USING EMME/2 TO ASSESS THE IMPACT OF AND INFLUENCE THE RESTRUCTURING OF THE APARTHEID CITY

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1. INTRODUCTION

South Africa lies on the southern tip of Africa and the city of Durban is on the east coast. South Africa is a democracy in its infancy having a newly elected democratic government since 1994. Since that time, many things are changing, including the form of the cities and towns in the country. The purpose of this paper is to show how EMME/2 is being used as a tool in planning these changes.

The paper initially gives some background on the current situation in Durban, long term strategic plans for the city and how EMME/2 is being used in this process. A profile of the city is given next, including the demographics and economy of the region. A brief overview of the transport system is then presented. The EMME/2 model developed is then described in some detail, including how it is to be used in a predictive mode

2. BACKGROUND

The period prior to the democracy was characterised by decades of policies and institutions aimed at promoting the separate development of the different race groups at that time. This was known as apartheid. The corner stone of apartheid was built on the premise that different races should live in separate areas and use separate facilities. This led to a very distorted spatial structure for the City and has been the main contributory factor that has led to the settlement of the poorest people the furthest away from the city centre. One of the other peculiarities as a result of these policies was a duplication of services, separate bus services for different race groups for example. Furthermore, public facilities such as schools, hospitals and social facilities were also duplicated. In the transportation arena during this period the main emphasis was on road building and private transport mainly to cater for the high income groups. Needless to say the 60 years of apartheid has created a real challenge for the transportation professionals in that the poorest of the poor live the furthest away from the job opportunities but at the same time they are totally reliant on public transport. During the apartheid reign the government artificially propped the public transport system with huge subsidies which is clearly not sustainable in today's situation where the inequalities of the past policies are in the process of being addressed and there isn't spare resources to cater for inefficiencies.

Currently there are various initiatives looking at restructuring the city (not necessarily rectifying the situation) with a strong emphasis on developing a long term development strategy that will provide the framework for making the city more efficient and globally competitive into the future. The main focus revolves around better integration of the City and transport is seen as one of the main elements to act as a catalyst in this process.

As part of the team involved in contributing towards this development plan for the City, one of the first steps in the process in terms of transportation planning was the re-calibration of the EMME/2 model to reflect the current situation in order to be able to simulate some of the long term strategic directions of the City.

3. PROFILE OF DURBAN

The Metropolitan area of Durban lies on the east coast of South Africa with an population of some 2.5 million. The Durban Metropolitan area covers some 1366 square km and has the following demographic and economic profile:

Population

High Income	= 7 %	White	= 12%
Middle Income	= 21%	Indian	= 22%
Low Income	= 72%	African	= 66%

Modal Split

Approximately 57% of the population is public transport dependent in the commuter peaks. This varies from practically 100% in some areas to practically 0% in others.

Sixty percent of employment is close to the CBD with only thirty percent of the employees living close to the CBD which translates to long travel distances for the majority of the people.

Economic Factors

Contributes to 9% to National GDP. Number of households 609 000. Durban is a Port City serving most of Southern African with the busiest Port in Africa - 1 million containers/annum

Other activities: Tourism, commerce, subtropical fruit, sugarcane, motor manufacturing, agriculture and construction.

4. EXISTING TRANSPORT SYSTEM

Durban has an excellent freeway, arterial and local road network with a reasonably well covered rail network. There are three modes of public transport, being conventional buses, mini-buses and rail. Mini-buses are 16 seater vehicles that operate in a less formalised fashion than rail and bus. These mini-buses are operated and managed by individuals from within mainly the lower income groups and they have captured a large proportion of the market share over the last 20 years in opposition to the monopolies of the bus and rail operators. Rail uses old heavy rolling stock and is limited in the areas it serves due to the topography of the region.

The public transport system is however in a very poor state with huge inefficiencies and huge subsidies (R418 million/annum - US$ 58million) being paid to cater for the large number of unproductive routes and the duplication of routes by different modes. The deregulation of the industry in the apartheid years certainly contributed to the current state of affairs. There is currently new legislation in place to restructure the public transport system and to regulate the industry in line with international best practice.

Vehicles & Routes

Excess of 1 500 buses
Excess of 6 000 mini bus taxis
450 000 cars
800 bus routes
600 taxi routes
535 km of rail track

Passenger Flows	**daily**	**peak hour**
Bus passengers	270 000	50 000

Minibus passengers	600 000	100 000
Rail Passengers	230 000	40 000
Car Passengers	900 000	170 000

5. PUBLIC TRANSPORT RESTRUCTURING

One of the major sources of information in terms of public transport usage is an exercise that is currently being undertaken in parallel with this study. The public transport restructuring project's main thrust is to establish a least cost network with optimal modes on the main corridors in order to move towards a restructured public transport system that subscribes to improving efficiencies and making the system sustainable.

As part of this exercise a detailed data collection exercise provided public transport information for the public transport OD matrix. The data was collected on all routes and a large proportion of the vehicles was surveyed, including on board bus surveys. This information is the best data available in terms of supply and demand for public transport.

One of the main outputs from this assessment provided what is now commonly termed the High Priority Public Transport Network (HPPTN) with recommendations on appropriate modes on the main corridors. The O-D matrix and the HPPTN are the main inputs into the forecast public transport model.

6. THE EMME/2 MODEL STRUCTURE

Demographics

The starting point for the Durban EMME/2 model was the collection of demographic information by zone. A nation wide population census was undertaken in 1996 from which populations and levels of employment by zone were extracted. Added to this information, from various sources, was employment and car ownership levels by zone.

In the past, in view of the government's policy of separate development for the various races, this demographic data was captured on racial lines. Similarly, all traffic data surveyed was also on racial lines, thus making it relatively simple to calibrate the model. In the new model, race classification has been eliminated and three stratifications of income levels (high, medium and low) have been introduced which best reflects car ownership levels and hence use of public transport. This change, however, necessitated a total re-think in the formulation of the model as traffic data surveyed is now on the global population rather than racial groups which directly correlated to trip types. This required a simplification within the trip generation and distribution functions to incorporate fewer global parameters rather than more specific parameters by trip type. Some detail has been lost using this approach, but has proved to be minimal and the results obtained are still acceptable. Some details of the previous and new models are as shown in Table 1 below.

Trip Generation

From this demographic information, a simple trip generation model was developed (using

linear regression) which relates this demographic information to an estimate of person trips in the morning commuter peak period. This distinguishes between HBW and NW trips as well as by household income levels.

Modal Split

The modal split is at the origins only and estimates the proportion of person trips by public transport or by private car based on the level of car ownership by income level by zone. Two separate car ownership curves are used which distinguish between HBW trips and NW trips, with the use of public transport being less for NW trips than HBW trips for the same car ownership level.

The model within EMME/2 allows for four modes (auto, rail, bus and mini-bus) and an auxiliary transit mode (walk). Transit lines for the three transit modes are incorporated, including walk only links between road and rail.

Trip Distribution

Trip distribution uses a two dimensioned balance by trip type, incorporating two matrices at origin (person trips by auto and person trips by transit) and a single destination matrix (total person trips attracted) using the macro BALMPROD.MAC as developed by INRO. This procedure distributes trips between each O-D pair based on separate trip distribution functions by mode (auto and transit) and the relative attractiveness of each mode. A simple entropy trip distribution function is used. The strength of this procedure is that the transit lines, as incorporated into the model, have an influence on the resulting distribution.

Prior to the assignment, the various trip types are combined by mode into two peak one hour matrices, one for transit trips (in persons) and one for auto (in vehicles).

Assignment

Auto is assigned first using a single class fixed demand assignment, with the auto equivalent of transit vehicles included as the additional auto volumes. Transit is assigned next, with the speed of road based transit vehicles determined by the auto speeds (as extracted from the auto assignment) as set in the transit travel time functions. In the transit assignment, trips can use any mode (rail, bus or mini-bus taxi) and any combination of modes.

Results Obtained

The results obtained from the model were reasonably good. A list of the R^2 values obtained are as listed below:

Cars (auto) on 174 link counts	$R^2 = 0.921$
Public transport (total) on 22 screenlines	$R^2 = 0.984$
Public transport (buses) on 22 screenlines	$R^2 = 0.890$
Public transport (mini-buses) on 22 screenlines	$R^2 = 0.826$
Public transport (rail) on 22 screenlines	$R^2 = 0.950$

More details of the results obtained will be presented at the conference.

TABLE 1 : COMPARISON OF OLD TO NEW MODEL

ELEMENT		OLD MODEL	NEW MODEL
Number of zones Area covered		**176** Beyond previously proclaimed metro boundary (1 350km^2)	**330** Beyond present metro boundary, less than proclaimed uni-city (1 720km^2)
Road (Link types 1-15)		2 987,5km	3 711,7km
Rail (Link Type 60)		315,8km	406,0km
Trip Generation	Based on	Racial	Income
	No. of trip types	7 : W-HBW W-HBO W - NHB I/C - HBW I/C - NW B - HBW B - NW	4 : H - HBW M - HBW L - HBW NW
	Factors affecting productions	Employed Residents Population Employment Cars Accessibility Index	Employed Residents Population Employment
	Factors affecting attractions	Employment Population Cars Accessibility Index	Population Employment (Activity Zone)
Modal Split		Based on level of car ownership by zone and by race (HBW & NW separate)	Based on level of car ownership by zone and by income (HBW & NW separate)
Trip Distribution	Procedure	Two dimensional balance incorporating modal split at origin (PT/car)	Two dimensional balance incorporating modal split at origin (PT/car)
	Function	Exp (-β*C)	Exp (-β*C)
	Beta Values (β)	By race group By mode (PT/Car) By purpose (HBW/NW) By area	By mode (PT/Car) By zone
	Cost for PT(C)	Trip cost, including weightings, walking and value of time	Trip cost, including weightings, walking and value of time
	Cost for Cars (C) Format	Travel time Integrates to car and PT assignments	Travel time Integrates the car and PT assignments
Trip Assignment	Car Assignment (Run first)	Fixed demand auto assignment. Public transport road based vehicles included as PCU's.	Fixed demand auto assignment. Public transport road based vehicles included as PCU's.
	PT Assignment (Run second)	After auto assignment. Road based PT speeds set by auto speeds. Single matrix, competing modes (bus, mini-bus, rail and walk).	After auto assignment. Road based PT speeds set by auto speeds. Single matrix, competing modes (bus, mini-bus, rail and walk).

7. USE OF THE EMME/2 MODEL IN A PREDICTIVE MODE

The main use of the model is to simulate the impacts of any future scenario on the transportation system. The future scenarios could range from a simple trend projection through to various intervention policies aimed at certain objectives. It also needs to be emphasised that public transport planning needs are of paramount importance. Built into the model are a number of parameters that would allow for the assessment of these future scenarios, as listed below.

Future Demographics

Future populations (and their spatial distribution), levels of employment and the distribution of the employment can be input into the model.

Use of Public Transport

The use of public transport will have a major impact on the type and extent of infrastructure that will be needed in the future. The model allows for assessing the impact of various levels of public transport in the future. The current modal split is 57% and the National target is 80%.

Public Transport Networks

Refinements to the existing public transport networks can be incorporated to support any planned changes to the spatial distribution of populations and employment opportunities.

Within the vision of creating a more efficient urban form for the city, various transportation issues/parameters have emerged, the objectives of which include the following:

- Influencing the abnormal trip length frequency distribution (or travel distances) currently experienced in a number of areas in the Metropolitan area.
- Rationalising the public transport network, using estimated operating costs and fare income as a measure of improvement.
- Incorporating various land use strategies such as node and corridor developments in selected areas in the City.
- Elimination of bottlenecks in the road network.
- Limited road building programs, with the focus on supporting road based public transport services.
- Various potential travel demand management (TDM) measures, including target levels of public transport usage in some detail down to specific OD pairings as well as global metropolitan wide targets.

8. CONCLUDING REMARKS

The Metropolitan traffic model has been successfully calibrated and simplified to reflect the current transportation system and goes a long way to accurately simulate the travel characteristics of the region. Additionally, the model has been structured to easily reflect and simulate scenarios and the associated impacts thereof. In particular, land use strategies that are focussed on integrating and restructuring the city can be assessed from a transportation perspective with particular emphasis on making the city more efficient and globally competitive.

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