POSSIBLE IMPACT OF TRANSIT ORIENTED DEVELOPMENT ON PUBLIC TRANSPORT – CASE CORNUBIA (TO D, or not to D, that is the question)

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ABSTRACT

In South Africa, with traditional land use, public transport (PT) trips are long and slow. PT is mainly used by Captives and is operated inefficiently and expensive. Walking is seen as a necessity to reduce transportation costs, or to cater for the lack of PT coverage. Higher income Choice Users mainly travel by private car.

As a response, Integrated Public Transport Network and, more recently, Transit Oriented Development (TOD) plans have been developed. In this paper the impact of TOD on PT is explained through the Cornubia Boulevard case study.

It can be concluded that improved PT – with traditional land use developments – would hardly see any difference in peak trip generation and distribution, and only a small shift to PT use, due to improved QLoS. However, additional high density, mixed-use and well-designed TOD could lead to more PT trips: shorter trips in peak periods and more off-peak trips, which will make PT systems more efficient.

1. INTRODUCTION

1.1 Background

In South Africa, traditionally, developments are mostly based on segregated mono-functional sub-areas. This would lead to longer transportation connectivity to other activity areas. Long travel distances are not promoting walkability and will lead to higher transportation costs for lower-income Public Transport (PT) users and for higher-income car users. Also, this will lead to high operational costs and less efficiency for PT systems, and more infrastructure.

As a response, a 'Transit Oriented Development' (TOD) policy is developed, where new developments are preferably located near PT nodes with a high Quality Level of Service (QLoS). In line with this, Integrated PT Network (IPTN) plans have been developed. These networks would provide better QLoS for the current 'Captive' PT passengers (those without a car who rely on PT), and ideally also see a shift in transport mode from car to PT use, attracting 'Choice Users'.

TOD is often associated with higher densities, as this would lead to an increased PT use and PT efficiency. Another important impact of TOD is the use of mixed-use developments at these PT nodes. TOD would then lead to shorter trips, as some activities are available

'around the corner'. This would improve walkability and PT use, start to attract more Choice Users, and further reduce reliance and use of private cars.

1.2 Objective of this paper

The objective of this paper is to investigate the influence of the main TOD factors: Improved PT, Density, Mixed-Use, and Design. The paper looks at the impact of such TOD developments on transportation issues: mainly PT and NMT.

Firstly, this paper provides some theoretical background on transportation behaviour (section 2) and discusses the theoretical benefits of different ingredients of TOD for PT planning (section 3). Then, this is applied to the study area of Cornubia Boulevard, located in the north of Durban (section 4). The ingredients of this study can form basis for future PT and urban development plans elsewhere (section 5).

2. TRANSIT ORIENTED DEVELOPMENT AND TRANSPORTATION

2.1 Historic overview

The concept of Transit Oriented Development (TOD) appears to have originated in the United States during the late 1970s and early 1980s (Wilkinson, 2006). Since then, many scientific papers have studied TOD and its impact on Transportation, mostly for a western world context.

Wilkinson was amongst the first to publish explicitly on Transit Oriented Development in South Africa and described TOD as "the establishment of high density, mixed use public transport corridors as a way of enhancing the effectiveness of urban public transport systems" (Wilkinson, 2006).

Some of the benefits of TOD were already implicitly known, as NDoT (1999) identified "the densification of public transport corridors as the key component of urban passenger strategy".

The National Development Plan (NPC, 2011) mentioned TOD as a vision for spatial and transportation developments. At the same time, Municipalities started developing Density Strategies and Policies, as well as Integrated Public Transport Plans. The first policies mainly focused on the benefits of high densities for the PT system. However, the term TOD was hardly used in these policies.

Recently, several researchers, MSc and PhD students and consultants have looked at TOD in a South-African context (see literature references at the end of this paper).

2.2 Ingredients of TOD

Many studies have come to a list of requirements for TOD. One of the founding fathers of TOD science, Cervero (1997), proposed to characterise TOD by "3Ds": Density, Diversity and Design. Others, like SACN (2014), have added other aspects.

From a Transportation point of view, this paper will look at the impact of Improved PT, Density, Mixed-Use (Diversity), and some Design aspects.

Other aspects will not be discussed: cycling, which is not really part of SA's mode choice, yet; and regulating parking and road use / traffic management. This paper would like to focus on the strength of PT itself. Obviously, in TOD planning, all aspects should be included.

2.3 Transportation background

Each person has an average standard activity pattern. Regardless of living or working in a traditional development area or a TOD area, one needs to travel for economic activities (work, school), some supporting activities (shopping and visiting facilities), and/or additional social activities (visit friends and family, leisure, etc.), depending on his/her position in the household. Transportation is a derived activity to access these daily economic or social activities. Therefore, each person would have a base trip generation.

From a user perspective, transport incurs monetary costs, utilises time, and requires physical and mental effort. Each passenger has these three types of budget available (Onderwater, 2017). In order to preserve sufficient budget for other activities, one wants to minimise the total burden on these transportation budgets.
When the quality of the transportation system is insufficient and/or travel budgets are limited, people will have to make a plan B:

- They would choose for the cheapest (or otherwise appropriate) transportation mode: if having or using a car is too expensive, one would travel by PT; choosing a cheaper PT mode: train or bus; or walk.
- They would choose for activities closer by (to reduce travel costs and time), even when these activities are not optimal (e.g. less optimal work opportunities, not the best school, more expensive shops).
- They would even reduce their number of trips (cannot afford leisure activities or social trips).

This could therefore reduce their social inclusion and their economic activities.

On the other hand, when travel would take up less of these budgets, one could use the 'saved' budget for additional activities and/or for additional travel. For instance, with improved PT, people would spend less time on their trips. This would lead to having more time available for other activities, or an acceptable longer travel time / distance, hence a higher accessibility for e.g. better job-opportunities. This will improve one's economic and/or social opportunities.

These aspects will also impact on the operational efficiency of the PT system, and/or impact on the capacity of infrastructure. These impacts will be discussed in the next section.

3. ANALYSING TRANSIT ORIENTED PLANNING

Starting from 'traditional' land use planning, this section will look at the impact on transportation (mainly PT) of additional TOD aspects as: Improved PT, Density, Mixed-Use, and Design.

3.1 Traditional land use

The traditional South African urban pattern consists mostly of monofunctional residential and segregated working areas, with a relatively low density (compared to other African cities). Firstly, this was driven by Apartheid Planning. Then, since democracy, government was tasked to build millions of cheap housing, and had little other opportunity than urban sprawl (IRR, 2017). With that, people need to travel further to e.g. work opportunities.

Due to poor PT planning by Transport Authorities, and as protest against these Apartheid services, the 'private sector' started providing informal PT services (Smith, 1992). However, with low urban densities, PT could only provide an acceptable QLoS when small vehicles are used, like minibus-taxi. As a result, PT supply is infrequent and unscheduled, and therefore is mainly used by Captives. Also, PT is operated inefficiently and expensive.

Walking is seen as a necessity to reduce transportation costs, or to cater for the lack of PT coverage.

As a result, with traditional land use and PT systems, PT trips are long, slow and expensive; and people spend a relatively great amount of money, time and effort on transportation, often 20% (NHTS, 2013) and up to 40% of their household budget; and/or more than 2 or even 4 hours per day.

3.2 Improved PT

The recent IPTN plans aim to improve Public Transport, firstly to accommodate the current Captive PT Users; secondly to support a modal shift for Choice Users from their private car to PT (source: NDoT).

IPTN has an improved QLoS of PT and trips to developments along such corridors see a first modal shift:

- BRT starts to attract the first Choice Users. However, many Captives remain using minibus-taxis.
- Current Metrorail is not appealing; a Modernisation Programme is underway to provide much higher QLoS.
- Gautrain has a high QLoS but, due to high fares, mainly attracts Choice Users.

Still, with traditional land use, PT trips remain long. Also, the current low-density PT nodes have few activities within the station's walking influence area, and the high-quality PT systems mentioned above, rely on additional feeder and distribution services. At the Origin side of the trip, the car could be used (sometimes dubbed as 'Car Oriented Transit'). However, at the Destination side of the trip, with long walking distances at low densities, these PT systems heavily rely on a distribution system for the 'Last Mile'. This is a barrier for attracting many Choice Users, as these transfers take additional time and effort.

3.3 High density

As a first element, Transit Oriented Development is often associated with higher densities and in TOD policy, new developments are preferably located near PT nodes. However, TOD is more than 'Transit Adjacent Development'.

Each activity requires a minimum catchment area to be self-sufficient. With higher densities, this area is smaller. Ditto, each resident desires several accessible activities within a certain range. With higher densities, the accessibility increases, and trip distances will be shorter.

With higher densities, there are more activities in the area, attracting more transportation: both car and PT. Road transport can hardly cater for high densities. On one side, it requires wide roads and huge car parking facility, both reducing density. On the other side, it causes more congestion. Improved PT can cater for high densities of activities with far less space requirements. And instead of sitting in congestion, Choice Users are keener to use PT (provided PT has good QLoS), increasing the modal split. Also, with more activities near PT nodes, this reduces walking distances and the need for additional feedering.

With high density, PT patronage will increase. In PT operations, larger vehicles can be deployed, which will increase the efficiency of the PT system, and still provide a decent service frequency.

A metropolitan rail system can be efficient when the gross density of population + jobs combined is greater than roughly 200 people per hectare. Below that, and above 100 activities/ha, BRT would function properly (Onderwater, 2018). Worldwide best practises show that there is a strong relationship between density and modal split, where with higher densities the share of NMT and PT is much higher as with lower densities, which areas are much more car oriented.

3.4 Mixed use TOD

With segregated areas, independent of density, trips are still relatively long. With additional mixed-use, trips will become shorter, as many more activities will be accessible at short distance of – or within – residential areas.

A secondary impact of high-density mixed-use areas, is that some commuters will also be accommodated for additional trips, for instance doing shopping or leisure activities in lunchtime or after work, as such facilities would be ‘around the corner’ and walkable. This would reduce the need for the original commuting by car, as these trips can be combined by PT and walking, as a ‘trip-chain’.

Mixed-use areas with relatively short trips are efficient for operating a mixed PT service: as workers alight a PT vehicle, they free up space for residents boarding the same vehicle and/or in the reverse contra-peak direction; it will make the same PT vehicle available for more paid trips in the same peak period.

A secondary impact would be that the additional travel opportunities would require a decent off-peak PT services (one aspect of a high QLoS). This in turn could also accommodate a small shift of some non-peak-dependent trips to the off-peak period, making PT more efficient (Onderwater, 2019).

Some trips will be very short (intra-zonal), which will enhance the use of walking and cycling.

3.5 Design of public spaces for pedestrians

A dense mixed-use TOD area enhances walking trips and PT trips. When the 'Last Half Mile' is catered for with a dense pedestrian network and walking in a pleasant environment, PT will become more convenient for more Choice Users; and for pedestrians in general.

Another design element is to develop the right type of activities that are suited for higher densities (e.g. not only cater for workers but also attract many visitors), like offices, facilities, retail, lunch and coffee bars, etc. TOD areas should avoid wholesale, car dealers or petrol stations, that would attract car-reliant transport. Also, off-street structured (preferably underground) parking should be developed, to free-up space for other developments and for better experience of public realm.

Density and mixed-use will enhance lively cities, with many people walking on the street and areas busy throughout the day and not in peak hours only. These aspects would further improve when the urban transportation design has far less interaction between vehicle movements and pedestrians, improving traffic safety.

3.6 Other aspects

Obviously, many other aspects play a role in developing, planning and designing TOD areas. From a traffic and transport point of view, sufficient road provision and parking require attention. Although this paper has focused on the TOD impact on PT, it is expected that similar reasoning and conclusions could be derived for car transport: more but shorter car trips; and distant parking being acceptable within a pleasant walking environment; etc.

Building in higher densities is often more expensive, compared to 'traditional' low densities. On the other hand, it could lead to a reduction of bulk costs (road infra, water, electricity) per unit. The costs and benefits could best be assessed in collaboration between the public authorities and private developers.

These aspects are left outside the scope of this paper. Obviously, in TOD planning, all aspects should be included.

4. CASE CORNUBIA BOULEVARD

Cornubia is a recent development in the north of Durban, developed by Tongaat Hulett Development (THD) in collaboration with eThekwini Municipality (see Figure 1). From the start, Cornubia was planned along new IPTN Corridors to optimise PT use. Also, Cornubia was planned with higher densities than normally used in eThekwini (or South Africa for that matter). Recently, other TOD aspects are being designed for.

4.1 PT in Cornubia

Within Cornubia, 2 BRT trunk corridors are planned (see Figure 2):

- C9: Umhlanga – Cornubia – Phoenix – Bridge City
- C8: Durban – Umhlanga – Cornubia – Airport – Tongaat.
- And possibly an IPTN sub-route from C9 Bridge City – Phoenix to C8 Cornubia North – Airport.

The combined C9/C8 corridor runs past a series of areas with (potentially) higher density and mixed-use: Umhlanga Town Centre and Gateway, Cornubia Town Centre, and Cornubia Boulevard. C9 continues to the dense Bridge City Town Centre, while other areas like Phoenix have few opportunities to densify. C8 continues to the Airport, with densification opportunities along the route. However, mixed-use developments (especially residential developments) are limited by the Airport's noise contour.

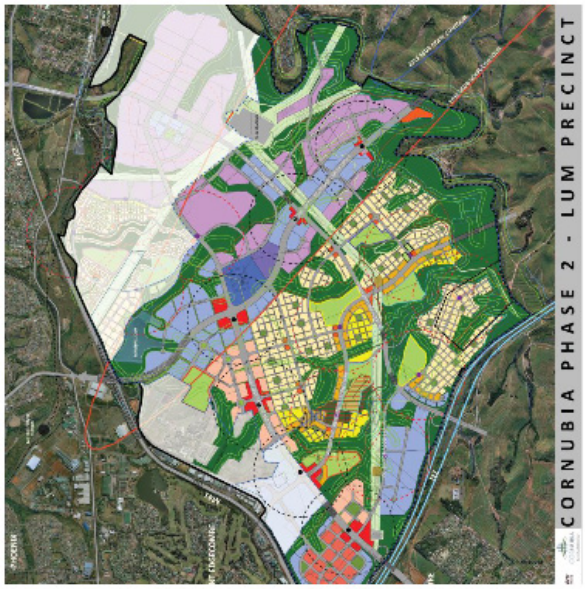

Figure 1: Cornubia development plan

Figure 2: eThekwini's IPTN plan

Apart from the 2 BRT trunk corridors, there are several additional PT routes and feeder routes to open-up adjacent areas. These routes intersect at several points within Cornubia and provide a transfer opportunity to the BRT trunk routes. However, in deviation to a 'standard' Trunk and Feeder network, these feeder routes are proposed not to terminate at the BRT station but continue to other areas to provide additional connectivity.

4.2 Dense mixed design for Cornubia Boulevard

At the junction of C9 and C8, a development called Cornubia Boulevard is situated. Recently, the proposals for Cornubia Boulevard were changed to allow for an even higher density and mixed-use development. These developments are concentrated along the BRT Corridor, in between 2 stations 800m apart: one at the north-western end near a proposed Civic Centre; and one at the south-eastern end of the Boulevard development. The corridor in between is planned as a pedestrianised boulevard with many destinations alongside: shops, leisure and other activities on ground floor, offices and facilities on the next floors, and residential units on the higher floors (up to 12 floors high), as well as behind the first lines of development (less high). The main roads are not planned along the BRT Boulevard, but behind this central development zone, with integrated parking in basements. The architect is making effort to design the area as a pleasant place to walk, live, work and stay; see Figure 3.

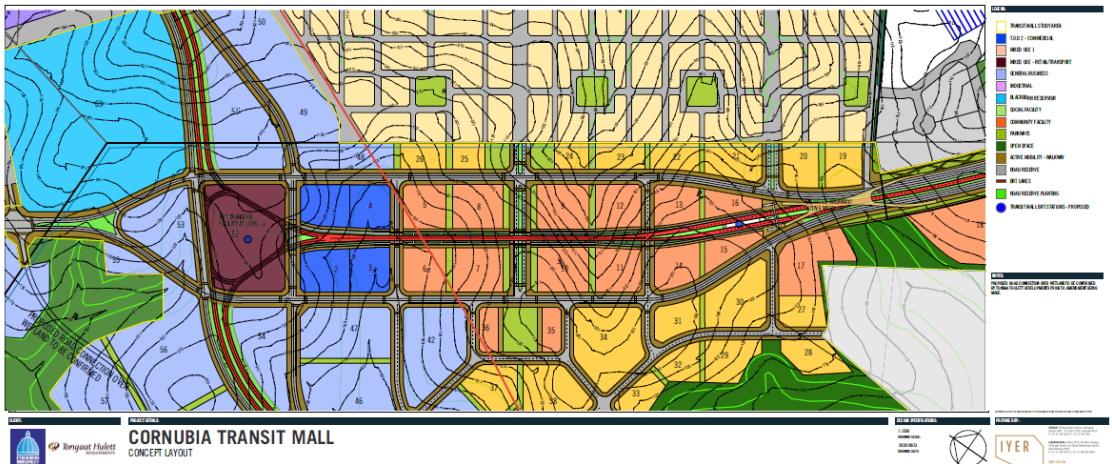

Figure 3: Cornubia Boulevard (Source: Iyer)

4.3 Model exercise

Ideally, the planning elements of TOD (Improved PT, Densification, Mixed-Use, and Design) would be tested by a 4-step Transportation Model, with: 1- Trip Generation, 2- Distribution, 3- Modal Split, and 4- Assignment. In the planning and design for Cornubia, some TOD elements have been tested with eThekwini's EMME model. Unfortunately, the available models have some restrictions which are discussed in this section. Other elements could not be tested (e.g.: how to model a 'pleasant design'?).

A transportation model's first step 1- Trip Generation, is based on people's activity pattern (Onderwater, 2018), and the more people in higher density, the more trips will be made. During the design process of Cornubia Boulevard, densities were increased, and the model resulted in more PT trips: almost double compared to the base case.

As a result, the combined C8/C9 BRT corridor between Cornubia Boulevard and Umhlanga can expect some 15,000 passengers per peak hour direction. This is at the max capacity of BRT systems. For that reason, future transformation to Light Rail should be considered and/or additional parallel IPTN corridors be provided to spread the passenger volumes.

However, eThekwini's model is a peak model, focusing on commuter trips. Off-peak trips are not assessed in the model. Therefore, the model would not show any TOD benefits for off-peak transportation. Also, mixed-use development could lead to a reduction of trips and PT trips, as more trips could be made walking. However, a model would not show this.

Ideally, step 2- Distribution should be based on the number of available activities within reach of residents. eThekwini's model has a generic distribution-function, based upon the Household Travel Survey (HTS), and indicates average trip lengths of 20-25 km (THD, 2011, 2015). This, however, is based on 'traditional' segregated land-use patterns. Another restriction of an HTS in general, is that it tends to ignore many short trips and off-peak trips.

With dense mixed use, many more activities are accessible at shorter distances; hence the average trip length will reduce. The model, however, would hardly show this as the distribution function would remain unchanged. Therefore, the current model cannot be used to illustrate the wider impacts of mixed-use TOD.

In the model exercise, only mixed densification of Cornubia Boulevard is tested, while ideally other areas in the network be developed denser and more mixed as well. This would enhance the impact of TOD. It is recommended to optimise all development for the whole Durban northern area, and test this with an adapted model.

Another general concern of eThekwini's model is that it does not have a modal-split-function. Instead, step 3- Mode Choice between car and PT is given as a policy parameter. This is partly based on historic experience as per HTS, partly based on expertise of the modellers, and partly based on 'wishful thinking' by policy makers. With the planning of improved PT, the modal split is set at a higher value, differentiated per income level. Ideally, the models' modal split should be based on generalised costs (money, time and effort).

A similar shortcoming of transportation models in general is that these cannot model for the effects of insufficient PT QLoS and/or insufficient passengers' travel budgets (as discussed in section 2.3), which would lead to sub-optimal choices for mode choice, distribution, or even reduce trip generation. These impacts are merely modelled with a current generic parameter, as per HTS. With an improved situation, these aspects would not automatically change in the model.

The last step of a model, 4- Assignment, will show the patronage on each corridor, with which the PT operations can be designed. With the proposed mixed-use, the model for Cornubia Boulevard shows an equal number of passengers board and alight in the peak hour. This is an indication for an efficient PT system, at least on this section of the route.

The model also shows - indirectly - some effects of PT improvements. As an example, the fact that in the latest PT plans feeder routes are not terminating at the BRT stations but continuing to other destinations, has resulted in thousands less passengers transferring. This would indicate a better QLoS for passengers, hence more PT use could be expected. However, with a fixed trip generation and modal split, this effect is not shown in the model.

The above-mentioned model shortcomings are not specific for eThekwini's model only. Many transport models have more-or-less similar issues.

It is recommended to develop a new generation of transportation models, that consider a flexible trip generation (and also look at off-peak travel patterns), a distribution depending on accessibility of facilities, and a modal split function depending on generalised costs and available budgets in terms of money, time and effort.

4.4 Unpacking modal shift

Despite the model's shortcomings, a model exercise has been done for Cornubia in the Proposed Cornubia Development Transportation Study (THD, 2011), and are used in the Traffic Impact Assessment (TIA) reports for Cornubia Phase 2 (THD, 2015). In these studies, it is indicated that an improved PT network – plus implicitly other TOD elements – would lead to a modal shift from car to PT use, depending on the income level of the population; see Table 1.

Table 1: Modal split for traditional PT and IPTN. Source: TIA Cornubia

Modal Split %	Traditional planning		IPTN (with TOD)	
Mode:	Car	PT	Car	PT
High Income	100 %	0 %	70 %	30 %
Middle Income	80 %	20 %	30 %	70 %
Low Income	20 %	80 %	10 %	90 %

It must be stated that the target modal split seems high and only be achieved in the long term, including all other type of measures, like dense mixed-use. However, the impact of the individual TOD elements is not assessed. Therefore, in table 2, a guestimate is given for the PT modal split, for the individual TOD elements.

It is expected that lower-income Captive passengers would quickly respond to any improvement of PT and land use; while for higher-income Choice Users, only the whole pallet of TOD improvements would lead to some shift from Car to PT.

Table 2: PT Modal split for individual TOD elements (indicative)

PT Modal Split %	Traditional Planning	+ Improved PT	+ Densification	+ Mixed-Use + Design
High Income	0 %	5 %	15 %	30 %
Middle Income	20 %	35 %	50 %	70 %
Low Income	80 %	85 %	90 %	90 %

5. CONCLUSIONS AND RECOMMENDATIONS

In summary, improved PT as per IPTN plans – with traditional land use developments – would hardly see any difference in peak trip generation and distribution, and only a small shift to PT use, due to improved QLoS.

However, additional high density, mixed-use and well-designed TOD could lead to more PT trips: shorter trips in peak periods and more off-peak trips. This would lead to some peak-spreading, which would further favour the use and efficiency of PT.

The recent plans for Cornubia Boulevard represent all the features for Transit Oriented Development: high density, mixed-use, and well-designed developments along a high QLoS Public Transport system. With this mix of measures, it is possible to come to a shift towards PT use, as well as a liveable city environment.

This type of development should not be limited to the Cornubia Boulevard project only, but along most of the IPTN corridors. It is recommended to review current planning for all developments (in Cornubia, and elsewhere in South Africa), to include all TOD elements: Improved PT, Densification, Mixed-Use, and Design.

It is also recommended to further improve the available transportation models, to better ‘prove’ the effects of TOD.

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