first mile transport	8.7%	4.7%	8.8%	14.3%
Transport costs as % of net farmers' incomes	6.4%	7%	23.8%	25%

A more detailed investigation was carried out for the Madeke pineapples, looking into how road accessibility could be improved for the more remotely located farms and analysing the effects on farmers' incomes. It was found that farms located further than 0.5 km from the collection point had 9% less yield, 7% higher non-transport production costs, and 16% lower selling prices compared with more closely located farms. The lower selling prices are likely to be a combination of greater bruising to the crop, combined with poorer bargaining power and less efficient marketing at less established collection points (with poorer access the more remote collection points will be subject to closure in the wet season). Overall it was estimated that a programme of road and track improvements in which trucks could come closer to the remote farms, throughout the year, would be highly beneficial in cost-benefit terms. Headloading distances, and therefore transport costs would be dramatically reduced. There would also be benefits of higher prices to farmers, through more efficient distribution and lower damage to the crop. For an investment of $0.5m it was estimated there would be a gain of around $1.9m in farmer's incomes, in present value terms, over 15 years, discounted at 12% [28, 29].

4. DISCUSSION

Drawing on a range of recent research, the paper has argued that existing rural road planning models are particularly weak when major changes in accessibility, or modal composition are predicted. Likewise, the numerous studies of rural road impacts have also been inadequate in providing detailed guidance for road planning. Where major changes in rural accessibility are anticipated, then a more holistic planning approach is required taking into account transport services.

The surveys from Liberia show that motorcycles alone can provide a useful means of transport for people to access markets, healthcare and schools. Rural Liberia has a low population density, and with the very high rainfall there is a high density of rivers and streams. To improve basic rural access, the national transport masterplan has proposed all

off-road villages be connected to the road network by low-cost motorcycle trails, involving simple water-crossing structures such as trail bridges [30]. Motorcycle trails and trail bridges have been used to connect off-road villages in many countries, and are now considered a realistic option to allow governments and authorities to provide basic access to their rural populations [31]. In view of the transport services data that has been collected, the solution appears sensible for remotely located communities, when funds are limited. However, as the surveys in Kenya and Tanzania have found, where substantial volumes of produce are to be transported then there are major benefits from providing access for truck transport.

Much more information is needed on how exactly transport services will respond to different road interventions. The examples given provide some insights into how transport services interact with different sectors. On-going research, implemented as part of the UKAid-funded Research for Community Access Partnership (ReCAP), aims to gather evidence of how changes in road condition affect transport services and how these changes in transport services differentially affect sector outcomes and impacts.

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