Maputo Bus Study

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Introduction

Scott Wilson were invited by *Gabinete de Coordinacao de Projectos da Marinha* (GAPROMAR) to study the potential for the creation of co-operatives for the management and operation of mini-buses in Maputo. The main aims of the study are to identify and examine alternative ways of restructuring the semi-collective sector of the transport system. In addition, to present the alternatives to the Government of Mozambique and relevant private sector organisations.

Initial proposals following a scoping study were presented and discussed in a workshop held at the Ministry of Transport and Communication (MTC). Following the workshop, the need for a more detailed study was highlighted, which would assess the demand and supply systems, establish the geographic areas for operation, examine operating costs and define a tariff policy, with a view to the implementation of the co-operatives. This formed the remit for a second stage study, which is the subject of this paper.

The Study Area

The City is divided into 5 sectors, which are then split into some 53 boroughs. The boroughs essentially identified the traffic zones used in the study. The corridor along Av. Mao Tung, Marien Ngoabi, Av. Da Tanzania formed a convenient screenline around the Central Business District (CBD). The study area was in the end made up of 51 internal zones and 4 external zones that represented the primary routes into Maputo, as shown in Figure 1.

Surveys Undertaken

The following surveys were undertaken to establish the public transport network characteristics and passenger demand in Maputo:

- bus counts.
- passenger counts.
- origin-destination interviews.
- bus route surveys.
- journey time surveys.

Bus and Passenger Counts

The primary types of public transport vehicles identified and their capacity in terms of current usage. is shown below:

Type of Bus	Ownership	Capacity
Pick-up	semi-collectivo	22
Mini-bus	semi-collectivo	26
Combi	semi-collectivo	16
Trucks (Covered & Open)	semi-collectivo	45
TPM	Public bus company	90
Large inter urban bus	Public bus company	90

Due to the heavy overloading of the vehicles, it was not easy to obtain an accurate passenger count, and methods were adopted for estimating this. A number of survey checkpoints were identified, and are shown in Figure 2. The surveys were carried out during the period between 0500 and 0800, which was recognised as being the peak period. Bus and passenger counts were continued at Av. de Lusaka beyond 0800 and until 2130 to estimate peak to daily ratios.

Origin-Destination and Route Surveys

The four main terminals, shown in Figure 2, at Jardim, Combatantes, Xipamanine and Benfica were selected for the OD surveys. Questions were asked about the origin, destination, and trip purpose at both ends of the trip. The time at which the interview was conducted was noted, and so was the vehicle type. A pilot survey was carried out to test the questionnaire, and identify any problems, after which the full survey was undertaken.

During the time the OD surveys were carried out, bus and passenger count information was being collected on buses departing from the terminus, so that the OD sample could be expanded. During these surveys, a bus route survey was also conducted, where bus drivers waiting to load passengers, were asked about the route they will take. It was recognised that privately owned bus drivers (which formed the majority) take different routes, as their operation is unregulated.

Journey Time Surveys

Information on the average running speeds of buses was collected through a journey time survey by following a bus along its route. This was not without its problems as buses soon became aware of the survey car.

Salient Survey Results

The count at many of the roads into CBD (such as Av. de Lusaka) would justify a single decker bus running at capacity every minute. The volume profile establishes 0630-0730 to be the peak hour. The inbound morning peak hour represents 20.4% of the 16 hour flow, and is very peaky. The afternoon peak occurs at 1730-1830, and is less peaky forming only 12% of the 16 hour flow.

Substantial bus flows were observed of over 2.5 buses per minute inbound at some corridors into the central area. The results demonstrate a heavy market share for pickup and minibus. There was a total volume of 20,610 passengers per hour, of which 55% were carried by two roads.

Home makes up the majority of the origins, whilst work and education (going to school or university) form 58% and 24% respectively.

A survey was specifically undertaken to estimate the inaccuracy in passenger counts. The results illustrate that although the two distributions are slightly dis-similar, the average number of estimated passengers of 19.8 is very close to the actual counted of 20.1.

The Model

An EMME/2 model representing the existing morning peak hour demand for public transport network and services was built using the survey data. Generalised time was used and a weighting of 2 is applied to the waiting, boarding and walking. A walking speed of 5kph was assumed for the zone connector link access to the network.. The network is depicted in Figure 3.

Network Calibration

From the bus driver surveys, the bus routes and service frequencies were input to the model. Combining the observed public transport services from the four Terminals resulted in some double counting of services which served more than one of the terminals. In addition, the frequencies of some of the routes was underestimated and other services, particularly those from outside Maputo, would probably not have been observed at the terminals. Matrix Estimation was used to initially assign the bus on to the public transport network and compare the resulting bus flows with observed data. Some manual adjustments had to be undertaken, and a comparison of observed and modelled flows is shown in Figure 4. The model suggested that the base network has in total 895 vehicles, and this was in itself a useful finding for the authorities, as they did not have this sort of information due to bus de-regulation. This figure was made up of about 60 large TPM buses, almost 200 inter city buses and 635 pickups, small buses and lorries.

Model Calibration

Socio economic data was used to develop an initial or ‘prior’ matrix. For the zonal trip generations, estimates of the population in 1994 by urban district centres was used. Data to provide an estimate of the attractiveness of zones was not as readily available. The employer ‘doors’ survey was used to provide a distribution for zonal trip attractions. A gravity distribution was used with the following deterrence function

$$f(t_{ij}) = exp(-0.1*t_{ij})$$

where t_{ij} is the generalised travel time from zone i to zone j.

Matrix estimation was again used through the 'gradient method' which takes observed volumes for a subset of links and the starting origin and destination matrix, and adjusts this matrix to obtain a better fit to the observed link flows. Matrix estimation was undertaken using the EMME/2 macro 'DEMADJT.MAC' downloaded from the INRO web site. At the time that the work was undertaken, this macro explicitly required 'segment' counts. To use the macro, the counts had to be specified in user segment attribute 'us1' and they are interpreted at the segment level. The macro uses the 'gradient' method to adjust each of the segments using the same link to the corresponding. value of 'us1' .

This method is not ideal and a version using link counts may be a more robust measure to use for matrix estimation. As we did not have the luxury of having counts for each of the services from the roadside counts, the total link flows were therefore divided onto the transit lines each weighted by the service headway. The matrix estimation process worked quite well using this method, although particular parts of the network required further attention. For these areas, the matrix was adjusted manually.

The resulting calibrated matrix contains 43,041 inter-zonal passenger trips, which were assigned to the public transport network. The table below compares the modelled and observed flows across the screenline line into the centre of Maputo.

Bus Passengers travelling <u>into</u> the centre of Maputo (06.30-07.30)

Location	Observed	Modelled	Percentage difference
Av. Julius Nyerere	1,468	1,445	-1.6%
Av. Vladimir Lenine	2,684	2,628	-2.1%
Avenida de Lusaka	5,390	5,564	3.2%
Avenida de Angola	1,804	1,948	8.0%
R. dos Irmaos Roby	1,432	1,543	7.8%
Av. do Trabalho	1,857	1,846	-0.6%
Av. 24 de Julho	5,975	5,593	-6.4%
Total	20,610	20,564	-0.2%

Bus Passengers travelling <u>from</u> the centre of Maputo (06.30-07.30)

Location	Observed	Modelled	Percentage difference
Av. Julius Nyerere	473	456	-3.6%
Av. Vladimir Lenine	936	880	-6.0%
Avenida de	611	598	-2.1%
Avenida de Angola	337	377	11.9%
R. dos Irmaos Roby	1,550	1,397	-9.9%
Av. do Trabalho	1,559	1,459	-6.4%
Av. 24 de Julho	1,557	1,500	-3.7%
Total	7,023	6,667	-5.1%

Having confirmed the successful calibration of the model, was utilised to test the impact of future network and service strategies on the efficiency of public transport.

Scenario Testing

A framework was developed in which public transport services could be franchised, on the basis of either geographical areas or corridors within which the services were rationalised. An important element was the need to establish packages (of routes) that would be similar in maintaining income to the operator.

The model was used to test the two different scenarios in terms of route wide and global parameters. Examples of the former would be boardings and overcrowded vehicles, and the latter, vehicle kilometres and vehicle fleet requirements. The results indicated that the corridor strategy was preferable requiring less interchanges and reasonable frequencies on the different routes.

The Corridor Scenario was detailed, and consisted essentially of three sets or routes: radial, circular and inter-municipal. The patronage justified the use of larger buses, and the vehicle fleet required would be 450 large buses providing a frequency of 10-15 buses per hour on most routes. This gave the longer term strategy, as the currently used smaller buses have to be phased out gradually.