

# **DEVELOPMENT OF A PUBLIC TRANSPORT MANAGEMENT INFORMATION SYSTEM TO ASSIST DECISION-MAKING IN THE RESTRUCTURING OF PUBLIC TRANSPORT IN DURBAN**

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## **ABSTRACT**

The national flagship project to restructure the public transport system of the Durban Metropolitan Area consists of various planning and modeling processes that are based on surveys of the public transport system and its users. The overall project, which is described in another paper by the Durban Unicity Council, is very dependent on decision-makers' and planners' understanding of the current supply, utilization, and trip patterns of various public transport modes as contained in the Current Public Transport Record (CPTR) of Durban. To assist decision-makers in extracting synthesized information from a massive database such as the CPTR, the Durban Unicity Council decided to make use of a Public Transport Management Information System (PTMIS) developed by Stewart Scott.

PTMIS is a menu driven GIS viewer providing easy access to public transport information in a GIS environment that allows for interfacing with the central GIS system and other databases. A user-defined SQL and band width query facility on all link geographic features are also provided. Various functions were added to PTMIS as part of the project:

PTMIS was adjusted to accommodate and query the public transport origin-destination (O-D) matrix in addition to the route-based CPTR information. The O-D information was required for the strategic public transport demand model that was developed to evaluate various integrated multi-modal network scenarios.

PTMIS was subsequently used to assist with the network demand modeling process by providing the CPTR information for the calibration of the EMME/2 model and subsequently by displaying the modeled passenger and vehicle volumes on a GIS base map in PTMIS for the visual assessment of alternative scenarios.

PTMIS also proved very useful in the design of the user preference surveys as it provided easy access to view the main corridors for each mode, and extracting travel times, frequencies and fares for selected corridors.

The paper describes PTMIS by means of thematic maps and graphical information of Durban's public transport system and how the system was used to assist decision-making for the restructuring project. Further developments of PTMIS to assist in the various implementation phases are also described. These are a route financial feasibility module, a link with the National Traffic Information System (NATIS) and the Provincial Registrar's taxi permit data bases to assist with the allocation of taxi route permissions, and a contract design and monitoring module.

## **1. INTRODUCTION**

The national demonstration project to fundamentally restructure the public transport system of the Durban metropolitan area consists of various planning and modelling processes that are based on surveys of the public transport system and its users. These planning processes are very dependent on decision-makers' and planners' understanding of the current supply, utilisation and trip patterns of various public transport modes as contained in the Current Public Transport Record (CPTR) of Durban. (The overall restructuring project is described in the SATC paper by Aucamp, et al (2001)). To assist decision-makers and planners in extracting synthesized information from a massive database such as the CPTR, the Durban Unicity Council decided to make use of a Public Transport Management Information System (PTMIS) developed by Stewart Scott.

This paper describes the functionality developed to meet the needs of the Durban Unicity Council and illustrates how PTMIS was used to support the various planning processes of the restructuring project. In order to put the role and function of PTMIS into perspective, the paper briefly describes the historic development of PTMIS and the vision and guiding principles driving the development of the new generation PTMIS. The paper concludes with the most recent software development and planning for future developments.

### **1.1 Historic Development**

When the focus of national transport policy shifted from private to public transport various problems were experienced by public transport planners:

Information about public transport was often:

- inaccessible and in various hard copy reports;
- in various locations and at various sources such as operators
- not in the same format

In 1994 the concept of a user friendly electronic report on public transport information was conceived and the first version was implemented for Midrand Town Council. With subsequent applications the needs of various local authority users for more sophisticated functionality and a user friendly GIS platform became apparent. PTMIS was subsequently developed on a continuous basis according to user needs. Its real value was demonstrated when the Current Public Transport Records (CPTR) were established by metropolitan authorities and easy access to these large data bases was required.

The largest CPTR application of PTMIS was conducted for the former Pretoria City Council, the former Eastern Gauteng Services Council, and Durban Unicity Council.

Although this paper focuses on the Durban application of PTMIS, the authors gratefully acknowledge the support and contributions of the other local authority users.

## **2. TOWARDS A VISION FOR A HOLISTIC AND INTEGRATED DECISION SUPPORT SYSTEM FOR PUBLIC TRANSPORT**

Public transport in SA is currently going through a critical transformation process involving all dimensions of management, funding, planning and operations. All spheres of government are in the process of fundamentally restructuring public transport, according to the principles defined by the new National Land Transport Transition Act.

Figure 1 indicates the public transport service delivery life cycle that needs to be managed and facilitated by metropolitan authorities, or in future by proposed Transport Authorities according to the new Act.

In S.A. strategic planning (10 to 15 years planning horizon) failed to guide the daily operation of public transport at grass roots level. The missing link between strategic and operational planning is tactical planning which is much shorter term in nature i.e. 1-2 years. PTMIS therefore aims to address the tactical planning component in order to translate the strategic plans into improved operations.

The various phases of the public transport management and planning life cycle are briefly explained below, as well as how PTMIS can assist in the various phases.

- Understanding the Current Public Transport System (CPTR)

The public transport life-cycle starts with the understanding of the current supply and utilisation of services. The National Land Transport Interim Arrangements Act requires metropolitan authorities to prepare a Current Public Transport Record, which is an inventory of the supply of public transport services and their capacity utilisation. This was the main focus of PTMIS in Durban. Not only did it facilitate the easy communication of the CPTR to Durban planners and decision-makers, but also to Province and the National Department of Transport for policy and strategic purposes. Section 3 describes the functionality developed in PTMIS to view and query the CPTR database.

- Assessment of User Preferences

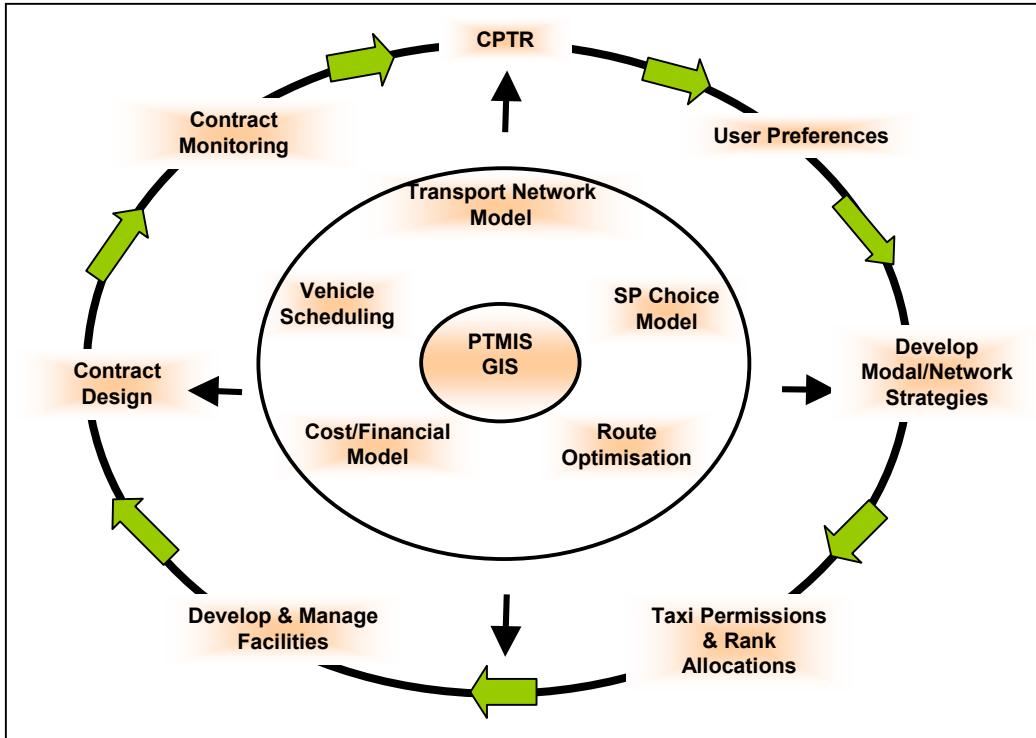
Following the understanding of the current public transport system, it is necessary to understand user needs and preferences to ensure that the public transport system meets the needs of its users. In Durban this took the form of a Stated Preference Study which is described in Section 4.

- Develop Modal and Network Strategies

Following the assessment of user needs and modelling of their choices, the impact of user choices on the demand for services by specific modes and routes can be simulated by means of travel demand models, such as EMME/2. Section 4 describes how PTMIS was used in Durban to assist in this phase.

- Taxi Permissions and Rank Allocations

Provincial and Metropolitan Authorities are in the process of legalising mini-bus taxi operators and converting area-based permits into route permissions, according to the requirements of the National Land Transport Transition Act. Various data bases containing information on taxi operators, routes and vehicles can be interfaced with PTMIS in order to assist authorities in the above process such as The National Traffic Information System (NATIS), Registration Administration System (RAS) of the Provincial Registrar, and the Land Transport Permit System of the LRTB's.



**Figure 1. : The Public Transport Life Cycle and Decision-Support Tools**

- Development and Management of Facilities

The development and management of terminal and modal transfer facilities are critical for an effective strategy to integrate different modes. The best location and demand for terminal and modal transfer facilities are determined from the travel demand on the preferred modal and network strategy. By capturing information on the type and condition of amenities at facilities and passenger utilisation of facilities, PTMIS can also be used as a facility management tool.

- Contract Design and Monitoring

The contract design and monitoring is the implementation phase and concludes the life-cycle. This involves the detailed specification of the preferred services in an area, putting the services out to tender, appointing the preferred operators, and monitoring the service to ensure that the operators adhere to the prescribed services.

The current bus contract and monitoring system was introduced by the NDOT in Gauteng in 1988 and all government subsidised bus services are operated under this contract system. The National Land Transport Transition Act envisages that all public transport services, including mini-bus taxi services, in future be conducted under this system.

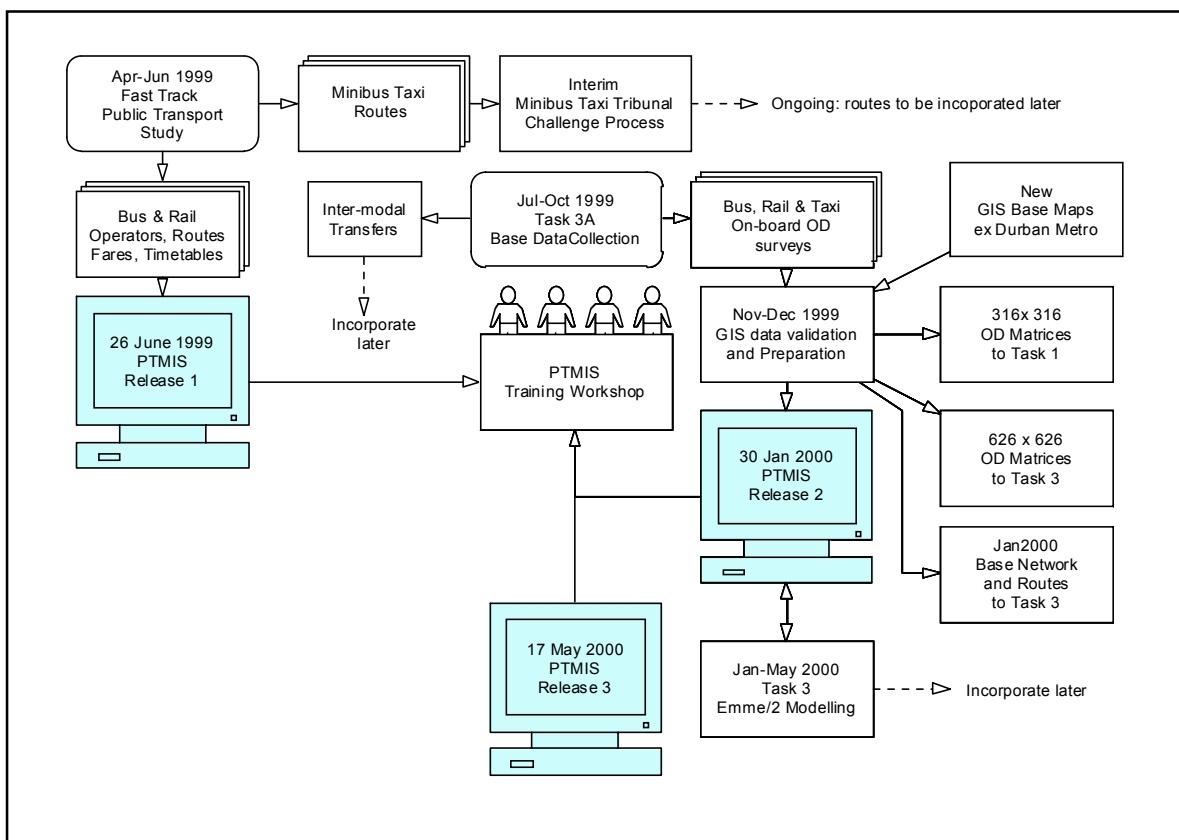
Further development of PTMIS is envisaged to assist authorities and operators in monitoring services. For this purpose it will be important for authorities to formulate standard data specifications and requirements for operators to supply operating information on a regular basis. This will ensure that the CPTR is automatically updated and will avoid huge costs every five years to survey public transport services.

### 3. FUNCTIONAL OVERVIEW OF PTMIS DEVELOPED FOR THE DURBAN METROPOLITAN AREA

#### 3.1 Introduction

Initially, Stewart Scott developed PTMIS in support of the Durban Metro Fast Track Public Transport Study, to capture and report upon the current public transport records (CPTR), as collected during the course of that investigation.

Figure 2 illustrates the approximate time-line accompanying the interactions and data transfers between PTMIS and the affected Phase Two tasks.



**Figure 2 : PTMIS Interaction with Other Tasks**

#### 3.2 DBN PTMIS Components

PTMIS is a customised application of the GIS viewing software, Planet. Planet's unique indexing technique, easy usage, cheap and flexibility to apply rapid application design (RAD) was ideal within the limited project budget and project time.

The system have allowed standard GIS feature creation (and/or import from other GIS systems) of *features* such as points, lines, polygons and text. These features can be handled individually or by group, and a different *style* (colour, texture, line type, text font etc) can be associated with each feature. The software allows one to define different *views*, within which any number of features can be included. Any geographical feature can be linked to one or more *database tables*, with support for different types of formats, via the Open Database Connectivity (ODBC) standard. Thematic *queries* linked to such tables can be created and displayed graphically. All these capabilities are performed within the GIS

framework, which allows one to zoom into or out of a map area, pan across the map, tag items of interest, print any specific view at any scale, etc.

In addition, supplementary data fields can be defined in the database to allow the display of multimedia elements such as bitmaps, sound and video. Any of these multimedia elements can then be activated, simply by clicking the mouse on the relevant geographic feature.

PTMIS has focused on the following key components, with a geographical **view** defined for each major grouping of features. These are:

- Creation of a suitable **base map**, by importing data made available by the Durban Metro's GIS section. These included the following:
  - KwaZulu-Natal and Durban sub-structure boundaries.
  - Named and unnamed built-up areas.
  - Water features, such as dams, rivers and marshes.
  - Roads and streets, categorised into national roads, main roads and four other classes as well as street names.
  - Places of interest.
- Definition of Road and rail **sub-sections**, as required by the CPTR. These include:
  - Demarcation points (sub-section nodes), marking the start and end of road-based sub-sections. These points were originally used by the task 3A survey teams for orientation of observed public transport routes.
  - Railway stations, serving as the start and end of rail-based sub-sections.
  - Cross-referencing of sub-sections to the relevant base map road sections.
- Analysis and display of information as defined by the requirements pertaining to the collection and publication of current public transport records (**CPTR**). These include:
  - Passenger volumes per sub-sections. These are displayed as bandwidths categorised by time period, mode, operator or individual route.
  - Public transport capacity per sub-section, displayed as bandwidths for a given time period, mode, operator or individual route.
  - Public transport utilisation (passenger demand volumes as a percentage of the supplied capacity). These are colour-coded into different ranges.
- Display of **customised bandwidths**: These include specific thematic queries, categorised into colour-coded ranges.

Adjacent to any of the above selected views, a number of custom-written **report modules** are active, inclusive of the following:

- Display or print public transport routes, either individually, by mode, by operator or association, or by selected origin-destination.
- Display or print public transport fares, either individually, by mode, by operator or association, or by selected origin-destination.
- Display or print public transport timetables, either individually, by mode, by operator or association, or by selected origin-destination.
- Display or print public transport route descriptions, either individually, by mode, by operator or association, or by selected origin-destination.
- Display or print public transport origin-destination information, by selected origin-destination sub-sections.
- Display or print C PTR information (i.e. volumes, capacity, utilisation) either per individual sub-section, or by mode, operator or association, for any given survey period.

The ease of usage allows any operator to become familiar with all the above basic components of the system, in most cases in less than an hour.

PTMIS also contains advanced features that will allow **custom dynamic link libraries** (dll's) to be developed for specific requirements. Such software could be written by any competent programmer to extend the system functionality. Generally such modules would be associated with geographical features, to be activated whenever the feature is selected by a click of the mouse.

**Other** components include the geographical features or data tables that can be imported easily into or exported from PTMIS, thereby extending the usefulness of PTMIS beyond the boundaries originally intended by the CPTR guidelines. Specific examples include the display of Emme/2 modelling results as bandwidth polygons, the tabulation of railway station amenities, the storage and display of taxi rank layout drawings and photographs, the illustration of daily operations using video clips of bus termini, etc. Such enhancements are only limited by the available memory and disk storage constraints, since PTMIS is capable of handling very large maps and database tables.

### 3.3 Selected Durban PTMIS examples

The intention of this section is to provide a few examples of the more common PTMIS operations, in order to illustrate briefly some of the capabilities of the system, in a manner that is commensurate with this broad overview.

#### a) Base Map and Common Functions

Figure 3 illustrates a typical screen “snapshot” taken during a PTMIS work session. The tabs immediately above the map indicate that three main views have been defined for this configuration of PTMIS, with the base-map tab being active. Further sub-views are also possible, e.g. the CPTR tab allows one to look at four sub-views (passengers, capacity, utilisation and custom-defined bandwidths).

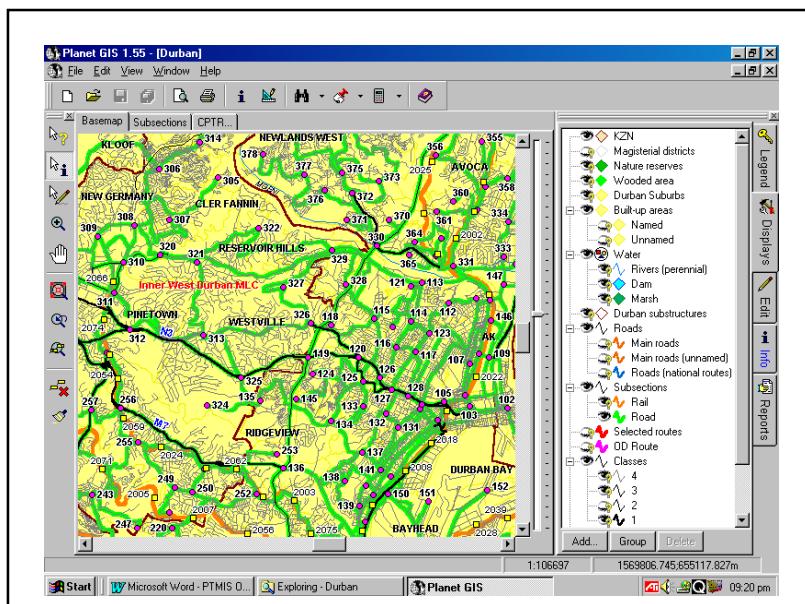
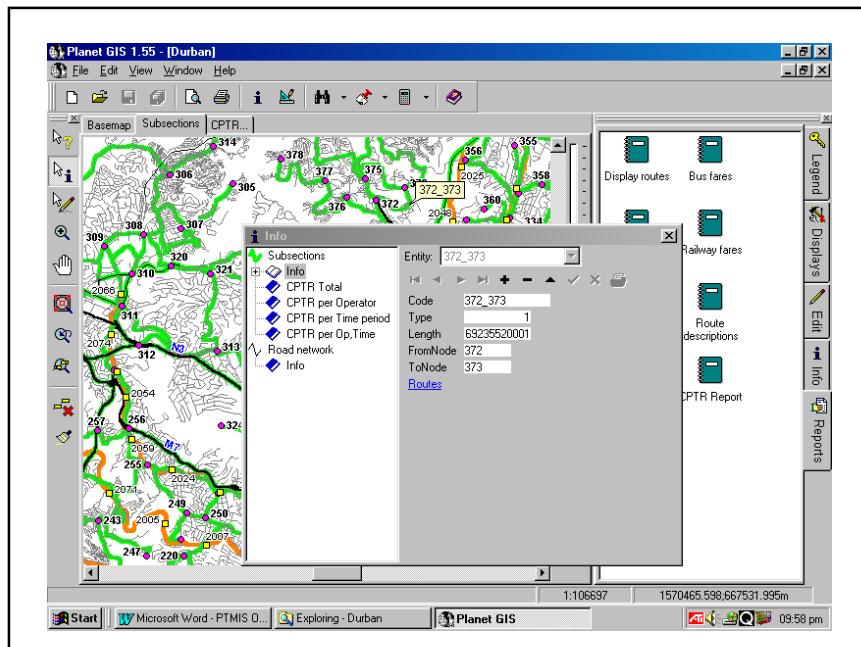


Figure 3 : Typical PTMIS Base-Map View

The toolbar on the left allows one to tag specific features, display feature information, zoom in or out, pan vertically or horizontally, display the full extent of the map, zoom previous, clear all tags and redraw the map. The vertical tabs on the extreme right allow one to select different modes of operation, i.e. display the legend, display features, edit features, display more detailed information as contained in database tables, or display the reports menu. The icons at the top allow file handling, print preview, print, display of database tables, design mode (where one can define geographical features, views, database tables and styles), search mode, store selected views, calculate geographical statistics (e.g. distance between points) and a help facility. The menu items at the top of the main window duplicate most of the other functions available from toolbars and other icons.

### b) Sub-Sections

Figure 4 illustrates a typical sub-section view, with an information window displayed as a result of tagging the sub-section 372-373 with the information selection tool, shown depressed on the left toolbar.

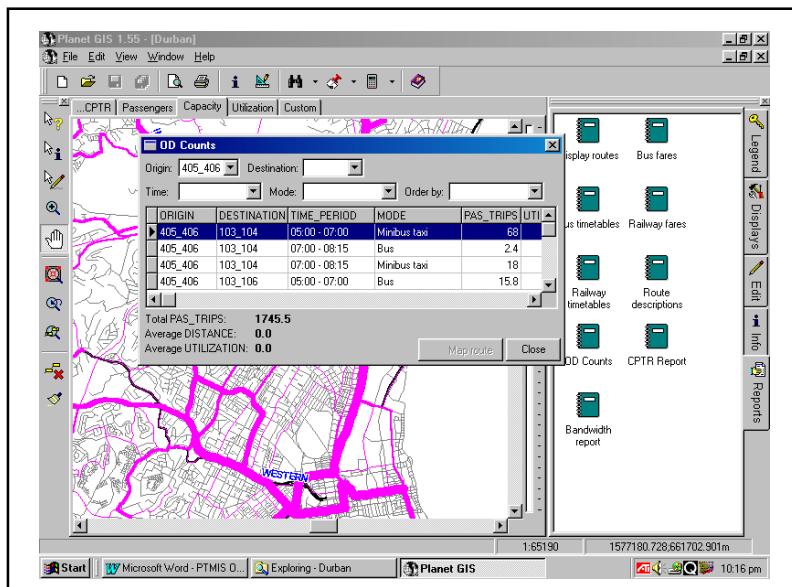


**Figure 4: Typical PTMIS Sub-Section View**

The icons on the left of the smaller window list the available database tables linked to the particular sub-section. By clicking on the particular table of interest, the relevant data fields are displayed. In the example, a mouse click on the underlined text, (Routes), will display a table of all routes that travel on the specific sub-section. The report menu on the right (partly obscured by the sub-window) is displayed by clicking on the “Reports” tab shown vertically on the right.

### c) Current Public Transport Records

The CPTR component of PTMIS is illustrated in Figure 5. In this example, relative capacities are illustrated by means of bandwidths (partly obscured by the OD counts window).



**Figure 5 : Typical CPTR Passenger Information**

The sub-window illustrates a typical OD-count report for a selected sub-section, displayed by clicking on the “OD Counts” icon in the report menu, and then selecting the required sub-section from a drop-down table. Data displayed can be filtered further by narrowing down the selection with respect to destination, time-period (as used during the Task 3A surveys), and mode.

Several other reports are available, some with options to highlight selected routes on the base map.

#### **4. APPLICATION OF PTMIS IN DURBAN’S FUNDAMENTAL RESTRUCTURING PROCESS**

##### **4.1. Assisting in the User Preference Study**

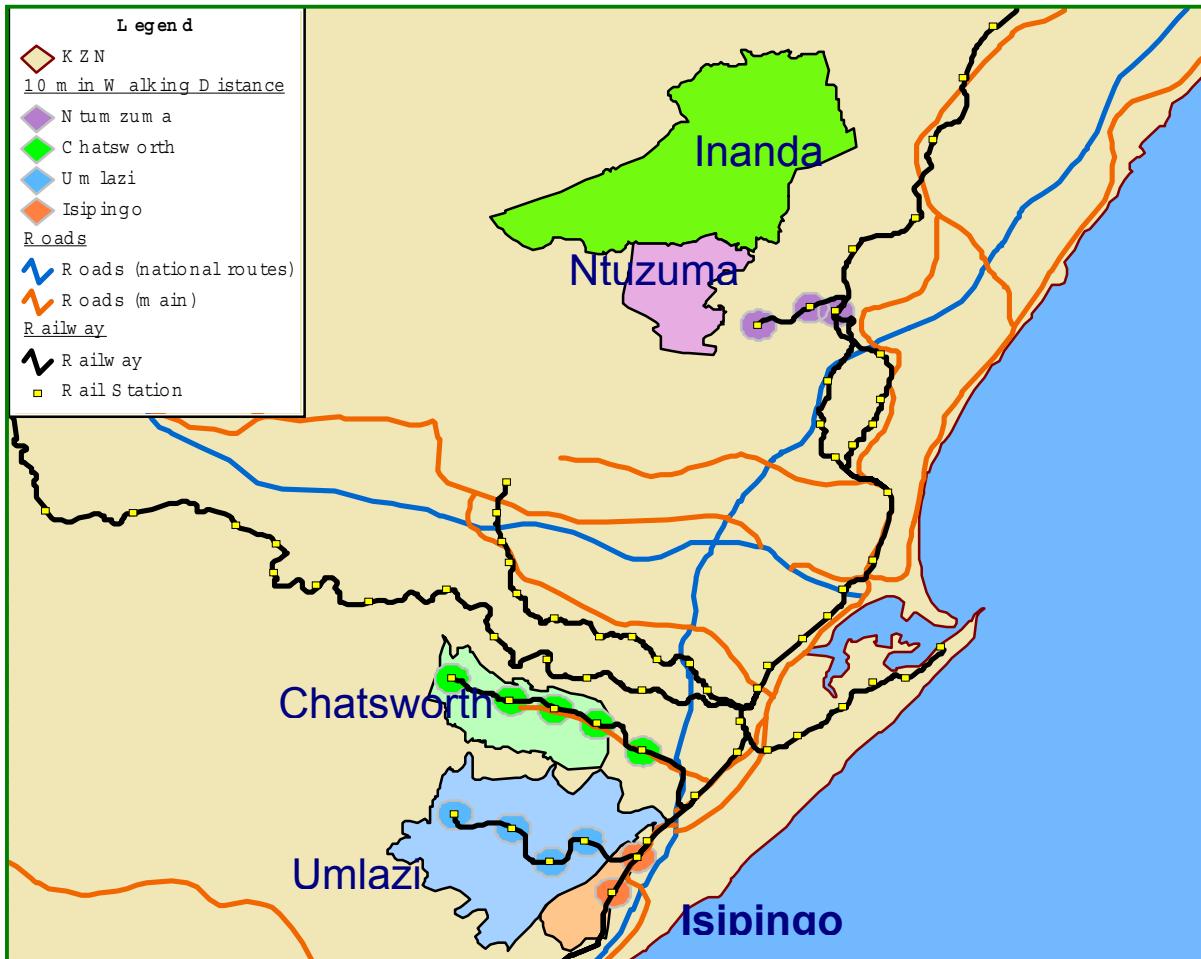
A key component of Durban’s Public Transport restructuring programme was a user preference study consisting of fundamental market research of users’ travel patterns and preferences as well as developing user choice, or Stated Preference (SP), models to test various policies and strategies. SATC Paper by Lombard, et al (2001a) gives a detailed description of the User Preference Study.

In order to design the SP user preference surveys, information from the Current Public Transport Record was required. The SP experiments typically involved the testing of certain changes and improvements to current public transport services. PTMIS proved to be very useful in extracting information such as routes, fares and timetables along the relevant corridors selected for the study.

The main purpose of Phase 2 of the SP study was to test the preferred model and network strategy identified by the restructuring project by means of the EMME/2 model. Viewing of the assigned passenger volumes on GIS base maps assisted in identifying the corridors and sub-areas to be included in the SP surveys.

An integrated rail service with feeder/distributor services along the North-South corridor was selected for testing in Phase 2 of the study. PTMIS was used to produce maps of the target survey areas for the fieldworkers of the market research company.

The SP sample had to be stratified between people living within 10 minutes walking distance of train stations, and those living beyond this walking distance. Figure 6 shows the 10-minute buffer zones around the targeted train stations and the SP survey areas, which were produced to assist the sample selection.



**Figure 6 : SP Areas Surveyed**

#### 4.2 Interfacing with EMME/2 model

The EMME/2 model was used to simulate demand patterns of specified mode and route network scenarios and comparing these with current patterns to assist in the selection of the preferred public transport system. The application of the EMME/2 model is discussed in the SATC paper by Nijhout, et al (2001b).

PTMIS was a valuable tool in the EMME/2 modelling task. Firstly PTMIS was used to extract routes, passenger volumes, fares and travel times for input into the model calibration exercise. Secondly, PTMIS was used to display the modelled passenger volumes and network information on GIS base maps to facilitate communication of the model outputs to decision-makers

## **5. THE NEW ARC PTMIS**

### **5.1 Introduction**

The current PTMIS is called ARC PTMIS Version 4. This upgrade was developed jointly for three authorities following its development for Durban's public transport restructuring programme. The following objectives were defined for this major upgrade:

- To move away from standalone custom software to extension technology.
- SDE capabilities.
- To make the new PTMIS as user friendly and easy to operate as possible.
- To be as generic as possible to allow the user to be his own limit on functionality.
- To standardise the client on one GIS platform.
- To allow the client the best of both worlds, GIS and Transport Modules.
- To improve network architecture

### **5.2 Functionality**

The functionality of ARC PTMIS can be broadly broken into 3 areas, namely:

- a) Viewer
- b) Reports
- c) Queries

- a) Viewer

Additional to the standard view functionalities, the viewer has the following added main display groups and functions:

#### Capture New Transport Information

Drawing and capture tools have been introduced that will allow the user to capture all types of transport routes and facilities by simply click on the location. Tools have been provided to add direction and distance automatically.

#### EMME/2 Extensions

The viewer consists of 4 modules. The user have the option capture and edit the Emme/2 Network and display Emme/2 results. The software have also the option to translate the Emme2 network back to the GIS street network and draw desirelines according OD matrixes.

#### Economic Model

The user is able to display economic feasibility of routes. The viewer tries to:

- Estimate the fare income for a route (if all fares were collected).
- Estimate the effect of changes in fare policy on fare income.
- Estimate the cost of serving the route with PT.
- Estimate the surplus from or subsidy required per route.

Emme/2 Public Transport assignment line data can also be used as input in this model. The summary contains all relevant data of a PT-line like the number of vehicles, headway, time, length, number of boarding, loading ratio etc.

### Rank Permit Issuing System

This option is still under construction, but the following component has already been introduced. The viewer can validate registration numbers on the NATIS, RAS and LTPS System and compare this with existing Taxi Rank Information. The system is used at the moment to issue taxi rank permits, but could also be used to monitor existing taxi operators.

### Facilities Management

The transport facility management component is still under construction, but included at the moment is the capacity to select transport facilities like bus terminals and display the structure status, drawings, videoclips and photo's.

#### b) Reports

All the previous reporting capability has been included in the new version. The emphasis was to make to bundle all the report in one form instead of 8 or 10 different reports and improve the integration between spatial and reporting. The reports that are available at the moment are:

- Display Routes
- Bus fares
- Bus timetables
- Railway fares
- Railway timetables
- OD counts
- CPTR Report

The reporting has also been extended to include now additional summary levels. Figure 7 illustrates the reporting wizard:

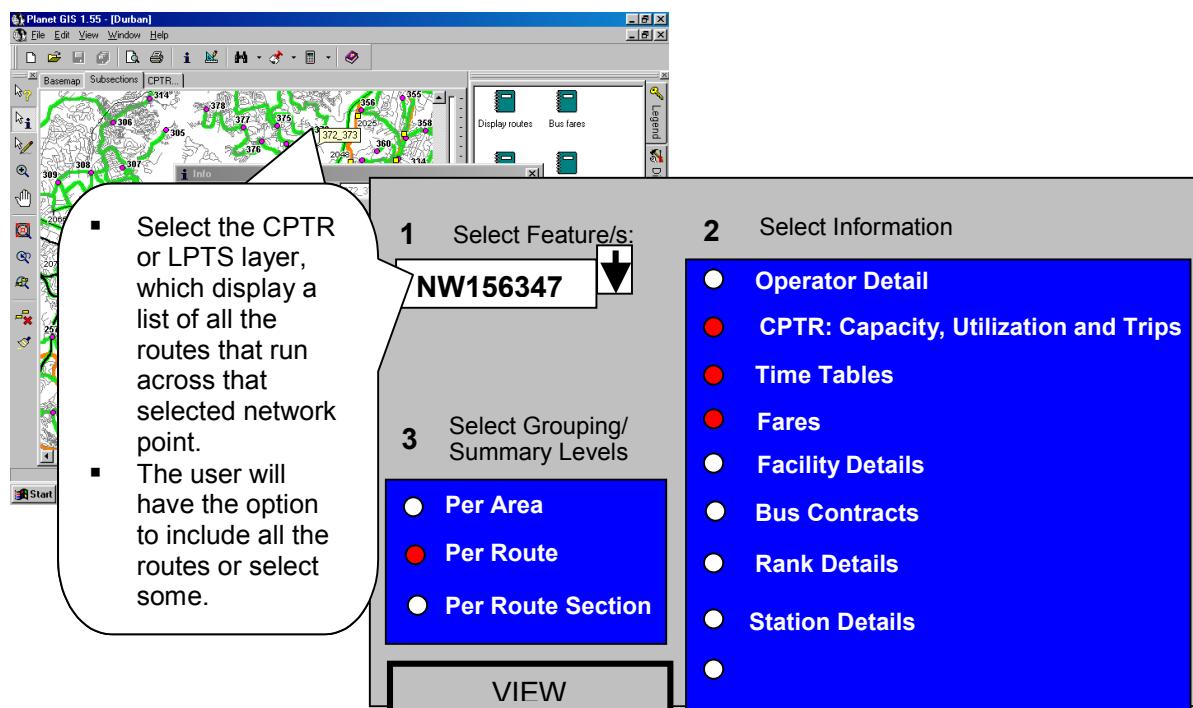
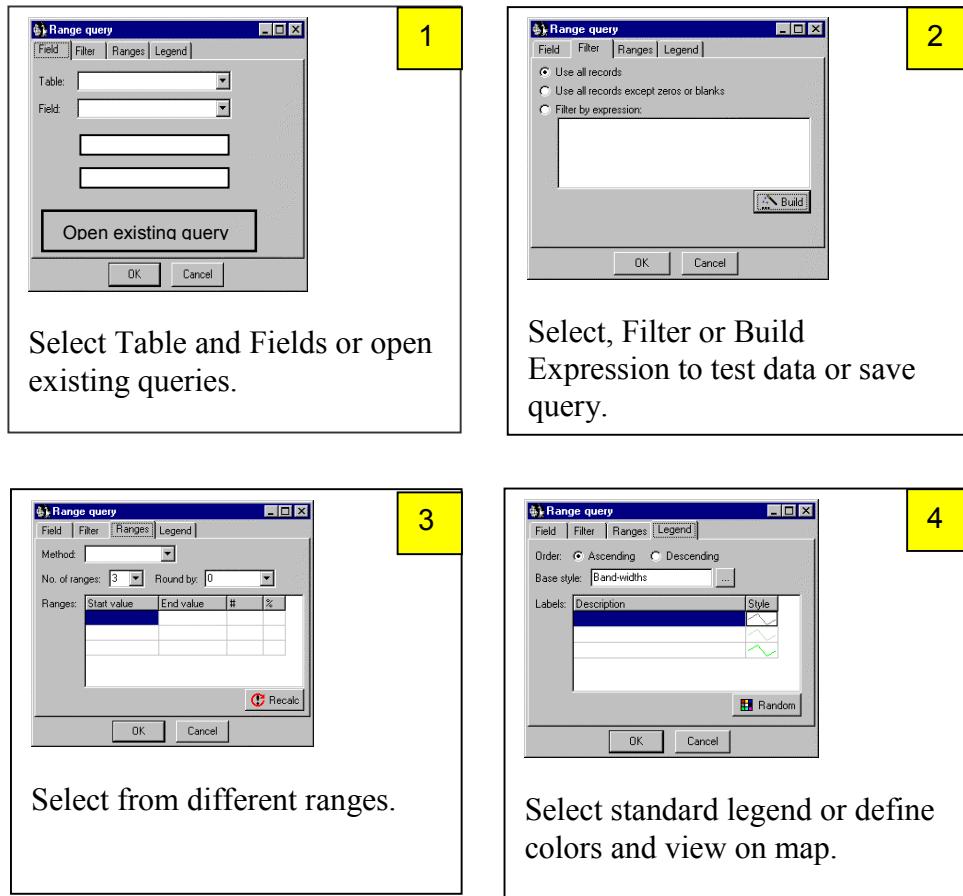


Figure 7: PTMIS Report Wizard

## Query Wizard (Attribute to Spatial)

The query wizard have been significantly improved. The query wizard allow the user to view data, summarize, save and display answer as part of the GUI. The query wizard has four components illustrated in Figure 8.



**Figure 8 : The Four Components of the Query Wizard**

Typical queries that the user can make are:

- Which routes depart from Depot A or facility B (e.g. rank or stations)?
- List/Display routes with a frequency of more than 3 trips in the morning peak hour?
- List/Display the amount of buses, the total capacity (seats plus standing places), the total passenger demand (utilisation) of bus in the morning peak hour?
- List/Display routes which have a capacity utilisation of less than 40%?
- List/Display facilities with X amount of vehicles, destinations, passengers, in peak period?
- List/Display the main destinations with (more than x (e.g.1000) passengers or an average vehicle occupation of less than X (e.g.13) passengers?)
- List/Display services with a frequency of more than 3 trips in the morning peak hour?
- List/Display bus contract details for route X?
- List/Display CPTR capacity, utilization and trips for route X?
- List/Display Registrar's database details for route X?

- List/Display license plate numbers for route X?
- List/Display stations served by route X?
- List/Display which services travel along rail section S27 (per direction)?
- List/Display how many trains/passengers, the total capacity (seats plus standing places), total passenger demand (utilisation) on section S27?
- List/Display timetables per route X?

#### Quick Search

The quick search option will provide the user the option to select the shapefile and from the list of features select some to be located in the GUI. The user has the option to select the attribute field he wants to include in this option.

Sample questions would include:

- Show me location of mini bus taxi rank Ramaza?
- Show me route BN0007BI?

## 6. CONCLUSIONS

This brief overview provides a very summarized picture or executive “bird’s eye-view” of the current status of PTMIS as installed at Durban Metro’s Traffic and Transportation Department as well as the new ArcPTMIS 4.

Whilst PTMIS is very easy to learn, it contains a vast store of information which needs to be explored in great detail, before all its benefits can be assessed and applied. Its flexibility in interfacing with GIS platforms allows one to add almost unlimited geographical features and tables, and the modularity of its design creates interesting possibilities for extending its range of functions, especially with the standard range of extensions that is available in ArcView 3.2.

PTMIS has undergone substantial evolutionary change since it was first released for Durban almost two years ago. Its scope and capabilities have been extended far beyond what was originally envisaged for the Fast Track Study, and in the process it is becoming an almost indispensable thread of continuity for many of the tasks which are currently in progress.

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Johnny Louw is the manager of the GIS Unit of Stewart Scott (Pty) Ltd of Pretoria since 1998.

He received his Masters degree in Town and Regional Planning in 1993. He specializes in Geographic Information Systems and Project Management.

Over the past ten years he has attended several applicable courses, conferences and also has knowledge of relational database design. For the last three years he developed the Public Transport Management Information System of Stewart Scott from a standalone version with very limited graphical interface to a robust and generic public transport planning tool for use by transport planners and managers.