ENGINEERING SUSTAINABLE PUBLIC PARKS IN RESIDENTIAL AREAS OF CITIES IN SOUTH AFRICA

Doctor of Engineering in Civil Engineering

Department of Civil Engineering
Faculty of Engineering, Built Environment and Information Technology
Central University of Technology, Free State

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By

James Honiball

Supervisor: Professor Dillip Kumar Das

ABSTRACT

Public parks (PP) in urban residential areas are essential for a balanced urban lifestyle. The literature gives evidence that public parks have a positive influence on the wellbeing of persons who have access to, and regularly spend time, in public parks.

A fair number of public parks in the residential areas of South African cities, are found to be well-spaced and developed according to urban planning guidelines and regulations established by urban planners. Nevertheless, many of them are not functional or effectively utilised by the residents living in their vicinity. Only a few of the residents seem to visit the public parks in their area.

Many factors, for instance, attractiveness, accessibility, comfortability, and social concerns such as the incidence of crime, or the fear of being exposed to crime, lifestyle, and time constraints are frequently given as the reasons for the non-utilisation of public parks. This phenomenon has been identified as a public park lacking in vibrancy.

The vibrancy of public parks are determined by four key elements namely, the degree of sociability, the availability and practicality of infrastructure that encourage a variety of activities, comfort levels and image, and the conditions influencing the accessibility of a public park. The degree of influence from these four key elements towards the vibrancy of public parks in residential areas has not yet been investigated. Also, the major independent factors making up the four key elements have not yet been analysed and modelled. Consequently, an investigation into the determinants influencing vibrancy of public parks and how the degree of vibrancy of the public parks in the residential areas of South African cities can be improved, was conducted. This was done by means of a case study of the public parks in some of the residential areas of Bloemfontein, a mid-sized city in central South Africa, where many of the public parks in the city are under-utilized and far from vibrant.

An applied systems analysis methodology, survey researching, the use of GIS and development of linear and multilinear regression models were followed in this investigation. Data was collected through household-, physical park-, and park use surveys. The surveys were performed in five of the suburbs, as a representation of all of the suburbs in the city. The suburbs representing the city was Universitas (on the south-

western side of Bloemfontein), Langenhoven Park (on the western side of the city), Batho (east of Bloemfontein, Lourier Park (on the southern end of the city), and Dan Pienaar (on the northern side of Bloemfontein). The suburbs were selected according to a set of criteria such as the geographic location, the population density, the social demographic circumstances in the area, the number, size and type of public parks available, and the types of access, for example, road- and sidewalk-networks. The suburban residential areas selected differ from each other in terms of its demographics, size, location, and accessibility via road networks.

A household survey with a sample size of 400, was completed by using a systematic stratified random sampling process through a semi-structured interview method. The physical- and park use surveys were carried out through uninterrupted digital photography and videography. Eighteen public parks located in the five selected residential areas were identified for the physical- and park use surveys. To this purpose, a camera which filmed the parks, non-stop, for a period of up to one month, was set up in each of the identified public parks. The purpose of the filming was to determine the extent of park use and to identify the factors responsible for the low degree of vibrancy of the public parks. GIS was employed to extract the spatial- and location attributes of public parks. In order to identify the determinants with the most influence on the vibrancy of public parks as well as establish the relationships between the use of public parks and the major control determinants, the data collected were analysed statistically. On the grounds of Applied Systems Analysis paradigms, theoretical multilinear regression models were developed. These models established the relationships between the use of public parks (measured in terms of the average number of users per year) as the dependent variable and the most influential independent variables. The models are then used to examine the extent of the use of public parks under varied simulated scenarios. The simulated results were used to develop several policy scenarios intended to improve the use of the public parks in the residential areas of South African cities.

The findings of the surveys suggest that there are 18 key determinants, which most commonly influence the vibrancy of the public parks in the city. The variables include the availability of volunteer caretakers, the average number of organized events hosted in the public parks per year, the percentage of the adjacent land being used for residential purposes, the number of trees in the park, the presence of a water feature, the availability and numbers of playground apparatus, the availability of seating, the number of tables available, the availability and number of sports fields and other sports facilities, the percentage of grass covering, the residents' perception of safety in the service areas of

the public parks, the extent of cleanness, the attractiveness of a park, the greenness of a park, the number of streets accessing the public park, the public park environment, the extent of illumination in the public park, and the road-network to sidewalk-network ratio. Of these 18 key determinants, however, only four variables namely, the road-network to sidewalk-network ratio, the average number of organized events hosted in the public parks per year, the presence of a water feature, and the perception of safety in the public park service area are the control variables, which significantly influence the vibrancy of the parks independently, and in combination.

The major infrastructural-, social-, and environmental challenges were examined against the creation of sustainable and vibrant public parks in the study area and the factors acting as obstacles against it were analysed. A delineation of the major control influential engineering infrastructure, social- and environmental attributes that will contribute to the creating of successful public parks in the study area were established.

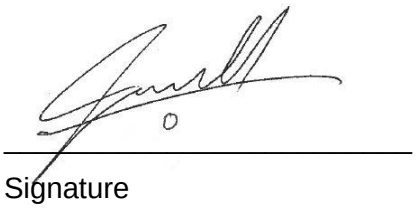
The simulated scenarios revealed that in a composite scenario with an increase in the perception of safety, setting the road-network to sidewalk-network ratio on an optimal level, having an increased number of organized events per year, and the inclusion of a water feature, will improve the utilization of the parks extensively. The sensitivity analysis shows, however, that the combination of the physical design elements contributing to accessibility, comfort, usability and image, and the number of organized events hosted in the public parks per year, is the most important consideration for making public parks vibrant. All of these elements, individually, or in combination, can be augmented to improve the vibrancy of public parks in the cities of South Africa.

The novelty and contribution of this study lies in the development of models that can forecast the number of annual public park users and measure the vibrancy of public parks in suburban areas of South Africa. This can be used for developing and analysing different scenarios under different simulated scenarios to evolve policy interventions or strategies leading to public parks becoming more vibrant.

Keywords: Vibrancy, Accessibility; Comfort; Image; Sociability; Uses; Activities; Access; Linkage; Public parks; Public park usability, Residential areas.

DECLARATION

I, the undersigned, hereby declare that the work contained in this dissertation is my own independent work and that this dissertation, or any part thereof, has not previously been submitted by anyone or by me to another institution in order to obtain a degree.



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Date: 28 November 2019

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LIST OF ABBREVIATIONS

Applied Systems Analysis: ..... ASA
Green Space: .....GS
Neighbourhood Park: .....NP
Recreational Facility: .....RF
Open Space: .....OS
Open Green Space: .....GS
Public Park: ..... PP
Project for Public Spaces: .....PPS
Simple distance indicators: .....SIs
Proximity indicators: .....PIs
Residential Area: .....RA
Commercial Area: .....CA
Educational Area: ..... EA
Industrial Area: ..... IA

DEFINITIONS

Accessibility: The quality of being able to be reached or entered.

Adjusted R^2: Also indicates how well terms fit a curve or line but adjusts for the number of terms in a model. If you add more and more useless variables to a model, adjusted r-squared will decrease.

ANOVA: Analysis of variance, a statistical method in which the variation in a set of observations is divided into distinct components.

Correlation: a mutual relationship or connection between two or more things.

Heteroscedasticity: Refers to the circumstance in which the variability of a variable is unequal across the range of values of a second variable that predicts it.

Illumination: level of lighting or light.

Log transformations: Can be used to make highly skewed distributions less skewed. This occurs because the anti-**log** of the arithmetic mean of **log**-transformed values is the geometric mean.

Model: a representation of an idea, an object or even a process or a system that is used to describe and explain phenomena that cannot be experienced directly. Models are central to what scientists do, both in their research as well as when communicating their explanations. In this thesis, all models will be to explain the contributing factors and relationships of vibrancy in public parks.

Multilinear Regression: also known simply as multiple regression, is a statistical technique that uses several explanatory variables to predict the outcome of a response variable. Multiple regression is an extension of linear regression that uses just one explanatory variable.

Open Space: Any open piece of land that is undeveloped (has no buildings or other built structures) and is accessible to the public. Open space can include Green space (land that is partly or completely covered with grass, trees, shrubs, or other vegetation).

Pavement: A path with a hard surface that forms a road carriageway, airfield runway, vehicle park, or other paved areas.

Public Park: An area of land set aside for public use, as a. A piece of land with few or no buildings within or adjoining a town maintained for recreational and ornamental purposes.

R^2: In statistics, the coefficient of determination, denoted R^2 or r^2 and pronounced "R squared", is the proportion of the variance in the dependent variable that is predictable from the independent

Regression: A measure of the relation between the mean value of one variable (e.g. output) and corresponding values of other variables (e.g. time and cost).

Sidewalk: A paved path for pedestrians at the side of a road; a sidewalk

System Analysis: the act, process, or profession of studying an activity (such as a procedure, a business, or a physiological function) typically by mathematical means in order to define its goals or purposes and to discover operations and procedures for accomplishing them most efficiently.

System: a set of things working together as parts of a mechanism or an interconnecting network; a complex whole

Variance Inflation Test (VIF): In statistics, the variance inflation factor (VIF) is the quotient of the variance in a model with multiple terms by the variance of a model with one term alone. It quantifies the severity of multicollinearity in an ordinary least squares regression analysis

Vibrancy: The state of being full of energy and life. The level of regular human movement in and out of an area.

Water Feature: One or more items from a range of fountains, jeux d'eau, pools, ponds, rills, artificial waterfalls, and streams.

CHAPTER 1: INTRODUCTION AND RESEARCH DESIGN

1.1 INTRODUCTION

Freely accessible open spaces (OSs), for instance, public parks (PPs), recreational facilities, botanical gardens, nature reserves, and the like, are vital to the well-being of people living in an urban society (Shores and West, 2010; Zhang, Holt, Lu, Onufrak, Yang, French, and Sui, 2014). Open spaces allow people to get in touch with nature, unwind, relax, rebuild their energies, interact with other residents of their community, exercise, and promote their physical and mental vigour (Sugiyama, Paquet, Howard, Coffee, Taylor, Adams, and Daniel, 2014). Open spaces, typically, have some form of greenery and provide areas for relaxation, refreshment, and activity. Moreover, green open spaces produce clean, fresh air (Haq, 2011). The social and economic health of cities and towns depend on the establishment of an adequate number of adequately equipped and operational open spaces (Sallis, Frank, Saelens, and Kraft, 2004).

Having taken the attributes of vibrant public parks (PPs) into consideration, the public parks in most of the residential areas in South African cities are proving to be underutilized (Das, Honiball, 2016). Many of the observed failings of PPs may be attributed to the reforms South Africa has been undergoing since the Referendum of 1994 and the adoption of the Constitution of the Republic of South Africa in 1996. The country has since been adjusting to transformation in the areas of land use, civic roles and population migrations. The latter fostered an escalation in the populace of many of the residential areas and contributed to the hierarchical changes in the administration of the country's urban residential areas (Spocter, 2004).

The continued rise in the population density of residential areas in South African cities gave rise to the development and construction of other urban requirements, for instance, commercial- and civic centres (Department of Science and Technology South Africa, 2011). The demand for more facilities in the space available in residential areas was, and often still is, satisfied at the loss of existing underutilised open spaces—notably, public parks.

As in the case of other complex systems, many factors contribute to public parks failing to fulfil their purpose (Thompson, 2002). Some of the more notable factors include inappropriate location, the absence—or shortage, of amenities, low aesthetic appeal and insufficient, or impractical, accessibility. Behavioural- and social issues, for example, crime and drug abuse, also play a leading role in the frequency of park visits; it may be that residents in the neighbourhood will refrain from visiting the park due to the presence of the criminal and anti-

social elements causing the park environment to lack appeal, or because of fear for their safety—to name a few. (Nicholls, 2001).

Several studies analysing the successes of public spaces have been published (Kent, Madden, 2013; Shackleton, Blair, 2013; Lindholst, van den Bosch, Kjøller, Sullivan, Kristoffersson, Fors, and Nilsson, 2016). Perhaps the most influential study was conducted by the *Project for Public Spaces* (PPS) team. In their model, known as 'The Place Diagram', they set out the key determinants for the success of a public space: accessibility, the engagement of people in similar activities, and the image, comfort, and sociability of the space (Korpela, Ylén, Tyrväinen, and Silvennoinen, 2008; Lindholst et al., 2016, Project for Public Spaces, 2013).

South Africa has a unique history in urban development and although the factors mentioned above are also relevant to the open spaces of cities in South Africa, the extent to which each factor affects the success of a park is still undetermined (Shackleton, Blair, 2013). Therefore, it is believed that an in-depth study of public parks in South Africa will be the best way to address this matter.

Employing a systems approach and analysing each input value, this study aims to determine the extent to which each of the four key determinants, as outlined in the *Project for Public Spaces*, will contribute towards the bringing about of vibrant public parks in the residential areas of cities in South Africa.

The city of Bloemfontein, in central South Africa, was selected as the study area. Bloemfontein is a typical mid-sized city with no recognizable natural traits or features which may affect the study results. Also, the residential areas of Bloemfontein render fair portrayals of the standards of growth in the residential areas of South African cities over the last 25 years.

1.2 PROBLEM STATEMENT

Organized public parks and open (partially or fully) recreational spaces are integral to land allocation in the urban areas of South Africa and the majority of cities have adequate numbers of public parks in their residential areas (Shackleton, Blair, 2013). The public parks and recreational open spaces are positioned in a hierarchical order in urban areas to provide recreational facilities for citizens, at different levels of habitation, and are usually located within a comfortable walking distance from established dwellings (Goličnik, Ward, Thompson, 2010). It has, however, been coming to light over time that the public parks in residential areas are seldom utilised according to their intended purpose by the residents in the communities and

have, subsequently, become spaces that are exploited for unwarranted activities (Todes, Kok, Wentzel, Van Zyl and Cross, 2010). Besides, many public parks in residential areas have now been rezoned for commercial- or housing purposes. The reasons for underutilization are manifold and range from adequate and quality engineering (civic and accessibility) to infrastructure, the quality of parks, maintenance issues, social challenges—such as crime and fear of crime—comfortability and image etc. (Ben Dor, Westervelt, Song, and Sexton, 2013).

Some studies indicate that public parks are decisive contributors to the physical and psychological well-being of urban communities and the sustainability of cities (Heidt and Neef, 2008; Atiqul Haq, 2011; Van Melik, Van Aalst, Van Weesep, 2009). It is essential to understand the reasons for public parks in the residential areas to come across as dysfunctional and dull. Armed, therefore, with a sound underpinning of evidence and drawing on the identified key attributes of public parks namely: infrastructure, accessibility, activities, sociability, comfort, image, and environment, a strategy for restoring and maintaining the vibrancy of public parks can be instituted.

As in all other societies in the world, public parks are a fundamental component of residential communities in South African cities. Public parks are, as a rule, distributed evenly and with regular intervals among the houses and built-up apartment buildings in residential areas. Public parks provide a place for people to relax, take their children to play, walk their dogs and have social interaction with others by way of picnics and other forms of recreation (Saelens, Handy, 2010).

The city of Bloemfontein currently has an acceptable number of public parks spread across all the residential areas. The city also has enough central parks, open spaces, and stadiums and these are frequently and effectively utilised.

As in most of the public parks in South African cities, however, the public parks in the residential areas of Bloemfontein are underutilised and lacking in the vibrancy required by a public park to be deemed functional.

At first glance, it seems as if this phenomenon can mainly be ascribed to factors such as inadequate accessibility, a general perception that parks are unsafe places to visit, the actual safety inside the parks, insufficient vibrancy, disrepair and deficient maintenance, a shortage of amenities and little or no sense of wellbeing (Dempsey, 2012).

By applying an ASA approach, all the factors contributing to the vibrancy of a public park can be analysed. From the analysis, a model, or models, to assist with the planning and design of public parks in residential areas of South Africa can be developed. The factors contributing to the vibrancy of public parks, as presented in 'The Place Diagram' (see Figure 2-1) of the *Project for Public Spaces* (Project for Public Spaces, 2013), can be divided into four categories namely, sociability, uses and activities, access and linkages, and comfort and image. The *sociability* of public parks includes aspects such as the number of women, children and the elderly visiting the parks, the social networks, the extent of volunteerism, the evening use and street life of the parks. The *uses and activities* of public parks generally refers to the ownership, sustainability and usefulness of the public park, itself, and the area surrounding the park. The *comfort and image* of a public park has much to do with the safety—and the park users' perception of safety—the cleanness, attractiveness, and degree of greenness. *Access and linkages* refer to the accessibility of the public park.

1.3 PURPOSE OF STUDY

1.3.1 Research Aims of the Study

This study aims, first, to identify the fundamental elements contributing to sustainable and vibrant public parks in the residential areas in South African cities as set out in published studies. Secondly, the study must establish the attributes, of those elements, with the power to induce the bringing about of vibrant and sustainable public parks.

The study will be conducted by investigating the public parks located in the residential areas of Mangaung Metro Municipality. The research questions to be investigated are:

1. What are the urban attributes (location, land use, accessibility and infrastructure), natural environmental elements, and social attributes which influence the bringing about of sustainable and vibrant public parks in residential areas of cities in South Africa?
2. How will urban engineering infrastructure contribute to the development of sustainable public parks?
3. How will urban land use and environmental elements contribute to the development of sustainable public parks?

The main research aims of the study are:

- To investigate the level of the vibrancy of public parks and open recreational facilities in the residential areas of Bloemfontein city.

- To construct urban planning and design guidelines which will provide greater vibrancy to these parks.

1.3.2 Objectives of the Study

The specific objectives are to:

- Identify and categorize the different public parks in the residential areas of the study area and to assess their performance in terms of utilisation.
- Examine the major infrastructural-, social-, and environmental challenges against the creation of sustainable and vibrant public parks in the study area and analyse the factors acting as obstacles against it.
- Delineate and interlink the major control influential engineering infrastructure, social- and environmental attributes that will contribute towards creating sustainable vibrant public parks.
- Develop empirical model(s) premised on Applied Systems Analysis (ASA) paradigms, in order to comprehend the sustainability and vibrancy of public parks under different simulated scenarios, with the provision of relevant infrastructure, and social-, and environmental elements.
- Construct a set of guidelines for the developing of sustainable public parks, in the residential areas of South African cities, that would contribute to the development of socio-environmentally sustainable cities.

1.4 SCOPE OF THE STUDY

The scope of the investigation is limited to the development of a strategy, and a set of urban planning- and design guidelines, aimed at improving the vibrancy of the public parks in the residential areas of the city of Bloemfontein, South Africa, by investigating the impact of the physical-, infrastructural-, and spatial parameters of the residential areas on the vibrancy of the public parks. Human psychological-, behavioural- and social issues, for instance, crime and safety, have not been included in the scope of the investigation. The investigation will be conducted by concentrating on the public parks in the selected residential areas of the city and collecting data, using sample surveys, for analysis. It is believed that if the recommendations of the present study are implemented according to the proposed guidelines, the vibrancy of public parks will be improved significantly, making them more vibrant and user-friendly. Consequently, greater utilization of the public parks and open recreational spaces within the study area will be experienced.

1.4 HYPOTHESIS

A hypothesis, as set out below, has been framed and tested:

The provision of adequate and accessible engineering infrastructure, facilities, activities, and comfort and image elements, for the public parks in residential areas, will improve the utilization (vibrancy) of the public parks in residential areas.

1.5 RESEARCH DESIGN

The study's research design and methodology are briefly outlined in this chapter. The full outline and description of the methodology will be discussed in Chapter 4.

1.5.1 Methodology of the Study

A survey research method and ASA paradigm will be used in the study. The study will be relying on quantitative data collected from surveys, secondary sources and statistical analysis premised on ASA paradigms. Empirical models will be developed and simulated under varied policy intervention options to develop policy guidelines. The details of the methodology adopted for this study will be presented in Chapter 4. However, the steps followed **(Fig 1.1)** in the study include:

1. Problem identification, literature review, the setting of objectives and hypotheses and research design.
2. Identification of a study area (selected from cities in South Africa):
    a. Selection of the case study city (Mangaung Metro Municipality)
    b. Identification and selection of sample areas for survey and investigation
    c. Identification and selection of primary public parks and organized open spaces in residential areas (on a city scale)
3. Households-, physical and park use surveys:
    a. Households survey
    b. Physical survey of the identified parks (by manual means, digital photography and videography)
    c. Park use survey (park user perception survey, digital photography and videography)
4. Compilation and syntheses of primary data and secondary (statistical) data
5. Conceptual Applied System Analysis and Statistical Analysis of the collected data modelling, and assessment of the variables related to sustainability challenges
6. Results and discussions; hypothesis testing and the drawing of inferences
7. Formulation of guidelines for the improvement of vibrancy.

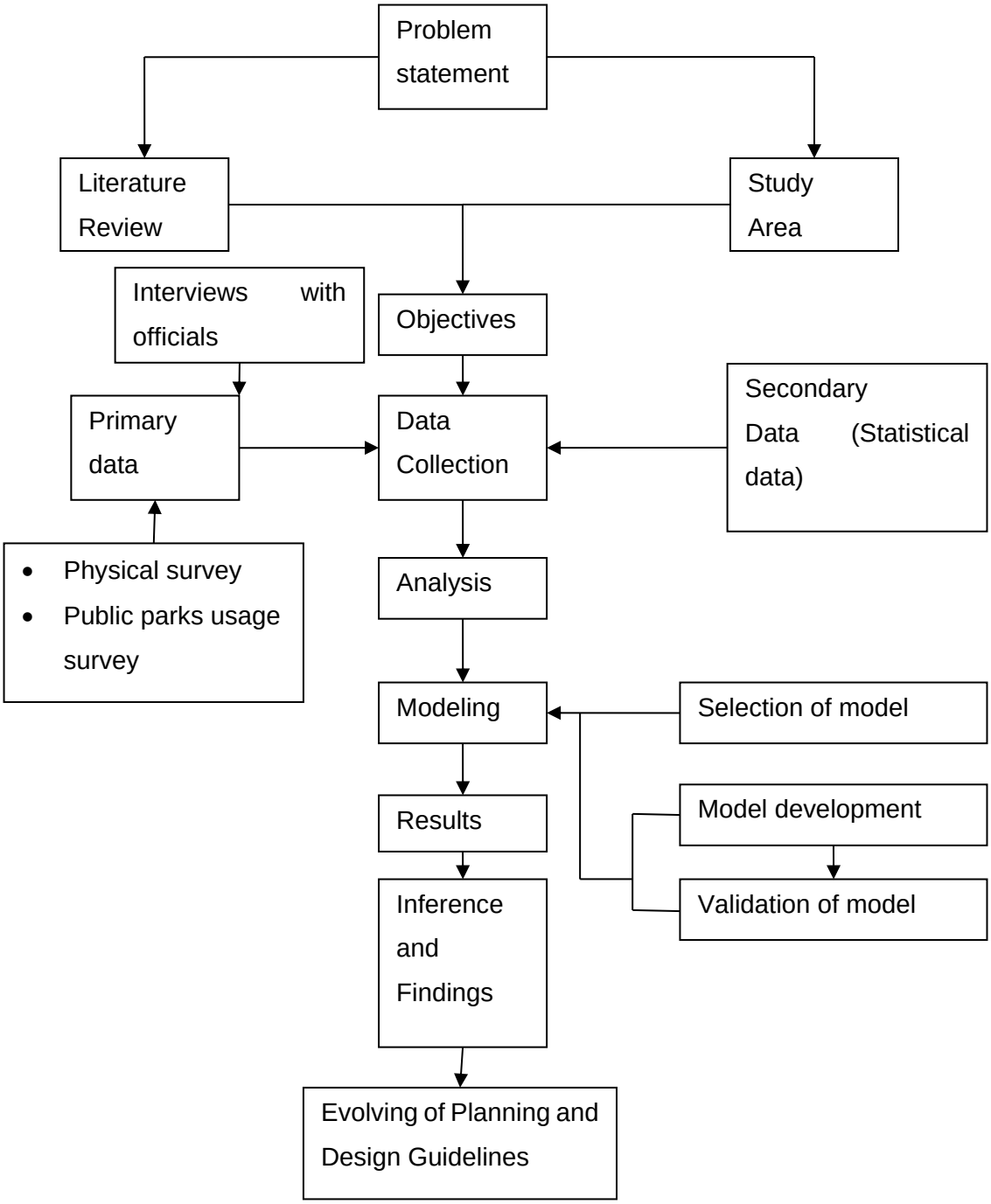

Figure 1-1: *Methodology Flow Chart*

1.5.2 Data Collection

Both primary and secondary data for analysis will be collected to aid in this investigation.

1.5.2.1 Primary Data

Primary data will be collected through physical surveys of some of the public parks and their surrounding residential areas in the city of Bloemfontein, as well as by taking candid household surveys. The physical surveys of public parks, the surrounding neighbourhoods and traffic networks are essential for obtaining accurate and current data of the study area; GIS data will be obtained from the relevant authorities. To have a complete representation of the degree of vibrancy of the public parks in the city, careful selection of the residential areas and public parks will be imperative.

Five residential areas, representative of the socio-economic groupings in the city, will be identified and primary data, covering all the identified accessibility scenarios and challenges, collected. The primary data collected will not only contribute to obtaining an in-depth understanding of the physical requirements each public park in the study area will have to adhere to, but also serve as justification for the formulated guidelines, planned solutions and verification of the hypothesis.

1.5.2.2 Selection of the Sites for the Survey

The city of Bloemfontein comprises 60 suburban residential areas; five residential areas in Bloemfontein city will be selected as the study area. In order to have a fair representation of the city's demographics and varying transportation networks, the selected suburbs will be Batho (eastern part), Universitas (south-western part), Langenhoven Park (western part), Lourier Park (southern part), and Dan Pienaar (northern part).

1.5.2.3 Household and Physical Surveys

The household surveys will be conducted in the chosen suburbs. To conduct the household surveys the investigator will collect a list of households available in the selected suburbs from the Mangaung Metropolitan Municipality.

Up to date GIS data will be obtained from the municipality or relevant authorities and will be included in the physical survey data for the assessment of the physical conditions and the accessibility of the selected suburbs and public parks to local users. Additionally, other physical surveys, which include investigating the traffic network systems around the public parks in the selected areas, parking access to public parks, the condition and availability of

pedestrian access, the public transport system servicing the selected areas and the surrounding land use and conditions, will be conducted.

1.5.2.4 Public Park Survey

Every public park in the study area will be surveyed. The data to be collected from the surveys will include the public park environment, the maintenance of the park, the types of access to each park, the lighting conditions in the park and the apparatuses available.

1.5.2.5 Significance of Data Collected

The data collected, from both household and physical surveys, will provide insights into the neighbourhood's demographic composition, socio-economic circumstances, daily activities, residents' perception of the public parks, utilization of the parks, the residents' reasons for not utilizing the public parks in their environment and the guidelines intended to improve park use.

1.5.2.6 Secondary Sources of Data

Secondary data, for this study, will be accumulated from sources such as published and unpublished literature, documents from the Mangaung Metropolitan Municipality and GIS data of the selected areas from the years 2005 to 2019.

1.6 DATA ANALYSES

All the data collected will be checked for completeness and accuracy. Data errors and bias returns will be eliminated by cross-checking.

1.7 ANALYTICAL TOOLS AND TECHNIQUES

1.7.1 Analytical Tools

Relevant analytical tools, including software, such as SPPS, EXCEL, VENSIM, and Global Mapper, will be used for data processing, analysis and modelling.

1.7.2 Analytical Techniques

Relevant statistical techniques, which include correlation, tabulation, significance tests (F distribution and t-test for p-values), perception index (PI), variance inverse factor (VIF) tests and multiple regressions, will be used according to the requirements of the present investigation. The weighted average index method will be employed to find the residents' perception indices of the variables regarding the accidents.

1.8 MODELLING

Apart from ASA soft models, statistical multiple regression models will be developed and employed to understand the vibrancy of public parks. All the major control parameters that can influence the vibrancy of parks will be measured and quantitatively analysed before using them to build the model.

1.8.1 Validation of Model

To obtain accurate and credible results and future predictions, the model will be validated before its application. The validation will be conducted by testing the model on four other public parks, located both inside and outside the study area indicated, and by comparing the model results with the actual field data collected.

1.8.2 Simulation and Forecasting

The developed and validated model will be employed to project the average annual public park use.

1.8.3 Application of the Model

Alternative plausible simulated scenarios will be developed by employing the model; the scenarios will be used to develop feasible policy interventions.

1.9 RESULTS AND DISCUSSION

A detailed discussion of the results and analyses of primary household surveys, literature reviews, GIS surveys and public parks surveys, as well as of the simulated models, will be completed before finding plausible solutions.

1.10 INFERENCES

Plausible inferences for developing and establishing a set of feasible policies will be drawn.

1.11 STRATEGIES AND RECOMMENDATIONS

Based on the results, discussions and inferences of this investigation, a set of policy guidelines, for developing measures aimed at increasing the vibrancy of public parks and recreational facilities, will be prepared and recommended.

1.12 LIMITATIONS

The limitations of the study include:

- Only public parks and open recreational facilities in Bloemfontein city will be studied and, thus, the results cannot be generalized and applied to other urban areas in South Africa
- Time limit (D. Eng. research is time-based)
- Because of manpower constraints for conducting the survey (the researcher will conduct the investigation at the grassroots level because it will hold more advantages) and limited funding available for the research, a relatively small, but adequate, sample size will be used for the survey.

1.13 ETHICS IN HOUSEHOLD SURVEY AND SURVEY OF PUBLIC PARK USERS

The survey data will be used in many different disciplines for various purposes (Fink, 2012). By obtaining data directly from households and public park users, an investigator will be able to identify important variables more easily and accurately. When conducting public park user surveys, certain guidelines and ethics will have to be adhered to. The most important ethical guideline will be prioritizing the privacy and confidentiality of the survey responses (Fink, 2012). Anyone wishing to complete a valid and credible survey, involving public park users, will have an ethical responsibility, underlined by respect, with two fundamental requirements: (a) confidentiality and (b) informed consent. This will mean that all the participants must be fully informed of the survey's goals and their right to confidentiality will have to be respected. Therefore, recorded and attached evidence of obtaining respondents' consent to participate, together with any other relevant legal requirements for data protection, will have to be adhered to (Kelley, Clark, Brown, and Sitzia, 2003). Based on this premise, the investigator will follow strict protocols to acquire the consent to participate in the survey from the potential respondents and to inform them of the type, purpose, use and implications of the survey. The investigator will keep the respondents' responses and their identity strictly confidential. Besides anonymity, care will be taken to protect the participants against any form of risk, unusual stress, embarrassment—or loss of self-esteem—and to keep, as far as possible
any natural- or living elements and artefacts safe from harm. The sensitivity of the different attitudes, norms and cultural expectations of respondents will also be respected and appreciated by the investigator.

1.14 CHAPTER SCHEME

The thesis is organised according to the following chapters:

Chapter 1: The chapter comprises of an introduction, problem statement, objectives, scope, outline of the research methods used and limitations of the research.

Chapter 2: This chapter consists of a review of relevant literature.

Chapter 3: This chapter outlines the profile of the study area which includes: background of the study area, demographic profile, social functions, basic infrastructure, transportation, accessibility, traffic management systems and attributes of public parks.

Chapter 4: This chapter focuses on the detailed methodology used and an outline of Applied Systems Analysis

Chapter 5: This chapter is comprised of data and their representations

Chapter 6: This chapter includes the data analyses, modelling and results.

Chapter 7: This chapter discusses the findings and discussions. It also includes proposals for policy recommendations and conclusions.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

Green open spaces are essential landmarks of built-up urban environments and can contribute significantly to the development of sustainable urban areas (Byrne, Lo, and Jianjun, 2015; Coles and Grayson, 2004; Korpela, Ylén, Tyrväinenand and Silvennoinen, 2008). Organised open spaces, particularly public parks and other localities for leisure activities, have, due to their marked contribution to the viability and vitality of cities, special significance for the sustainability of cities (Ojala, Korpela, Tyrväinen, Tiittanen, Lanki, 2019).

According to some scholars, public parks and recreational areas extend a host of benefits, from many perspectives to urban areas (Lo and Jim, 2015). These include physical-, environmental-, economic- and social benefits (Hakim, Petrovitch, Burchfiel, Ross, Rodriguez and White, 1998; Hass-Klau, 1993; Jacobs, 1972; Whyte, 1988). The parks and areas can, for instance, enhance the ecosystem equilibrium of the area by maintaining the biodiversity and regulating the urban climate in cities (Heidt and Neef, 2008), reduce the energy spent through cooling systems in buildings, and also—depending on their number, quality, and distance from the source of noise pollution—lower the noise levels in crowded cities considerably (Heidt and Neef, 2008; Atiqul Haq, 2011). Besides, the spaces offer facilities for various outdoor activities and aid daily pedestrian traffic, (Hakim et al., 1998; Hass-Klau, 1993; Jacobs, 1972; Whyte, 1988).

Green open spaces, which include public parks in residential areas, assist in actualising an attractive and inviting city image and it can be argued that the city and its way of life will benefit from purposeful, good quality public parks and recreational areas (Madanipour, 2003; Van Melik, Van Aalst, Van Weesep, 2009). Moreover, public parks can serve as safe spaces for people of different races and cultures to interact and develop a better understanding and forbearance of each other's differences (Eizenberg and Cohen, 2015). To that end, the exploration of public parks and recreational spaces has become integral to the analysis of the factors which sustain the endurance of cities.

The literature study revealed studies, by various scholars, on different aspects of public parks and recreational areas in cities (Wicramasinghe and Dissanayake, 2017; Ojala, Korpela, Tyrväinen, Tiittanen, and Lanki, 2019; Salwa and Mahdzar, 2019; Zavadskas, Bausys and

Mazonaviciute, 2019). The aspects under scrutiny include, but are not limited to; physical- and spatial attributes, such as location and accessibility (Maroko, Maantay, 2009), socio-economic- and environmental contributions (Hakim et al., 1998; Hass-Klau, 1993; Jacobs, 1972; Whyte, 1988), environmental justice and equity (Boone, Buckley, Grove and Sister, 2009; Estabrooks, Lee and Gyurcsik, 2003; Wolch, Jerrett, Reynolds, McConnell, Chang, Dahmann, Brady, Gilliland, Su, and Berhane, 2011) the role parks assume in pedestrian- and vehicular traffic matters, human health benefits (Cohen, McKenzie, Sehgal, Williamson, Golinelli and Lurie, 2007), and the image a city portrays (Madanipour, 2003; Van Melik, Van Aalst, Van Weesep, 2009).

Just as elsewhere, accessibility, safety, comfort, vibrancy, and sociability are fundamental to the functioning of public parks in the residential areas of South African cities (Das and Honiball, 2016). These fundamentals, in turn, depend on several demographic-, physical-, and spatial attributes, as well as local transportation- and other traffic mechanisms, to be successful (Goličnik and Ward Thompson, 2010).

Within the South African context, little is known about the influence the fundamental forces, and the factors contributing to their success or failure, have in bringing about vibrant public parks (Landman, 2006). In the light of this, and with vibrant public parks, in demand by the community, in mind, a comprehensive study of the influence the essential elements have on the vibrancy and appeal of public parks is indispensable.

An in-depth study relating to the vibrancy of public parks requires a durable theoretical framework formulated on the findings harvested from literature, success stories, and case studies. In keeping with this premise, the theoretical framework for this study was formulated through a process of reviewing, analysing, and synthesising the data linked to the accessibility, safety, comfort, vibrancy, and sociability of parks. Other dimensions related to sustainable urban development, which have been investigated extensively by some scholars, were also included in the study (Kent and Madden, 2013; Shuib, Hashim and Nasir, 2015). The following dimensions were incorporated into the theoretical framework: the image and attributes of public spaces and parks, the configuration of public parks, the contribution of public parks to the community, the accessibility of public parks, the challenges to the vibrancy of public parks, the paradigms set in place to meet the challenges against the vibrancy of public parks and the analytical methods and models used to analyse and synthesise the assembled data (Kojima, Matsunaga and Yamaguchi, 2017).

In the past, public parks were planned as part of a broader, interconnected ‘open-space-system’ which included town squares, plazas, greenways and a variety of other types of spaces—just about anything in a city that was not a building or a road (Shuib, Hashim and Nasir, 2015). This may have left the impression that the range of benefits open spaces could bring to cities was fully understood. (Ehrlich, 1986; Sendi and Golicˇnik Marusˇic, 2012). The current conditions of public spaces and public life in most cities suggest, however, that the benefits are not fully understood at all. At the same time, the dynamic role parks can play in the resurgence of communities is also far from being understood (Kent and Madden, 2013).

According to Salwa and Mahdzar (2019), many of the urban parks of today have few activities, besides recreational ones, on offer and do not attract the elderly, teenagers, or people who are regularly just out for a pleasant time and looking for a place to sit and relax or take a walk, either. There is often not even a sidewalk, a place in the shade or an opportunity to buy a sandwich or cup of coffee available. The danger to the existence of a park lies therein that with few incentives for people to visit a park fewer people will spend time there and urban parks will lose their value to society. (Salwa and Mahdzar, 2019)

Several important steps are involved in creating parks that are valued by a community. The process of regenerating public parks starts with an understanding of a community's concerns about, and expectations of, a particular space. The next step is to determine how the assets of the community can be used to develop, both the plan, and the implementation of the plan for the park; this will lead to step three: the expression of a community's vision for the public park. (Kent and Madden, 2013)

The fourth step is to observe how the park is utilised and to assess the community’s perspectives on it. This step is key to understanding the changes required to transform a park—from a boring, unattractive, dysfunctional place—into a successful, attractive, and purposeful place: a good park.

A good park provides a range of activities that appeal to people of all ages and walks of life. Concerning *accessibility*, it should be safe and easy, for the neighbouring residents and other visitors, to get to and into the park. As far as *comfort and image* is concerned, a park should be safe, clean, pleasant and attractive and there should be enough functional amenities available. *Sociability* is thought to be the most important characteristic of the public park and, as such, the park should be central to community life: a welcoming place where people can get together and share.

The final and most essential step in this process is to implement the changes required and, thereafter, to determine the extent to which the park has increased in popularity with the community, and thereafter, follow it up with research and analysis, relating to the effect of the changes made, on park use (Project for Public Spaces, 2013).

2.2 UNDERSTANDING THE VIBRANCY OF PUBLIC PARKS

The Oxford Dictionary explains the term 'vibrant' as something, or someone, pulsating with life, vigour and/or activity. It seems fitting, therefore, to describe a public park that is serving its intended purpose as *vibrant*. A public park should be pulsating with life in as much as it constantly and regularly facilitates visits from the residents living in the area (Jabben, Weber and Verheijen, 2015). Moreover, to advance the physical and mental health of park visitors, as well as to propagate healthy plant life, a public park should be pulsating with vigour (Halper, Dall'erba, Bark, Scott and Yool, 2015). Finally, a public park should facilitate frequent, wholesome activities, for instance, physical exercise, walking the dog, playing games or sports, and social gatherings (Shores and West, 2010). It seems apparent that, unless parks are vibrant, merely having public parks in residential areas serve little or no purpose.

Although many factors contribute to the vibrancy of a public park, its vibrancy can mostly be directly related to the number of people visiting the park regularly, for instance, users per day, per month, or year. Public parks without frequent visitors are either under constraint because access is challenging, or because it is not vibrant enough (Thompson, 2002).

The availability of vibrant public parks in residential areas is fundamental to the actualisation of an attractive city image (Madanipour, 2003; Van Melik, Van Aalst, Van Weesep, 2009). Public parks in cities offer respite from crowded and busy city life and, if they are natural green spaces as well, provide places where people can touch base with nature (Dempsey, 2012). Attractive public parks can complement the architectural articulation of the surrounding built-up environments, improve the value and attraction of the surrounding residential areas, and create spaces for people to acquaint themselves with the city (Dempsey, 2012). There is a general agreement that public spaces—and in particular public parks and organized open green spaces—of quality bring about constructive, positive, atmospheres that increase the worth of the surrounding built-up environments (Punter, 1990; Vanolo 2008; Van Melik, Van Aalst, Van Weesep, 2009). Aspects related to the design of public parks and open spaces, for instance, the location, physical configuration, architectural articulation, cultural- and heritage values, and their integration into the surrounding environment, can contribute much to the well-being of people and add significance to the surrounding neighbourhoods. Ariane (2005), propose that properly planned and designed public spaces, including public parks and open

green spaces, greatly add to the aesthetic appearance of the environment and bring greater contentment with their residential surroundings to neighbouring residents (Ariane L. Bedimo-Rung, PhD, Andrew J. Mowen, PhD, Deborah A. Cohen, 2005). It can also not be overlooked that the spaces generate a restorative atmosphere that has a wholesome effect on the health and well-being of the residents. (Ariane L. Bedimo-Rung, PhD, Andrew J. Mowen, PhD, Deborah A. Cohen, 2005).

A comprehensive study by Ewing and Handy (2009), objectively measures the subjective qualities of people's views on the environment (including public parks). The study discloses five important qualities to consider namely, imageability, enclosure, human scale, transparency and complexity. The result of such an investigation can be valuable to researchers investigating walkability. The *Project for Public Spaces* (PPS) concluded its worldwide evaluations with four fundamental considerations for identifying successful public parks and recreational facilities. First and foremost is the impression parks make on visitors. Parks should be attractive and inviting and impart a sense of well-being. The other three considerations are that they should be accessible, people ought to engage in various activities, and socialising should be dynamic (PPS, 2011). Based on their research, an instrument called 'The Place Diagram' (Figure 2-1) was developed to facilitate the judgement of whether a public place is 'good' or 'bad'.

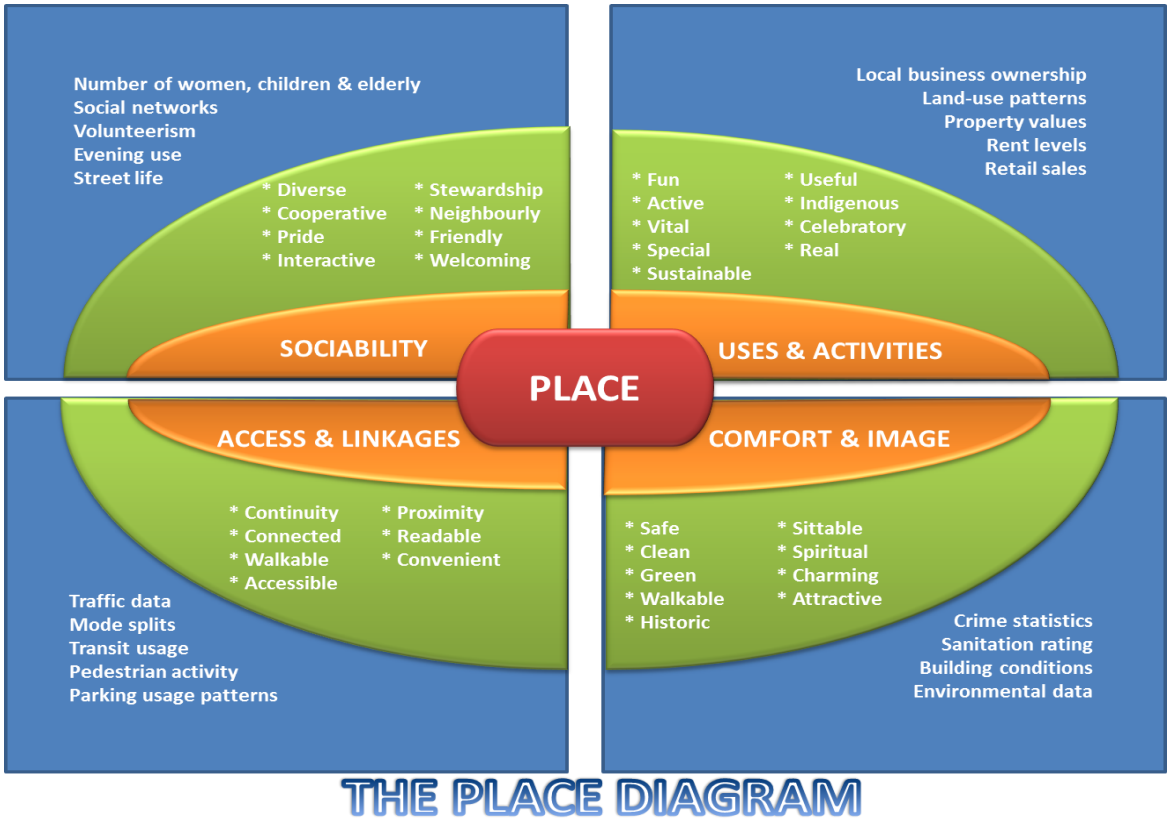

Figure 2-1: *The Place Diagram* (PPS, 2011)

As seen in 'The Place Diagram' (Figure 2-1), the centre (red) position, identified as 'PLACE' in the diagram, is a specific place, for instance, a street corner, a playground, a garden located just outside a building, or a public field (or park) somewhere in the neighbourhood.
The given place must be assessed against the four criteria namely, *access and linkage*, *comfort and image*, *uses and activities*, and *sociability*, located in the oval (orange) adjacent to 'PLACE'. The following oval (green) delineates the key attributes which influence each of the four main criteria. These are quantitative aspects that can be measured through research and statistics. Some researchers are of the persuasion that, of all the parameters under investigation, those concerning *access and linkages* influence the success of parks and open recreational spaces the most (PPS, 2011; Zhang et al., 2014). The outer perimeter of the space (blue) is important for the study of parks, in as much as investigating these factors allow for a broader understanding of the workings of a park or open space. For instance, people find it more interesting—and feel safer—when they stroll alongside allocated units of stalls or shops than when they walk past open spaces or walls.

Qualities, such as the size of the park (Giles-Corti, 2005), the presence of sports fields (Cohen et al., 2006; Floyd, Spengler, Maddock, Gobster and Suau, 2008), lanes, trails, footpaths, walkways, swimming pools, water features, shady wooded areas(Cohen et al., 2006; Kaczynski, 2008; Reed, Arant, Wells, Stevens, Hagen and Harring, 2008; Shores and West, 2008), and communal conveniences, as well as other amenities and facilities, for instance, benches, playgrounds and cafeterias (Kaczynski, 2008; Giles-Corti, 2005), also promote the vibrancy of public parks.

For a park to convey a good impression, the condition of the park, ease of access, aesthetic appeal, and safety measures should be of high standing (McCormack, Rock, Toohey, Hignel 2010)**.** The presence of litter, vandalism, and dirty or unkempt washrooms and conveniences, for example, may leave a negative impression of the park and its facilities on visitors and discourage them from using the facilities, or from visiting the park altogether (Gobster, 2002). The availability of sports facilities and arenas in parks also promote physical activity significantly (Cohen et al., 2006). The availability and condition of the attributes above, individually or in combination, allow for a park to leave either a good or a bad impression on visitors.

For public parks to become essential components in the transformation and enhancement of cities, they must change over from their current role of being, primarily, an area for recreation to be a catalyst for community development. A park and its surrounding environment can not only be a place to get to know and connect to nature, but also a place for social and cultural

exchange. A park can become alive and crammed with a wide range of activities, for instance: entrepreneurial activities, such as markets; physical activities, like children playing, or people skating, walking or jogging; cultural activities, as expressed by art and community events; or for simply spending time with friends. (Kent and Madden, 2013).

For many years, and in many cities throughout the world, parks have played a pivotal role in shaping social- and economic success. The first formal public parks, Central Park in New York City, for instance, were introduced in the 19th century. Their purpose was to be a quiet, clean and beautiful contrast to the crowded and polluted reality of city life. They have, however, over time, each become a cluster of popular localities which can each be visited separately as the destination of the day or visited along with other localities within the park as part of a day out in nature. Sailboat Pond in Central Park, New York is a good example of such a place (Kent and Madden, 2013).

To summarize: the vibrancy of a public park relates to the frequency with which the public park is visited by the people of the community, how often the public park is used for sporting activities, exercise, recreation, socializing and relaxation, and how friendly and welcoming the general attitude of the people in the public park is (Veitch, Ball, Crawford, Abbott and Salmon., 2013). This study will refer to the vibrancy of a public park as a standard of measurement: the vibrancy of a public park is directly related to the average number of people visiting the park within the context explained above.

2.3 THE CONTRIBUTION OF PUBLIC PARKS

'The measure of any great civilisation is its cities and the "measure of a city's greatness is to be found in the quality of its public spaces, it's parks and squares'

-John Ruskin

It is generally recognized that greenery filled public areas, such as public parks, provide comfortable and pleasant living environments for urban residents (Lawrence 1996; Bureau of City Planning, 2000). Public areas make physical-, social-, economic-, and environmental contributions to cities. Physically, it leaves an impression of the city which may lead to other benefits, such as, increased tourism, drawing people to city living and perhaps, even promoting investment in the city (Atiqul Haq 2011; Madanipour, 2003; Sorensen; Smit, Barzetti and Williams, 1997; Van Melik, Van Aalst, Van Weesep, 2009). Environmentally, as indicated earlier, public parks supply cities with ecosystem services which may range from the maintenance of biodiversity to the regulation of urban climate (Heidt and Neef, 2008). The presence of vegetation can reduce the energy costs incurred by the cooling of buildings,

particularly in cities with temperate climates (Heidt and Neef, 2008). Depending on their number, condition, and distance from the source of noise pollution, public parks and urban green spaces in overcrowded cities can reduce the levels of noise significantly. Public parks, through natural ecosystems, are capable of absorbing CO_2 and, as shown through research, alleviating air pollution (Bolund and Sven, 1999; Huang, Lu and Wang, 2009).

People mainly try to meet most of their recreational needs within their immediate environment (Nicol and Blake 2000). Public parks and green spaces within urban areas can provide for a maintainable share of the daily (or on every second day) outdoor recreation- or activity opportunities available (Neuvonen, Sievanen, Susan and Terhi, 2007). They serve as a close-to-home place of relaxation, offer opportunities for a wide range of activities, and can also impart emotional warmth (Grahn and Stigsdotter, 2003; Heidt and Neef, 2008; SorensenSmit, Barzetti and Williams, 1997)**.**

The proximity and ease of access of recreational facilities and amenities, evidently, also encourage participation in physical activities, like walking and running, and stress-reducing activities, such as socialising among persons of different age-, ethnocultural-, and socio-economic groups (Cummins, Curtis, Diez-Roux and Macintyre, 2007; Kaczynski and Henderson, 2007). Several studies have also established that meritorious public parks make an impact on certain health outcomes, for instance, the mortality rates in the community, and the incidence of cardiovascular disease, diabetes, and obesity (Lovasi, Quinn, Neckerman, Perzanowski and Rundle, 2008; Takano, Nakamura, Watanabe 2002). It can, therefore, be concluded that public parks offer a unique setting, within the urban landscape, where opportunities for physical activity, enjoyment of nature, social interaction, and relaxation, along with health benefits, can be found (Hayward and Weitzer, 1984 McCormack, Rock, Toohey, Hignel 2010). Consequently, the design (and redesign), of public parks and their upkeep is essential for physical, emotional and social well-being (Hayward and Weitzer).

At this time, some cities are becoming more aware of the significant contribution public parks can make to the quality of urban life (Ojala, Korpela, Tyrväinen, Tiittanen and Lanki, 2019). By integrating parks into the cultural lives of neighbourhoods and handing over the responsibility for maintenance, new programs, and, in some cases, design to the communities themselves, a renewal of parks is emerging in places where some may have thought it to be impossible to happen (James, Tzoulas, Adams, Barber, Box, Breuste, Ward Thompson, 2009).

2.4 THE CONFIGURATIONS OF PUBLIC PARKS

Open green spaces in urban areas can be categorised by function and type: parks, gardens, urban forests, nature reserves, corridors along waterways, playgrounds and other informal green areas (La Rosa, 2014). Well-designed and well-kept public parks and open green spaces add to the attraction and worth of the surrounding urban area and, at the same time, bring about a favourable impression of the city in general (Perovic and Folic, 2012). For public parks and open green spaces, regardless of type or function, to be successful, usable, and sustainable, their design should firmly adhere to the established quality standards and norms for the development of such spaces (Selmi, Weber, Rivière, Blond, Mehdi, and Nowak, 2016). Study results propose that appropriate landscaping adds significantly to the merit of public parks and the worth of the surrounding urban environment (Shackleton and Blair, 2013).

Proper landscaping reconnects people with nature and is soothing and calming to communities (Beeco and Brown, 2013). Natural elements like grass, trees, streams, and different kinds of plants, are generally recognized as important for enforcing the image of public parks and rendering them vibrant and purposeful. Natural elements also assist with formulating a proper configuration of the parks' complement to the neighbourhood (Khotdee, Singhirunnusorn and Sahachaisaeree, 2012).

The Public parks referred to in this study are open green spaces within residential areas. They are included in the municipal zone plan and are maintained by the local governing entity. Public parks may include either playgrounds, or sports facilities, or both, along with landscaping and some civic elements (Sendi and Golicˇnik Marusˇic, 2012) as shown in Figure 2-2. Similarly, playgrounds are areas in open spaces equipped with traditional play equipment like slides, swings and jungle gyms (Figure 2-3). Playgrounds may have benches for adults and may also include sports facilities (Crawford, 2008). Playgrounds can be situated in neighbourhood parks, as well as in commercial areas where children are expected to need recreation (Evenson, Jones, Holliday, Cohen, and McKenzie, 2016). The configuration of public parks vary in line with their function (such as neighbourhood parks or neighbourhood parks with playgrounds), their physical attributes, the available activities, or actual uses and has to be addressed accordingly (Sendi and Golicˇnik Marusˇic, 2012).

Figure 2-2: *Example of Neighbourhood Parks* (Universitas, Bloemfontein) (Google Earth, Accessed 2017)

Figure 2-3: *Example of a Playground in Universitas, Bloemfontein* (Google Earth, (Google Earth, Accessed 2017)

In most parts of the world safety and ease of access are important criteria for the planning and development of public parks (OECD, 2011). In developed, and even most developing nations, it is regarded as important to make public parks available in urban areas and to safeguard them. The European Environment Agency (EEA) issued a recommendation in 2007 (Barbosa, Tratalos, Armsworth, Davies, Fuller, Johnson, and Gaston, 2007) that access to public parks

should be within a 15-minute walking distance from residences in the vicinity. Many European cities already meet this standard. A UK government agency, namely the EN (English Nature), furthermore advocates that access to an urban park should be within 300m from the residences served by the park. In Israel, on the other hand, urban planners apply different scales for the park-to-person ratio depending on where the park is located. The average global scale for public parks in cities is 20m² per person.

2.5 SOCIABILITY OF PUBLIC PARKS

The degree of *sociability* of a public park is one of the four major determinants for a good, vibrant public park. A vibrant park can to some degree be recognised by the social interaction among the people in that park (PPS, 2014). The interaction can be planned or spontaneous and create a sense of belonging and attachment to their community (Abercrombie, Sallis, Conway, Frank, Saelens, and Chapman, 2008).

A public park merited with good sociability should be characterised by diversity, cooperation and interaction between users, an inherent sense of pride, stewardship of the park shown by the homeowners in the neighbourhood, and an atmosphere of neighbourliness (Sakip, Akhir and Omar, 2015).

2.5.1 Questions to Consider on Sociability

Some important questions, relating to the degree of sociability evident in a public park, can be summarized as follows:

- Is the public park merited as one where people feel comfortable to meet and greet?
- Are groups and/or individuals found socializing and communicating with one another?
- Are the people familiar with one another? Do they know or recognise each other?
- Is there a sense of interest or pride, bringing people to the park?
- How friendly are the people in the park and do they smile and make eye contact?
- Are the parks visited by choice and regularly?
- Is the attendance a true reflection of the average age- and ethnic groupings in the community?
- How clean is the park being kept?

(Sakip, Akhir and Omar, 2015; Nathanail, Adamos and Gogas, 2017; Ojala *et al.*, 2019)

2.6 ACCESSIBILITY OF PUBLIC PARKS

One of the important aspects of public parks and recreational facilities emphasized in the literature, is *accessibility*. Accessibility is essential to the success of public parks (PPS, 2011;

Setyowati, Harani, and Falah, 2013). It has been well documented that access to public parks and natural settings can be associated with the improved physical and mental well-being of people (Payne, Orsega-Smith, Roy and Godbey,2005; More and Payne, 1978; Potwarka, Kaczynski, Flack 2008; Sugiyama Leslie, Giles-Corti and Owen, 2008). Compared to people who don't visit public parks regularly persons who do are more likely to maintain physical activity and well-being (Deshpande, 2005; Giles-Corti et al., 2005). There is some evidence that difficult access to and long distances away from parks and open spaces are associated with fewer visitors and little physical activity in the parks (Kaczynski and Henderson, 2007).

According to 'The Place Diagram', park access for residential populations in a city is generally based on the spatial configurations of parks, the number of parks, and the spatial distribution of parks across neighbourhoods or local regions (PPS, 2011). It is, therefore, general practice to plan access to parks around the way the proximity, locality and dimensions of the parks contribute to the use of the parks (Zhang *et al.*, 2014). Besides, according to the PPS model, the accessibility of a place is determined by its links to its surroundings. A successful public park has to be accessed and traversed with ease and must also be visible from both far away and close by (Reyes, Páez and Morency, 2014). The general agreement is that the more the local parks are within walking distance of residential areas, the better the parks will be utilised. It is also recognised that the requirement of having to drive a distance to reach a park often discourages park visits (McCormack, Rock, Toohey, Hignel, 2010; Wilbur, Chandler, Dancy, Choi, Plonczynski, 2002,), even though other park attributes, for instance, safety and location, may override the weight of proximity.

Some scholars argue that the distance, or the time it takes to walk from home to the park, is the single most important precondition for accessing and making use of green spaces (Luoma and Peltola, 2013; Wang, Brown and Liu, 2015; Herzele and Wiedeman, 2003). Easy access and short distances to public parks lead to more visits to parks and it seems that people, living close to green spaces, access and utilize them more often than those who live further away (Atiqul Haq 201; Herzele and Wiedeman, 2003; Neuvonen, Sievanen, Susan and Terhi, 2007, Atiqul Haq, 2011). A study in Helsinki, Finland, for example, found that people living close to public parks (<0.5 km) visited the parks or green spaces more often than four times a week (Neuvonen, Sievanen, Susan and Terhi, 2007; Atiqul Haq, 2011).

Some scholars believe that public parks, or green spaces, should be in the centre of neighbourhoods and not more than five minutes' walk away from home, for most of the residents, and from public buildings or shops (Cohen *et al.*, 2010; Veitch *et al.*, 2013; Sarkar *et al.*, 2015). If one travels to a public park by bicycle, the route should be passably short and

have few obstructions along the way (Atiqul Haq 2011). Some countries have set stipulations for the placement of accessible public parks. Britain, for example, requires that accessible public parks (or natural green spaces) should be situated within 300 meters of homes and that the (statutory) dimensions of local nature reserves should be a minimum of one hectare per thousand people. It also states that a 20-hectare site should be positioned within two kilometres, a 100-hectare site within five kilometres, and a 500-hectare site within ten kilometres of homes (Moughtin and Shirley, 2005; Atiqul Haq, 2011).

Individual attributes of a park may affect the utilisation of the park on-site or within the neighbourhood. Dog-owners, for example, could be looking for a place to walk their dogs (Cutt, Giles-Corti, Wood, Knuiman and Burke, 2008), while people wishing to visit pools, with specified hours of operation, within the parks (Tucker, Gilliland, Irwin, 2007), will access and make use of the parks according to their individual requirements.

The availability of public transport was also identified as an enabler for park access as it is always associated with some physical activity for some people in addition to providing accessibility to the park (Day, 2008, p. 306). Parks and playgrounds on regularly traversed routes were accessed and used more often than those located elsewhere (Ferre´, Guitart, Ferret, 2006; McCormack, Rock, Toohey, Hignel, 2010).

Assertions have been made that the rapid increase in the number of vehicles on the roads has affected the accessibility of public parks in cities to a large extent. The absence of cycle lanes and sidewalks, linking residential areas to parks and recreational facilities, as well as insufficient parking facilities near public parks and recreational facilities, complicate the accessibility of parks and open recreational areas in cities (Nevhutanda, 2007). At the same time, pedestrian safety, considering the accessibility of public parks, is a leading concern. Pedestrian safety depends largely on the design features of the roadway but is affected just as much by the design of the land conjoining the road (Nambuusi, Hermans, Brijsa, and Wets, 2010). Regardless of the allocation of the land, a case is made for the design of the roadway to go hand in hand with the design of the open spaces bordering on it (Nambuusi *et al.*, 2010). The planning for land allocation should include facilities and services that ensure uninterrupted and safe pedestrian walkways that facilitate access to public parks (Guo, Wang, Jiang and Bubb, 2012; Luoma and Peltola, 2013).

According to Morency, Paez and Galfan (2013), a public facility and, more to the point, the area serviced by the facility, is equal to the accessibility of the facility. In other words, the road- and traffic networks around the facility, is a measure of the accessibility of the facility (Morency,

Paez and Galfan, 2013). The accessibility, in the case of a public space, such as a public park, is accordingly, associated with the effort it requires to reach the space using public transport, private transport, or the infrastructures provided for pedestrians. A public park set close to a busy road may draw passers-by in addition to the people who live close to the park (Cohen *et al.*, 2010; Dempsey, 2012). In addition to these features, accessible public parks and recreational facilities also have high parking requirements (PPS, 2011). The other relevant aspects concerning the accessibility of public parks and recreational facilities to consider are: the visibility of the park—from a distance, as well as from close by—and inside the park, the vibrancy of the park, the provision made for people with special needs—ramps, handrails, signboards, wide doorways and ablution facilities—and the availability of convenient transportation departure points close to prominent social and civic elements, for example, park entrances, libraries, post offices, shopping centres and more (Veitch *et al.*, 2012; Project for Public Spaces, 2013).

For the sake of simplicity, the accessibility properties of public parks have been divided into three categories: physical access, visual access, and symbolic access (Sendi and Golicˇnik Marusˇic, 2012).

2.6.1 Physical Access

Physical access refers to how people enter and exit a public park. Physical access requires proper linking between the park and neighbouring residential areas (Sendi and Golicˇnik Marusˇic, 2012). and access for all persons, but particularly for children, the elderly, and persons who have physical limitations, should be made as easy as possible. Access points should be void of any obstruction that prevents access to a public park. It is possible, however, that the number of residents in the neighbourhood and the movement of traffic in the vicinity of the park may influence accessibility which, in response, may affect the layout of the park (Dempsey, 2012), and ultimately result in inadequate accessibility.

Walkability has to do with a means of access for pedestrians and refers to the suitability and attraction of the built-up pathway and its environment (Talen, Allen, Bosse, Ahmann, Koschinsky, Wentz and Anselin, 2016). Simply put, it is a route connecting a point of departure and a destination within a designated area (Moudon, Lee, Cheadle, Garvin, Johnson, Schmid, Weathers and Lin, 2006). Southworth (2005), noted that the six fundamental attributes of walkability are: the network of links, connectivity, patterns, safety, quality, and context related to pathways.

The concern in the field of medicine for the overwhelming escalation in obesity among the population has recently led to an increasing number of studies investigating the relationship between built-up walkways and functional walkability. This relationship has become a growing field of interest in multi-disciplinary studies (Babb and Curtis, 2015; Ewing and Cervero, 2001; Saelens and Handy, 2008; Todes et al., 2010; Heath, Brownson, Kruger, Miles, Powell and Ramsey, 2006; Leslie, Saelens, Frank, Owen, Bauman, Coffee and Hugo, 2005; Saelens, Sallis and Frank, 2003). The concern for deteriorating levels of physical activity that lead to health issues, such as obesity, type two diabetes, and metabolic syndrome, all leading to higher mortality rates, as well as mental health problems, for example, depression, is now a global phenomenon (Hillsdon, Panter, Foster and Jones, 2006). Therefore, it is important to encourage participation in physical activity: an active lifestyle is known to have positive effects on health (Shores and West, 2010).

The follow-up research on questions derived from the analyses of other studies related to walkability is considered to be insubstantial compared to what is called for, but there has been an increased interest in the matter in the fields of urban planning, geography, psychology and public health over the last decade (Brownson, Hoehner, Day, Forsyth and Sallis, 2009), (Brown, Morris and Taylor, 2009; Lo, 2009; Southworth, 2005).

The number of available walkways, and the extent to which they are structured to meet the needs of pedestrians, should be appraised clearly and objectively (Saelens and Handy, 2008). The outcomes of the assessments may play a decisive role in the planning and design of motorways and give some precedence to sidewalk improvement (Landis, Vattikuti, Ottenberg, McLeod and Guttenplan, 2001). Published studies suggest that the extent of service to pedestrians will usually serve as the approach for assessing walkability (Tanvir, Hossain and Idris, 2016). Many of the factors and attributes affecting pedestrians and the environment are qualitative and difficult to measure. Therefore, it can easily be excluded in the computation of the level of service. A good example can be found in the Highway Capacity Manual (Transportation Research Board, 2010) which provides thorough information regarding the factors affecting the level of service to pedestrians, but then lacks the proper guidance to identify the contribution of each factor to the overall level of service (Muraleetharan, Adachi, Hagiwara, Kagaya and Member, 2000).

The obvious difference and memorable value of a place are described by imageability; this aspect is made personal by the sociocultural- and environmental background of individuals (Ehrlich, 1986; Sakip, Akhir and Omar, 2015). Enclosure refers to the perception of space within the physical environment and can be influenced by elements obstructing the line of

vision (Joffe and Smith, 2016). Additionally, human scale is the proportion of buildings or spaces to human bodies. The example given by Ewing and Handy (2009), illustrates how pedestrians can be discomforted and disorientated simply by larger road signs that are designed for high vehicle speeds. Transparency explains how pedestrians perceive some physical elements and human activities further away than the edge of a street, such as the openings between buildings, walls, windows, signs, and landscaping. The combination of various elements in the physical environment is defined as the quality of complexity and is listed by Ewing and Hardy (2009) in order of significance namely, the number of people, the number of ascendant building colours, the number of buildings, the presence of outdoor dining facilities, the number of distinctive colours and the number of public art pieces. Unfortunately, the results of their study may not apply to every setting, because it was limited to streets where commercial activity takes place only.

In one of several systematic reviews of walkability studies, and how to measure it, Saelens and Handy (2008) found that there are consistent positive relationships between density, walking, distances to non-residential destinations, transportation, and land use mix. Furthermore, with walking, there is a significant correlation between sidewalks for pedestrians and connectivity (Saelens and Handy, 2008).

Maghelal and Capp (2011), by reviewing existing pedestrian indices and using GIS, found built-up environment variables associated with walking that could be measured objectively and found that only 13 out of 25 pedestrian indices used variables allowing for objective measurement. Maghelal and Capp (2011) compiled a standardised list of objectively measured variables to quantify walking and indicated that various indices quantified the same built-up environment, by using different measures, through GIS.

The historical lack of available technology to support these studies shows that the traditional methods, used to measure and analyse the effect of the built environment on walking, were either conducted audits, or self-measured environmental correlations. Using GIS together with the rapid improvements in technology enable and encourage researchers to identify, collect, store, compare, simulate, evaluate, analyse and apply data at a separate component level (Lee and Moudon, 2006; Moudon, Hess, Snyder and Stanilov, 1997; Rodríguez, Khattak and Evenson, 2006).

It has become a principal rule to apply macro- and micro design factors to the approach of assessing a pedestrian environment. Relevant to its boundaries, the macro design factors include origin, destination, distance, density and land use (Kim, Park and Lee, 2014), whereas

the micro design factors relate to the range from sidewalk width to amenities at street level (Kim et al., 2014).

Thus far in any relevant research, the sources of reference and the available literature explaining and evaluating the tools to measure the categories above, cannot be overlooked. When considering sidewalk- and walkability assessment tools to improve the microscale factors influencing walkability in a neighbourhood, it is, therefore, worth mentioning the studies of Aghaabbasi, Moeinaddini, Zaly Shah, and Asadi-Shekari (2017). Giles-Corti, Macaulay, Middleton, Boruff, Bull, Butterworth, Badland, Mavoa, Roberts and Christian (2014), on the other hand, looked at the development of an automated geospatial tool by taking both the intra- and inter-neighbourhood walkability into consideration. Frackelton, Grossman, Palinginis, Castrillon, Enlago and Guensler (2013) generated spatial sidewalk inventories for assessing the quality of sidewalks, and to prioritise repairs automatically, by using an Android application. Smith, Malik, and Culler (2013) developed computer techniques that enable visibility and information in street view images. Many studies promote: (1) the use of *Walk Store*—an online tool used to measure and evaluate neighbourhood walkability based on distance and connectivity metrics—(2) the value of GIS indicators in their assessments and (3) the importance of objective and subjective assessments of the physical environment (Frackelton et al., 2013).

2.6.2 Visual Access

The visual access of a PS refers to the visual connection a user has with the public park when heading towards it. As proper visibility is required for safe navigation towards the public park, visual access furthers the safety of the user. Not only must a public park be easily seen by its users, but visibility for the users, when accessing, as well as when traversing, the public park must be ensured (Sendi and Golicˇnik Marusˇic, 2012).

2.6.3 Symbolic Access

Symbolic access to public parks is becoming increasingly important for defining the full spectrum of the accessibility and vibrancy of public parks (Brorström, 2015). Symbolic access to public parks can be defined by the range and quality of signs and markings that share information, pertaining to who and what is welcome, or who and what is not welcome in the park, with prospective users (Sakip, Akhir and Omar, 2015). These markings and signs can also be elements such as structures, landmarks, monuments, sculptures and more. Public display areas and programs, for example, pavilions, galleries, and other theme objects, can also be features contributing to symbolic access. The visibility of park users: groups, teenagers, the elderly, small children, dog walkers and the like, as well as of maintenance

workers and security staff, is also an important contributor to the symbolic access of public parks (Sendi and Golicˇnik Marusˇic, 2012).

Factors, like the location, size, physical access, pedestrian facilities, availability of different modes of travel, safety, and visual access—for example illumination and visibility—symbolic access—for instance structures, landmarks, monuments, sculptures and so forth—all require keen consideration when planning the accessibility of public parks (Ngesan, Karim and Zubir, 2013).

2.6.4 Questions relating to the Accessibility of Public Parks to Consider

Some important questions to consider which emanates from the literature and which relate to the uses and activities existing in a public park can be summarized as follows:

- Can people walk from their homes to the nearest public park without having to walk in the road?
- Can the elderly and people in wheelchairs commute to the park with ease and without being confronted by obstructions and barriers?
- Can pedestrians walking to the park see it from a fair distance?
- Are the routes leading towards the park dangerous because of busy traffic?
- Are there enough routes, from all around the park, leading towards the park?
- Is there enough parking space for vehicles near the public park?
- Are there any abnormal physical barriers prolonging a pedestrian's journey to the park?
- Are there any obstructions or detours extending the route to the park?
- Are the access points and park information boards clearly visible and easy to find?
- Are there distinct pathways for easy access and movement towards and between all the areas of interest in the parks?

(Thompson, 2002; Maroko, 2009; Sarkar *et al.*, 2015)

2.7 USEABILITY AND ACTIVITIES OF PUBLIC PARKS

Activities are the basic building blocks of vibrant public parks. Activities are the reasons people visit parks in the first place, and why they return in the second place. Activities are also the reasons for a place being special or unique. When there is nothing to do in a public park, it will sit empty and unused (Byrne, Lo and Jianjun, 2015; Taylor and Hochuli, 2017).

2.7.1 Principles to Keep in Mind when Evaluating the Uses and Activities of a Place

The more the activities available for people to participate in the better.

Concerning the gender of people visiting the parks, there is very little distinction to be made between men and women visitors. People of different ages make use of the space and the space can be used throughout the day. A space that is used by individuals and people in groups is better to have than one that is only used by individuals, because it encourages socializing (Haq, 2011; Joffe and Smith, 2016; Uysal, 2016).

2.7.2 Questions to Consider on Uses and Activities of Public Parks

Some of the important questions, relating to the uses and activities to engage in in a public park, to consider are as follows:

- Is it merely an empty space or is it being utilized?
- What are the age ranges of the people using it?
- Is the empty space being used by groups or individuals?
- Is the empty space being utilized for a range of activities, e.g. organised leisure such as playing chess or a sport, or taking part in informal activities, for instance walking, reading and relaxing?
- Are some of the sections or areas in the park made use of more frequently than others; are certain areas not being used at all, or are all areas utilized equally?
- Does the park provide a selection of activities for people to engage in?
- How well is the space being maintained and can visitors relate to the person or entity managing the park?

(Thompson, 2002; Maroko, 2009; Sarkar *et al.*, 2015)

2.8 IMAGE AND COMFORT ASPECTS OF A PUBLIC PARK

One of the key factors for the success of a public park is image and comfort which can generally be understood in terms of cleanness, safety and the availability of comfortable seating (Ngesan, Karim and Zubir, 2013; Sakip, Akhir and Omar, 2015). The value of providing visitors with comfortable seating is largely underestimated.

Some of the most important questions to ask when considering the comfort and image of a public park can be summarized as follows:

- Is the initial impression of the park positive?
- What is the ratio of male to female users?
- Is there a choice between seats in the sun or shade and are the seats easily accessible?
- Are the parks well maintained and kept clean? Who is responsible for the maintenance; how and when is it done?

- How is the park being managed to secure the safety of its users and at what times?
- Is the park photography friendly and are people making use of it?
- In what way does vehicular traffic influence pedestrian access to public parks?

(Thompson, 2002; Maroko, 2009; Sarkar *et al.*, 2015)

2.9 RESIDENTIAL PUBLIC PARKS OF SOUTH AFRICA

Thus far, the concept of public parks has been discussed in a global context. Although public parks across the world share common attributes, public parks in South African cities have unique and complex attributes, contributing to their functionality, which will be discussed in this next section.

Public parks in South Africa were mainly designed and developed by using conventional design and planning standards (Nevhutanda, 2007). Just as in most other countries, a public park can be found within 1 km of a residential dwelling. The reality is, however, that most of the public parks in the residential areas of South African cities are underutilised and deemed as dead spaces (Dingaan and Du Preez, 2013). Due to this underutilisation, the public parks in residential areas have become dumping sites: unattractive, dangerous, and useless to the communities in their vicinity (Dingaan and Du Preez, 2013). The value of public parks to communities in South Africa are not yet fully appreciated, and as such, municipalities have started rezoning public parks into commercial centres and residential complexes (Landman, 2006).

The underutilisation of public parks in South Africa is a unique problem, mainly because of the significant combination of historical and current affairs. Because of these unique and complex factors, keeping open spaces relevant in the current urban transformation process, being what it is, is a challenge (Albers and Olwoch, 2010). The transformation, which has been taking place since 1994, along with the consequent identification of new needs and the establishment of applicable new systems, requires new legislation. This social- and economic transition, combined with constraining influences, also necessitate intense adjustments, such as settlement planning, new investments, the relationships among various government departments, and the financial capacities of the relevant parties.

To stay in touch with the rest of the world, communities in South Africa will have to adjust, modify and improve the existing infrastructures and facilities (Landman, 2014), and for the communities (rich or poor) in South Africa to develop into more sociable and welcoming

communities, urban elements, such as public parks and the reasons for their not serving their purpose effectively, will have to be addressed.

In Johannesburg—the largest city in South Africa—which often serves as a model for urban planning guidelines, the design guidelines for public green spaces is 20m² to 40m² per-capita, but distance and accessibility are not mentioned in these guidelines (Johannesburg Open Space System, 2002). It is important, therefore, to investigate the relevance of the influential factors, not currently included in current policies and guidelines, that may yet contribute to the vibrancy of public parks.

The key policies, relevant to primary open spaces, that have been identified at the provincial level of the South African government are the Development Guidelines for Ridges (GDACE, 2001) and the Red Data Plant Policy for Environmental Impact Evaluations (GDACE,2001b).

Upon reviewing the relevant policies relating to open spaces in South Africa, it became clear that the protection of primary open spaces is inadequate and that possibly the most effective mechanism to protect it is to have it declared a protected area under the Protected Areas Act, 2003 (Act No. 57 of 2003). Furthermore, in order to determine the type of declaration most suited to the inclusion of a primary space within the system of protected areas, a set of criteria for open spaces must be developed. Decision making will then be based on the criteria related to the type, function and management of these open spaces (STRATEGIC ENVIRONMENTAL FOCUS, 2004).

Key fundamental factors included in the criteria are:

- Ecological viability or ecological integrity
- Illustrative in terms of South Africa's biodiversity
- Inclusion of characteristic ecosystems, habitats or species
- Inclusion of rare or threatened species
- Vulnerability/ ecological sensitivity/ resilience
- Provision of environmental goods and services, both direct and indirect
- Sustainable uses
- Suitability as a nature-based tourist destination
- Primary open spaces under development pressure: where management of the interrelationship of environment and development is required
- Contribution to human-, social-, cultural-, spiritual- and economic development

- Need for rehabilitation and restoration of a degraded or threatened ecosystem (Thompson, 2002; Maroko, 2009; Sarkar *et al.*, 2015).

Not all the key criteria mentioned above apply to public parks in the residential areas of South African cities. Perhaps the only criterium that applies to all the public parks in South Africa, is the contribution to human-, social-, cultural-, spiritual-, and economic development (Albers and Olwoch, 2010). As stated earlier in this chapter, public parks are essential for human-, social-, cultural-, spiritual-, and economic development. For this reason, defences for the protection of public parks in residential areas should be raised. Having a public park protected by law, however, will still not improve the vibrancy of parks or promote frequent visits to public parks in the residential areas of cities (Krishnamurthy and Desouza, 2015).

In 1994, the beginning of a new democratic system introduced many challenges to the overcoming of the racially defined backlogs of public service and to providing and creating new residential areas (Wilkinson,1998). The current government embarked on a motivated housing programme, but this was hindered by the influx of new residents into urban areas (Gilbert, 2004). A high post-apartheid priority was the provision of housing—at the lowest possible cost—to the poor and previously homeless (Gilbert, 2004), now known as the Reconstruction and Development Programme (RDP) and referred to as RDP houses. These houses were reserved for the indigent, as listed and provided by local governments, and were mostly single-storey buildings and 40m² in size. Creating and developing formal public parks in RDP residential areas are still relatively limited in most towns (McConnachie and Shackleton, 2010).

South Africa faces unique urban developmental issues which cannot be properly addressed by using universal design standards and guidelines (Wicramasinghe and Dissanayake, 2017). A more comprehensive and deeper understanding of the workings of the public parks, found in the residential areas of South African cities, is needed to solve the current dilemma of public parks that are almost completely devoid of vibrancy.

As highlighted in chapter 1, the use of modelling—which will be further described in chapter 4—will be implemented in this study. The next section of this chapter will discuss the existing modelling approaches for assessing public parks.

2.10 EXISTING MODELLING APPROACHES FOR ASSESSMENT OF VIBRANCY OF PUBLIC PARKS

The literature revealed that several approaches, techniques and models have been used to assess the success of public parks (Grady and Ramírez, 2008; Potwarka, Kaczynski, Flack, 2008; De Oliveira and Lessa, 2017; Iwan and Małecki, 2017). Some of the models which have been used readily are census tract models, proximity models, service area analysis models and Geographic Information Science (GISc) frameworks, in combination with various statistical techniques. In order to understand the suitability, implications and limitations of each model, before choosing or establishing a model/models for the current investigation, a brief review and discussion of the different approaches and models are added here:

2.10.1 Census Tract Model

The census tract model has the accessibility aspect of public parks as its focal point. The census tract model examines/analyses the four dimensions of accessibility from a tract to public parks, namely the number of public parks, the area of the public parks, the number of facilities in the public parks, and the number of different accessibility facilities from a tract. This model can easily be adapted to densely populated cities and is based on the number of people living in a tract (certain zone) surrounding an open space, as well as the cultural- and racial compositions of these people. Scenarios of three different attributes can be generated by using this model. The first scenario can reveal the distribution of park measures, park characteristics and socio-demographic characteristics of the tracts (Bancroft, Joshi, Rundle, Hutson, Chong, Weiss and Genkinger, 2015). It also examines the correlation between socio-demographic characteristics of a neighbourhood and the availability of parks, park facilities, areas of parks, safety, and pollution in parks (Weiss, Purciel, Bader, Quinn, Lovasi, Neckerman, and Rundle, 2011)(Weiss *et al.*, 2011).

The census tract model only looks at the accessibility aspects of public parks and does not take any other aspects or factors into consideration; in so doing, it prevents this model from providing a holistic understanding of public park vibrancy.

2.10.2 Proximity Models Using a Gravity Potential Expression

Proximity models assess the physical distance that needs to be travelled to a point of interest. Proximity models have been used to analyse public parks in the light of potential visitors (Maroko, 2009).

Proximity models are based on the number of services weighted by their distance from a specific location and then adjusted for the friction of distance (Sister, Wilson, and Wolch,

2007). Using a gravity potential expression, these models make use of different indicators to investigate the role of distance to public parks on accessibility to public parks. These indicators can be divided into the following two classes: simple distance indicators (SIs) and proximity indicators (PIs). SIs measures the number of people situated at predetermined fixed distances from each public park accessible to them; quantify the number of users at the predetermined fixed distances from each public park and weigh them with their distance from the public park. This is seen as a gravitational model. Geometric centroids are used as origin places in the model and census tracts are used as destination places (La Rosa, 2014). The indicators are calculated by making use of two types of distances: Euclidean distance and road network distance based on Dijkstra's algorithm (Zhu and Zhang, 2008).

This model, therefore, uses a set of indicators that can be used in the planning of public parks by highlighting the pros, cons and limitations of their use (Talen *et al.*, 2013). The rating of accessibility of public parks can vary depending on the indicators used (Riva, Gauvin, Apparicio and Brodeur, 2009). By finding the right variables (indicators) and applying them, in the same way as the proximity model, one will be able to provide local municipalities and governing bodies with a proper base from which to develop the policy interventions needed to create more functional public parks.

Like the census track model, proximity models do not take all the factors contributing to vibrant public parks into account and is limited to improving only accessibility-related aspects of public parks.

2.10.3 Service Area Analysis Models

Accessibility to public parks, in terms of distribution and potential inequalities, is evaluated by using a service area analysis. Service area analysis models establish a baseline measure of public parks accessible to users within a pre-determined distance (Boone *et al.*, 2014). This method of analysing existing public parks is a combination of a proximity model and some of the methods used in the census tract model. These models make use of data collected from systematic observation and interviews with users. The perception, preferences and barriers, as obtained from the data collection, can then be analysed. The model is largely focused on the influence of the gender- and socio-economic aspects of the users' experience of public parks. Models such as these, however, require both qualitative and quantitative data to work effectively (Wright Wendel, Zarger and Mihelcic, 2012).

2.10.4 Geographic Information Science (GISc) Approach

The analysis and quantification of accessibility also rely on Geographic Information Science (GISc) frameworks. Two of the most frequently used GISc approaches include the container approach (Talen and Anselin 1998), and network analysis. These approaches concentrate on accessibility based on various measures of proximity, walkability, and park density (Miyake, Maroko, Grady, Maantay, and Arno, 2010). In these methods, the populations with greater access to parks are compared to those with lesser access to parks in terms of demographic characteristics (Miyake, Maroko, Grady, Maantay, and Arno, 2010).

The container approach is the most straightforward method for determining proximity. In this method, a spatial aggregation unit (postal ZIP-codes, census tracts, etc.) is selected as the resolution for aggregating population demographics. A population living within each aggregation unit is considered proximate and is, therefore, assumed to have access to those parks located within or intersecting the aggregation unit boundaries. Correlations between the total number of parks per areal unit (park density) and various population characteristics can be estimated for the chosen unit of aggregation (Miyake, Maroko, Grady, Maantay, and Arno, 2010). This can, however, be problematic, because it assumes that a park intersecting an aggregation unit implies proximity which is not always a valid assumption. The container approach has limited validity for areas with heterogeneously distributed populations or aggregated units of different sizes. It, for instance, does not reckon the residents living across the street from a public park as part of the population with access to that park, because there may be a boundary between those houses and the park. It may, however, to the contrary, consider a park located at one end of an aggregation unit, as being accessible to residents living at the opposite end of the aggregation unit, notwithstanding that it is reasonably accessible to the people on the other side because of the size or configuration of the aggregation units (Miyake, Maroko, Grady, Maantay, and Arno, 2010).

A Network Analyst tool in a software application, such as ArcGIS, can also be used to analyse public parks. The analysis, however, excludes non-walkable features, i.e. highways and railroads, in order to maintain a more realistic representation of walkable routes (Miyake, Maroko, Grady, Maantay, and Arno, 2010), rather than defining park access in terms of a ‘reasonable walking distance’. This is an important consideration, because walking, or any other equivalent non-vehicular mode of transportation, is the most widely used mode of transportation across age, ability, and status (Moore, 2008; Nicholls 2001; Wolch 2005). The other limitation of the application is that it does not attempt to evaluate the environmental conditions which affect users’ perception of park access routes to parks, or the usability of

parks (Loukaitou-Sideris 2006; Miyake, Maroko, Grady, Maantay, and Arno, 2010), following the identification of parks within walking distance of individual residences.

2.10.5 The System for Observing Play and Recreation in Communities (SOPARC)

The System for Observing Play and Recreation in Communities (SOPARC) is a reliable conceptual model for assessing the physical activity (such as that seen in public parks) in community settings (Veitch *et al.*, 2012). The model aims to develop new tools to examine physical activity and the contexts wherein it occurs. Community parks contribute to physical activity but measuring the activity and its associated variables is challenging, because the area contexts change, and the numbers and characteristics of users differ.

The SOPARC model was developed and tested by observing 16,244 individuals in 165 parks. Reliabilities included 472 simultaneous measures by independent observers.

Correlations between observers on the number of area participants were 0.99 for female and male park users. Reliabilities (i.e. agreement percentage) for age (89% females, 85% males); race/ethnic (80% females, 82% males); and activity level (80% females, 88% males) groupings met acceptable criteria. Reliabilities for area contexts (i.e. usable, accessible, supervised, organized, equipped) exceeded 94%.

The SOPARC tool is, therefore, a reliable and feasible instrument for assessing physical activity and the associated contextual data in community settings (McKenzie, T.L., Cohen, D.A., Sehgal, A., Williamson, S. and Golinelli, D., 2006) The SOPARC tool, however, is not useful for assessing the causes of the increase or decrease of public park users overall. For this study, to achieve its outcomes, a tool which concentrates more on the factors which increase user numbers in public parks is required.

2.10.6 The F-F Framework Used in Analysing Parks

The F-F Framework process of modelling generally uses methods of statistical comparison (e.g. descriptive statistics and correlation analysis) and parallel observation between groups (due to a large difference in sample sizes between the government respondents and the other groups). Thereafter the F–F framework (Chan, Peters and Marafa, 2015) (Figure 2-4) and the F–F grid is plotted. The familiarity–favourability spot as perceived by residents is in the zone of a ‘challenging brand’. Even potential visitors have a more challenged F–F condition. (Chan, Peters and Marafa, 2015) The F-F Framework process of modelling draws relationships between people’s perception and the physical attributes of public parks which assist in understanding the value of each physical attribute.

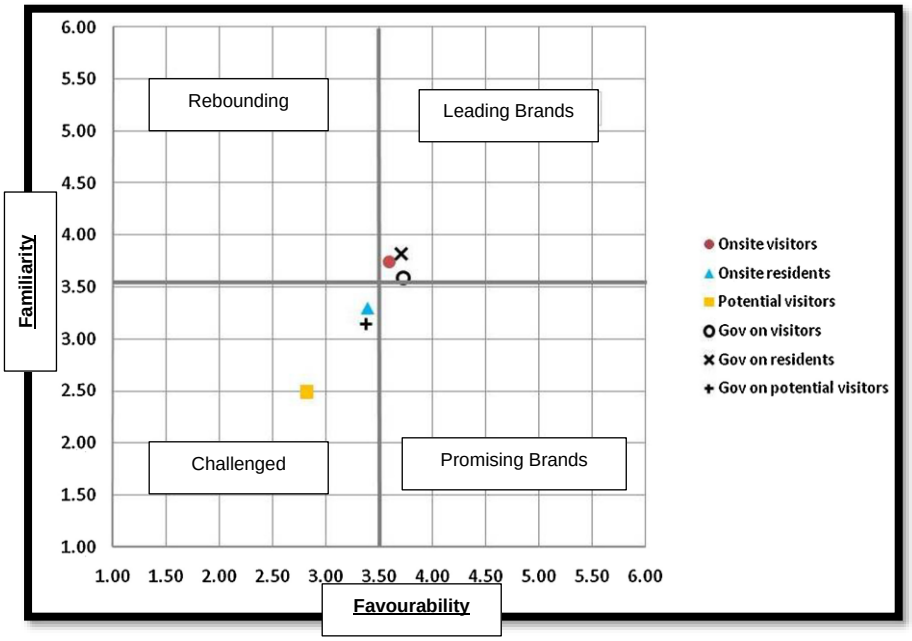

Figure 2-4: *Example of Familiarity–Favourability* (F–F) Grid (Chan, Peters and Marafa, 2015)

A major limitation of this modelling method is the use of general statements to represent a possible multi-dimensional entity, i.e. familiarity and favourability may be extended to include more dimensions. In a city where an official brand is unavailable, the measurement of familiarity and favourability should be based on the type of resource or theme under research. Another shortcoming lies in the convenience sampling method of the online survey (Chan, Peters and Marafa, 2015).

2.11 SYNTHESIS, DISCUSSION AND CONCLUSION

The need for recreation is increasingly recognised as an important and vital aspect of residential neighbourhoods (Veitch, Ball, Crawford, Abbott, and Salmon, 2013). This need for recreation, in turn, requires that residential neighbourhoods have public parks and open spaces where residents of the neighbourhood can effectively partake in recreational activities (World Health Organization, 2013). Public parks meeting their purpose will then ensure that the residents of the neighbourhood enjoy a healthy physical and social lifestyle (Arianeg, Andrew, Deborah, 2005). Public parks must, therefore, be carefully planned and placed within residential areas to ensure adequate open and free recreational facilities for the various users in the area (Szeremeta and Zannin, 2009).

Although older, established residential areas in cities, including those in South Africa, normally have enough public parks to service the area, new developments, the rezoning of land and

socio-economic transformation brought great change to the older established residential areas. Along with the transformation happening in and around older, established residential areas, public parks in new developing residential areas are still being planned and positioned using conventional methods. The changes, brought about by the transformation, seem to have affected the accessibility of public parks negatively and have consequently become barriers against successful park use (BenDor, Westervelt, Song, and Sexton, 2013; South Africa's Transport Network, 2013).

2.11.1 Access and Linkages

It has been proven that accessibility is one of the major determinants of the effective usability of public parks. Regarding the accessibility of public parks, three types of access, namely physical-, visual-, and symbolic access are generally considered. Spatial accessibility (proximity), the locations, and sizes of parks, also contribute to the usability of parks. It has been argued that a successful public park should be easily accessed on foot or by vehicle, as well as be clearly visible from a distance and close by. Similarly, the accessibility of a facility depends a great deal on the traffic networks in the vicinity of the facility (Thompson, 2002; Kienast, 2012; Sarkar *et al.*, 2015).

Access to public transportation is another important enabler of park access. The rapid increase of vehicles in park environments has to some extent, however, affected the accessibility of public parks in the cities negatively. The absence or scarcity of bicycle lanes and pedestrian walkways connected to parks and recreational facilities and parking areas close to public parks and recreational facilities have also been identified as constraints to the accessibility of the public parks in cities. According to some scholars, the time it takes to walk from home and the walking distance to the park, as well as pedestrian safety, are some of the most important preconditions for good accessibility and vibrancy of public parks (Miyake, 2010; Reyes, Páez and Morency, 2014).

To consider the accessibility of an open green space at the level of the individual resident only is insufficient (Barbosa *et al.*, 2007). One should also take the differences in accessibility across urban societies and suburbs into consideration (De Oliveira, Alves, Abreu, 2017). Previous studies have shown that open green spaces are rarely distributed uniformly across cities, and this factor, in turn, has an impact on user ratios, (Omer, 2006). It is not uncommon to encounter suburbs with disproportionate numbers of public parks—whether too many or too few. These levels of disproportionateness have rarely been studied (Malek, Mariapan and Rahman, 2015), but there have been some studies on the correlates of the abundance of open

spaces and the socio-economic variables of open spaces, such as age, affluence, and race (Martin, Warren and Kinzig, 2004).

According to some studies, public park access in the residential areas of a city is founded on the spatial configuration of parks, the number of parks, and their spatial distribution across neighbourhoods or local regions (Bancroft *et al.*, 2015). The planning of land allocation to provide facilities and services that will ensure continuous and safe park access is, therefore, advocated. This kind of access, in turn, has the potential to increase access to public parks. Furthermore, the interior visibility, usability and functionality connected to people with special needs—as well as the availability of methods to provide ease of movement for them—and the availability of convenient transportation nodal points close to important social- and civic elements (park entrances, libraries and post offices) are other aspects, relevant to the accessibility of public parks and recreational facilities, to consider (Nicholls, 2001; Dony, Delmelle and Delmelle, 2015). It seems clear that accessibility is key to the utilisation of public parks in residential areas and that the availability and influence of the various accessibility components should be investigated extensively (Glaesener and Caruso, 2015).

Measurable qualities relating to the access and linkages of public parks in residential areas include the following factors:

- The size of the public park
- The size of the residential area bordering on the park
- The number of residents living close to the park
- The availability and condition of the infrastructure for pedestrians heading to the park
- The road-network infrastructure close to the park
- The speed limit in the vicinity of the park
- The availability and condition of parking facilities
- The barriers and fencing around the park
- The kind of entrance to the park
- The average walking distance from the neighbouring residents to the park
- The visibility of the park
- The number and condition of access roads leading to the public park
- The degree of illumination in the parks.

(Glaesener and Caruso, 2015; Lindholst *et al.*, 2016)

These factors will be included in the list of variables to be measured for further analysis.

2.11.2 Comfort and Image

Another important determinant of the vibrancy of public parks, as expressed in the literature, is the comfort and image of a public park. South Africa has many difficulties relating to this determinant. Apart from the literature and personal observation, government-, police-, and municipal reports also present evidence that the parks' state of disrepair and the—seemingly regular—presence of loiterers and criminal elements, play an important role in residents' perception of public parks as unsafe places to be.

Much can be done to improve the comfort and image of public parks in the residential areas of South African cities and it is, therefore, important to measure the comfort and image of public parks in residential areas quantitatively, and qualitatively for proper analysis.

The measurable qualities of the comfort and image of public parks in residential areas include the following factors:

- The level of cleanness
- The available seating
- The perception of safety
- The intrusion of vehicles into areas designated for pedestrians
- The level of attractiveness
- The degree of natural elements (greenness) present
- The actual level of safety.

(Erkip, 1997)

These factors will be included in the list of variables to be measured, for further analysis.

2.11.3 Uses and Activities

As one of the four major determinants of the vibrancy of public parks in the residential areas of cities the usefulness and activities to engage in during visits to public parks form part of the fundamental building blocks for developing and maintaining the vibrancy of public parks. It, nevertheless, seems evident that only a few of the public parks in the residential areas of South African cities provide a selection of activities for visitors to enjoy.

Even though some effort has been made to introduce more activities for the different social groups visiting the public parks in South Africa, there is, currently, a shortage of study results relating to the expediency of, and activities available at, public parks. There is, for that reason, a demand for additional research into the factors contributing to the usefulness of, and the activities available, in the public parks of cities in South Africa.

Measurable qualities relating to the uses and activities of public parks in residential areas include the following:

- The configuration of land use around the park
- The varieties and arrangement of vegetation within the park
- The style and composition of playground facilities for children
- The nature and layout of picnic facilities
- The variety and layout of sport facilities
- The availability of other recreational activities.

(Veitch *et al.*, 2013; Malek, Mariapan and Rahman, 2015)

These factors will be included in the list of variables to be measured for further analysis.

2.11.4 Sociability

The final major determinant described in the literature is probably also the most difficult quality of public parks to accomplish in the residential areas of cities in South Africa. For several reasons, which will be explored in this thesis, the sociability of public parks in residential areas of South Africa is currently almost non-existent. The importance of sociability in any open space is emphasised in numerous articles relating to public parks from around the world. It is, consequently, important to find out how sociability in the public parks of South African cities can be improved. This is particularly important since very little analytical research, relating to the sociability of local public parks, has been undertaken so far.

According to the literature, the measurable qualities, relating to the sociability of public parks in residential areas, include the following:

- The age groups of people visiting the parks
- The availability of volunteer caretakers
- The number of social events that take place within the park

The diversity of the people visiting the parks

- The extent of ownership taken up by those living close to parks
- The eagerness of the residents in the vicinity to visit the parks

(Sakip, Akhir and Omar, 2015; Salwa and Mahdzar, 2019)

These factors will be included in the list of variables to be measured for further analysis.

2.11.5 Employment and Development of Models

Several models used mainly for the assessment of the characteristics that influence the vibrancy of public parks have already been developed and a number of these can be utilised for the analysis of certain challenges affecting the under-utilisation of public parks. These models include, but are not limited to, Census tract models, Proximity models, Service area analysis models, SOPARC models, F-F Framework models, and Geographic Information Science (GISc) frameworks, and are applied in unison with various statistical techniques (Giles-Corti *et al.*, 2005; Neema and Ohgai, 2010; Kienast, 2012; Jabben, Weber and Verheijen, 2015; Pietilä, 2015). There is, nevertheless, a scarcity of models applicable to the demographic conditions and developments in South Africa as a whole. It has also been found that most of the models available can be applied either, comprehensively to all the parks in the city, or individually to an allocated park. There are currently no systematic models that have been developed specifically for the assessment of public parks in residential areas and, in particular, none for the residential areas of South African cities (Anguluri and Narayanan, 2017).

2.12 SUMMARY

It is understood that a public park, transformed to be fully utilized (safe, easy, and convenient) by its potential users, ought to have a positive effect on the circumstances in its neighbourhood, because the park becomes a place of attraction for local residents, as well as visitors from outside the area. Studies relating to the vibrancy of public parks at a local residential, and neighbourhood level are, unfortunately, quite limited, and for that reason, this study aims to explore the challenges against the vibrancy of public parks at a neighbourhood level in cities and at bridging the current gap in the research relating to this field of study. The findings from the literature will form the primary context for this investigation into the vibrancy of public parks in the residential areas of cities in South Africa.

CHAPTER 3: PROFILE OF STUDY AREA

3.1 INTRODUCTION

An exploration of the study area yields insights into its characteristics, its challenges and its hidden opportunities and prospects. These, in combination, provide a profile that serves as a guide for the advance of general policy interventions, as well as, the formulation of credible planning guidelines for the development of sustainable public parks and open recreational spaces within the area.

The socio-economical-, physical-, infrastructural-, environmental- and ecological makeup of a city affect the vibrancy of public parks and open recreational spaces within its borders and need to be taken into account when planning these sites. This chapter aims to shed light on the potentialities, and restrictions, which influence the utilisation (vibrancy) of the public parks in the study area. The dynamics under investigation include background of the area, demographic- and socio-economic profiles, land allocation, transportation and the current standing of public parks and open recreational spaces.

A clear and objective conception of the infrastructural-, physical-, geographical- and socio-economical parameters of the study area is indispensable to a reliable visualisation of the present circumstances and can lead the way to the successful planning, design, and construction of vibrant public parks and other open recreational spaces.

Bloemfontein city in South Africa has been selected as the case study area for the above purpose; the residential neighbourhoods of Universitas, Langenhoven Park, Lourier Park, Dan Pienaar, and Batho have been selected as the suburbs for data collection through sample surveys.

3.2 BACKGROUND OF STUDY AREA

Bloemfontein, a city in central South Africa, was chosen to be the study area for this investigation. Bloemfontein is the capital of the Free State province and has been the judicial capital of South Africa since 1910. The city is also called the ‘City of Roses’ and its area of municipal jurisdiction is known as ‘Mangaung’ (the place of cheetahs).

Geographically, Bloemfontein is positioned at 29°06′S and 26°13′E at an altitude of 1395 m above sea level (Figure 3.1). The climate in the region ranges from very cold (-10°C to 14°C)

in winter, to very warm (19°C to 38°C) in summer. The rainy season normally occurs during summer and strong winds are typical during spring (Department of Science and Technology South Africa, 2011). The vegetation surrounding the city is mainly dry grassland on a flat plateau. Summer in Bloemfontein generally stretches from December to February and winter falls between June and August. Spring (September to November) and autumn (March to May) are generally moderate in temperature. The annual rainfall of Bloemfontein, under normal conditions, ranges between 600mm to 750mm per annum, and snowfall occasionally occurs in the area during winter (Department of Science and Technology South Africa, 2011).

Bloemfontein is a medium-sized city consisting of 35 suburbs surrounding a central business district.

Figure 3-1: *Map of South Africa and the Free State (Department of Peacekeeping Operations Cartographic Section, 2007)*

3.3 DEMOGRAPHIC PROFILE

3.3.1 Population and Density of the Study Area

The Free State province has a population of 2 824 500 people, which is approximately 5.7% of the total South African population. The population of the Mangaung Metropolitan Municipality, which includes Bloemfontein, is estimated at 747,431 (Statistics South Africa, 2017). Bloemfontein is the largest city in the Free State has about 32% (569 558) of the total population of the province living in the city. Bloemfontein is also the largest component of the Mangaung Metropolitan Municipality, its population constituting more or less 80% of the total population of the municipality. The population density of the city is in the region of 1729 people per square kilometre (Statistics South Africa, 2017).

As well as being the capital of the Free State province, Bloemfontein is also the most prominent economic contributor to the province and has an estimated population of 569 558 people. This is 31% more than the 256 534 taken from the 2011 Census (Statistics South Africa, 2011) when the population growth was underestimated because the migration of people from surrounding areas and nearby smaller towns was greater than anticipated (Mangaung Metropolitan Municipality, 2017). Finance, trade, transport, and community service are the main drivers of the economy in Bloemfontein. The expected population growth for Bloemfontein by 2030 is illustrated in Figure 3.3.

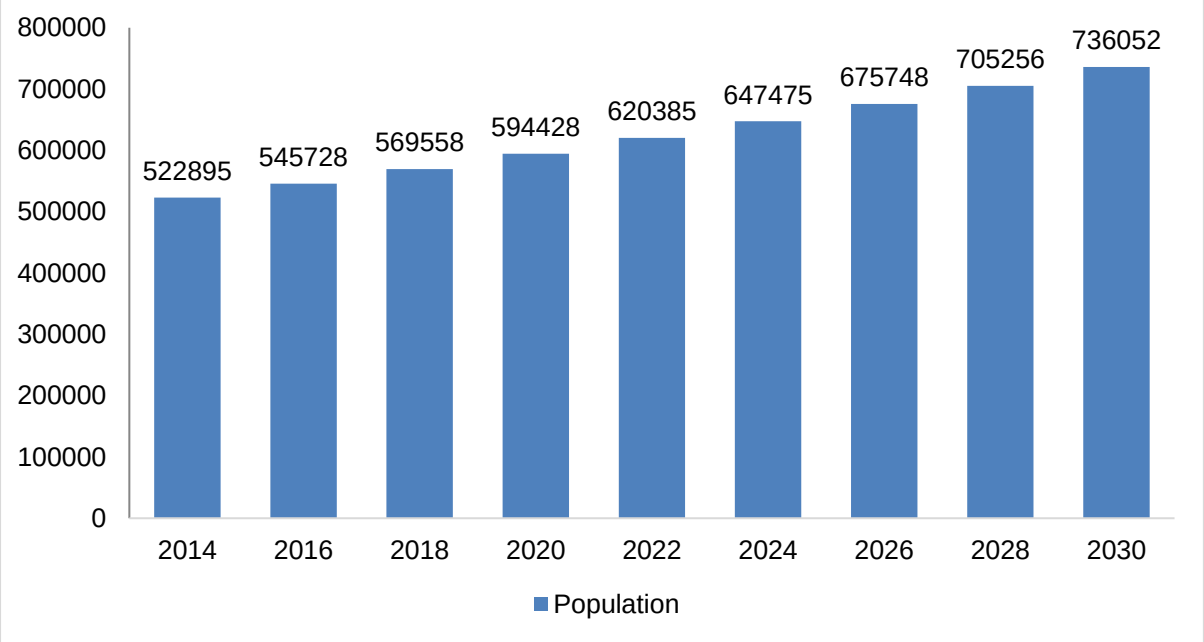

Figure 3-2: *Expected population growth for Bloemfontein City (Mangaung Metropolitan Municipality, 2017).*

3.3.2 Gender and Age Structure of Mangaung Metropolitan, Free State.

Figure 3-3 illustrates the gender- and age structure of the study area. It is important to note that the largest age group of people in the Free State is 10–14 years; it makes up 11% of the total population of the province—an estimated number of 2 824 500 people (Statistics South Africa, 2017).

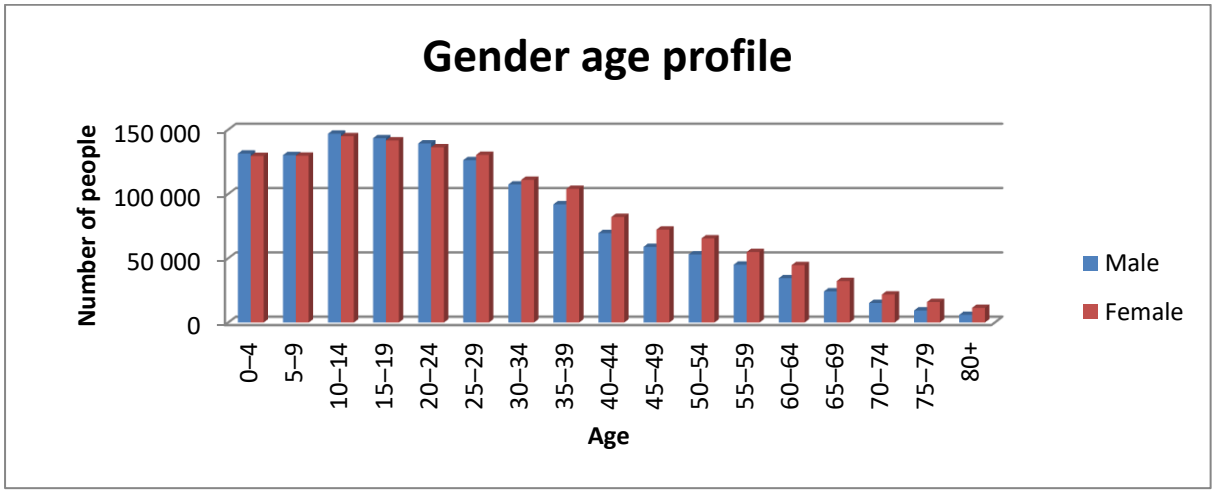

Figure 3-3: *Gender and Age profile of residents in the Free State by age group*

Figure 3.4 shows a clear decline in the age groups from 14–80 years old—each of the age groups shows a decline of 2%. It is notable that the male population, up to the age of 24, is slightly larger than the female population. In the age range of 25–80 years the female population, is slightly larger than the male population (Statistics South Africa, 2011). As previously stated, 32% of the population of the entire province (an estimated 900000 people) live in and around Bloemfontein. The age and gender profile of the city is comparable to that of the rest of the province.

Table 3-1 presents a detailed age- and gender distribution of the population of the city of Bloemfontein. From Table 3-1 it is clear that more than 30% of the population comprise the age groups 10–24 years and approximately 19%, the age groups between 0—9 years. This indicates that more or less 49% of the population is aged 24 years and younger. It must also be noted that almost 24% of the population falls between the age groups 25–39 years, meaning that about 73% of the population in the province is 39 years and younger and that a sizable portion of the population is still young and in need of recreational outdoor activity. This deduction infers that large numbers of the population in the study area are potential users of public parks and other open spaces in residential areas (Baur, Tynon and Gómez, 2013).

Table 3-1: *Gender age profile of the Mangaung Metropolitan Municipality (includes Bloemfontein)*

Mangaung Metropolitan Municipality				
Age (Years)	Male (No. Of People)	Female (No. Of People)	Total (No. Of People)	%
0–4	42536	41942	84478	9.39
5–9	42145	42006	84151	9.35
10–14	47487	46851	94339	10.48
15–19	46357	45816	92173	10.24
20–24	45067	44089	89156	9.91
25–29	40894	42205	83099	9.23
30–34	34851	35996	70847	7.87
35–39	29925	33749	63674	7.07
40–44	22749	26764	49513	5.50
45–49	19317	23614	42932	4.77
50–54	17455	21433	38888	4.32
55–59	14901	18050	32951	3.66
60–64	11526	14784	26309	2.92
65–69	8249	10823	19072	2.12
70–74	5359	7471	12830	1.43
75–79	3513	5610	9124	1.01
80+	2409	4141	6550	0.73
Total	434741	465345	900086	100

3.4 SOCIAL FUNCTIONS: EDUCATION AND HEALTH SCENARIOS

The level of literacy for South African adults is estimated at between 80% and 89%, whereas, that of the younger population is estimated at between 90% and 100%. These percentages are on par with the global literacy ranges, which is 84% for adults and 89% for the youth (UNESCO, 2015). The level of literacy in the study area corresponds to that of the rest of the country.

The high literacy level in Bloemfontein can, to a large measure, be attributed to the education infrastructure in the city. Bloemfontein is well known for schools, and tertiary institutions of higher education, that offer a high standard of education. Almost every residential area in Bloemfontein has a primary-, and/or high school. The two universities—e.g. the Central

University of Technology and the University of the Free State—have a combined student population of more than 50,000.

The city of Bloemfontein also has health care facilities that follow the trends set by the national health care system and adheres to the standards set by the minister of health. There are several advanced health care facilities, including three sizeable, private general hospitals, some specialist (e.g ophthalmology and psychiatric) private hospitals and three public hospitals. Thirteen primary health care clinics spread across the city add to the health care facilities available, even so, at the time of the study the life expectancy for residents in the study area is 54.9 years for males and 59.1 years for females (Statistics South Africa, 2011).

3.5 ECONOMY

Figure 3-5 shows the economic distribution across the nine provinces of South Africa. Economic trends in South Africa seem to follow the national population distribution. The province with the largest population, Gauteng, has 33% of the country's population. Gauteng also makes the highest contribution to the GDP. The Northern Cape Province has the lowest population and contributes the lowest percentage (2%) to the national GDP. Similarly, the Free State has the second-lowest population (6%) and also makes the second-lowest contribution (6%) to the national GDP. Bloemfontein is the largest populated city in the province and the biggest contributor to the economy of the province. (Mcdonald and Valente, 2005). The main economic activities in the city are industrial-, commercial-, and service activities. There are some industrial areas located in and around the city, but commercial pursuits and service functions, for instance, governance-, education- and health-related occupations are the more predominant economic activities in the city. Farming endeavours in the district also make a significant mark on the economic welfare of Bloemfontein.

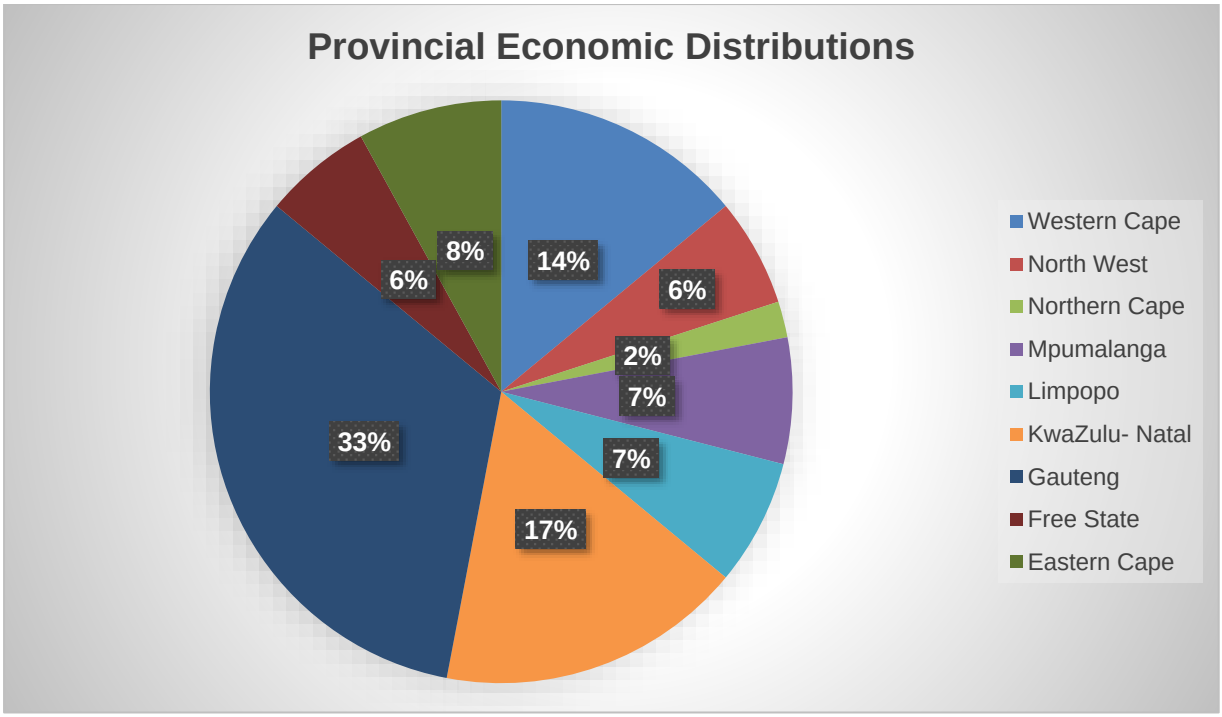

Figure 3-4: *Economic balance in South Africa (Statistics South Africa, 2011)*

3.5.1 Employment and Occupation

The three main sources of income in the Free State province are mining, farming, and industry. The northern parts of the Free State are home to several gold- and coal mines. The 12 gold mines of the Free State provide 30% of the country's gold reserves and approximately 20% of the world's gold stock. Almost all the branches of farming are represented in the Free State and most of the land in the Free State is utilised for agricultural purposes. The industrial sector of the Free State revolves mainly around the import and export of high-tech materials, among other, petroleum and different waxes.

As mentioned earlier, Bloemfontein's economy is predominantly commerce-based with only some industries and farms located in and around the city. Due to the population growth in the study area, the labour force in the area has increased and that has resulted in a greater demand for work than the jobs available. Additionally, unemployment has a major impact on the economy of the Free State.

People in the higher income groups generally reside more in the northern parts of the city; the middle- to higher-income families are located more to the western side- and the middle- to low-income earners mostly live in the south-western residential areas of the city.

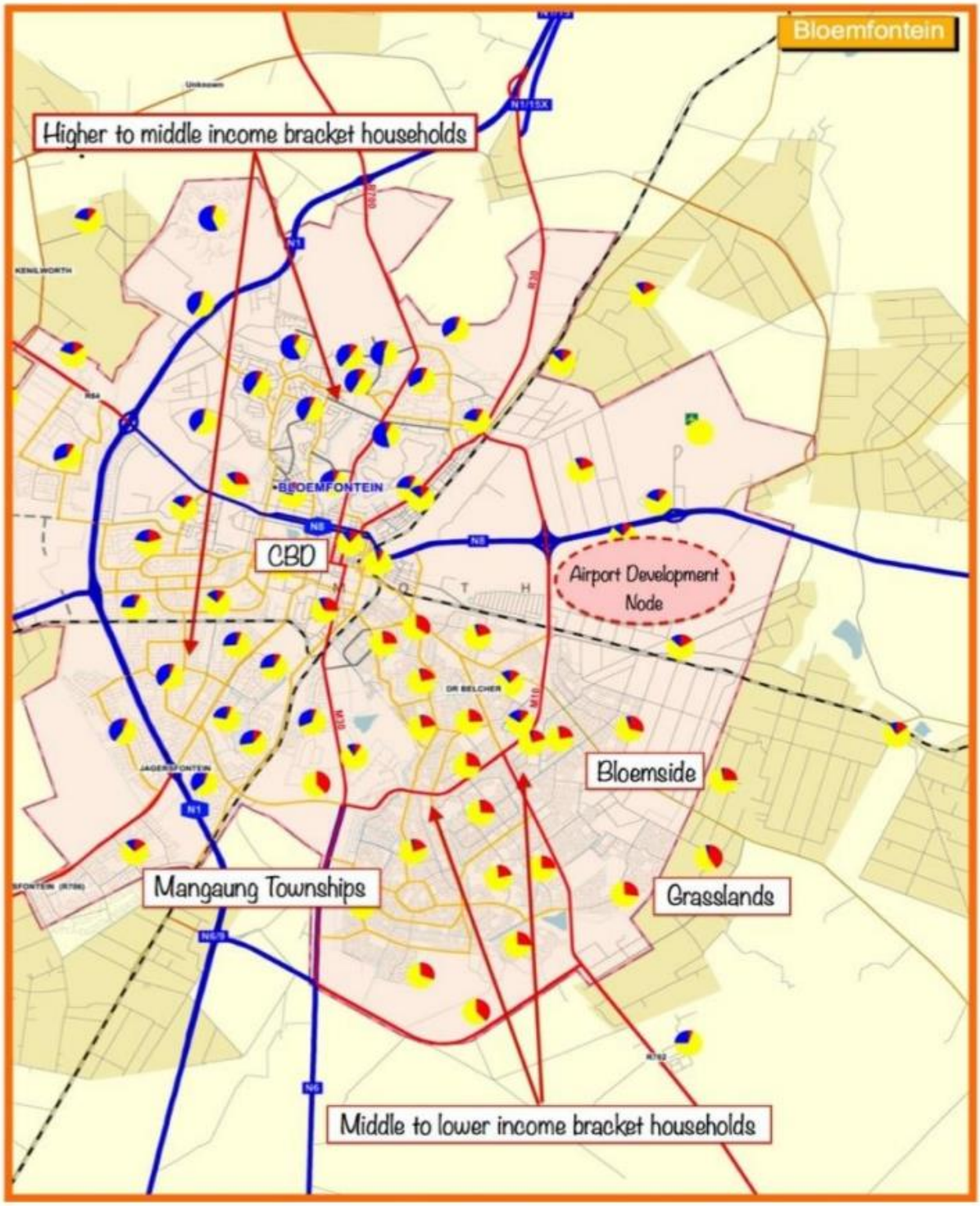

Figure 3-5: *Spatial income classification (Mangaung Metropolitan Municipality, 2017).*

As seen in Figure 3.7, about half of the population (46%) works in the private sector, about 30% work in the public sector, for example, local government, and 17% have private enterprises. Unemployment in Bloemfontein—at about 1%—is very low.

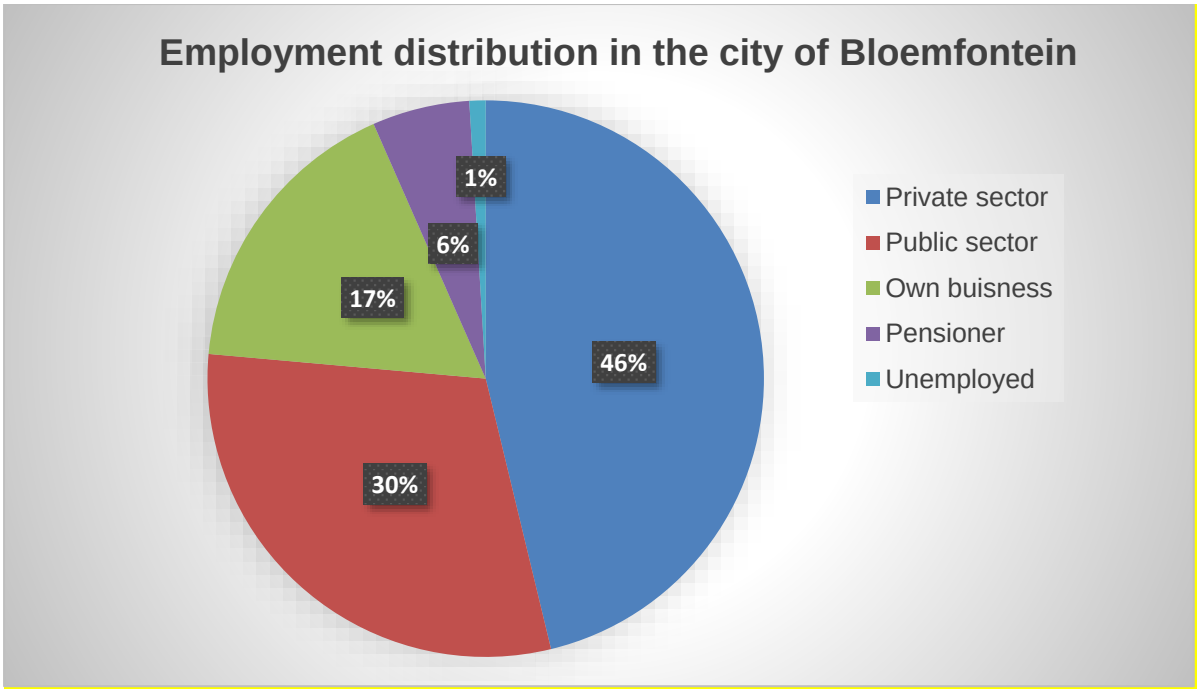

Figure 3-6: *Employment Distribution in the city of Bloemfontein (Source: Household survey, 2015).*

3.6 BASIC INFRASTRUCTURE AND HOUSING

The infrastructure and services in the study area comprise a road network, railway lines, housing, water supply and sanitation, electricity, solid waste management systems, telecommunication facilities, information communication technology (ICT) systems, recreational- and sports facilities, public parks and various private utilities and services. Most of the built-up infrastructure in the city is housing. During the physical survey of the study area, it was noted that nearly 58% of dwellings in the residential areas are stand-alone houses for single families; 42% are apartments—or flats—townhouses, semi-detached (duplex) houses, and cluster homes.

3.7 URBAN MORPHOLOGY

The urban morphology of the study area denotes the relationship between land-application and the individual patterns of application in the urban areas. Each residential area in Bloemfontein has its peculiar characteristics and functions, causing each of these to have a unique urban pattern and land application. This section explains the urban pattern and land application of the city in general but mainly pays attention to the residential areas selected for the survey of this study, namely, Langenhoven Park, Universitas, Batho, and Lourier Park.

3.7.1 Urban Patterns

Although Bloemfontein is characteristically designed to accommodate motorised transport, which is typical of all South African cities, it is, according to the Mangaung Metropolitan Municipality Integrated Development Plan of 2017 (2017), known as the “walking city,”. This was verified by the National Household Travel Survey (2014), indicating in its evaluations that 17% of all work-related journeys happened on foot. In that period, it was also found that, more or less, 190 000 work-related trips —which equates to 32,56% of those travelling to work— were made by taxi. An estimated 10,55% of the workers travelled by bus, 8,44% through ‘ride-sharing’ and 29,3% by personal transport (Statistics South Africa, 2014).

Figure 3.5 shows the road networks of the city of Bloemfontein and, as specified in TRH 26 South African Road Classification and Access Management Manual (2012), all six types of roads namely, principal-, major- and minor; collector- and local streets, and walkways, are evident. The surrounding suburbs, residential neighbourhoods, and commercial areas are all connected to the city centre or each other through a network of major arterial roads and thoroughfares.

The road networks of an urban area, as a rule, form the framework and structure of the urban pattern and is dependent on the of roads being accessed in a hierarchical order. The combination of roads types creates a pattern which forms the urban pattern of the area (Zhu and Zhang, 2008). In South African cities the roads are classified according to COTO 2012. The classifications range from urban principal major arterials (U1), urban major arterials (U2), urban minor arterials (U3), urban collector streets (U4), urban local streets (U5) to urban walkways (U6) (TRH, 26, COTO 2012).

The Class U1 arterials are used to serve as connectors to rural Class R1 routes and preferably start and stop at arterials of equal class (Class 1). The Class U2 arterials provide connections between larger regions of the city; these arterials also serve important economic activity centres that are not otherwise served by Class 1 arterials. The Class U3 arterials provide connections between districts of the city or town and form the last leg of the journey on the mobility side of the road network. They bring traffic to within one kilometre of its final destination, and also serve economic activity centres that are not served by Class 1 or 2 arterials. The collector streets penetrate the local neighbourhoods to collect (and distribute) traffic between local streets and the arterial system. The local streets are intended to serve an access function with limited mobility and traffic volumes. Urban local streets provide access to individual properties and both traffic volumes, and trip lengths, have to be limited in these

streets. Pedestrians have priority on all walkways, at all times—even without signs and road markings (TRH, 26, COTO 2012).

Bloemfontein city has a hierarchical road network comprising all six types of roads. Major (U2) and minor arterial (U3) roads form the nervous system of the city by providing connectivity to all the other parts of the city. The road network layout and urban pattern of Bloemfontein are illustrated in Figure 3-8.

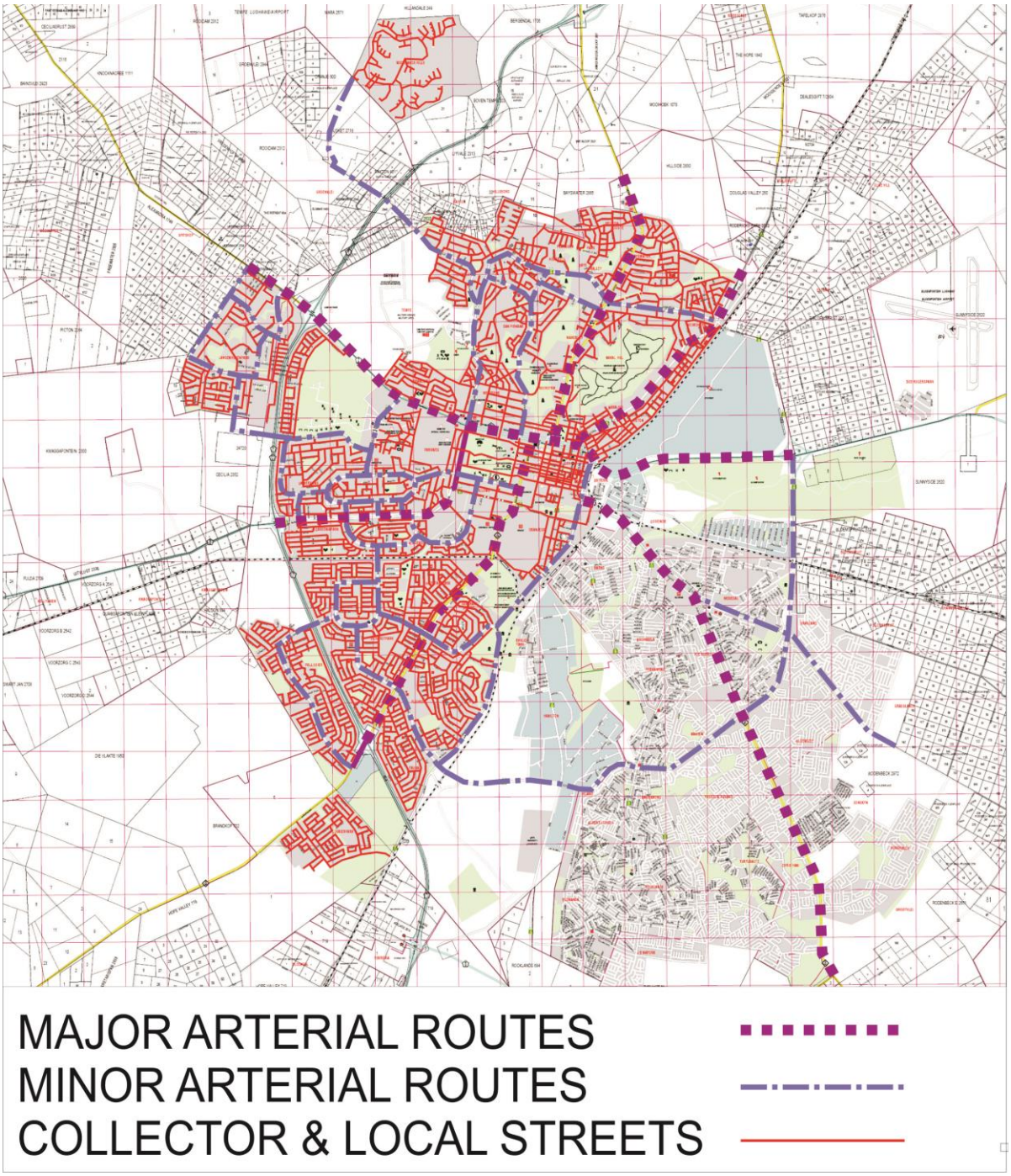

Figure 3-7: *Road network and urban pattern of Bloemfontein (Mapsource © GIS Software)*

Figure 3-8 shows how the major arterial roads originate in the city centre and spread to the outer parts of the city. The urban areas of the city are divided by these major arterial roads and can be accessed with ease, from the different areas using minor arterial routes, which in turn, are accessed through collector streets. The major arterial roads in the city have a linear pattern, whereas the minor arterial roads are configured in either a linear or a loop pattern. The smaller collector streets are configured in a variety of road patterns, such as loops, gridiron, a combination of loops and gridiron and dead-end streets with occasional loop patterns. The city centre is primarily configured in a gridiron pattern, which switches to a radial-combined with gridiron pattern as one moves outward, away from the city centre

The functional allocation land in an area is referred to as the 'land use' of the area. The city of Bloemfontein has allocated land for several uses, namely, residential-, commercial-, industrial-, civic-, open space- and mixed land. There are several local plans (called structure plans), that have been approved by the governing council that facilitate decision-making, in Bloemfontein. These plans do not have the same status as the mandatory municipal Spatial Development Frameworks but are the municipal policies that guide planning, development, and land use management (COGTA, 2009). Bloemfontein has, except for, the large military base, the same pattern of land use as most South African cities. Some areas in the city have mixed land use where, for instance, business- and residential-functions are combined. Figure 3-8 shows the locations and types of land use in the city of Bloemfontein.

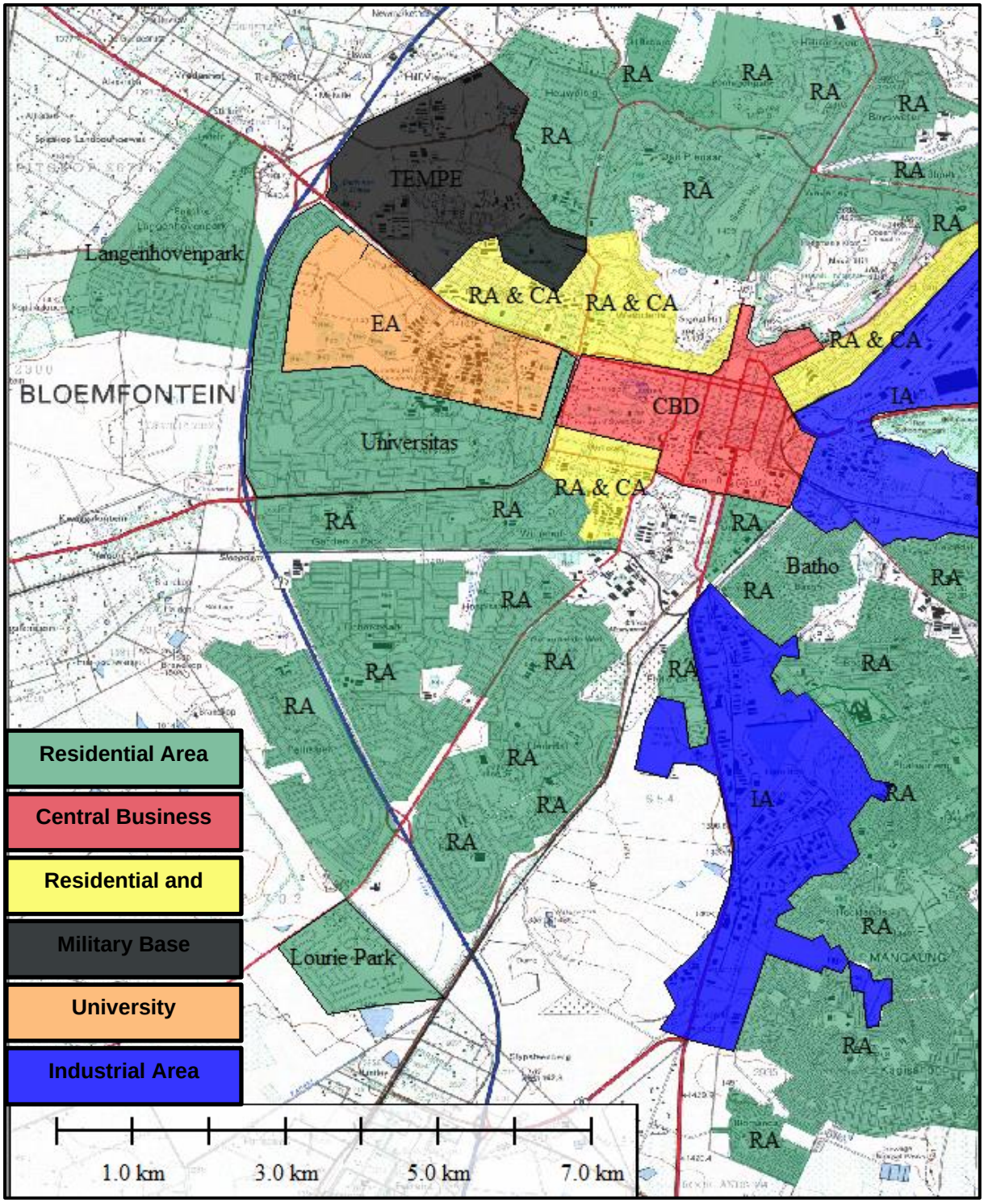

Figure 3-8: *Land Use in Bloemfontein (Mapsource © GIS Software)*

In Figure 3-9, it can be seen that the central business district of the city is flanked by commercial combined with residential areas. The residential areas of the city surround the commercial areas and the university. Figure 3-9 also shows that the industrial areas of the city are confined to the outer eastern parts of the city and are surrounded by low-income residential areas. Tempe military base is situated on the outer north-western end of the city.

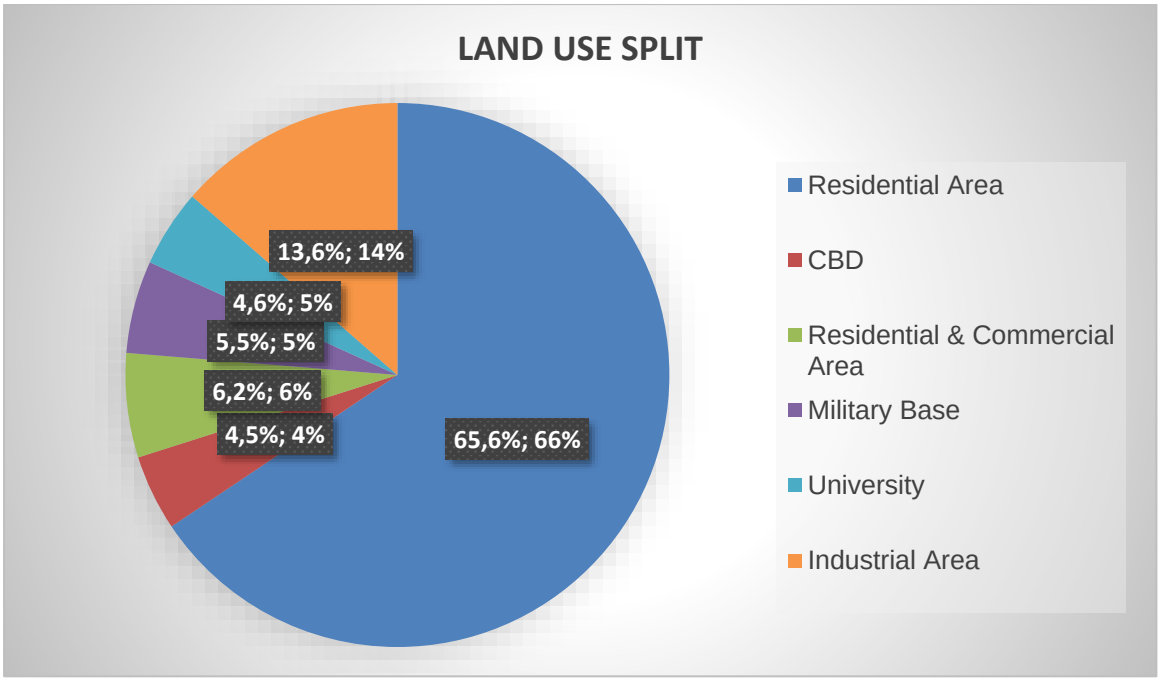

Figure 3-9: *Bloemfontein Land Use Composition*

The general land use composition of the city is illustrated in Figure 3-10. Residential areas with mixed land use have taken up the majority of land space (65.6%) in the city. Compared to the size of the rest of the city, the CBD is fairly small and constitutes approximately 4.5% of the total land of the city. About 13.6% of the total land is utilised for industrial purposes. There are also two prominent areas set aside inside the city, these being the University of the Free State and Tempe Military Base, which contribute to the total population of the city and potential users of public parks. Therefore, the city has a combination of different land use and road network patterns. Furthermore, it is observed that the public parks and organized open recreational areas prominent in the residential- and mixed land use areas of the city.

3.8 TRANSPORTATION CHARACTERISTICS

3.8.1 Road Networks

As discussed in section 3.7.1, the road network of the city of Bloemfontein functions on a hierarchical system and provides access to every part of the city. As illustrated in Figure 3-7 the city is comprised of major arterials (U2), minor arterials (U3), collector roads (U4) and local streets (U5) with occasional dead-end streets. Most of the roads in the city are paved but some roads in the lower-income class residential areas are unpaved. These unpaved roads receive less maintenance, due to the lower number of vehicles travelling on these roads. A priority network of major arterials connects the surrounding suburbs to the city centre, whilst the residential areas serving as thoroughfares to other residential areas and commercial areas

are respectively connected by minor arterial roads. Residents in each residential area make use of collector roads to access the minor and major arterials.

The speed limit for all the roads in the city ranges from 80km/h for certain major arterial roads, to 40km/h for certain collector roads where frequent pedestrian crossings (scholars and students) are encountered. However, the speed limit for most of the roads in the city is 60km/h. Most of the major arterials in the city are multiple lane roads with medians separating the direction flow of traffic. Whereas minor arterials are mostly multiple lane roads, collector roads comprise mostly of single carriage roadways. All roadways are equipped with street lighting, but poor maintenance and vandalism frequently cause various road sections of the city to have non-functioning streetlights. The city has a well functional traffic control and management system. Majority of the junctions are controlled by automated traffic signalling system. Minor or unimportant junctions are managed by stop signs. Most of the traffic movements on the roads are managed by appropriate road signs, sidewalk marking, on-street, off-street parking systems and traffic calming measures.

3.8.2 Types and Numbers of Vehicles

The modes of transport in the city of Bloemfontein has been following a trend similar to that of the rest of the country. About 62% of the commuters in the city make use of privately-owned vehicles. The remaining 38% of the commuters make use of public transport such as taxis, mini-buses and buses (Merven, Stone, Hughes and Cohen, 2012). The city does not currently provide the infrastructure to allow for commuting by train other than that of travelling to other cities and towns in the country.

Figure 3-11 shows the distribution of transport mode in the city of Bloemfontein. At 56%, the use of motorcars is significantly higher than other modes of transport, followed by light delivery vehicles, the second most frequent mode of transport, at 24%.

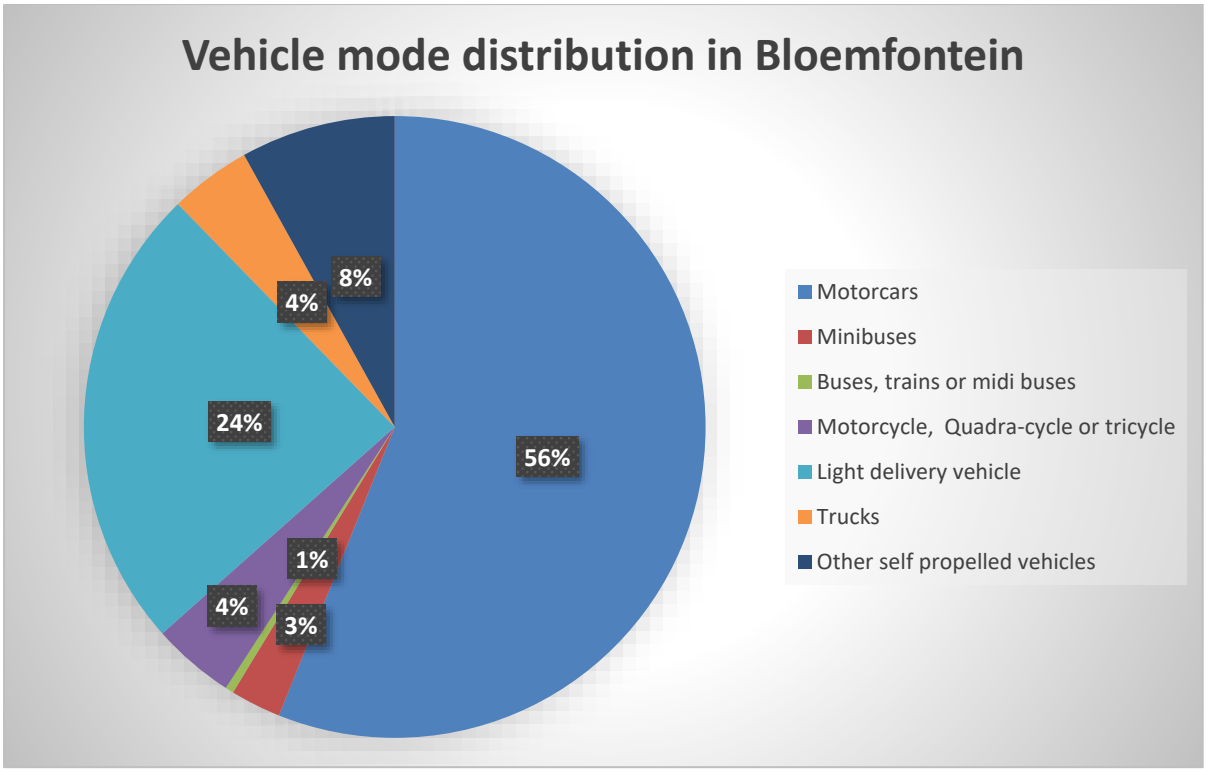

Figure 3-10: *Transport Mode Distribution in Bloemfontein*

3.8.3 Public Transportation System

Bloemfontein has a bus transport system that runs on predetermined routes and provides commuters with access to all the residential areas of the city. The buses make stops at specific points along all the main and minor arterial roads of the city. Commuters making use of public transport have to walk from collector roads to main- and minor arterial roads meet a bus. Most of the passengers travelling by bus, in the mornings and afternoons, come from the east side of the city and go to work at the central- and western parts of the city. There are designated stops for commuters to embark, or disembark, the bus, and the bus only departs from the bus stop, once all the waiting passengers are on board, or the bus is full.

The bus system operates according to a timetable and, should they choose to travel by bus, it is expected of commuters to familiarize themselves with the bus schedule.

Minibuses also operate on a large scale, and an informal fashion, in the city. The passengers pay per trip. Minibuses do not have designated stops the way buses do. They stop anywhere, and at any time along any road—wherever a commuter stands and waits to be picked up. Minibus taxis cover all the major- and minor arterial routes and do not follow schedules as the bus system does.

A small number of commuters make use of private taxis that pick them up and drop them off at any point on the public road they choose.

Commuters often use neighbourhood- and public parks as a waiting point for the minibus taxis or buses they intend to make use of.

3.8.4 Walkability Aspects

The notion of Bloemfontein being a ‘walking city’ is not supported essentially or functionally, because the infrastructure, as confirmed by the information compiled from the Mangaung Integrated Development Plan, is deficient (Mangaung Metropolitan Municipality, 2017).

Various projects aimed at improving walkability has been surfacing, but it is still an ongoing process. Some of the continuing sidewalk upgrades (see Figure 3.14) in the central business district of the city; the pedestrianisation of Selbourne (see Figure 3.13) and Elizabeth Street for the 2010 Soccer World Cup as well as the upgraded Hoffman Square (see Figure 3.12) in the city centre.

Figure 3-11: *Upgraded Hoffman Square in Bloemfontein City (Source: Author).*

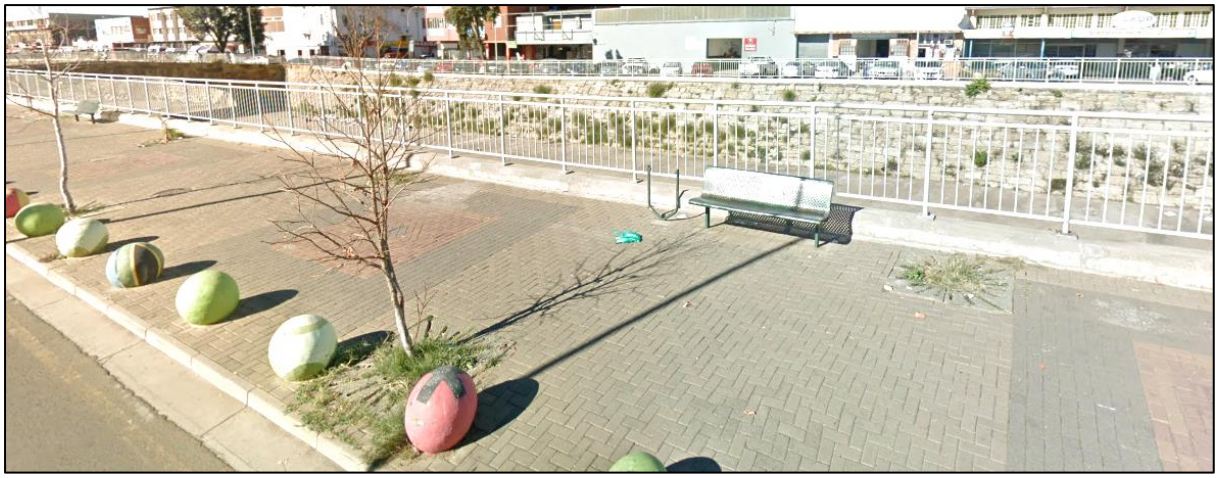

Figure 3-12: *Pedestrianisation of Selbourne Avenue in Bloemfontein City (Source: Author).*

Figure 3-13: *Historical imagery from Google Maps Street View showing the sidewalk upgrade in Henry Street, Bloemfontein (Google LLC, 2017).*

The municipality's efforts (especially in the central business area) to improve walkability in Bloemfontein can be seen in the photographs above. It is, however, also clear that residential areas have not been receiving much attention (Mangaung Metropolitan Municipality, 2017), and due to the population growth in section 3.3.1, the problem may continue to escalate.

In the following examples, small-scale private sidewalks and pathway developments in residential areas can be seen: (1) the pathway around the Striata Retirement Village (see Figure 3.15); (2) the sidewalk upgrade at the Campus Key Student Accommodation (see Figure 3.16) in Universitas; (3) isolated examples of homeowners developing the sidewalks in

front of their homes (see Figure 3.17). These figures show that only a small share of the sidewalks in the selected residential areas have constructed a more walkable sidewalk.

Figure 3-14: *Sidewalk around Striata Retirement Village, Universitas (Source: Author).*

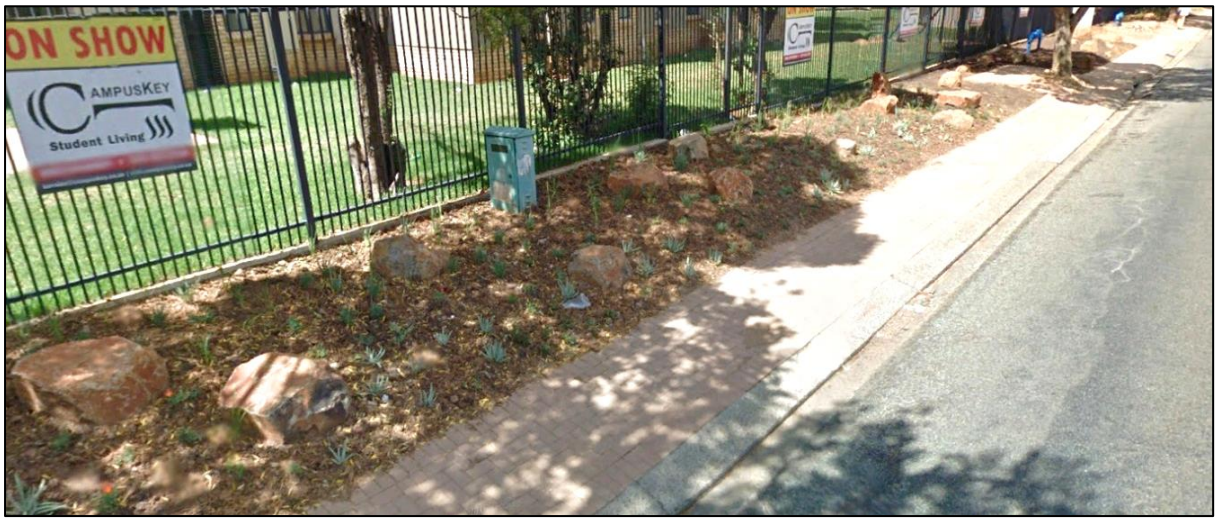

Figure 3-15: *Sidewalk at the Campus Key Student Accommodation, Universitas (Source: Author).*

Figure 3-16: *Example of a sidewalk upgraded by a homeowner in Lyle Street, Universitas (Source: Author).*

3.9 OPEN SPACES AND RECREATIONAL FACILITIES

There are many organized open spaces in the city of Bloemfontein and every residential area has been provided with public- and neighbourhood parks. The city has several sports fields (stadiums, -arenas, and other sports facilities), categorized under public recreational facilities, but because of the limited/private access to these facilities, they will not be considered in this study. Nature reserves, zoos and botanical gardens where the public have to pay an entrance fee to gain access are also outside the scope of this study

3.9.1 Public Parks in the CBD Area of the City of Bloemfontein

Open free accessible public parks are situated all across the city. The CBD area of the city has the largest number of public parks with free access, but they are only open during certain hours. These public parks situated in the CBD area of the city are not only the busiest public parks in the city but have also become very popular and vibrant since 1994.

Figure 3-17 shows the two main central public parks in the city of Bloemfontein. These two parks are partially bordered by the city zoo and the sports stadiums and -arenas comprising the rugby- and cricket stadiums, tennis courts, swimming pool, and the athletics stadium. These two public parks can be accessed daily, without cost, between 8 am and 8 pm. The other sports- and recreational facilities shown on the map can only be accessed by members and ticket holders. The public parks servicing the CBD area are regularly utilized by city citizens and are subjected to higher utilisation because of the unique land use and urban functions of their immediate environment. These two public parks in the CBD area of the city cover an area of 100 000m². They are well-kept and maintained and are equipped with all the features and amenities expected of a public park (Figure 3-19 and 3-20).

In 2010 some of the FIFA soccer world cup matches were hosted in the stadium neighbouring the public parks of the CBD. This event led to the upgrade and rehabilitation of services and of accessibility to the stadium in the years preceding 2010. t renovation tactics and improvements also added to the appeal of the public parks bordering the stadium.

Figure 3-17: *Parks and Recreation Facilities in the Bloemfontein City CBD Area (Mapsource © GIS Software)*

Figure 3-18: *Public Park 1 in the Bloemfontein CBD Area (Source: Author).*

Figure 3-19: *Public Park 2 in the Bloemfontein CBD Area (Source: Author).*

Each of the 60 residential areas in Bloemfontein have public parks at certain positions within the neighbourhood. Due to their larger sizes and populations, some of the residential areas have more public parks around. Some in lower-income residential areas, however, have been occupied by illegal settlements (Marais and Ntema, 2013).

3.10 PUBLIC PARK DISTRIBUTION IN RESIDENTIAL AREAS

Figure 3-21 displays the distribution and sizes of the public parks in the city of Bloemfontein. The city has a well-distributed network of public parks throughout the residential areas. There are 202 public parks, covering an area of 167 km² in the city, indicating that there are, on an average, 1.2 public parks for every square kilometre of the city. In its planning, the city of Bloemfontein has ensured that there is a public park within 1km walking distance from every residence. With such availability of public parks, it is expected that these public parks will be vibrant and busy, but that is, unfortunately, not so. Thus, in to identify the aggravating influences, find possible solutions and develop strategies to boost the use of public parks, it is essential to launch an in-depth investigation into public parks.

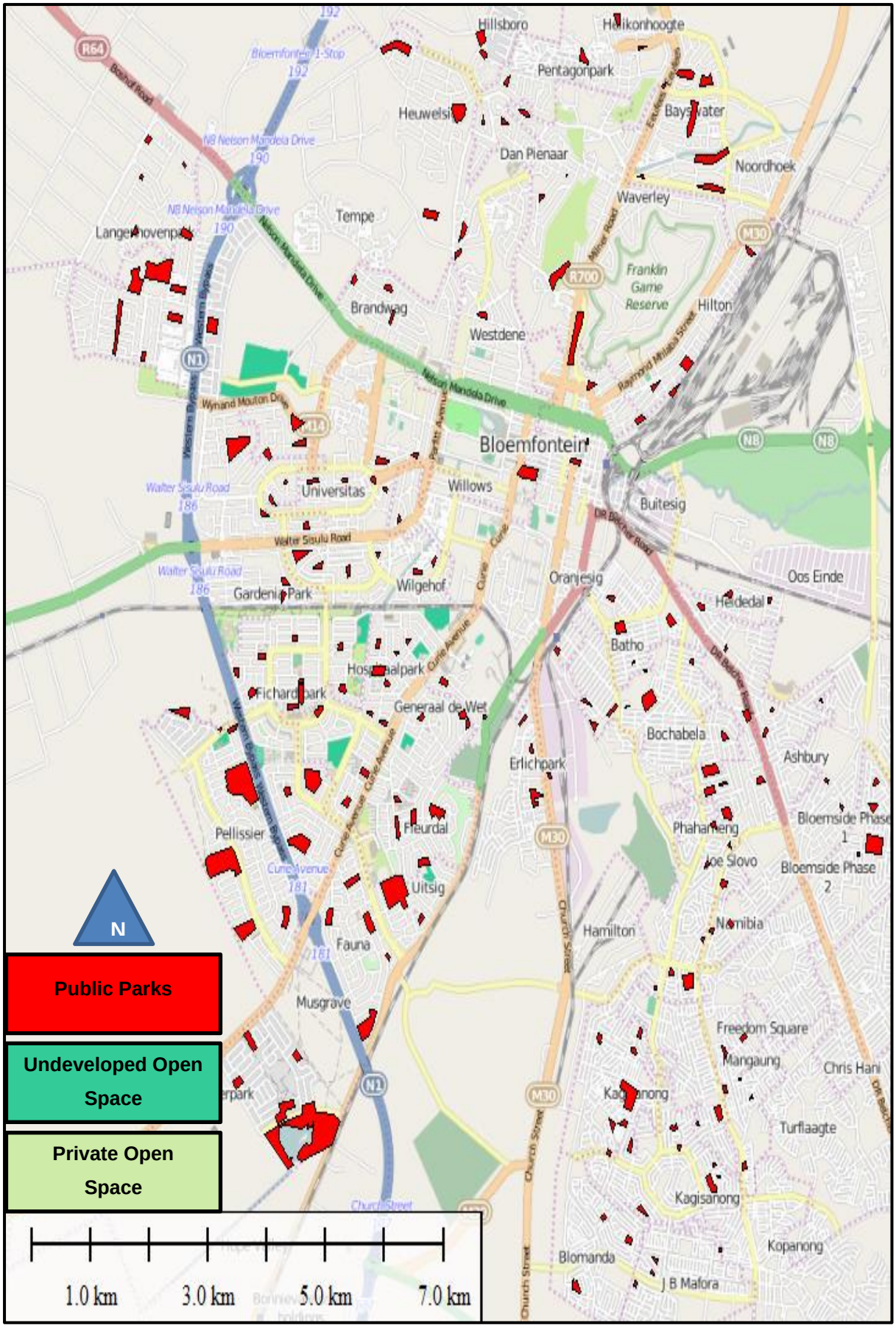

Figure 3-20: *Public Parks in Bloemfontein City (Mapsource © GIS Software)*

3.10.1 Public Parks in the Five Selected Residential Areas

The public parks in the residential areas of Langenhoven Park (Figure 3.22), Universitas (Figure 3.23), Batho (Figure 3.24), Lourier Park (Figure 3.25), and Dan Pienaar (Figure 3.26) have been selected to represent all the public parks in the city. Considering their locations, characteristics and demographics, these parks seem to typify the parks in all the residential areas of the city.

Table 3-2 shows that the five selected residential areas each have a different number of public parks. It also presents the variance in the ratio of the total land area in the residential area to the combined land area of the public parks. Of the total land area of Langenhoven Park, approximately 4.8% is taken up by public parks. Since the University of the Free State has its parks as a service to its students, only 1.8% of the total land area of Universitas is allocated to public parks. When the parks of the university are included, the whole area of public parks in Univeritas adds up to about 11.8% of the overall land area.

The University of the Free State granted the general public access to their parks up until 2014, but have since restricted access to the university grounds to students, staff and service providers. A large portion of the residents in Universitas are students and have unrestricted access to the parks of the university.

Of Batho's total land area, more or less 6,6% is allocated to public parks and of Lourier Park about 25.7%. Dan Pienaar has the lowest ratio of total public park area to total residential land area, with approximately 1.4% of the total land area taken up by public parks. This shows an inconsistency between the different residential areas, indicating that the planning guidelines and procedures were not consistently followed, for all the residential areas.

Table 3-2: *Public Park Details of Five Selected Residential Areas of Bloemfontein*

Public Parks in the Five Selected Residential Areas				
Residential Area	**Number of Public Parks**	**Total Land Area (m²)**	**Total Combined Land area of Public Parks (m²)**	**Access Type to Residential Areas**
Langenhovenpark	11	45x10⁵	220 000	Limited
Universitas	16	97x10⁵	169 800	Thoroughfare
Batho	7	10x10⁵	65 900	Thoroughfare
Lourier Park	5	15x10⁵	385 200	Limited
Dan Pienaar	6	38x10⁵	54 600	Thoroughfare

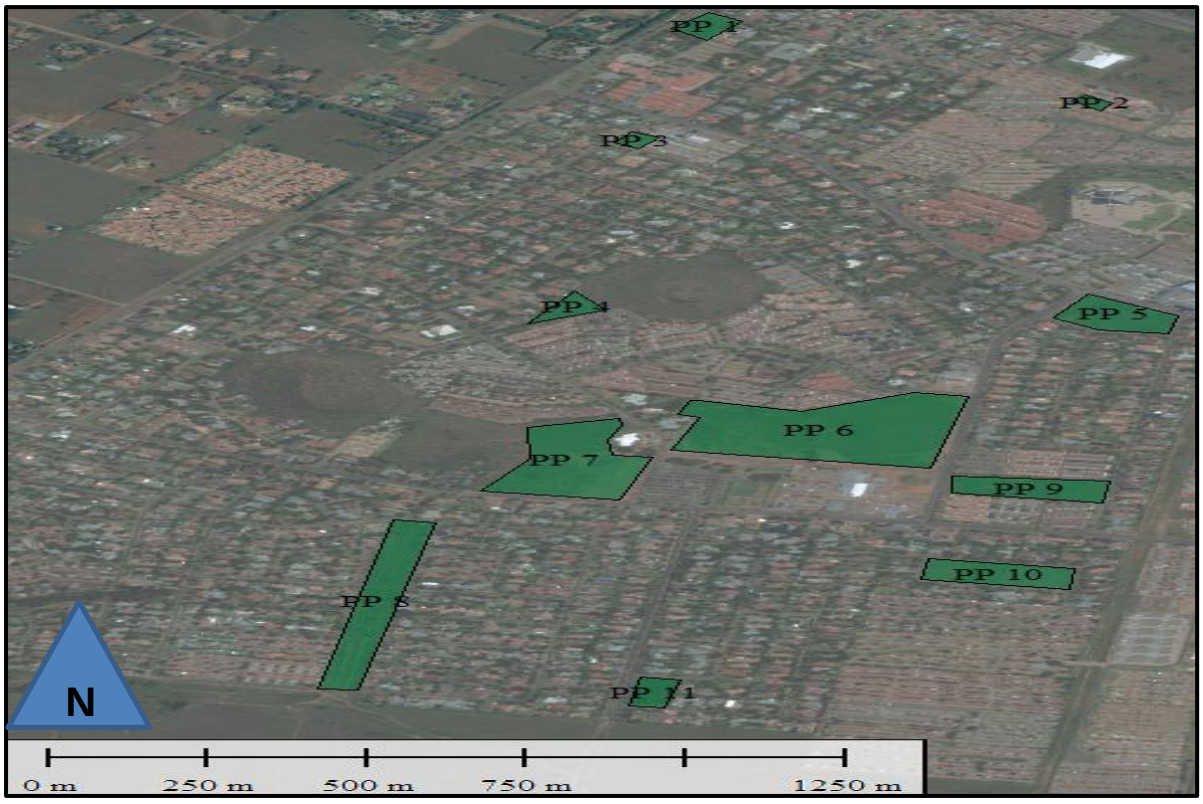

Figure 3-21: *Public Parks in Langenhovenpark (Mapsource © GIS Software)*

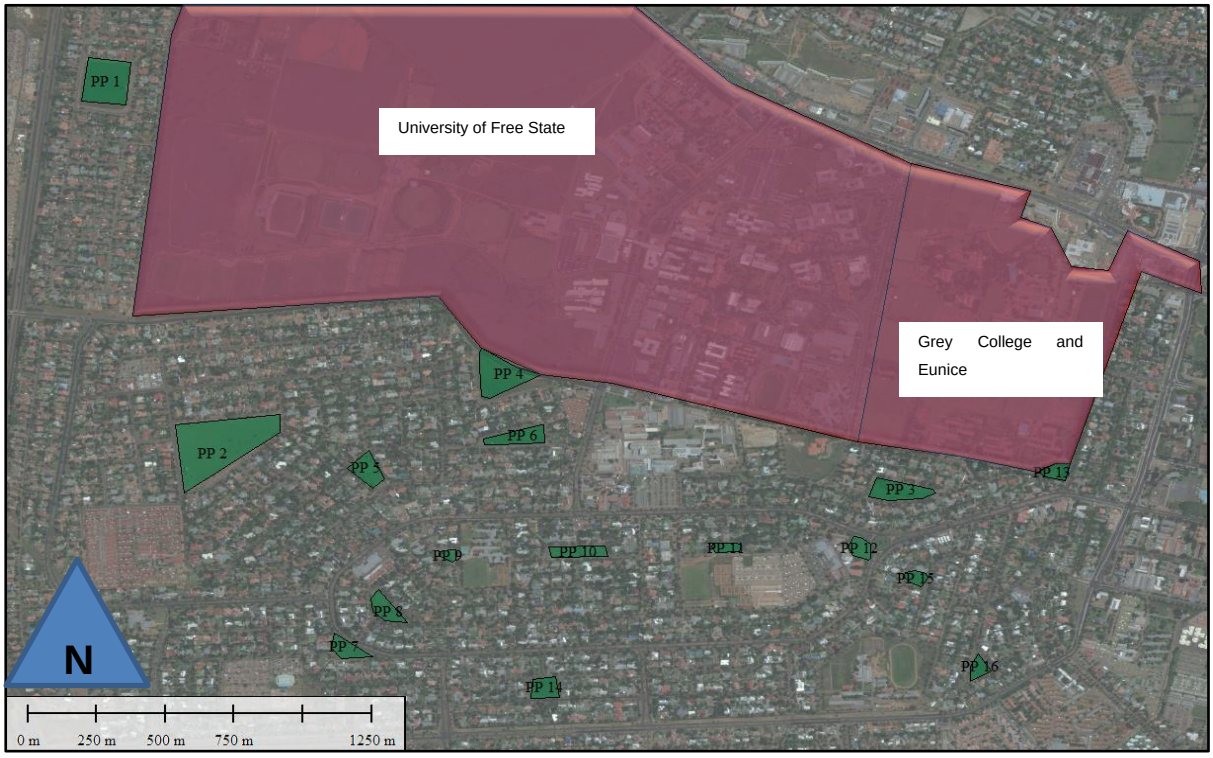

Figure 3-22: *Public Parks in Universitas (Mapsource © GIS Software)*

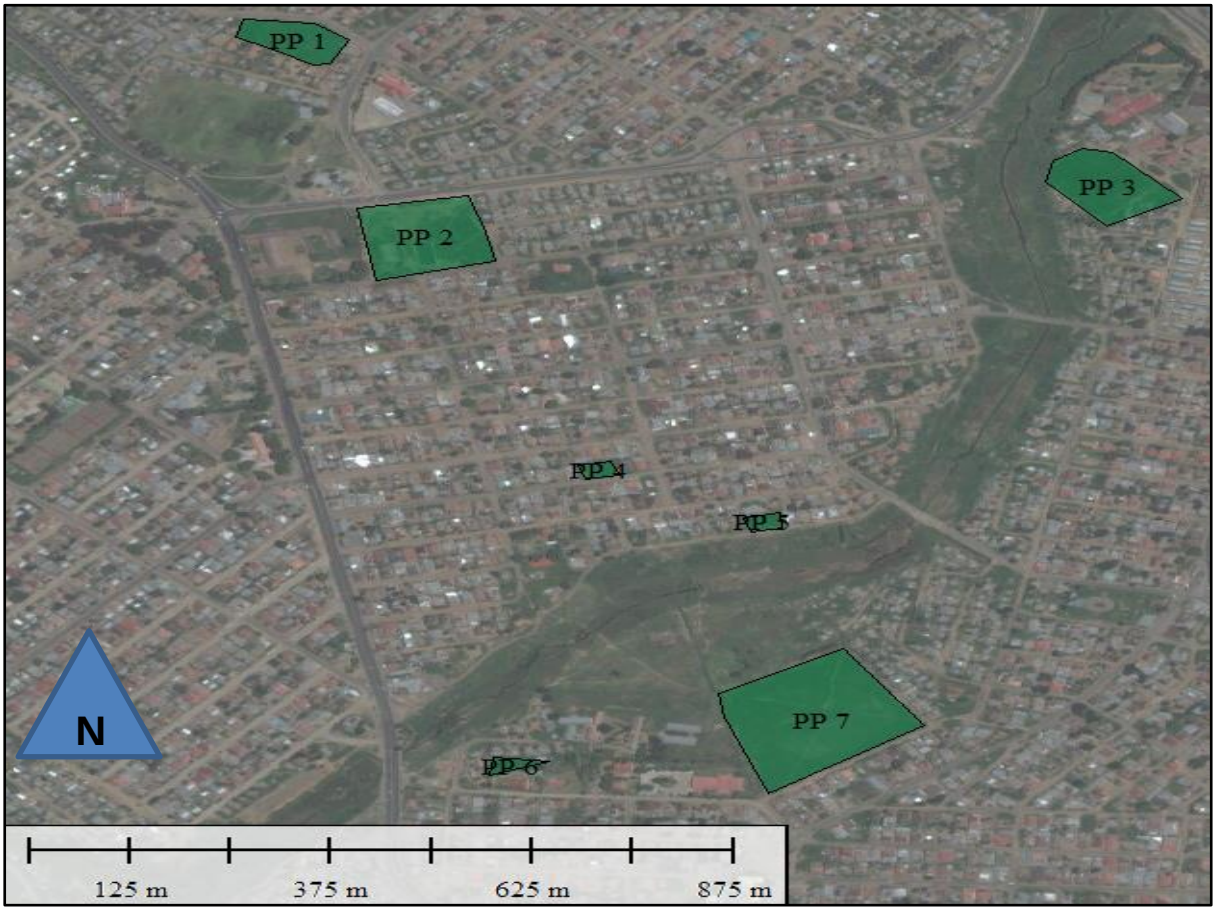

Figure 3-23: *Public Parks in Batho (Mapsource © GIS Software)*

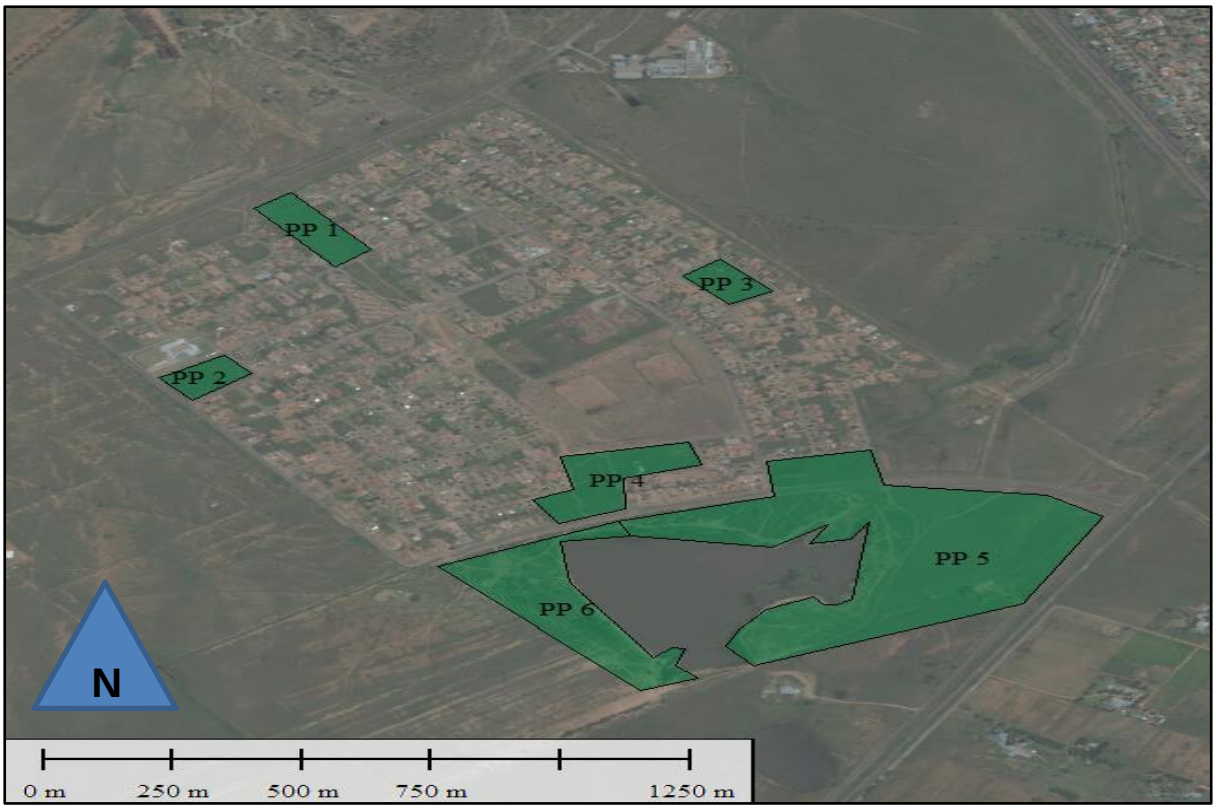

Figure 3-24: *Public Parks in Lourier Park (Mapsource © GIS Software)*

Figure 3-25: *Public Parks in Dan Pienaar (Mapsource © GIS Software)*

3.11 SUMMARY

- An important aspect shown in the analysis of the Bloemfontein City study area is that the Mangaung Metropolitan Municipality (Bloemfontein and surrounding areas) has 747,431 residents, which is the second-lowest population density in South Africa. Approximately 74% of the residents are below the age of 40, and more than 30% of the residents are between the ages of 10 to 24. Only 26% of the residents are older than 40. On reflection, this clearly shows that the majority of the city's residents are in the active age group and affirms the need for recreational and leisure activities.

- The educational institutions of the city of Bloemfontein (schools, colleges and universities) are distributed across the entire city and most of the clinics and large hospitals, for instance, Universitas- and Rosepark Hospitals are located within residential areas.

- Compared to the general unemployment rate of 27% in South Africa (Statistics South Africa, 2011), the unemployment rate in the Free State, at 36%, is very high, whereas in the study area it matches the country's average of 27%. Also, most of the residents work in the private sector.

- Bloemfontein has the same pattern of land use, as most of the cities in South Africa. Some areas in the city have mixed land uses patterns where, for instance, business- and residential-functions, are combined.

- The roads and streets of Bloemfontein City take on a linear pattern of major and minor arterials which serve all the urban areas. The minor arterials and local streets form grid iron-, loop- or linear systems of road networks in the suburban areas of the city.

- Bloemfontein has a public transportation system consisting of bus and operations system that travel from and to several locations across the city. However, the public transportation system is mainly used by residents residing in low-income residential areas, causing an unbalanced public transportation system with the majority (62%) of commuters making use of their privately-owned vehicles.

- There are two central public parks situated in the CBD area of Bloemfontein. These parks are well equipped with facilities and amenities and are fully utilised. These parks

are not included in the study as they do not meet the criteria for public parks located in the residential areas.

- Several other recreational facilities and open spaces such as stadiums, sports grounds, a zoo, a nature reserve and botanical gardens are also in or near the city, but are, due to the regulated access of these facilities to the public, not included in this study.

- A fair number (202) of public parks—an average of 1.2 public parks per square kilometre—are spread across the city. However, as observed from the survey, these parks are not used to their full potential. There are several factors which contribute to their underutilisation of which, the accessibility, comfortability, sociability, and usefulness are the major reasons.

- Locals in the residential areas of Bloemfontein are all within walking distance of a public park in their area, thus raising concern for the reasons why not many residents make use of the public parks available—the reason for this investigation.

CHAPTER 4: METHODOLOGY

4.1 INTRODUCTION

This study employs a positivism approach, which as a philosophy, adheres to the view that only accurate knowledge gained through observation, including measurement, is trustworthy. In positivism studies, the role of the researcher is limited to objective data collection and interpretation. In these types of studies research findings are, as a rule, observable and quantifiable (Collins, 2018).

Positivism depends on quantifiable observations that lead to statistical analyses. Positivism accords with the empiricist view that knowledge stems from human experience. It has an atomistic, ontological view of the world as comprising discrete, observable elements and events that interact in an observable, determined and regular manner (Crowther, Lancaster, 2012).

Moreover, in positivism studies, the researcher is independent of the study and there are no provisions for human interests within the study. Crowther and Lancaster (2008) argue that as a rule, positivist studies adopt a deductive approach, whereas an inductive research approach is usually associated with a phenomenology philosophy. Additionally, positivism holds to the viewpoint that the researcher needs to concentrate on facts, whereas phenomenology concentrates on meaning and makes provision for human interest (Collins, 2018).

This study adopted an applied research strategy which endeavoured to find feasible solutions to the problem identified and explained in Chapter 1. An Applied System Analysis (ASA) approach was utilized, in part, for the conceptualization of soft models to understand the systematic creation of vibrant public parks better. Additional statistical analysis techniques were applied to develop linear and multi-linear regression models, which would assist with the development of precise policies and guidelines, for the construction of vibrant public parks. The first part of this chapter highlights the specific methodologies employed in this study; the second part explains the concept of ASA and how it can be implemented in a study.

4.2 METHODOLOGY OF THIS STUDY

A survey research method and modelling, premised upon Applied System Analysis (ASA) principles, were adopted for this study. For data collection, physical surveys of public parks and questionnaire surveys at households were conducted. Both descriptive and inferential

statistical methods were applied for data analysis. ASA principles were used to develop integrated models to examine the vibrancy of the public parks in the city of Bloemfontein and to construct simulated scenarios that could assist with the formulation of policy interventions.

The research design followed a set of systematic steps:

1. Problem identification, literature review, the setting of objectives and hypotheses, and research design.
2. Identification of a study area (from a selection of cities in South Africa).
    a. Selection of the case study city (Bloemfontein / Mangaung Metropolitan Municipality)
    b. Identification and selection of sample areas for survey and investigation
    c. Identification and selection of primary public parks and organized open spaces in residential areas (on a city-wide scale)
3. Households-, and physical and park use surveys
    a. Households survey
    b. Physical survey of the identified parks (by manual means, digital photography and videography)
    c. Park use survey (park user perception survey, digital photography and videography)
4. Compilation and synthesis of primary- and secondary (statistical) data.
5. Statistical analysis of the survey data and assessment of the variables related to the challenges against sustainability
6. Establishment of the ASA paradigm, and conceptualisation of the ASA linked model(s)
7. Statistical Analysis and Regression Modelling
8. Results and discussions, hypothesis testing, and drawing inferences
9. Formulation of guidelines for improvement

The detailed data collection, data analysis methods, and modelling are discussed in the subsequent sections.

4.3 DATA COLLECTION

Both primary and secondary data were collected for analysis and to aid in the investigation. Primary data were collected through physical surveys of the public parks in the study area and their surrounding residential areas, as well as, through direct household surveys. The physical surveys of public parks, the surrounding neighbourhood and traffic networks were essential for obtaining accurate and current data of the study area. GIS data was collected from the

local municipality. For a fair representation of the use, and the degree of vibrancy, of public parks in the city, residential areas and public parks had to be identified meticulously. The selection of the survey areas for the collection of primary data was made according to specific selection criteria namely: population, social demographic conditions, location, the numbers and sizes of parks and the availability of infrastructure.

Household surveys were conducted among households in the suburbs of the study area using pre-tested questionnaires (with one questionnaire per household) and through conducting semi-structured interviews with respondents by using a stratified, random sampling process.

Data relating to the physical- and infrastructural conditions of public parks in the selected suburbs were obtained through conducting physical surveys and obtaining up to date GIS data from the municipality. The physical surveys encompassed investigations into the engineering- and physical infrastructures, underlying accessibility, road- and traffic network systems around the public parks, the availability of parking in the vicinity of the public parks, the existing conditions of pedestrian access, the public transport system servicing the selected areas, civil services and the allocation and statuses of the land surrounding the public parks.

The physical conditions of parks, and the park use surveys were conducted via continuous digital photography and videography.

The data relating to the physical- and infrastructural conditions of public parks were supplemented by up to date GIS data, as well as, statistical data obtained from secondary sources (Statistics SA, the Mangaung Metropolitan Municipality, the Department of Parks and Recreation, and others).

4.3.1 Primary Data

Five residential areas, representative of the distinguishing socio-economic rankings in the city, were identified for primary data collection (which included all the accessibility scenarios and challenges). The primary data collected did not only contribute to obtaining an in-depth understanding of the physical characteristics required of each public park in the study area, but also served as validation for the guidelines and solutions and for establishing the hypothesis.

4.3.2 Selection of the Sites for the Survey

The city of Bloemfontein comprises 60 suburban residential areas. Table 4-1, in conjunction with Figure 4-1 and Figure 4-2, display the 35 primary suburbs of the city; their size, and the

nature of their infrastructure. Of the 60 suburbs, 5 were selected for survey and data collection. The suburban areas selected were Batho (on the eastern side), Universitas (on the south-western side), Langenhoven Park (on the western side), Lourier Park (on the southern side), and Dan Pienaar (on the northern side). The suburbs selected, differ from one another in terms of demographics, size, location, and accessibility via road networks. These five suburbs also, adequately represent the utilisation of the public parks for the entire city. Primary data were collected according to a set of selection criteria namely, population, social-demographic conditions, accessibility via road networks, location, and size.

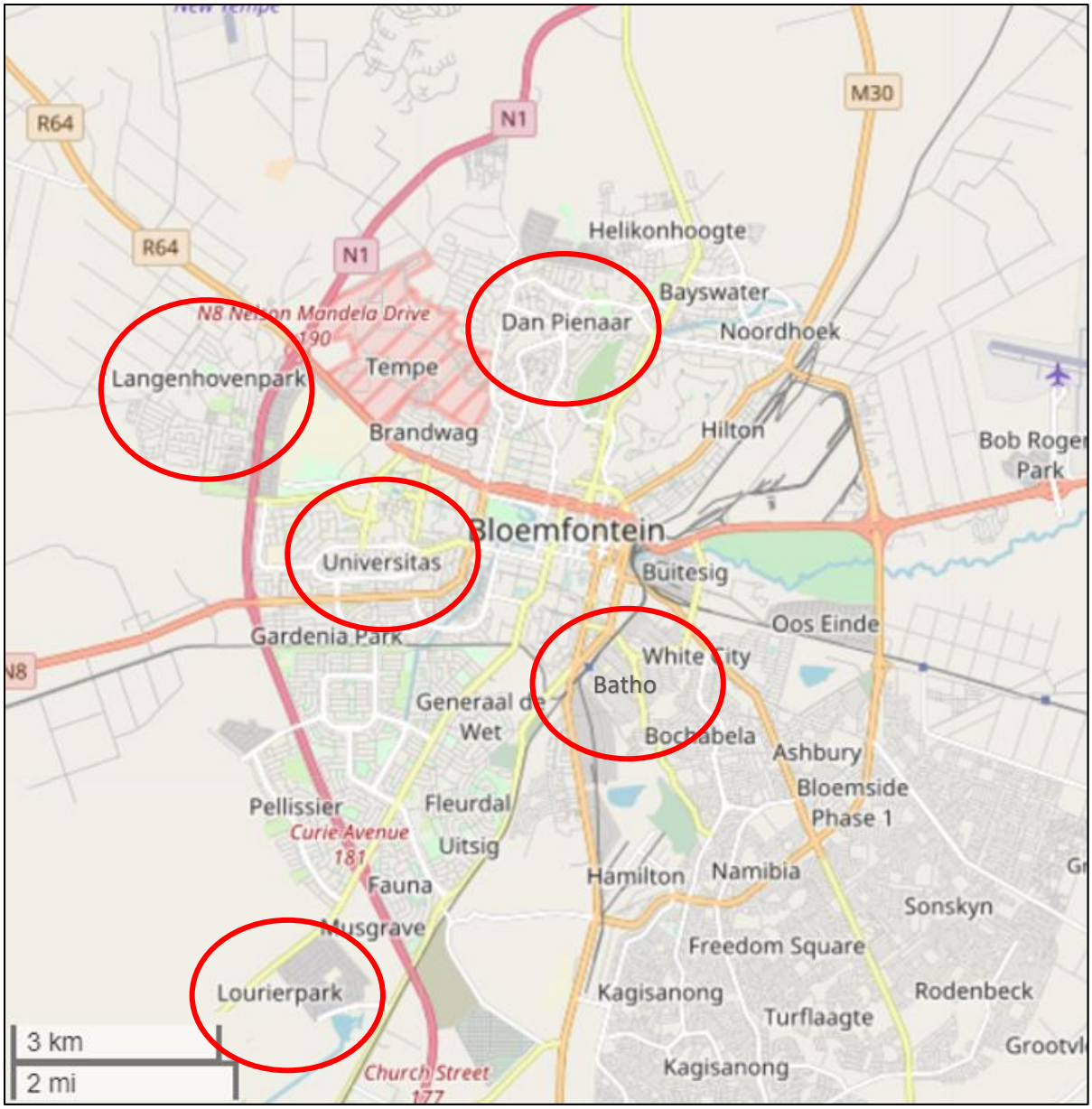

Figure 4-1: *City of Bloemfontein* (© OpenStreetMap contributors, 2018)

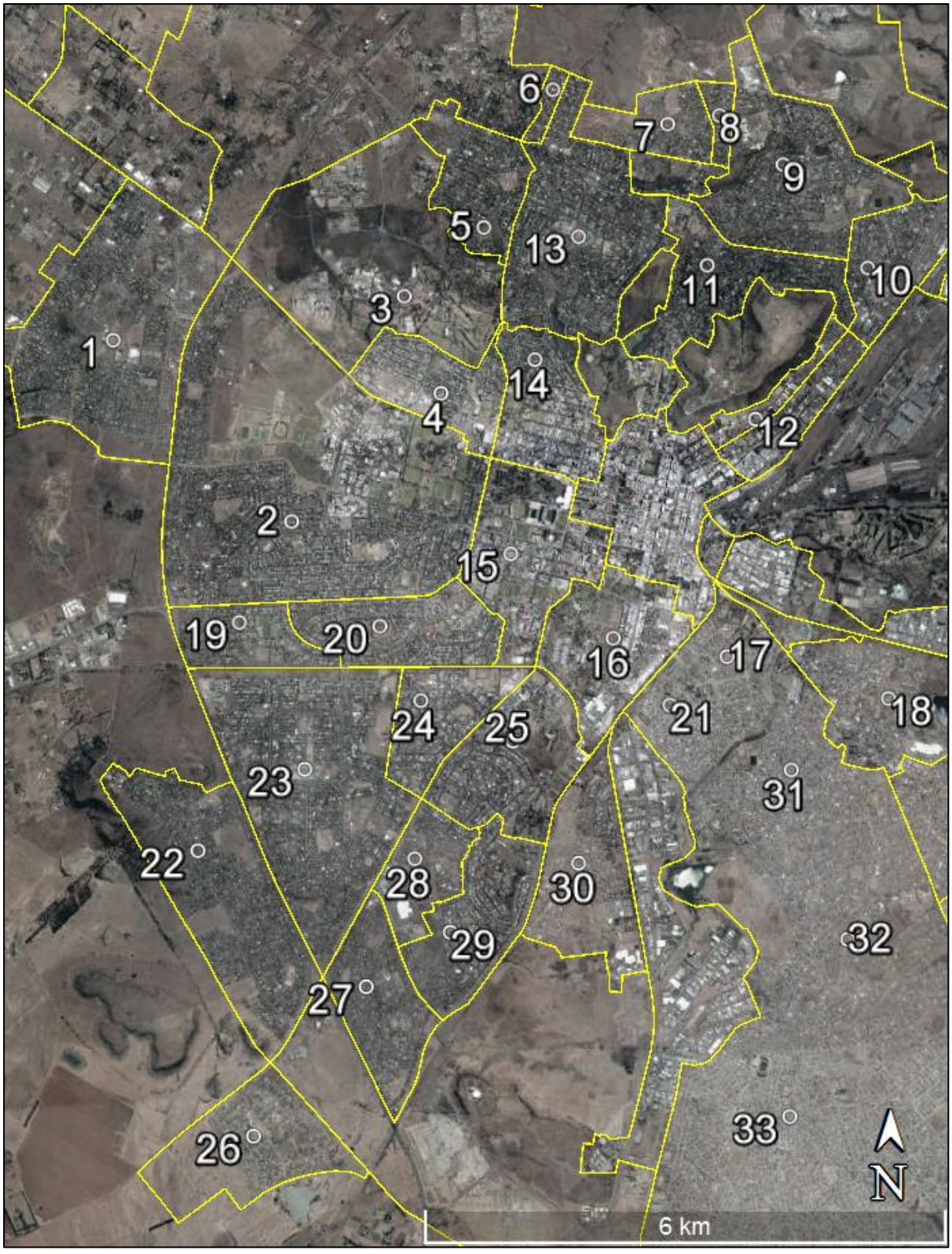

Figure 4-2: *Suburban Residential Areas of Bloemfontein* (Google LLC, 2018a)

Table 4-1: *Accessibility and Area of Suburbs of Bloemfontein*

	Bloemfontein Suburbs	Area (km^2)	Thoroughfare or Limited Access
1	Langenhoven Park	4.5	Limited
2	Universitas	9.66	Thoroughfare
3	Tempe	1.3	Limited
4	Brandwag	1.5	Thoroughfare
5	Heuwelsig	2.4	Limited
6	Hillsboro	1	Limited
7	Pentagon Park	1.3	Limited
8	Helicon Heights	1.2	Thoroughfare
9	Bayswater	1.3	Thoroughfare
10	Noordhoek	0.5	Limited
11	Waverley	1.3	Thoroughfare
12	Hilton	1.25	Limited
13	Dan Pienaar	3.8	Thoroughfare
14	Westdene	1.6	Thoroughfare
15	Willows	1.14	Thoroughfare
16	Oranjesig	0.5	Thoroughfare
17	Batho	1	Thoroughfare
18	Heidedal	0.8	Thoroughfare
19	Gardenia Park	1.4	Thoroughfare
20	Wilgehof	1.6	Thoroughfare
21	Hamilton	0.63	Thoroughfare
22	Pellisier	3	Limited
23	Fichardtpark	4.04	Thoroughfare
24	Hospital Park	1.2	Thoroughfare
25	Generaal De Wet	1.5	Thoroughfare
26	Lourier Park	1.5	Limited
27	Fauna	1.54	Thoroughfare
28	Fleurdal	1.48	Thoroughfare
29	Uitsig	0.79	Thoroughfare
30	Ehlrichpark	0.47	Limited
31	Bochabella	2.35	Thoroughfare
32	Phamaneng	2.44	Thoroughfare
33	Rocklands	3.05	Thoroughfare

34	Kagisanong	4.54	Thoroughfare
35	Blomanda	0.73	Thoroughfare

Langenhoven Park is a densely populated suburb located to the west of the city. Most of the residents fall in the middle- and upper-income groups of the population. Access to the suburb is limited to a few sub arterial (class U4, COTO, 2012) roads and the internal road network has a gridiron, and gridiron with loops, pattern. Neighbourhood civic and commercial facilities, for instance, schools, medical facilities, entertainment and sports facilities, and shopping centres are on hand in the suburb.

Although there are no large public parks or playgrounds to be found in this area, there is an acceptable number of public parks within this suburb as shown in **Figure 4-3.**

Figure 4-3: *Public Park in Langenhoven Park, Bloemfontein* (Google Earth, Accessed 2017)

Universitas, located to the south-west of the city, is the largest suburb in Bloemfontein. The largest university in the Free State province, namely, the University of Free State, is situated in this suburb. The suburb acts as a thoroughfare to other residential areas and major sub-arterial roads pass through Universitas and connect to other suburbs of the city. The residents fall mainly within the middle- to upper-income brackets. A large portion of the residents in this

area is students. Most of the residents either live in stand-alone houses or apartments; due to its proximity to the university, many of the houses have been converted into student houses. The suburb also has civic and commercial facilities comparable to that of most of the other suburbs of the city. There are several public parks in the residential areas of Universitas and in addition to these, a large public park and playground, belonging to the University of Free State, and close to sub arterial roads, are in this suburb. An example of a public park in the residential area is presented in Figure 4-4.

Figure 4-4: *Public Park Surrounded by Houses in Universitas, Bloemfontein* (Google Earth, Accessed 2017)

Batho is a densely populated suburb located to the east of the city. The greater part of the residents fit into a lower-income category. It consists of residential areas with houses in smaller yards and some informal settlements. In addition to some civic and commercial facilities, there are also some public parks within the residential areas as shown in Figure 4-5.

Figure 4-5: *Public Park in Batho, Bloemfontein* (Google Earth, Accessed 2017)

Lourier Park is a suburb with limited access situated to the south of the city. The population density is the same as that of Langenhoven Park. The residents in this part of the city mainly fit into a lower- to middle-income categories. Most residents live in stand-alone houses on medium- to small yards, or in group houses and apartments. There are also a few informal settlements and some large open spaces in this suburb. Six (6) public parks are situated in this residential area. An example of such a public park is presented in Figure 4-6.

Figure 4-6: *Public Park in Lourier Park, Bloemfontein* (Google Earth, Accessed 2017)

Dan Pienaar is a typically populated suburb located in the northern part of the city. Most of the residents fit into the upper-income category of the city's residents. With major sub arterial roads passing through the suburb and connecting to other suburbs, Dan Pienaar, in part, acts as a thoroughfare to other residential areas. The residents mostly live in stand-alone houses, but there are also some apartment buildings in the suburb. Neighbourhood civil- and commercial facilities, for example, schools, medical facilities, entertainment and sports facilities, and shopping centres are also located in this suburb. The public parks in this area are mostly of average size, but there are a few larger parks. Dan Pienaar has an adequate number of public parks and they have been designed and constructed to an accepted standard as shown in Figure 4-7

Figure 4-7: *Public Park in Dan Pienaar, Bloemfontein (Google Earth, Accessed 2017)*

4.3.3 Household and Physical Surveys

The household surveys were conducted in the suburbs selected. To conduct the household surveys, the investigators collected a list of the available households in the suburbs. A total of 408 households (ranging from 80 to 85 households per suburb) were chosen and surveyed and (91%) of the questionnaires were returned. Based on a confidence level of 95% and a confidence interval of 4.9, the sample selected was adequate. For the execution of the survey, a systematic stratified random sampling process (by employing standard statistical survey procedure) was employed. Pretested survey schedules comprised of various parameters relating to demographic-, socio-economic-, infrastructural-, daily activities-, recreational-, and means of transport, were used (see appendix E) (Fink, 2012; Kumar and Phrommathed, 2005).

For the assessment of the physical conditions of the public parks and their accessibility to the local users, up to date GIS data, obtained from the municipality, were included in the physical survey data besides the data of the other physical surveys conducted. Among these were, surveys of the traffic network systems in the vicinity of the public parks in the chosen areas, the availability of parking space close to the public parks, the presence and physical state of pedestrian accesses, the public transport system servicing the selected areas and the allocation and condition of the adjoining land.

4.3.3.1 Public Park Survey

Each public park in the study area was surveyed. The data collected from the survey included data relating to the whereabouts of the public parks, their upkeep, the type of access to each park, the lighting conditions and the apparatus available.

Physical park surveys were carried out by utilising uninterrupted digital photography and videography. There are in the order of 202 public parks in the city, of which 39 (19%) are situated in the chosen suburbs. For the park survey, 18 prominent public parks, located in the five chosen residential areas, were identified. Keeping the number of parks present in the selected suburbs and the city, along with their prominence in mind, the sample size was adequate (one in every 2.5 parks in the selected suburbs and one in every 14.5 public parks in the city). A time-lapse video camera to monitor the daily activity and the vibrancy issues of each park was set up at each of the identified public parks and filmed the park non-stop for seven days, (Figure 4-8). GIS was used to extract the spatial- and locational characteristics of those public parks.

Figure 4-8: *GoPro Hero 4 camera used to time-lapse the public parks* (Source: Author)

4.3.3.2 Significance of Data Collected

The data collected from the household survey provided insights to the demographic composition, socio-economic circumstances, daily activities, the residents' perception of the public parks and their use, the various reasons residents in the selected areas have for not utilizing the public parks accessible to them, and their ideas of how to improve their use.

The physical survey assisted in assessing the states of the residential areas, the availability of accessibility infrastructures, such as, roads and sidewalks, the prominence of the parks and

the distance from which it was visible, pedestrian convenience, parking facilities, illumination, the sizes of the public parks and the safety and security associated with park use.

The public parks survey provided the information which assisted with the appraisal of the available facilities, the turnout of visitors, and the obstacles in the way of the optimal utilisation of the park facilities.

4.3.3.3 Secondary Data

The secondary data for this study was gathered from published and unpublished literature, documents from Mangaung Metropolitan Municipality and GIS data on the selected areas, from the years 2005 to 2019, from the relevant authorities. The secondary data was integrated with the primary data for the formulation and development of theoretical simulation models. The models were put into operation to analyse the cause and effect relationships of the factors influencing the degree of vibrancy of the public parks in residential areas. They were also employed to simulate scenarios for dealing with the challenges against the vibrancy of public parks and to single out strategies which, when implemented, would maximise the vibrancy and use of public parks.

4.4 DATA ANALYSES

All the data collected was checked for completeness and accuracy. Data errors and bias returns were eliminated by cross-checking. Of the 408 household survey samples returned, 400 (96%) were selected for further analysis. The data was thereafter entered into excel code sheets for computer analysis; the software-based analysis was conducted by making use of the tools and techniques set out below.

4.5 ANALYTICAL TOOLS AND TECHNIQUES

4.5.1 Analytical Tools

Relevant analytical tools, including software, such as SPPS, Vensim, Excel, and Global Mapper, were used for data processing (SPSS and Excel), analysis (Excel), GIS (Global Mapper) and modelling (Excel and Vensim).

4.5.2 Analytical Techniques

Relevant statistical techniques, which included correlation, tabulation, significance tests (F distribution and t-test for p values), perception index (PI), variance inverse factor (VIF) tests and multiple regressions, were applied according to the requirements of the investigation.

The weighted average index method was employed to find the people's perception indices of the variables related to the accidents. The model used was:
Perception weighted average index= PI = (∑Pi*Ni)/ (∑Ni)

Where:
Ni = number of respondents,
Pi = index values provided by the respondents on a scale of 0 to 1 as observed from the household survey (Das, 2014).

Correlation coefficients between the number of annual public park users, as the dependent variable, and vibrancy factors as the independent variables were also obtained. A Variance Inflation Factor (VIF) test was conducted to observe the co-linearity among the independent variables. This was followed by the development of linear and multi-linear regression models between the number of public park users and the major independent variables. The results were examined, and trend analyses conducted to determine the impact of the major variables on the number of public park users and the implications, of applying the outcomes, on the use of parks (Guideline, I.H.T., 2005).

4.6 APPLIED SYSTEMS ANALYSIS

System Analysis means the analysis of a system, or in other words, a structured technique for coping with large, complex problems and bringing about an effectual allocation of resources to meet the conditions spelt out by well-defined goals and objectives (Neumann, 1999). System analysis can also be defined as an inquiry meant to aid the decision-maker in the choice of a course of action by systematically investigating precise objectives. This is followed, wherever possible, by a quantitative comparison of the costs and risks factors accompanying alternative policies, or strategies for achieving them. Last but not least, a system analysis can be seen as a vantage point, or perspective from which to ask questions, and a manner of thinking (Beimborn, 2003).

Applied Systems Analysis (ASA) is a problem-solving process, involving several stakeholders joining the researcher. The problems addressed by a system analysis are complex and incorporate associated factors and concepts. The structure of applied system analysis can be quantitative, qualitative, or a combination of the two (Miser, 1985). The main purpose of using an applied systems analysis is to help decision-makers and public policymakers with solving the problems they encounter on the short-, medium-, and long term. System analyses are useful for solving social-technical problems, for instance, challenges facing the future of the

human race, human energy needs and -health, air quality, and changes in the biosphere (Beck, Das, Thompson, Chirisa, Eromobor, Kubanza, Rewal, and Burger, 2018).

Systems analyses have been proven to be of benefit for issues generated by science and engineering. It can also work well for budgetary decisions by pointing decision-makers to the most cost-effective courses of action. Sensitive political-, social-, and organisational issues can be addressed more discreetly by making use of system analyses and often a delicate balance, acceptable to most of the stakeholders, can be found (Neumann, 1999; Gusti, Havlik and Obersteiner, 2008, Beck et al., 2018)

4.6.1 Applied Systems Analysis Approach

The International Institute for Applied Systems Analysis (IIASA) is dedicated to researching matters of global significance by drawing on applied system analysis methodologies. They also concede that the mode of systems analysis currently in use is constantly evolving as it adapts to varied problems and contexts. Applied Systems Analysis is a dynamic activity and, therefore, IIASA researchers follow the next 9 steps during their research:

- Marshall all the information and scientific knowledge on the problem in question available, and if necessary, gather additional evidence and develop an extended knowledge base.
- Establish the stakeholders'—both the people and institutions—of goals.
- Explore alternative ways of reaching the set goals and design, or invent distinctive mechanisms, as required, for reaching them.
- Reconsider the problem considering the knowledge gained.
- Estimate the impact and effect of the possible courses of action while accounting for the uncertain future and the organizational structures required to implement the proposals.
- Compare the alternatives through a detailed inventory of possible impacts and consequences.
- Present the results of the study to the stakeholders in a framework that facilitates decision making.
- Provide follow-up assistance.
- Evaluate the results.

Societal problems have become large and complex and cannot be solved by intuition or predisposition. A system analysis takes a wide-angle view of a problem and, therefore, it

seems to be the more appropriate problem-solving course to follow (Tomlinson and Kiss, 2013).

At first glance, a system analysis may seem the same as conventional methods, but because a system analysis allows for a more comprehensive insight into the problem being investigated, it is substantially different. Consequently, the understanding gained will allow decision-makers to make more resourceful, and effective, decisions (Hall, 1962, Beck et al., 2018).

4.6.2 Applied System Analysis Methodology

It is a generally accepted tenet that every problem is unique and requires a distinctive approach. A specific, orderly procedure or technique can, therefore, not be adopted in all cases. It is, however, as explained in the following section, possible to make use of general principles and techniques to address impending problems.

To steer the five fundamental activities of a systems analysis, namely, Formulation, Searching, Explanation, Evaluation, and Interpretation, a sequential framework is put into operation. The process of planning also needs to be added and must precede analysis (evaluation). The system will also benefit from an implementation process following the analysis (evaluation) (De Neufville, 1990). Figure 4-9 shows the flow of these 5 processes and how planning and implementation relate to the analysis (Tomlinson and Kiss, 2013, Beck et al., 2018).

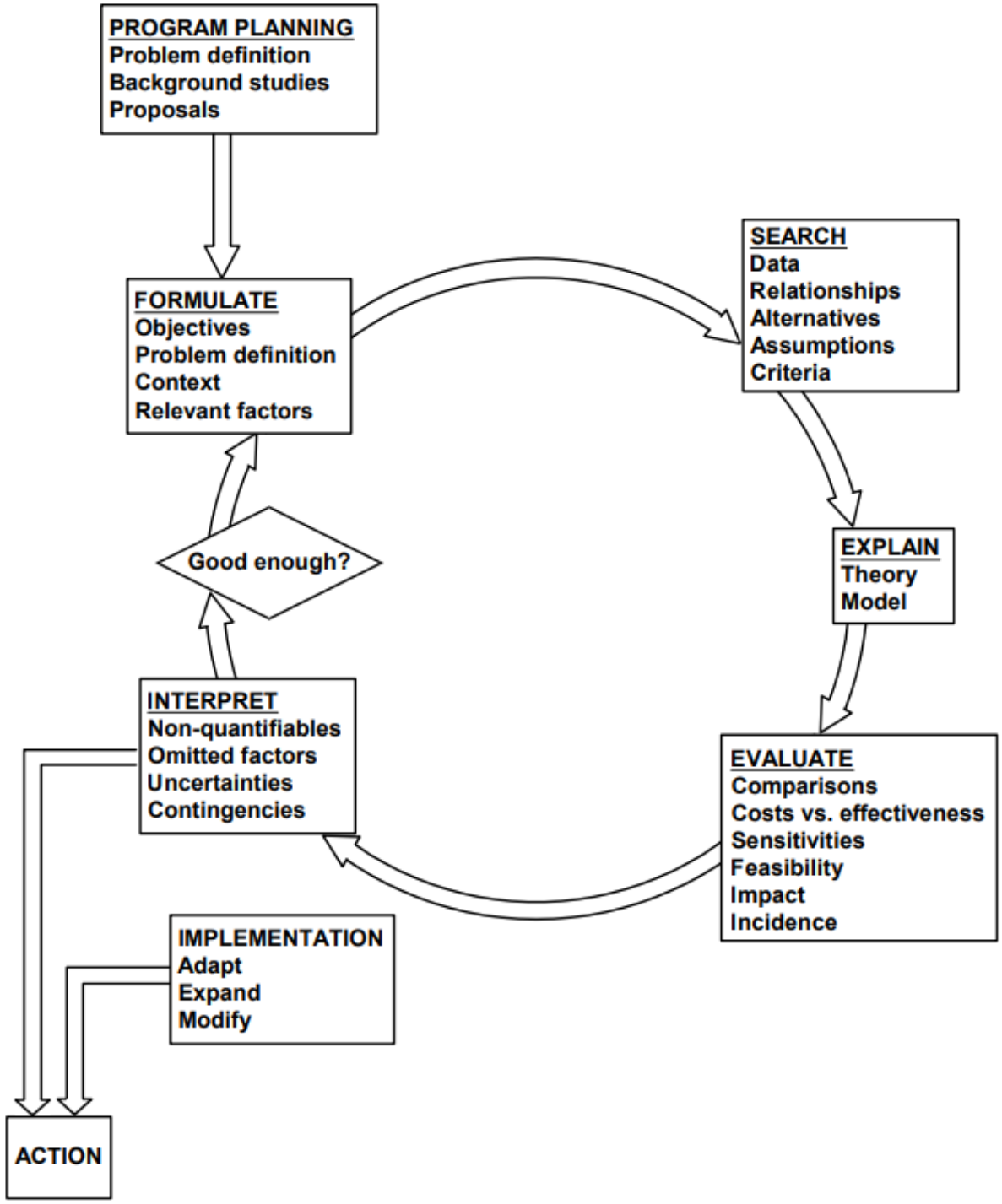

Figure 4-9: *The System Analysis Cycle* (Beimborn, 2003)

4.6.2.1 Planning Process

The planning process involves planning all the activities related to each of the system analysis processes. During this process, a comprehensive list of problems, that may require analysis, is compiled. Background studies for each problem should be included in this process and all the background information relevant to the problem ought to be collected. The development

of plans and proposals, for analysis purposes, also come about during this process. Questions such as, '"Why must this be done?' and 'How must this be done?' have to be addressed in some detail. The analysis process is made less intricate if meticulous planning is done. The application of devices, such as flow diagrams, work schedules, milestones, charts and deadlines add to the thoroughness of the planning process and is a worthwhile practice (Beimborn, 2003)

4.6.2.2 Formulation

Formulation has to do with how a problem is stated. It is important to note that the original problem statement cannot be accepted as conclusive and considerable effort should be applied to understanding and formulating the problem.

When outlining a problem, consideration must be given to such factors as the inputs, outputs, variables, constraints, parameters and relationships which must be considered when formulating the goals and objectives to be realised. The questions to be asked should include: 'What functions will the system you are studying perform?', 'What is disturbing the status quo?', ''Which factors are most relevant to the problem?' (There can easily be hundreds of them), 'Which are the higher and lower order systems?', 'What resources for studying the problem and implementing solutions are available?' and 'Can the problem be generalised?' Such questions can promote insight into the characteristics of a problem. A problem statement is not a solution statement and must not be defined as such, e.g. Problem statement: 'Build a better sidewalk' is poor because it refers to the solution—the sidewalk. A more appropriate problem statement may be: '"Rodents have taken up residence in the barn.' In that case, the mousetrap, and other rodent control techniques can be possible solutions to the problem.

4.6.2.3 Searching

This phase involves finding facts and data, searching for relationships, and assessing the relevant factors. Usually, information and data will incur costs, and shouldn't be collected unless necessary. Information overload can happen when the collected data is not used or needed. A proper perspective, all the way through the process, should, therefore, be maintained.

The development of alternatives is largely an exercise in creativity, but certain principles may facilitate the process. There should initially be many alternatives and, ideally, they must vary in scope widely. By avoiding criticism during the development phase, it is possible to develop a large number of alternatives, and since a later phase of the analysis cycle will be used to

give an explicit rationale for their elimination, it is essential to consider alternatives spontaneously and without prejudice.

Since elimination may often be carried out for poor reasons, and potentially good alternatives are lost, the premature elimination of alternatives is undesirable. Alternatives may involve changes in technology, policies, procedures or constraints. It is also essential to explore radical alternatives and to try and develop a continuum to link all the alternatives together. By looking for the basic elements—and the forms they may take—of a system, alternatives may be recombined in new ways (Beimborn, 2003).

4.6.2.4 Explanation

A model or relevant theory is a useful tool for communicating or explaining what a process is. An analysis can be reinforced by theories or models to bring about a better understanding of the relevant behaviour of a system. The models are small scale versions of the fields of study and should, therefore, realistically match the purpose and function occurring in the field. They are, nevertheless, merely indicators; results must be interpreted with care. Assumptions ought to be stated clearly, and in detail, leaving no room for confusion or doubt.

Models can be formatted by either contraction or expansion. Contraction selects all the available, significant variables and establishes a sizeable model of relevant, equitable details through a process of systematic elimination. Expansion, on the other hand, builds a simplified model from initial assumptions and then expands it to the desired measure of detail by defining the assumptions and differentiating them into constants and variables. (Beimborn, 2003).

4.6.2.5 Applied Systems Analysis Modelling

The four types of data models at work in ASA are:

- Conceptual Data Models
- Enterprise Data Models
- Logical Data Models
- Physical Data Models

Conceptual Data Models simulate the perceived strength of the relationships between the different entities but do not show the value-specific impact these entities, attributes and relationships have on a system. These models do not express the application and database-specific implementation as Logical Data Models do.

Enterprise Data Models address the unique requirements of a specific business and can be like a Conceptual Data Model.

Logical Data Models clarify the specific entities, attributes, and relationships involved in the function of the system. This serves as the starting point for the creation of the Physical Data Model.

Physical Data Models express the application- and database-specific implementation of Logical Data Models.

4.6.2.6 Evaluation

Alternatives should be compared according to their cost and efficacy. For the sake of meaningful solutions, both must be taken into consideration. Costs and efficacy should both be defined rather broadly, and perhaps include such features as, social costs and secondary benefits. The significance of the evaluation process lies in maintaining its main concern, which is finding the most applicable and effectual solution, at the lowest cost, or within the budget allowance, by way of consistently comparing cost to efficacy. Evaluation should also include the assessment of sensitivities. This may provide clues to the additional data that may be needed, or to the strength of the alternative or choice. The feasibility of the alternatives also must be considered. This can include political-, economic-, social-, technical-, and institutional feasibilities. The evaluation ought to also take note of the impact and incidence of costs and benefits and the stage at which these occur (Beimborn, 2003).

4.6.2.7 Interpretation

The outcome of the analysis should be interpreted in the light of factors that were not directly considered. Results should not be accepted blindly but should be interpreted responsibly. Assumptions must be stated clearly and in detail and leave no room for confusion or doubt. In other words, there may be quantifiable factors, uncertainties or contingencies absent, or that have not been considered. Likewise, how the recommended solution will act under unusual circumstances which are possible, but not probable, (i.e.) contingencies should be considered. Confidence in a choice made may be increased by an analysis that breaks even, (i.e.) how far can you be off before the recommendations changes(Beimborn, 2003).

4.6.2.8 Implementation

The final phase of the analysis process is implementation. In many ways, this phase is inherent in all the other activities because solutions that cannot be implemented are of little value. Implementation is aided by careful planning and an understanding of the conditions for

implementation. In this phase, as much as in all the other phases of analysis, careful planning is imperative. In addition, this phase involves the modification, and adaptation of results to new conditions and circumstances and it also involves the updating of data, re-evaluation of procedures and techniques and the expansion of results to other uses, applications, and activities (Beimborn, 2003).

4.6.3 Summary

The key elements of Systems Analysis explicitly explore:

- The system.
- The setting of the system: How does it relate to other systems?
- The goals and objectives: what are you trying to do? why?
- Interrelationships: how do the elements of a system affect one another?
- Technology and creativity: innovate, open your mind and try something different and new.
- Costs and effects: are they defined broadly, how are they related? Trade-offs.
- Uncertainty: don't ignore it, assess it, and try and get around it.
- Contingencies: will your solutions apply to many possible circumstances?

4.6.4 Applied System Analysis Check List

To facilitate the process of analysis or problem solving, a checklist of questions, which may simplify the maintenance of the system's perspective and help to avoid bias or error, is given. This checklist can be drawn on either during the analysis itself or while weighing up someone else's recommendations, plans or analysis. The checklist includes the following questions:

1) What is the purpose of the analysis?

2) Who is doing the analysis and is he /she qualified to do it?

3) What decision the analysis is concerned with?

4) Who must make the decision?

5) When are the decisions due?

6) Does the analysis ignore any related factors that should be considered jointly with the problems in the analysis?

7) Have many alternatives been developed, and do they represent diverse and extreme, as well as conventional all-purpose solutions?

8) Are all the actions, recommended in the analysis, technically-, economically-, politically- and socially feasible?

9) Does the analysis, during the decision making, disregard any consequence of the solution that should be considered?

10) Are the assumptions explicitly stated?
11) What are the criteria for the preliminary elimination of inferior alternatives?
12) Do the criteria appear reasonable?
13) Does the systems analyst disclose his subjective judgments fully?
14) Are the results of the analysis submitted in a useful form?
15) Are the limitations, as well as the advantages, of the analysis put across clearly and candidly?
16) Does the analysis provide straightforward rules for computation or any other strategy the decision-maker may use to eliminate inferior actions.
17) Are the conclusions intuitively satisfying?
18) Are there unique situations where the conclusions are obvious and are those conclusions consistent with the general ones?
19) Is the problem being considered the principal problem or related one?
20) Does the analysis allow for uncertainties?
21) What contingencies to address uncertainties are in place?
22) Are enemy- or competitor reactions considered?
23) Is the model adequate, logical and reasonable?
24) Does the study consider other possible models?
25) Are the recommendations made with full recognition of the uncertainties involved?
26) Have the goals and objectives been considered throughout the analysis?
27) How sensitive are the final recommendations to assumptions, and how the analysis was carried out? (Beimborn, 2003).

4.6.5 Conclusion to Applied System Analysis

While a system analysis, as much as any other human endeavour, has its limitations, and there are also other means of investigation available, it does have some merit. For one, it brings a certain objectivity into the subjective process of decision making and can, as such, facilitate the acceptance and implementation of the decisions. It can also interpret ambiguity more clearly. It shows interactions and side effects, may reveal unexpected consequences of policies and actions and it may provide deeper insight into problems which may open doors to better alternatives (De Neufville, 1990).

It can also be postulated that Applied Systems Analysis, is inherent, a multi- and interdisciplinary approach to problem-solving. It appears that studies, undertaken through Applied Systems Analysis, are making significant and indispensable contributions to solving some of the world's most complex problems. Reports of some of the studies can be found on the IIASA website.

4.7 MODELLING

4.7.1 Statistical Models

Statistical multiple regression models were developed and employed to understand the vibrancy of public parks. All the parameters, that could affect the vibrancy of parks, were measured and quantitatively analysed before drawing on them to build the models. Only the most relevant influential parameters were used to develop the models. While developing the models, the number of park visitors was applied as the measured parameter (dependent variable), and the major influential, statistically independent, vibrancy inducing parameters as the independent variables.

A multiple linear regression was run on 18 variables to evaluate the predictive power they had on the independent variable Y (Average Number of Annual Users). The regression assumptions were checked for violations. To solve multiple collinearities, the variables were split into four categories and regressions were run on each:

- a. Sociability,
- b. Uses and activities,
- c. Comfort and image
- d. Accessibility.

To adjust for the normality violations, the variables were log-transformed, and the regressions repeated. The transformations were checked to see if it changed the interpretation or significance of the regressions. Because log transformations make the interpretation of the coefficients more difficult (without adding value), the remaining regressions were done without transformations. The residuals were also analysed for heteroscedasticity.

Although the model development and conceptualisation were based on ASA, the relationships between the variables were linear, hence the use of linear multiple regressions which, in turn, would help to justify the conceptualizations of the ASA models.

4.7.2 ASA Modelling

On the grounds of the problem statement, a conceptualized model can be developed to work out the principle underlying the way vibrancy comes about in the public parks of the study areas. Before doing a detailed statistical analysis on all the collected data, these ASA models -will be conceptualized to promote a better understanding of the relevant system behaviour.

The ASA conceptual models are small scale theorized versions of the current fields of study and therefore, realistically match the purpose and function occurring in the field on a conceptual level only.

V= f (A, I, S, E) ……Eq. (1)

Where:
V= Vibrancy and sustainability of the parks
A= parameters related to activities in the park
I= parameters related to Engineering Infrastructure
S= parameters related to Sociability and social attributes
E= parameters related to Environment, image and comfort

Figure 4-10 presents the conceptual inter-linkage of sustainable and vibrant parks between communities, cities, and residential areas, at the city level. It is conceptualized that residential areas in a city will require sustainable and vibrant parks. The presence of sustainable parks will contribute to the creation of a healthy community characterised by physical and psychological health and the sociability and cohesion of people.

A healthy community, along with the environmental depiction and appearance of parks, will contribute to the making of sustainable cities. Sustainable cities, in return, will generate wholesome, and excellent, residential areas (Crawford, Timperio Giles-Corti, Ball, Hume, Roberts, Andrianopoulos, and Salmon, 2008).

Sustainable parks are, therefore, built on the function of parameters related to activities in the park, parameters related to engineering infrastructure, parameters related to sociability and social attributes and parameters related to the environment, image and comfort.

It is conceptualised that at the public parks division, the engineering infrastructure (influenced by access and the civic infrastructure), activities in the park, activities and sociability, sociability and image, comfort and environment and engineering infrastructure and image will have causal feedback relationships among themselves. Besides these, the availability of engineering infrastructure should enhance activities in the park and, as a result, engender greater sociability.

The presence of these parameters ought to contribute to: a change for the better in the way residents feel about the park, an improvement in the environment and an increase in the

degree of repose experienced (Korpela, Ylén, Tyrväinenand Silvennoinen, 2008). Consequently, all four attributes, along with their feedback relationships, should engender sustainable and vibrant public parks.

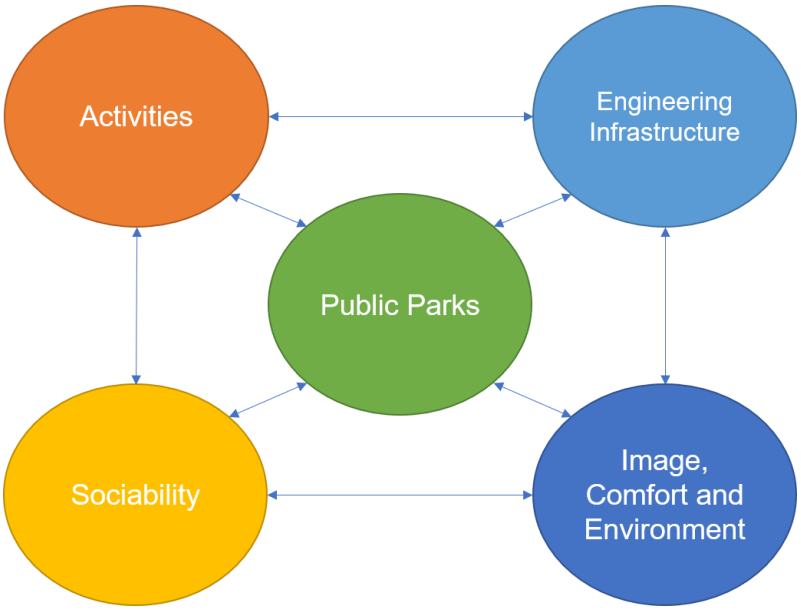

Figure 4-10: *Conceptual model (Soft model) based on the inter-linkage of the possible attributive areas engendering sustainable and vibrant public parks.*

4.7.1 Validation of Model

An indication of the accuracy and credibility of the model, for future predictions, was obtained by testing it on some of the public parks outside the study area.

4.7.2 Simulation and Forecasting

Based on the variations of several major control parameters, the developed and validated model was employed to project the average annual users of the public parks.

4.7.3 Application of the Model

To advance feasible policy interventions, alternative, plausible, simulated scenarios were developed by employing the model.

4.8 SUMMARY

A better and more accurate understanding of public parks in residential areas will be obtained by applying a methodology with a positivism approach that is rooted in ASA and statistical

analysis techniques. Public parks in residential areas will quantitatively be analysed and their functionality better understood from making use of the methodology highlighted in this chapter.

The next chapter will present and discuss the data collected for this study, as well as offer a preliminary analysis of the collected data.

CHAPTER 5: DATA REPRESENTATION AND ANALYSIS

5.1 INTRODUCTION

This chapter outlines how the study investigated the factors with the greatest influence on access to public parks. These include: *socio-economic environment; the physical access to, visibility of the public park; the transportation networks and traffic-related conditions around the parks, the sociability parameters; park functions and activities; the comfort and image parameters of public parks; and the influence of these factors, individually and combined, on the vibrancy of public parks.*

Data were collected by following Survey Research methods (c.f. Section 4.3). The available data was thereafter statistically analysed to work out the major control parameters influencing the access-ability of public parks in the study area.

Once all the necessary data was collected, all the records were vetted and cross-checked. The survey and analytical data collected on the public parks were tested for accuracy by making use of GIS software having up to date survey data, the latest aerial photographs of the study area as well physically surveying all the sites. The discrepancies found were corrected, and the data transferred to code sheets in order to steer clear of errors. Thereafter, the data was transferred to Microsoft Excel sheets and the relevant statistical analyses performed. The analyses included:

- A socio-economic scenario of the study area
- A conceptual Applied System Analysis
- An analysis based on a physical survey of the access systems to the public parks
- The relationship between the ability to access public parks and the number of frequent users
- The link between land application and access to the public parks
- The relationship between transportation networks and the ability to access public parks
- Parameterisation (delineating the major control parameters influencing the access-ability of public parks in the study area)
- Modelling and simulation for predicting the access-ability of public parks in the study area
- Predicting the access-ability of public parks in the study area

5.2 SOCIO-ECONOMIC STATUS OF THE STUDY AREA

The relationship between the economic welfare and social conditions of the study area provides a clearer analysis and understanding of the conduct of the residents as well as the potential functions of public parks. The study revealed that income, demographic characteristics, the availability of social infrastructure, lifestyle, daily activities, travel habits, and the use of various modes of transport for daily travel by potential users, all have a direct, and indirect, influence on the access-ability of public parks in the study area.

The analysis was conducted according to a range of variables, namely: (a) household income; (b) age; (c) age vs. public park utilisation; (d) academic qualification; (e) occupation; (f) type of dwelling/ house; (g) property ownership; (h) numbers and types of vehicles; (i) travelling distance to public parks; (j) back and forth trips; (k) transportation costs; and l) the degree to which public parks are utilised.

5.2.1 Households based on income

The residential area where a household lives is, for the greater part, decided by the income of that household, and usually, a household in a higher income bracket can have better living conditions than those in lower-income categories. Most of the household parameters, such as purchasing and spending power, personal transportation modes, recreational equipment and expenditures, as well as, the cost of daily activities, are dictated by the household income. Thus, household income is directly related to the socio-economic functions and recreational activities of the household.

For the purpose of analysis, and based on the data on household income collected, the households, and suburban study areas, were divided into income groups. Preliminary assessments on the individual households, as well as on the income range variations of all the households, were conducted. Income groups were thereafter put together according to income ranges. In order to ensure error-free and easy, unambiguous analysis, the income category intervals were kept identical. Seven groups, according to annual income, were subsequently created and presented in ascending order of income, from R 0-60000, R60001-120000, R 120001-180000, R180001-240000, R240001-300000, R300001-360000, and R360001 and above.

The numbers of families in the various income groups are presented in Table 5-1. The table shows that most of the households surveyed (approximately 62%) have a general income of below R240 0000 per year (R20 000 per month). Approximately 18% of the households are within the income range below R60000 per annum, followed by 19% in the income range of

between R60001 to R180000. Thirty per cent (30%) of households fit into the income categories of between R180001-R360000, and R360000 and above. Consequently, half of the households surveyed (52%) fit into lower-income categories (< R180000), approximately 28% fit into middle-income categories (R180001-R360000), and 20% are in the high-income category. Contrasts between the household income categories of the different residential areas can also be seen. Batho and Lourier Park have more households in the low-income category than Langenhoven Park, where households are spread more evenly across income categories. Due to the high number of non-working students residing in the area, Universitas has a unique range of income categories. Households in Dan Pienaar mainly fall into high-income categories.

5.2.2 Socio-Economic and Demographic Conditions of the Study Area

This section will focus on the over-all socio-economic background and the demographic, and socio-economic parameters of the study area. The parameters selected for analysis and discussion are: employment, age, level of academic qualification, occupation, living arrangements, property ownership, methods of transport, the distance travelled to public parks by each household, the number of visits to public parks per household, transportation costs, and the number of public park visitors in each household.

5.2.2.1 General Socio-Economic Background of the Households Surveyed in the Study Area

Table 5-1 shows the socio-economic background of the five residential areas surveyed. The purpose of this analysis was to observe the variations and patterns in the socio-economic parameters of each suburb. Factors such as the number of households, the average number of vehicles per household, the average number of persons per household, the number of property owners, the average number of there and back trips to public parks per household, and the average distances travelled to and from public parks, by households in each income category.

Table 5-1: *Socio-Economic Background of the Residential Areas*

Income Per Annum	No. of Households	Ave. No. of Vehicles	Ave. No. of People Per Dwelling	No. of Property Owners	Ave. No. of Visits Per Month to Public Parks in Area	Ave. Km/Month Travelled to a Public Park
Batho						
R 0 - 60000	10 (20%)	0	1	7	5	<10 km
R 60001-R120000	20 (40%)	0	3	19	3	<6 km
R 120001-R180000	15 (30%)	1	8	15	1	<3km
R180 001 – R240 000	5 (10%)	1	7	5	1	1-2 km
R240001-R300000	0 (0%)	-	-	-	-	-
R300001-R360000	0 (0%)	-	-	-	-	-
> R360 000	0 (0%)	-	-	-	-	-
Subtotal	50	0.3	4	46	3	-
Langenhoven Park						
R 0 - 60000	5 (10%)	1	2	2	2	< 10km
R 60001-R120000	5 (10%)	1	1	3	2	< 6km
R 120001-R180000	5 (10%)	1	2	4	1	1-2 km
R180 001 – R240 000	6 (12%)	2	2	3	1	1km
R240001-R300000	6 (12%)	2	2	3	1	1km
R300001-R360000	10 (20%)	2	3	3	0	1km
> R360 000	13 (26%)	2	3	2	0	1km
Subtotal	50	1.6	2	20	2	

Universitas						
R 0 - 60000	14 (28%)	1	1	5	4	< 10km
R 60001-R120000	10 (20%)	1	1	5	3	< 6km
R 120001-R180000	8 (16%)	1	2	5	2	1-2 km
R180 001 – R240 000	6 (12%)	2	3	5	1	1km
R240001-R300000	5 (10%)	2	3	5	1	1km
R300001-R360000	4 (8%)	2	3	4	0	1km
> R360 000	3 (6%)	2	2	3	0	1km
Subtotal	50	1.6	1.8	32	2	
Lourier Park						
R 0 - 60000	16 (32%)	0	1	8	5	< 10km
R 60001-R120000	12 (24%)	1	3	10	3	< 6km
R 120001-R180000	7 (14%)	1	4	5	1	1-2 km
R180 001 – R240 000	5 (10%)	1	6	5	1	1km
R240001-R300000	5 (10%)	2	6	5	1	1km
R300001-R360000	3 (6%)	2	6	3	0.5	1km
> R360 000	2 (3%)	2	6	2	0.5	1km
Subtotal	50	1.2	5	38	2	-
Dan Pienaar						
R 0 - 60000	0	0	1	0	2	1-2 km
R 60001-R120000	1	0	1	0	2	1-2 km
R 120001-R180000	2	1	2	0	1	1-2 km
R180 001 – R240 000	2	1	3	0	2	1-2 km

R240001-R300000	5	1	3	2	1	1-2 km
R300001-R360000	7	2	3	6	1	1-2 km
> R360 000	33	2	3	28	0	1-2 km
Subtotal	50	1	2.5	36	1	

The table reveals the following:

- The number of people per dwelling in higher-income households tends to be higher than those in lower-income households by about 30%.
- The average number of vehicles per household, for each of the five areas, differ from one another. The higher income group has a higher number of vehicles.
- All the households surveyed admit to travelling 1km or less to a public park in their area. This is in line with the findings of the GIS data survey conducted in this study.
- Households without vehicles are more inclined to visit public parks in their own neighbourhood.
- In four of the five residential areas, higher-income households tend to travel significantly shorter distances to public parks than those of - lower-income households do. There is, however, no clear correlation between the number of property owners, and the frequency of household visits to public parks.
- Residents in lower-income groups visit public parks more frequently than residents in higher-income groups do.
- There seems to be a correlation between the average monthly distance travelled to public parks and the average number of visits to public parks per month.

5.2.3 The Population of Study Areas

As a rule, public parks are visited by those residing in the vicinity of the parks. The population of a residential area can provide an accurate estimation of the potential number of visitors, to public parks in that area. It can, therefore, be significant to be familiar with the number of residents in each of the selected residential areas, in order to identify how that number, relates to the actual number, of visitors to public parks in these areas.

Table 5-2: *Population of Study Areas*

Residential Study Area	Male Population	Female Population	Total Population
Batho	3218	3376	6594
Langenhoven Park	5192	6176	11368
Lourier Park	1483	1694	3177
Universitas	4519	4559	9076
Dan Pienaar	2578	2684	5262

(Statistics South Africa, 2011)

Table 5-3 shows that Langenhoven Park has the highest number of residents in the study area, whereas Lourier Park, has the least. This can be attributed to the fact that of the five selected, established, residential areas, Lourier Park is the youngest. From a different perspective, however, Universitas, even though it has slightly fewer residents than Langenhoven Park, has more public parks. This came about because some of the public parks in Langenhoven Park were rezoned for commercial and residential use. A comparative analysis of Table 5-2 and Table 5-3 shows that the number of public parks per residential area is almost directly related to the number of residents per residential area.

5.2.4 Age

The age of the population in any society has some bearing on the activity, mobility, social ability and recreational tendencies of the people. Based on the household surveys of the five residential areas, public parks are being utilized by persons of employment age, just as often as by those aged under 18 (Worpole, no date). Bearing this in mind, the investigation sought to determine the age groups of the family members in the households of the study area. The outcomes are presented in Table 5-2.

Table 5-3: *General Age of Households*

Study Area	Population Distribution (%) According to General Age (Years)							
	0 – 6	**7 - 13**	**14 - 18**	**19 - 24**	**25 - 40**	**41 - 60**	**> 60**	**Total**
Batho	16%	15%	12%	10%	25%	16%	6%	**100%**
Langenhoven Park	12%	10%	12%	11%	26%	21%	12%	**100%**
Lourier Park	12%	11%	12%	12%	27%	18%	8%	**100%**
Universitas	8%	8%	12%	15%	30%	17%	6%	**100%**
Dan Pienaar	12%	10%	12%	11%	23%	21%	15%	**100%**
Average	**12%**	**11%**	**12%**	**12%**	**27%**	**18%**	**8%**	**100%**

From Table 5-2, it can be seen that more or less 57% of the population in the study areas, fall in the age group between 19 and 60 years. Thirty-five per cent (35%) are in the group 0-18 years, and of these, 12% are infants (i.e. below 6 years). Only 8% of the population is over 60 years of age. This implies that the study area has a significant number of active people in all the age groups, who are potential visitors to public parks. Considering the importance of, and need for, frequent recreational activities for people of all ages, public parks need to be easily accessed and more inviting to people of all age groups.

5.2.5 Academic Qualifications

Education seems to be crucial for the upgrading of human resources, and because the development of human resources is of vital importance to the effective functioning of a city, education and training is a major role player in the functioning of a city, and it is often used as a mechanism to measure the social and economic development in an area. In consideration, this investigation attempted to establish the academic ability of residents in the study area. The academic qualifications and education levels of residents in the study area are presented in Table 5-4.

Table 5-4: *Academic Qualifications vs. Income Level*

Income	Academic Qualification				
	Secondary School	**Undergraduate**	**Post-graduate**	**Technical**	**Total**
R 0 - 60000	20 (41.67%)	8(16.67%)	2 (4.17%)	18 (37.50%)	48 (100%)
	(28.57%)	(13.79%)	(6.67%)	(37.73%)	(23.07%)
R 60001-R120000	18 (36.00%)	15 (30.00%)	2 (4.00%)	15 (30.00%)	50 (100%)
	(25.71%)	(25.86%)	(6.67%)	(30.61%)	(24.03%)
R 120001-R180000	20 (42.55%)	15 (31.91%)	3 (6.38%)	9 (19.14%)	47 (100%)
	(28.57%)	(25.86%)	(10.00%)	(18.36%)	(22.60%)
R180001 – R240000	4 (19.04%)	7 (33.33%)	5 (23.81%)	5 (23.81%)	21 (100%)
	(5.71%)	(12.07%)	(16.67%)	(10.20%)	(10.10%)
R240001-R300000	4 (22.22%)	7 (38.89%)	5 (27.78%)	2 (11.11%)	18 (100%)
	(5.71%)	(12.07%)	(16.67%)	(4.08%)	(8.65%)
R300001-R360000	4 (28.57%)	4 (28.57%)	6 (42.56%)	0 (0.00%)	14 (100%)
	(5.71%)	(6.90%)	(20.00%)	(0.00%)	(6.73%)
R360001 and above	1 (10.00%)	2 (20.00%)	7 (70.00%)	0 .00(0%)	10 (100%)
	(1.43%)	(3.45%)	(23.33%)	(0.00%)	(4.81%)
Total	70 (33.65%)	58 (27.88%)	30 (14.42%)	49 (23.56%)	208 (100%)
	(100%)	(100%)	(100%)	(100%)	

Table 5-4 shows the educational background of most of the residents in the income ranges between R0 and R360000.00, including those with secondary-school education and graduates. Only a few households, however, have residents with postgraduate and technical qualifications. Many residents in the income range above R360000 have graduate or postgraduate qualifications.

The table also shows that approximately 34% of the people surveyed in the study have a secondary-school qualification. Twenty-eight per cent (28%) of the people surveyed in these residential areas are graduates, while 15% have post-graduate qualifications. Twenty-four per cent (24%) of the study group are artisans or technicians. It can also be noted that 81% of the individuals in the higher income bracket (more than R360000 per annum), have either undergraduate- or postgraduate qualifications. Sixty-nine per cent of 69% of the persons earning less than R60000 per annum have only a secondary-school or technical qualification. No clear correlation could be established between public parks users and their level of qualification.

5.2.6 Dwelling Type

The type of dwelling indicates the living conditions in the study area. It also reflects on the recreational restrictions a household may experience, due to the space available in their dwelling.

Table 5-5: *Dwelling Type in Study Areas*

Residential Area	Dwelling type						
	House	Duplex	Townhouse	Flat	Student House	Informal Settlement	Total
Batho	22 (44%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	28 (56%)	50 (100%)
Langenhoven Park	25 (50%)	5 (10%)	12 (24%)	3 (6%)	5 (10%)	0 (0%)	50 (100%)
Lourie Park	40 (80%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	10 (20%)	50 (100%)
Universitas	26 (52%)	3 (6%)	4 (8%)	0 (0%)	17 (34%)	0 (0%)	50 (100%)
Dan Pienaar	44 (88%)	2 (6%)	4 (8%)	0 (0%)	0 (0%)	0 (0%)	50 (100%)
TOTAL	157 (63%)	10 (4%)	20 (8%)	3 (2%)	22 (8%)	38 (15%)	250 (100%)

From Table 5-5, it can be observed that most of the dwellings in the study areas (63%) are houses, followed by informal settlements (15%). The remainder of the dwellings (22%) are apartments, student houses, and duplexes or townhouses. Houses are the preferred type of dwelling in all five of the selected residential areas. No clear correlation could be established between public parks users and their type of housing.

5.2.7 Summary Findings from Socio-economic Conditions

Having analysed the data regarding income, age, population, academic qualification, and dwelling types in the tables, the following observations were made:

- There are a significant number (over 80% of the population) of active people (aged between 13 and 60) who can visit public parks, in the study area.
- The potential numbers of public park visitors are higher (about 30% more) among adults than among infants and children (0-18 years).
- Households in the higher income category tend to make less use of public parks in their area than households in the lower-income range.

- Residential areas with a higher population do not necessarily have a higher number of public park visitors.

5.3 PHYSICAL CONDITION AND USAGE SCENARIO OF PUBLIC PARKS IN STUDY AREAS

In order to establish the parameters affecting the accessibility of public parks, a total of 18 public parks were surveyed physically. This included 4 public parks in Universitas, 4 public parks in Langenhoven Park, 3 public parks in Batho and 3 public parks in Lourier Park, and 4 public parks in Dan Pienaar. Table 5-6 presents the different attributes of the public parks, such as the coordinates, area, service area, and population of each selected public park, as well as, the average number of monthly users as obtained from the video surveillance data.

Table 5-6: *Surveyed Public Parks in Study Area*

Public Park Reference Number	Average # Users Per Month	GPS Coordinates	Area of Park (Km²)	Service Area of Park (Km²)	Population in Service Area
Batho					
BP1	706	29°08'07"S; 26°13'42"E	0.016	0.4	2413
BP2	206	29°07'55"S; 26°13'38"E	0.006	0.33	1991
BP3	134	29°08'29"S; 26°13'49"E	0.002	0.15	905
Langenhoven Park					
LHPP1	294	29°05'06"S; 26°09'24"E	0.005	0.32	698
LHPP2	168	29°06'25"S; 26°09'21"E	0.006	0.21	458
LHPP3	34	29°06'02"S; 26°09'41"E	0.015	0.16	350
LHPP4	34	29°05'39"S; 26°09'17"E	0.005	0.4	873
Lourier Park					
LPP1	882	29°11'17"S; 26°10'43"E	0.241	0.78	1116
LPP2	147	29°11'08"S; 26°10'37"E	0.033	0.12	172
LPP3	294	29°10'56"S; 26°10'40"E	0.06	0.36	515

Universitas					
UP1	34	29°07'0"S; 26°10'11"E	0.054	1.44	2437
UP2	294	29°07'2"S; 26°10'30"E	0.008	0.33	559
UP3	13	29°06'58"S; 26°10'48"E	0.009	0.24	406
UP4	38	29°07'19"S; 26°10'31"E	0.006	0.19	321
Dan Pienaar					
DP1	121	29°04'59"S; 26°12'28"E	0.002	0.85	483
DP2	203	29°05'27"S; 26°12'59"E	0.004	0.54	526
DP3	102	29°05'42"S; 26°12'55"E	0.002	0.26	432
DP4	521	29°04'55"S; 26°12'14"E	0.044	1.2	419

5.3.1 Spatial Area of Public Parks in Study Areas

By drawing on GIS software and data obtained from the local authorities, the locations of every public park in Bloemfontein was established. Detailed information on the location of each public park is essential for developing a working model.

The physical locations of the public parks in the study areas are presented in Table 5-6. It can be observed that the sizes of public parks vary between 0.002 km² (minimum) to 0.241 km² (maximum). The sizes of most of the parks (10 out of 18) range between 0.006 km² and 0.016 km. Some of the parks (4 out of 18), however, are somewhat larger, and range between 0.033 km² to 0.054 km². This indicated that the parks in the residential areas fluctuate between small and large. Most of the parks, however, are even sized and fluctuate between 0.006 km² to 0.016 km².

5.3.2 The Service Area of Public Parks in the Study Areas

Every public park is meant to be accessible to the residences located within a certain radius of that public park. By making use of GIS software, the service area of every public park in the study area was measured and tabulated (Table 5-6). The boundary lines of each service area were determined by drawing lines of equal distance from the congruent public parks. The population of each service area was also established from census data and is presented in Table 5-6. As observed from Table 5-6, the service area of public parks fluctuates between 0.12 km² (minimum) to 0.78 km² (maximum). Most of the parks, however, have a service area that ranges between 0.19 km² to 0.40 km². On account of these calculations, it can be surmised that public parks are well-spaced across the residential areas investigated.

5.4 SOCIABILITY PARAMETERS OF PUBLIC PARKS IN THE STUDY AREAS

The level of sociability to which a public park adheres is one of the four major determinants of a good, vibrant public park. The sociability of a public park refers to the extent to which people meet there and intentionally also take other people, such as friends and family there on social outings. The facets and dynamics are the numbers of adults, children and elderly persons visiting the park, as well as, the number of visits they make; the presence of, and types of social networks in operation; the involvement of volunteers in the upkeep and maintenance of the public parks; evening activities in the public park; and the presence and kinds of street life in the vicinity of the public park.

5.4.1 The age groups of public park users in the study areas

The age groups of all the visitors to all the public parks of the study areas were recorded – Illustrated in Table 5-7.

Table 5-7: *The Ages of Visitors to the Public Parks in the Study*

Public Park Reference Number	Attendance Age Groups (% of the users)						
	0-5	6 to 12	13 to 18	18 to 29	30 to 49	50 to 64	65 and over
BP1	10	50	19	6	5	2	8
BP2	9	61	12	4	3	4	7
BP3	13	60	11	7	6	3	0
LHPP1	30	20	10	8	29	2	1
LHPP2	26	24	12	5	28	4	1
LHPP3	35	22	11	6	20	3	3
LHPP4	38	20	13	7	15	2	5
LPP1	2	9	20	35	28	5	1
LPP2	5	22	28	17	20	4	4
LPP3	4	20	25	26	17	3	5
UP1	4	13	10	49	9	5	10
UP2	5	15	12	43	10	6	9
UP3	7	17	11	35	14	7	9
UP4	6	16	13	38	11	7	9
DP1	25	33	11	12	13	4	2
DP2	23	34	12	8	15	3	5
DP3	22	26	15	12	15	4	6
DP4	31	29	10	11	12	3	4
Average	**16**	**27**	**14**	**18**	**15**	**4**	**5**

Table 5-7 shows the percentages of the different age groups visiting public parks. From table 5-7 it can be derived that most of the public park users are between 6 and 12 years old, but not to a large extent. The percentage of older visitors, those aged 50 and up, only add up to 9% of all the public park visitors. This may imply that public parks in residential areas of South African cities are primarily visited by people under 50. Another interesting point of interest to take note of from table 5-7, is that Batho has a significantly higher number of users aged between 6 and 12, which can be the result of the fact that this residential area is a low-income neighbourhood.

5.4.2 The presence of volunteers at the public parks in the study areas

The household- and physical surveys disclosed which of the public parks in the study areas were attended to by volunteers willing to assist with the upkeep and maintenance of the public parks. These volunteers were willing to sacrifice their time, and or money, towards the upkeep and maintenance of the public parks, without compensation. Table 5-8 displays a breakdown of the known volunteers in all the public parks of the study areas.

Table 5-8: *Breakdown of Volunteers*

Public Park Reference Number	Volunteering caretakers. Y/N
BP1	N
BP2	N
BP3	N
LHPP1	N
LHPP2	Y
LHPP3	Y
LHPP4	N
LPP1	N
LPP2	N
LPP3	N
UP1	Y
UP2	Y
UP3	Y
UP4	Y
DP1	Y
DP2	Y
DP3	Y
DP4	Y

Table 5-8 shows that only the residential areas in the middle- and higher-income categories have volunteers willing to spend their time and money on the maintenance and upkeep of the public parks in their neighbourhood. Later comparisons with the average number of monthly users, which will be discussed in greater detail in chapter 6.

5.4.3 Special functions and events in the public parks of the study areas

Public parks are great spaces to hold special events and functions. Events such as, produce markets, fairs, carnivals, fundraisers, fun runs, art and craft markets, and more motivate residents in their communities to socialise and network with one another, ultimately facilitating the escalation of social interaction. Table 5-9 presents a breakdown of the average number of events hosted by each public park in the study area per year. The average number of events were obtained from household surveys, interviews, and physical surveys. Only official and planned events were included for analysis.

Table 5-9: *Average Number of Events Held in PPs of Study Area*

Public Park Reference Number	Average # Users Per Month	Average Number of Events per year
BP1	681	6
BP2	540	3
BP3	62	0
LHPP1	294	1
LHPP2	168	4
LHPP3	154	2
LHPP4	42	0
LPP1	882	4
LPP2	147	0
LPP3	294	0
UP1	72	3
UP2	512	6
UP3	33	0
UP4	186	1
DP1	121	0
DP2	203	1
DP3	102	0
DP4	521	3

According to this table, 6 events per year is the most events hosted in only two of the public parks, with several (7) public parks not hosting any events throughout the year. Some (2) of the public parks in the study area hosted events every quarter, while other public parks (7) in the study areas hosted only 1 to 3 events per year. None of the public parks in the study areas hosted frequent events on a monthly or weekly basis.

5.4.4 The role of the ethnicity of public park users in the study areas

The ethnic diversity of persons visiting public parks has a notable bearing on the sociability of a park. It is therefore helpful to understand the diversity of the public parks in the study area. Table 5-10 lists a classification of the ethnic groupings of public park users in the selected study areas.

Table 5-10: *Ethnic Classification of PP Users in Study Areas*

Public Park Reference Number	Average # Users Per Month	Ethnic Diversity			
		% White	% Black	% Coloured	% Other
BP1	681	2	83	15	0
BP2	540	3	77	20	0
BP3	62	0	95	5	0
LHPP1	294	59	16	15	10
LHPP2	168	65	11	12	12
LHPP3	154	61	15	13	11
LHPP4	42	85	5	5	5
LPP1	882	9	67	22	2
LPP2	147	3	77	19	1
LPP3	294	5	78	14	3
UP1	72	42	35	15	8
UP2	512	27	35	25	13
UP3	33	52	20	19	9
UP4	186	35	26	24	15
DP1	121	85	5	5	5
DP2	203	81	5	5	9
DP3	102	80	5	5	10
DP4	521	86	2	2	10

When referring to the most recent national census (2011), it is brought to light that Bloemfontein's ethnic grouping is approximately 56% black, 30% White, and 13% Coloured. From Table 5-10 the observation is that public parks in Universitas show the most ethnic diversity among park visitors in the city with close to an even percentage of 25% of representation spread across the four ethnic groups. This is likely caused by many students taking up residence in this neighbourhood because of the university (University of the Free State) being located close by. The public parks in the other residential areas of the study area are visited by either mostly black or mostly white users.

5.5. USES AND ACTIVITY PARAMETERS IN THE PUBLIC PARKS OF THE STUDY AREAS

This section will inspect all the activities and uses available or occurring in public parks of the study area. Activities in public parks include friendly social interactions, free public concerts, community art shows, and more. The usefulness and activities in a public park end up being the basic building blocks of a vibrant public park (PPS,2014), since it is the reason people visit, and return to the park, in the first place. Activities also make room for something special or unique, which in turn, may help generate community pride. Parameters and factors that will be analysed under uses and activities are neighbouring land use allocation; the type, condition,

and expanse of vegetation (greenery) in the public parks; and available activity-related facilities in the public parks.

5.5.1 Public Parks' adjacent land use

Urban residential areas are mainly comprised of different types of dwellings. Public parks situated within the residential areas have primarily been developed for the residents in the surrounding neighbourhood. As with all cities of South Africa, residential areas contain pockets of other land allocations, for instance, schools, churches, commercial premises, agricultural areas, and industrial compounds. This being the case, it is important to know how the land use around the public parks of residential areas, can possibly impact the use of public parks. Table 5-11 displays a breakdown of the various land uses surrounding the public parks in the study areas.

Table 5-11: *Breakdown of Adjacent Land Use of PPs in Study Areas*

Public Park Reference Number	Average # Users Per Month	Adjacent Land Use Percentage Breakdown					
		School	Church	Commercial	Residential	Agricultural	Industrial
BP1	681	34	3	8	53	0	3
BP2	540	6	19	6	63	0	6
BP3	62	3	12	18	68	0	0
LHPP1	294	0	0	0	64	36	0
LHPP2	168	6	0	0	89	0	6
LHPP3	154	0	0	15	85	0	0
LHPP4	42	0	12	0	88	0	0
LPP1	882	0	0	0	67	33	0
LPP2	147	16	5	0	79	0	0
LPP3	294	33	0	0	67	0	0
UP1	72	0	0	0	100	0	0
UP2	512	0	0	10	90	0	0
UP3	33	0	0	0	100	0	0
UP4	186	0	0	14	86	0	0
DP1	121	0	0	0	100	0	0
DP2	203	0	0	0	100	0	0
DP3	102	0	0	0	100	0	0
DP4	521	0	0	0	100	0	0

From Table 5-11, the observation is that the public parks in the study areas are mostly hemmed in by residences. Some of the public parks in the study areas are conjoined by churches and

schools. Lourier Park and Langenhoven Park each have two public parks with adjacent agricultural land. Since these two residential areas are on the outskirts of the city, this is not an unexpected occurrence.

Due to the unpleasantness of noise, air pollution, and an unappealing and inhospitable environment, the presence of industrial compounds close to public parks should be avoided as far as possible (Yin *et al.*, 2011). It is seen from Table 5-11, however, that two public parks in Batho and one in Langenhoven Park do have industrial complexes adjoining them which affects the attractiveness and safety of these parks. The percentages of land adjacent to public parks, used for industrial purposes, are at 3 to 6 % nevertheless, low. The rest of the public parks in the study areas have no (0%) exposure to industries.

5.5.2 Public Parks vegetation

The literature review verified the significance of vegetation in public parks. The type and extent of vegetation in the study areas is summarised in Table 5-12. The study area (city of Bloemfontein) is characterised by a semi-arid climate with grassy plains. The rainfall in the region happens mostly in summer, but it can be erratic.

Throughout the year, there is not much rainfall in the study area. The climate in the study area is classified as BSk (cold semi-arid) by the Köppen-Geiger system (Conradie, 2012). The average annual temperature in Bloemfontein is 16.1 °C and the average annual rainfall 548 mm (Conradie, 2012). The vegetation in the public parks of the study areas struggles to sustain its verdure all year round. Without manual irrigation, the plant-life tends to present sparse, pale, semi-arid features. During times of rain, the vegetation revives and becomes lush and green.

Water scarcity is a reality in most of the residential areas of cities in South Africa, and water restrictions are implemented, to various degrees, from time to time, as has recently been experienced. The water restrictions, currently in operation in most of South Africa's cities, result in public parks in residential areas not being able to rely on manual irrigation to maintain its verdure (Savenije, 2000).

Due to droughts and seasons with out of the ordinary climate conditions, the vegetation in public parks is prone to frequent adjustments. To determine if there is a direct correlation (and if so, its degree) between park use and vegetation density and verdure, the types of vegetation, as well as the degree of coverage in the public parks of the study areas, were recorded simultaneously with the recording of the average users per month

Table 5-12 shows that the public park in Lourier Park having a water feature, has the highest number of trees (102), as well as good grass coverage (80%) and little-known barren ground (14%). It is also noteworthy that this public park receives the highest number of regular visitors per month. The water feature in this public park is a natural dam, which provides enough water for the trees in the park to survive. Additional discussion of the impact this water feature has on the public park's vibrancy will be found in chapter 6.

Another noteworthy linking derived from Table 5-12, is that public parks with higher percentages of barren ground also tend to have lower numbers of average users per month.

Table 5-12: *Type and Extend of Vegetation in the PPs of the Study Areas*

Public Park Reference Number	Average # Users Per Month	Vegetation Type				
		Number of Trees	% Plant coverage	Barren Ground	Water Feature YES/NO	% Grass Coverage
BP1	681	13	5%	15%	NO	80%
BP2	540	3	5%	10%	NO	85%
BP3	62	0	0%	100%	NO	0%
LHPP1	294	11	2%	3%	NO	95%
LHPP2	168	23	5%	5%	NO	90%
LHPP3	154	39	2%	12%	NO	86%
LHPP4	42	19	20%	0%	NO	80%
LPP1	882	102	6%	14%	YES	80%
LPP2	147	12	60%	20%	NO	20%
LPP3	294	23	15%	5%	NO	80%
UP1	72	35	10%	10%	NO	80%
UP2	512	28	15%	5%	NO	80%
UP3	33	16	0%	5%	NO	95%
UP4	186	13	18%	1%	NO	81%
DP1	121	15	13%	5%	NO	82%
DP2	203	19	12%	7%	NO	81%
DP3	102	12	0%	5%	NO	95%
DP4	521	33	5%	10%	NO	85%

5.5.3 Public Parks activity facilities

From the literature, it can be derived people visit public parks to interact and engage with the various activities on hand at the parks. This seems to be the main reason for people to visit public parks, and if there are no activities to engage in, they tend to choose either staying home or to visit a place where they can take part in some or other activity. Getting a hold on the kinds of activity-inducing facilities available at the public parks in the study area may make it easier to understand the effect activities have on the vibrancy of public parks.

Not all the public parks in the study area are on par with the numbers and kinds of facilities that will draw visitors. The activity infrastructure found in the different public parks of the study areas is summarised in Table 5-13**.**

From Table 5-13 the observation is that none of the public parks in the study area has all the potential activity-inducing facilities available. A very low number of tables (only found in 4 of the 18 public parks) and sports facilities (only found in 5 of the 18 public parks) have been made available to public parks, whereas seating and playground structures can be found in most of them.

Table 5-13: *Breakdown of Activity Infrastructure in PPs of the Study Areas*

Public Park Reference Number	Average # Users Per Month	Activity Facility			
		Number of Playground structures	Number of Seating	Number of Tables	Number of Sports Field Available
BP1	681	3	0	0	4
BP2	540	4	0	0	0
BP3	62	0	0	0	1
LHPP1	294	7	0	0	0
LHPP2	168	8	3	0	0
LHPP3	154	7	3	0	1
LHPP4	42	0	0	0	0
LPP1	882	0	15	3	0
LPP2	147	0	0	0	1
LPP3	294	0	0	0	2
UP1	72	5	4	1	0
UP2	512	6	20	4	0
UP3	33	0	0	0	0
UP4	186	4	6	0	0
DP1	121	0	0	0	0
DP2	203	0	0	0	0
DP3	102	0	0	0	0
DP4	521	5	8	2	0

Although many other activity-inducing facilities such as, open-air gyms, model trains, and chess tables, to name a few, exist, the activity-inducing facilities of the public parks in the study areas are only those listed in Table 5-13 which are playground structures, seating, tables, and

sports fields. Additional studies on other types of activity-inducing facilities in public parks are open for exploration but are not covered in this study.

5.6 COMFORT AND IMAGE PARAMETERS OF PUBLIC PARKS IN THE STUDY AREAS

The important aspects to account for when considering the sense of wellbeing, attraction, and visual appeal presented by a public park, as identified in the literature, are the actual measure of safety; the perception of safety; the degree of cleanliness; the extent of allure; and the presence of natural elements (greenness).

The actual measure of safety associated with a public park in a residential area is subject to several factors and conditions which may require additional research. Not many studies concerning safety aspects in public parks have been carried out so far, yet literature suggests that open spaces are safer, as well as perceived to be safer, the more people there are in the space (Wang, Brown and Liu, 2015)(Luymes and Tamminga, 1995). Residents of urban areas should be able to visit their public parks without fear of tripping and falling, or of being attacked. Recording aspects such as the state of pedestrian walkways, lighting conditions, the degree of visibility, the crime rate in the neighbourhood, and people's perceptions of safety can give pertinent insight into the matter of safety in public parks. (Zavadskas, Bausys and Mazonaviciute, 2019).

5.6.1 Crime rates and statistics in study areas

Nonconforming social constructs, dissimilar safety infrastructures, and the crime level in each of the residential areas are contrary to one another. and can be evaluated better if individually broken down into each residential area's relative share of crime.

The measure of crime in each public park's service area was determined from police reports, interviews with security companies, and the most recent crime statistics obtained from the Mangaung Metropolitan Municipality.

Table 5-14 shows the proportion of crime in each public park's service area has compared to that of the other selected public parks of the same residential area.

Table 5-14: *Percentage Breakdown of Crime Rate in and Around the PPs of the Study Areas*

Public Park Reference Number	Average # Users Per Month	Share of % of Residential Pedestrian Crime in Service Area
BP1	681	0,30
BP2	540	0,35
BP3	62	0,35
LHPP1	294	0,29
LHPP2	168	0,24
LHPP3	154	0,22
LHPP4	42	0,25
LPP1	882	0,30
LPP2	147	0,33
LPP3	294	0,37
UP1	72	0,23
UP2	512	0,30
UP3	33	0,25
UP4	186	0,22
DP1	121	0,23
DP2	203	0,22
DP3	102	0,27
DP4	521	0,28

From table 5-14, it can be noted that in general, fewer people visit public parks where the incidence of crime is high. Yet, this does not seem to be true for five of the public parks and residential areas and may be the result of residents' awareness of the crime rate in their area.

5.6.2 Perception of safety in public parks and surrounding areas in study areas

The safer people perceive an open space to be, the easier their decision to visit that open space will be. A public park where frequent crime-related incidents happen may, for instance, be perceived as safe by those visiting the park. It is therefore essential to be aware of the way people perceive the safety of the public parks in their area. Table 5-15 presents the extents to which residents in the study area perceive their public parks as being safe. From extensive interviews with residents and public park users, each public park in the study area was given a perception-of-safety score ranging from 1 to 5, with 1 being perceived as "very unsafe", and 5 as "very safe".

Table 5-15: *Perception of Safety by Users of PPs in the Study Areas*

Public Park Reference Number	Average # Users Per Month	Perception of Safety in PP Service Area (1 -5) *
BP1	681	4
BP2	540	3
BP3	62	1
LHPP1	294	4
LHPP2	168	3
LHPP3	154	3
LHPP4	42	2
LPP1	882	4
LPP2	147	2
LPP3	294	3
UP1	72	2
UP2	512	4
UP3	33	2
UP4	186	3
DP1	121	3
DP2	203	4
DP3	102	2
DP4	521	4
*** 1 = Very unsafe; 2 = Unsafe; 3 = Fairly Safe; 4 = Safe; 5 = Very safe**		

Compared to the actual crime taking place in the service areas of the public parks, the residents' perceptions of safety, appear to have a more direct influence on the monthly visits paid to the public parks. The number of monthly visitors to the public parks in the study area do not exceed 147 if they are perceived as very unsafe or unsafe. None of the parks were perceived as very safe, and parks that were perceived as safe had several monthly visitors as high as 882. Public parks in the study area with a low (very unsafe) perception-of-safety score, for instance, clearly show fewer monthly users than those with a high score, even though the actual crime rate in the area may be high.

5.6.3 Cleanliness of public parks in study areas

Even though a public park may have been designed and developed to be a clean, litter-free environment, it may become littered with waste. The presence of waste, coupled with the absence of waste-removal efforts, may turn a public park into a dump: messy, unhygienic, and bad-smelling, and making traverse difficult. Table 5-16 shows the extent of cleanness of each public park in the study area, as obtained from the physical survey. The severity of litter and

waste observed in each public park during the period in which the user numbers where counted, is ranked from 1 to 5, where 1 is the rating of a public park with a very high volume of waste present, and 5 is a public park with hardly any litter around.

Table 5-16: *Level of Cleanness Recorded on the PPs in the Study Areas*

Public Park Reference Number	Average # Users Per Month	Cleanness Level (1 -5) **
BP1	681	3
BP2	540	2
BP3	62	1
LHPP1	294	4
LHPP2	168	3
LHPP3	154	3
LHPP4	42	2
LPP1	882	4
LPP2	147	2
LPP3	294	3
UP1	72	4
UP2	512	4
UP3	33	4
UP4	186	4
DP1	121	4
DP2	203	4
DP3	102	4
DP4	521	4
**** 1 = Very unclean; 2 = Unclean; 3 = Relatively clean; 4 = clean; 5 = Very clean**		

As was expected, some relationship between the monthly user numbers of a public park and the extent of its cleanness could be drawn. None of the public parks were found to be very clean, yet 10 of the 18 parks were clean. Four of the 18 parks were found to be very unclean or unclean. The scale of this relationship in one neighbourhood has, however, no bearing on that of another. This circumstance may be a consequence of the socio-economic disparities among the neighbourhoods.

5.6.4 Greenery aspects of public parks in the study areas

As derived from the literature, it can be assumed that people are attracted to public parks displaying lots of green, natural elements (Shackleton and Blair, 2013). Although the study area is in a dry, water-restricted region of South Africa, each of the public parks in the study

area, has its own range of green, as set out in Table 5-17. As with most of the other data on public parks in the study area collected, the range of green in each of the public parks was recorded at the same time the monthly visitors were calculated. This was done so that a plausible relationship (if there was one) between the range of greenness, and the average number of monthly visitors to the public parks could be drawn.

Table 5-17: *Level of Greenness Recorded on the PPs of the Study Areas*

Public Park Reference Number	Average # Users Per Month	Level of Greenness (1-5) ***
BP1	681	3
BP2	540	4
BP3	62	1
LHPP1	294	4
LHPP2	168	4
LHPP3	154	4
LHPP4	42	4
LPP1	882	5
LPP2	147	3
LPP3	294	4
UP1	72	3
UP2	512	4
UP3	33	4
UP4	186	4
DP1	121	4
DP2	203	4
DP3	102	4
DP4	521	4
**** Levels of Greenness: 1 = Very Low 2 = Low; 3 = Moderate; 4 = High; 5 = Very High**		

Except for two public parks (BP3 being 1, and LPP1 being 5), the range of greenness in the public parks, of the study area, was much alike. There were no clear conclusions on the impact of the range of greenness on the average monthly number of public park visitors, to be drawn. It must, however, be noted that the public park with the least greenness (BP3 at level 1), had the smallest overall, number of monthly visitors, and accordingly, the public park with the highest level of greenness (LPP1 at level 5), had the most (882) monthly visitors. This may suggest that the range of greenness in a public park cannot be ignored and must be accounted for when designing and maintaining the natural elements of a public park.

5.6.5 The attractiveness of public parks in study areas

The extent of cleanness and range of greenness in a public park automatically enhances the attractiveness of that park. There are, however, some other elements which also contribute to the pleasant appearance of a public park, and when these are combined, the quantitative assigning of a value to the attractiveness of a public park becomes complicated. One solution for this difficulty may be to have each of the public parks in the study areas ranged from 1 to 5, with 1 being 'very unattractive' and five being 'very attractive'. Table 5-18 summarizes the scores for attractiveness, allocated, by the users, to each of the public parks in the study area.

Table 5-18: *Level of Attractiveness Rated by PP Users on the PPs of the Study Areas*

Public Park Reference Number	Average # Users Per Month	Attractiveness (1-5) ****
BP1	681	3
BP2	540	3
BP3	62	1
LHPP1	294	3
LHPP2	168	4
LHPP3	154	3
LHPP4	42	3
LPP1	882	4
LPP2	147	2
LPP3	294	3
UP1	72	3
UP2	512	4
UP3	33	2
UP4	186	4
DP1	121	3
DP2	203	4
DP3	102	3
DP4	521	5
**** 1 = Very unattractive; 2 = Unattractive; 3 = Relatively attractive; 4 = Attractive; 5 = Very Attractive**		

Table 5-18 shows that it is possible for a public park, in the study area, to achieve a very high level of attractiveness, as with public park DP4 which is rated as very attractive. BP3 and UP3 are two parks which are rated as unattractive and are also experiencing low numbers (62 and 33) of monthly users. There is, however, no clear relationship between the attractiveness of a park and the number of monthly visitors. Even so, Table 5-18 does give some indication of such a relationship. Table 5-18 also suggests that people's perceptions of attractiveness are influenced by the actual range of greenness and the extent of cleanness.

5.7 ACCESSIBILITY AND LINKAGE PARAMETERS TO PUBLIC PARKS IN THE STUDY AREAS

Several physical conditions have bearing on park use by those have to travel there, and back home, by means of a transport system. Difficult travelling conditions and other obstructions may, therefore, prevent people from making the journey. Access restrictions also seem to impede visits to public parks. On the outside of the park, dynamics such as the number of access streets, sidewalk infrastructure and condition, and traffic conditions and parking, can either deter or facilitate, access to a park. On the inside of the park, the presence of fences, the number of access points, and physical barricades at entrances can have the same result.

5.7.1 Road and Sidewalk Conditions

Most of the people visiting public parks walk there. It is therefore important to evaluate the road and sidewalk conditions pedestrians will encounter when walking back and forth between the parks and home. Table 5-19 shows the various physiognomies of the roads and sidewalks in the proximity of the public parks in the study area. Table 5-19 shows the continuity of walkability a sidewalk possesses where a score of 100% would be a sidewalk that is unobstructed and fully walkable. The average road lane and sidewalk widths are also displayed in table 5-6, showing that the road lanes are never less than 3.6 meters and sidewalk widths are never less than 3 meters wide. The conditions of the road lanes and sidewalks are also shown in Table 5-19. The condition of the pedestrian sidewalks is found to be mostly (11 out of 18) acceptable but sidewalks leading to 7 of the public parks were also found to be unacceptable. Pedestrian sidewalks found to be bad or very bad means that they have many obstructions for walking in the form of uneven terrain or physical barriers.

Table 5-19: *Road and Sidewalk Conditions*

Public Park Reference Number	Service Area Sidewalk Network Length (meters)	Road Network to Sidewalk Network Ratio (%)	Average Lane Widths (meters)	Average Sidewalk Width (meters)	Road Lane Condition*	Pedestrian Sidewalk Condition*
BP1	6851	95	3.8	3.5	3	3
BP2	5881	93	3.8	3.5	2	3
BP3	2029	91	3.8	3.5	1	3
LHPP1	2032	93	3.6	3	4	3
LHPP2	2240	88	3.6	3	4	3
LHPP3	1582	83	3.6	3	4	2
LHPP4	3106	83	3.6	3	4	2
LPP1	3776	97	4.8	3.5	4	3
LPP2	2746	93	4.8	3.5	4	3
LPP3	3465	95	4.8	3.5	4	3
UP1	10622	83	3.6	3	4	2
UP2	3473	93	3.6	3	4	3
UP3	2453	83	3.6	3	4	2
UP4	1700	88	3.6	3	4	2
DP1	121	82	3,6	3	4	2
DP2	203	88	3,6	3	4	3
DP3	102	85	3,6	3	4	2
DP4	521	92	3,3	3	4	3

Note: *1=Very Bad; 2= Bad; 3=Acceptable; 4= Good; and 5=Very Good.

Table 5-19 presents the amount of space and the quality of the space pedestrians enjoy when commuting to public parks. The pedestrian infrastructure around public parks in the study area are not very conducive for walking and Table 5-19 shows this.

Table 5-20: *Qualitative Condition of Road Condition and Pedestrian Sidewalks Condition Leading to Public Parks*

Condition	Road condition		Pedestrian sidewalk condition	
	Share leading to public parks		Share leading to public parks	
	Number	%	Number	%
Very Bad	2	7.1	0	0
Bad	2	7.1	7	35.8
Acceptable	2	7.1	11	64.2
Good	12	78.7	0	0
Very good	0	0	0	0
Total	18	100	18	100

Figure 5-1: *Obstructed Sidewalk Network (Google Earth, Accessed in 2017)*

The sidewalk -network distance in the service area was determined using GIS software and is shown in Table 5.20. The sidewalk-network distance was required, in order to establish the road-network to - sidewalk-network ratio. The finding was that the ratio varied from between 83% to 95% in the study area. This confirmed that sidewalks conjoin most of the roads leading to public parks. The presence of obstructions on sidewalks, however, create difficulties for pedestrians, because it compels them to walk in the road because the space on the sidewalk has been taken up by extended gardens, fences or poles, and rocks. Figure 5-1 shows an

example of an obstructed sidewalk in the study area. From Table 5.19 as much as 17% of the sidewalk-networks in the service areas of public parks are obstructed and inadequate for pedestrian use. It has also been found that all the sidewalk-networks leading to public parks in the study area are obstructed by 5% or more, compelling pedestrians on their way to public parks to leave the sidewalk, at some stage of their journey and walk in the road.

The average widths of sidewalks and road lanes were measured using GIS software. From Table 5.19 it can be observed that all the road lane widths (varying between 3.6m and 4.8m) are enough for vehicles to travel safely in both directions. under circumstances where road must be shared by vehicles travelling in both directions, as well as pedestrians, road use, for both vehicles and pedestrians, turns out to be unsafe, and the flow of traffic is slowed down. The sidewalks in the service areas are wide enough (varying between 3.0 m and 3.5 m) for easy pedestrian movement, provided that the sidewalks are not obstructed.

A rating system was implemented to summarize the road- and sidewalk conditions, in the service areas of public parks. The rating system was founded on the recurrence of the road or sidewalk being in a state of disrepair, as well as the rate at which the road, or sidewalk was obstructed. Table 5-20 show these ratings as: 1 = Very Bad; 2 = Bad; 3 = Acceptable; 4 = Good; and 5 = Very Good. From the Table 5-20, it can be taken that none of the roads in the service areas were in a very good condition, most of them (78.7%), were in a good condition, and 7.1% were in an acceptable condition. Approximately 14.2% of the roads were, however, in a bad, or very bad, state.

The pedestrian sidewalk conditions in the service areas were found to be fluctuating between being acceptable and being bad. Approximately 64.2% of pedestrian sidewalks were in an acceptable condition, and about 35.8% were n a bad condition.

5.7.2 Pedestrian and Vehicle Access to Public Parks in Study Area

Although most of the public park users prefer to walk, instead of drive, to public parks, facilitating vehicle access for groups coming from farther away, or for those who prefer to drive instead of walk, remains a requirement. In order to determine the influence of vehicle access on the accessibility of public parks, the condition and design of access points, and parking facilities for vehicles had to be assessed and analysed to determine its influence on accessibility public parks. Table 5-21 presents the current types of parking at the public parks in the study areas, the number of parking spaces available at each public park, and the kind of access provided for visitors. Most (11 out of 18) of the public parks in the study area provide on-street parking, with only one of the public parks having a designated parking area for

parking. Further analysis of the influence vehicle parking space has on monthly visitors will be done in the next chapter, yet Table 5-22 further presents the type of access vehicles and pedestrians have with regards to accessing the public parks in the study area.

Table 5-21: *Pedestrian and Vehicle Access to Public Parks in Study Areas*

Public park reference number	**Parking Type (1=street; 2=designated; 3=both)**	**Number of parking spaces**	**Park access type (1=gated with limited access points; 2=one-sided access; 3= two-sided access; 4= three-sided access; 5=all-round access) ****
BP1	1	50	1
BP2	1	20	2
BP3	1	0	2
LHPP1	1	16	4
LHPP2	3	0	3
LHPP3	1	13	2
LHPP4	3	10	1
LPP1	2	200	5
LPP2	1	10	3
LPP3	3	50	3
UP1	3	125	5
UP2	1	5	4
UP3	1	0	5
UP4	1	0	5
DP1	1	16	5
DP2	1	25	5
DP3	1	10	5
DP4	1	0	5

**** (1=gated with limited access points; 2=one-sided access;**
3= two-sided access; 4= three-sided access; 5=all-round access)

Table 5-22: *A Scenario of Accessibility of Public Parks and Parking Type*

Accessibility			**Parking Type**		
Type of Access	**Number of Parks**	**%**	**Type of Parking**	**Number of Parks**	**%**
Gated with limited access points	2	11.1	On-street	13	72.2
One-sided access	3	16.7	Designated off street	1	5.6
Two-sided access	3	16.7	Both	4	22.2
Three-sided access	2	11.1	Total	18	100
All-round access	8	44.4			
Total	18	100			

According to Table 5-22, most of the public parks (72.2%) only allow for vehicles to park in the street. Approximately 22.2%, have both parking spaces in the street, and a designated parking section. The parking spaces allocated for vehicles around the public parks vary from 0 to 200 parking bays with no real pattern or design purpose.

It was also important to investigate the accessibility of parks in terms of the types of physical entrance. Table 5-22 shows that access to the public parks in the study area varies between, one-sided, two-sided, three-sided, four-sided, and gated access. Approximately 44.4% of the parks have all-round access, about 33.4% have either one-sided (16.7%), or two-sided access (16.7%), approximately 11.1% of the public parks have three-sided access, and 11.1% of the parks have limited access. This shows that most parks in the study (72.2%), have access from more than two sides.

5.7.3 Ambulatory Access to Public Parks in the Study Areas

From the household survey data, most of the visitors (more than 95%) to public parks in the study areas prefer to walk, instead of driving to the parks an assessment of the average time it takes to get to the park, the longest and shortest distances from the park before it can be seen, and the number of access streets leading into the public parks was required.
Table 5-23 summarizes the findings of this assessment.

Table 5-23: *Commuting Access to Public Parks in Study Areas*

Public Park Reference Number	Average Walking Travel Time (minutes)	Longest Sight Distance (meter)	Shortest Sight Distance (meter)	Number of Access Streets into Park
BP1	5	570	14	9
BP2	9	174	20	5
BP3	8	260	30	2
LHPP1	4	150	12	4
LHPP2	6	270	8	4
LHPP3	4	211	8	4
LHPP4	9	98	8	3
LPP1	7	704	50	5
LPP2	6	300	45	2
LPP3	7	450	35	3
UP1	13	200	15	5
UP2	5	280	7	4
UP3	5	146	20	2
UP4	12	128	20	4
DP1	7	120	15	2
DP2	7	205	20	3
DP3	8	155	25	2
DP4	6	300	30	4

The average ambulatory time was calculated by measuring the average distance the person had to walk to get to the public park and then calculating it against the average walking speed of a person. Table 5-23 shows that the average person does take no longer than 13 minutes to walk from home to the public park, with a minimum walking time of approximately 4 minutes. The average walking time to most of the public parks varies between 6 and 9 minutes.

The longest range of visibility was determined by measuring the farthest distance from which a person, walking to a public park, would have a clear line of sight to the public park. The shortest range of visibility to a public park refers to the shortest range of visibility a person would have when standing outside his residence. Table 5-23 shows that there is a public park that can be seen from, as far as, 704 meters, whereas another public park, is only visible from 50 meters. The longest range of visibility, for most of the public parks, however, stretches from 150m to 400m. Similarly, the shortest range of visibility stretches from 7m to 50m, indicating that most of the parks can be seen from a fair distance away.

The number of streets leading into a public park ranges from a minimum of 1 to a maximum of 9 access streets. At close examination, Table 5-23 reveals that approximately 36% of the

public parks are connected by 4 access streets, followed by 21.5%, connected by 5 access streets. Likewise, 21.5% of parks are connected by 2 access streets and 14% by 3 access streets. Only 7% of the parks are, however, accessed by 9 streets. Thus, the majority (78.5%) of public parks are accessed by more than 3 access streets. When comparing Table 5-23 to Table 5-6, it can be seen that the numbers of access streets, leading into public parks, undoubtedly influence the number of monthly visitors to public parks: the higher the number of access streets, the higher the number of visitors to the park.

5.7.4 Maintenance of Public Parks in Study Areas

It is important to evaluate the maintained condition of the public parks in the study area, as it influences the symbolic, visual, and physical access to the public parks. Table 5-24 shows a qualitative description of the maintained condition of the public parks in the study areas.

Table 5-24: *Maintained Condition of Public Parks in Study Areas*

Public Park Reference Number	Maintained Condition (1=Very Bad, 2= Bad; 3=Acceptable, 4= Good, 5=Very Good)
BP1	2
BP2	2
BP3	1
LHPP1	3
LHPP2	4
LHPP3	3
LHPP4	4
LPP1	2
LPP2	2
LPP3	2
UP1	3
UP2	4
UP3	3
UP4	4
DP1	5
DP2	4
DP3	4
DP4	3

Table 5-25: *Maintained Condition of Public Parks in Study Areas*

Maintenance Condition of Public Parks	Number	%
Very bad	1	5.6
Bad	5	27.8
Acceptable	6	33.3
Good	6	33.3
Very good	1	5.6

The maintained condition of public parks refers to its measure of vibrancy in terms of mowed lawns, working playground apparatus and benches, and the condition of walkways and gardens. Tables 5-24 and 5-25 show that only one of the public parks in the study area is well maintained. Approximately 33.3% of the public parks have been found to be well maintained, while, the degree of maintenance, in another 33.3% of the public parks, is acceptable. About 33.4% of the public parks have, however, not been maintained properly. Thus, it can be concluded that, although the degree of maintenance in most of the public parks is acceptable to good, a sizable number of parks have not been maintained properly.

5.7.5 Illumination of Public Parks in the Study Areas

While meticulously investigating the determinants of accessibility to public parks in the study areas, illuminance was found to be a vital key to either bettering or complicating accessibility to those public parks. Utilizing household- and physical surveys, it was established that residents generally prefer to visit public parks from late afternoon on towards evening.

Table 5-26 shows the intensity of light in the public parks during the early evening, as measured in Lumens (lux). The measurements were obtained by using identical light meters at the same time in the evening (6:30 pm) at all 18 of the public parks.

Table 5-26: *Illumination of Public Parks in Study Areas during Peak User Hours*

Public Park Reference Number	Light of Park in Evenings Measured in Lumens (lux)
BP1	9.43
BP2	2.36
BP3	7.07
LHPP1	4.81
LHPP2	4.75
LHPP3	2.34
LHPP4	2.35
LPP1	7.05
LPP2	2.35
LPP3	4.92
UP1	2.35
UP2	4.74
UP3	2.35
UP4	2.38
DP1	3,01
DP2	4,53
DP3	2,39
DP4	6,03

Table 5-26 shows that the maximum intensity of light measured in the public parks is 9.43 lux, which is like the luminance of deep twilight. The lowest level of light during the peak user hour was found to be 2.34 lux, which is too dark for a person to be able to read signs or navigate safely through the park. For a better understanding of how low the light intensity in the public parks of the study areas were, Figure 5-2 presents a logarithmic scale of light intensity.

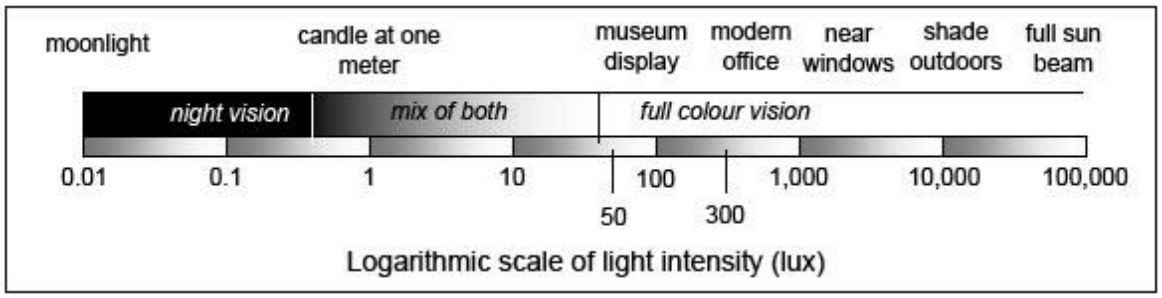

Figure 5-2: *Logarithmic Scale of Light Intensity (EOHS, 2015)*

It should be noted, that all the public parks in the study areas have illumination levels below the minimum of 20lux, as recommended by the Encyclopedia of Occupational Health and Safety.

5.7.6 Available Playground Facilities at the Public Parks in the Study Area

Because playground facilities in public parks have a symbolic reason for people to access parks, the presence of playgrounds in the selected public parks was included under accessibility and linkage factors as well.

Table 5-27: *Presence of Playgrounds in the Public Parks of the Study Areas*

Public Park Reference Number	Playground? Y/N
BP1	Y
BP2	Y
BP3	Y
LHPP1	Y
LHPP2	Y
LHPP3	Y
LHPP4	N
LPP1	N
LPP2	N
LPP3	N
UP1	Y
UP2	Y
UP3	N
UP4	N
DP1	Y
DP2	N
DP3	N
DP4	N

Note: Y= Yes; N=No

It can be seen in Table 5-27 that playgrounds are found in 50% of the public parks. The influence of playgrounds towards public park vibrancy underwent further analysis in the next chapter.

Table 5-28: *Summary of Public Parks Equipped with Playgrounds*

Availability of Playgrounds in Public Parks	**Number**	**%**
Yes	9	50
No	9	50
Total	14	100

Table 5-28 shows that only half (50%) of the 18 public parks have playgrounds. While comparing Table 5-10 with the average number of monthly users, it was observed that no real linkage between the average number users of public parks, and the presence, or absence, of playgrounds, could be established.

5.7.7 Average Vehicle Speed on the streets around Public Parks in the Study Areas

Access to public parks can be deterred by vehicles travelling at excessive speeds in the service areas of the public parks. Table 5-29 indicates the average speed of vehicles travelling, in each of the service areas, of the selected public parks. The data was obtained by measuring the speed of vehicles, travelling on the access roads to public parks during a busy day, and then calculating the average speed travelled in each service area.

Table 5-29: *Average Speed of Vehicles in the Service Area of Selected Public Parks*

Public Park Reference Number	Average Vehicle Speed (Km/Hour)
BP1	67
BP2	58
BP3	55
LHPP1	76
LHPP2	77
LHPP3	58
LHPP4	62
LPP1	58
LPP2	63
LPP3	59
UP1	62
UP2	59
UP3	58
UP4	58
DP1	60
DP2	58
DP3	56
DP4	45

Table 5-30: *Vehicle Speed on the Roads near The Public Parks*

Speed of Vehicles Travelling on The Roads Near Public Parks	Number	%
Exceeding speed limit of 60Km/h	6	33.3
Within speed limits	12	66.7
Total	18	100

Table 5-29 and 5-30 show that vehicles travel faster than the maximum speed limit (60 Km/h promulgated by the Mangaung Metropolitan Municipality on about 33.3% of the roads passing near the public parks, while approximately 66.7% of vehicles, stay within the speed limit.

5.8 PERCEPTION OF PEOPLE ON FACTORS INFLUENCING USAGE OF PUBLIC PARKS

From the 400 household surveys conducted in the study areas and drawn from the perceptions of the park users (Table 5-31), the investigator summarised a list of factors which seem to have a bearing on the vibrancy of public parks.

Table 5-31: *Factors Influencing Vibrancy of Public Parks Based on Perceptions of People*

Factors influencing vibrancy of public parks	PI = (∑ Nix)/N
Walk to public parks	0.99
Use a vehicle to access	0.01
Walk distance importance	0.69
Walk distance satisfaction	0.26
Quality of parks (Availability adequate infrastructure and playgrounds)	0.34
Safety	0.80
Period of the day (morning)	0.20
Period of the day (Mid-day)	0.05
Period of the day (Evening/afternoon)	0.75
Lighting for night visibility	0.62
Entry fees	0.00

The following subsections discuss the importance and findings of the people's perceptions towards public park vibrancy.

5.8.1 Perceptions of Users Regarding the Factors Influencing Use of Public Parks

As shown in Table 5-31, people perceive walking to the public parks, their safety in and around parks, the walking distance, visiting the parks in the late afternoon, or early evening, and the intensity of illumination in the parks, as the factors which influence the use of parks in the residential areas of the study area most. It was found that the quality of parks, vehicle access, spending time in the parks in morning or at mid-day, being satisfied with the walking experience (distance, the availability of safe and smooth walking surfaces), and entry fees, are the factors which influence the vibrancy of parks to a lesser extent.

5.8.2 Walk to Public Parks, Walking Distance and Vehicular Uses

Walking (PI= 0.99) was found to be the preferred way to access public parks. People also stated that the distance they had to walk (PI= 0.69) had only a moderate influence on their decision to walk to the park. It was also found that the use of a vehicle had the least (PI=0.01) influence on people's decision to visit public parks. Since most of the parks in the residential areas are located within 1 to 2 km from each potential user's home, and the longest time it takes to walk there are about 13 minutes, most of the respondents prefer to walk to the parks.

5.8.3 The degree of Safety in Public Parks

It was found that people's perceptions of their safety in a park, had a major influence on the residents' tendencies to visit their local parks them. Table 5-31 shows that users perceive the insufficiency of safety in public parks (PI= 0.80) as one of the most important reasons for not making use of public parks. Although it is necessary to take note of the safety in public parks, the scope of this investigation was limited to the safety aspects relating to the design policies of public parks only.

5.8.4 Preferred Time of Day when Accessing Public Parks

According to the respondents' perceptions, afternoons and evenings (from 5 pm to 8 pm) (PI= 0.75) was the most preferred time of day for visiting public parks. Some preferred mornings (PI=0.20), but (PI= 0.05) only a few visited the parks in the middle of the day (Table 4-19).

5.8.5 Perceptions of Park Illumination Levels for Evening Users

Since the early evenings and late afternoons are the most preferred times for users to visit public parks, it was important to investigate the influence that the intensity of light has on the evening visitors to the public parks. As shown in Table 5-31, most of the park users were influenced by the degree of illumination in the parks (PI=0.62), and it can be deducted that insufficient light in public parks during the evening hours, when users still want to be in the parks, can have a negative influence on the accessibility of the park.

5.8.6 Perception of Users Having to Pay to Access Public Parks

As shown in Table 5-31, it is very clear from the respondents, that paying entry fees, is the factor with the least influence on their desire to access a public park, because, for almost all the parks, entrance is without cost anyway. It is clear, however, that people do not wish to pay an entrance fee in order to enter a public park.

5.9 SUMMARY

All the possible factors and parameters which may influence the vibrancy of public parks were discussed in this chapter. Although many of the factors presented in this chapter seemed to have an influence on the frequency of visitors to public parks, no clear conclusions can be drawn without conducting further analysis, statistical modelling and ASA modelling which will be the purpose of Chapter 6.

CHAPTER 6: MODELLING, RESULTS AND FINDINGS

6.1 INTRODUCTION

Investigations into all the factors and aspects contributing to the vibrancy of public parks were conducted from which the collected data is presented in the previous chapter. In order to establish further conclusions and findings, additional analysis, statistical modelling and ASA modelling will be presented in this chapter.

6.2 PREDICTION OF THE NUMBER OF PUBLIC PARK USERS

The vibrancy of a public park can be shaped by the number of users of the park. The vibrancy of a public park is affected by many socio-economic-, physical-, and infrastructural factors. As explained previously, sociability, usability, accessibility and comfort are the four main determinants of vibrancy. It is evident that the number of potential visitors to public parks is directly affected by the sense of sociability, usability, accessibility, and comfortability users have towards the public parks they wish to visit.

There are various determinants that influence the level of vibrancy in public parks. The average number of users can be affected by determinants from any of the three categories of accessibility. It is, therefore, necessary to delineate the control parameters and variables, which may influence the vibrancy of the public parks, and thereafter develop a model to simulate various scenarios to assist with developing suitable policy interventions for increasing the vibrancy of public parks.

In order to analyse the variables of the public parks in the study areas effectively and accurately, the average number of monthly users recorded in each of the parks must be converted to the average number of users per year. The purpose of this conversion is to correlate the monthly user data with data sets, such as the average number of events, and the regularity of volunteer caretakers, which are presented in an annual format.

Based on the formulated problem, which is the lack of vibrancy in the public parks of the residential areas in the study areas, and in order to understand how vibrancy comes about in public parks, a conceptualized model to can be developed. For a better understanding of the relevant system behaviour, ASA models are conceptualized along with performing a detailed statistical analysis on all the collected data.

6.3 CONCEPTUALIZATION OF INFLUENTIAL FACTORS

The ASA models are small-scale, theorized versions of the current fields of study and as such, realistically match the purpose and function that would occur in the field on a conceptual level only.

The ASA conceptual models developed are only conceptual indicators, and further evaluation of the variables must be conducted, in order to interpret and implement the findings of the model accurately.

The conceptual ASA models were developed by using the contraction method. All the available, important variables (60 in total) were used in a process of systematic elimination until a sizeable model of relevant, and reasonable details could be established. Initially, a total number of 60 factors were identified, but after eliminating the factors showing no significant influence on the vibrancy of public parks in the study areas, a list of 37 factors were selected for additional analysis. These factors, which may possibly be systematically related to the vibrancy of public parks in the study areas, are summarised in Table 6-1.

Table 6-1: *List of Influential Factors*

Variables Analysed as Possible Independent Variables Influencing Public Park Vibrancy
1. SOCIABILITY (S)
1.1 Attendance Age Groups
1.2 Volunteering caretakers
1.3 Average Number of Events per year
1.4 Ethnic Diversity
2. USES AND ACTIVITIES (U)
2.1 Adjacent Land Use Percentage Breakdown
2.2 Number of Trees
2.3 Percentage of Plant coverage
2.4 Percentage of Barren Ground
2.5 Percentage of Grass Coverage
2.6 Water Feature Present
2.7 Number of Playground structures
2.8 Number of Seating
2.9 Number of Tables
2.10 Number of Sports Field Available
3. COMFORT AND IMAGE (C)
3.1 Share of Percentage of Residential Pedestrian Crime in Service Area
3.2 Perception of Safety in Public Park's Service Area
3.3 Level of Cleanness
3.4 Level of Greenness
3.5 Rated Attractiveness
4. ACCESSIBILITY (A)
4.1 Area of Park (Km^2)
4.2 Service Area of Park (Km^2)
4.3 Population in Service Area
4.4 Service Area Sidewalk Network Length (meters)
4.5 Road Network to Sidewalk Network Ratio (%)
4.6 Average Lane Widths (meters)
4.7 Average Sidewalk Width (meters)
4.8 Road Lane Condition*
4.9 Pedestrian Sidewalk Condition
4.10 Parking type
4.11 Number of parking spaces
4.12 Park access type
4.13 Average Walking Travel Time (minutes)
4.14 Longest Sight Distance (meter)
4.15 Shortest Sight Distance (meter)
4.16 Number of Access Streets into Park
4.17 Light of Park in Evenings Measured in Lumens (lux)
4.18 Average Vehicle Speed (Km/Hour)

6.4 STATISTICAL ANALYSIS

Since the application of the ASA was only taken to a conceptual level in this study, additional statistical analyses were conducted. Keeping the ASA paradigm and the conceptual model in view, statistical analyses were conducted to comprehend the interlinkage between the vibrancy of public parks and various influential variables under the four previously mentioned aspects such as accessibility, sociability, comfortability, and uses and activities.

Various statistical techniques, such as correlation coefficients, Variance Inverse Factors (VIF) test and significance tests were applied in order to observe the major control parameters influencing the number of users of the public parks in Bloemfontein. These were followed by the development of multiple regression models for the prediction of the number of users of public parks, in the study area.

To this purpose, the average number of users of public parks per year was considered as the measured dependent variable (y) of the vibrancy of the parks.

The following sections deal with the delineation of the major control parameters and variables, which influence the vibrancy of the public parks in the study area, and the development of an appropriate model, based on the major control parameters, to predict the number of users in the public parks of the study area.

To this purpose, a statistical analysis was undertaken in the following manner:

1. A multiple linear regression was run on 18 variables to evaluate the predictive power they have on the independent variable Y (Average Number of Annual Users).
2. The regression had a perfect R^2 fit but this might be due to the high number of variables or due to violations in regression assumptions.
3. The regression assumptions were checked for violations.
4. The regression had multiple collinearities and some variables violated normality assumptions.
5. To solve multiple collinearities, the variables were split into 4 categories and regression was run on each:
    a. Sociability,
    b. Uses and activities,
    c. Comfort and image and
    d. Accessibility.
6. To adjust for the normality violations, the variables were log-transformed, and the regressions were repeated. The transformations did not change the interpretation or

significance of the regressions. Because log transformations make the interpretation of the coefficients more difficult (without adding value), the remaining regression was done without transformations.

7. The residuals were also analysed for heteroscedasticity, and none were found in any of the regressions.

6.4.1 Current Vibrancy of the Public Parks Surveyed

As mentioned before, the vibrancy of the public parks is measured by the number of users of the parks (in the present context of the study, the average annual users of public parks are used as a proxy for the vibrancy of the parks). Adequate care was taken with obtaining the actual average number of annual users at each public park since these values are crucial to the successful delineation of the control variables influencing the vibrancy, and formulation of the models. These seasonal variations have, however, not been considered since the study area does not experience the extreme weather conditions, that will influence how residents utilise public parks. The average number of monthly users, obtained from the video human recognition data, is presented in Table 5-6.

From the household- and physical surveys, and by taking seasonal influences into account, an average number of annual users for each public park in the study area could be determined and is summarized in Table 6-2.

It can be observed that the average number of visitors to public parks in the study area range between 396- and 8172-, with an average of 3343, visitors per year. Fifty per cent (50%) of the parks recorded numbers of visitors ranging between 1501 and 3500 per year, and about 14.3% have more than 5000 visitors per year. Approximately 35.7% of the parks, however, have fewer than 1500 users per year, which in comparison, is a very low number (Table 6-3).

Table 6-2: *Average Number Users of Public Parks in the Selected Study Areas*

Residential Area (Location)	Public Park Reference Number	Average Users Per Year
Batho	BP1	**8172**
	BP2	**6480**
	BP3	**744**
Langenhoven Park	LHPP1	**3528**
	LHPP2	**2016**
	LHPP3	**1848**
	LHPP4	**504**
Lourier Park	LPP1	**10584**
	LPP2	**1764**
	LPP3	**3528**
Universitas	UP1	**864**
	UP2	**6144**
	UP3	**396**
	UP4	**2232**
Dan Pienaar	DP1	**1452**
	DP2	**2436**
	DP3	**1224**
	DP4	**6252**
	AVERAGE	**3343**

Table 6-3: *A Share of Public Parks for Different Range of Users*

Range of Number of Users Per Year	Share of Public Parks in The Study Area
0-1500	35.7.0%
1501-3000	50.0%
>5000	14.3%

6.4.2 Delineation of Major Variables

The correlation coefficient was used to analyse the parameters, which have a significant influence on the vibrancy of public parks, in the study area. The data collected from the surveys taken for this investigation were utilised for this purpose, and correlation coefficients between the dependent variable and various independent variables were established. For the purpose of analysis, the average number annual users of each public park in the study area were considered as the dependent variable, and the various parameters related to vibrancy were considered as the independent variables

After conducting initial correlation tests and eliminating all the variables found to be dependent, a reduced list of 18 variables, were identified for further analysis (Table 6-4). The reduced list of variables which may be independent factors influencing the vibrancy of public parks is separated into the four major quadrants (Sociability, Uses and Activities, Comfort and Image, Accessibility) established by the Place Diagram (PPS, 2011). These variables are the number of volunteering caretakers, the average number of events hosted per year, the percentage of adjacent land use being residential, the number of trees present, the presence of a water feature, the number of playground structures available, number of seating available, number of tables available, number of sports field available, the percentage of total grass coverage, the visitor's perception of safety inside the public park, the level of cleanness, the level of attractiveness, the level of greenness, the road network to sidewalk network ratio, the number of access street leading towards the public park, the total area of the park, and the level of artificial lighting created inside the public park.

Table 6-4: *Reduced List of Possible Independent Variables*

Reference Number	Variables Analysed as Possible Independent Variables Influencing Public Park Vibrancy
S	**SOCIABILITY (S)**
S1	Volunteering caretakers
S2	Average Number of Events per year
	USES AND ACTIVITIES (U)
U1	Percentage of Adjacent Land Use Being Residential
U2	Number of Trees
U3	Water Feature Present
U4	Number of Playground structures
U5	Number of Seating
U6	Number of Tables
U7	Number of Sports Field Available
U8	Percentage Grass Coverage
	COMFORT AND IMAGE (C)
C1	Perception of Safety in Public Park's Service Area
C2	Level of Cleanness
C3	Rated Attractiveness
C4	Level of Greenness
	ACCESSIBILITY (A)
A1	Road Network to Sidewalk Network Ratio (%)
A2	Number of Access Streets into Park
A3	Area of Park (Km^2)
A4	Light of Park in Evenings Measured in Lumens (lux)

The correlation results of all 18 selected variables can be found in Annexure G. Of the 18 selected variables, 4 were identified (shown later in this chapter) as an independent variable with influence on the Average Annual Number of Users (Y). The four independent variables are the Average Number of Events per year (S2), whether a Water Feature is Present (U3), the Road Network to Sidewalk Network Ratio (A1) and the Perception of Safety in the Public Park's Service Area (C1). The correlations result between these 4 independent variables were verified and are presented below in Table 6-5.

Table 6-5: *Correlation Test Results*

	Y	*S2*	*U3*	*C1*	*A1*
Y	1,00				
S2	0,72	1,00			
U3	0,61	0,25	1,00		
C1	0,73	0,60	0,28	1,00	
A1	0,76	0,42	0,38	0,47	1,00

In order to check the mutual exclusiveness and significance of the independent variables, Variance Inflation Factor (VIF) tests were conducted. The variables with a significant correlation coefficient, which influence the average number of yearly users of each public park in the study areas, were chosen as the control variables and employed for further analysis and model development.

Table 6-6 presents only the variables with the most significant correlation coefficients, resulting from the separate regression analysis. Thus, the average number of public parks users, per year, in the study areas correlates highly with the following parameters, listed in descending order of correlation: average number of events per year (0.72), whether a water feature is present (0.61), perception of safety in public park's service area (0.73), and the road-network to sidewalk-network ratio (0.76).

Table 6-6: *Variables with the Most Significant Correlation Coefficients from the Four Major Determinants*

Independent Variables	S2- Average Number of Events per year	U3- Water Feature Present	C1- Perception of Safety in Public Park's Service Area	A1- Road Network to Sidewalk Network Ratio (%)
Average Number Users Per Year	0.72	0.61	0.73	0.76

The high correlation coefficient (0.76) between the road-network to sidewalk-network ratio and the average number of public parks users per month supports the premise that the more continuous the sidewalk network leading to the public parks are, the higher the average number of annual users of those public parks. will be. The high correlation between the average number public parks users per year and the user's perception of safety (0.73) implies that the safer users perceive the service area of the public park, the higher the average number

of public park users per year, will be. Variables such as the number of events presented in the public parks each year (0.72), and the presence of a water feature in the public park (0.61), also have significant correlation coefficients with the average number of public parks users per month, being greater than 0.6, and thus also influence the average number public park users per year in the study area. Variables with highly insignificant correlation coefficients (<0.5), were not considered as major control variables for influencing users to visit the public parks. Although some variables have high correlation coefficients, it was found to be largely dependent on the size of public parks, indicating its co-linearity, and as such was not considered as independent variables for further analysis.

VIF test results (Table 6-7) presents the interdependency among the independent variables. It can be observed that all the independent variables considered, are independent, and mutually exclusive of each other, since the VIF factors of each of the independent variables are found to be much less than 4. Thus, the major control variables, which largely influence the average number of public parks users per month in the study area, are the average number of events per year, the presence of water features, the perception of safety in the public park's service area, and the road-network to sidewalk-network ratio.

Table 6-7: *Variance Inflation Factors (VIF) Test Results on Selected Variables*

Independent Variables	**VIF**
Average Number of Events per year	1.63
Water Feature Present	1.19
Perception of Safety in Public Park's Service Area	1.73
Road Network to Sidewalk Network Ratio (%)	1.45

6.5 MODELLING FOR PREDICTING NUMBER OF USERS OF PUBLIC PARKS

By considering the major control parameters influencing the number of users of public parks in the study area, an attempt was made to develop statistical models, which would be able to predict the number of users of public parks per year, in the study area, under different scenarios. Since the relationship between the variables and the average number of users were found to be linear, regression models were developed. The regression analysis employed the survey data and major control variables that influence the number of users of public parks, in the study area. The results of the regression analysis also help to confirm the established

hypothesis of this study as well as to develop various scenarios, under different simulated conditions. Plausible policy guidelines, to enhance the vibrancy of the public parks in the study area, were then structured.

6.6 APPLIED SYSTEMS ANALYSIS CONCEPTUALIZED MODELS

The primary factors in each of the four major parameters established from the regression analysis, and that are independent of the others can be conceptualized into a systematic relationship with the vibrancy of public parks. The factors forming the conceptualized model are shown in Table 6-8.

Table 6-8: *Primary Factors of Conceptual ASA Model*

Reference	Description of Referenced Factors
V	Vibrancy of the public park measured in average annual users
A	Water Feature Present
I	Road Network to Sidewalk Network Ratio (%)
S	Average Number of Events per year
E	Perception of Safety in Public Park's Service Area

By referring to Table 6-8 for the description of each variable, the equation below is the basis of the ASA conceptual model which was developed

$V = f(A, I, S, E)$

It was therefore conceptualised that a full, continuous sidewalk infrastructure leading to public parks, designing a water feature of some kind; organizing and planning more frequent events; and improving the level of safety users perceive the public park areas to have, will engender sustainable and vibrant public parks (Figure 6.1).

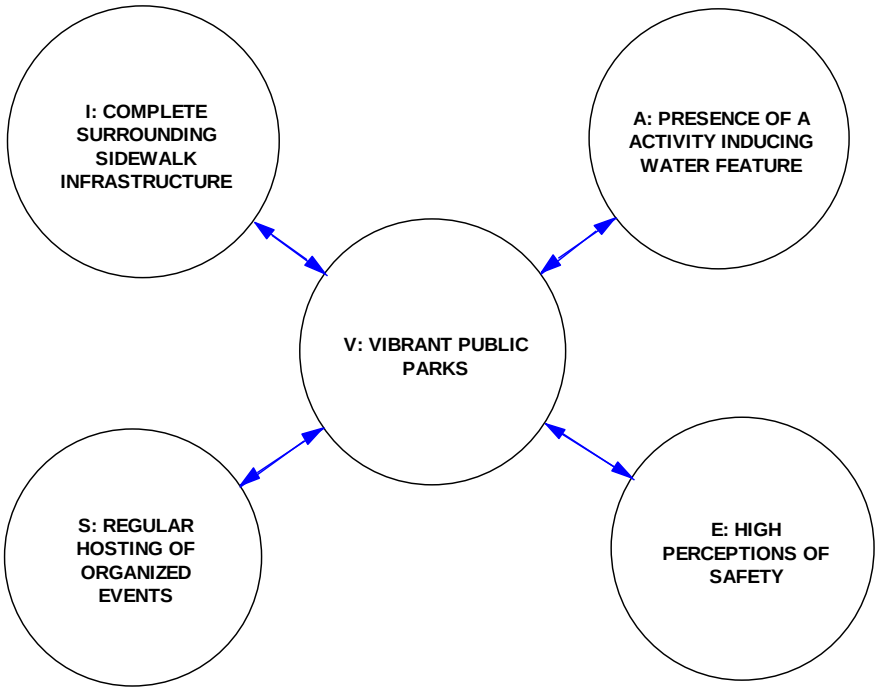

Figure 6-1: *Conceptual model (Soft model) based on the inter-linkage of the possible attributive areas engendering sustainable and vibrant public parks.*

Based on the literature study, a soft conceptual model (Figure 6-2) of the conceptual inter-linkage sustainable and vibrant parks have with communities, cities, and residential areas at the city level can be developed as well. It is conceptualized that residential areas in a city will require sustainable and vibrant parks. The presence of sustainable parks will contribute to the creation of a healthy community, characterised by physical- and psychological wellbeing, sociability, and the cohesion of people.

A healthy community augmented by environmental image and the appearance of parks will contribute to the creation of sustainable cities. Sustainable cities will engender a healthy and quality residential area (Crawford, Timperio Giles-Corti, Ball, Hume, Roberts, Andrianopoulos, and Salmon, 2008).

Thus, sustainable parks are the function of, parameters related to activities in the park, parameters related to engineering infrastructure, parameters related to sociability and social attributes, parameters related to the environment, image and comfort.

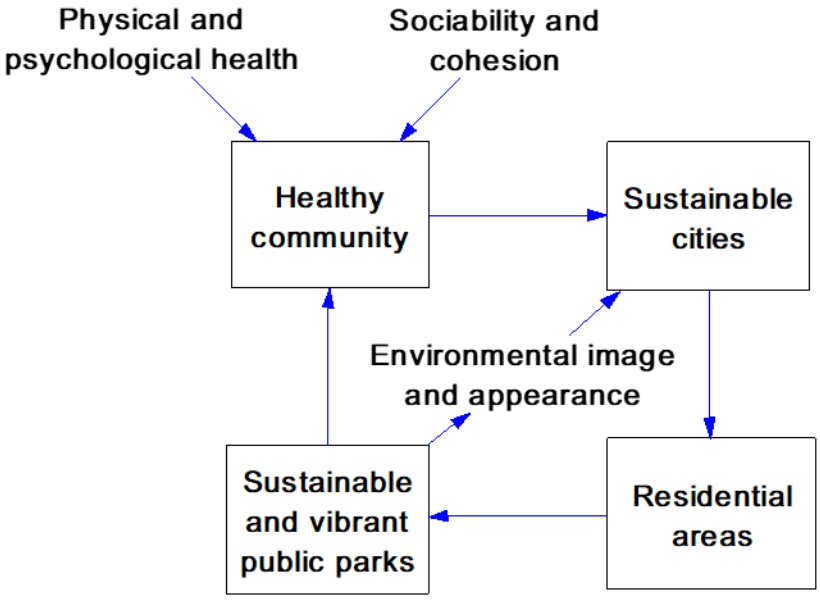

Figure 6-2: *Conceptual model of the relationship between sustainable and vibrant parks with communities, cities, and residential areas.*

6.7 REGRESSION ANALYSIS OF INFLUENTIAL VARIABLES

A regression analysis was conducted separately, on each one of the four major groups of independent variables, to illustrate the significance of each variable, and to develop the model. The model is conceptually presented in the following form:

$$Y_i = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + \varepsilon_i$$

Where:

Y_i = dependant variable

b_0 = intercept

b_i = slopes (sensitivities) to the variables

X = independent variables

ε = error term

To adjust for the normality violations, the variables were log-transformed, and the regressions were repeated. The transformations did not change the interpretation or significance of the regressions. Because log transformations make the interpretation of the coefficients more difficult (without adding value), the remaining regressions were done without transformations. The residuals were also analysed for heteroscedasticity and none were found in any of the regressions.

6.7.1 Results of Regression Analysis of Sociability Variables

The two sociability variables forming part of the 18 variables to be further analysed are the availability of volunteer caretakers and the average number of events hosted in the public park each year. Table 6-9 shows the results from the regression analysis between these two selected variables (S1, S2) and the annual park users (Y).

Table 6-9a: *Regression Analysis Model Summary Results of Sociability Variables*

Model Summary										
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
Sociability	0.814[a]	0,662	0,617	1827,252	0,662	14,697	2	15	0,000	2,090

a. Predictors: (Constant), S2, S1

b. Dependent Variable: Y

Table 6-9b: *Regression Analysis ANOVA Results of Sociability Variables*

ANOVA						
Model		Sum of Squares	df	Mean Square	F	Sig.
Sociability	Regression	98142836	2	49071418	14,697	0.000[b]
	Residual	50082764	15	3338851		
	Total	148225600	17			

a. Dependent Variable: Y

b. Predictors: (Constant), S2, S1

Table 6-9c: *Regression Analysis Coefficients Results of Sociability Variables*

Coefficients										
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
Sociability	(Constant)	2569	746		3,443	0,004	979	4159		
	S1	-2190	868	-0,379	-2,522	0,023	-4041	-339	0,996	1,004
	S2	1054	213	0,744	4,945	0,000	600	1508	0,996	1,004

a. Dependent Variable: Y

It can be noted from the tables above, that the R^2 indicates that the variables S1 (Volunteering caretakers) and S2 (Average Number of Events per year) explain 66,2% of the variance in the

regression. The R^2 and adjusted R^2 is about the same, indicating that the model is correctly specified. The ANOVA ($p < 0.001$) indicates that the model's slope differs significantly from 0. The standardized coefficients indicate that S2 contributes more to the predictive power of the model than S1, yet both S1 ($p < 0.05$) and S2 ($p < 0.001$) are significant at the $\alpha = 0.05$ level. From the correlation, VIF, heteroscedasticity, log transformations, multiple collinearity, and regression analysis tests, it can be seen that variable S2 (the average number of events hosted in the public park each year), can be used for the development of a final multiple regression model to predict the number of users, and essentially the vibrancy of public parks.

Figure 6.3 shows the linear relationship between S2 and the average number of annual visitors to public parks in the study areas.

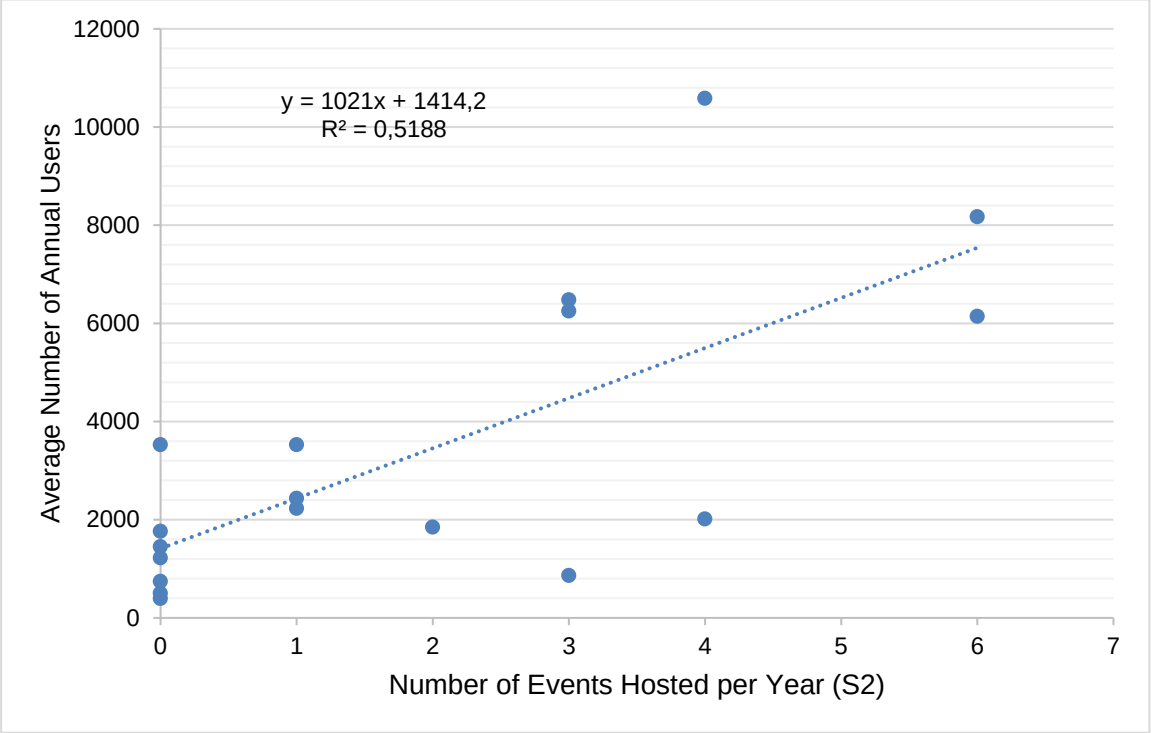

Figure 6-3: *Relationship between the Number of Events Hosted per year and the Average Number of Users*

6.7.2 Predictive Model Using Sociability Factors

From the regression analysis of the sociability variables (S1 and S2), the unstandardized coefficients are substituted into the model and the equation would simply be stated as:

$$Y = 2569 - 22761(S_1) + 1054(S_2) \quad \text{Eq.2}$$

Where:

Y = Average Number of Annual Users (Vibrancy)

S_1 = Level of the Perception of Safety (1-5)

S_2 = Volunteering caretakers

6.7.3 Results of Regression Analysis on Uses and Activities Variables

There were 8 functions and activities variables forming part of the 18 variables to be analysed further, as shown in Table 6-5. Table 6-10 shows the results of the regression analysis between these 8 selected variables (U1, U2, U3, U4, U5, U6, U7, and U8), and the annual park users (Y).

Table 6-10a: *Regression Analysis Model Summary Results of Uses and Activities Variables*

Model Summary										
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
Uses and Activities	.917[a]	0,840	0,698	1622	0,840	5,918	8	9	0,008	1,558

a. Predictors: (Constant), U8, U3, U7, U4, U6, U1, U2, U5

b. Dependent Variable: Y

Table 6-10b: *Regression Analysis ANOVA Results of Uses and Activities Variables*

ANOVA						
Model		Sum of Squares	df	Mean Square	F	Sig.
Uses and Activities	Regression	124549780	8	15568722	5,918	0.008[b]
	Residual	23675820	9	2630647		
	Total	148225600	17			

a. Dependent Variable: Y

b. Predictors: (Constant), U8, U3, U7, U4, U6, U1, U2, U5

Table 6-10c: *Regression Analysis Coefficients Results*

Coefficients										
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
Uses and Activities	(Constant)	5205	4468		3,443	0,004	979	4159		
	U1	-6574	5590	-0,356	-1,176	0,270	-19220	6072	0,193	5,175
	U2	-35	66	-0,266	-0,535	0,606	-185	114	0,072	13,980
	U3	6559	7070	0,524	0,928	0,378	-9435	22553	0,056	17,947
	U4	93	231	0,095	0,403	0,697	-429	615	0,317	3,150
	U5	-164	265	-0,321	-0,620	0,550	-764	435	0,066	15,088
	U6	2121	1188	0,861	1,785	0,108	-567	4809	0,076	13,120
	U7	774	668	0,273	1,158	0,277	-738	2285	0,318	3,140
	U8	3627	1870	0,307	1,939	0,084	-604	7858	0,707	1,414

a. Dependent Variable: Y

From the above tables, it can be derived that the R^2 indicates that the variables U_1 (Percentage of Adjacent Land Use Being Residential), U_2 (Number of Trees), U_3 (Water Feature Present), U_4 (Number of Playground Structures), U_5 (Number of Seating), U_6 (Number of Tables), U_7 (Number of Sports Field Available) and U_8 (Percentage Grass Coverage) explain 84% of the variance in the regression. The adjusted R^2 (0.698), is less than the R^2 (0.84), indicating that there are variables which artificially increase the R^2 without adding predictive power (see the definition for adjusted R^2). The ANOVA ($p < 0.05$) indicates that the model's slope differs significantly from 0, but the high multiple collinearities indicate that these values are not reliable since multiple collinearities inflate significance and predictability. To solve for multiple collinearities, variables that correlate highly can be dropped, until the multiple collinearities disappear. This was done multiple times, in order to isolate the variable that contributes to predictability.

From the correlation, VIF, heteroscedasticity, log transformations, multiple collinearity, and regression analysis tests, it was found that variable U3 (whether the public park has a water feature present), can be used to develop a final multiple regression model to predict the number of users, and essentially, the vibrancy of public parks. To validate the final inclusion of this variable further, two public parks outside the study area, for which the average number of annual users are known, and in which water features are present, will be used to test the model.

6.7.4 Predictive Model Using Uses and Activities Factors

From the regression analysis of the uses and activities variables (U_1, U_2, U_3, U_4, U_5, U_6, U_7, and U_8), the unstandardized coefficients are substituted into the model and the equation would simply be stated as:

$$Y = 5205 - 6574(U_1) - 35(U_2) + 6539(U_3) - 93(U_4) - 164(U_5) + 2121(U_6) + 774(U_7) + 3627(U_8)$$

..... Eq.3

Where:

Y = Average Number of Annual Users (Vibrancy)

U_1 = Percentage of Adjacent Land Use Being Residential

U_2 = Number of Trees

U_3 = Water Feature Present

U_4 = Number of Playground Structures

U_5 = Number of Seating

U_6 = Number of Tables

U_7 = Number of Sports Field Available

U_8 = Percentage Grass Coverage

6.7.5 Results of Regression Analysis on Comfort and Image Variables

There were 4 comfort and image variables forming part of the 18 variables to be analysed further as shown in Table 6-5. Table 6-11 show the results from the regression analysis between these 4 selected variables (C4, C1, C2, and C3), and the annual park users (Y).

Table 6-11a: *Regression Analysis Model Summary Results of Comfort and Image Variables*

Model Summary										
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
Comfort and Image	0.782[a]	0,611	0,492	2105	0,611	5,111	4	13	0,011	1,790

a. Predictors: (Constant), C4, C1, C2, C3

b. Dependent Variable: Y

Table 6-11b: *Regression Analysis ANOVA Results of Comfort and Image Variables*

ANOVA						
Model		Sum of Squares	df	Mean Square	F	Sig.
Comfort and Image	Regression	90606089	4	22651522	5,111	0.011[b]
	Residual	57619511	13	4432270		
	Total	148225600	17			

a. Dependent Variable: Y

b. Predictors: (Constant), C4, C1, C2, C3

Table 6-11c: *Regression Analysis Coefficients Results*

Coefficients										
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
Uses and Activities	(Constant)	-2213	2378		3,443	0,004	979	4159		
	C1	3032	868	0,963	3,494	0,004	1158	4907	0,394	2,539
	C2	-1206	805	-0,385	-1,498	0,158	-2944	533	0,453	2,208
	C3	-227	955	-0,071	-0,237	0,816	-2291	1837	0,335	2,987
	C4	330	948	0,092	0,349	0,733	-1717	2377	0,425	2,352

a. Dependent Variable: Y

The above tables disclose that the R^2 (0.611) indicates that the variables C_1 (Perception of Safety in Public Park's Service Area), C_2 (Level of Cleanness), C_3 (Rated Attractiveness) and C_4 (Level of Greenness) explain 61.1% of the variance in the regression. The adjusted R^2 (0.492) is less than the R^2 (0.611), indicating that there are variables that artificially increase the R^2 without adding predictive power (see the definition for adjusted R^2). The ANOVA ($p < 0.05$) indicates that the model's slope differs significantly from 0. The standardized coefficients indicate that the variables contribute more to the predictive power of the model in the following order: $C_1 > C_2 > C_4 > C_3$. C_1 ($p < 0.01$) is significant at the $\alpha = 0.05$ level.

From the correlation, VIF, heteroscedasticity, log-transformations, multiple collinearities, and regression analysis tests, it was deducted that variable C1 (the level of perception of safety in public park's service area) can be used for the development of a final multiple regression model to predict the number of users and essentially the vibrancy of public parks.

Figure 6.4 shows the linear relationship between the user's perception of safety, and the average number of annual users, of the public parks in the study areas.

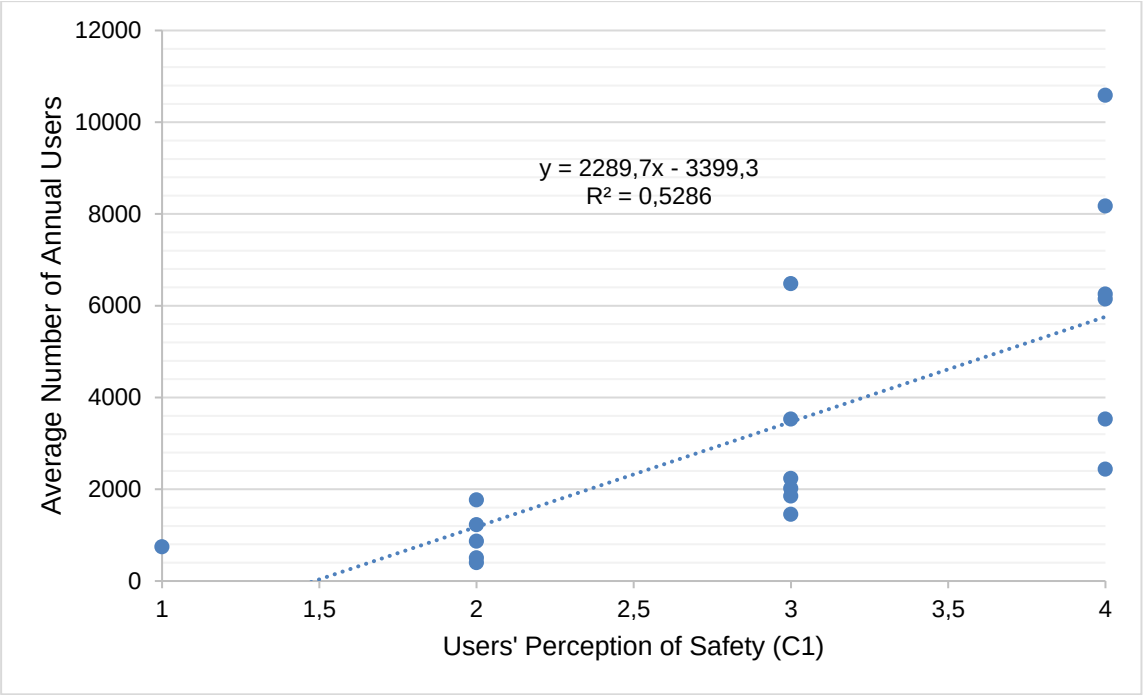

Figure 6-4: *Relationship between the User's Perception of Safety and the Average Number of Users*

It is observed from Figure 6.4 that the park users' perception of how safe the area in and around a public park has a linear relationship with the average number of annual users of public parks in the study areas (Y).

6.7.6 Predictive Model Using Comfort and Image Factors

From the regression analysis of the comfort and images variables (C_1, C_2, C_3, and C_4), the unstandardized coefficients are substituted into the model and the equation would simply be stated as:

$$Y = -2213 + 3032(C_1) - 1206(C_2) - 227(C_3) + 330(C_4) \quad \text{Eq.4}$$

Where:

Y = Average Number of Annual Users (Vibrancy)

C_1 = Perception of Safety in Public Park's Service Area (1-5)

C_2 = Level of Cleanness (1-5)

C_3 = Rated Attractiveness (1-5)

C_4 = Level of Greenness (1-5)

6.7.7 Results of Regression Analysis on Accessibility Variables

There were 4 accessibility variables forming part of the 18 variables to be analysed further, as shown in Table 6-5. Table 6-12 shows the results from the regression analysis between these 4 selected variables (A4, A3, A2, and A1) and the annual park users (Y).

Table 6-12a: *Regression Analysis Model Summary Results of Accessibility Variables*

Model Summary										
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
Accessibility	.912[a]	0,832	0,780	1385	0,832	16,055	4	13	0,000	2,215

a. Predictors: (Constant), A4, A3, A2, A1

b. Dependent Variable: Y

Table 6-12b: *Regression Analysis ANOVA Results of Accessibility Variables*

ANOVA						
Model		Sum of Squares	df	Mean Square	F	Sig.
Accessibility	Regression	123271563	4	30817891	16,055	0.000[b]
	Residual	24954037	13	1919541		
	Total	148225600	17			

a. Dependent Variable: Y

b. Predictors: (Constant), A4, A3, A2, A1

Table 6-12c: *Regression Analysis Coefficients Results*

Coefficients										
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
Accessibility	(Constant)	-21817	7426		3,443	0,004	979	4159		
	A1	24228	8913	0,410	2,718	0,018	4973	43483	0,570	1,753
	A2	689	222	0,399	3,098	0,008	209	1170	0,782	1,279
	A3	0	0	0,322	2,546	0,024	0	0	0,810	1,235
	A4	258	398	0,092	0,648	0,528	-602	1118	0,640	1,563

a. Dependent Variable: Y

The above tables disclose that the R^2 (0.832) indicates that the variables A_1 (Road Network to Sidewalk Network Ratio), A_2 (Number of Access Streets into Park), A_3 (Area of Park) and A_4

(Light of Park in Evenings Measured in Lumens) explain 83,2% of the variance in the regression. The adjusted R^2 (0.78), is less than the R^2 (0.832), indicating that there are variables that artificially increase the $R^{2,}$ without adding predictive power. The ANOVA ($p < 0.001$), indicates that the model's slope differs significantly from 0. The standardized coefficients indicate that the variables contribute more to the predictive power of the model in the following order: $A_1 > A_2 > A_3 > A_4$. A_1 ($p < 0.05$), A_2 ($p < 0.01$) and A_3 ($p < 0.05$) is significant at the $\alpha = 0.05$ level.

From the correlation, VIF, heteroscedasticity, log transformations, multiple collinearity, and regression analysis tests, it was learnt that variable A1 (road-network to sidewalk-network ratio (%) can be used for the development of a final multiple regression model to predict the number of users, and essentially the vibrancy of public parks.

Figure 6.4 shows the linear relationship between the sidewalk network's continuity for walking with the average number of annual users of public parks in the study areas (Y).

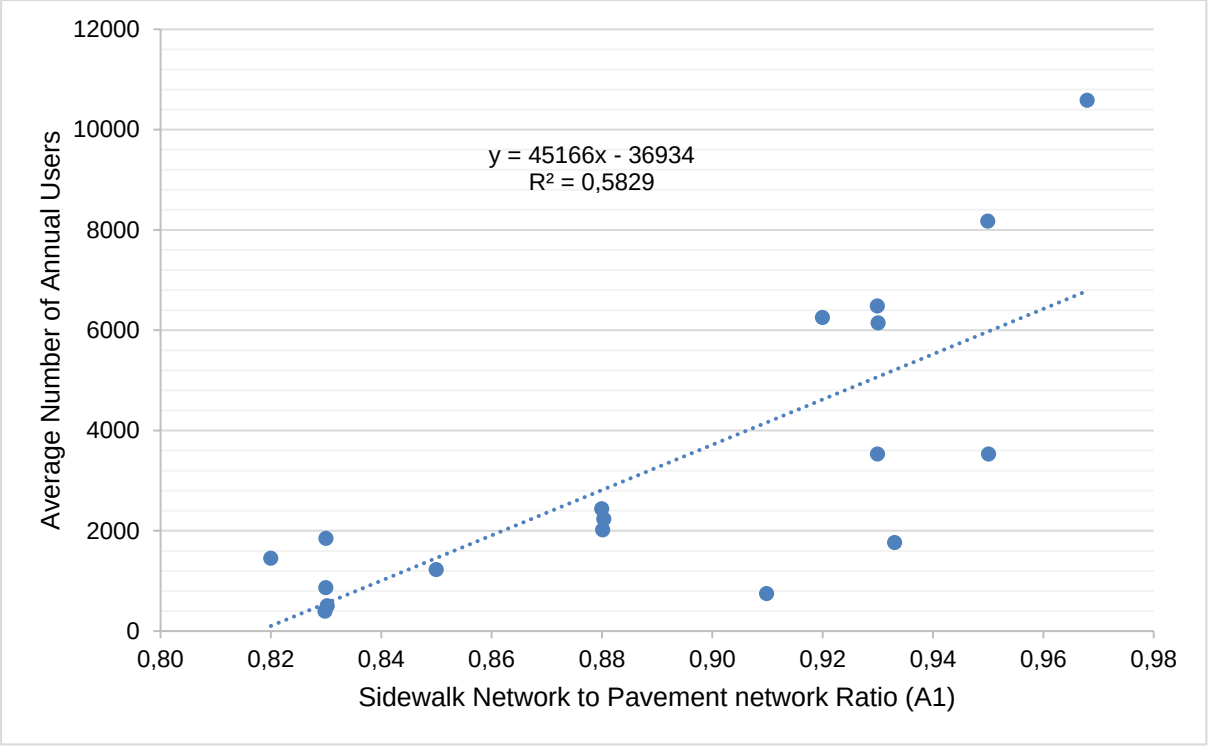

Figure 6-5: *Relationship between the Sidewalk Network to Pavement Network Ratio and the Average Number of Users*

Figure 6.5 reveals that a linear relationship exists between the average number of annual users and the completeness of a sidewalk leading to a public park.

6.7.3 Predictive Model Using Accessibility Factors

From the regression analysis of the accessibility variables (A_1, A_2, A_3, and A_4), the unstandardized coefficients are substituted into the model and the equation would simply be stated as:

$$Y = -21817 + 24228(A_1) - 689(A_2) - 0(A_3) + 258(A_4) \quad \text{Eq.5}$$

Where:

Y = Average Number of Annual Users (Vibrancy)

A_1 = Road Network to Sidewalk Network Ratio (%)

A_2 = Number of Access Streets into Park

A_3 = Area of Park (m^2)

A_4 = Light of Park in Evenings Measured in Lumens (Lux)

6.8 INTEGRATED MODEL FOR PREDICTION OF AVERAGE NUMBER USERS OF PUBLIC PARKS IN THE STUDY AREAS

By considering the major control parameters influencing the average number of annual users of the public parks in the study areas, an attempt was made to develop a model which would be capable of predicting the average number of annual users of the public parks in the study areas, under different conditions. Accordingly, a close examination of the various available modelling approaches (literature review section 2.9), was done. Having examined the available data, the various major control parameters influencing vibrancy, and the consequent applicability of the various models for the prediction of annual public park users in the study area, it was concluded that the multiple linear regression model would be the most relevant for the study area. Accordingly, a model was developed to predict the average number of annual users of the public parks in the study areas. The model was employed to develop various scenarios under different simulated conditions. Based on the findings, policy guidelines to increase the number of annual public park users, and to improve the vibrancy of public parks in the study area were constructed.

6.8.1 Predictive Model

All the public parks that had an average number of annual users and the related parameters observed from physical surveys were used for the development of the model. The model was built by making use of SPSS software.

As shown in Table 6-13, the highest contributors (standardized coefficients) were selected for the final regression model. R^2 indicates that the variables A_1, U_3, S_2 and C_1 explain 90.8% of

the variance in the regression. The R^2 and adjusted R^2 are about the same, indicating that the model is correctly specified. The ANOVA ($p < 0.001$) indicates that the model's slope differs significantly from 0. The standardized coefficients indicate that the variables contribute more to the predictive power of the model in the following order: $A_1 > S_2 > U_3 > C_1$. A_1 ($p < 0.01$), S_2 ($p < 0.05$) U_3 ($p < 0.01$) and C_1 ($p < 0.05$) is significant at the $\alpha = 0.05$ level.

Table 6-13a: *Regression Analysis Model Summary Results of Vibrancy Variables*

Model Summary										
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
Vibrancy	.953[a]	0,908	0,879	1026	0,908	31,930	4	13	0,000	1,451

a. Predictors: (Constant), A1, U3, S2 and C1

b. Dependent Variable: Y

Table 6-13b: *Regression Analysis ANOVA Results of Vibrancy Variables*

ANOVA						
Model		Sum of Squares	df	Mean Square	F	Sig.
Vibrancy	Regression	134532237	4	33633059	31,930	0.000[b]
	Residual	13693363	13	1053336		
	Total	148225600	17			

a. Dependent Variable: Y

b. Predictors: (Constant), A_1, U_3, S_2 and C_1

Table 6-13c: *Regression Analysis Coefficients Results of Vibrancy Variables*

Coefficients										
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
Vibrancy	(Constant)	-20491	5092		-4,024	0,001	-31492	-9490		
	S_2	455	152	0,321	2,989	0,010	126	785	0,615	1,626
	U_3	3879	1153	0,310	3,364	0,005	1388	6369	0,839	1,192
	C_1	836	349	0,265	2,393	0,033	81	1590	0,578	1,731
	A_1	22761	6010	0,385	3,787	0,002	9777	35746	0,688	1,453

a. Dependent Variable: Y

Substituting into the general conceptualized model using the unstandardized coefficients, the equation would simply be stated as:

$$Y = -20491 + 22761(A_1) + 455(S_1) + 3879(U_3) + 836(C_2)$$ Eq.6

With $R^2 = 0.908$

Where:

Y = Average Number of Annual Users (Vibrancy)

C_1 = Level of the Perception of Safety (1-5)

A_1 = Road Network to Sidewalk Network Ratio (%)

U_3 = Water Feature Present (0 or 1)

S_2 = Average Number of Events Per Year

6.8.2 Validation of the Model

Before employing the established model for future predictions and scenario analyses, its suitability and correctness were validated. Apart from establishing the accuracy of the model through checking the regression parameters such as critical and actual F values, t-statistics and p values (for $\alpha < 0.05$), validation of the model was further done by comparing and examining the results obtained by employing the model for 3 public parks in the study area, and one additional park, containing a water feature, outside the study area, which was not considered in the survey, and the subsequent analysis (obtained from physical survey). The comparisons were made between the results (number of users predicted) obtained by using the model and the actual number of users obtained from the physical survey.

A close examination of the compared results between actual users and simulated users in four different parks revealed that the results vary within a range of only 2.2% and 6.1% (Table 6-14, Figure 6.6), thereby, validating the applicability of the model for the predicted number of users of public parks under different scenarios.

Table 6-14: *Validation of Model*

Public Park	Coordinates	x_1	x_2	x_3	x_4	Actual number of users obtained from field survey	Simulated number of users Obtained from the application of the model	Variations (%)
Van Rooy Avenue	29.07.29.25 S 26.10.50.86 E	0,85	2	0	3	2013	2274	6,1
Anna M Louw St	29.06.11.83 S 26.09.39.03 E	0,87	3	0	3	3050	3184	2,2
Welwitchia Road	29.10.45.60 S 26.10.46.27 E	0,91	1	0	2,5	2958	2767	-3,3
King's Park	29.1150735,2 S 6.2056214,17 E	0,99	40	1	4	30000	27465	-4,4

Where:

x_1 = Road Network to Sidewalk Network Ratio (%)

x_2 = Average Number of Events Per Year

x_3 = Water Feature Present (0 or 1)

x_4 = Level of the Perception of Safety (1-5)

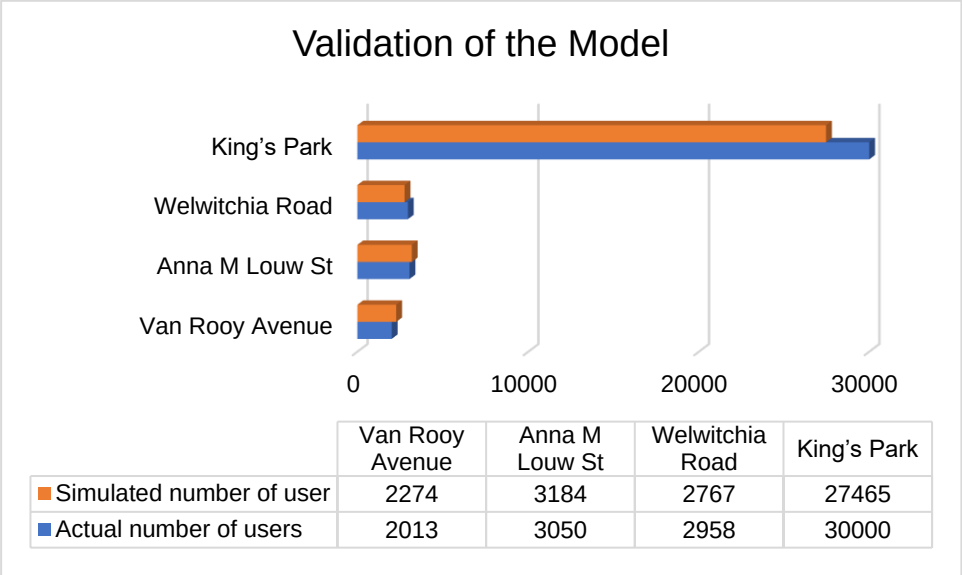

Figure 6-6: *Validation of Model*

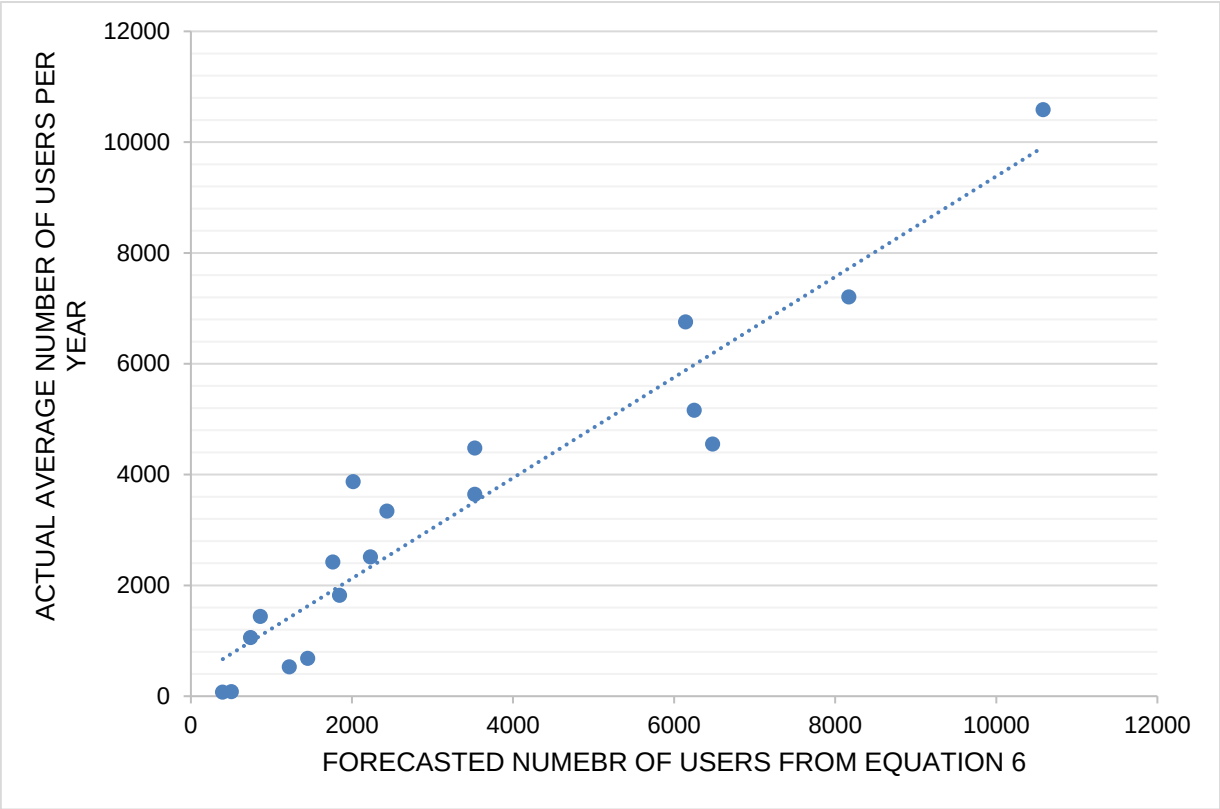

Figure 6-7: *Relationship between Vibrancy Factors and Average Annual Users*

By making use of the developed equation 6, Figure 6.7 presents a clear linear relationship between the actual average number of users per year and the forecasted numbers showing that there is very little deviation between the actual numbers and the forecasted numbers.

6.9 HYPOTHESIS TESTING

From the validated multilinear regression model created, a test was done to prove the hypothesis either true or false.

The hypothesis of this study is as follow:
The provision of adequate and accessible engineering infrastructure, facilities, activities, and comfort and image elements, in the public parks of residential areas, will improve the utilization (vibrancy) of public parks in residential areas.

The validation of the model was done by examining the regression parameters such as critical and actual F values, t-statistics and p-values (for $\alpha < 0.05$). The regression variables (Table 6-15), show that the actual F-value found from the regression analysis (31.93), is much higher than the critical F value. Both the single and two-tailed p-values are less than 0.05 for $\alpha < 0.05$, indicating the validity and correctness of the model.

Table 6-15: *Hypothesis Testing with Significance Test Results of Model between Vibrancy Factors and Average Annual Users*

Variable	F-Value	P-values (two-tailed)	t-statistics	Statistical Significance
S_2	31,930	0,010	2,989	Significant
U_3		0,005	3,364	Significant
C_1		0,033	2,393	Significant
A_1		0,002	3,787	Significant

Table 6-16 illustrates the outcome of the hypothesis testing, which was done by varying three variables i.e., the sidewalk-network to road-network ratio, number of annual events hosted and users' perception of safety levels in the public parks independently, and keeping all the other variables unchanged (the average values of the surveyed results of various variables).

Table 6-16: *Hypothesis Testing in Terms of Average Annual Users and Influential Factors*

Sidewalk network to road network ratio	No of public park users	Number of annual events hosted	No of public park users	Safety perception levels	No of public park users
0.80	5697	3	7746	1	6074
0.85	6608	6	9111	2	6910
0.90	7746	12	11841	3	7746
0.95	8884	24	17301	4	8582
1.00	10022	48	28221	5	9418

Table 6-16 shows that, with an improvement of vibrancy parameters, the number of users of public parks is increased. This proves the hypothesis, considered in this investigation, namely that the provision of adequate and effective engineering infrastructure facilities, activities, comfort and image elements to the public parks of residential areas, will improve the utilization (vibrancy) of public parks in residential areas.

6.10 FORECASTING OF THE AVERAGE NUMBER OF ANNUAL USERS IN PUBLIC PARKS

The validated multiple linear regression model was applied to predict the average number of annual users of public parks, in the study areas, under various simulated scenarios, created by varying the independent variables. The simulated scenarios and predicted results are presented below.

6.10.1 Simulations

To comprehend the park uses scenarios under different public park vibrancy conditions in the study area, simulations of the model developed were conducted, and plausible policy intervention measures were constructed. While developing simulated scenarios, the four important vibrancy variables were considered as the major control variables. The major control variables considered in developing simulated scenarios are:

- The Road Network to Sidewalk Network Ratio (%)
- The Average Number of Events Per Year
- The presence of a Water Feature (0 or 1)
- The Level of the Perception of Safety (1-5)

The simulation of conditions and the variation in independent variables forming the prediction of the average number of annual users of public parks are presented in Table 6-17.

Table 6-17: *Simulation Conditions for Prediction the Average Number Annual Users of Public Parks in the Study Area*

No.	Simulation conditions of variables	Variation in conditions
1	Road Network to Sidewalk Network Ratio (%)	Varied from a minimum of 0.50 to a maximum of 1.0 at every 0.01 increment
2	Average Number of Events Per Year	Varied from a minimum of 0 to a maximum of 52 at every one increment
3	Presence of Water Feature (0 or 1)	Varied from a value of 0 (no water feature present) and 1 (water feature present) with each variable change.
4	Level of the Perception of Safety (1-5)	Varied from a minimum perception level of 1.0 to a maximum of 5 at an increment change of 0.08 per simulation

Several simulation runs were conducted by considering the variables individually and in combination with one another (presented in appendix E). From the total number of 400 simulated scenarios developed, the 15 most important and feasible scenarios (Table 6-18), were considered and discussed for the development of strategies to improve the vibrancy of public parks and to increase the average number annual users of public parks. The first stage consisted of combining variables (simultaneous changes to multiple variables in a planned sequence). This sequence started by incrementally changing all four variables, with the variable pertaining to the water feature being present (1) with each increment and then not present (0) with each increment of the other three variables. In the next stage of simulation, every variable was considered and analysed separately to determine its individual impact.

When single or multiple parameters were changed for the purpose of the simulation, the remainder of parameters were kept to their average values. Appendix E illustrates the different simulations that were conducted. All the simulations were evaluated and the most feasible scenarios (Table 6-18) were considered for policy analysis. One additional negative scenario (scenario 16) were also included to illustrate the negative effects of worsening the variable conditions.

Table 6-18: *Plausible Simulated Policy Scenarios*

Scenarios	Simulation Number	Road Network to Sidewalk Network Ratio (%)	Average Number of Events Per Year	Water Feature Present (0 or 1)	Level of the Perception of Safety (1-5)	Simulated Number of Users Per Year	Increase in Public Park Users from the Average Number (%)
Baseline	1	0,9	3	0	3	3867	0
1	153	1	3	0	3	6143	59
2	154	0,9	52	0	3	26162	577
3	256	0,9	3	1	3	7746	100
4	255	0,9	3	0	5	5539	43
5	256	1	12	0	3	10238	165
6	392	1	3	1	3	10022	159
7	336	1	3	0	5	7815	102
8	353	0,9	12	1	3	11841	206
9	366	0,9	12	0	5	9634	149
10	390	0,9	3	1	5	9418	144
11	396	1	12	1	3	14117	265
12	397	1	3	1	5	11694	202
13	399	1	12	0	5	11910	208
14	398	0,9	12	1	5	13513	249
15	400	1	12	1	5	15789	308
16	2	0,85	0	0	2	528	-314

It can be seen from Table 6-18 that by altering the independent variables, the expected average number annual users of a public park can be increased from 3867 to 26162 (an increase of 557% in Scenario 2), which is quite significant. However, this is not necessarily plausible, as it assumes that public parks in residential areas can host an event once a week. Scenario 15 is more plausible, since it suggests a hosted event once a month, and still shows a significant increase of 308% in the number of annual users.

The number of events per year in public parks is the most influential independent variable, yet since there are many public parks (5-10) in a residential area, it is not plausible to suggest that all the public parks can host an event once a week. Therefore, the maximum suggestion for the number of annual events should rather be 12 (once a month) which will contribute towards the most plausible scenario. It must be stated, however, that if a public park can host events weekly (52), the average number of annual users can increase by up to 577% without altering any of the other variables.

All 16 scenarios have been compared and are shown in Figure 6.7. An additional scenario was included so that the negative effects of not addressing the primary contributing factors can be discussed and shown.

6.10.2 Scenario 1 (Road Network to Sidewalk Network Ratio Increased to 1.0)

In scenario 1, only the road-network to sidewalk-network ratio is increased to 1.0 (100%). That means that all the roads are conjoined by continuous, walkable sidewalks. It is predicted that the potential number of annual users will increase significantly (59%), compared to the current scenario (from 3867 users to 6143 users). This indicates that sidewalk-networks, in the service areas of public parks, have an important role to play in the enhancing of the vibrancy of the parks.

6.10.3 Scenario 2 (Average Number of Events Per Year Organized in the Public Park Increased to 52)

In scenario 2, only the average number of events, organized per year in the public parks, are increased to 52 from the current scenario. This implies that the public park has an organized event once a week throughout the year. Some public parks in other parts of the world have organized events, such as farmers' markets, food markets, park runs, and more, once a week. so, to plan for 52 events per year in a public park, does therefore not seem impractical. It is, however, not a plausible number if you want to apply it to all the public parks in the same residential area. By altering this variable only, the potential number of annual users is increased from the current average users of 3867 to 26162 users, indicating an increase of approximately 577%. This significant increase indicates the importance of organized events in public parks. Though it is not always possible to have more organized events in public parks, it is obvious that potential users will be more inclined to go to a public park, if there are more organized events to draw them there. This is also the factor, which impacts the vibrancy of public parks the most.

6.10.4 Scenario 3 (Water Feature is Set to be Present)

In scenario 3, only the presence of a water feature, such as a pond, stream, fountain or dam in the park, is changed. By altering only this variable from 0 to 1, the potential number of annual users is increased by 100% (from current users of 3867 to predicted users of 7746). This means, that by including a water feature in a public park, the number of visitors per year should double. Additional research on how water features can be added to public parks, in a feasible manner, can be done.

6.10.5 Scenario 4 (Level of the Perception of Safety is improved)

In scenario 4, only the level of the perception of the safety of the potential public park users is increased to 5 (very safe). By altering only this variable, the potential number of annual users (43%), is increased from the current 3867 users to 5539 users. This increase indicates that the level of safety, that almost half of the potential users, perceive a public park and its surrounding areas to have, directly influences their decision to visit the public park. The perception of safety that potential users of public parks have, has out of the four major variables, the smallest impact. There are some design elements that can be applied to improve people's perception of safety, and which will be discussed in greater detail, in the next chapter.

6.10.6 Scenario 5 (Combination of Road Network to Sidewalk Network Ratio (1) with Average Number of Events Per Year (12))

In scenario 5, the sidewalk, to road-network ratio, and the number of annual events hosted in the public parks are set at 1.0 (100%) and 12 respectively. The number of annual events was set to 12, in order to set a more reasonable goal of, having at least one event per month, in the public parks. By improving the sidewalk network and increasing the number of annual events, the average number of annual users increases from 3867 to 10238, which is a 165% increase. It shows that this scenario is advantageous for new public park developments. Sidewalks, fit for their purpose, can be constructed, and serve to motivate users to attend the public park events.

6.10.7 Scenario 6 (Combination of the sidewalk to road network ratio (1.0) and the inclusion of a water feature (1))

In scenario 6, the sidewalk-network to road-network ratio, leading to the public parks are set at 1.0 (100%) and the presence of a water feature is included. By changing these two variables, the average number of annual users increases from 3867 to 10022, which accounts for a 159% increase. This indicates, once again, that a walkable sidewalk leading to a public park, motivates users to visit the park, for the sake of enjoying the water feature.

6.10.8 Scenario 7 (Combination of the sidewalk to road network ratio (1.0) and the perception of the safety of potential users)

In scenario 7, the sidewalk-network to road-network ratio, and the perception of safety by potential users are set to levels of 1.0 (100%) and 5 respectively in combination. By changing these two variables, the average number of annual users increases from 3867 to 7815, which is a 102% increase. It can, therefore, be noted that a combination of an increase in the sidewalk-network to road-network ratio, along with improving potential users' perceptions of safety in parks, will increase the numbers of public park users.

6.10.9 Scenario 8 (Combination of the average number of annual events hosted and the presence of a water feature)

In scenario 8, the number of annual events hosted, and the presence of a water feature is set to their optimum levels of 12 and 1 respectively in combination. By changing these two variables, the average number of annual users increases from 3867 to 11841, which is a 206% increase. This signifies that the hosting of events and water features can co-exist in public parks and increase the number of annual visits.

6.10.10 Scenario 9 (Combination of the number of annual events hosted and potential user's perception of safety)

In scenario 9, the number of annual events and the perception of safety levels are set at 12 and 5 respectively in combination. This scenario shows that the average number of annual users increases from 3867 to 9634, which is a 149% increase. It is therefore construed that the combination of an increase in the number of annual events, and safety perception levels, will enhance the number of park users significantly.

6.10.11 Scenario 10 (Combination of including a water feature (1) and increasing safety perceptions (5))

In scenario 10, the inclusion of a water feature and improvements to the safety perceptions are set to 1 and 5 respectively. This scenario reveals that the average number of annual users increases from 3867 to 9418, which is approximately a 144% enhancement. It shows that water features and potential users' safety perception can positively impact the annual numbers of users in public parks.

6.10.12 Scenario 11 (Combination of sidewalk network to road network ratio (1.0), number of annual events hosted (12), and including a water feature in the public parks (1))

In scenario 11, the sidewalk network to road network ratio is set at 1 (100%), the number of annual events hosted is 12 (1 per month), and a water feature in the public parks are included. By changing these three variables, the average number of annual users increases by 265% (from average 3867 users to 14117 users), which is very significant. Therefore, while the improvement of parks is considered, the above three parameters need to be considered together appropriately.

6.10.13 Scenario 12 (Combination of sidewalk network to road network ratio (1.0), safety perception levels (5), and including a water feature in the public parks)

In scenario 12, the sidewalk network to road network ratio is set at 1 (100%), the safety perception levels are increased to 5 (very safe), and a water feature in the public parks are included. By changing these three variables, the average number of annual users increases by 202% (from average 3867 users to 11694 users), which is very significant. Therefore, sidewalk network improvements, increasing safety perceptions, and incorporating water features can be considered together for the improvement of public parks.

6.10.14 Scenario 13 (Combination of sidewalk network to road network ratio (1.0), the number of annual events hosted (12), and the safety perception levels (5))

In scenario 13, the sidewalk network to road network ratio, the number of annual events hosted, and the safety perception levels of public parks are considered at levels of 1.0 (100%), 12 and 5 respectively in combination. This scenario will lead to an enhancement of about 208% (current average 3867 users to 11910 users) of users of public parks, which is highly significant, and should be considered in the planning of new public parks, and the upgrading of existing parks.

6.10.15 Scenario 14 (Combination of 12 of annual events hosted, the inclusion of a water feature, and the safety perception level at its highest of 5)

In scenario 14, the number of annual events hosted, the inclusion of a water feature, and the safety perception levels were set at optimum levels with a hosted event set at 12 per year, the inclusion of a water feature, and a high level of safety perception at 5. Findings suggest that by improving these three variables, the average number of annual users will increase by 249% (increases from 3867 current users, to 13513 users).

6.10.16 Scenario 15 (Combination of all four variables: Road Network to Sidewalk Network Ratio (1), Average Number of Events Per Year (12), Water Feature Present (1), and Level of the Perception of Safety (5))

In scenario 15, all four variables were considered in combination. The sidewalk network to road network ratio is taken at 1.0, the number of annual events hosted is set at 12 suggesting events to be once a month, a water feature is included in the park layout, and the users' perception of safety in and around the public parks is taken at 5 (very safe). Under this scenario it is observed that the number of users will be enhanced from the current average number of users (3867) to a predicted 15789 users, indicating an increase of 308%. This is highly significant and is the scenario deemed to deliver the most significant increase in users of public parks, in the study area. Thus, Scenario 15 clearly shows the significant increase in the average number of annual users a public park may experience if all four variables are set up to their optimum conditions.

6.10.17 Scenario 16 (Combination of all four variables set on a pessimistic level: Road Network to Sidewalk Network Ratio (0.85), No Events Per Year (0), No Water Feature Present (0), Very Low Perception of Safety (2))

Scenario 16 was developed to present a pessimistic outlook for how negative the impact can be if all the major parameters were set to unfavourable conditions. The scenario presumes that the sidewalk network is only 85% complete/available, no events are being hosted, there is no water feature present in the park, and the user's perception of safety is low (2). This shows that the public park will have 86% fewer users than the current average. Seven of the 18 public parks in the study area have no water features and annual events, which means that the only two parameters influencing a positive number of annual users are the sidewalk network, and perceptions of safety.

6.10.18 Comparative Analysis of Various Scenarios

Figure 6.8 presents a comparative analysis of the 15 various scenarios (Scenario 16 excluded) obtained and discussed above. The comparative analysis was conducted in order to find the scenario(s), most suitable to be considered as the universal scenario formulation, for increasing the average number of annual users of public parks in the study area.

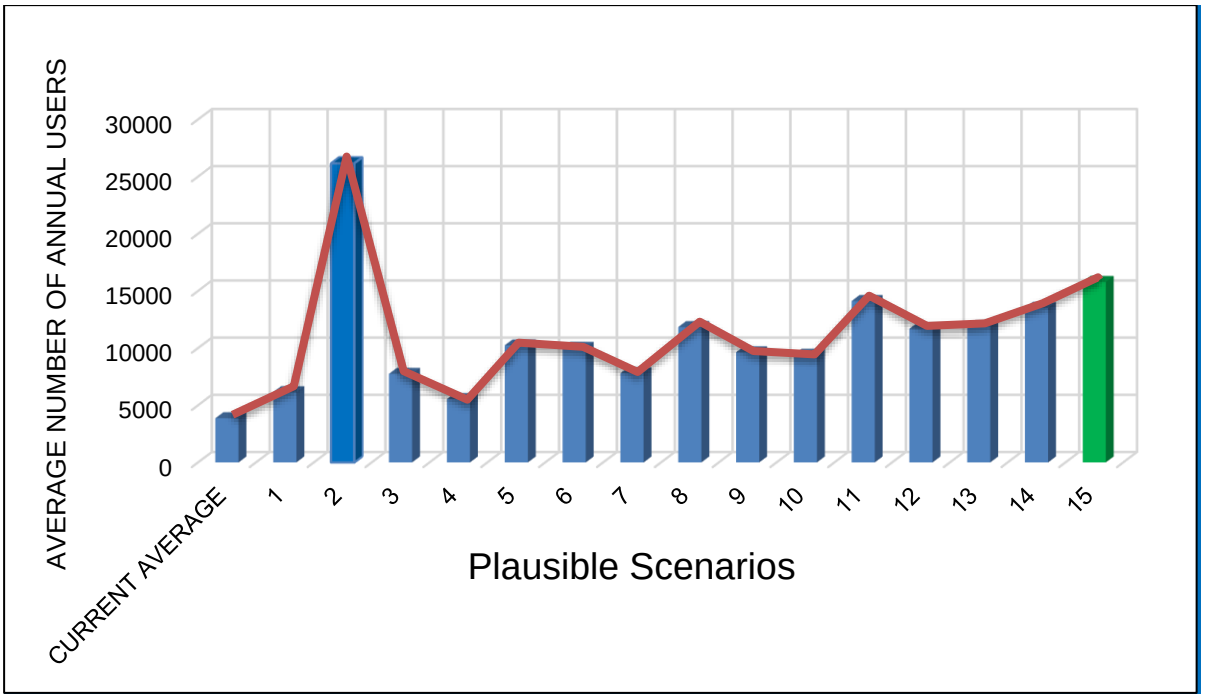

Figure 6-8: *Comparative Analysis of Various Scenarios*

This comparative analysis reveals that scenario 2 receives the greatest increase in the average number of annual users (26212). This is only because the scenario assumes a public park will host an event weekly, which is not plausible when considering all the public parks in a residential area as a collective. For this reason, Scenario 15 is promoted for consideration in future policy development. In Scenario 15, the public parks in the study areas will receive a very high average number of annual users. Similarly, under scenarios 8, 11, 13 and 14, the average number of annual users are raised significantly and can also be useful as recommendations for designing vibrant public parks. All the other scenarios provide similar trends of increase in average annual users although not as big as the scenarios just mentioned. Scenario 15, however, increases the average number of annual users extensively and can be appropriate for structuring policy guidelines Scenario 15 is aimed at increasing the number of annual users of public parks and advancing the vibrancy of public parks in the study areas. When weighing up all the unique situations each public park may have in terms of adhering to the four major variables, it ought to be considered which of the other scenarios is most appropriate for further examination while the policies are being developed.

6.10.19 Summary of Scenarios

The comparative scenario analysis clarified the way the four public park vibrancy variables, in different combinations, alter the expected number of annual users. Although the average number of events hosted per year, by itself influences the increase in park users significantly, it has been found that the combined scenarios are more effective in improving the annual

number of users of the parks in the study area. It has also been found that scenario 15, which is an augmentation of all four the variables combined, ought to yield the most significant increase in park functioning in the study areas. It is, however, not always possible to control or change all four the variables at every public park being designed, (at the same time). Accordingly, to increase the number of park users, and by taking the constraints and specific context of each park into consideration, other scenarios with the capacity to deliver appropriate improvements, also must be considered. For instance, not all public parks in residential areas can facilitate a water feature, and then emphasis needs to be directed towards other scenarios that do not include the construction of a water feature.

CHAPTER 7: CONCLUSION, POLICY GUIDELINES, AND RECOMMENDATIONS

7.1 INTRODUCTION

Understanding the purpose of public parks in residential areas and identifying possible solutions for improvements to the vibrancy of these parks in residential areas, requires a comprehensive set of planning- and design guidelines to be gathered through intensive investigation and evaluation. This study aimed and succeeded at identifying and categorizing the different public parks in the residential areas of the study area, assessing their performance in terms of utilisation, examining the major infrastructural-, social-, and environmental challenges against the creation of sustainable and vibrant public parks, delineating the major control influential engineering infrastructure, social- and environmental attributes that will contribute to the creating of successful of public parks in the study area, and developing an empirical model, or models, according to Applied Systems Analysis (ASA) paradigms, in order to comprehend the sustainability and vibrancy of public parks under different simulated scenarios.

Therefore, in this study, the existing socio-economic environments, combined with the physical, symbolic, and visual access scenarios present in the city, were gathered and investigated. Along with available and useful literature, a variety of statistical analyses, which included data from both the survey and secondary sources, were executed consistently through several stages. The obstacles to the vibrancy of public parks were evaluated and a multilinear regression model for the prediction of the average number of annual public park users under various simulated scenarios was developed.

To conclude the process, this chapter explains the inferences drawn from the results of the analyses and introduces a planning concept for establishing vibrant public parks. From the inferences that were drawn and the concept that was developed, policy guidelines and plausible recommendations for the improvement of vibrancy to public parks in the residential areas of the study area were formulated. The inferences drawn from the results of the analyses are presented in the following section.

7.2 INFERENCES FROM LITERATURE REVIEW

The following inferences are made from the review of literature:

- The need for recreation is increasingly being recognised as a vital part of residential neighbourhoods and in turn, this need for recreation requires residential neighbourhoods to have open spaces where potential users of the parks in the neighbourhood can partake in recreational activities.
- Public parks that function effectively (vibrantly) will ensure that the people of the neighbourhood enjoy mental-, physical-, and social wellbeing.
- Public parks need to be carefully planned and positioned in residential areas in order to provide adequate open space and recreational facilities for the various categories of users in the area.
- The same standard procedures for the planning and placement of public parks in residential areas have mostly been followed by urban planners for many years.
- Old established residential areas in South Africa, in general, have enough public parks to service the area, but new developments, rezoning of land use and socio-economic transformations brought about changes to established residential areas which negatively affected the vibrancy of these public parks.
- Along with the transformations happening in and around old and established residential areas, public parks in developing residential areas are still being planned and positioned using conventional planning methods. This may not suffice for the future vibrancy requirements of successful public parks.
- Accessibility, usability, sociability, and comfortability is noted to be one of the major determinants of successful, vibrant public parks.
- There are three forms of access (physical-, visual-, and symbolic access), in respect of the access ability of public parks, which are generally taken into consideration.
- Spatial accessibility on the proximity, location and size of the parks contribute to the vibrancy of the parks.
- A successful public park needs to be easily accessed on foot or by vehicle, as well as, be clearly visible from a distance, as well as from up close.
- Traffic networks in the vicinity of the facilities are a measure of the accessibility of the park.
- Access to public transportation is also identified as a major enabler for park access.
- The rapid increase in vehicles has affected the accessibility of public parks in the cities to some extent.

- Besides, lack of bicycle lanes and pedestrian sidewalks connected to parks and recreational facilities, parking areas near public parks and recreational facilities are constraints to the accessibility of the parks in cities.
- The time it takes to walk from home and the walking distance is observed to be some of the most important preconditions for access to and the vibrancy of public parks.
- Pedestrian safety is of great consequence as far as the vibrancy of public parks is concerned.
- In general, access to public parks in residential areas of a city is decided by the spatial configuration of parks, the number of parks, and their spatial distribution across neighbourhoods or local regions.
- Planning related to land allocation is taken into consideration for the provision of facilities and services meant to ensure constant and safe access to public parks. This can promote access to public parks.
- Interior visibility, vibrancy, functionality with respect to people with special needs, availability of various modes of movement, availability of convenient transportation nodal points close to important social and civic elements (park entrances, libraries and post offices) are the other relevant aspects to consider regarding the accessibility to public parks and recreational facilities.
- The measurable aspects relating to the access to and links with public parks in residential areas include the following:
    - The size of a public park
    - The size of the residential area surrounding the public park
    - The number of residents living in the vicinity of the public park
    - The condition and availability of walkways leading to a public park
    - The road network infrastructure in the area around the public park
    - The average driving speed near the public parks
    - The availability and conditions of parking facilities
    - Barriers and fencing around public parks
    - The types of entrances into public parks
    - The average walking distance from the neighbouring residences to the public parks
    - The distance from which the public parks are visible
    - The access roads leading to the public parks
    - The lighting in public parks, etc.

- South Africa has many issues with regards to the level of comfort and image which provide evidence towards the poor condition and low level of the perceived safety of public parks.
- It is important to understand how to quantitatively and qualitatively measure the comfort and image of public parks in residential areas, so that we may properly analyse this determinant.
- The Measurable qualities relating to the comfort and image of public parks in residential areas include factors such as:
    - The degree of cleanliness
    - The available seating
    - The perceptions of safety
    - The intrusion of vehicles in pedestrian spaces
    - The pleasant appearance
    - The proportion of natural elements (greenness)
    - The actual experience of safety inside the park

  These factors will be included in the list of factors that will be measured in the study area for further analysis.
- It is evident from the study that many public parks in the residential areas of South African cities provide little opportunity for a range of activities to happen.
- Additional investigation into the factors contributing to the activities (and their usefulness), currently on handing the public parks of South African cities is recommended.
- Measurable factors relating to the functions of and activities in public parks in residential areas include the following:
    - The configurations and allocation of land in the areas surrounding the public parks
    - The type and layout of vegetation inside the public park
    - The type and layout of playground facilities for children
    - The type and layout of picnic facilities
    - The type and layout of sport facilities
    - The availability facilities, if any at all, which can be used for a variety of recreational activities
- Sociability is the most difficult aspect of public parks in residential areas of South African cities, to achieve.
- The sociability aspect of public parks in residential areas of South African cities are perceived to be pessimistic.

- The importance of a high degree of sociability in any open space is emphasised in academic literature from around the world.
- It is vital to explore ways in which sociability can be advanced in the public parks of South African cities, particularly because very little analytical research, concerning this challenge, has been presented.
- According to the literature study, the measurable qualities relating to the sociability of public parks in residential areas include factors such as:
    - The age groups of persons visiting the public parks
    - The availability of volunteer caretakers
    - The number of social events taking place within the public park
    - The diversity of people visiting the public parks
    - The degree of ownership adopted by the residents in the vicinity of the public parks
    - The eagerness of residents in the neighbourhood to visit the public parks

- The current developed models that can be used to analyse public park utilization are Census tract models, Proximity models, Service area analysis models, SOPRC models, F-F Framework models and Geographic Information Science (GISc) frameworks in addition to different statistical techniques.
- Models that are completely applicable to the demographic situations and developments encountered in South Africa are noted to be scarce.
- It is recognised that a public park which has been transformed to become fully utilized (safe, easy, and convenient) by its potential users, should, due to the fact that the park has become more vibrant, and is an attraction in the area, have a positive effect on its surrounding neighbourhood.
- Studies relating to the vibrancy of public parks in residential neighbourhoods are observed to be limited.

7.3 INFERENCES FROM SURVEYS, SPATIAL ANALYSES AND MODELLING IN THE STUDY AREA

Presented below are the inferences drawn from the various surveys, showing spatial analysis and statistical modelling.

- The average household size in the study area is 2.95. persons
- The average number of vehicles per household in the study area is 1.18.

- Most of the dwellings in the study areas are houses (57%), followed by informal settlements (19%). The remainder of the dwellings (24%) are flats (apartments), student houses and, duplexes or townhouses.
- More than 73% of the population in the study area are aged 39 years or younger.
- More than 30% of the residents are aged between the ages of 10 to 24 years, and only 26% of the residents are older than 40 years. On reflection, it clearly shows that the majority of the city's residents are in the active age group and, as such, signifies the importance of recreational and leisure activities.
- About 88% of the people in residential areas are potential users of parks. This includes 57% adults (19-60 Years), 23% children (6-18%) and 8% of persons older than 60 years of age. Public parks need to be made more accessible to all age groups due to the importance for all age groups to have frequent recreational activities.
- The potential number of users of public parks is greater among adults (19-65) than among infants and children (0-18 years).
- Households in the higher income range tend to make less use of public parks in their area than households in the lower-income range.
- The public parks in all the residential areas except one (Universitas) have visitors made up of just one dominant ethnic group. The Universitas residential area is the most ethnically diverse study area due to the University of the Free State being located there.
- Only the residential areas which are dominantly in the middle- and higher-income groups, have volunteers willing to spend time and money on the maintenance and upkeep of the public parks in their area.
- Public parks with volunteer caretakers, tend to have higher levels of greenery and cleanliness.
- The public parks which host organized events, tend to experience more visitors.
- Public parks in the study areas are mostly bordered on by residential dwellings
- Most of the cities in South Africa face water shortage to one degree or another. Water restrictions are often implemented. Due to the water restrictions, public parks in residential areas cannot rely fully on manual irrigation to maintain its greenness.
- Except for two public parks, the level of greenness in the public parks of the study area was much alike, and therefore the impact of the level of greenness on the average yearly number of public park users could not be established.
- The public park with the lowest level of greenness (BP3), notably has the lowest overall number of monthly users and the public park with the highest level of greenness the highest.

- Tables and sports fields are seldom available in public parks, whereas, seating and playground structures can be found frequently.
- In some instances, public parks, where crime happens frequently, have fewer annual visitors. This is, however, not always the case and may be due to ignorance about the occurrence of crime in their neighbourhood among residents.
- Public parks in the study area. where residents in the vicinity of the parks perceive them as unsafe, clearly show fewer monthly visitors.
- There seems to be no clear relationship between the level of attractiveness of a park and the number of monthly visitors.
- The linear relationship between the actual level of greenness and cleanness of a park and the people's perceptions of the attractiveness of a public park indicates that the actual level of greenness and cleanness of a park has some bearing on people's perceptions of the attractiveness of a public park.
- Residential areas in the study area where mixed land use is applied have taken up most of the land space (65.6%) in the city. To date, these areas have seldom been considered for new design concepts.
- Residential areas with higher populations do not necessarily have a more public park visitor.
- Although the city of the study area is designed to accommodate vehicle transport like that of most of the cities in South Africa, it is also known as the "city of walkers".
- The Mangaung Metropolitan Municipality's efforts (especially in the central business area) to improve facilities and services for pedestrians in Bloemfontein can be observed. It is, nevertheless, also clear that little priority is given to the needs of pedestrians in residential areas, where the need is also important.
- Most users of public parks travel on foot from their homes to public parks and back.
- It is expected of pedestrians to use sidewalks when walking to public parks instead of in the road reserved for vehicles. Due to the sidewalk-network frequently being obstructed by various means, such as, homeowners extending their gardens right up next to the road, or placing rocks or fences in the way, this does often not happen
- As much as 17% of the sidewalk-network in the service area of the public parks in the study area is obstructed and unfit for pedestrian use.
- The sidewalk widths in the service areas are adequate for pedestrians, provided that, the sidewalks are not obstructed.
- None of the roads in the service areas are in a pristine condition, even so, most of them are in an acceptable- or good condition.

- The conditions of the majority (64.2%) of sidewalks in the service areas are acceptable, however, more than one-third of the sidewalks are in a poor state.
- Vehicles are mostly parked in the street close to the public parks. Only about 28% of the public parks have allocated parking zones, both in the street and inside the park. The distances of the zones, allowing for park users to park in the streets around the public parks, extend from 0 to 200 meters. The parking areas allocated near the public parks, however, have been found to be without a pattern.
- The average time it takes park visitors to walk to the public parks from their homes, is no longer than 13 minutes.
- Some of the public parks in the study area can be seen from 704 meters away, while others are only visible from 98 meters. This may be due to the location, size, and topography of the public parks in the study area.
- According to the perceptions of the respondents surveyed, the option of walking to public parks, as well as, the distance they must walk, are factors which influence the accessibility of public parks.
- None of the public parks in the study areas is well maintained. Most of them (74.3%) are in either an acceptable or a good condition. More than - one-third of the parks surveyed, however, have been found to be in a bad state.
- According to the perception of the respondents in the study area, evenings and afternoons are the most preferred time of day to visit public parks (75% of park-goers visit the public parks during these times). Only about - one-fifth of the visitors prefer to visit the public parks during the morning and about 5% prefer to visit the parks during mid-day.
- During early evenings, all the public parks in the study areas have below the minimum recommended illumination levels of 20lux, as recommended by various established illuminance codes. Illumination is found to be a major indicator of accessibility as gathered from the perceptions of the respondents of the survey.
- More than half of the public parks surveyed have playgrounds and only about 42.86% of the public parks do not have playgrounds.
- Approximately 57.14 % of the vehicles in the areas of the public parks were found to travel within the accepted speed limits of the city in and around the public parks. , Almost 42.86% of the vehicles, however, exceed the speed limit of 60 km/h in and around the public parks. This is a cause of concern for public park user safety.
- According to the perception of the respondents, the presence, or absence, of entertainment facilities and playgrounds, do not have any real bearing on the accessibility and vibrancy of public parks in the study area.

- Safety is a major concern for the accessibility and comfortability of public parks.
- Vehicles travel faster than the maximum speed limit (60 Km/h) promulgated by the Mangaung Metro Municipality on about 33.3% of the roads passing near the public parks. However, the vehicles stay within the speed limits on about 66.7% of the roads near the public parks.
- The parameters which were found to influence the vibrancy of public parks the most are the sidewalk-network to road-network ratio, the number of events hosted in the public parks per year, the presence of a water feature, and how safe potential users perceived the public park and its service area to be. These parameters have been identified as the main contributors to the use of public parks in the residential areas of the study area.
- ASA is found to be a suitable approach to finding the relationships between the vibrancy of public parks and their residential areas. Once these relationships have been established, the inter-linkage of the attributes, which may stimulate the development of sustainable and vibrant public parks, can be systematically analysed.

From this investigation, it can be noted that the four vibrancy parameters, as discussed above, are foundational to the restoration of the vibrancy of the public parks in the study area. All these parameters (individually and in combination) have a greater or lesser influence on the number of people visiting public parks. As far as the sidewalk-network to road-network is concerned, has been found that the more complete these networks in the service areas are, the more people, on average, visit the public parks per month. A 5% enhancement of the ratio, for instance, has the potential to increase the number of visitors to public parks by 24% per year.

The average number of annual users increases considerably along with the increase in the average number of organized events hosted in the public park per year. If a public park hosts an organized event once a week, the average number of users can increase by 676% per year. Yet, more realistically, if a public park hosts an event at least once a month, an 149% increase of annual public park users can still be witnessed. Similarly, incorporating one water feature into a public park can lead to a 200% increase of visitors to the public parks per year.

The fourth parameter, that of perceiving public parks as safe places to be, also have some bearing on the number of visitors per park, per year. It has been estimated that if people perceive the public parks as safe places to be, a 43% increase of people visiting public parks annually will occur.

A significant increase of visitors to public parks in the study area can be expected if all four the vibrancy parameters are reflected in combination. By, for instance, combining the effect of an optimal sidewalk-network to road-network ratio of 1.0 (100%), increasing the number of organized events in the public parks to once a month (12), facilitating the people's perception of safety in public parks to be deemed as very safe (level 5), and setting up a water feature in the public park, the annual number of visitors to public parks can be increased by 308% from their current number.

7.4 PLANNING CONCEPT

Established on the major control parameters influencing the average number of annual visitors to public parks, a concept, aimed at enhancing the vibrancy of public parks and increasing the average number visitors to public parks per year, has been devised for the study area.

This investigation revealed that the potential of, not only contributing to an increase in the average number of annual visitors but also of improving the vibrancy of public parks in the study area, can be attributed to addressing the following aspects:

- Sidewalk-network to road-network balance (Sidewalk continuity).
- Bringing about the required renovation and implementing the structures necessary to amend the residents' perception of their safety in public parks.
- Promoting the hosting of more organized events in public parks.
- Installing a water feature, in one form or another, in the public parks

The improvement and development of such an infrastructure will, however, require effective planning and good policy interventions. In order to develop a comprehensive set of policy guidelines, present plausible recommendations, and guide the concept formation, the following strategies have been formulated:

1. The absence of well-structured sidewalk-networks in the service areas of public parks prevent many potential park users from walking to the parks. The residents in the vicinity of public parks also often visit the parks together as families, with children. With many of the sidewalks being in states of disrepair or obstructed, the pedestrians are compelled to walk in the road, which may put them in danger.

   Obstructions on the pavements are frequently caused by home-owners extending their gardens and driveways right up to the road or placing other obstructions or barriers, for instance, rocks and poles or fences, in the way of pedestrians. Seeing as the pavement

areas are municipal property, sidewalks should at all times be available to pedestrians, and not be utilised by home-owners as garden-space, or obstructed in any way. Therefore, appropriate policy interventions for the provision of adequate, well maintained and unobstructed sidewalks, commensurate to the roads leading to the public parks in the residential areas, are of the foremost requirements. Efforts should be made to remove obstructions on sidewalks and construct pavements in the residential areas where there are none.

2. The number of events that can be organized and hosted in the public parks of residential areas are far too few. Most of the events hosted for residents in urban areas are held on private open spaces. More encouragement and opportunities for residents to organize and host events in their public parks should be given. This is foundational to the fostering of a sense of ownership among the residents which, may then, promote an increase in other, more dependent, vibrancy factors. An approachable system whereby residents have opportunities to organize enjoyable events in their public parks, without too much effort, ought to be implemented. Some of the suggestions for events to be organized and hosted in public parks are weekly fun runs, open-air chess club events, weekly yoga sessions, dog training classes, free-to-join neighbourhood sports matches and craft markets.

3. The impact water features have on natural public park surroundings are too significant to ignore. Additional studies and surveys relating to the possibility of using sustainable, automated groundwater-systems (automated boreholes) rainwater, and natural waterways to supply water to keep a water feature sustained, and also provide irrigation for the plant life (and ultimately lead to a greener park) should be conducted. The feasibility studies for installing water features in public parks can also determine whether government funding or alternatively, private sector funding will be feasible.

4. Residents perceive the level of safety in open spaces partly according to their personal opinions and experiences, which is not easy to change. Even so, park visitors' perception of how safe they are in and around public parks, may be influenced for the better if some of the physical features of public parks in the study area are adapted. Previous studies suggest that proper lighting improves the visibility in the parks, as well as end route to the parks and, for that reason, adds to people's sense of being safe in that space (Peña-García, Hurtado and Aguilar-Luzón, 2015; Stevens and Salmon, 2015). Public Surveillance systems that are clearly visible also tend to, actually, keep crime at bay and deepen a sense of being safe (Evenson *et al.*, 2016). The physical

layout of public parks must be openly visible with little to no thick shrubbery that can obscure users' range of vision. Pathways should be level and unobstructed, and free-ranging animals can be kept in check by means of uncompromising dog-on-leash policies (Luymes and Tamminga, 1995; Wicramasinghe and Dissanayake, 2017).

7.5 ALTERNATIVE POLICIES

Based on this planning concept and the different combinations of simulated scenarios developed using the developed model to predict the number of park users, several alternative policy scenarios were devised and are presented below.

- Policy 1 - The sidewalk-network to road-network ratio must be 1.0 (100%). This scenario will enhance the potential number of visitors to public parks by about 59% annually.
- Policy 2 - The average number of events organized in the public parks per year can be coordinated to be 52. This will mean that the public park has an organized event once a week, throughout the year. By altering only this variable, the potential number of annual visitors is increased by a staggering 577%. It is known that some public parks outside the study area have organized events, such as farmers markets, food markets, park runs, etc., once a week, and for this reason, it may seem practical to plan for 52 events. However, to expect all the public parks in a residential area, let alone a city, to host weekly events, is not realistic. It would, therefore, be more practical to envision for public parks to host an event at least once a month.
- Policy 3 – Installing a water-feature, such as an artificial pond, stream, fountain or dam, increases the potential number of annual users by 100. This means that by including a water feature in a public park, the number of visitors per year should double.
- Policy 4 – Facilitate and design the infrastructure surrounding the park to increase the degree to which visitors perceive a park as a safe place to be. By improving only this variable, the potential number of annual users is increased by 43%.
- Policy 5 – It is proposed that the sidewalk to road-network ratio and the number of annual events hosted in the public parks are set at 1.0 (100%) and 12 respectively. The number of annual events is set to 12, in order to have a more reasonable goal of having at least one event per month in the public parks. By changing these two variables, the average number of annual users increases by 165%.
- Policy 6 – It is proposed that the sidewalk to road network ratio leading to the public parks are set at 1.0 (100%) and the presence of a water feature is included. By changing these two variables, the average number of annual users increases by 159%.

- Policy 7 – It is proposed that the sidewalk to road-network ratio and the perception of safety by potential users are set to levels of 1.0 (100%) and 5 respectively and in combination. By changing these two variables, the average number of annual users increases by 102%
- Policy 8 – Policy 8 proposes that the number of annual events hosted, and the presence of a water feature is set to their optimum levels of 12 and 1 respectively and in combination. By changing these two variables, the average number of annual users increases by 206%.
- Policy 9 – This policy proposes that the number of annual events and the perception of safety levels are set to be 12 events per year and a “very safe” (5) perception of safety. This scenario shows that the average number of annual users increases by 149%.
- Policy 10 - This policy proposes that the inclusion of a water feature and adjustments relating to the perceptions of safety are set in place. This scenario expands the average number of annual users by 144%.
- Policy 11 - It is proposed that the sidewalk-network to road-network ratio is set at 1 (100%), the number of annual events hosted is 12 (1 per month), and a water-feature is brought into the park. By changing these three variables, the average number of annual users increases by 265%.
- Policy 12 - This policy proposes that the sidewalk-network to road-network ratio is set at 1 (100%), the safety perception levels are increased to 5 (very safe), and a water feature is set up in the public park. By changing these three variables, the average number of annual users increases by 202%.
- Policy 13 - It is proposed that the sidewalk-network to road-network ratio, the number of annual events hosted, and the safety perception levels of public parks are considered at levels of 1.0 (100%), 12 and 5 respectively and in combination. This scenario will lead to a visitor increase of about 208%.
- Policy 14 - This policy proposes that the number of annual events hosted, the inclusion of a water feature, and the safety perception levels were set at optimum levels. Findings suggest that by improving these three variables, the average number of annual users will increase by 249%.
- Policy 15 – The final and most suggested policy proposes that all four variables were considered in combination. The sidewalk-network to road-network ratio is taken at 1.0, the number of annual events hosted is set at 12, indicating the events to be held once a month, a water feature is brought into the park layout, and the users’ perception of safety in and around the public parks is set at 5 (very safe). In this scenario, the number of users to visit the park will increase by 308%

7.5.1 Recommended Policies

Based on the detailed analysis of the policies and their results, it was concluded that policy number 15 offers the most preferred possibility for the number of park users to be increased to the maximum and will be the most suitable for increasing the average number of visitors to public parks per year. The policy was founded on the composite scenario of ensuring that a 100% of the sidewalk-network in the service area is accessible to pedestrians, the number of annual events hosted is set at 12, suggesting that events will be organized and hosted once a month, a water-feature is brought into in the park layout, and the users' perception of safety in and around the public parks are taken into serious consideration and upgrading the perception of safety by adapting the infrastructure in and around the public park. Because of the possibility that one or more of the four determinants cannot be altered, it may, however, not always be feasible to implement this policy. In that case, one of the other policies may according to the constraints and potentials of the residential area, and the public parks as well as, the context the park functions in, must be considered. For example, not all public parks in residential areas can facilitate a water feature, and then emphasis needs to be directed towards other policies that do not include the construction of a water feature, such as policy 13. All 15 policies are suitable for the existing public parks, as well as for public parks still in their planning and design phase, which means that policies can be selected based on their viability and degree of difficulty to be implemented according to the uniqueness of the circumstances encountered in each park individually.

7.6 PLAUSIBLE PLANNING GUIDELINES AND RECOMMENDATIONS

The focus of this study has been to find ways through which the level of vibrancy of public parks, and a substantial increase in the average number of public park users in the residential areas of the city of Bloemfontein, can be achieved. Based on the analysis of various determinants, a review of literature, the results of the surveys taken, the views of the respondents to the surveys, and some general observations pertaining to the actions required to increase the number of public park users in the study area, the following recommendations, in addition to the policy guidelines presented above, are proposed.

1 The pavements, or sidewalks, adjoining the roads accessing public parks must be fully paved, s- well-maintained, and diligently kept free from obstructions.
2 The illumination in all the public parks must be increased substantially, in order to facilitate accessibility during the afternoon, and evening hours.
3 The grounds of a public park should be big enough to provide room for various kinds of activities and to make the parks easy to see.
4 The parks must be made more accessible, by increasing the number of access streets.
5 For the sake of pedestrian safety, speeding on the roads near parks must be restricted.

6 Public parks should not be developed along major arterials or excessively busy roads. It has been found that public parks located next to busy roads have almost no visitors, due to the intricacy of access, and the safety risk imposed on them by the heavy traffic in the vicinity.

7 Public parks that are not utilized effectively, should not be re-zoned for other applications, such as residential or commercial practices, but should rather be reconditioned by attending to the degrees of vibrancy and safety.

8 Since it has been proven that a community with a sense of ownership towards an open space will utilize it more and take better care of it, More symbolic themes, such as flower arranging, should be brought into public parks Symbolic reasons for access to public parks are mostly deficient in the public parks of the residential areas.

9 A large portion of the public park users comprises of adults (18-65) which contribute to the level of safety in public parks. Therefore, since potential adult users are not properly catered for in current public parks designs, more facilities that are focussed on potential adult users, such as, open-air gyms, benches, jogging tracks, solar device charging stations, etc., should be installed in public parks.

10 Dense vegetation and hidden areas should not be allowed in public parks. This will ensure proper visual access to all the areas in the park and enhance a sense of feeling safe, as well. Visitors to public parks should be able to see all the areas of the public parks, always, from anywhere in a park.

11 The physical environments of public parks must be improved. Regular maintenance of public parks should be performed to ensure that the physical, visual, and symbolic accesses of public parks are always up to a good standard.

12 Entry fees charged, in order to access parks, should not be permitted in the residential neighbourhoods of the study area.

13 Since water features play such a significant role in the vibrancy of public parks, investigations should be conducted to determine the feasibility and possibility of developing water features inside the public parks.

14 It was also proven that organized events held frequently in public parks, significantly increase the public park's vibrancy. For this reason, the infrastructure of public parks should be reviewed, and the installation of elements used for facilitating events, such as plug-in power points, tables, benches, shade netting, open stages, notice boards, etc., should be considered.

7.7 CONCLUSION, LIMITATIONS, AND FUTURE RESEARCH

7.7.1 Conclusions of the Study

The necessity for public parks in residential areas can be justified by considering the benefits that vibrant public parks bring to the surrounding communities. The public parks in the urban areas of the central region of South Africa notably lost their vibrancy and purpose. The decreasing number of public park users and the deteriorating state of public parks in the urban areas of the central region of South Africa, therefore, warranted an investigation to identify the constraints against the vibrancy of public parks and to explore ways to improve the vibrancy and consequent functionality of public parks in the urban areas of the region.

To accomplish the aim of the study, GIS- and survey research methodologies data collection, and subsequent applied systems analyses were conducted. Regression models, including a multilinear regression model premised upon ASA, were developed to construct a variety of scenarios, under different simulated conditions, which would assist with bringing about policies and strategic interventions to increase the vibrancy of public parks, and ultimately, build up the numbers of people enjoying a park experience.

The investigation revealed that the road-network to sidewalk-network ratio, the average number of organized events hosted in the public parks per year, the presence of a water feature, and the perception of safety in the public park service area held by residents in the neighbourhood, are the major control variables, which independently, and in combination, significantly influence the vibrancy of public parks**.**

Based on the statistical analyses and regression models, the hypothesis, that the availability of quality infrastructure would increase the number of users in the public parks, was tested. Several alternate policy scenarios, based on the simulated model results, were developed. Plausible planning guidelines to improve vibrancy and user increase at public parks in the study area were also recommended.

Findings suggest that a reconstruction effort, incorporating all four the major variables in combination, (increasing the sidewalk-network to road-network ratio to 1.0, increasing the number of annual events hosted to 12, making it one event per month, bringing a water feature into the public park environment, and raising the users' perception of safety in and around the public parks, by bringing about certain infrastructural changes) would increase the average number of visitors to public parks. Concurrently, context-specific policies, based on the constraints and potentials of the suburban areas, and aimed at improving the vibrancy and number park users in the study area, must be established.

7.7.2 Limitations of Study

The surveys taken in the study area were, because of a manpower shortage, limited time, and budget constraints, limited to a smaller selection of residential areas, and as such, allowed for some limitation on the outcome of the investigation. An additional encumbrance was the lack of available, structured, statistical data, relevant to the study area. The fact that the scope of the research was confined to the city of Bloemfontein, underlines the need for similar investigations in other cities before propositions can be generalised with a greater assertion. Extensive surveys are also required for a thorough understanding of the detailed scenarios.

7.7.3 Future Research Opportunities Emerging from Study

This study offers several opportunities for further research. Some of the possibilities for further research include:

1 Exploring possibilities for more sustainable water delivery to public parks in residential areas through the extraction of groundwater, or by harvesting rainwater.
2 An investigation at the individual micro-level (public park) to complement the macro-level analysis.
3 Detailed investigations into the influences of individual parameters, for instance, opportunities to explore the park by means of walkways, safety factors, the influence of the preferred activities and behavioural patterns of persons, who spend time in the parks, on the functioning of the public parks.
4 Evaluating the impact of infrastructure on the residents' perception of the safety they experience in the parks.
5 An investigation into possible sustainable sidewalk designs which can be easily implemented and constructed in residential areas.
6 Exploring possible methods to promote the creation and continuation of organized events in public parks of residential areas.

Based on the content of this study, it can be argued that if local legislation will support the proposed planning guidelines and policies, and implement them accordingly, the construction and functioning of public parks in the cities of South Africa can improve substantially.

It will also be of great benefit to this study if the current annual numbers of visitors to public parks in residential areas of other cities in South Africa, can be recorded and compared to the prediction model developed in this study. This will further validate this model and make it possible for policies and guidelines to be standardized and generalized for all the urban areas of South Africa. A further step would then be to see the validity of this model in residential public parks globally.

7.8 CONTRIBUTION AND NOVELTY OF THE STUDY

The contributions of the research are multi-fold. First, it contributed to the knowledge of how the vibrancy of public parks can be enhanced, particularly in the suburban residential areas of cities of South Africa. Second, the study established linkages between the vibrancy of public parks and various infrastructure, social, and environmental parameters. Third, it has practical implications. The ASA premised integrated model developed, will enable formulation of various plausible scenarios based on which policy interventions can be taken by the municipalities or city development authorities to make the parks vibrant and sustainable.

The novelty of the study lies in the use of the methodology in which ASA and conventional statistical modelling techniques were integrated to develop models for forecasting the number of annual public park users as well as the level of vibrancy in public parks. This can be used for developing and analysing different scenarios under different simulated scenarios to evolve policy interventions or strategies leading to public parks becoming more vibrant.

Also, a set of guidelines were constructed for the developing of sustainable public parks in the residential areas of South African cities. These guidelines will contribute to the development of socio-environmentally sustainable cities.

"Everybody needs beauty as well as bread, places to play in and pray in, where nature may heal and give strength to body and soul."

-John Muir

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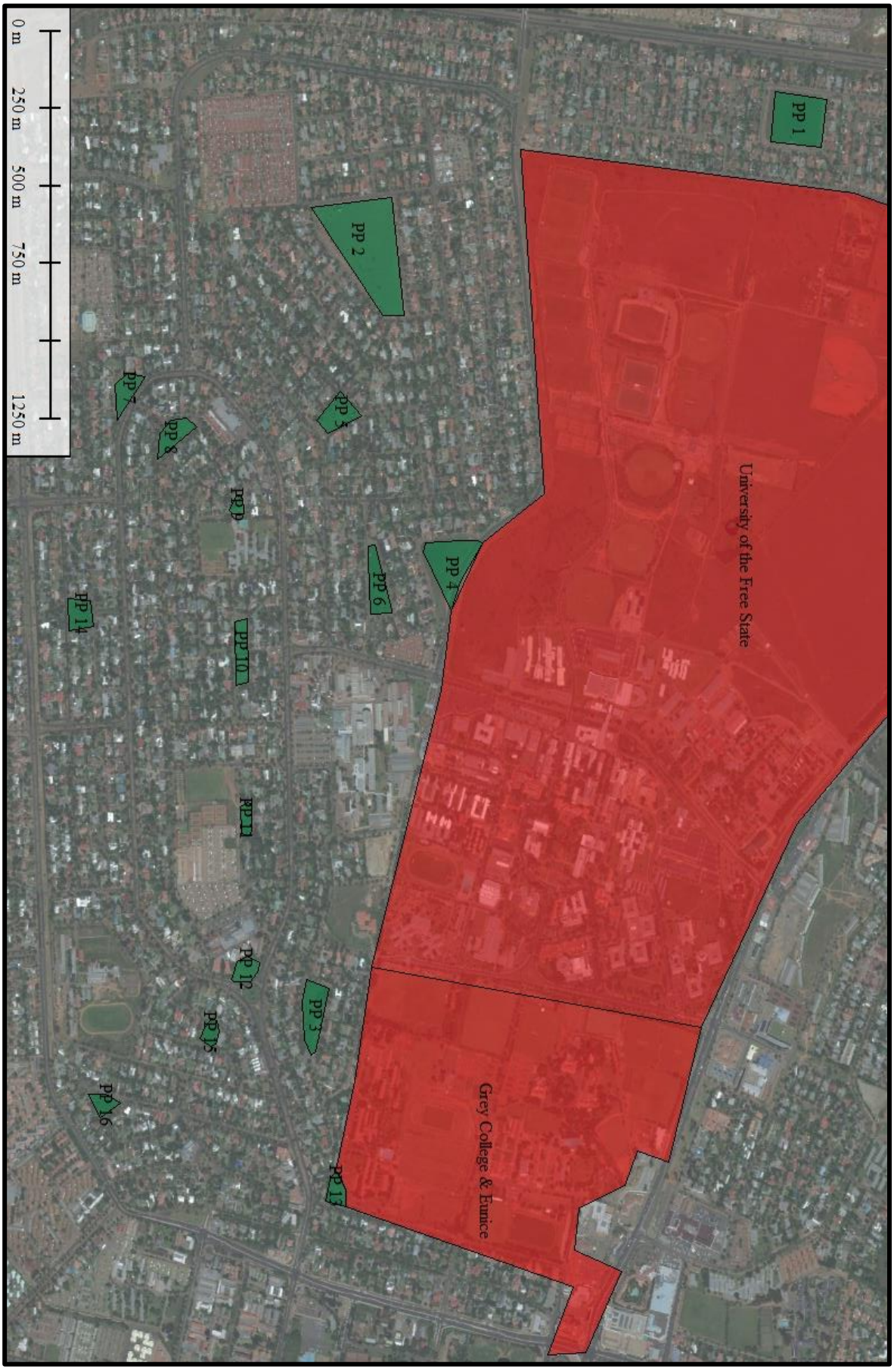
ANNEXURE A

Public Parks Langenhovenpark

Annexure A (Mapsource © GIS Software)

ANNEXURE B

Public Parks Universitas



Annexure B (Mapsource © GIS Software)

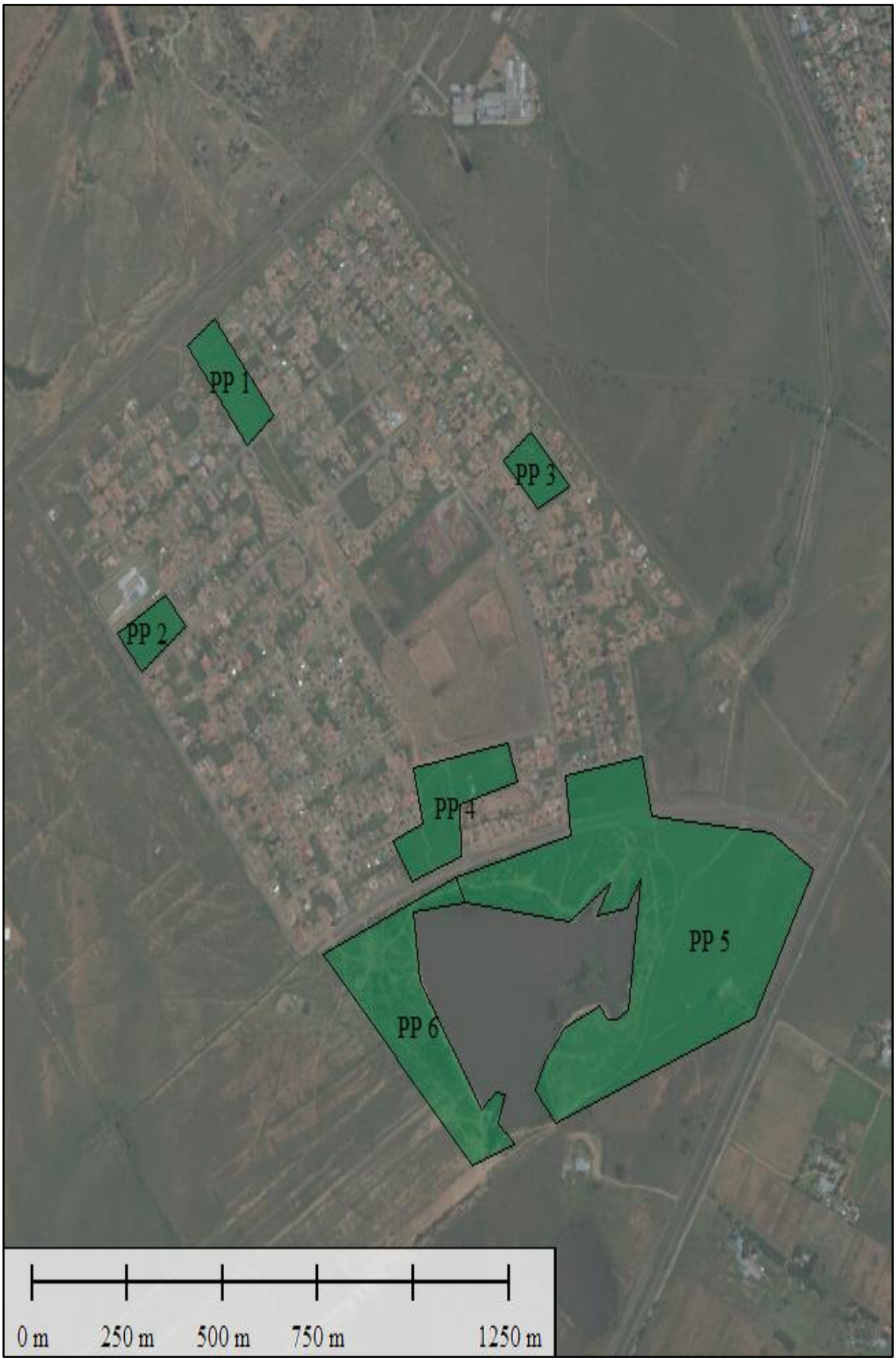
ANNEXURE C

Public Parks Batho

Annexure C (Mapsource © GIS Software)

ANNEXURE D

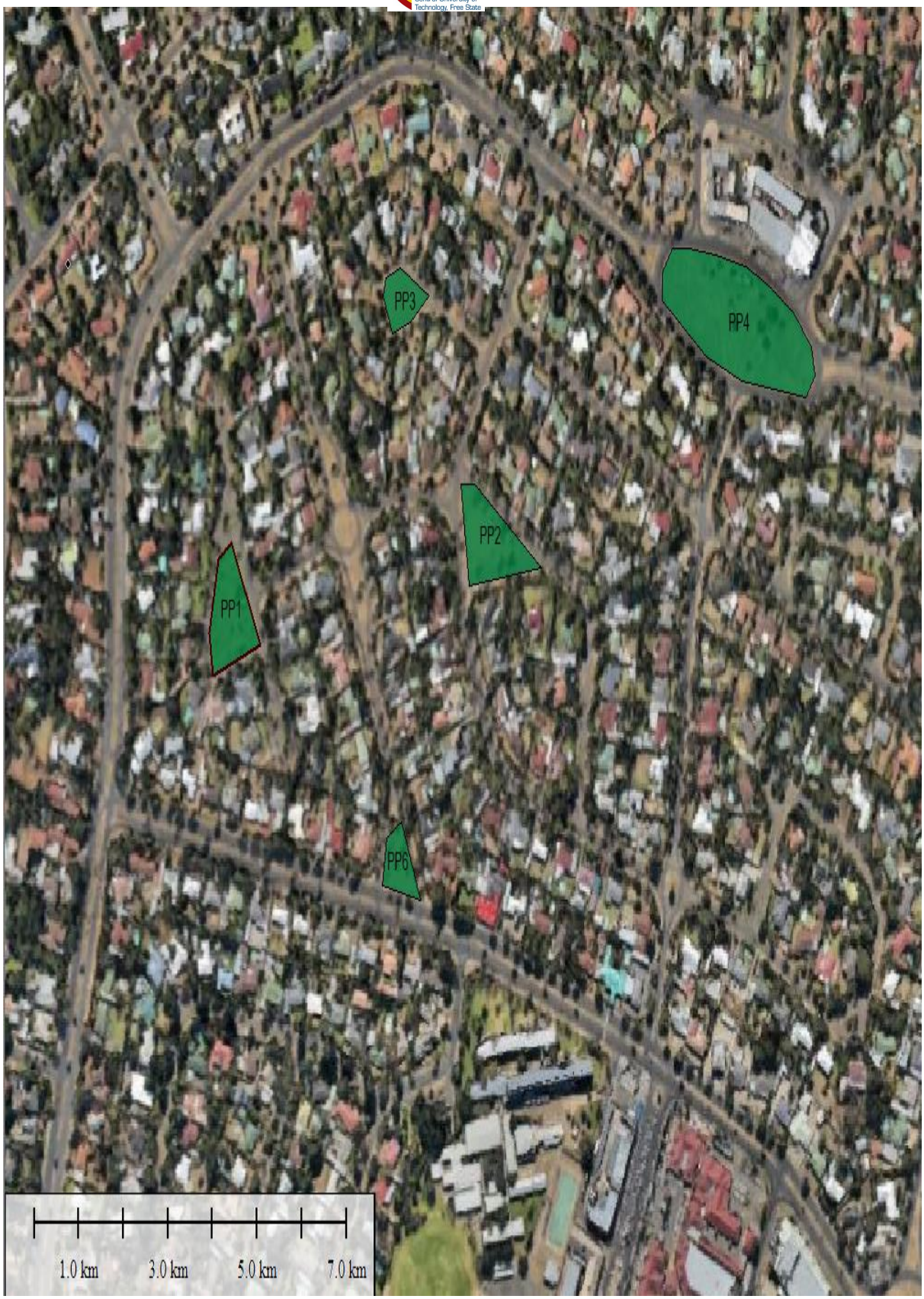
Public Parks Lourier Park



Annexure D (Mapsource © GIS Software)

ANNEXURE E

Public Parks Dan Pienaar



Annexure E (Mapsource © GIS Software)

ANNEXURE E

Household Surveys

PUBLIC PARKS IN URBAN RESI AREAS OF BLOEMFONTEIN CITY, SOUTH AFRICA HOUSEHOLD SURVEY

Date: _____ **Time:** _____

Name of Surveyed Person: _____

Age: _____ **Gender: M ☐ F ☐**

Residential Area: _____

Occupation: _____

1. How recently have you made use of the open recreational facilities in your area?

- ○ Less than 1 months
- ○ Less than 3 months
- ○ Between 6 and 3 months
- ○ Between 6- and 12-months years
- ○ Over one year
- ○ Never

2. How often do you make use of the open recreational facilities in your area?

- ○ Once per week or more
- ○ 2 to 3 times per month
- ○ Once per month
- ○ Less than once per month

2.1 Which facility (field, playground, benches, etc.) do you make use of in the park?

_____

_____

_____

_____

2.2 What is the main purpose of your visits to the park facility?

- ○ Daily exercise
- ○ Casual walking
- ○ Dog walking
- ○ For children to play
- ○ Lunch/Food break
- ○ Sport

2.3 What time of the day do you use th creational facilities in your area?

_____

3. Overall, how satisfied are you with the open recreational facilities in your area?

- 5 - Very satisfied
- 4 - Somewhat satisfied
- 3 - Neither satisfied nor dissatisfied
- 2 - Somewhat dissatisfied
- 1 - Very dissatisfied

4.1 Please tell us why you feel this way.

_____

_____

_____

_____

4.2 What are some of the challenges and constraints in visiting the open recreational facilities in your area?

* Distance, Cost, Vehicular Access, Entry fee
* Safety
* Parking
* Position of Entrance
* Route Accessibility

5. How satisfied are you with the following characteristics of the open recreational facilities in your area?

	5 - Very satisfied	4 - Somewhat satisfied	3 - Neither satisfied nor dissatisfied	2 - Somewhat dissatisfied	1 - Very dissatisfied
Accessibility					
Safety (perception of safety)					
Variety for activities (vibrancy)					
Comfort and image					
Sociability					
Proximity					
Convenience					

6. How important are the following characteristics when use of the open recreational facilities in your area?

	5 - Extremely important	4 - Very important	3 - Somewhat important	2 - Not very important	1 - Not at all important
Accessibility					
Safety (perception of safety)					
Variety for activities (vibrancy)					
Comfort and image					
Sociability					
Proximity					
Convenience					

7. Thinking of your most recent experience with the open recreational facilities in your area, how much do you agree with the following statements?

	5 - Strongly agree	4 - Somewhat agree	3 - Neither agree nor disagree	2 - Somewhat disagree	1 - Strongly disagree
The park was worth the visit					
The park serves its purpose					
The park is sufficient to my needs					
The park is easily accessible					
I would rather pay to access a private park					

8. What do you like about the open recreational facilities in your area?

_____

_____

_____

_____

_____

9. What did you dislike about the open recreational facilities in your area?

_____

_____

_____

_____

_____

10. Thinking of similar open recreational facilities offered by other countries; how would you compare your open recreational facilities offered to them?

- Much better
- Somewhat better
- About the same
- Somewhat worse
- Much worse
- Don't know

11. Would you visit the open recreational facility in your area again?

- Definitely
- Probably
- Not sure
- Probably not
- Definitely not

12. Why do you feel that way about visiting the open recreational facility in your area again?

_____

_____

_____

_____

_____

13. Would you recommend the open recreational facility in your area to family, friends, and neighbours?

- Definitely
- Probably
- Not sure
- Probably not
- Definitely not

14. Why do you feel that way about recommending the open recreational facility in your area?

_____

_____

_____

_____

_____

15. What suggestions do you have to ıe open recreational facility in your area?

_____

_____

_____

_____

_____

16. Which category describes your living accommodation status?

- Single
- Living with spouse and without any children
- Single with children
- Living with spouse and children

17. What is your employment status?

- Full-time employed
- Part-time employed
- Unemployed
- Retired
- Student/Scholar
- Prefer not to answer

18. Which category best describes your household annual income?

- R0 – R1500
- R1500 – R5000
- R5000 – R15000
- R15000 – R30000
- R 30000 and above
- Prefer not to answer

19. What is the highest level of education you received?

- High School or less
- Trade or vocational school
- Attend some college
- Undergraduate degree
- Graduate degree
- Prefer not to answer

20. What distance do you travel to the public park you make use of?

_____

_____

21. What mode of travel do you use to go to a public park?

_____

_____

22. What does it cost you to make it there?

_____

_____

SIDEW SURVEY

IN RESIDENTIAL AREAS OF BLOEMFONTEIN CITY, SOUTH AFRICA.

This survey is voluntary and anonymous. Information will only be used for research purposes.

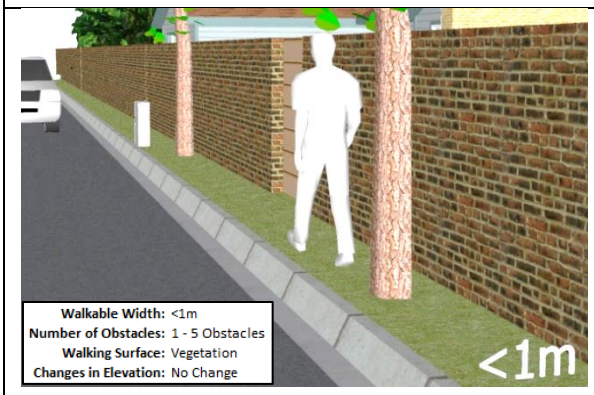
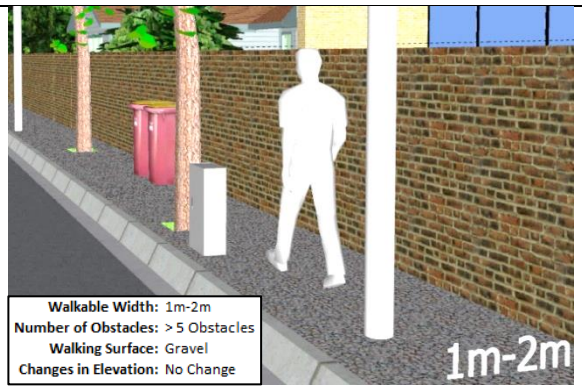
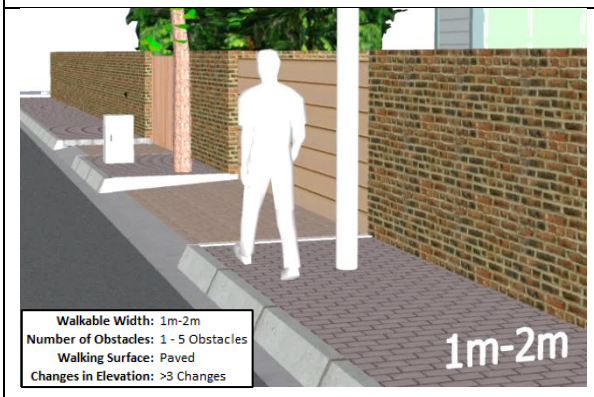
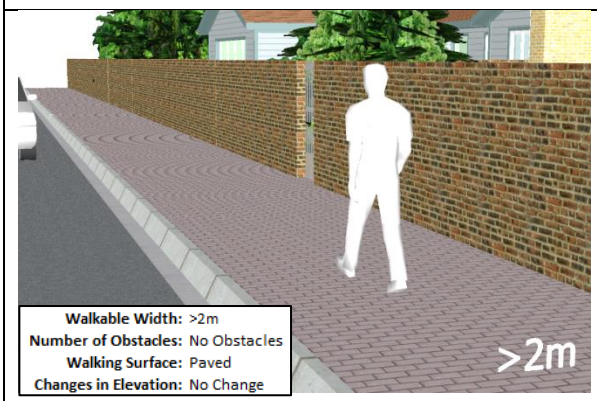
1.	**Name:** Optional – We respect your privacy		
2.	**Date:**		
3.	**Time:**		
4.	**Age:**		
5.	**Gender:**	**4.** Male **5.** Female	
6.	**Neighbourhood where you stay?**	**6.** Universitas	**7.** Other; Please Specify: _____
7.	**Highest Level of Education?**	**8.** High School or less **9.** Trade or vocational school **10.** Undergraduate degree	**11.** Graduate degree **12.** Prefer not to answer
8.	**Employment Status?**	**13.** Student / Scholar **14.** Full-Time Employed **15.** Part-Time Employed	**16.** Retired **17.** Unemployed **18.** Prefer not to answer
9.	**Do you/your household own a vehicle?**	**19.** Yes, I own a car **20.** No, I don't own a car	**21.** Yes, there is a car in the household **22.** No, there is not a car in the household
10.	**If/when you drive a vehicle in the neighbourhood, do pedestrians obstruct the roadway?**		
	23. Never **24.** Less than once per week **25.** 2 to 3 times per week	**26.** Once per day or more **27.** Not applicable	
11.	**How often do you walk in the neighbourhood?**		
	28. Never **29.** Less than once per month **30.** 2 to 3 times per month	**31.** Once per week or more **32.** Every day	
12.	**How would you rate your current walking experience in the neighbourhood?**		

1	2	3	4	5
Very Unsatisfied	Reasonably Unsatisfied	Acceptable	Reasonably Satisfied	Very Satisfied

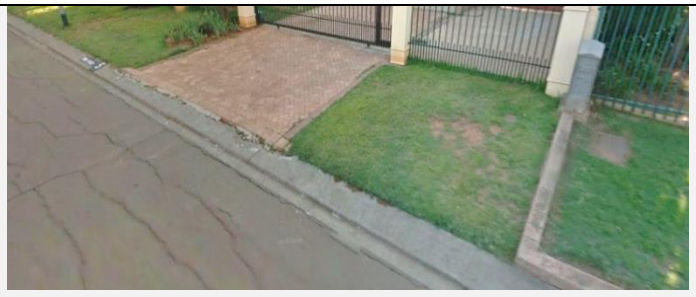
13.	**If/when you walk in the neighbourhood, what is the main purpose?**	
	33. Fun/Relaxation **34.** Exercise **35.** Shopping **36.** To go to work	**37.** Attend School/University **38.** Attend church **39.** Visit a public park **40.** Other; Please Specify: _____
14.	**What is the furthest distance you would walk to a point of interest?**	
	41. Less than 1km **42.** 1 to 2 km **43.** 2 to 3 km	**44.** 3 to 5 km **45.** 5 to 10 km
15.	**If it was more comfortable and safe to walk, would you do it more often?**	
	46. Yes, definitely **47.** Maybe	**48.** No, I would walk the same amount **49.** I have no choice but to walk anyway
16.	**If/When walking in the neighbourhood, what is your biggest concern?** Please specify: _____	
17.	**Where do you prefer to physically walk in the neighbourhood?** **50.** Sidewalk; If chosen, why? _____ **51.** Roadway; If chosen, why? _____	

Rank the following sidewalk illustr ording to preference from **1 to 9**.

(1 = Most preferred) (9 = Least preferred) *NB: Use a number only once*

Sidewalk Illustrations	Rank	Sidewalk Illustrations	Rank
			
			
			
			
			

Indicate how likely you would use the f dewalks in Universitas, Bloemfontein.

#	Sidewalk	Definitely Not	Probably Not	Not Sure	Probably Yes	Definitely Yes
1		1	2	3	4	5
2		1	2	3	4	5
3		1	2	3	4	5
4		1	2	3	4	5
5		1	2	3	4	5
6		1	2	3	4	5

#	Sidewalk	Definitely Not	Probably Not	Not Sure	Probably Yes	Definitely Yes
7		①	②	③	④	⑤
8		①	②	③	④	⑤
9		①	②	③	④	⑤
10		①	②	③	④	⑤
11		①	②	③	④	⑤

Thank you for your participation.

ANNEXURE F

Model Simulations

Constant = 1567.7877	
Coefficients	
X1	**22761**
X2	**455**
X3	**3879**
X4	**836**

Y= -20491 (Constant) + 22761(X1) + 455(X2) + 3879 (X3) + 836(X4)

Simulation Number	Road Network to Sidewalk Network Ratio (%)	Average Number of Events Per Year	Water Feature Present (0 or 1)	Level of the Perception of Safety (1-5)	Simulated number of user	Increase or Decrease in Public Park Annual User Numbers (%)
	x_1	x_2	x_3	x_4	Y	
AVERAGE	**0,9**	**3**	**0**	**3**	3867	**0**
1	0,5	0	0	1	-8275	-314
2	0,51	1	0	1,08	-7525	-295
3	0,52	2	0	1,16	-6776	-275
4	0,53	3	0	1,24	-6026	-256
5	0,54	4	0	1,32	-5277	-236
6	0,55	5	0	1,4	-4527	-217
7	0,56	6	0	1,48	-3778	-198
8	0,57	7	0	1,56	-3028	-178
9	0,58	8	0	1,64	-2279	-159
10	0,59	9	0	1,72	-1529	-140
11	0,6	10	0	1,8	-780	-120
12	0,61	11	0	1,88	-30	-101
13	0,62	12	0	1,96	719	-81
14	0,63	13	0	2,04	1469	-62
15	0,64	14	0	2,12	2218	-43
16	0,65	15	0	2,2	2968	-23
17	0,66	16	0	2,28	3717	-4
18	0,67	17	0	2,36	4467	16
19	0,68	18	0	2,44	5216	35
20	0,69	19	0	2,52	5966	54
21	0,7	20	0	2,6	6715	74
22	0,71	21	0	2,68	7465	93
23	0,72	22	0	2,76	8214	112
24	0,73	23	0	2,84	8964	132
25	0,74	24	0	2,92	9713	151
26	0,75	25	0	3	10463	171

27	0,76	26	0	3,08	11212	190
28	0,77	27	0	3,16	11962	209
29	0,78	28	0	3,24	12711	229
30	0,79	29	0	3,32	13461	248
31	0,8	30	0	3,4	14210	267
32	0,81	31	0	3,48	14960	287
33	0,82	32	0	3,56	15709	306
34	0,83	33	0	3,64	16459	326
35	0,84	34	0	3,72	17208	345
36	0,85	35	0	3,8	17958	364
37	0,86	36	0	3,88	18707	384
38	0,87	37	0	3,96	19457	403
39	0,88	38	0	4,04	20206	423
40	0,89	39	0	4,12	20956	442
41	0,9	40	0	4,2	21705	461
42	0,91	41	0	4,28	22455	481
43	0,92	42	0	4,36	23204	500
44	0,93	43	0	4,44	23954	519
45	0,94	44	0	4,52	24703	539
46	0,95	45	0	4,6	25453	558
47	0,96	46	0	4,68	26202	578
48	0,97	47	0	4,76	26952	597
49	0,98	48	0	4,84	27701	616
50	0,99	49	0	4,92	28451	636
51	1	50	0	5	29200	655
52	0,5	0	1	1	-4396	-214
53	0,51	1	1	1,08	-3646	-194
54	0,52	2	1	1,16	-2897	-175
55	0,53	3	1	1,24	-2147	-156
56	0,54	4	1	1,32	-1398	-136
57	0,55	5	1	1,4	-648	-117
58	0,56	6	1	1,48	101	-97
59	0,57	7	1	1,56	851	-78
60	0,58	8	1	1,64	1600	-59
61	0,59	9	1	1,72	2350	-39
62	0,6	10	1	1,8	3099	-20
63	0,61	11	1	1,88	3849	0
64	0,62	12	1	1,96	4598	19
65	0,63	13	1	2,04	5348	38
66	0,64	14	1	2,12	6097	58
67	0,65	15	1	2,2	6847	77
68	0,66	16	1	2,28	7596	96
69	0,67	17	1	2,36	8346	116
70	0,68	18	1	2,44	9095	135
71	0,69	19	1	2,52	9845	155

72	0,7	20	1	2,6	10594	174
73	0,71	21	1	2,68	11344	193
74	0,72	22	1	2,76	12093	213
75	0,73	23	1	2,84	12843	232
76	0,74	24	1	2,92	13592	251
77	0,75	25	1	3	14342	271
78	0,76	26	1	3,08	15091	290
79	0,77	27	1	3,16	15841	310
80	0,78	28	1	3,24	16590	329
81	0,79	29	1	3,32	17340	348
82	0,8	30	1	3,4	18089	368
83	0,81	31	1	3,48	18839	387
84	0,82	32	1	3,56	19588	407
85	0,83	33	1	3,64	20338	426
86	0,84	34	1	3,72	21087	445
87	0,85	35	1	3,8	21837	465
88	0,86	36	1	3,88	22586	484
89	0,87	37	1	3,96	23336	503
90	0,88	38	1	4,04	24085	523
91	0,89	39	1	4,12	24835	542
92	0,9	40	1	4,2	25584	562
93	0,91	41	1	4,28	26334	581
94	0,92	42	1	4,36	27083	600
95	0,93	43	1	4,44	27833	620
96	0,94	44	1	4,52	28582	639
97	0,95	45	1	4,6	29332	659
98	0,96	46	1	4,68	30081	678
99	0,97	47	1	4,76	30831	697
100	0,98	48	1	4,84	31580	717
101	0,99	49	1	4,92	32330	736
102	1	50	1	5	33079	755
103	0,5	3	0	3	-5238	-235
104	0,51	3	0	3	-5010	-230
105	0,52	3	0	3	-4782	-224
106	0,53	3	0	3	-4555	-218
107	0,54	3	0	3	-4327	-212
108	0,55	3	0	3	-4099	-206
109	0,56	3	0	3	-3872	-200
110	0,57	3	0	3	-3644	-194
111	0,58	3	0	3	-3417	-188
112	0,59	3	0	3	-3189	-182
113	0,6	3	0	3	-2961	-177
114	0,61	3	0	3	-2734	-171
115	0,62	3	0	3	-2506	-165
116	0,63	3	0	3	-2279	-159

117	0,64	3	0	3	-2051	-153
118	0,65	3	0	3	-1823	-147
119	0,66	3	0	3	-1596	-141
120	0,67	3	0	3	-1368	-135
121	0,68	3	0	3	-1141	-129
122	0,69	3	0	3	-913	-124
123	0,7	3	0	3	-685	-118
124	0,71	3	0	3	-458	-112
125	0,72	3	0	3	-230	-106
126	0,73	3	0	3	-2	-100
127	0,74	3	0	3	225	-94
128	0,75	3	0	3	453	-88
129	0,76	3	0	3	680	-82
130	0,77	3	0	3	908	-77
131	0,78	3	0	3	1136	-71
132	0,79	3	0	3	1363	-65
133	0,8	3	0	3	1591	-59
134	0,81	3	0	3	1818	-53
135	0,82	3	0	3	2046	-47
136	0,83	3	0	3	2274	-41
137	0,84	3	0	3	2501	-35
138	0,85	3	0	3	2729	-29
139	0,86	3	0	3	2956	-24
140	0,87	3	0	3	3184	-18
141	0,88	3	0	3	3412	-12
142	0,89	3	0	3	3639	-6
143	0,9	3	0	3	3867	0
144	0,91	3	0	3	4095	6
145	0,92	3	0	3	4322	12
146	0,93	3	0	3	4550	18
147	0,94	3	0	3	4777	24
148	0,95	3	0	3	5005	29
149	0,96	3	0	3	5233	35
150	0,97	3	0	3	5460	41
151	0,98	3	0	3	5688	47
152	0,99	3	0	3	5915	53
153	1	3	0	3	6143	59
154	0,9	0	0	3	2502	-35
155	0,9	1	0	3	2957	-24
156	0,9	2	0	3	3412	-12
157	0,9	3	0	3	3867	0
158	0,9	4	0	3	4322	12
159	0,9	5	0	3	4777	24
160	0,9	6	0	3	5232	35
161	0,9	7	0	3	5687	47

162	0,9	8	0	3	6142	59
163	0,9	9	0	3	6597	71
164	0,9	10	0	3	7052	82
165	0,9	11	0	3	7507	94
166	0,9	12	0	3	7962	106
167	0,9	13	0	3	8417	118
168	0,9	14	0	3	8872	129
169	0,9	15	0	3	9327	141
170	0,9	16	0	3	9782	153
171	0,9	17	0	3	10237	165
172	0,9	18	0	3	10692	176
173	0,9	19	0	3	11147	188
174	0,9	20	0	3	11602	200
175	0,9	21	0	3	12057	212
176	0,9	22	0	3	12512	224
177	0,9	23	0	3	12967	235
178	0,9	24	0	3	13422	247
179	0,9	25	0	3	13877	259
180	0,9	26	0	3	14332	271
181	0,9	27	0	3	14787	282
182	0,9	28	0	3	15242	294
183	0,9	29	0	3	15697	306
184	0,9	30	0	3	16152	318
185	0,9	31	0	3	16607	329
186	0,9	32	0	3	17062	341
187	0,9	33	0	3	17517	353
188	0,9	34	0	3	17972	365
189	0,9	35	0	3	18427	377
190	0,9	36	0	3	18882	388
191	0,9	37	0	3	19337	400
192	0,9	38	0	3	19792	412
193	0,9	39	0	3	20247	424
194	0,9	40	0	3	20702	435
195	0,9	41	0	3	21157	447
196	0,9	42	0	3	21612	459
197	0,9	43	0	3	22067	471
198	0,9	44	0	3	22522	482
199	0,9	45	0	3	22977	494
200	0,9	46	0	3	23432	506
201	0,9	47	0	3	23887	518
202	0,9	48	0	3	24342	529
203	0,9	49	0	3	24797	541
204	0,9	50	0	3	25252	553
205	0,9	0	0	3	2502	-35
206	0,9	1	0	3	2957	-24

207	0,9	2	0	3	3412	-12
208	0,9	3	0	3	3867	0
209	0,9	4	0	3	4322	12
210	0,9	5	0	3	4777	24
211	0,9	6	0	3	5232	35
212	0,9	7	0	3	5687	47
213	0,9	8	0	3	6142	59
214	0,9	9	0	3	6597	71
215	0,9	10	0	3	7052	82
216	0,9	11	0	3	7507	94
217	0,9	12	0	3	7962	106
218	0,9	13	0	3	8417	118
219	0,9	14	0	3	8872	129
220	0,9	15	0	3	9327	141
221	0,9	16	0	3	9782	153
222	0,9	17	0	3	10237	165
223	0,9	18	0	3	10692	176
224	0,9	19	0	3	11147	188
225	0,9	20	0	3	11602	200
226	0,9	21	0	3	12057	212
227	0,9	22	0	3	12512	224
228	0,9	23	0	3	12967	235
229	0,9	24	0	3	13422	247
230	0,9	25	0	3	13877	259
231	0,9	26	0	3	14332	271
232	0,9	27	0	3	14787	282
233	0,9	28	0	3	15242	294
234	0,9	29	0	3	15697	306
235	0,9	30	0	3	16152	318
236	0,9	31	0	3	16607	329
237	0,9	32	0	3	17062	341
238	0,9	33	0	3	17517	353
239	0,9	34	0	3	17972	365
240	0,9	35	0	3	18427	377
241	0,9	36	0	3	18882	388
242	0,9	37	0	3	19337	400
243	0,9	38	0	3	19792	412
244	0,9	39	0	3	20247	424
245	0,9	40	0	3	20702	435
246	0,9	41	0	3	21157	447
247	0,9	42	0	3	21612	459
248	0,9	43	0	3	22067	471
249	0,9	44	0	3	22522	482
250	0,9	45	0	3	22977	494
251	0,9	46	0	3	23432	506

252	0,9	47	0	3	23887	518
253	0,9	48	0	3	24342	529
254	0,9	49	0	3	24797	541
255	0,9	50	0	3	25252	553
256	0,9	3	1	3	7746	100
257	0,9	3	0	3	3867	0
258	0,9	3	0	1	2195	-43
259	0,9	3	0	1,08	2262	-42
260	0,9	3	0	1,16	2329	-40
261	0,9	3	0	1,24	2396	-38
262	0,9	3	0	1,32	2462	-36
263	0,9	3	0	1,4	2529	-35
264	0,9	3	0	1,48	2596	-33
265	0,9	3	0	1,56	2663	-31
266	0,9	3	0	1,64	2730	-29
267	0,9	3	0	1,72	2797	-28
268	0,9	3	0	1,8	2864	-26
269	0,9	3	0	1,88	2931	-24
270	0,9	3	0	1,96	2997	-22
271	0,9	3	0	2,04	3064	-21
272	0,9	3	0	2,12	3131	-19
273	0,9	3	0	2,2	3198	-17
274	0,9	3	0	2,28	3265	-16
275	0,9	3	0	2,36	3332	-14
276	0,9	3	0	2,44	3399	-12
277	0,9	3	0	2,52	3466	-10
278	0,9	3	0	2,6	3533	-9
279	0,9	3	0	2,68	3599	-7
280	0,9	3	0	2,76	3666	-5
281	0,9	3	0	2,84	3733	-3
282	0,9	3	0	2,92	3800	-2
283	0,9	3	0	3	3867	0
284	0,9	3	0	3,08	3934	2
285	0,9	3	0	3,16	4001	3
286	0,9	3	0	3,24	4068	5
287	0,9	3	0	3,32	4134	7
288	0,9	3	0	3,4	4201	9
289	0,9	3	0	3,48	4268	10
290	0,9	3	0	3,56	4335	12
291	0,9	3	0	3,64	4402	14
292	0,9	3	0	3,72	4469	16
293	0,9	3	0	3,8	4536	17
294	0,9	3	0	3,88	4603	19
295	0,9	3	0	3,96	4669	21
296	0,9	3	0	4,04	4736	22

297	0,9	3	0	4,12	4803	24
298	0,9	3	0	4,2	4870	26
299	0,9	3	0	4,28	4937	28
300	0,9	3	0	4,36	5004	29
301	0,9	3	0	4,44	5071	31
302	0,9	3	0	4,52	5138	33
303	0,9	3	0	4,6	5205	35
304	0,9	3	0	4,68	5271	36
305	0,9	3	0	4,76	5338	38
306	0,9	3	0	4,84	5405	40
307	0,9	3	0	4,92	5472	42
308	0,9	3	0	5	5539	43
309	0,91	4	0	3	4550	18
310	0,92	5	0	3	5232	35
311	0,93	6	0	3	5915	53
312	0,94	7	0	3	6597	71
313	0,95	8	0	3	7280	88
314	0,96	9	0	3	7963	106
315	0,97	10	0	3	8645	124
316	0,98	11	0	3	9328	141
317	0,99	12	0	3	10010	159
318	0,91	3	1	3	7974	106
319	0,92	3	1	3	8201	112
320	0,93	3	1	3	8429	118
321	0,94	3	1	3	8656	124
322	0,95	3	1	3	8884	130
323	0,96	3	1	3	9112	136
324	0,97	3	1	3	9339	142
325	0,98	3	1	3	9567	147
326	0,99	3	1	3	9794	153
327	0,91	3	0	3,2	4262	10
328	0,92	3	0	3,4	4657	20
329	0,93	3	0	3,6	5051	31
330	0,94	3	0	3,8	5446	41
331	0,95	3	0	4	5841	51
332	0,96	3	0	4,2	6236	61
333	0,97	3	0	4,4	6631	71
334	0,98	3	0	4,6	7025	82
335	0,99	3	0	4,8	7420	92
336	1	3	0	5	7815	102
337	0,9	4	1	3	8201	112
338	0,9	4	0	3	4322	12
339	0,9	5	1	3	8656	124
340	0,9	5	0	3	4777	24
341	0,9	6	1	3	9111	136

342	0,9	6	0	3	5232	35
343	0,9	7	1	3	9566	147
344	0,9	7	0	3	5687	47
345	0,9	8	1	3	10021	159
346	0,9	8	0	3	6142	59
347	0,9	9	1	3	10476	171
348	0,9	9	0	3	6597	71
349	0,9	10	1	3	10931	183
350	0,9	10	0	3	7052	82
351	0,9	11	1	3	11386	194
352	0,9	11	0	3	7507	94
353	0,9	12	1	3	11841	206
354	0,9	12	0	3	7962	106
355	0,9	1	0	3	2957	-24
356	0,9	2	0	3,2	3579	-7
357	0,9	3	0	3,4	4201	9
358	0,9	4	0	3,6	4824	25
359	0,9	5	0	3,8	5446	41
360	0,9	6	0	4	6068	57
361	0,9	7	0	4,2	6690	73
362	0,9	8	0	4,4	7312	89
363	0,9	9	0	4,6	7935	105
364	0,9	10	0	4,8	8557	121
365	0,9	11	0	4,9	9095	135
366	0,9	12	0	5	9634	149
367	0,9	3	0	3	3867	0
368	0,9	3	0	3,2	4034	4
369	0,9	3	0	3,4	4201	9
370	0,9	3	0	3,6	4369	13
371	0,9	3	0	3,8	4536	17
372	0,9	3	0	4	4703	22
373	0,9	3	0	4,2	4870	26
374	0,9	3	0	4,4	5037	30
375	0,9	3	0	4,6	5205	35
376	0,9	3	0	4,8	5372	39
377	0,9	3	0	4,9	5455	41
378	0,9	3	0	5	5539	43
379	0,9	3	1	3	7746	100
380	0,9	3	1	3,2	7913	105
381	0,9	3	1	3,4	8080	109
382	0,9	3	1	3,6	8248	113
383	0,9	3	1	3,8	8415	118
384	0,9	3	1	4	8582	122
385	0,9	3	1	4,2	8749	126
386	0,9	3	1	4,4	8916	131

387	0,9	3	1	4,6	9084	135
388	0,9	3	1	4,8	9251	139
389	0,9	3	1	4,9	9334	141
390	0,9	3	1	5	9418	144
391	0,91	3	0	4	4931	28
392	1	3	1	3	10022	159
393	1	50	0	3	27528	612
394	0,9	3	1	3	7746	100
395	0,9	12	0	5	9634	149
396	1	12	1	3	14117	265
397	1	3	1	5	11694	202
398	0,9	12	1	5	13513	249
399	1	12	0	5	11910	208
400	1	52	1	5	33989	779

ANNEXURE G

Correlation Coefficients of the Surveyed Variables

Correlation Test Results

Correlations

	Y	S1	S2	U1	U2	U3	U4	U5	U6	U7	U8	C1	C2	C3	C4	A1	A2	A3	A4
Y	1,00																		
S1	-0,33	1,00																	
S2	0.720**	0,06	1,00																
U1	-0.528*	0.850**	-0,25	1,00															
U2	0.564*	0,01	0,39	-0,01	1,00														
U3	0.612**	-0,27	0,25	-0,26	0.884**	1,00													
U4	0,14	0,30	0.564*	-0,04	-0,01	-0,22	1,00												
U5	0.563*	0,22	0.629**	0,08	0.639**	0.507*	0,30	1,00											
U6	0.603**	0,14	0.615**	0,09	0.635**	0.509*	0,19	0.954**	1,00										
U7	0,27	-0,44	0,24	-0.609**	-0,15	-0,12	-0,10	-0,26	-0,24	1,00									
U8	0,18	0,42	0,25	0,27	0,21	0,04	0,35	0,13	0,09	-0,23	1,00								
C1	0.727**	0,07	0.599**	-0,18	0,36	0,28	0,39	0,46	0,45	0,09	0.520*	1,00							
C2	0,22	0.583*	0,16	0,42	0,30	0,21	0,15	0,39	0,35	-0,30	0.707**	0.614**	1,00						
C3	0.480*	0,42	0.499*	0,27	0,44	0,23	0,42	0.554*	0.496*	-0,27	0.606**	0.759**	0.631**	1,00					
C4	0,34	0,25	0,15	0,21	0.502*	0,39	0,13	0,34	0,28	-0,38	0.802**	0.586*	0.688**	0.681**	1,00				
A1	0.764**	-0.616**	0,42	-0.731**	0,21	0,38	0,03	0,33	0,37	0,39	-0,25	0.474*	-0,09	0,15	-0,02	1,00			
A2	0.675**	-0,22	0.801**	-0.516*	0,24	0,19	0,43	0,21	0,19	0.545*	0,28	0.541*	0,04	0,33	0,07	0,41	1,00		
A3	0.612**	-0,28	0,26	-0,24	0.914**	0.944**	-0,20	0.499*	0.533*	-0,03	0,02	0,27	0,18	0,25	0,35	0,43	0,22	1,00	
A4	0.574*	-0,16	0,43	-0,27	0,19	0,25	-0,02	0,21	0,30	0,40	-0,09	0.472*	0,13	0,31	-0,15	0.565*	0,41	0,26	1,00

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

N = 18

Significant

May cause multiple collinearity

Reference Number	Variables Analysed as Possible Independent Variables Influencing Public Park Vibrancy
S	**SOCIABILITY (S)**
S1	Volunteering caretakers
S2	Average Number of Events per year
	USES AND ACTIVITIES (U)
U1	Percentage of Adjacent Land Use Being Residential
U2	Number of Trees
U3	Water Feature Present
U4	Number of Playground structures
U5	Number of Seating
U6	Number of Tables
U7	Number of Sports Field Available
U8	Percentage Grass Coverage
	COMFORT AND IMAGE (C)
C1	Perception of Safety in Public Park's Service Area
C2	Level of Cleanness
C3	Rated Attractiveness
C4	Level of Greenness
	ACCESSIBILITY (A)
A1	Road Network to Sidewalk Network Ratio (%)
A2	Number of Access Streets into Park
A3	Area Of Park (Km^2)
A4	Light of Park in Evenings Measured In Lumens (lux)

ANNEXURE H

List of Publications

1. Honiball, J., Mostafa, M. and Pretorius, 2018. H. UNDERUTILISATION OF PEDESTRIAN SIDEWALKS IN URBAN RESIDENTIAL AREAS IN SOUTH AFRICA. 4th International Conference on Traffic Transport and Engineering, ICTTE 2018, Belgrade, Serbia, pp. 1172-1179.

2. Honiball, J. and Das, D.K. 2018 UNDERUTILISATION OF PEDESTRIAN SIDEWALKS IN URBAN RESIDENTIAL AREAS IN SOUTH AFRICA. 4th International Conference on Traffic Transport and Engineering, ICTTE 2018, Belgrade, Serbia

3. Das, D.K. and Honiball, J.E., 2017. Appraisal of public park accessibility in South African cities. ICE Publishing: Proceedings of the Institution of Civil Engineers - Municipal Engineer. http://dx.doi.org/10.1680/jmuen.16.00036. Paper 1600036

4. Das, D. and Honiball, J., 2016. Evaluation of accessibility challenges of public parks in residential areas of South African cities-a case study of Bloemfontein City. 35th Annual Southern African Transport Conference.

5. Honiball, J. and Das, D.K., 2016. EFFECTS OF THE PEDESTRIAN PAVEMENT NETWORK AND ILLUMINATION ON ACCESSIBILITY ON PUBLIC PARKS IN SOUTH AFRICAN CITIES. International Conference on Traffic and Transport Engineering-Belgrade November 24-25.

6. Honiball, J. and Das, D., 2015. Effects of illumination on accessibility of public parks in South African cities. *Interim: Interdisciplinary Journal*, *14*(2), pp.143-152.