CAPE TOWN URBAN DEVELOPMENT INDEX A RUBRIC FOR URBAN TRANSFORMATION

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ABSTRACT

The City of Cape Town has been working towards understanding the intricate relationship between land-use and transportation in order to develop growth management strategies that seek to create a more balanced travel demand profile of the city over time by enabling a better spatial relationship between trip producing and trip attracting land-uses. The City produced the TOD Strategic Framework in 2016, the revised Integrated Development Plan in 2017 and the new Municipal Spatial Development Framework in 2018 all of which emphasise the need for Spatial Transformation. An important question then arises from this which is: *The City has aligned its key policies, strategies and priorities towards urban and spatial transformation but how do we know that the implementation of these is effective and what should we measure to assess this?*

The Urban Development Index (UDI) was conceived as a mechanism to answer this question but also to enable the identification of future transformation priorities. The Cape Town UDI builds on the previously developed Transport Development Index (TDI) by adding spatially disaggregated indices relating to land-use diversity, residential and employment density in public transport corridors, housing price diversity and informality ratios in the City. Eleven indices covering transport, land-use and housing were defined to measure the different facets of spatial and urban transformation.

1. INTRODUCTION

1.1 Background

Cape Town's transformation journey required the data driven Transport Development Index (TDI), which was first developed in 2015, to be expanded and revised into an Urban Development Index (UDI) that will act as a barometer that measures progress in achieving the City of Cape Town's transformational priorities. The City of Cape Town states eleven transformational priorities in its Integrated Development Plan (IDP) (City of Cape Town, 2017). The transformational priorities specific to the UDI include dense and transit oriented growth and development (Priority 8), an efficient, integrated transport system (Priority 9) as well as building integrated communities (Priority 10).

The UDI through the collection and analysis of multiple data sources measures the progressive spatial and economic transformation of Cape Town in terms of the change in people's mobility over time and the city's spatial form, as well as the extent to which the City's development agenda has been successfully implemented over time. Further to this the intention is to calculate the UDI periodically to enable the City to track these changes over time, establish trends and enable incremental adjustments to implementation programmes to better effect positive change. Because the UDI measures the change of elements relating to transport, land use and human settlements it will be possible to gain a better understanding of the relationships between them as a result of comparisons of relative change over time.

1.2 Aim of Paper

The purpose of the UDI is to measure the impact of the City's implementation of its IDP priorities that relate to urban and spatial transformation. As the strategy of TOD and spatial transformation is implemented over time through interrelated changes in land use and transport, the UDI will measure these changes. Hence, three key areas are measured within the UDI which relate to Transport, Land Use and Human Settlements.

The aim of this paper is to provide a summary of the rational, methodology and results of the work undertaken in the calculation of the Urban Development Index for Cape Town.

2. SCOPE OF PAPER

This paper provides a summary of the work undertaken to develop the UDI for Cape Town covering the, data and methodology, the UDI concept, description and extracts of results for each of the 3 sets of indices of transport, land use and housing. The paper concludes with the potential for its use as a replicable rubric for urban transformation in developing world Cities facing disparate spatial form and significant urbanisation pressures as well as some concluding remarks relating to the Cape Town UDI.

Due to the stipulated limitations of the length of this paper spatial representations of the UDI results are excluded. These are instead included in the conference presentation.

3. UDI CONCEPT

3.1 Focus of Spatial Transformation

The TOD principles for Cape Town as defined in the Cape Town TOD Strategic Framework include striving towards spatially concentrated developments around high-order public transport corridors. Further, trip producing and trip attracting residential and non-residential land uses are balanced to optimise public transport movements. Using the UDI as the tool to measure the level of an integrated and spatially transformed city; spatial transformation in this context was defined to include the following:

- Optimised movements of people where trip producing and attracting land uses in the city are located in relation to each other spatially in a way that minimises travel distance, travel time and travel cost for travellers as well as resulting in metropolitan and corridor scale travel demand profiles that enable the provision of viable and improved public transport systems.
- Enhanced living in well-located areas where residents have improved access and proximity to economic, social and Public Transport Opportunities.
- Spatial balance where suburbs and neighbourhoods to have a healthy mix of residential & employment opportunities.
- Increased densities along higher order Public Transport corridors, both for residential and for commercial use (employment).

- Inclusive communities where suburbs and neighbourhoods have a more diverse housing market mix.
- Progressive upgrade of informal settlements.

The transport element of the UDI measures multiple facets of the transport response to the travel demand profile created by the spatial relationships of land use types.

4. DATA SOURCES

Additional information about every data set and its use in the UDI calculations has been defined and detailed in a data specification document as part of the UDI suit of documents. Table 1 below lists the data sources of the UDI Transport indices.

Table 1: Overview of UDI data sources – Transport indices

Main Mode	Travel Time/ Distance	Fares/ Direct Costs	Modal Split to Work
Mini-bus Taxi (MBT)	Tracking information of MBT routes 2018	Probe data 2018	2018 cordon counts
Golden Arrow Bus Service (GABS)	Tracking information of GABS fleet 2019	Official publication 2018/2019	2018 cordon counts
Bus Rapid Transport (BRT)	Timetable information 2019	Official publication 2018	2018 cordon counts and 2019 boarding data
Rail	Timetable info and rail delays 2018	Official publication 2015	2018 ticket sale information
Car	Probe data 2019	see assumptions	2018 on counts

5. METHODOLOGY PRINCIPLES & DATA LIMITATIONS

Principles of the methodology and general limitations are as follows:

- Effort was made to develop a methodology that is easily repeatable guided by the range of regularly updated data sets. Therefore, ensuring measurability on a regular basis using existing, readily available data and minimising efforts that require ad hoc primary research.
- Ensure sensitivity to annual change and responsiveness to the City's efforts, particularly in relation to public transport, densification and land use diversification.
- Repeatability is more important than detail. Hence, the following applies (specifically relevant for the Transport indices):
  - o Focus is on a typical work trip in the morning peak period. Working population refers to the City's labour force who is economically active, i.e. receiving a monthly income.
  - o Educational trips are largely excluded from the analysis as most of them are internal trips within 5x5km grids (see zonal definition in 6.2).
  - o Reporting by main mode only. Main mode refers to the mode of travel used for the longest part of the journey in terms of distance to reach the destination. Certain O-D pairs were excluded in cases where the main mode is unavailable in connecting these O-D pairs.

    - Exclusion of rail in-vehicle travel times due to unavailability of regularly updated data. However, rail delays are reported on.
    - Travel time analyses refer to in-vehicle travel times, i.e. transfers and trip chains are excluded. Also, travel times for PT modes are measured from and to major stops and informal roadside stops are not considered. Detailed data on trip origins and respective destinations is currently unavailable and it is recommended to include this kind of information in future data collection projects.
    - The transport elements are calculated based on the trip characteristics to the top five destinations. The top five destinations per grid cell make up more than 75% of all destinations.
    - The top five destinations vary between modes and grid cells. The Private Transport trip distribution was taken from the probe data and the PT trip distribution is based on the commuter matrices of the City's EMME model.
    - Travel time between modes cannot be compared strictly speaking, due to the fact that the top five destinations vary between grid cells as well as considering that certain destinations cannot be reached by every mode equally.
- The grid system allows the exclusion of cells with fewer than a given number of data points by applying a minimum threshold. It may then be possible to apply a spatial interpolation method to fill any gaps.
- The UDI incorporates the latest available data up to March of every year in which an update of the UDI is done. The UDI as of June 2019 refers to the period March 2018 to February 2019.

6. URBAN DEVELOPMENT INDICES

6.1 Overview of UDI Indices

Eleven indices were defined to measure the different facets of spatial transformation. These indices provide a comprehensive and representative view of the mobility patterns of the city's citizens, and linking it to describe the full spectrum of spatial transformation. While the City is implementing its TOD strategy, the UDI should show a change towards a more integrated and spatially transformed city.

The eleven indices across the 3 categories of Transport, Land-Use and Housing were specifically chosen as representing important characteristics of the functioning of the city and their effect on the people that reside within it and are considered to be a realistic barometer for the urban transformation required to achieve the strategic outcomes defined in current City policy. Transport, Land Use and Housing are key building blocks of a functional city and whilst they are important in their own right the intention of measuring them together in a combined index periodically is that it is hoped that this will provide a more nuanced understanding of the relative change between them and how change in one influences or is affected by change in another. Consideration was given to the combination of the eleven indices into a single composite number but this would not provide the nuance required to make specific policy or implementation programme shifts if the relative change over time is not leading towards achievement of the City strategic goals. A composite index would not be particularly useful in identifying policy or implementation adaptation requirements over time.

6.2 Zonal Definition

The UDI is based on 100-hectare grid cells that span the entire metropolitan area. However, in cases where data points are sparse, a 2 500-hectare ($25km^2$) grid delineation is used. This is the case for most of the Transport measures. The 100-hectare grid cells were aggregated into this bigger grid system, considering the following principles:

- Major employment areas are to be covered within one $25km^2$ big grid cell.
- Wider grid to ensure representativeness amidst sparse data. The set of transport indices is ultimately intended to be indicative for the efficacy of the transport system-as-a-whole, rather than a local scale transport assessment tool.
- The proposed zoning matches across indices. $1km^2$ grid can be aggregated to $25km^2$.
- The grid system is geographically flexible and universally applicable within cities, not tied to one specific scalar unit or specific urban context.

6.3 Transport

6.3.1 Employed Population

As the spatial form of the city responds to policy intervention implementation, the UDI tracks changes of land use diversity and proximity between places of work and residence. It therefore focuses on the mobility patterns of the City's working population (35% of the City's total population (Statistics South Africa, 2011) of 4.4 million in *2019 (City of Cape Town, 2019))*.

Almost half of the City's working population (47%) fall into the low income group (with an average monthly income of R 2 400), 45% fall into the medium income group and receiving an average monthly income of R 14 000, and 8% are high income users with an average monthly income of R71 000 (Statistics South Africa, 2011). It is evident from the UDI that a significant amount of households located further from economic opportunities are also low income. Income groups are spatially disaggregated to the grid system used by the UDI.

6.3.2 Travel Times

Travel Times of Typical Commuter (to the Top Five Destinations by Mode)

In order to determine the average travel time of a typical commuter for different geographical areas of the city, travel times were analysed to the top five destinations from every grid cell. The top five destinations vary between grids and by main mode. The private transport trip distribution is estimated from the probe data sample and PT trip distribution by mode is based on the commuter matrices of the City's EMME model.

The UDI measure of Travel Time is not primarily aiming to compare travel times between modes but rather to compare average travel times of commuters of different geographical areas. he analysis revealed the following by main mode to work:

- The average **MBT user** takes 39 minutes to work, with an average minimum in-vehicle travel time of 20 minutes and maximum of 72 minutes. More than 30% of the MBT commuters experience travel time longer than 45 minutes.
- The average **Bus user** takes 79 minutes to work, with an average minimum in-vehicle travel time of 26 minutes and maximum of 124 minutes. 95% of all bus commuters experience on average travel times longer than 45 minutes.

- The average **BRT user** takes 38 minutes to work, with an average minimum in-vehicle travel time of 24 minutes and maximum of 64 minutes. About 25% of all BRT commuters experience on average travel times longer than 45 minutes
- The average **car user** takes 21 minutes to work, with an average minimum travel time of 7 minutes and maximum of 53 minutes. This is based on the top five destination spread, which vary between car and PT users.

The above figures are average travel times to the top five destinations.

- The city-wide average delay per **railway** line in the morning peak is 12 minutes (Passenger Rail Agency of South Africa, 2015 & 2018). This is a 60% increase from 2015. The longest delays are experienced along the central line with an average of 30 minutes. It needs to be highlighted that the delays on some of the lines are sometimes over one hour and occasionally even more than 3 hours. The reason being infrastructure problems, community protest actions, vandalism and train sets out of service. The reduction in rail capacity has resulted in a shift from rail to other modes.

6.3.3 Travel Distance

The average travel distance to the top five destinations is 8km for private vehicles and 17km for PT modes. Note that the top five destinations vary between the private and PT user per grid cell. The trip distances for car are based on the trip patterns of the probe sample 2019. The travel distances for PT were calculated for driving mode based on the road network by means of the Google Distance Matrix API.

More than 10% of private car journeys are on average less than 5km. Over time, the City wants to see an increase of shorter trips in response to a denser and more compact urban form. For such short distances, the bicycle is an efficient mode of transport. The City promotes active travel and encourages cycling and walking as alternative means of transportation.

6.3.4 Congestion

Background

A host of congestion related measures are available internationally which are used to report and compare congestion impacts (Victoria Transport Policy Unit, Litman T, 2019). Comparative congestion indices are also produced that estimate the relative level of congestion across international cities based on real time data. Such indicators (e.g. TomTom Traffic Index and INRIX Global Traffic Scorecard) are useful to compare and rank cities, but they are unsuited to provide a robust assessment of the context specific and relative congestion in Cape Town.

Data Sources

The UDI quantifies the current peak period traffic conditions based on actual observations using probe data information provided by Tracker South Africa. Approximately 22 000 vehicles in Cape Town have Tracker devices installed (in the 4-week study period 1 February – 29 February 2019). The Tracker GPS technology allows the location of tracked vehicles to an accuracy of five metres. The vehicle tracking data from the probes not only provides location and time at each point, but also provides the speed of the vehicle at the point. This allows the evaluation of average speeds at all locations across the metropolitan road network for any period.

Definition

A road link is defined as congested if the average speed of that road segment is below a set threshold. Speed thresholds are based on average speeds with corresponding Level of Service (LOS) values for urban roads based on the Highway Capacity Manual (HCM) (Transport Research Board, Highway Capacity Manual, 2016). The higher order road classes 1, 2 and 3 (approximately 11 700km (City of Cape Town, Comprehensive Integrated Transport Plan 2018 2023)) are included in the analysis and different speed thresholds were defined for each of the road classes:

- Principal Arterials/Freeways (Class 1): 30 km/h.
- Major Arterial (Class 2): 25 km/h.
- Minor Arterial (Class 3): 20 km/h.

The speed thresholds are based on what is typically referred to in the HCM as LOS F conditions, i.e. where demand exceeds the capacity of a link, except for the Class 1 roads. For Class 1 roads the LOS F threshold is typically closer to 50% of free flow and/or posted speeds. For 100km/h freeways, the speed threshold will thus be in the order of 50 km/h, and for 80 km/h freeways the threshold speed will be in the order of 40 km/h. Often at these speeds the vehicles on the freeways are still moving at speeds which most people could find acceptable, since their overall travel time will still be acceptable. It is at conditions where the traffic speeds break down to stop/start conditions where travel times become long and unpredictable. Therefore, a threshold speed of 30 km/h was selected for freeways. These definitions were confirmed through the evaluation of observed spot speeds along sample roadway sections throughout the City.

Results (summary only)

The congestion analysis was conducted for every 15-minute time interval throughout a typical weekday, i.e. Tuesday, Wednesday and Thursday of a typical week in February 2019. The actual **Congested Network Length** is based on the average speed during each 15-minute study period in comparison with the specified speed criteria per class of road. It is also measured per direction of travel, i.e. only the peak direction is considered. If both directions of a link are congested, then the lengths of both congested sections are included in the analysis. The length of congested network for each of the 3 classes of road analysed throughout the day is represented in Figure 1 below.

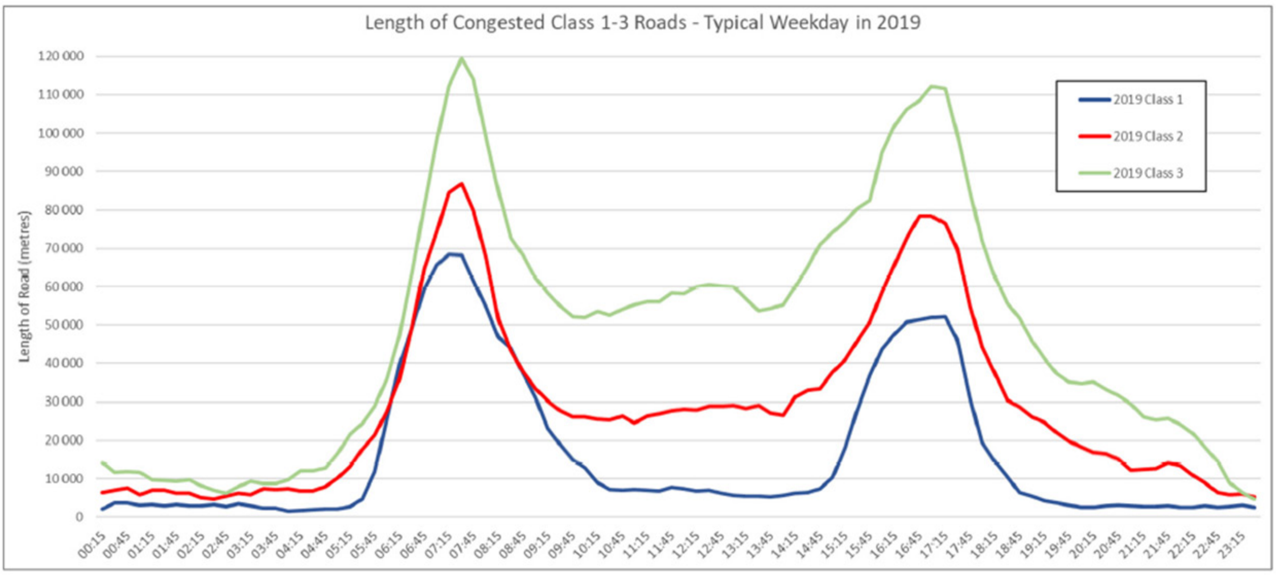

Figure 1: Length of Congested Network in 2019

The **Total Congested Network Hours** in 2019 are close to 2.2 million km-hours, slightly down from 2018 when it exceeded 2.2 million km-hours. This is almost a 30% increase in comparison to the prevalent congestion levels in 2016, and a 2% improvement to 2018.

6.3.5 Transport Direct Cost Expenditure

The UDI measures the monthly expenditure for commuters based on typical work trips. The results are reflected in Table 2 below.

Table 2: Direct Transport Expenditure per income group (2018)

Income group	Income stratification	Percentage of employed population	Average monthly income	Average direct cost expenditure vs monthly income (%)		
				PT	Private	Mix Public & Private
Low Income	< R 4 640	47%	R 2 400	17%	35%	26%
Medium Income	R 4 641 – R 37 100	45%	R 14 100	3%	23%	14%
High Income	> R 37 101	8%	R 70 800	1%	9%	7%

6.3.6 Flexibility

The City is striving towards a spatial form that is well connected, efficient and which provides cost effective mobility. The City therefore wants to track service levels and the extent of its PT system. The UDI measures this in the form of a “Flexibility” analysis. In 2015, the City approved the Integrated Public Transport Network (IPTN) Operations Plan which sets out the long-term operational details for the MyCiTi trunk and rail routes for the entire city. Based on this, the definition for the UDI element “Flexibility” is as follows. Ideal flexibility for a small area exists if the centroid of the small area is:

- Within 500m walking distance (bee line) of at least three public transport modes or any one IPTN mode, and
- Where the headway at the station/stop is less than or equal to 10 minutes during the morning peak period.
- The maximum walking distance to reach one mode was set at 3 km from a Census small area centroid, i.e. 45 minutes of walking time. Hence, the maximum additional cumulative walking distance to reach 3 modes is 7500 metres. This is a theoretic indicator only since this is neither a desirable nor a realistic walking distance.

The UDI calculates the level of flexibility for each 1km grid cell across the metropolitan area.

6.4 Land-Use & Housing

6.4.1 Jobs versus Residents

The ratio of jobs to residents (JRB) measures the extent of an area’s current land use balance by comparing the number of residents versus the number of jobs in that area. The rationale of this index is that there is a direct relationship between, on the one hand, the balance between residential (i.e. origins) and non-residential (i.e. destinations) land uses within and across neighbourhoods, and, on the other, the cost of access to jobs and services on households. Where a balance is achieved between jobs and residents, trip-distances become shorter and more walkable, public environments become safer and more vibrant, and air and noise pollution is reduced.

The number of residents per cell is drawn from the City's Urban Growth Monitoring System and interpolated from ward boundaries. The number of workplaces is drawn from the City's valuation data which includes the use and internal floor space of non-residential buildings. The analysis revealed that the distribution is heavily skewed towards -1, indicating the dominance of monofunctional residential neighbourhoods compared to more mixed use and predominantly business-oriented neighbourhoods. The median neighbourhood has a score of - 0.74, and the average value is -0.39 as indicated in Figure 2 below.

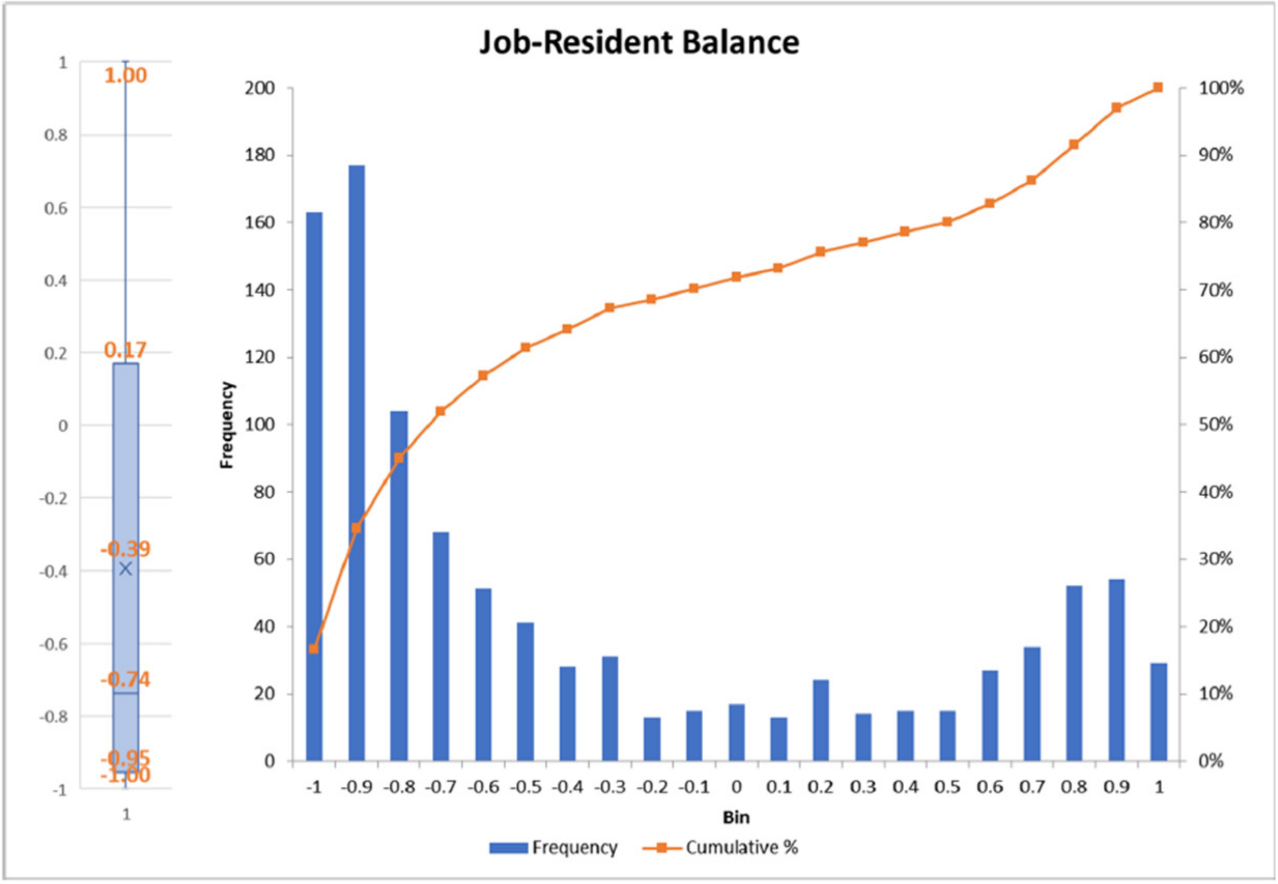

Figure 2: Histogram showing job-resident balance

Salient patterns discernible at city-wide scale are (1) two job-rich corridors (i.e. east-west, north-south, intersecting in Maitland), and (2) the monofunctional, job-scarce character of neighbourhoods in the northern and eastern periphery, as well as the south-eastern quadrant of the urban footprint. Whereas mixed use neighbourhoods are 'balanced' in that they generate both origins and destinations, creating the proximity conditions for shorter, walkable trips, neighbourhoods are skewed to either jobs and residents tend to generate inward and outward movements respectively (proportional to the degree of skew).

6.4.2 Residential and Workplace Densities along High-Order Public Transport Routes

The purpose of this index is to calculate residential and employment densities within 500 metres of existing high-order public transport routes, specifically operational passenger rail and MyCiTi trunk routes (i.e. excluding feeder and express routes). The rationale behind density indicators is that public transport systems are more likely to be financially sustainable and better utilised if supported by higher density land uses along their routes.

According to international surveys, people only find public transport attractive when it requires no more than 10 minutes' walk to reach a station (Bertaud, 2004). It is estimated, for example, that BRT systems can only remain financially viable if there are at least 10 passenger boardings per kilometre, per day, per bus (Greenfield, 2004, The Guardian, 27 August 2014). Both residential and non-residential density contribute to the number of boardings. The importance of proximity highlights the key role for urban land use policy to complement the City's investment in mobility and vice versa.

Residential densities are drawn from the City's Urban Growth Monitoring System and interpolated from ward boundaries. Workplace densities are drawn from the City's valuation data which includes the use and internal floor space of non-residential buildings. Residential and workplace densities per 1km^2 grid cell were calculated. These results were overlaid with a spatial layer highlighting cells within 500m of the higher order public transport routes.

The most salient pattern that may be discerned from the results of this process is the spatial disjuncture between the alignment and coverage of the higher order public transport network, and the high-density residential neighbourhoods in the south-eastern quadrant of the city. This is particularly evident in the missing north-south link corresponding to Delft (south of Bellville). In contrast, the public transport network is fairly well-aligned to the spatial distribution of workplaces.

6.4.3 Housing Price Diversity Index

The Housing Price Diversity Index (HPDI) measures the extent to which the proportional distribution of housing submarkets within a certain area is similar to the city-wide distribution. The city-wide distribution changes over time (reflecting what Cape Town's citizens can afford in terms of housing). The HPDI is agnostic to an ideal city-wide distribution. The HPDI measures in a way the level of achieving integrated communities, in terms of income mix. Therefore, it measures spatial socio-economic balance or imbalance.

The HPDI measures the range of housing options within neighbourhoods from the perspective of households. The index explicitly measures the extent to which Cape Town's suburbs and precincts offer housing affordable to a range of household incomes, or, conversely, the extent to which spatial imbalances in the housing market exclude low- and middle-income households from particular neighbourhoods, thus encumbering upward progression on the housing ladder.

Methodology

The HPDI is based on a tested measure of spatial imbalance: the dissimilarity index. This index measures the degree to which the distribution of different housing markets (classified by house price) occurring in a given neighbourhood is similar to the city as a whole. The value of the index ranges between 0 and 1 and is effective in evaluating spatial imbalance across neighbourhoods for up to four classes (Song et al., 2013). These classes are shown in Table 3. The HPDI covers all formal residential properties on the City's valuation roll; i.e. all forms of formal housing were considered, not only single dwellings (i.e. 'houses').

Table 3: Overview of housing submarket classes incorporated in the HPDI

Housing submarket	House price thresholds	Count	Types
Affordable	<R500 000	321 445	o Subsidy: Breaking New Ground (BNG) o Community Residential Units (CRU) o Social Housing
Mid-market	R500 000 - R1 000 000	182 335	o Inclusionary housing o GAP
Middle-upper	R1 000 000 – R2 000 000	164 125	Market
Upmarket	> R2 000 000	100 578	Market
	Total	768 483	

The city-wide distribution of the housing submarket categories is shown in Table 4.

Table 4: Distribution of housing sub-markets in Cape Town (2015)

Count per price category			
Price category	**Threshold**	**Count (2015)**	**City-wide %**
Affordable	R50 000 - R500 000	321 445	42%
Middle Income (1)	R500 000 - R1 000 000	182 335	24%
Middle Income (2)	R1 000 000 – R2 000 000	164 125	21%
Upmarket	> R2 000 000	100 578	13%
Total		**768 483**	**100%**

The number of properties per price category were aggregated per grid cell, excluding cells where the total count of residential properties was less than 50. For each price category, the difference in the percental proportion to the corresponding city-wide percentage is calculated. The differences are summed per grid cell, normalised between 0 and 1, and inverted so that a higher score signals diversity and a lower score dissimilarity.

The Results

As shown in Figure 3, the distribution HPDI is less skewed than the JRB. The average neighbourhood has a HPDI of 0.43 and a fairly small standard deviation of 0.21. This is ostensibly suggestive that neighbourhoods tend towards an ‘equilibrium’ level of housing price diversity. Put differently, localised residential property markets do not under normal circumstances maintain stark differences in housing prices over time, since they are in theory resultant not only of the attributes of the properties themselves, but reflective of shared amenities and shared distances to job centres.

Should very upmarket housing be introduced to a low-price neighbourhood, or conversely should entry-level housing units be introduced to an upmarket neighbourhood, overall housing prices will veer upwards or downwards, respectively except under specific circumstances such as hard ‘edges’ or exclusive amenities where access is somehow prevented.

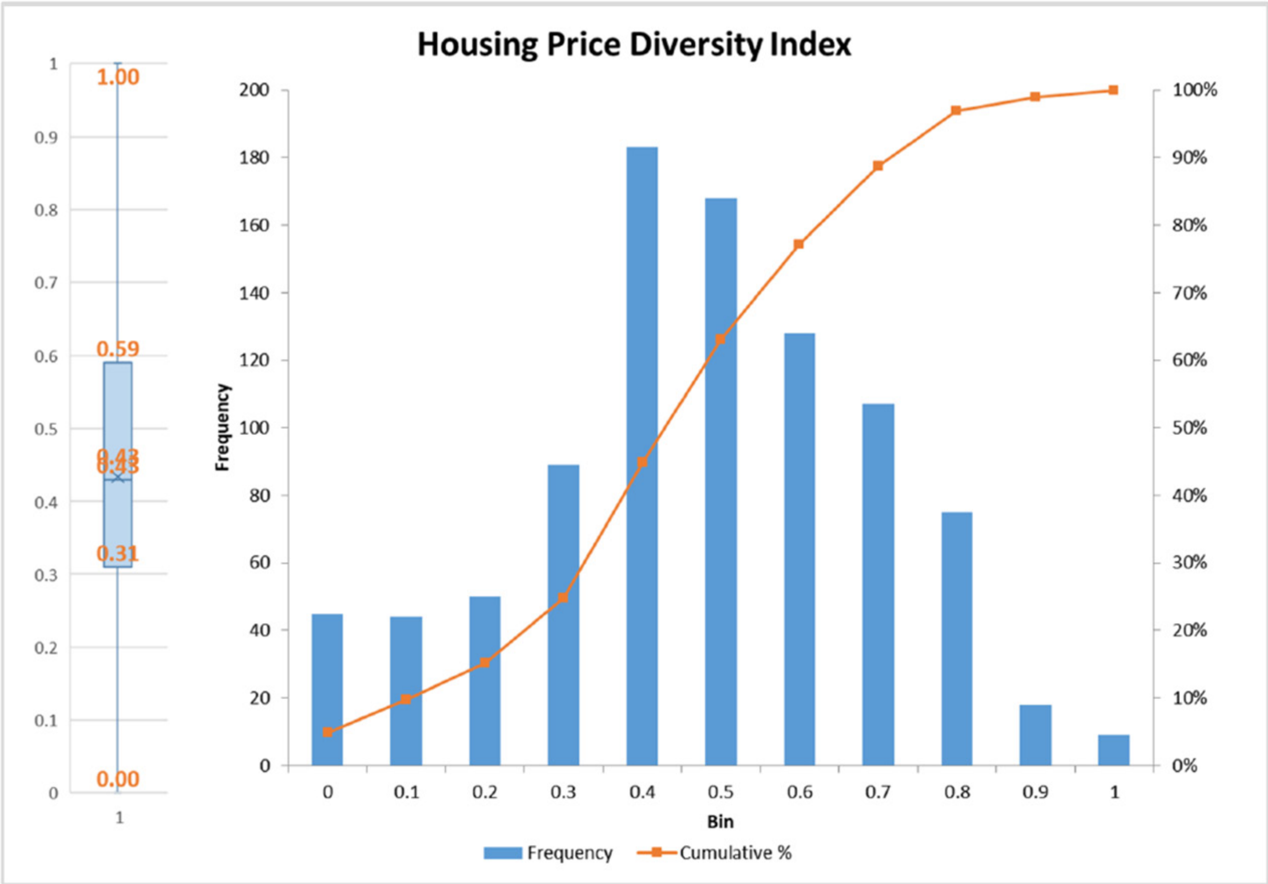

Figure 3: Histogram showing the Housing Price Diversity Index

6.4.4 Share of Informal Housing

Cape Town has significant numbers of residents living in informal environments. As long as urbanisation continues and demand for formal housing exceeds the supply, informal living conditions will likely remain a reality of Cape Town's urban landscape.

With the City's Human Settlements Programme, the City aims to progressively upgrade informal settlements. It is therefore that the City tracks the number of people staying in informal settlements versus formal settlements. This is to show progress in the City's effort to upgrade informal settlements (formalise top structures).

The City reports the estimated informal and formal population to National Treasury on an annual basis (City of Cape Town, 2019). With the assumption of an average household size of 3.2 (for both formal and informal), the ratio of informal households versus formal households is **19%** in 2018. "Informal" includes people staying in backyarding and traditional structures. Backyarding accounts for 34% of all informal structures.

7. A RUBRIC FOR URBAN TRANSFORMATION

Estimated global annual population growth rates between 2020 and 2100 show that Africa will have by far the highest population growth projections. The total population of Africa by 2100 is expected to be approximately 4.3 billion people only half a billion less than Asia whose population is in decline (United Nations, 2019). The implications of this are that African cities are going to be under increasing pressure to accommodate high growth rates and urban migration as the growing population seeks economic and social opportunities afforded by cities. It will be critically important for these cities to grow in such a way that they are able prosper and function efficiently which will require careful consideration in the development of effective growth management strategies and tools.

Most South African cities have sub-optimal travel demand profiles as a result of historical inefficient growth patterns. The UDI can be an important element of a suite of tools that cities could use to assess and identify growth and development priorities that enable urban efficiencies and disable prevailing socio-economic disparities.

The Cape Town Urban Development Index is contextually relevant to all South African Cities and is designed specifically to measure key aspects of Cities facing rapid urbanisation pressures on top of an unbalanced, inefficient and inequitable base. It is replicable in all South African Cities and potentially others in the developing world.

8. CONCLUSIONS

The UDI was developed as a tool to track changes in transport patterns and land use in response to the City's efforts in creating a liveable City, particularly in relation to public transport, densification and land use re-balancing. The aim with the index is to measure and track land use and transport changes due to the implementation of policies and projects focused on transit-oriented growth and development.

This paper provides a summary of the rational, methodology and results of the 3 core sets of indices of Transport, Land use and Housing that have been calculated as part of the Cape Town Urban Development Index. It describes each of the indices within these 3 core sets and defines the data used and the calculation methodology. The paper further provides a brief summary of the pertinent results of the calculation of each index and relates these results to their overall purpose and significance in context of the broader objectives of the UDI as a metric for urban transformation.

As discussed in section 5 of this paper, and since the intended use of the UDI is to periodically measure the identified indices and track their relative change over time, it is imperative that careful consideration is given to the input data in terms of repeatability, quality and source availability. This is also a key consideration for replicability of tools such as the UDI applied elsewhere. For this reason, a data specification document has been prepared supplementary to the Cape Town UDI which defines the data sources and how they are used in the calculation methodology in order to enable comparable results for each successive periodic calculation.

The UDI will enable the City to measure its progress to achieve its social and spatial transformation objectives against the status quo baseline. The UDI will act as a barometer that measures progress in achieving these key transformational priorities. Whilst the City's IDP identifies 11 transformational priorities it does not weight them and they are considered to be of equal importance in the UDI methodology. Since the UDI is designed to periodically measure an intentionally defined set of indices relating to specific IDP transformational priorities it is important to know if the relative change in the indices between successive calculations of the UDI is moving closer to or further from achieving those transformational priorities. For this reason, the UDI technical document provides guidance with regard to the desired change for each index within the UDI. This is intended to enable the continuous refinement of strategic planning and implementation initiatives of the City to ensure the desired change in the indices and associated urban transformation outcomes.

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