

# The Role of 6Ds: Density, Diversity, Design, Destination, Distance, and Demand Management in Transit Oriented Development (TOD)

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**ABSTRACT:** *This paper reflects on the efficacy of Transit Oriented Development (TOD) and the primary components that constitute it. These components are widely recognized as manifesting themselves through the concept of “6Ds”: Design, Diversity, Density, Distance, Destination, and Demand management. The paper thus investigates the main aspects that underlie these “Ds” and how they can equally be taken up in TOD initiatives. The development of efficient and sustainable transport systems has become a key mitigation method for major traffic problems such as congestion, poor mobility and access to services, as well as greenhouse gas emissions. The primary argument of this paper centres on the premise that the application of “6Ds” through TOD can go a long way in addressing current challenges that confront urban transport within cities. Using a case study, the paper contextualizes one of the “6Ds” and subsequent conclusions are drawn thereof in the form of key determinants.*

**Keywords:** Transit Oriented Development, Density, Diversity, Design, Demand Management, Destination accessibility, Distance to transit.

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## Introduction

Being the wealthiest and largest city in South Africa, Johannesburg continues to be the main economic hub for South Africa and sub-Saharan Africa at large. Notwithstanding this, the city has to contend with its fragmented spatial patterns emanating from the legacy of apartheid. As part of its attempts toward addressing these challenges, the municipality has embarked on a new spatial vision: ‘The Corridors of Freedom’. Introduced in May 2013 by Executive Mayor Mpho Parks Tau in his State

of the City Address, these corridors are envisaged to be "...well-planned transport arteries linked to interchanges where the focus will be on mixed-use development - high-density accommodation, supported by office buildings, retail development and opportunities for leisure and recreation" (COJ, 2013). Central to achieving these imperatives will be TOD through the 6Ds.

## Literature review

The high level of automobile dependence is one of the major challenges that confront urban and transport planners in contemporary cities. A growing body of literature and evidence from practice indicate that low density development and fragmented spatial patterns are the main agents through which car dependency has perpetuated itself. In response thereof, the Transit Oriented Development (TOD) model has in recent years taken a central role in transport policy and become one of the key planning paradigms aimed at reversing auto oriented developments. Its origins can be traced back to 1993 and find expression in a book [1] by American Architect Peter Calthorpe. Although several definitions for TOD have emerged over the years, they all however capture the same essence. [2] define TOD as "...a planning technique that aims to reduce automobile use and promote the use of public transit and human-powered transportation modes through high density, mixed use, environmentally friendly development within areas of walking distance from transit centres".

In the same vein, [3] posit that TODs are "...higher density mixed use residential and commercial developments set within walking distance of key transit nodes such as rail or bus stations or around activity centres such as major shopping centres/offices. The definitions above encapsulate TOD as a progressive effort aimed at reducing auto dependency through mixed land use and high density development complemented by a built environment that supports non-motorised options. Planning and implementing TOD has thus become widely cast in the context of the "6Ds" (Density, Diversity, Design, Distance to Transit, Destination Accessibility, and Demand Management). These variables are considered very crucial in achieving the objectives TODs and are described below in turn.

**Diversity:** The availability of a wide range of amenities and activities within a given area is one of the main aspects that underpin successful TODs. This heterogeneity is generally considered to be synonymous of the term "diversity". In the literature, there are several definitions of this term depending on the context in which it is being used. In the context of TODs nonetheless, diversity is used to describe a mix of different uses and the degree of balance thereof, a varied physical design, an expanded public realm, and multiple social groupings of different races, ethnicities, genders, ages, occupations, and households [4,5,6].

## Density

As was mentioned earlier, a critical challenge facing transport policy makers and urban planners alike is the high level of automobile dependency partly due to low density developments and poor integration of land uses. In order to reverse these patterns, urban areas need to be designed in a manner that supports 'high-density' development complemented by mixed land use and investments in easily accessible public transport systems [7,8,9]. [10] defines density the number or concentration of opportunities per square kilometre or another surface indicator, such as dwellings, households, people and jobs. The main premise of high density development "assumes that placing residential buildings near major transport nodes, amenities and workplaces will heighten the convenience and, therefore,

the uptake, of sustainable transport modes such as public transit and walking"[11],[12]. Similarly state that "high densities tend to be associated with lower average trip distances for all modes, improved public transport through higher potential patronage around each stop and in particular, enhanced viability of walking and cycling".

## **Design**

Built environment dimensions play a considerable role in transit ridership [13]. Design includes "carefully articulated land-use mixtures; safe and smooth accessibility to transit stations (enabled by foot paths, cycle paths, and street lights, for example); and amenities such as benches, parks, landscaping, and libraries - which all contribute to the development of a good built environment" [4]. Neighbourhoods that are designed with walkability and cycling in mind facilitate sustainable mobility for cities and increase transit ridership [14,13].

## **Distance to transit**

Being an equally critical variable in the TOD equation, distance has substantial implications for the viability and effectiveness of a public transit system. In essence, distance measures the proximity and accessibility of a transit station. [15] enunciate that such measures are very crucial for a number of reasons, some of which include "evaluating existing transit services, allocating transportation investments, and making decisions on land development" [15]. [4] also argue that cities designed to reduce travel distances encourage walking, cycling, and use of the public transit system. However, these choices are influenced by various factors. According to [11] these include "land use factors, psycho-social and cultural factors, habitual or automatic behavioural processes, and practical or instrumental reasoned factors". This captures the complexity of transport choices and indicates that proximity and accessibility alone don't determine the use of transit systems.

## **Destination accessibility**

Efforts in achieving destination accessibility are premised on the logic of providing greater mobility by moving people around the city more swiftly, not by bringing urban activities closer together [16,4]. In this regard, transit systems need to be cast in manner that facilitates access to a wide variety of destinations such as work, service centres, recreation, and so forth. "BRT has been demonstrated to provide efficient and effective public transport that can even increase transit ridership and attractiveness within defined urban corridors in both developing and developed countries" [17]. However, lack of accessibility to the transit system and/or different destinations often prevents large sections of society from using the bus [18,19].

## **Demand management**

The concept of "Travel Demand Management" has its roots in the energy crisis of the US during the 1970s [20,21]. It is used to describe "...any activity, method or program that reduces vehicle trips, resulting in more efficient use of transportation resources" [20,22]. [23] states that policy interventions for demand management can be considered in two contexts: "actions that are implemented at specific sites (e.g., rideshare programs at an employment site), or strategies that are implemented at an

area-wide level (e.g., growth management policies for a state or community, or the implementation of an area-wide variable work hours program)".

## Objectives

The objective of this study is twofold. Firstly, it intends to provide a comprehensive outline of the main theoretical underpinnings of TOD and the 6Ds. Secondly, it uses a case study (from an ongoing research exercise) to contextualize one of the 6Ds' variables through which several determinants thereof has been ascertained. A sample of 42 respondents was used for the research study.

## Methodology

The study uses a qualitative case study approach and the process followed thereof is illustrated below:  
Case study: Orange Grove

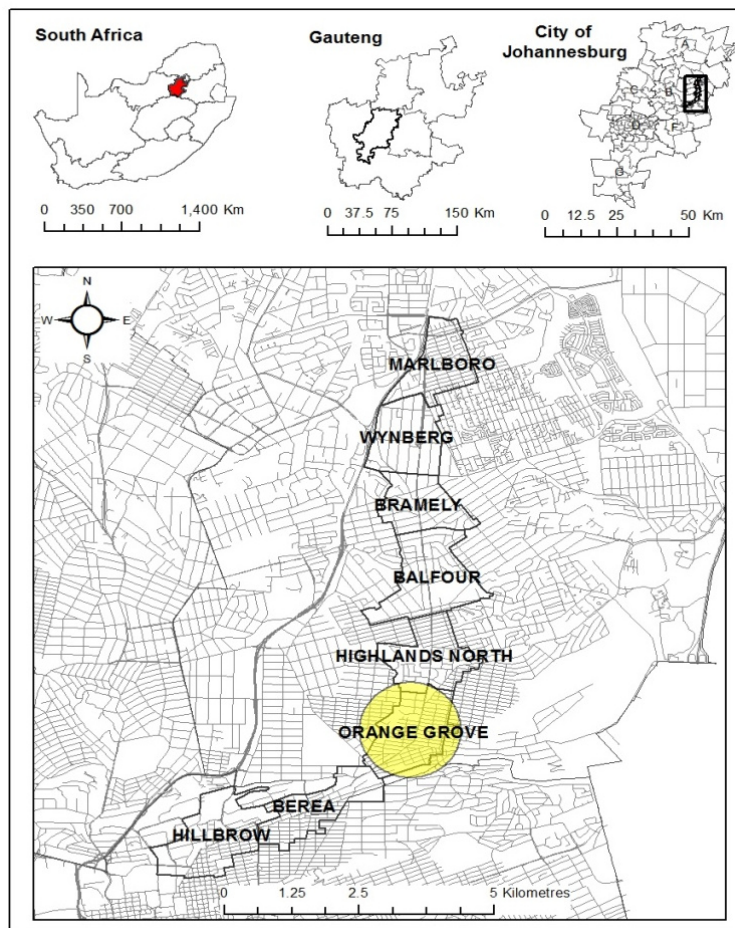


Fig.1 Locality

The Orange Grove node is located north east of the Johannesburg Central Business District (CBD). It is characterized by a large footprint of residential dwellings and several small scale businesses within specific locations. In particular, there is a high concentration of these businesses right along Louis Botha, a BRT envisaged route.

## Results / Findings

This section is divided into two. The first deals with corridor determinants based on data collected through the research instrument. The subsequent section seeks to establish how respondents perceive the importance of specific variables for demand management using a scale and rank approach.

### Determinants

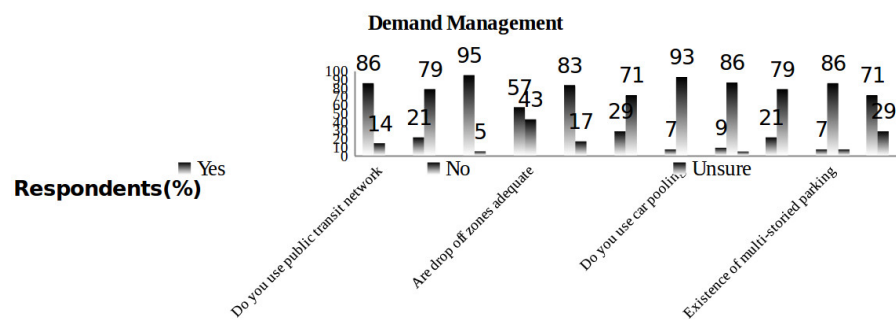


Fig.2 Determinants: Demand Management

As previously alluded to, demand management describes various strategies aimed at reducing the need to travel (vehicle trips). Such strategies find expression through, inter alia, increasing the share of public transit ridership, carpooling, parking management strategies and so forth. In Fig 1, a high proportion of respondents indicate that the node exhibits a high level of public transit. This ultimately explains the corresponding high percentage of public transit use within the node. With regard to carpooling, there is both a huge gap and opportunity thereof. In this regard, various incentives such as subsidies and priority parking can be adopted to improve the attractiveness of shared ridership. Parking is also a critical factor for urban transport. In the bar graph, there is an apparent lack of parking areas. Although this may be the case, there appears to be some slight resistance for parking management strategies such as multistoried parking.

The intention here was to ascertain how respondents perceive the importance of certain variables for demand management. As such, a scaling approach was used to accomplish this. In line with theory, a considerable number of respondents regard public transit fundamental in nodal development. In Figure 1, it was mentioned that prioritized parking is also one of the strategies for demand management. However, an analysis of Figure 2 above indicates that the relevance of this aspect is highly compromised by virtue of its relatively low score.

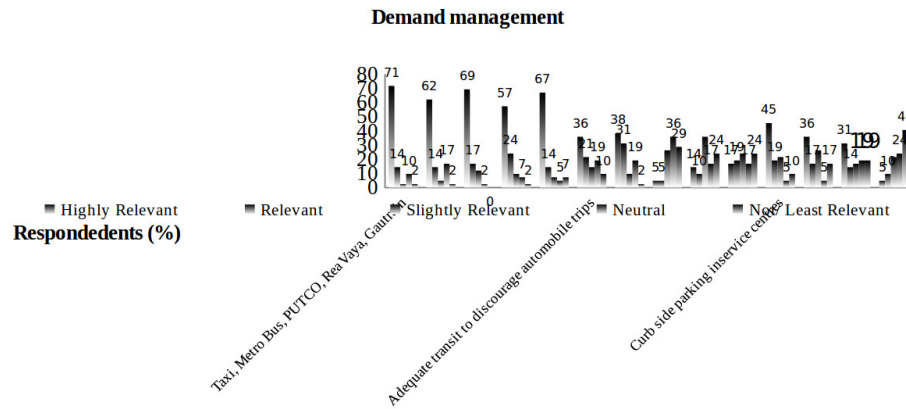


Fig.3 Scoring: Demand Management

### Scoring

The table below outlines/ summarizes these determinants based on their high scores on the bar graph.

Sr. No.	“D” dimension	Demand management determinants	Respondents Score: Highly Relevant (%)
1	Demand management	Public transport facilities (Taxi, Metro Bus, Rea Vaya, Gautrain)	71%
		Sufficient parking in nodes	69%
		Adequate drop off zones in nodes	57%

Table 1: Determinants

### Concluding remarks

This study has provided an in-depth discussion of the theoretical foundations of TOD and the 6Ds. The case study analysis drawn from one of the 6D dimensions in the determination to understand some of the key determinants in TOD and implementation provides an interesting highlight around the key determinants. The key determinants around demand management include high relevance for public transport facilities, sufficient parking in nodes, and adequate drop off zones. These determinants are highly linked with each other and influence commuting patterns as well as perception on TOD. Adequate parking is equally one of the critical and important determinants along public transit facilities in TOD planning / existing infrastructure.

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