HOW STANDARD (AND VALID) ARE SOUTH AFRICAN PARKING STANDARDS?

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ABSTRACT

Parking standards ensure that the correct parking allocation is provided for at land uses. Historically, minimum parking standards were applied worldwide, indicating the minimum number of parking bays that must be provided per land use. Many industrialised countries now regulate parking allowances by applying a maximum parking rate, limiting the number of parking bays per land use, which can assist to reduce travel demand and promote sustainable transport options. South Africa still adheres to minimum parking standards. Parking standards in South Africa are curated and published by individual local and metropolitan municipalities. The first objective of this paper is to compare South African parking standards in various municipalities for numerous land uses. Parking standards were observed to vary widely between municipal areas, resulting in vastly different parking requirements for the same land uses. The second objective of this research was to develop a methodology to conduct representative parking studies to evaluate if there is regularly an oversupply in parking bays at new developments as a result of minimum parking requirements. The findings of this paper indicate that South African parking standards should be reviewed to allow an equitable approach to parking provision between municipalities. Research into a move to maximum parking standards is also required to prevent an oversupply of parking and encourage sustainable transport usage where public transport options are available.

1. INTRODUCTION

1.1 Background to Parking Standards

Parking standards prescribe the number of parking bays to be provided at land uses, relating parking bays required (or allowed) to a unit of a land use characteristic, such as floor area, number of households, or number of patrons. The purpose of parking standards is to ensure that new developments are provided with a suitable number of parking bays (Mladenovič & Plevnik, 2019). Parking standards are either indicated as a minimum number of parking bays, or maximum parking bays per land use unit.

Parking standards were originally implemented as minimum parking requirements, defining the least number of parking bays that must be provided at a land use. This approach, of course, would allow more parking to be provided than is indicated in the standard. Minimum parking requirements are inflexible and emphasise parking capacity instead of active management of parking, resulting in various disadvantages (Engel-Yan, Hollingworth & Anderson, 2007; Mladenovič & Plevnik, 2019), including:

- Encouragement of private vehicle use;
- Oversupply of parking bays;

- Limiting land available for development; and
- Increasing the cost of developments.

A move to more sustainable transport solutions underpinned by Travel Demand Management (TDM) schemes has resulted in the redirection, internationally, from minimum parking standards to maximum parking allowances (Milosavljevic, Simicevic & Maletic, 2010). Many cities in the United States and Europe now follow maximum parking standards (Berg, 2016).

Maximum parking standards limit parking provision. The active management of parking to reduce parking availability has widely been promoted as a TDM strategy (Ferguson, 1999; Gärling, et al., 2002; Feng, Shen & Hu, 2018), falling into the category of "push policies" which actively dissuade the use of private vehicles (Gärling et al., 2002; Feng, Shen & Hu, 2018). If there are limited (or no) parking bays at a destination, then people will be encouraged to make a trip to that destination using public transport, for example. TDM measures that discourage private vehicle use do, however, require that adequate and desirable alternative (public) transport modes are available, and that provision is made for active transport modes (such as walking and cycling).

Sasman and Behrens (2022) recommended an alternative method to reduce parking, suggesting that parking standards should be separated from land use characteristics to encourage shared parking. They also recommended that the assumptions which are held in generating minimum parking requirements be reassessed, particularly on the destination (trip attractor) trip end (Sasman & Behrens, 2022). Sustainable parking provision can be encouraged through thinking of parking as a commodity, rather than a public good. More sustainable parking provision can be provided when parking demand is flexible and elastic, rather than fixed for extended periods. This allows parking supply to be managed downwards over time, rather than simply growing with travel demand (Sasman & Behrens, 2022).

1.2 Research Aim and Objectives

South African parking standards apply minimum parking requirements. In South Africa, parking standard are prescribed individually by municipalities, resulting in a wide range of differing parking standards. There are certainly similarities between the parking standards, which aligns with the finding of Mladenovič and Plevnik (2019) that existing parking standards are often used as the baseline to generate new standards, with little to no deliberation or adaption to local conditions.

The aim of this paper is to highlight the need for research on parking standards and parking provision in South Africa, promoting the reconsideration of parking standards called for by Sasman and Behrens (2022). This paper further intends to propose the need for investigation of whether South African parking standards are optimised for local needs.

This study comprises two objectives. The first objective is to evaluate how standard parking standards are for various land uses in South Africa, comparing the parking requirements defined by different municipalities. Secondly, this research will provide an example of a methodology to evaluate the correctness of South African parking standards. A limited number of parking studies are conducted to demonstrate this method. This second objective is defined to provide input to future research in evaluating parking standards, rather than provide a comprehensive evaluation of parking standards for all land uses.

2. METHODOLOGY

The two objectives of this paper are dealt with through two separate methodologies, detailed in Section 2.1 and 2.2.

2.1 Evaluation of Parking Standards of Different Municipalities

The parking standards from a number of South African municipalities were compared to each other to evaluate the (dis)similarities between the standards. The zoning schemes, which include parking standards, of 15 municipalities were obtained, representing at least one municipality (and a maximum of two municipalities) for each of the nine provinces of South Africa. Both metropolitan and local municipalities are represented, and many of the local municipalities are predominantly rural in nature. The selection of parking standards therefore represents a good overview of parking standards throughout South Africa. Relevant details of each municipality for which parking standards were obtained are presented in Table 1.

Table 1: Municipalities for which parking standards were evaluated

Municipality	Province	Date of Zoning Scheme
City of Cape Town Metropolitan Municipality	Western Cape	2019
Stellenbosch Local Municipality	Western Cape	2019
Nelson Mandela Bay Metropolitan Municipality	Eastern Cape	2008
Buffalo City Metropolitan Municipality	Eastern Cape	2007
Mangaung Metropolitan Municipality	Free State	2021
Moqhaka Local Municipality	Free State	2018
Nama Khoi Local Municipality	Northern Cape	2021
Sol Plaaitjie Local Municipality	Northern Cape	2008
Polokwane Local Municipality	Limpopo	2017
City of Tshwane Metropolitan Municipality	Gauteng	2021
City of Johannesburg Metropolitan Municipality	Gauteng	2018
City of Mbombela Local Municipality	Mpumalanga	2019
eThekwini Metropolitan Municipality	KwaZulu-Natal	2022
Msunduzi Local Municipality	KwaZulu-Natal	2018
Rustenburg Local Municipality	North West Province	2021

Section 3 of this paper addresses the first objective of the study: the comparison of parking standards between municipalities. Parking standards from the listed 15 municipalities are discussed in Section 3.1 with consideration of parking rates and land use characteristics. Comparison of the parking requirement per land use is then conducted by defining a reasonable theoretical development for each land use, and calculating the number of parking bays that the same theoretical development would require in each municipality. A detailed description of the method to define a theoretical land use and estimate the parking requirement in each municipality is provided in Chapter 3.2 for a school. The parking requirements for a further six land uses are then similarly compared in Chapter 3.3 and used to evaluate dissimilarities between parking standards in South Africa.

Every effort was taken to ensure that the defined theoretical land use developments had comparative values for the different land use characteristics used by the 15 investigated parking standards. For example, “number of offices” is used in one parking standard, but “gross leasable area (GLA)” is used in another. In this case the number of offices were multiplied by an office size of 20 m^2 per office to estimate the GLA to make the parking requirements between number of offices and GLA comparative. There are of course limitations to this method (for example, offices size in different developments is likely to be inconsistent), however this method can at least allow a level of comparison of parking requirements between municipalities.

2.2 Parking Studies to Evaluate Suitability of Parking Standards

The second objective of the study, to demonstrate a methodology to evaluate how suitable South African parking standards are, is presented in Chapter 4. Detailed parking studies were conducted at two land uses: a private hospital and a large shopping centre, to evaluate the actual parking turnover, duration, and volume. The number of occupied parking bays were compared to actual and required parking provision applicable to the host municipality (City of Cape Town Metropolitan Municipality in both instances). The aim of this part of the study was not to comprehensively evaluate parking standards, and no inference is made on the appropriateness of all parking standards and parking requirements for all land uses. Rather, this study aimed to give an overview of suitability for only two land uses in order to provide input for the correct methodology of future research in evaluating parking standards.

3. COMPARATIVE ANALYSIS OF PARKING STANDARDS IN SOUTH AFRICA

3.1 Inconsistency of Parking Standards

Parking standards were observed to vary widely between municipalities in South Africa. Both the land use characteristic used to calculate parking, and the parking rates vary between municipalities. For example, the number of parking bays for hospitals are defined either according to number of beds, floor area, gross leasable area (GLA), number of consulting rooms, number of offices, or number of staff, depending on the municipality. Some municipalities use a single parking rate per land use (for example Moqhaka Local Municipality specifies parking for a hospital according to number of beds only), while other municipalities use a combination of land use characteristics to recommend total parking requirement (the City of Mbombela calculates parking at a hospital cumulatively for number of beds, consulting rooms, and offices). The magnitude of the variation in parking requirements are investigated in Section 3.2 and 3.3.

Some municipalities use specific parking rates for different areas according to public transport availability. The City of Cape Town has reduced parking requirements for areas that are served by formal public transport. PT2 areas fall within a radius of 400 m from a public transport stop, while PT1 extends somewhat further to 800 m from a public transport stop (Sasman & Behrens, 2022). Reduced parking requirements are allowed in these zones, with some land uses in PT2 areas being completely exempt from parking provision. The City of Tshwane Metropolitan Municipality defines zones of reduced parking requirements according to proximity to the central business district (CBD). Zone A (within the CBD) requires no parking to be provided, and Zone B, the area just adjacent to the CBD has decreased parking requirements compared to the rest of the city. The City of Johannesburg Metropolitan Municipality has a similarly defined Zone A with no parking requirements for the CBD, and Zone B with reduced parking requirements, however, Zone

B are defined as public transport priority areas and transit orientated development zones. Polokwane Local Municipality has a number of zone types, each with their own parking requirements. These zones are defined according to various levels each for residential, business and industrial land uses.

3.2 Parking Variability at a Similar School in Each Municipality

Comparison of parking requirements becomes quite complex considering the myriad of parking standards and land use characteristics that are applied throughout South Africa. In order to compare the total parking requirement of various land uses, according to individual local parking standards, this paper proposes a standard theoretical development for each evaluated land use, and then calculates the number of parking bays required in each municipal area. For brevity, only parking for a school is discussed in detail in this section.

The land use characteristics associated with the theoretical comparative school are indicated in Table 2. This is a school with 480 learners (32 leaners per class – 15 classes) and 25 staff members. Total GLA was calculated as total area for classrooms plus total area for offices, additional space for circulation and toilet facilities, etc. was excluded from GLA.

Table 2: The comparative school

Land Use Characteristic	Units	GLA
Number of learners	480 learners	-
Number of staff	25 staff	-
Number of classrooms	18 classrooms	42 m^2 each
Number of offices	5 offices	20 m^2 each
Total GLA	-	856 m^2

The number of parking bays required for the same theoretical school in each of the 15 municipalities is presented in Figure 1. Most of the municipalities applied similar parking requirements based on number of parking bays per classroom (1 bay / classroom) plus number of parking bays per office (1 bay / office). Stellenbosch Local Municipality does not require additional parking for offices and Nama Khoi Local Municipality prescribes half of the office parking of the other municipalities. eThekwini Metropolitan Municipality requires two parking bays per classroom and office.

The City of Johannesburg requires parking according to number of classrooms *plus* number of learners, resulting in a much greater number of parking bays required overall. Polokwane school parking is based on GLA only, Mangaung on number of leaners only, and Moqhaka on seats (note that in this instance, the number of seats were reduced to “actively used seats”, and so was calculated according to seats in 15 classrooms instead of 18 classrooms).

City of Cape Town, Nama Khoi and Mbombela municipalities specify additional drop-off parking bays that should be provided for parents or public transport to drop-off students.

Buffalo City, Mangaung, eThekwini, and Msunduzi Municipalities indicate that “sufficient” or “additional” parking is needed at drop-off facilities, but do not indicate a specific parking rate. The other eight municipalities do not mention drop-off parking. Figure 1 certainly demonstrates the significant difference in parking requirements that are specified per municipality for schools.

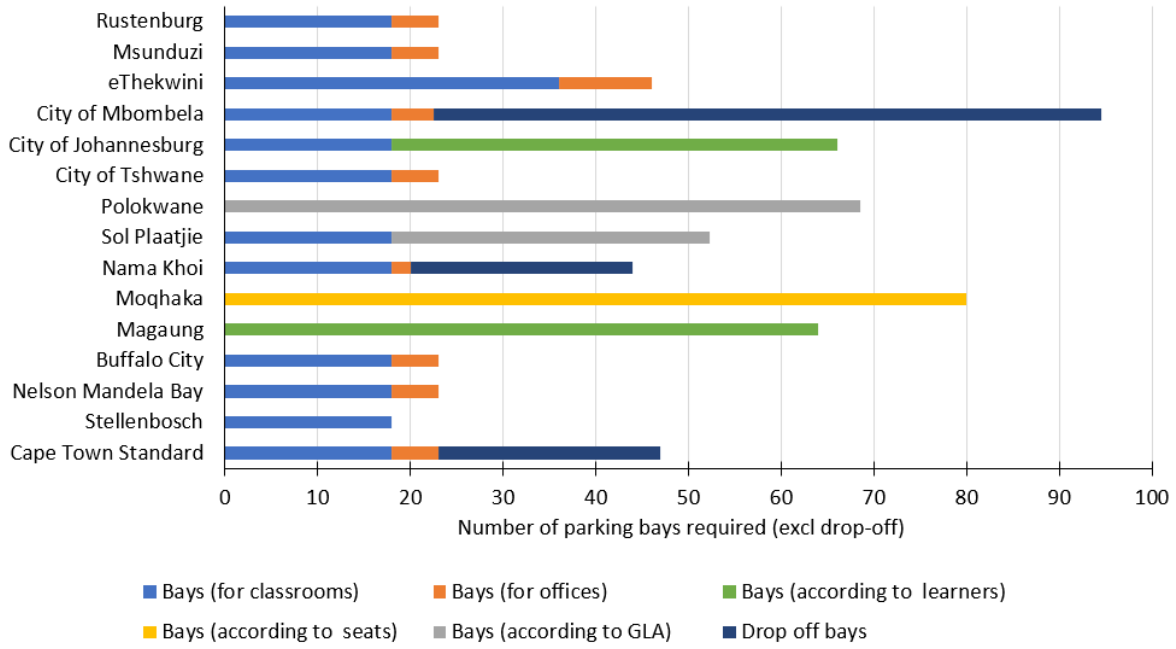

Figure 1: Parking requirements for a similar school in each municipality

3.3 Analysis of Parking Requirement Variation Between Multiple Land Uses

Calculations similar to that carried out in Section 3.2 for schools were conducted for six further land uses: offices, shopping centres, restaurants, hospitals, guesthouses and residential homes. Table 3 quantifies the land use characteristics of the standard theoretical developments defined for each land use. To ensure equal comparison, land uses were assumed to be located in areas where reduction of parking is not applicable in municipalities where reductions are permitted for certain areas (for example, close to CBD and public transport).

Descriptive statistics of the parking requirements at all seven land uses in each of the 15 municipalities are presented in Table 4. The minimum, maximum and average number of parking bays are indicated per land use. The municipality with the minimum and maximum parking bay requirements are also indicated. The standard deviation of parking bay requirements is provided (indicated as a percentage of the average parking requirement to enable comparison), describing just how variable parking requirements between municipalities are. The variability of parking bays per land use and per municipality are further described in Figure 2 and Figure 3, respectively. Note that school parking requirements used in subsequent analyses exclude drop-off parking requirements because it is not consistently required by all municipalities.

Table 3: Description of comparative land uses

Land Use	Land Use Characteristics of Theoretical Development
Office	Office building with GLA of 2500 m^2 and total floor area of 2875m^2 (15% additional area for circulation)
Shopping Centre	GLA of 6800 m^2 and total floor area of 8000m^2 (15% additional area for circulation, public toilets, etc.)
Restaurant	Floor area: 250 m^2, GLA: 210 m^2, public floor area (patron space): 150 m^2, 24 tables (6.25 m^2/table), 72 seats (2-seater: 12 tables, 4-seater: 12 tables)
Hospital	150 beds, 8 offices (20 m^2), 28 consulting rooms (35 m^2), GLA: 4600 m^2, total floor area: 5300m^2 (15% additional area for circulation)
Guesthouse	12 guest rooms, 1 manager and 2 additional staff members, 1 office (40m^2)
Residential	10 single-family homes on 250 m^2 erven with 3 bedrooms each

Table 4: Descriptive statistics of parking requirements at land uses

	Minimum parking bays	Average parking bays	Maximum parking bays	Standard deviation (% of ave.)	Municipality with minimum parking	Municipality with maximum parking
Schools (excl. drop-off)	18	38	80	55.24	Stellenbosch	Moqhaka
Offices	63	106	150	19.22	Buffalo City	Mangaung
Shopping centre	272	369	408	15.12	Cape Town, Nama Khoi & eThekwini	*Multiple*
Restaurant	8	15	36	47.59	Stellenbosch & Moqhaka	City of Tshwane
Hospital	38	220	378	38.02	Moqhaka	Mangaung
Guesthouse	8	12	14	13.83	Buffalo City	NMB, Tshwane & Sol Plaaitjie
Residential	10	16	23	27.36	Stellenbosch, Polokwane & Rustenburg	City of Tshwane

The variability of parking bay requirements per land use is graphically described in Figure 2. Comparability between different land uses is enabled by evaluating the number of parking bays required by each municipality as a percentage of the highest parking requirement (number of parking bays required by the municipality with the highest parking requirement). Figure 2 provides a good indication of just how variable parking standards between land uses in South Africa are. There is certainly no consistency in parking requirements by municipalities for the different land uses, and no consistency in the variability of parking required between land uses.

High variability in parking requirements is particularly prevalent at schools, hospitals, and residential land uses, as indicated by the large interquartile range (the difference between the 25th and 75th percentile of parking bays - the “box” area). Hospitals, specifically, have a high range of parking requirements, with the minimum parking standard (Moqhaka Local

Municipality) requiring only 10% of the parking indicated by the municipality with the highest parking requirement (Mangaung Metropolitan Municipality).

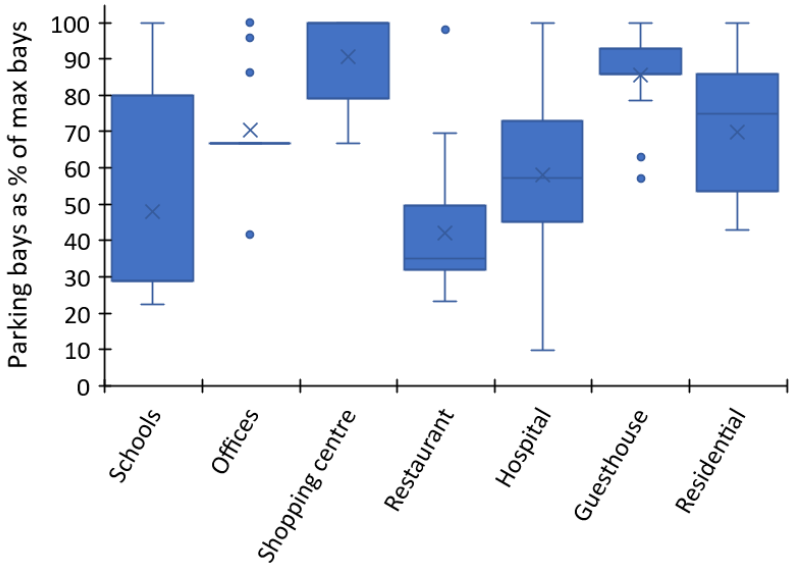

Figure 2: Variability of parking requirements per land use

The majority of parking standards for offices recommend similar parking requirements (4 bays/100m^2 GLA) – only four of the 15 municipalities differ from this. For this reason, the 25th and 75th percentile number of parking bays are the same as the median number of parking bays, resulting in the strange box plot indicated for offices. Outliers were Buffalo City Metropolitan Municipality (the minimum parking requirement – 2.5 bays/100m^2 GLA) and Mangaung Metropolitan Municipality (the maximum parking requirement – 6 bays/100m^2 GLA for professional use).

Nine municipalities have similar parking requirements for shopping centres (6 bays/100m^2 GLA), which is also the maximum number of parking bays required for this land use within the municipal parking standards evaluated. For this reason, the 75th percentile parking requirement and the maximum parking requirement are equivalent.

From Table 2, it would seem that there is some level of consistency of which municipalities have the highest and the lowest parking requirements. For example, Stellenbosch Local Municipality has the lowest parking requirement at three land uses, while City of Tshwane Metropolitan Municipality has the highest parking requirement at four land uses. Figure 3 describes the variability in the parking requirement per municipality, with required parking bays indicated as a percentage of the maximum parking requirement at that land use, similarly to Figure 2.

Figure 3 indicates the average parking requirement across the seven land uses for the 15 evaluated municipalities, provided in descending order according to average parking requirement. Mangaung Metropolitan Municipality has the highest average parking requirement – 85% of the overall maximum parking requirement for all land uses. Rustenburg, by comparison, has an average parking requirement of only 52% of the overall maximum parking requirement for all land uses, the lowest. Figure 3 also demonstrates how parking requirements vary between land uses within each municipal standard. There are significant differences in the 25th and 75th percentile parking requirements between land uses in each municipality. This would indicate that low or high parking requirements are not consistent per municipality, with some land uses in each

municipality allocated a comparatively low or high parking requirement in comparison to other municipalities. This indicates that the local conditions, including private vehicle travel demand and development traits of a particular municipality, were likely not taken into account when the parking standards were created for each municipality.

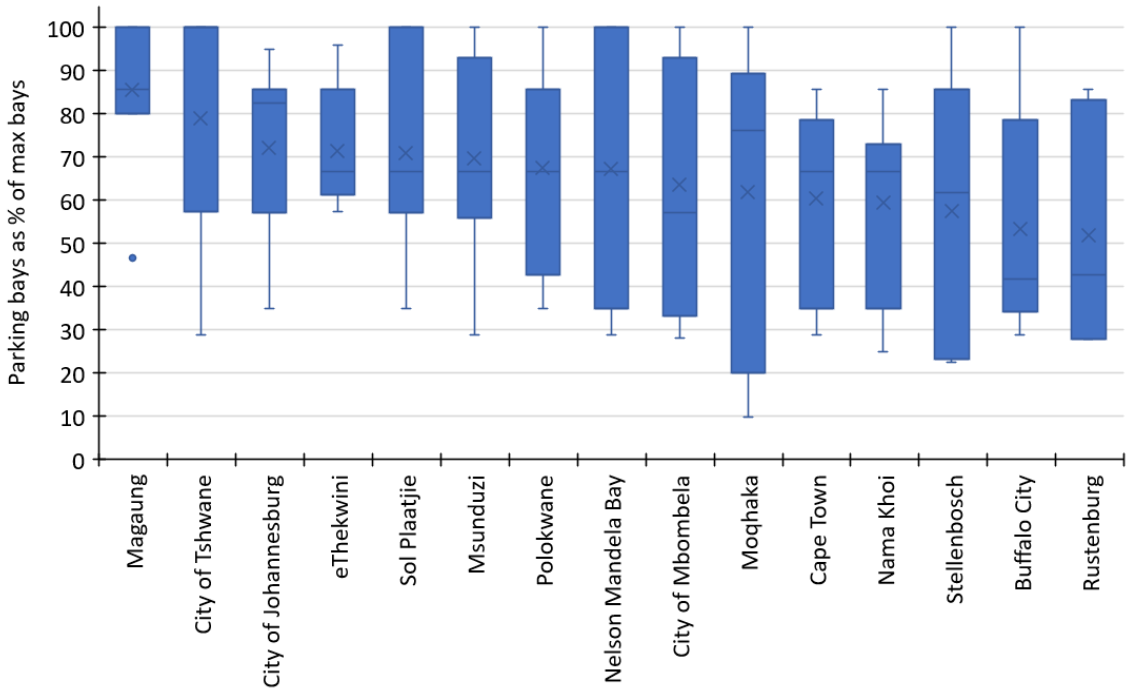

Figure 3: Variability of parking requirements per city

The variability in parking standards between South African municipalities and land uses identified in Figures 2 and 3 beg numerous questions: 1) On what scientific base are these parking standards founded? 2) Do the standards for each municipality reflect the actual parking demand that is typical of that municipality (the variability of parking requirements per municipality would argue that this is not the case)? and 3) Do the parking standards reflect a desire to address parking management for sustainable transport use? To answer these questions, we need to develop an understanding of actual parking demand compared to parking requirement stipulated by municipal parking standards, as investigated in the following section.

4. PARKING STUDIES FOR PARKING STANDARD EVALUATION

Parking studies were conducted at two land uses in Cape Town: a private hospital and a shopping centre. Both were developed relatively recently (the hospital was opened in 2010 and the shopping centre in 2014) and so should reflect design according to recent parking standards. Written permission to conduct a parking study was obtained from the management of both the hospital and shopping centre.

The purpose of these parking studies was to evaluate how well the current parking standard for the City of Cape Town meet the observed parking needs and prescribe a methodology to investigate the discrepancy between parking standards and actual parking need. This is of course not a comprehensive evaluation of the applicability of parking standards, even in the City of Cape Town, as only two land uses were evaluated. However, the aim of this section was not to identify patterns of consistency or disparity, but rather to set the scene for future research in this area.

4.1 Proposed Parking Study Methodology

Parking accumulation should be evaluated in 20-minute intervals in the parking area of a land use. This can be compared to the total number of parking bays provided by the land use, and to the number of parking bays that are required according to the appropriate parking standard of the same municipality where the land use is located. Discussion of any special-use parking spaces should be included in the evaluation. The following sections demonstrate this methodology, applied to a private hospital and shopping centre.

4.2 Parking Study at the Private Hospital

The hospital investigated has 180 beds and 42 consultation rooms. This equates to a minimum parking requirement of 306 parking bays, according to the City of Cape Town standard (1 parking bay per bed PLUS 3 parking bays per consultation room). The hospital, in fact, provides significantly more parking: 421 parking bays (of which 155 are allocated for staff, 248 for general use, and 18 bays for special use – accessible parking, emergency centre parking and parking for parents with small children), representing a parking surplus of 38%.

The parking study was conducted on Thursday 29 September 2022, between 11:00 AM and 13:00 PM, which coincided with the time of busiest operation at the hospital according to hospital management. The parking accumulation was obtained every 20 minutes. Figure 4 presents the parking accumulation curve. The capacity (421 parking bays) of the parking area was never reached, with a maximum of 379 vehicles parked at 11:20. The general parking capacity was however exceeded between 11:00 and 12:00, with vehicles parked illegally next to sidewalks. Vehicles parking in the demarcated staff parking remined constant, at 74% occupation (115 of 155 parking bays occupied). Similarly, the special use parking never reached capacity, with a maximum of 13 vehicles parked in the 18 allotted bays at 11:40 (72% occupation). It should be noted that the maximum parking accumulation (379 occupied bays), well exceeds the minimum parking requirement according to the applicable parking standard (306 parking bays).

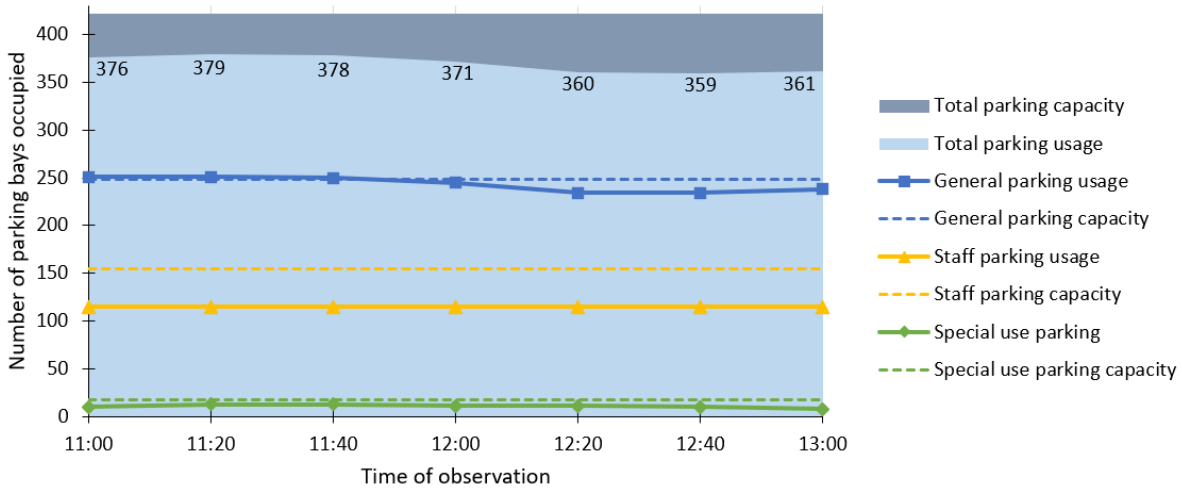

Figure 4: Parking accumulation at private hospital

The parking patterns describe a good level of compliance of the hospital patrons to parking regulations: they did not use specifically allocated parking bays, even when there was insufficient space in the general parking area. During the parking study, drivers were observed to search (unsuccessfully) for parking in the general parking area, and then park

at the adjacent shopping centre. The total parking usage therefore indicates actual parking accumulation, not demand. Various curious hospital patrons approached the research team during the parking study. On hearing that they were conducting a parking study, many people expressed happiness, thinking that the hospital was addressing the parking shortage (of course, this was not the purpose of the parking study). This echoes the findings that insufficient parking is provided for general use.

4.3 Parking Study at the Shopping Centre

The shopping centre has a total floor area of 10 400 m^2. Assuming a reduction of 15% to account for non-leasable space (circulation, public toilets, etc.) results in a GLA estimate of 8840 m^2. The minimum parking requirement is therefore 354 parking bays, according to the City of Cape Town standard (4 parking bay per 100 m^2 GLA). The shopping centre actually provides exactly 354 parking bays, of which 7 are accessible parking bays. The City of Cape Town parking standard requires one accessible parking bay for every 25 parking bays, which equates to 14 accessible parking spaces. The shopping centre therefore under-caters for accessible parking.

The parking study was conducted on Saturday 1 October 2022 between 10:30 AM and 12:30 PM, coinciding with the busiest period according to management. The parking volume was obtained every 20 minutes. Figure 5 presents the parking accumulation curve. The capacity (354 parking bays) of the parking area was never reached, with a maximum of 238 vehicles parked at 11:40 AM (67% of capacity). The number of used accessible bays reached 7 parking bays for only one 20-minute interval during the parking study.

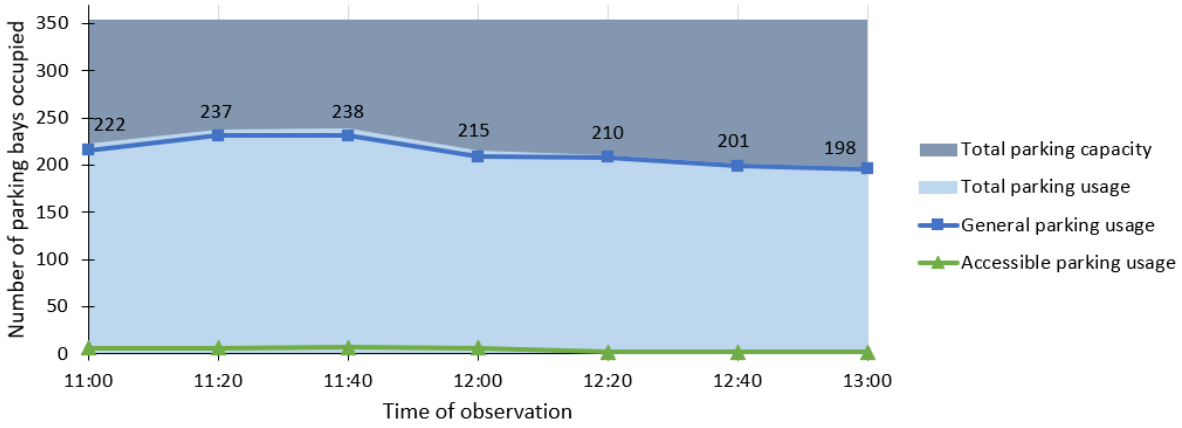

Figure 5: Parking accumulation at shopping centre

4.4 Implications of Parking Study Findings

The two parking studies would indicate that the City of Cape Town parking standard is inadequate to evaluate the actual parking need at both a hospital and shopping centre. The hospital investigated provides well over the minimum parking requirement (nearly 40% more) and yet there is still inadequate parking for general use, with patrons having to find alternative parking areas at nearby land uses. The allocation of parking for staff and special use parking bays are however over catered by about 35%. The shopping centre provides the correct amount of parking, according to the standard, and yet was only ever 2/3 full during the peak shopping time of the week. The parking standard therefore under-estimates parking need for one lane use, while significantly over-estimating parking demand for another. The need for accessible parking at both land uses was over-estimated by the standard.

Of course, this parking study is inadequate to infer a pattern to the application of parking standard in City of Cape Town, never mind South Africa as a whole. However, the results do indicate that it is necessary to investigate parking standards in substantially more detail to evaluate the validity of the standards.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of Findings

The aim of this paper was to highlight the need for detailed research on parking standards in South Africa, for the purpose of promoting the reconsideration of parking standards, as called for by Sasman and Behrens (2022).

Parking standards throughout South Africa are implemented as minimum parking requirements, indicating that consideration is not given to the benefits that can be derived from implementing maximum parking standards as a method of Travel Demand Management. There were however areas were reduced minimum parking standards allowed for less parking in areas served by public transport and CBD's (in City of Cape Town, City of Tshwane and City of Johannesburg Metropolitan Municipalities), which indicates at least a step in the direction of using parking standards to implement travel demand changes.

Comparison between the parking standards of 15 municipalities in South Africa were conducted by comparing the parking requirement for 7 land uses. A theoretical development was defined for each land use, and parking requirements calculated according to the parking standard of each municipality. Significant differences in the parking bay requirements of each land use between the municipalities were identified. Variability in parking requirement in each municipality indicates that either low or high parking requirements are not consistent per municipality, which seems to show that the local conditions, such as private vehicle travel demand, were not considered when the parking standards were created for each municipality. This mirrors the finding of Mladenovič and Plevnik (2019) that parking standards often are not adapted to local conditions.

Limited parking studies then showed that the local parking standards are likely inadequate to evaluate actual parking need, which was significantly underestimated at one land use and over-estimated at another. This again reiterates the conclusion that local parking standards are not developed or adequately studied to cater for local needs.

5.2 Recommendations for Future Research

Extensive parking studies should be carried out at a multitude of land uses, using a methodology similar to the investigation conducted in Section 4 of this paper. These studies will allow researchers to assess the applicability of local parking standards to reflect the actual parking demand of each land use per municipality, and should also consider the difference between rural, urban and metropolitan areas. Furthermore, researchers should also consider the parking needs within different local areas of municipalities that vary according to public transport provision, socioeconomic factors, and private vehicle travel demand. This information will be paramount in preparing more locally applicable, and ultimately sustainable parking standards. This is important, because inadequate parking standards have been shown to result in an oversupply of parking, increasing the cost of developments, limiting land that is available for developments, and reducing optimal land usage.

Research is then needed to consider how parking standards in South Africa should be further changed or optimised to evaluate if parking need reductions could result in a TDM type impact, leading to more sustainable transport patterns. Some municipalities are making an effort to change parking standards in certain zones where sustainable transport options should be encouraged (such as the CBD and areas where public transport is more accessible). Future research is needed to evaluate how changes to these parking requirements impact travel demand to land uses and if parking reductions are adequate or too restrictive.

The correct application of reduced minimum parking standards or maximum parking standards require transport planners to understand if parking restrictions at different land uses will lead to similar travel behaviour changes. For example, Engel-Yan, et al. (2007) found that restricting parking at certain land uses (like office space) had a greater impact on travel demand, but had little impact at, for example, large retail outlets in Toronto, Canada. This should also be studied in the South African context.

It is clear that extensive research is required to determine how best to tailor parking standards for local travel patterns and how to implement more sustainable parking standards that can assist to decrease travel demand.

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SUPPLEMENTARY MATERIAL

A detailed indication of the parking requirement required by the parking standards of the seven investigated land uses in the 15 municipalities is provided in the figure below.

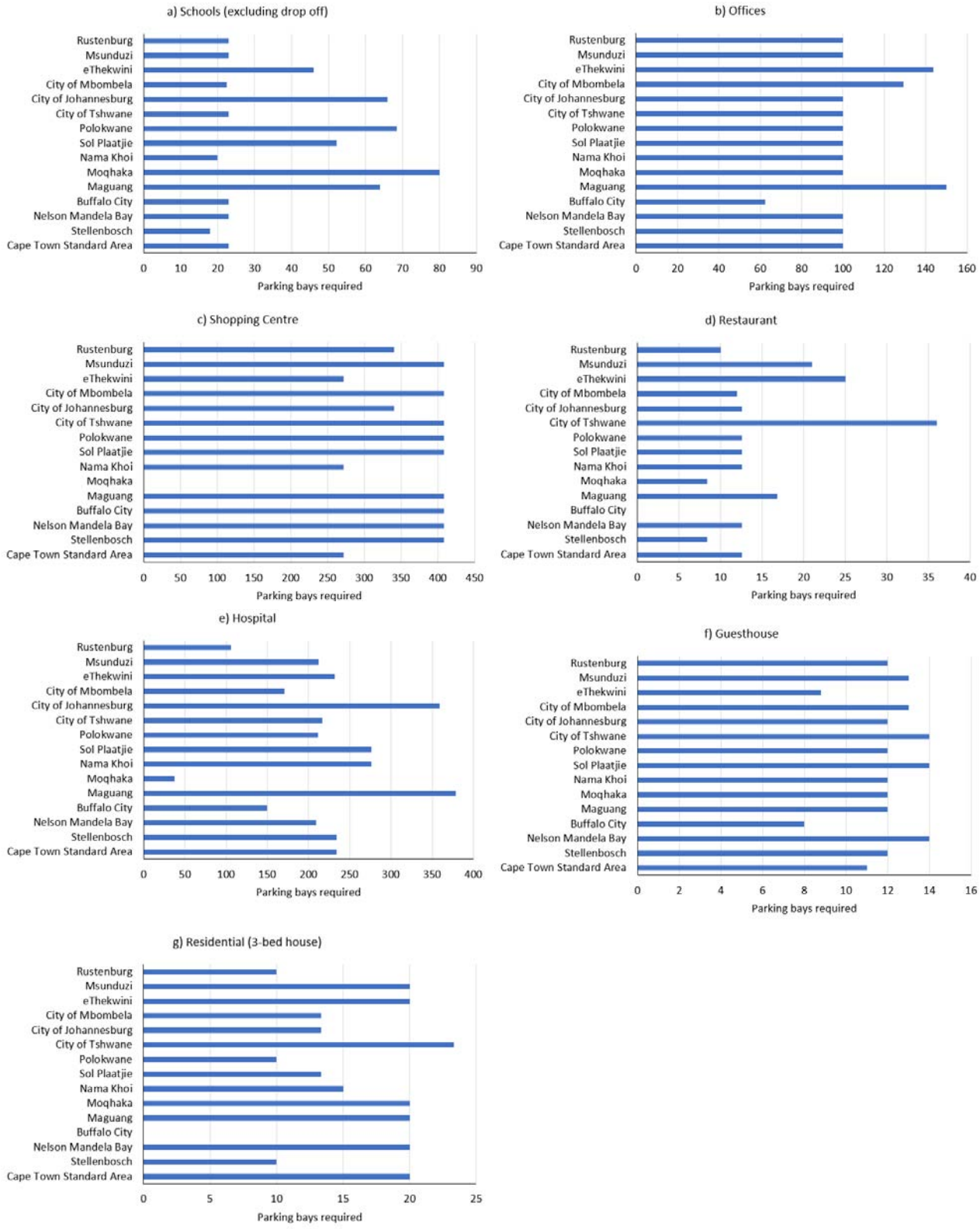

Figure 6: Parking requirements per land use investigated in 15 municipalities