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TITLE The transition from non-motorised to motorised modes of transport

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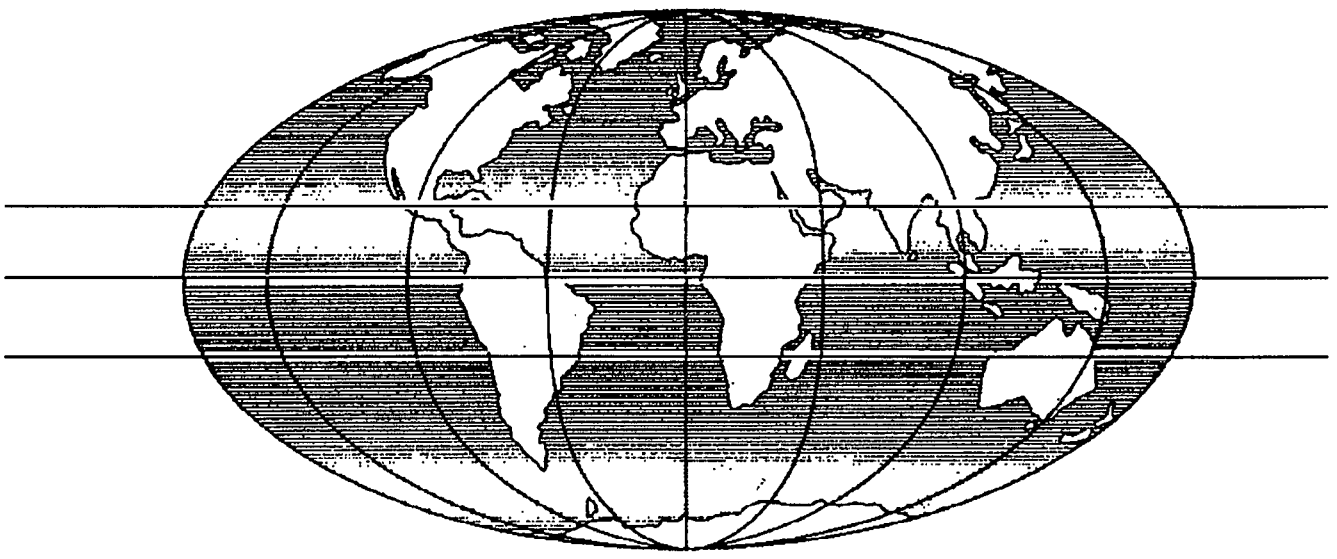

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THE TRANSITION FROM NON-MOTORISED TO MOTORISED MODES OF TRANSPORT

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1. INTRODUCTION

Recent studies carried out in the rural areas of developing countries have altered the way that transport planners look at rural accessibility. It is now understood that the bulk of transport requirements at the village level are for internal travel i.e. trips to collect water and firewood, to fields, and for internal marketing. Particularly in Sub-Saharan Africa, this transport is carried out on foot and by women, the use of other vehicle types, either motorised or non-motorised, is rare. However, in many parts of Asia there is a greater diversity in vehicle types which are used to reduce household transport burdens, as well as improve marketing efficiency.

The importance of the role played by non-motorised modes of transport (NMT's) in Asia is demonstrated by the proportion of these types of vehicles in the national fleet and the volume of goods they transport. For example, in Bangladesh a 1986 survey found that NMT's accounted for 94 per cent of all commercially operated vehicles and two thirds of total carrying capacity. Similarly in India, Srivastava (1989) estimated that there were 15 million animal drawn carts carrying between 1500-1800 million tonnes of goods per year. This exceeds by five times the quantity of goods being carried on India's railways. Bhalla et al (1994) finds that although the importance of NMT's is declining they still carry over half of all freight movements in the Northern and Southern regions in terms of tonnes.

By contrast Africa's reliance on NMT's is much less. Starkey (1989) estimates that although the population of Africa is half that of India they only have one twentieth of the number of animal carts. Additionally, the use of animals and other NMT's tends to be concentrated in North Africa and countries such as Ethiopia. The incidence of NMT's in the rest of Sub-Saharan Africa is much less, with many communities having no access to NMT's at all.

It is argued in this paper that the low diversity of vehicle types in Sub-Saharan Africa leads to high transport charges for rural communities. Many African countries lack the good base of NMT's and simple motorised vehicles that are common in much of Asia. This technology gap hinders economic growth in rural areas because as incomes rise, or farmers are able to take advantage of improved agricultural techniques, there are no appropriate technology options with which to capitalise on the situation. The gap between headloading and trucks or tractors is not only large in terms of cost, but also the skills and resources needed to support them.

From a transport perspective a low number and diversity of vehicles reduces competition for transport services. This results in poor operating practises. Vehicle utilisation is low; maintenance regimes are inadequate; and downtimes are excessive because of problems in the supply of spares and provision of technical services. Additionally, larger vehicles do not service the needs of rural communities whose demand is for transport over relatively short distances and relatively small loads.

The working assumption that is made throughout this paper is that agricultural productivity, and farmers incentives to increase it, are directly affected by farm gate prices for their produce. Therefore, a reduction in transport charges will effectively increase these prices as well as incentives to increase production and hence demand for transport services.

1.2 Methodology

The paper presents data collected in the rural areas of Thailand, Sri Lanka, Pakistan, Ghana and Zimbabwe as part of a three year project looking into the problems of the provision of rural transport services in developing countries. The survey used Participatory Techniques of Rapid Rural Appraisal as described by Chambers (1992). Each interview was conducted by the author and a member of the local community or researcher familiar with the area. The purpose of the study was to collect data on vehicle choice in rural areas of developing countries. This was accomplished through the use of semi-structured questionnaires and group sessions to gather information on vehicle operating costs, transport tariffs, constraints to vehicle use, and the type of operating environment necessary to promote the provision of efficient and competitive transport services. The main exercises used were:

1) Participatory Mapping - this involved drawing maps of the village indicating key destinations, distances and the roads used.

2) Historical Time Trend Analysis - this involved discussion with older members of the community to try and ascertain what has changed with regard to village transport and the factors which may have caused these changes.

3) Vehicle Preference Matrix - different vehicles were compared to each other against a set of important characteristics, most likely to affect vehicle choice.

4) Semi-Structured Questionnaires - vehicle questionnaires were conducted with all the major vehicle types in the village to calculate vehicle operating costs, hire costs, and the activities they are most used for. Household questionnaires were conducted to ascertain a households transport requirements.

5) Transect Walks - walks around the village to see first hand transport problems and their solutions.

6) Secondary Information - information from key informants either in the village or at administrative or research organisations in the country to get their perspective on the transport problems.

7) Seasonal Diagramming - designed to show the major activities in the communities agricultural calendar. A profile is then drawn to demonstrate seasonal fluctuations in vehicle usage.

2. TRANSPORT CHARACTERISTICS IN THE STUDY AREAS

The most obvious difference between the countries in the two continents is the greater number and diversity of vehicles in Asia. This is particularly the case with regard to the use of animals and other non-motorised modes of transport such as bicycles and handcarts. The degree of vehicle ownership, and the mix between motorised and non-motorised vehicles, varies greatly between and within the countries studied. Table 2.1 shows the large differences

in the level of vehicle ownership between countries and continents. The figures show the population per vehicle type for a representative village in each of the survey countries.

Vehicle Type	Thailand	Sri Lanka	Ghana	Zimbabwe
Non-Motorised	3.6	7.2	100	27.3
Motorised	3.0	58.3	-	300

Table 2.1: Population per vehicle type for typical villages in the survey sites

2.1 The Asian Transport Scene

Thailand was the most developed country visited, and Phitsanulok Province, where the study was carried out, is in the agricultural heartland. The use of animals in agriculture and transport has almost totally been phased out as land pressures have increased the cost of keeping animals. They have been replaced by simple motorised vehicles produced locally

	Thai Manufactured Chassis	Japanese Manufactured Chassis
Gear Box	Welded case of mild steel - heavy but easy to repair.	Caste iron case.
Transmission	Sprocket and Chain - cheap and easy to maintain.	A compact gear system.
Clutch	Four teeth at right angles to each other - the wear is greater but they are cheap to make and replace.	Multi-teeth dock clutch.
Brakes	No. Must disengage the transmission to stop.	Yes. Drum brakes.
Power Take Off	No.	Yes.
Gears	1 - 3 gears.	4 gears.
Dimensions W x L x H (mm)	1,080 x 3,250 x 810	1,080 x 3,250 x 810
Weight (kg)	220 kg	
Engine	8 - 11.5 hp but normally 8.5 - 9 hp. Engines manufactured through joint ventures between Japanese and Thai companies.	8 - 11.5 hp but normally 8.5 - 9 hp. Engines manufactured through joint ventures between Japanese and Thai companies.
Price - Chassis Engine	B11,000 - B15,000 B23,000 - B29,500	B25,500 B23,000 - B29,500

Table 2.2 - Power tiller specifications

in urban factories, such as the power tiller (a single axle tractor), and farm vehicles (E-Tan as they are locally known) which is an all terrain vehicle similar to a pickup. The power tiller has proved to be a perfect substitute for draught animal power. It is capable of performing all tasks associated with agriculture such as ploughing, threshing and pumping water, as well as transport tasks when attached to a trailer.

The design has been copied from imported Japanese power tillers but the technology used is appropriate to local manufacturing capabilities and needs of farmers. Therefore, the cost of the locally manufactured versions are a third cheaper than the imported equivalents. In many villages all households involved with agriculture own a power tiller. These vehicles have a load capacity of around one tonne and are complemented by specific transport vehicles such as the E-Tan, which has a load capacity of up to two and a half tonnes and is locally manufactured from second-hand pickup parts. Tables 2.2 and 2.3 demonstrate how local manufacturers can produce vehicles that are far less complex than the imported equivalents. Consequently they are considerably cheaper to buy spare parts are cheap and the technology is appropriate to the skills and resources available in rural communities. For longer distance transport, to regional markets for example, pickups and trucks are used. Household transport is satisfied by bicycles and motorcycles and again ownership levels are high.

Chassis	Manufactured at the factory from general steel
Rear Axle	From Toyota pickup, brakes are replaced but nothing else is done.
Suspension	New suspension from Izuzu pickup for the rear (very hard) and new suspension from Toyota for the front (softer). Some firms use Izuzu parts for both but driver comfort is not as good.
Transmission	From an old Toyota pickup, it is checked over and has new transmission oil.
Electric's	Built up in the factory.
Tyres	Goodyear 6.00 - 14 Nylon 6 ply rating.
Dimensions W x L x H (mm)	1,560 x 2,700-3,500 x 2,160
Weight	1,450 kg
Engine	The factory supplies with or without engines. If supplied they are Kubota single cylinder 8.5 - 16 hp.
Cost - Chassis Engine	With cab - B66,500 No cab - B40,000 With cab - B86,500 No cab - B60,000

Table 2.3 - Farm vehicle (E-Tan) specification

Sri Lanka and Pakistan are in an intermediate stage between the African countries and Thailand with regard to the level of vehicle ownership in rural areas. Both countries have a strong non-motorised vehicle base which satisfy the need for short haul, relatively low demand loads. Bicycles are extensively used for personal transport, and animals for agricultural and marketing purposes. Pakistan in particular, has a wide diversity of animal

transport including the use of donkeys, oxen, mules, horses and camels, either with or without trailers. In contrast Sri Lanka's animal transport is met almost entirely by oxen, although these are becoming less common in the face of increasing competition from power tillers, as experienced in Thailand.

The main competition to animals for draught agricultural and transport purposes varies between the countries studied, and is largely dependant upon their farming systems. In Sri Lanka the power tiller is now providing the main alternative to draught animal power, it copes well with the paddy cultivation which predominates and the small field sizes. In Pakistan the tractor provides the major competition as field sizes are larger and the agriculture more extensive. However, in both cases motorised vehicles have developed from a strong non-motorised base in response to increasing pressures on available land, more intensive agricultural production and increasing rural wages.

2.2 The African Transport Scene

As table 2.1 demonstrates the level of motorised and non-motorised vehicle ownership is considerably lower than in the Asian countries studied. Zimbabwe has one of the most developed transport infrastructures in Africa and this is now starting to extend into the communal areas (in the past the road network predominantly served white interests). It also has greater vehicle diversity with many areas having high animal cart ownership (donkey and oxen), and some households using wheelbarrows and bicycles for domestic tasks. In contrast, the use of animals or any other non-motorised transport mode in Ghana is extremely rare. In some villages there is no vehicle ownership of any kind. Transport tasks are completed almost entirely by headloading and by infrequent truck services. Not only are these services infrequent, but they also fail to satisfy the demands of rural communities, as a result, there is no alternative to headloading for long distances. In many cases load size is too small to justify a truck, but too big to be headloaded, which imposes restrictions on increasing production.

In both Ghana and Zimbabwe, government and donor agencies have devoted most effort in rural areas trying to make the quantum leap from human labour, whether for agriculture or transport, to tractors. The result has been highly unsuccessful, and highly subsidised tractorisation projects which lack any long term sustainability. Too little attention has been focused on promoting technology appropriate to the skills and resources available such as NMT's and simple motorised vehicles.

The consequence of these policies has been that the cost of transport services to rural communities in many parts of Africa are far in excess of those in Asia. This has been shown by previous research, for example, Ahmed et al (1987) found that African farmers get only 30-50 per cent of the final price of products, compared to 70-85 per cent in Asia. Similar research by Rizet et al (1993) into the difference in inter-urban freight charges between Pakistan and French speaking Africa, found that rates were between four and six times more expensive in French speaking Africa.

The data presented here confirms these findings, the subsequent analysis attempts to explain the differences, as well as stressing the importance of vehicle diversity and the need for non-

motorised vehicles in the early stages of a transport system to smooth the transition to simple motorised and then larger more sophisticated vehicles.

3. RURAL TRANSPORT CHARGES IN AFRICA AND ASIA

As discussed above, previous research has shown that transport tariffs in Africa are higher than in many Asian countries. The data presented here has been collected from the five survey sites and smoothed to produce the curves in figures 3.1 and 3.2. Figure 3.1 presents data from Zimbabwe, Ghana and Pakistan for various non-motorised modes of transport. The data from Zimbabwe and Pakistan are mainly animal carts where typical loads are between 500 kg and one tonne, the data from Ghana is for headloading where loads are in the range of 20 to 40 kg. It is clear that tariffs in the African countries are substantially higher, this is particularly the case in Ghana.

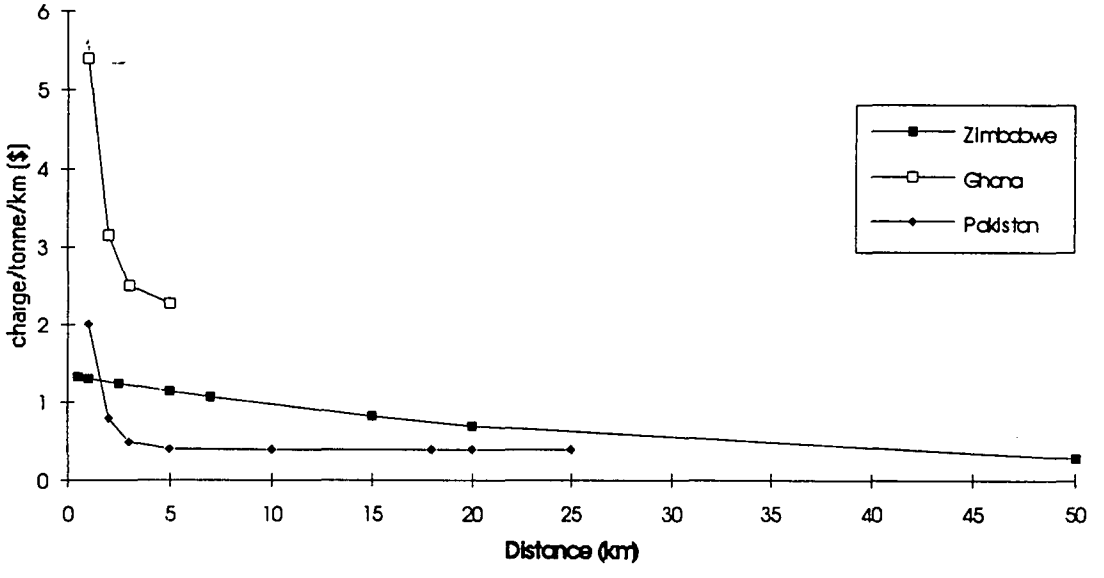

Figure 3.1: Tariff curves for non-motorised modes of transport

Although making cross country comparisons can be difficult, it is a worthwhile exercise because it highlights large differences in transport tariffs and points to major deficiencies in many African transport systems. In an attempt to compare the relative costs of transport for rural communities between countries, domestic tariffs have been converted to US dollars and also expressed as a proportion of the tariff per kilogram of rice at domestic prices. Table 3.1 shows that in dollar terms the cost of transport (charge per tonne per kilometre) in Zimbabwe is just under three times more expensive for a 5km trip and just under twice as expensive for a 20km trip as compared to Pakistan. However in Ghana this difference rises to nearly six times. The tariff as a proportion of rice is less clear cut in the Zimbabwe case falling from double the Pakistan level at 5km to only 20 per cent greater at 20km.

Similar trends are apparent when transport costs for motorised vehicles are compared. As illustrated in figure 3.2, African countries again have higher tariffs than in the Asian

examples. The vehicles in the survey were mainly those predominantly operating in rural areas, for example tractors, power tillers, pickups and a few trucks. Typical loads for these vehicles are in the range of one to five tonnes depending on the country and road conditions. If the data is further classified into vehicle types, it is found that the larger vehicles have lower tariffs, but the general trend remains.

Trip Distance	5 Km		10 Km		20 Km	
	$	Rice	$	Rice	$	Rice
Pakistan	100	100	100	100	100	100
Zimbabwe	280	190	240	160	180	120
Ghana	580	540	-	-	-	-

Table 3.1: The relative cost of transport for non-motorised modes of transport in US dollar terms, and as a proportion of the tariff per kilogram of rice.

In table 3.2 Pakistan is again taken as the base, the African countries have transport costs which are generally between two and two and a half times more expensive than in Pakistan in dollar terms. However, as distance increases in Zimbabwe the ratios narrow. Costs as a proportion of the tariff per kilogram of rice confirm these conclusions.

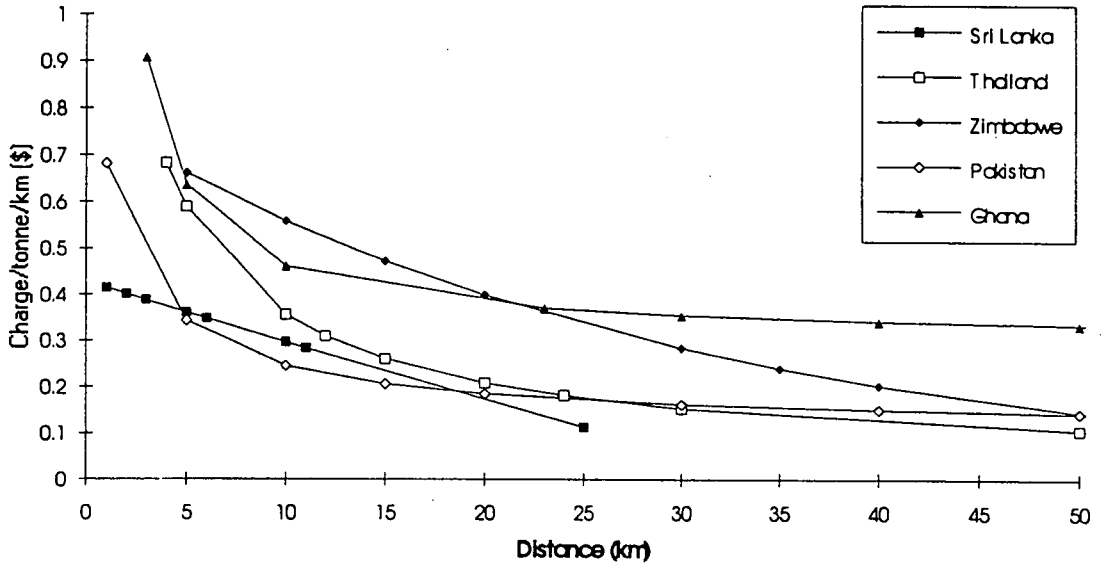

Figure 3.2: Tariff curves for motorised modes of transport

Thailand, which at first glance would appear to have the most efficient rural transport system, has higher than expected values both in dollar terms and with respect to the price of rice. This

is compounded by the way transport charges are made in the study area. For example, there is a flat rate for the transport of paddy within the district irrespective of the distance or vehicle type, therefore making short distance trips very expensive. Thailand also has a GNP per capita of over three times more than the next richest country in the study, possibly meaning that the labour component in total costs account for some of this difference.

The general conclusions that can be drawn from these results are that the African countries have transport charges in rural areas of at least double for relatively short haul trips. It is also apparent that Zimbabwe has a significant advantage over Ghana particularly when non-motorised modes of transport are considered, the category most affecting rural communities. In the next section, examination is made of how these results can be used to isolate particular problems in African transport systems.

Trip Distance	10 Km		25 Km		50 Km	
	$	Rice	$	Rice	$	Rice
Pakistan	100	100	100	100	100	100
Sri Lanka	120	110	65	60		
Thailand	140	190	106	130	80	100
Zimbabwe	220	150	200	130	100	70
Ghana	180	170	220	190	240	220

Table 3.2: The relative cost of transport for motorised modes of transport in US dollar terms, and as a proportion of the tariff per kilogram of rice.

4. THE TARIFF FRAMEWORK

In order to understand the deficiencies in the African transport system it is important to know the components which affect the size of the tariff and hence the cost of transport to rural communities. Figure 4.1 sets out a basic framework linking major components to the tariff. The left side deals with vehicle operating costs and those factors affecting fixed and variable costs. The right side deals with the operating environment of the transport vehicles involved, for example, the degree of competition and size of market. Components such as credit can influence both sides of the equation. The cost impacting on fixed costs, whilst availability affects choice. Accordingly these components are grouped under institutional infrastructure and include, the degree of regulation in the market and the backup infrastructure for the sale and repair of vehicles.

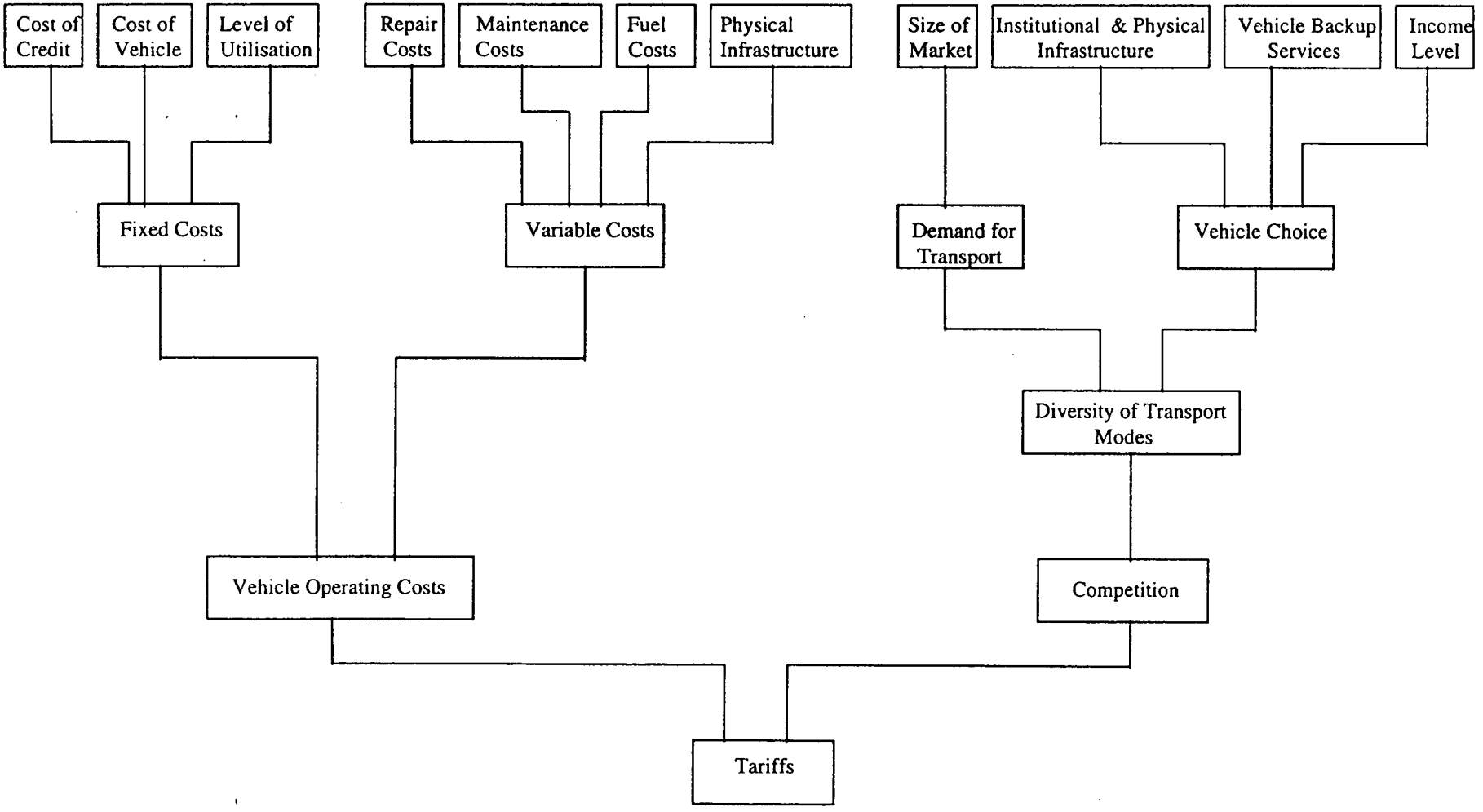

Figure 4.1: The components of a transport tariff

Vehicle Operating Costs - these costs are split between fixed and variable. Fixed costs are a function of the price of credit, vehicle prices and the level of utilisation. The higher the level of utilisation, and the lower the cost of vehicles and credit, the lower will be fixed costs. Variable costs are a function of repair costs, maintenance costs, fuel costs and the quality of the physical infrastructure i.e. primarily road roughness. Similarly, the better the quality of road infrastructure the lower will be repair, maintenance and fuel costs. However, the cost of these factors can also be reduced in their own right, and therefore also reducing variable costs. If the sum of fixed and variable costs can be reduced this will place a downward pressure on tariffs.

Competition - the efficiency with which transport operations are conducted is largely due to the competition in the market. If margins are squeezed by cheaper competition, this forces operators to increase utilisation and employ more efficient operating practises to ensure survival. The level of competition, in part, is going to be influenced by the number and diversity of vehicles, which in turn is a function of the demand for transport and amount of choice of vehicle type.

Transport demand is largely determined by the size of the market. In rural areas demand is related to population density and the intensity of agricultural production. Vehicle choice is affected by the type and quality of physical and institutional infrastructure, the vehicle backup services available, and the income level. Physical infrastructure affects the type of vehicles that can operate, for example, both trucks and bicycles can operate on a road, but only a bicycle can operate on a path. Institutional infrastructure affects the way that policy makers promote the use of certain vehicles, such as NMT's, and encourage local production. Institutional infrastructure also encompasses the availability of credit, and provision of markets etc. Vehicle backup services relates to the quality of mechanics, repair facilities and the availability of spares, the level of which will affect the complexity of vehicles that can be operated. Rural income levels also play a central role in the determination of vehicle choice, in some communities even the simplest of NMT's are out of reach to the majority of the population.

4.1 Constraints to Efficiency, Competition and the Introduction of IMT's in the African Transport System.

Institutional factors - it is often argued that one of the biggest problems to more widespread use of NMT's in Africa is the view held by government departments that this type of technology is backward, with the mechanised approach being the only way forward. This has resulted in NMT's, and simple motorised vehicles, not being promoted as much as is deserved, particularly by agricultural extension workers. This has been compounded by the fact that in areas where tractorisation projects have been attempted and failed, there is a great reluctance by local communities to use draught animal power or power tillers for example, when they have seen the superior productivity of tractors.

Utilisation - it is the low level of utilisation which is the biggest problem in Africa. This is further accentuated by excessive regulation in transport markets and the existence of highly subsidised vehicles and credit, particularly in tractorisation projects. For example, in a tractorisation project in the Afram Plains in Ghana, the Agricultural Mechanisation Office

estimated that the tractors were utilised around 800 hours per annum, whereas privately owned tractors in Pakistan operate up to 2000 hours per annum. In Asian countries utilisation levels are kept up by vehicle owners moving to different agro-climatic zones, allowing year round vehicle use. This is not just the case with motorised vehicles, for instance, in Pakistan camels are moved hundreds of kilometres to help out in harvests. Regulation and subsidy in any country have the effect of reducing efficiency and utilisation and therefore increasing costs.

Maintenance - in this context maintenance refers to the routine care of a vehicle, for example, changing the oil and filters, topping up the grease, and the more frequent checking of oil and water levels. It is very difficult to estimate the precise effects of poor maintenance practise on vehicle running costs, but it is clear that the lack of a maintenance culture in many parts of Africa drives up overall costs. For example, on a tractor scheme in Ghana where maintenance practise was poor, engine overhauls were being done every two years. In Pakistan where maintenance is probably carried out a little too over zealously, tractor engine overhauls happened only after five years and later. In filling out the survey questionnaires, the responses given in the Asian study areas were far more complete on all aspects of maintenance, and this was particularly noticeable for owners of NMT's.

In a comparison of freight costs between French speaking African countries and Pakistan good maintenance practise was identified as a key factor in explaining low running costs in Pakistan. Improved maintenance practise, particularly in Sub-Saharan Africa, has the potential for dramatically reducing the operating costs for all vehicle types. Drivers and owners need training on the importance of maintenance and of planning for the future i.e. saving for the big expense that is bound to come.

Vehicle Backup Services - the lack of a maintenance culture in Africa results in high repair costs and excessive down times. These problems are heightened by inadequate vehicle backup services with regard to repair facilities, technical expertise, spares availability, the dissemination of operating information, and manufacturers. Expertise in Africa tends to be very centralised around service centres and there are very few mechanics and facilities in rural areas. In contrast, Asian villages nearly all have small workshops dedicated to the service of vehicles. Again in Asia there has been a natural progression from the maintenance and repair of NMT's to simple and then more complicated motorised vehicles. In Thailand this process has further been smoothed by the existence of manufacturers making small, technically simple, motorised vehicles appropriate to the resources available in rural areas. It has the added advantage of being able to supply parts which are locally made and not excessively expensive.

Market size - the demand for transport is closely related to population densities and therefore the intensity of agricultural production. In general, Africa has low population densities in rural areas and a less intensive form of agriculture than Asian countries. As such, markets are generally more distant and therefore less accessible. This has important implications for vehicle choice. In comparison to Asia, loads in Africa will generally be smaller, and distances longer. Where demand is low NMT's and simple motorised vehicles will provide a cheaper option than either large motorised vehicles or headloading.

Income Levels - a major factor influencing the high vehicle ownership levels in Thailand is their access to alternative forms of income. The rapid growth in the rest of the economy has

increased the opportunities for rural dwellers to find work in urban areas, normally in the construction industry, and at wages that are far above the incomes they can make in the agricultural sector. As such they use this money to buy vehicles which can improve their agricultural productivity, as well as income earning opportunities from transport services. This to a lesser extent is also the case in Pakistan and Sri Lanka but is not so in Ghana and Zimbabwe. The low level of rural incomes in much of Africa precludes people from buying even the cheapest of NMT's, and makes them reliant on headloading at one end of the scale, and urban traders and vehicle owners at the other.

5. CONCLUSIONS AND RECOMMENDATIONS

The data presented in this paper demonstrates substantial differences in transport tariffs between the African and Asian countries surveyed. The African countries had tariffs in the region of double those found in Asia for both motorised and Non-motorised modes of transport. It has been suggested that a contributing factor to this is the low vehicle diversity in the African countries, particularly with regard to the lack of NMT's and simple motorised vehicles.

In order to better understand the underlying causes for the differences in transport charges, the major components affecting the size of the tariff were placed in a framework. Vehicle operating costs were placed on one side, and the degree of competition in the market on the other. The two parts were further divided into their component parts in order to isolate possible constraints to efficient transport operations in Africa. With regard to vehicle operating costs, particular problems included the low level of vehicle utilisation in Africa, and poor routine maintenance. On the competition side, Africa's low population densities, and less intensive farming systems limit the effective demand for transport. It was also found that low income levels, insufficient support from government departments, and poor backup services all contributed to low vehicle diversity, and particularly with problems in introducing NMT's and simple motorised vehicles.

It is suggested that a major contributing factor to Asia's more efficient and cheaper rural transport sector, is the gradation of transport modes from walking to trucks. The transition from one mode to the next is smoothed because of the diversity. As such NMT's, simple motorised vehicles, and sophisticated motorised vehicles, serve different sectors of the market depending on the load, distance and speed required. In this environment, communities or households can easily move to the next technology stage as their incomes increase. It also allows industries associated with the manufacture, supply and service of vehicles to grow and respond to demand more effectively. The existence of different vehicles serving different sectors of the market increases competition, efficiency and consequently leads to reductions in transport costs to rural communities.

Future donor and government funded projects aimed at improving the supply or quality of rural transport services, and/or reducing the costs of their services, should concentrate on the following:

1) Encourage competition by deregulating transport markets which encourage inefficient operating practise. Private operators are inclined to leave, or not join in the first place, transport markets where they have to compete against subsidised services.

2) Technical training needs to be given to operators in maintenance practise and to mechanics providing vehicle backup services.

3) Government should promote alternative vehicle modes whether they be NMT's or simple motorised vehicles. They should also encourage the domestic production of vehicles and parts.

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