MACRO TRANSPORTATION MODELLING IN ETHEKWINI: AN EXPLORATION OF TRAFFIC PREDICTIONS OVER THE PAST FIVE DECADES AND ITS IMPACT ON TRANSPORT PLANS AND PROGRAMMES

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ABSTRACT

The eThekwini Transport Authority (ETA) of the eThekwini Municipality has been at the forefront of transportation planning for the past fifty years and macroscopic traffic modelling has been at the heart of much work that has been done during this period. Large volumes of data were collected and many macro models have been developed in order to better predict future traffic growth. This enabled the city to prepare short, medium and long term plans to cater for the anticipated traffic growth in the greater Durban area. Over this period the size and shape of the city study area has grown from 800 km^2 to about 2 555 km^2. Similarly the population has grown fivefold to about 3.6 million.

This paper explores the journey of transportation planning in the City and highlights traffic predictions and infrastructure planning emanating from the analysis. The paper further highlights the level of accuracy of the predictions, challenges and key opportunities. Technological advances have played a pivotal role in this journey. The paper also details how the journey has been influenced by technology, mode choice and the political landscape.

It also provides some insights into the future specifically highlighting key aspects relating to predict and provide and the impacts of disruptive technology.

1. INTRODUCTION

The eThekwini Transport Authority (ETA) of the eThekwini Municipality has been at the forefront of transportation planning for the past fifty years and macroscopic traffic modelling has been at the heart of much work that has been done during this period. Large volumes of data were collected and many macro models have been developed in order to better predict future traffic growth. This enabled the city to prepare short, medium and long term plans to cater for the anticipated traffic growth in the greater Durban area. Over this period the size and shape of the city has grown from 800 km^2 to about 2 555 km^2. Similarly the population has grown fivefold to about 3.6 million.

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how the journey has been influenced by technology, mode choice and the political landscape.

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2. BACKGROUND

Transportation is a critical component of city development and prosperity. The former City of Durban boundary has over the past twenty five years been metamorphosed and transformed into a huge thriving and vibrant metropolis. This has been largely influenced by the political changes in the country since the advent of democracy in 1994. This has resulted in the consolidation of various small local authorities around the city to create a single metropolitan entity. A consolidation of some twenty five local authorities into a single entity with a central administration has been achieved. The size of the region (metropolitan area) has grown dramatically from a central core city of about under 1 000km^2 to over 2 500 km^2.

This consolidation into a single metro-pole with large parcels of green fields has had a dramatic impact on the delivery of general municipal services. This has been exacerbated with low population densities and under-serviced areas, especially in the outlying areas.

Fortunately from a Transportation Planning perspective the transition has been seamless. The main reason for this is that the city in terms of National Transportation Legislation specifically the Urban Transport Act of 1977 played a major role in Transportation Planning for the broader functional region of Durban. In fact, the erstwhile City of Durban was designated core city in terms of the Act and has played an advisory role specifically relating to transportation planning and development matters for most of the Local Councils in the functional region. In effect the City of Durban always had the mandate to prepare transport plans for the functional region of Durban. The macro transportation models so developed by the City of Durban since the 1980's therefore traversed well beyond the traditional political boundaries. Hence the transition since democracy has been really seamless with a few boundary amendments to incorporate areas in the north, west and south. Transport provision on the other hand has been quite challenging as the serviceable area has literally increased dramatically overnight.

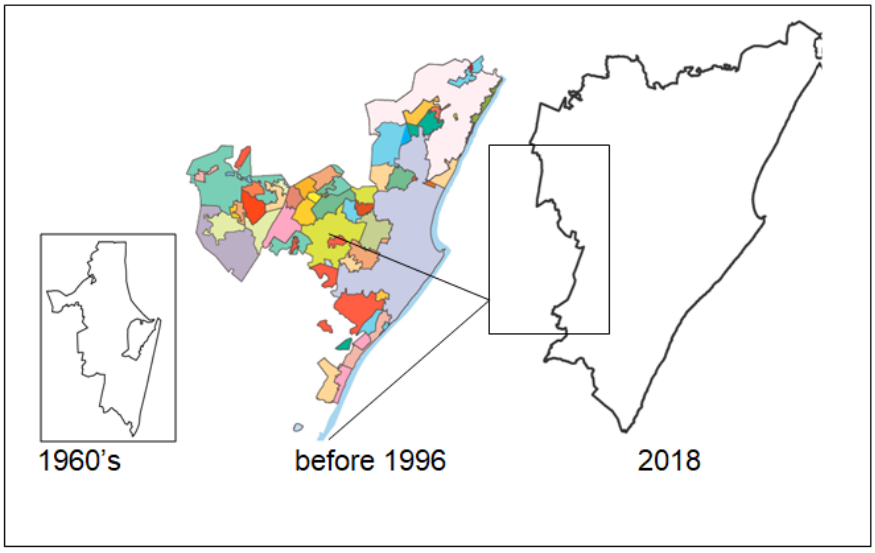

Figure 1: showing municipal boundary transition from 1960 to 2018

3. MACRO TRANSPORT MODELLING IN ETHEKWINI

Macro Transport Modelling in eThekwini can be traced back to the early plans developed by the City of Durban in 1957. The Deltran Suite of macro transportation modelling software programmes using the conventional four step modelling process was used.

The first travel survey for the City of Durban was conducted in 1966. In 1980 comprehensive travel surveys were conducted comprising both household travel data as well as on board surveys at public transport facilities. This survey formed the basis for much transportation planning work that was prepared between 1980 and 2010. In 2008 a household travel survey was commissioned and this has led to revised estimates for the base data as well as revised forecasts resulting in updated transport plans taking into account more realistic estimates.

Demographic data has obviously played an integral role in preparing traffic forecasts and modelling. Much reliance has been placed on various sources of data over the years. Census data as well as data from other relevant entities e.g. the Department of Labour has been crucial for establishing reliable demographic base as well as forecast data.

In 1985 it was considered prudent to supplement the 1980 surveys with on board public transport surveys so as to fill in the gaps that were identified in the base data. The Deltran Suite of programmes were utilised from around the 1970's to about 1990. This set of programmes served the City well in the early days and set a solid platform for transportation planning in the City. The software relied on extensive computing time and data cards that needed to be punched in at a remote location using batch entry on a VAX system. There was no graphic interface and all traffic assignments had to be plotted manually on printed A0 maps. This was very time consuming and cumbersome.

In the early nineties the City acquired the Emme multimodal network and demand modelling package developed by INRO which has all the features of new generation transportation planning software. This has proved to be a good investment. The Deltran networks, matrices, volume delay functions as well as other parameters and procedures were converted in 1991 and imported into the Emme databank. Comparisons were done to assess the suitability of the assignment outputs. This was found to be within the acceptable norms paving the way for the Emme software to become the software of choice in Durban as well as other major Cities in South Africa as well. The graphic interface as well as excellent user support has been extremely useful in terms of the work that has been done on Emme over the past two decades. It has been relatively easy to train new users on Emme either on the job or attendance at courses conducted by the developers.

The EMME Software has been improved on a regular basis resulting in the latest EMME 4 version which has numerous sophisticated features that makes modelling extremely powerful and dynamic. One notable change in the manner in which the traffic modelling was conducted in Durban needs to be highlighted. From the early seventies to the early nineties all demographic data used in the model was classified by race e.g. population, employment, car ownership etc. The macro transport model was structured into sub models based on race. This methodology recognised the differing trip making characteristics of the different groups in the City but also took into consideration the spatial locations of the various race groups. The modelling procedures performed were therefore structured according to the availability of data as well as the different travel characteristic of the residents.

With the political changes in 1994 and the emergence of a democratic order, the whole traffic modelling regime was re-engineered to aggregate some of the modelling routines to merge the separate categories in a much more cohesive way. The models were then revised to reflect groupings of persons within a particular income band as a unit for trip making purposes. The City has over the years reviewed the data requirements for these newer generation traffic models to take into account data that is classified more appropriately. Modelling software packages are data hungry and this will be elaborated in the next chapter.

4. DATA REQUIRED

Transportation planning especially at a city or metropolitan scale requires large volumes of data in order to prepare base data estimates as well as forecasts. Typically transportation planners need to determine future traffic growth in the city to determine future traffic volumes entering the city. More importantly, is to determine how the traffic is going to be managed. This is generally the key issue transportation professionals grapple with on a regular basis. In order to be able to respond to these issues on a regular and comprehensive manner, transportation models are set up such that it automates the inputs and computes reliable outputs to answer these vexing questions. Data requirements for transportation models are highlighted below:

4.1 Demographic data

This is one of the key inputs into the modelling process. Typically base information and forecast estimates for population, employed residents, employment and car ownership have been sourced and utilised. Data from census, household travel data, Department of Labour and Department of Transport have been key. In order to prepare forecast estimates it has been prudent to understand the economic trends in the City as well as the country. The Integrated Development Plan (IDP) and spatial planning of the City also provides an important determinant of establishing spatial distribution and anticipated spatial growth in the City. Invariably scenario planning has assisted greatly to establish an envelope of estimates based on a package of assumptions. This has typically assessed the City's growth trajectory under low or high economic scenarios and the implications thereof on transport.

4.2 Traffic Data

Large amounts of traffic data e.g. vehicle counts, occupancy etc. is required for transportation planning. This is mainly to assess the current situation accurately so that the estimates for the future is more realistic and reliable. The traffic data is also necessary for traffic modelling processes particularly the model calibration process. This City has been collecting vast amounts of data over the past few decades which has been done largely on a manual basis and captured on a database. Smart technology is however ensuring that more data is now being collected using TEL's and other technology.

5. REVIEW OF VARIOUS TRANSPORT PLANS

5.1 Discussion

During this period under review various Transport Plans were developed by the City as part of the Interim Transport Plan (ITP) requirements that Cities needed to comply with. Over and above that various specific studies were commissioned to assess the need for

roads to cater for the anticipated growth in the long term. The plans were developed taking cognisance of particular scenarios that needed to be considered. A case in point being the impact of Aids on population growth and its impact on the traffic projections. Pioneering work commenced in the early nineties that computed very accurately the impact of Aids on population growth and its resultant impact on transport provision. The results were in fact quite revealing and did in fact translate to a significant reduction in demand for transport. Various economic scenarios were also considered.

The early work focussed mainly on the private transport and this translated to a more road infrastructure biased plan. During the period under review the municipal boundary study area changed dramatically in size and any comparisons need to take this into careful consideration. A more detailed assessment of certain findings is explored in Section 6 of the report.

The table below summarises the key plans reviewed during the preparation of this paper.

Table 1: Transport Plans Predictions

Date Prepared	Plan Title	Study Area km^2	Base Population (m)	Projected Population (m) (forecast year)
1957	Durban Traffic Plan: 1957	815	0.5	1.1 (1980)
1968	Data Projections	1 120	0.9	1.4 (1980) 1.9 (1990)
1980	DMTA ITP: 1980-1985	1 120	1.6	1.9 (1985)
1985	DMTA ITP: 1985-1990	1 600	2.2	
1990	DMTA ITP: 1989-1994	1 600	2.2	2.6 (1990) 3.1 (1995)
1995	ITP: 1995-2000	2 200	3.1	3.7 (2020)
2000	ITP: 2000-2005	2 200	3.1	3.7 (2020)
2005	ITP: 2005-2010	2 200	3.4	3.7 (2020)
2011	ITP: 2010-2015	2 200	3.5	3.6 (2015) 3.9 (2025)
2018	2018 -2023 CITP	2 555	3.6	3.7 (2020) 4.4 (2035)

6. KEY FINDINGS EMANATING FROM PAST INTEGRATED TRANSPORT PLANS (ITPs)

6.1 Projections

The traffic predictions in the pioneering work of the City tended to overestimate traffic compared with some of the latter work. This can be attributed to better data as well as more sophistication in terms of analysis and technology.

Some of the population predictions for the study have been extremely accurate for example the work undertaken in 2004 and 2011 augured well in terms of a recent review which found that the projection was within 2% of the actual.

An in depth interrogation of the various transport plans prepared over the study period has revealed that certain projects that were identified as requiring critical intervention at a point in time have still not been implemented although the network has been able to cope adequately. This section of the paper highlights some of the key projects that falls under this category and tries to explain how traffic has automatically balanced on the network. In the early nineties 5 key projects amongst others were identified for implementation viz:

- Stapleton Corridor
- MR579
- Umhlatuzana Arterial
- MR360
- Second access to the Port

These projects have featured on a number of ITPs over the years but very little progress is noted in terms of implementation. The costs of these projects as well as the environmental impacts are quite staggering which has influenced the phasing of these projects. Safe to say the surrounding network with improved connections and capacity improvements have balanced the demand on the road network as a whole but the pressure for a more direct intervention is becoming more and more evident. Longer delays and gridlock situations are becoming the norm especially around the Port of Durban. Two of these projects support the Port. Another aspect that has had a major bearing on this narrative is the shift of road freight to rail. This has been the panacea waiting to happen with expectations of less road requirements in the future. Modal shift to rail has not materialised and it is still going to take a long time to materialise so the time to get some of these critical road projects is now supercritical. The City has acknowledged this and work is progressing on that basis.

6.2 Doomsday predictions

Much of the reports under review predicted huge volumes of traffic that could not be catered for simply by building roads. There was much emphasis placed on public transport as well as TDM interventions. In effect indications were that without these softer measures the City would be heavily congested leading to gridlock or long delays. Ironically despite the doomsday predictions the City has managed to keep people moving in spite of not materially addressing TDM nor public transport appropriately. This certainly suggests a certain level of peak spreading that has occurred over the years.

6.3 Prioritization

Various methods of road infrastructure prioritisation have been explored over the years and despite good and ethical intentions, various other factors have influenced how projects are prioritised and funded. Multicriteria analysis has over the years become a popular method for prioritisation and certain levels of success and frustration have been experienced in this regard.

6.4 Public transport

This paper has focussed primarily on macro modelling from a private car perspective although much of the modelling incorporated different levels of public transport interventions in the scenario development. Serious funding for public transport development only started in 2007 as preparations for the World Cup started gaining momentum. Prior to that much policy and planning work was undertaken. Rail transport had been playing a far more significant role in the early years under review and due to

under investment other modes have capitalised and large numbers of commuters have shifted to road based transport modes. In the early seventies, Durban had a tram system running in the City centre. This was operated as a municipal service but was discontinued due to newer technologies and the need for faster mobility. Ironically tram as a mode is currently being evaluated as part of the mode mix for the city centre.

6.5 Travel Demand Management (TDM)

This aspect has been neglected as a serious intervention in the City. The main reason being that congestion levels have always been considered mediocre. Public Transport provision has also not developed to the quality or standard expected from a choice user. Some park and ride initiatives were planned in the early eighties in the City which were subsequently stopped due to poor utilisation.

6.6 Road safety

There has not been much emphasis on road safety in the early plans for the City. Since 2005, with the City preparing and adopting the first Road Safety Plan much more proactive interventions have progressed in order to intervene in this space. The statistics demonstrates how accidents per 1000 vehicles have changed over the past 50 years. The accident rate has varied from a high of 144 crashes in the seventies to a current low of 76 crashes /1000 vehicles.

7. IMPLEMENTATION OF THE PLANS

Over the years the City has largely been successful in securing sufficient budget to keep the traffic moving in keeping with the norms and standards of large metropolitan cities.

It is evident from the research that most of the projects that were identified to be implemented during a specific period did not get implemented as planned. The identified infrastructure did however get implemented at a later date in most instances. This has been largely due to budgetary constraints or just lag time between planning and implementation. It is also clear that with the lag of the investment traffic did smooth out and peak spreading naturally allowed the system to accommodate more traffic than what was estimated.

Investment in Public Transport however, has lagged significantly having major implications for captive public transport users especially with regard to safety and reliability. The low levels of investment in Public Transport will no doubt exacerbate the need for new roads in the future and this is becoming quite evident in areas like the north where major roads are required to cater for the anticipated growth in traffic in the area. An accelerated investment in Public Transport will lead to a much more balanced and sustainable solution. This is currently carefully being assessed and developed. Despite some major roads like the Umhlatuzana Arterial being identified in a number of ITP's no progress has been made with implementation. This has surfaced as a serious problem in the southern basin especially with respect to Port traffic.

8. HOW HAS TRANSPORT MODELLING INFLUENCED THE LANDSCAPE OF SOUTH AFRICAN CITIES

Most of the South African Cities have been dominated by the private car and the shape and form of the cities have been firstly influenced by apartheid spatial planning and

secondly by the private car. With a strong reliance on the car for private mobility – exceptionally good road infrastructure has been developed in Durban linking residential areas and economic hubs. These routes have been improved and widened based on the demands of the private vehicle. As development moved away from the City centre road linkages were developed to cater for this new demand as well – so in effect the private car has encouraged urban sprawl in some cases.

9. FUTURE PREDICTIONS

The Durban metropolitan functional area is still growing as the population grows with in migration as well as economic growth. It has been established that the traditional approach of providing more capacity to address projected demand is counter intuitive. In the mid-nineties –pioneering work done as part of the ITP demonstrated that the projected demand necessitated the need to double the capacity entering the Durban CBD in the long term. It was also computed that in order to cater for the private growth that 20 more parking garages would be needed to be built is the City centre. This has certainly not materialised and has been reviewed taking into account a number of other pertinent enablers in the transport space. The traffic patterns are continuously changing and it is certain that sustainability will play a pivotal role in future city development. Transport sustainability will no doubt underpin this narrative. Trip lengths and travel cost is still inordinately too high. More compact city development is needed and will be promoted which will have a significant impact on travel patterns and transport provision. Serious interventions are part of the plan in order to move towards a more resilient and sustainable trajectory. There is no doubt that travel distances will reduce with time. It is also envisaged that cost of travel will be reduced into the future. There is no doubt that transport and land use development need to be more aligned in order to create a more sustainable city. User preference surveys will need to inform planning in a much more integrated manner. Disruptive technologies are clearly having a significant impact in the transport space. This aspect needs further strategizing into the future.

10. CONCLUSIONS

- Macro modelling in Durban has been useful in identifying key road infrastructure projects for prioritisation and implementation.

- Projects have been identified through a sophisticated technical process and have had a significant impact on City Development.

- The delayed implementation of some of the projects has resulted in extended delays and negative impacts on the economy.

- The City ITPs has been a good yardstick for monitoring transport needs and performance of the transport system in a holistic manner.

- Data is a key input to the planning process and with the advance in technology data mining from cell phone and vehicle tracking devices is already revolutionising the manner in which data is being accessed and utilised.

- Similarly new generation planning tools e.g. Replicate are being increasingly utilised with reciprocal benefits.

11. RECOMMENDATIONS

- Reliable data is crucial for model development and analysis. A data strategy to source data on a continuous basis is key to improving macro modelling capability. Technology will no doubt play a significant role in improving quality data that is clean and reliable.

- The model capability needs to be improved to take into account public transport, freight and TDM in a much more robust manner.

- The travel time distribution functions are anticipated to be reviewed with time against the backdrop of reducing travel distances associated with a compact City. This needs careful consideration in the development of future models.

- ITS systems especially APTMS and fare management systems currently being installed for the GO! Durban project will provide access to a massive amount of data that will need to be appropriately mined and utilized in a more constructive way to better predict travel behaviour, mode choice and choice users.

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