ENGINEERING ACCESSIBILITY OF OPEN RECREATIONAL FACILITIES IN URBAN RESIDENTIAL AREAS OF BLOEMFONTEIN CITY, SOUTH AFRICA

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Date: February 2016

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ABSTRACT

Public parks (PP) and open recreational facilities are essential elements in cities, particularly in the residential areas. Evidence from literaure suggests that public parks have a positive influence on the social and physical health of the people who have access to them. Although, public parks have been found to be placed strategically in the residential areas of South African cities according to urban planning guidelines and regulations, many of them are not being effectively utilised by the residents surrounding them, and less and less people are utilizing the public parks in their area. Many factors including location, accessibility, and social issues like crime or fear of crime, life style, and lack of time are generally attributed for the public parks for being less vibrant and under-utilised. However, accessibility is considered as a vital element for the use of public parks. Consequently, an investigation was conducted on to explore the determinants influencing accessibility to the public parks, and to examine how accessibility level of these public parks in the residential areas of South African cities will be improved. The study was conducted by using the case study of the public parks in residential areas of Bloemfontein, a mid-sized city situated in central South Africa, where many of the public parks in are found to be under-utilized.

A survey research methodology, use of GIS and development of regression models were followed in this investigation. Data was collected through household survey, physical and park use surveys. The surveys were conducted in four representative suburbs of the city, such as Universitas (South-Western part of Bloemfontein), Langenhovenpark (Western part of Bloemfontein), Batho (Eastern part of Bloemfontein, and Lourier Park (Southern part of Bloemfontein). The suburbs were selected on the basis of a set of selection criteria such as, geographic location, population, social demographic condition, availability of number and type public parks, type of accessibility through road network, and size of the public parks. These selected suburban residential areas vary from each other in terms of its diverse demographics, size, location, and accessibility via road networks. Household survey with a sample size of 208 was conducted by using systematic stratified random sampling process though semi-structured interview method. Physical and park use survey were conducted by using uninterrupted digital photography and videography. Fourteen public parks located in the four selected residential areas were identified for the physical and park user survey. For this purpose a camera was set up at each of the identified public parks, which filmed the parks for 7 days non-stop to monitor the daily use of each park and various accessibility issues. GIS was used to extract spatial and location attributes of these public parks. The data collected were statistically analysed to find the major determinants influencing accessibility to public parks and to establish relationships between parks use and the major control determinants. Based on the analysis, theoretical linear multiple regression models establishing relationships between the park use (measured in terms of number of users per month) as the dependent variable and most influential independent accessibility variables were developed to observe the level of use of parks under varied simulated scenarios. The simulated model results were employed to develop various policy scenarios to improve the use of the public parks in the study area.

Findings suggest that there are 22 key determinants, which generally influence the accessibility of the public parks in the city. The variables include average travel distance in service area; service area road network length; service area pavement network length; average lane widths; average pavement width; parking type; number of parking spaces; road lane condition; pedestrian pavement condition; park access type; average vehicle speed; playground or no playground; state of maintenance of public parks; size of public parks; service area; population in service area; average travel time (minutes); longest sight distance to public park(meter); shortest sight distance (meter); light in park at night measured in lumens; number of access streets into park; and road network to pavement network ratio. However, out of these 22 key determinants only four independent variables such as**,** road network to pavement network ratio, number of access streets to the parks, size of park and level of illumination in the park at night are the major control variables, which significantly influence the accessibility of the parks independently and in combination**.**

The simulated scenario revealed that under the composite scenario of increase in level of lights in the evenings, increase in the road network to pavement network ratio to an optimal level, increase in the number of access streets into the parks, and size of park can appreciably improve the utility of the parks**.** However, sensitivity analysis shows that the level of illumination in the nights and the number of access streets leading to the public parks is the two most important considerations, which need attention to make the public parks more accessible in the study area.

Key words: Accessibility; Illumination; Public parks; Public park use; Residential areas; Vibrancy

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.

__________________________ March 31, 2016

Signature Date

ACKNOWLEDGEMENTS

The author would like to take this opportunity to acknowledge the Central University of Technology (CUT), Free State, the Central Research Committee, the Faculty Research Committee and the Department of Civil Engineering of CUT, for their whole-hearted support rendered to me during this research work. My hearty gratitude and special thanks to Prof. Yali Woyessa, Head of the Department, Department of Civil Engineering for his invaluable support and constant encouragement. I am also quite indebted to my study leader and supervisor, Dr. Dillip Das, who assisted me during all the different stages of this research. His guidance and encouragement as a supervisor is much appreciated. I would also like to thank my colleagues for their support as well as acknowledge their critical comments and positive feedbacks which helped in improving the research work.

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Green Space: ………………………………………………………………………………………GS
Neighbourhood Park: ……………………………………………………………………………...NP
Recreational Facility: ……………………………………………………….……………………RF
Open Space:.. OS
Open Green Space: .... OGS
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

1. CHAPTER 1: INTRODUCTION AND RESEARCH DESIGN

1.1 INTRODUCTION

Public parks and recreational facilities are locations which provide people opportunities for a wide range of leisure, sport and recreational activities. As such public parks and recreational facilities are crucial for the social and economic health of cities and towns (Sallis, Frank, Saelens, & Kraft, 2004). However, it has been observed that the areas of habitation in South Africa – including residential areas in general and in particular in cities – have been undergoing much transformation since the establishment of the new constitution in the year 1994.As a result there have been transformations in urban functions and consequently land uses. Accordingly, a hierarchical change in the pattern of the country's urban residential areas has been experienced (Spocter, 2004). The residential areas have been expanded to develop suburban areas. The suburban areas, which were essentially established as residential areas, gradually incorporated other urban functions, such as, commercial, civic and recreational activities. Accordingly, there was a greater demand for the creation of organized open spaces including public parks and open recreational facilities in the residential areas of the cities. These spaces became one of the core urban functions and land uses in the city development plan. Although, a number of such public parks and recreational facilities have been developed in the South African urban areas, it has been observed that except for a few major and organized ones, the others are barely utilized.

The underutilization of the public parks are attributed to many factors which include lack of amenities, inappropriate location, lack of attractiveness, lack of accessibility, behavioural issues such as lack of time and life style, and social issues such as crime or fear of crime to name a few. However, according to a Project for Public Spaces (PPS) model, the success of public parks and open recreational spaces depends on several major determinants, which include accessibility, engagement of people in related activities, image, comfort, and sociability of the space (Project for Public Spaces, 2013). However, physical accessibility in terms of availability and quality of access facilities (road communication); cost of accessibility; time distance relationship from the residential areas as well as parking and security facilities – is considered as one of the most important characteristics influencing successful utilization of these public parks and recreational facilities. Therefore, this investigation focuses mainly on the assessment of the accessibility of public parks and open recreational facilities located in and around the residential areas of a typical mid-sized city of

South Africa for their optimal utilization. For this purpose the city of Bloemfontein in South Africa has been chosen as the study area.

1.2 PROBLEM STATEMENT

Organized open spaces in terms of public parks and open (partially or fully) recreational spaces form an integral part of land uses in the urban areas of South Africa. These public parks and recreational open spaces are located in urban areas in a hierarchical order to provide recreational facilities to citizens at different levels of habitation. Upon observation, it was found that the study area (Bloemfontein city of South Africa) like other urban areas of the country has an acceptable number of public parks located in different areas of the city in a hierarchical order. While there are central parks and stadiums at the city level, adequate number of neighbourhood parks and play grounds varying between 5 to 10 parks per residential areas are available at the suburban and neighbourhood level. However, these public parks areas seemed to lack vibrancy and are observed to under-utilized. This phenomenon could mainly be ascribed to aspects such as accessibility, perception of safety, actual safety, usability, lack of maintenance, and comfort to name a few.

From the above mentioned aspects, accessibility in terms of physical communication and visual accessibility facilities has been identified to be the main contributing factor to the lack of successful utilization of the public parks and recreational facilities in the Bloemfontein city. Accessibility of public parks in the city has largely been affected due to the lack of an efficient and adequate public transportation system; development of commercial and related activities engulfing their space; unavailability of quality physical communication facilities (roads, parking, pedestrian facilities, safety and security measures) and also the increase in traffic volumes resulting in traffic congestion and extended travel time. Similarly, according to PPS, the accessibility to parks is measured by characteristics such as continuity, proximity, connectedness, readability, walkability, convenience as well as vehicle and pedestrian access infrastructure. Thus, it is crucial to evaluate the most important determinants, which influence accessibility of public parks and recreational facilities in the city and then evolve planning and design guidelines to improve accessibility so that the parks and recreational areas will be more vibrant and optimally utilised.

1.3 PURPOSE OF STUDY

1.3.1 **Research Aims of the Study**

The main research aims of the study are:

- To investigate the level of accessibility and linkage to public parks and open recreational facilities in the residential areas of Bloemfontein city.
- To identify and evolve urban planning and design solutions which will provide higher accessibility to these parks.

1.3.2 **Objectives of the Study**

For the purpose mentioned above (section 1.3.1) a set of specific objectives were identified. The objectives of this investigation are:

- To identify and categorize the various public parks and open recreational facilities in the city Bloemfontein.

- To assess the problems and challenges relating to accessibility infrastructure for the public parks and open recreational areas in the study area.

- To establish the major control parameters which influence accessibility of these public parks and open recreational facilities.

- To develop empirical models based on the inter-linkage of the control parameters of accessibility and predict the utilization of the public parks and open recreational areas under different simulated scenarios of accessibility.

- To formulate a set of plausible guidelines for improving the accessibility of public parks and open recreational facilities for higher utilization thereof.

1.4 HYPOTHESIS

A plausible hypothesis is framed based on analytical work and is tested in this present investigation that availability of adequate access infrastructure will improve the utilization of public parks and open recreational. In other words if adequate access infrastructure are made available in the public parks, the use of the parks will be improved.

1.5 SCOPE OF THE STUDY

The scope of the investigation is limited to developing a strategy and a set of urban planning and design guidelines to improve the accessibility to public parks in the residential areas of the Bloemfontein city, South Africa, by considering the influencing physical, infrastructural as well as spatial parameters of these residential areas. Human psychological, behavioural and social issues such as crime and safety have been kept out of the scope of the investigation. The investigation was conducted by focussing on public parks in selected residential areas of the city and by collecting data through sample surveys. It is believed that should the recommendations of the present study be implemented according to the proposed guidelines, accessibility to public parks would be significantly improved, and they would be more vibrant and user-friendly. Consequently, higher utilization of the public park and open recreational spaces will be experienced in the study area.

1.6 RESEARCH DESIGN

1.6.1 **Methodology of the Study**

The investigation comprises of a survey research methodology followed by the development of an empirical model and simulation of accessibility under varied scenarios (Kumar and Phrommathed, 2005). Figure 1.1 presents the systematic and step wise methodology followed in the study. The various steps followed are:

1. Problem identification, literature review, setting of objectives and hypothesis and research design.
2. Identification and categorisation of parks and open recreational facilities in Bloemfontein as follows:
   2.1 Primary open spaces on a city scale.
   2.2 All primary open spaces on a local area scale (North, South, East, West zones).
   2.3 Open spaces of selected residential suburbs of the city, as a representation of all the residential suburbs of the city,
3. Survey of the identified parks and recreational facilities and assessment of access related infrastructural challenges. Data were collected by conducting the following surveys within the study area:
   3.1 Household surveys.
   3.2 Situational surveys
   3.3 Traffic data in terms of vehicle parking, vehicle access and road connectivity.
   3.4 Access variables to the public parks and open recreational spaces in terms of cost, time and distance.
4. Compilation, analysis and synthesis of primary (household) and secondary (statistical) data collected.

4.1 Development of a perception index (PI) from the household surveys to identify important variables using the formula $PI = (\sum N_iX_i)/N$

Where:

PI = Perception Index

N_i = Number of respondents

X_i = Value assigned from respondents (0-1)

5. Statistical analysis of the data and development of models, development of simulated scenarios and hypothesis testing.
6. Formulation of guidelines for improving the accessibility of parks and recreational facilities.

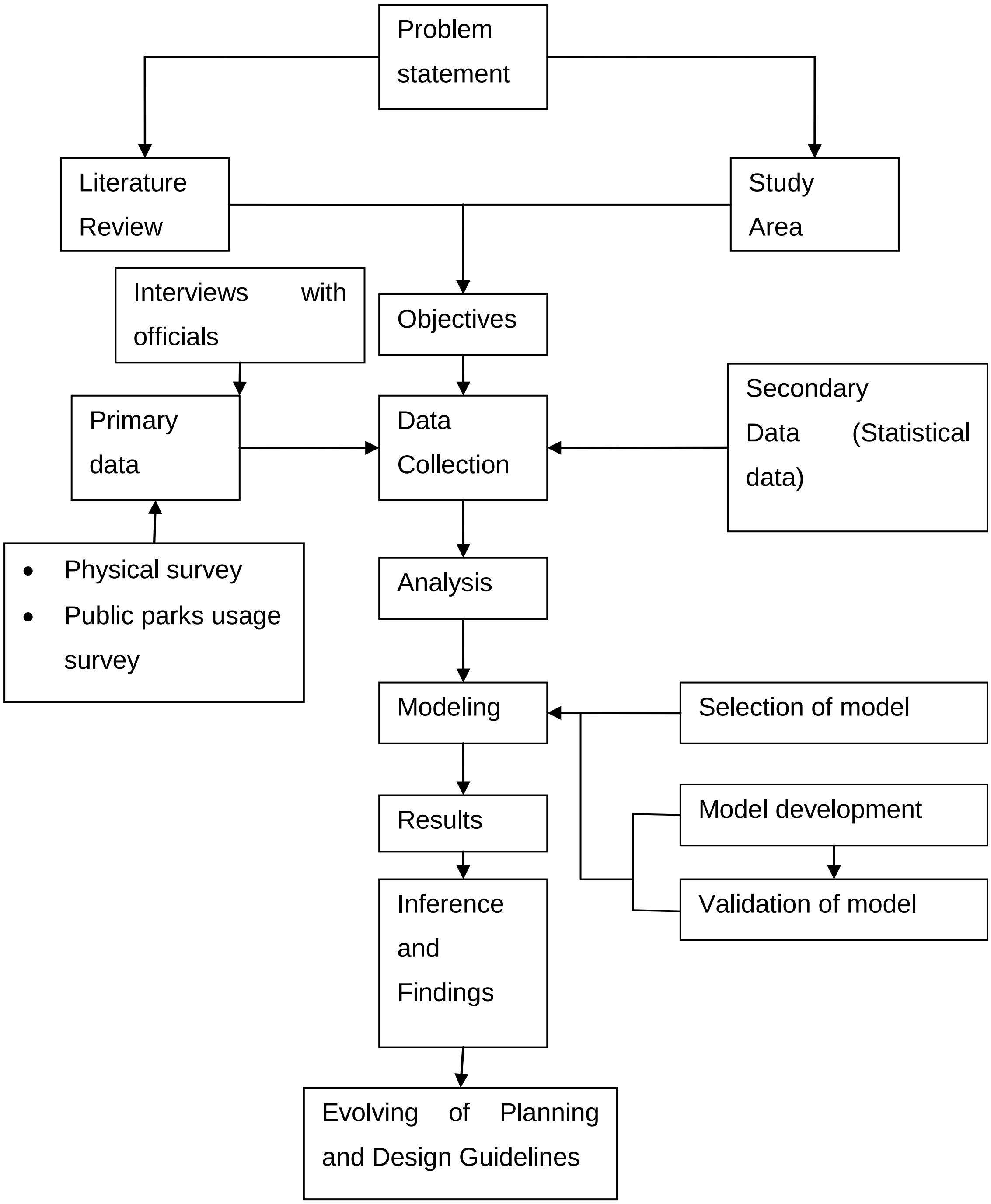

Figure 1-1 Methodology Flow Chart

1.6.2 **Data Collection**

Primary and secondary data have been collected and employed in this investigation.

1.6.2.1 Primary Data

Primary data were collected through physical surveys of public parks in the city of Bloemfontein and their surrounding residential areas, as well as through direct household surveys. Conduction of physical surveys of public parks, surrounding neighbourhood and traffic networks were essential for obtaining accurate and current data of the study area. GIS data were collected from the local municipality. Caution had to be taken in the identification of residential areas and public parks to have a complete representation of the level of accessibility to public parks in the city.

Four main residential areas that represent the different socio-economic levels of the city were identified and primary data were collected, which cover all the accessibility scenarios and challenges. The primary data collected did not only contribute to obtaining an in-depth understanding of the accessibility requirements that each public park in the study area would have to adhere to, but also served as justification of the formulated guidelines and planning solutions as well as establishing the hypothesis.

1.6.2.2 Selection of the Sites for Survey

The city of Bloemfontein comprises of 35 suburban residential areas. Table 1-1 in conjunction with Figure 1-2 presents the various suburban areas of the city, their size and type of accessibility. Of the 35 suburbs, 4 were selected for survey and collection of primary data on the basis of a set of selection criteria, namely population, social demographic condition, type of accessibility through road network, location and size. The selected suburban areas are Batho (Eastern part), Universitas (South-Western part), Langenhovenpark (Western part), and Lourier Park (Southern part). These selected suburban residential areas vary from one another in terms of diverse demographics, size, location, and accessibility via road networks, and apparently sufficiently represent the entire city and use of public parks.

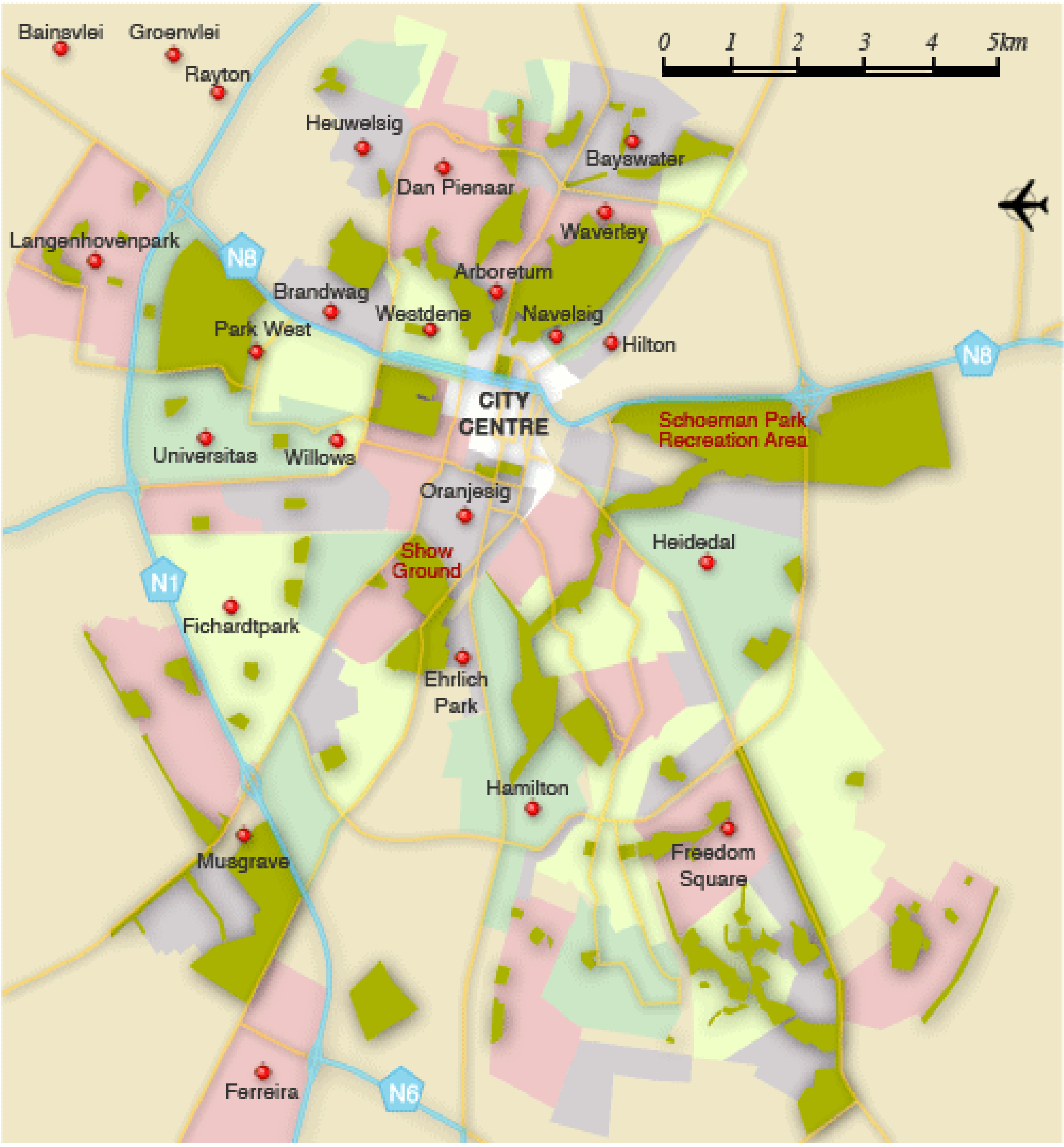

Figure 1-2 City of Bloemfontein (Mapsource © GIS Software)

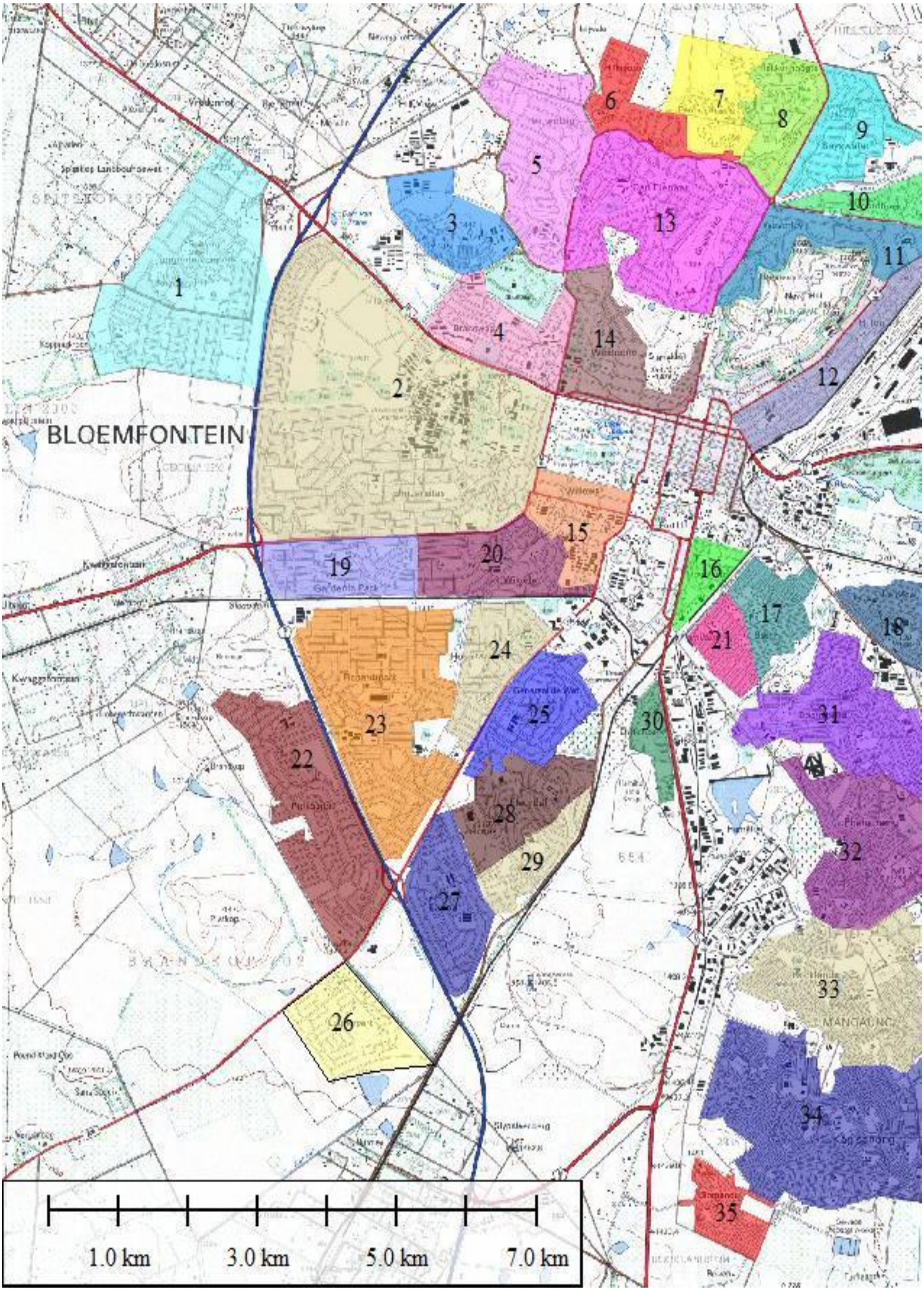

Figure 1-3 Suburban Residential Areas of Bloemfontein (Mapsource © GIS Software)

	Bloemfontein Suburbs	Area (km²)	Thoroughfare or Limited Access
1	Langenhovenpark	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

Table 1-1 Accessibility and Area of Suburbs of Bloemfontein

Langenhovenpark is a densely populated suburb located at the Western part of the city. Majority of the residents belong middle and upper working class of the society. It has limited accessibility through limited number of sub arterial (class U4, COTO, 2012) roads. However, it has a grid iron and grid iron with loops pattern of internal road network. Neighbourhood level civic and commercial facilities like schools, medical facilities, and entertainment and sports facilities, shopping centres are available in the suburb. Although, it does not have large public parks or play grounds, yet an acceptable number of Public parks are found to be available inside the residential areas of the suburbs as shown in Figure 1.3.

Figure 1-4 Public Park in Langenhovenpark, Bloemfontein (Google Earth, 2013)

Universitas located on the South-Western part is the largest suburban residential area of Bloemfontein. The largest university of Free State province University of Free State is located in this suburb. The suburb acts as a thoroughfare to other residential areas as major sub arterial roads pass through the suburb connecting other suburbs of the city. The suburb comprises of mainly the middle to upper class people and large number of students. Majority of the people live in either standalone houses or apartments. Due to its proximity to the university, many of the houses have been converted into student houses. The suburb also has most of civic and commercial facilities like other suburbs of the city. A number of public parks are provided in the residential areas. In addition, a large public park and play grounds belonging to the University of Free State close to sub arterial roads are also available in the suburb. An example of a public park inside the residential area is presented in the Figure 1.4.

Figure 1-5 Public Park Surrounded by Houses in Universitas, Bloemfontein (Google Earth, 2013)

Batho is a high densely populated thoroughfare suburb located in the Eastern part of the city. Majority of the residents belongs to the lower income working class category. It comprises of residential areas with houses with smaller yards and informal settlements. In addition to a number of civic and commercial facilities, it has a number of public parks inside the residential areas as shown in Figure 1.5.

Figure 1-6 Public Park in Batho, Bloemfontein (Google Earth, 2013)

Lourier Park is a limited access suburb situated in the Southern part of the city. The population density is almost similar to other suburbs like that of Langenhovenpark. It comprises of residents belonging to the lower to middle income category. Most of people live in standalone houses built on a medium to small sized yard or group houses and apartments. There are also a few informal settlements in the suburb, and large open spaces. A number of public parks are also available in the residential areas. An example of such a public park is presented in the Figure 1.6.

Figure 1-7 Public Park in Lourier Park, Bloemfontein (Google Earth, 2013)

1.6.2.2 Household Survey

The households survey was conducted in the in the selected suburbs. To conduct the household surveys, the investigator collected a list of households available in the selected suburbs. A total number of two hundred and fifty households (ranging from 60-70 households in each selected suburb) were selected and surveyed out of which 208 (83%) samples were returned. Although seems to be small, the sample size selected is adequate (<1 in 60 households) considering the population and number of households (about 15000 households) in the selected suburbs. For the purpose of the survey, a systematic stratified random sampling process (by employing standard statistical survey procedure) was employed. Pretested survey schedules comprising of various parameters relating to demographic, socio-economic, infrastructural, daily activities, recreational, and vehicular were used (see appendix E) (Fink, 2012; Kumar and Phrommathed, 2005). Physical Survey

Data on the physical condition of public parks in the selected suburbs and their accessibility and level of accessibility to users were obtained by conducting physical surveys and obtaining up to date GIS data from the municipality. The physical surveys included investigations on traffic network systems around the public parks in the selected areas; parking access to the public parks; the condition and availability of pedestrian access; the public transport system servicing the selected areas; and the surrounding land use and conditions.

1.6.2.3 Public Park Survey

Every public park in the study area was surveyed. The data collected from the survey included the areas of the public parks, the maintained condition of the public parks, the access types of each public park, lighting conditions of the public parks, and available apparatuses at each public park.

Physical park surveys were conducted by employing uninterrupted digital photography and videography. There are about 202 public parks available in the city out of which 39 (19%) are located in the selected suburbs. Therefore, for the purpose of park survey, 14 important public parks located in the four selected residential areas were identified. The sample size is found to be adequate (1 in every 2.5 parks in the selected suburbs and 1 in every 14.5 public parks at the city level) considering the number of parks available in the selected suburbs and in the city and their importance. A time-lapse video camera was set up at each of the identified public parks, which filmed the parks for 7 days non-stop to monitor the daily use of each park and various accessibility issues. GIS was used to extract spatial and location attributes of these public parks.

1.6.2.4 Significance of Data Collected

The data collected both from household survey provided insights to the demographic composition, socio-economic conditions, daily activities, perceptions towards the public parks, their uses, the various reasons of residents in the selected areas for not utilizing the public parks accessible to them and the perceptions of how to improve their use.

Physical survey assisted in assessing the condition of the residential areas, the level of availability of various accessibility infrastructures such as, roads, pavements, visibility and sight distance, pedestrian facilities, parking facilities, illumination, size of available public park and safety and security.

The public parks survey provided information, which assisted in evaluation of the available facilities, the level of use of the public parks and the challenges that deters their optimal utilisation.

1.6.2.5 Secondary Sources of Data

Secondary data relevant to this study were accumulated from a variety of sources, such as published and unpublished literature, documents from the local municipality, GIS data created on the selected areas over a period from the year 2005 to the year 2014. These secondary data were combined with the primary data to formulate and develop theoretical simulation models to analyse the cause and effect of levels of accessibility to public parks in residential areas, to evolve simulated scenarios to address the challenges and to improve of levels of accessibility, which in turn would improve the vibrancy and use of these public parks.

1.7 DATA ANALYSES

All data collected were checked for completeness and accuracy. Data errors and bias returns were eliminated by cross checking. Out of the 208 household survey samples received back, 200 (96%) were selected for further analysis. The data was then entered into excel code sheets for computer analysis. The computer analysis was completed by making use of the various tools and techniques described below.

1.8 ANALYTICAL TOOLS AND TECHNIQUES

1.8.1 Analytical Tools

Relevant analytical tools, including software such as SPPS, EXCELL, and Global Mapper were used for data processing, analysis and modelling.

1.8.2 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, were applied according to the requirements of the present investigation. The weighted average index method was employed to find the people's perception indices of the variables regarding the accidents. The model used is:

Perception weighted average index= $PI = (\sum P_i * N_i)/ (\sum N_i)$

Where, Ni = number of respondents, Pi = index values provided by the respondents in a scale of 0 to 1 as observed from household survey (Das, 2014). Also, correlation coefficients between the number of monthly public park users as the dependent variable and accessibility factors as the independent variables were obtained. A Variance Inverse Factor (VIF) test was conducted to observe the co-linearity among the independent variables. Followed by, linear regression models between the number of public park users and major independent variables were developed; the results were examined as well as trend analyses were conducted to determine the influence of the major variables on the number of public park users and their implications on the use of the parks (Guideline, I.H.T., 2005).

1.9 MODELLING

Statistical multiple regression models were developed and employed to understand accessibility to public parks. All possible parameters that could have an influence on accessibility of parks were measured qualitatively and quantitatively before using them to build the model. Only the most main influential parameters were used to develop the model. While developing the number of users of parks was considered as the measured parameter (dependent variable) and major influential statistically independent accessibility parameters were taken as independent variable.

1.9.1 **Validation of Model**

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

1.9.2 **Simulation and Forecasting**

The developed and validated model was employed to project average monthly users of the public parks, based on variations of several major control parameters such as pavement and road network ratio, area of public park, illumination level of public park and number of access streets to the public park.

1.9.3 **Application of the Model**

Alternative plausible simulated scenarios were developed by employing the model, which were used to evolve feasible policy interventions.

1.10 RESULTS AND DISCUSSION

Detailed discussion of the analysis and results of primary household surveys, literature reviews, GIS surveys, physical public parks surveys as well as the simulated model were done, before arriving at plausible findings.

1.11 INFERENCES

Plausible inferences were drawn for developing a set of feasible policies.

1.12 STRATEGIES AND RECOMMENDATIONS

Based on the results, discussions and inferences of this investigation, a set of policy guidelines has been prepared and recommended, for the planning of accessibility to public parks and recreational facilities.

1.13 LIMITATIONS

The following aspects are considered to be limitations to the study:

- Only public parks and open recreational facilities in Bloemfontein city were studied and thus results cannot be generalized and applied to other urban areas of South Africa
- Time limit (M.Tech research is time-based)
- Relatively limited but seemingly adequate sample size was used for the survey because of the limited availability of manpower for conducting the survey (the researcher conducted the investigation at grassroots level because it yields more advantages) and limited fund availability for the research.

1.14 ETHICS IN HOUSEHOLD SURVEY AND SURVEY OF PUBLIC PARK USERS

Survey data are used in many different disciplines for various purposes and are very useful due to the fact that it provides information regarding the grassroots level (Fink, 2012). By obtaining data directly from the households and public park users, an investigator can identify important variables easier and more accurately. When conducting surveys with public park users, certain guidelines and ethics need to be adhered to. The most important ethical guideline in conducting surveys is to prioritise the privacy and confidentiality of the survey responses (Fink, 2012). Anyone involved in collecting data from public park users has an ethical duty to respect each individual participant's autonomy. Any survey should be conducted in an ethical manner and one that accords with best research practice. Therefore, the two important ethical issues, which need to be adhered to while conducting a survey, are confidentiality and informed consent. The respondent's right to confidentiality should always be respected and any legal requirements on data protection adhered to. In the majority of surveys, the participant should be fully informed about the aims of the survey, and the participant's consent to participate in the survey must be obtained and recorded (Kelley, Clark, Brown, and Sitzia, 2003). Based on this premise, the investigator followed strict protocols of seeking consent of the potential respondents to participate in the survey and informing the respondents regarding the type, purpose, use and implication of the survey. The investigator kept the confidentiality of the responses and their anonymity of identity. Besides, care has been taken to prevent the participants from being subject to any form of risk, unusual stress, embarrassment or loss of self-esteem, and to cause harm to any natural, living elements and artefacts. The sensitivity of different attitudes, norms and cultural expectations was also respected and appreciated by the investigator.

1.15 CHAPTER SCHEME

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

Chapter 2: This chapter consists of review of literature.

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

Chapter 4: This chapter focuses on the data analyses, modeling, results and discussions.

Chapter 5: This chapter contains findings and discussions, proposal of policy recommendations and conclusion.

2. CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

Green open spaces are essential elements of urban built environment and can be significant contributors to sustainable development of urban areas (Coles & Grayson, 2004). Particularly organised open spaces in terms of public parks and recreational spaces have more significance for the development of sustainable cities because they contribute greatly to livability and vitality of the cities. According to several scholars, public parks and recreational areas offers multifold benefits to the cities from various perspectives, including physical, environmental, economical, and social aspects (Hakim et al., 1998; Hass-Klau, 1993; Jacobs, 1972; Whyte, 1988). For example, they supply ecosystem services ranging from maintenance of biodiversity to the regulation of urban climate in the cities (Heidt and Neef, 2008), can reduce energy use in cooling the buildings, can largely decrease the levels of noise in over crowded cities de-pending on their quantity, quality and the distance from the source of noise pollution (Heidt and Neef, 2008; Atiqul Haq, 2011). It also offers facilities for various outdoor activities and accommodates daily pedestrian traffic, (Hakim et al., 1998; Hass-Klau, 1993; Jacobs, 1972; Whyte, 1988). Green open spaces assist in creating an attractive image of a city and arguments have emerged that the city and its lifestyle can also benefit from good quality public parks and recreational areas (Madanipour, 2003; Van Melik, Van Aalst, Van Weesep, 2009). Therefore, the study of the public parks and recreational spaces has become an integral part of the sustainability analysis of the cities.

Evidence from literature suggests that a large number of studies have been conducted by various scholars on different aspects of the public parks and recreational area in cities that include, but not limited to aspects related to physical and spatial attributes such as location, accessibility (Maroko etal. 2009), socio-economic and environmental contributions (Hakim et al., 1998; Hass-Klau, 1993; Jacobs, 1972; Whyte, 1988), equity and environmental justice Boone et al. 2009; Estabrooks et al. 2003; Wolch et al. 2005), role in pedestrian and traffic movements, human health (Cohen et al. 2007; Scott et al., 2007) and image of cities(Madanipour, 2003; Van Melik, Van Aalst, Van Weesep, 2009).

However, accessibility at the local residential areas forms an essential element for use of parks and is dependent on several demographic, physical, spatial, and local transportation (traffic) attributes. Therefore, an in-depth study is necessary to observe the essential elements which contribute to higher accessibility of the parks and consequently higher use of the public parks. An in-depth study relating accessibility of public parks requires a strong theoretical background based on the established literature, success stories and case studies. Under this premise a sound theoretical background was developed for this investigation by reviewing, analysing, and synthesising the various aspects with respect to accessibility of parks and related sustainable urban development dimensions which have seen intensive investigations by various scholars. In this context, the various aspects considered are the image and attributes of public spaces and parks, configuration of public parks, contributions of the public parks, forms of accessibility of public parks, challenges in accessibility of public parks, paradigms to meet accessibility challenges of public parks and analytical methods and models used for analysing the accessibility issues of public parks.

2.2 IMAGE AND ATTRIBUTES OF PUBLIC SPACES AND PARKS

Availability of public parks to a large extent is crucial for the creation of an attractive image of a city (Madanipour, 2003; Van Melik, Van Aalst, Van Weesep, 2009). They are the areas in cities, which offers respite from the crowded and busy city life where people can have contact with nature (especially if it is a natural green space) (Dempsey, 2012). Attractive public parks can complement the architectural articulation of the surrounding built environment, improve the value and desirability of the surrounding residential area and create a space for people to orientate themselves with the greater part of the city (Dempsey, 2012). There is a general argument that that good quality public space, particularly public parks and organized open green spaces, constitutes a positive environment that increases the value of the surrounding built environment (Punter, 1990; Vanolo 2008; Van Melik, Van Aalst, Van Weesep, 2009). Many design aspects that include location, physical configuration, architectural articulation, cultural and heritage values, and integration to surrounding environment can positively contribute to the well-being and value of the surrounding spaces. As suggested, properly planned and designed public spaces, including public parks and open green spaces, greatly add to the aesthetic quality as well as bring greater satisfaction of the surrounding inhabitants with their residential surroundings (Ariane, Bedimo-Rung, Mowen, Deborah, Cohen, 2005). They also create a restorative environment which cannot be neglected because, the well-being and health of inhabitants are positively affected by them (Ariane, Bedimo-Rung, Mowen, Deborah, Cohen, 2005).

In this context, the project for public spaces (PPS) evaluated thousands of public spaces around the world and has found that successful public parks and recreational facilities have four key qualities in which good image of the parks that offer comfort and attractiveness is an essential attribute. The other three attributes are that the parks should be accessible, people are engaged in activities there, and they are sociable places where inhabitants meet or take their visitors (PPS, 2011). Based on such studies, a tool called "The Place Diagram (Figure 1)" was developed to aid in judging whether any public place is good or bad.

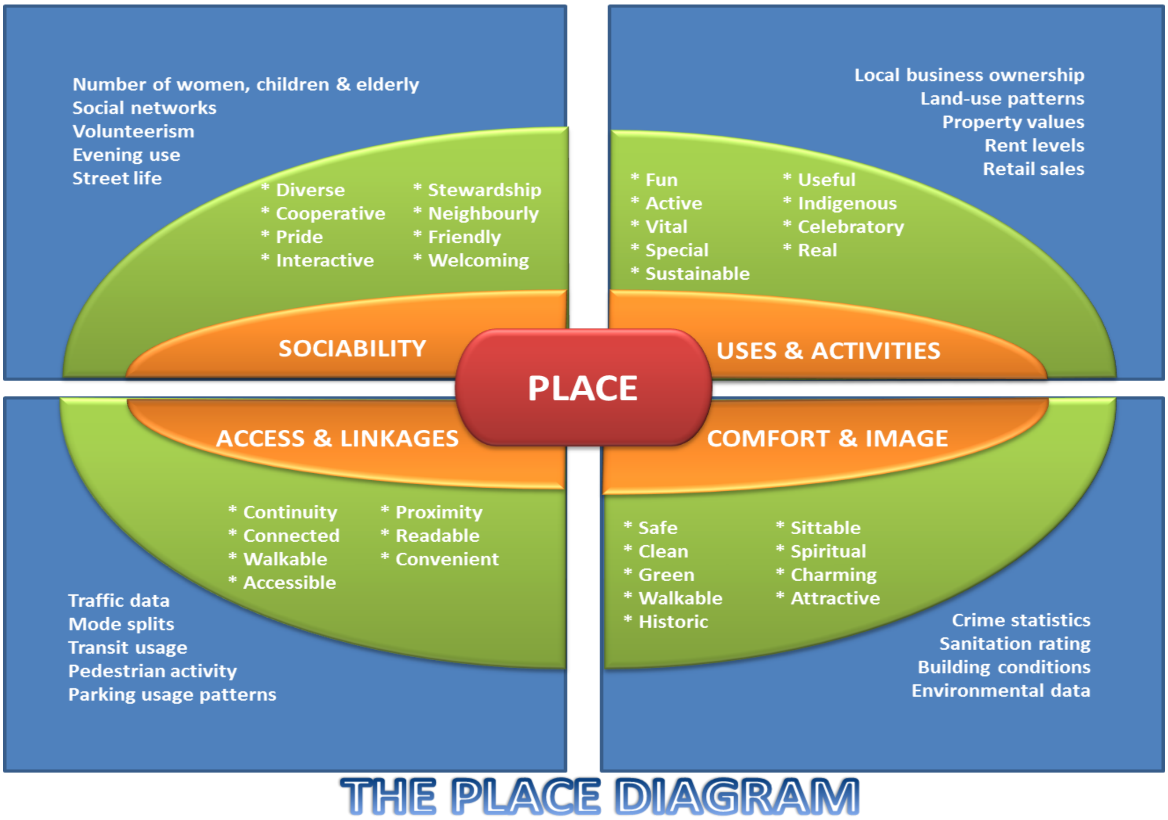

Figure 2-1 The Place Diagram (PPS, 2011)

As seen in the Place diagram (Figure 2-1), the center element (identified as "PLACE" in the diagram) can be identified as a specific place, such as a street corner, a playground, or a public field or park outside a building or in neighbourhood. This place can then be evaluated according to the four criteria namely access and linkage, comfort and image, uses and activities, and sociability located in the ring adjacent to the central ring. An examination of the place diagram further revealed that in the ring outside these main criteria are a number of intuitive or qualitative aspects by which a place is judged. The next outer ring shows the quantitative aspects that can be measured by statistics or research. According to some scholars, out of all these parameters, access and linkages is one of the most essential parameters for the success of parks and open recreational spaces (PPS, 2011; Zhang et al., 2014). The outer perimeter of the space is important as well. For example, a row of stalls or shops along a street is more interesting and generally much safer to walk by than a blank wall or empty lot.

Attributes such as park size (Giles- Corti et al., 2005a), the presence of sports fields (Cohen et al., 2006; Floyd et al., 2008); walking paths, running tracks, swimming areas, lighting, shade, and drinking fountains (wooded areas, trails, paths, sidewalks (Cohen et al., 2006; Kaczynski et al., 2008; Reed et al., 2008; Shores and West, 2008) and civic amenities and facilities (Kaczynski et al., 2008; Giles-Corti et al., 2005a) are integral parts of the public parks. Also, condition, accessibility, aesthetics, and safety, are important features of public parks which assist in creating an image (McCormack, Rock, Toohey, Hignel 2010)**.** For example, presence of litter, vandalism, and unclean washrooms may create a negative image and discourse people to use the facilities and the parks (Gobster, 2002). Availability of sporting activities and arenas in the parks could particularly be important for encouraging physical activity (Cohen et al., 2006). All the attributes in combination, depending upon their level of availability and quality, create either a good or bad image of the public parks.

2.3 CONFIGURATIONS OF PUBLIC PARKS

Open green spaces in urban areas can be categorised into different forms and types, such as parks, gardens, urban forests, nature reserves, corridors along waterways, playgrounds and other informal green areas (La Rosa, 2014). Public parks and open green spaces that are well-kept and designed add to the attractiveness and quality of the surrounding urban area, as well provides a good reflection on the city. The design of public parks and open green spaces, regardless of its type or form, should adhere to the quality standards and norms to be successful, usable and sustainable. Evidences suggest that appropriate landscaping makes a major contribution to the quality of public parks and the surrounding urban environment. Proper landscaping reconnects people with nature and is observed to be soothing and calming to the inhabitants. Natural elements like grass, trees, streams, and different kinds of plants, are generally recognized as important aspects, while enforcing the image of the public parks, making them vibrant and purposeful. Natural elements also assist in formulating a proper configuration of the parks' complement to the neighbouring areas (Khotdee, Singhirunnusorn, & Sahachaisaeree, 2012).

Public neighbourhood parks are open green spaces within residential areas. They are part of the municipal zone plan and are maintained by the local governing entity. They may include playgrounds, sport 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 opens 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 sport facilities. Playgrounds can be situated in neighbourhood parks, as well as commercial areas where children are expected to be in need of recreation. Therefore, the configuration of the public parks varies with the type of parks, such as neighbourhood parks or neighbourhood parks with playground, their physical attributes of places, activities or actual uses, and accordingly need to be addresses (Sendi and Golicˇnik Marusˇic, 2012).

Figure 2-2 Example of Neighbourhood parks (Universitas, Bloemfontein) (Google Earth, 2013)

Figure 2-3 Example of Playground in Universitas, Bloemfontein (Google Earth, 2013)

2.4 CONTRIBUTION OF PUBLIC PARKS

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 have physical, social and economic, environmental contributions to the cities. Physically it creates an image of the city which leads to other advantages like enhancement of tourism, attraction for people to live in and perhaps assisting in the investment of the city (Atiqul Haq 2011; Madanipour, 2003; Sorensen; Smit, Barzetti and Williams, 1997; Van Melik, Van Aalst, Van Weesep, 2009). Environmentally, public parks supply the cities with ecosystem services ranging from maintenance of biodiversity to the regulation of urban climate (Heidt and Neef, 2008). Availability of vegetation reduces the energy costs of cooling buildings particularly in temperate climate cities (Heidt and Neef, 2008). Public parks and urban green spaces in over crowded cities can largely reduce the levels of noise depending on their quantity, quality and the distance from the source of noise pollution. Public parks through natural eco systems have the ability for CO_2 absorption and research has shown that they alleviate air pollution (Bolund and Sven, 1999; Huang, Lu and Wang, 2009).

People try to satisfy most of their recreational needs within the locality where they live (Nicol and Blake 2000). Public parks and green spaces within urban areas provide a sustainable proportion of the total outdoor leisure opportunities on a daily basis or every second day (Neuvonen, Sievanen, Susan and Terhi, 2007). They serve as a near resource for relaxation; offer opportunities for wide variety of activities; and also provide emotional warmth (Grahn and Stigsdotter, 2003; Heidt and Neef, 2008; SorensenSmit, Barzetti and Williams, 1997)**.** The proximity of recreational facilities and amenities and ease of access apparently influence physical activity participation like walking, running and reduction of stress through meeting, and chatting among people belonging to different age, ethno-cultural, and socioeconomic groups (Bedimo-Rung et al. 2005; Diez Roux et al., 2007; Kaczynski and Henderson,2007 Roemmich et al. 2006; Wendel-Vos et al. 2004). Several studies have also established that quality public parks impacts on specific health outcomes like community level rates of mortality, cardiovascular disease, diabetes, and obesity (Berke et al. 2007; Frank et al. 2004; Gordon-Larson et al. 2006; Papas et al. 2007; Rundle et al. 2008; Takano, Nakamura, Watanabe 2002; Taylor et al., 2006). Therefore, it can be concluded that public parks offer a unique setting within the urban landscape, providing opportunities for physical activity, enjoyment of nature, social interaction, health benefits and escape (Hayward and Weitzer, 1984 McCormack, Rock, Toohey, Hignel 2010). Thus, design, and redesign of public parks and their upkeep are vitally important for population health (Hayward and Weitzer).

2.5 ACCESSIBILITY OF PUBLIC PARKS

One of the important aspects which have been emphasized in literature regarding the public parks and recreational facilities is the accessibility. Accessibility essentially influences their success (PPS, 2011). It is well established that access to public parks and natural settings is associated with improved physical and mental health of people (Payne et al., 2005; More and Payne, 1978; Payne et al., 2005; Potwarka et al., 2008; Sugiyama et al., 2008). Park users are more likely to achieve good levels of physical activity and health compared with non-users (Deshpande et al., 2005; Giles-Corti et al., 2005a) because there is evidence that lack of accessibility of parks and distance from parks and open space are inversely associated with use and physical activity behaviour (Kaczynski and Henderson, 2007).

According to the place diagram, basic park access for residential populations of a city is based on the spatial configuration of parks, the number of parks, and the spatial distribution of parks across neighborhood areas or local regions. It is therefore common practice to base spatial accessibility on the proximity, location, and size of the parks which contribute to the use of the parks (Zhang et al., 2014). Further, according to the PPS model, accessibility of a place is judged by its connections to its surroundings. A successful public park needs to be easily accessed and commuted through as well as be seen from both a distance and up close. Generally, it is argued that having more local parks within walking distance is positively associated with park use. The necessity of driving to reach a park often deterred use (McCormack, Rock, Toohey, Hignel, 2010; Wilbur et al., 2002, p. 22), although other park attributes like safety, and location may override the proximity factors. Some scholars argued that distance or walking time from home has appeared to be the single most important precondition for access and use of green spaces (Herzele and Wiedeman, 2003). Apparently, easy access and short distance to public parks increases the number of visits. People in close proximity to a green space access and use it more frequently (Atiqul Haq 201; Herzele and Wiedeman, 2003; Neuvonen, Sievanen, Susan and Terhi, 2007, Atiqul Haq, 2011). For example, a study in Helsinki, Finland found that people living close to public parks (<0.5 km) visited the parks or green spaces more frequently (>4 times per week) (Neuvonen, Sievanen, Susan and Terhi, 2007; Atiqul Haq, 2011).

Some scholars argue that public parks or green spaces should be at the center of neighbourhoods and not more than five minutes of walking for most residents, public buildings or shops (Etzioni, 1998). If one uses a bicycle to visit public parks, it should be adequately short and should have limited obstructions along the trip (Atiqul Haq 2011; Etzioni, 1998). Some countries have set up recommendations for the provision of accessible public parks. For example, Britain has standards stating that accessible public parks (natural green space) should be situated within 300 meters from homes, and that statutory local nature reserves should be at a minimum level of 1 hectare per thousand resident people. It further states that an accessible 20 hectare site should be located within 2 kilometers of homes, accessible 100 hectare site within 5 kilometers of homes, and accessible 500 hectare site to be located within 10 kilometers of homes (Moughtin and Shirley, 2005; Atiqul Haq, 2011).

Access to specific park attributes may influence park use at a local scale or neighbourhood level. For example, dog-owners looking for dog exercise areas (Cutt et al., 2008), or people wishing to use parks with pools that have specific hours of operation (Tucker et al., 2007) will access and use the parks according to their needs. Access to public transportation 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 (Day, 2008, p. 306). Parks and playgrounds on regularly walked routes are observed to be accessed and used more often than those located elsewhere (Ferre´ et al., 2006; McCormack, Rock, Toohey, Hignel, 2010).

Arguments have emerged that the rapid growth of vehicles has greatly affected the accessibility of public parks in the cities. The lack of bicycle lanes and pedestrian sidewalks connected to parks and recreational facilities and parking areas near public parks and recreational facilities create constraints in the accessibility of the parks and open recreational areas in the cities uses (Nevhutanda, 2007). Similarly, pedestrian safety is a major concern with respect to accessibility to public parks. Pedestrian safety is largely reliant on the design elements of the roadway. It is just as much influenced by the design of the land use surrounding the roadway (Nambuusi, Hermans, Brijsa, & Wets, 2010). Notwithstanding of the land uses, it is argued that the design of the roadway must go hand in hand with the design of the open spaces surrounding the roadway (Nambuusi et al., 2010). Land use-planning should provide facilities and services that ensure continuous and safe pedestrian access, which can increase access to public parks (Guo, Wang, Guo, Jiang, & Bubb, 2012; Luoma & Peltola, 2013).

According to Morency, Paez and Galfan (2013), public facility, and more specifically the service area of the facility, is equivalent to the accessibility of the facility. In other words, traffic networks around the facilities is a measure level of accessibility of the facility (Morency, Paez, & Galfan, 2013). The accessibility in case of public space like public parks is thus related to the ability of people to reach the space by public transport, private transport or pedestrian infrastructures. For example, a public park that is set on a busy road may draw more people that are passing by in addition to the people who are nearby the park

(Dempsey, 2012). Additionally, accessible public parks and recreational facilities also have a high parking usage (PPS, 2011).The other relevant aspects to consider regarding the accessibility to public parks and recreational facilities are the visibility of the space from a distance, interior visibility, usability, 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 such as park entrances, libraries, post offices, etc. (PPS, 2011).

Moreover, some scholars have categorized all the accessibility attributes of the public parks into three categories for simplicity. They are physical access, visual access, and symbolic access (Sendi and Golicˇnik Marusˇic, 2012).

2.5.1 Physical Access

Physical access to public parks requires proper linkage from neighbouring spaces as well as no barriers preventing pedestrians from entering the space. Not only should it be easy for children and elderly people to make use of physical access to the public parks, but there should also be relatively easy access to the space from houses and residential areas next to the public parks (Sendi and Golicˇnik Marusˇic, 2012). Consideration should be given to handicapped persons for convenient access as well. The physical accessibility of parks can also be influenced by the density of the neighbourhood which surrounds it, which possibly could be affecting the shape of the park (Dempsey, 2012). Vehicular movements around the public parks can also hamper physical access and can be a major reason for poor accessibility public parks.

2.5.2 Visual Access

The visual access of a PS refers to the visual connection a user would have with the public park they are heading towards. As proper visibility is required for safe navigation to the public park, visual access contributes to the safety of the user. Not only must a public park be easily visible to its users, but it must also ensure that the users are visible when accessing the public park as well as when using the public park (Sendi and Golicˇnik Marusˇic, 2012).

2.5.3 Symbolic Access

Symbolic access to public parks is becoming more and more important in defining the full spectrum of accessibility and vibrancy of the public parks. Symbolic access to public parks can be defined by the level and quality of signs and marks that share information to prospective users on who or what is welcome and who or what is not in the areas and territories of the space. These markings and signs can also be elements like structures, landmarks, monuments, sculptures, etc. Public display areas and programs such as pavilions, galleries, and other theme objects can also be seen as features contributing to symbolic access. The visibility of users such as groups - teenagers, small children, dog walkers, etc., maintenance workers, and security staff in public parks are also contributors to the symbolic access of public parks (Sendi and Golicˇnik Marusˇic, 2012)

Therefore, location, size, physical access, pedestrian facilities, availability of different modes of travel, safety, visual access like illumination, visibility and symbolic access (structures, landmarks, monuments, sculptures, etc.) are very important factors to consider while planning for accessibility of public parks.

2.6 MODELLING APPROACHES FOR ASSESSMENT OF ACCESSIBILITY OF PUBLIC PARKS

Literature revealed that a number of approaches, techniques and models have been used to assess accessibility of public parks. Some of the models, which were used prominently, are census tract models, proximity models, service area analysis models, Geographic Information Science (GISc) frameworks, with addition to different statistical techniques. A brief review and discussion of these approaches and models were done here in order to understand their suitability, implications and limitations before choosing or establishing model(s) for the current investigation.

2.6.1 Census Tract Model

The census tract model examines/analyses 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 is easily 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 composition of these people. Scenarios about 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 (Weiss et al., 2011). It also examines the correlation between socio-demographic characteristics of a neighbourhood with the availability of parks, park facilities, and area of parks, safety, and pollution (Weiss et al., 2011).

2.6.2 Proximity Models Using a Gravity Potential Expression

Proximity models is based on the number of services weighed by their distance from a specific location, which is 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 measure the number of people that are situated at predetermined fixed distances from each public park accessible to them; quantify the number of users at predetermined fixed distances from each public park; and weigh them with their distance from 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, such as Euclidean distance and road network distance based on Dijkstra's algorithm (Zhu & Zhang, 2008).

This model therefore uses a set of indicators that can be used in 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, & 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 a proper base to develop policies interventions to create more vibrant and healthy public parks.

2.6.3 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 accessible public parks to users within a pre-determined distance (Boone, Fragkias, Buckley, & Grove, 2014). This method of analysing existing public parks is similar to that of proximity models, with the inclusion of some methods being used in the census tract model. These models make use of data collected from systematic observation and interviews with users. The perceptions, preferences and barriers observed from the data collection can then be examined. The model is largely focused on the influence of gender and socio-economic aspects on the users' experience with public parks. However, such models require both qualitative and quantitative data to work efficiently (Wright Wendel, Zarger, & Mihelcic, 2012).

2.6.4 Geographic Information Science (GISc) Approach

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

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). However, this can be problematic because it assumes a park intersecting an aggregation unit implies proximity which is not always a valid assumption. It has a limitation for areas having heterogeneously distributed populations or differently sized aggregation units. For instance, it does not count people living across the street from a public park as part of the population with access to that park in the case that there is a boundary between the houses of the aggregation and the park. On the contrary, it would consider a park located on one end of an aggregation unit as being accessible to residents living on the other end of the aggregation unit notwithstanding whether 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).

Network Analyst tool in ArcGIS is also used to identify parks. However, sometimes the analysis excludes non-walkable features such as highways and railroads to maintain a more realistic representation of walkable routes (Miyake, Maroko, Grady, Maantay, and Arno, 2010) as against the notion of defining park access in terms of a reasonably walkable distance. This is important because walking, or an equivalent non-vehicular mode of transportation, is the most widely accessible mode of transportation across age, ability, and class status (Moore et al. 2008; Nicholls 2001; Wolch 2005). The other limitation is that it does not attempt to evaluate environmental conditions that affect perceptions of park access routes 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.

2.7 SYNTHESIS, DISCUSSION AND CONCLUSION

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

Although, old established residential areas in cities including that of South Africa normally have a sufficient amount of public parks to service the area, the new developments, rezoning of land uses and socio-economic transformations have changed these old established residential areas. Along with the transformations happening in and around old established residential areas, public parks in new developing residential areas are still being planned and placed using conventional planning methods. These changes are perceived to have negatively affected the level of accessibility to these public parks for users and consequently become a barrier against successful park uses (BenDor, Westervelt, Song, & Sexton, 2013; South Africa’s Transport Network, 2013).

It is evidenced that accessibility is one of the major determinates of successful usability of the public parks. There are three forms of access (physical, visual and symbolic access) which are generally considered with respect to accessibility of public parks. Spatial accessibility (proximity), location, and size of the parks contribute to the usability of the parks. It is argued that a successful public park needs to be easily accessed via foot or vehicle as well as be clearly visible from afar and up close. Similarly, traffic networks around the facilities are observed to be a measure of the level of accessibility of the facility.

Access to public transportation is also identified as a major enabler for park access. However, rapid growth of vehicles has affected the accessibility of public parks in the cities to some extent. Lack of bicycle lanes and pedestrian sidewalks connected to parks and recreational facilities, parking areas near public parks, and recreational facilities are also observed as constraints in the accessibility of the parks in cities. According to some scholars, the time it takes to walk from home and the walking distance are some of the most important preconditions for access and usability of public parks. Pedestrian safety was observed to be another major concern.

It is evidenced in literature that basic public park access in residential areas of a city is based on the spatial configuration of parks, the number of parks and their spatial distribution across neighborhood areas or local regions. Therefore, land use-planning is advocated to provide facilities and services that would ensure continuous and safe access. This will, in turn potentially increase access to public parks. Furthermore, interior visibility, usability, 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. Thus, accessibility remain pivotal to successful use of public parks, and it is essential to investigate the influence of various accessibility factors along with their level of availability with regards to the successful and higher use of public parks, particularly in the residential areas of a city.

A number of models exist and are used prominently to determine the levels of accessibility to public parks and to analyse accessibility challenges. These models include, but not limited to Census tract models, Proximity models, Service area analysis models, and Geographic Information Science (GISc) frameworks in addition to different statistical techniques. However, to date models that are completely applicable to the demographic situations and developments encountered in South Africa are observed to be scarce. A majority of the available models are applicable either at aggregate city level or on individual parks.

It is comprehended that a public park that is transformed to become fully accessible (safe, easy, and convenient) to its potential users, should have a positive effect on the quality of its surrounding neighbourhood due to the fact that the park becomes more vibrant with users and an attraction to the neighbourhood. However, investigations regarding accessibility of public parks at a local residential neighbourhood level are observed to be limited. Thus, this study pertains to explore the accessibility challenges of public parks at a neighbourhood level in cities which is expected to bridge the research gap observed in the field of study. The findings from the literature will therefore form the basic framework for this investigation of accessibility of public parks in residential areas of a city.

3. CHAPTER 3: PROFILE OF STUDY AREA

3.1 INTRODUCTION

Investigation of study area profile provides insights to its characteristics, various challenges, opportunities and prospects, which is essential to evolve policy interventions in general and formulate plausible planning guidelines in order to ensure sustainable development. Several socio-economic, physical, infrastructural, environmental and ecological attributes of a city influence the accessibility of public parks and open recreational areas in a city, which is essential to be investigated. Therefore, this chapter presents the current scenario of the various attributes and parameters of the study area, which influence the accessibility of the public parks and recreational areas. The parameters investigated include back ground of the area, demographic profile, socio-economic profile, land use, transportation system, and status of public parks and open recreational areas.

3.2 BACKGROUND OF STUDY AREA

Bloemfontein city in South Africa was chosen as the study area for this investigation. Bloemfontein is the capital city of the Free State province as well as the judicial capital of South Africa since the year 1910. The city is known as the 'City of Roses' and is often referred to as 'Mangaung' (the place of cheetahs). The vegetation surrounding the city is mainly dry grassland on a flat plateau bordered by the semi-arid region of the Karoo.

Geographically Bloemfontein is situated at 29°06′S and 26°13′E at an altitude of 1395 m above sea level (Figure 3.1). The climate of the area ranges from very cold (-10°C to 14°C) in the winter months to very warm (19°C to 38°C) in the summer months. The rainy season is encountered during the summer months and strong winds are experienced during spring season (Department of Science and Technology South Africa, 2011). The summer season in Bloemfontein is generally between December and February, whereas the winter months occur between June and August. The other months in between are generally moderate in temperature. The annual rainfall of Bloemfontein ranges from 600mm to 750mm per annum. Snowfall occurs occasionally during winter in the area (Department of Science and Technology South Africa, 2011). Spatially, Bloemfontein is a medium-sized city consisting of 35 suburban areas situated around the 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 about 5.7% of the total population of South Africa. The population in the Mangaung metropolitan municipality, which contains Bloemfontein city is estimated to be 900 000 (Statistics South Africa, 2011). Bloemfontein is the largest city in the Free State with about 32% of the total population of the province living in the city. It is also the largest component of Mangaung metro municipality constituting about 80% of the total population of the metropolitan municipality. The population density of the city is about 105 people per square kilometer (Statistics South Africa, 2011). Figure 3-2 shows the population distribution between all nine provinces of South Africa.

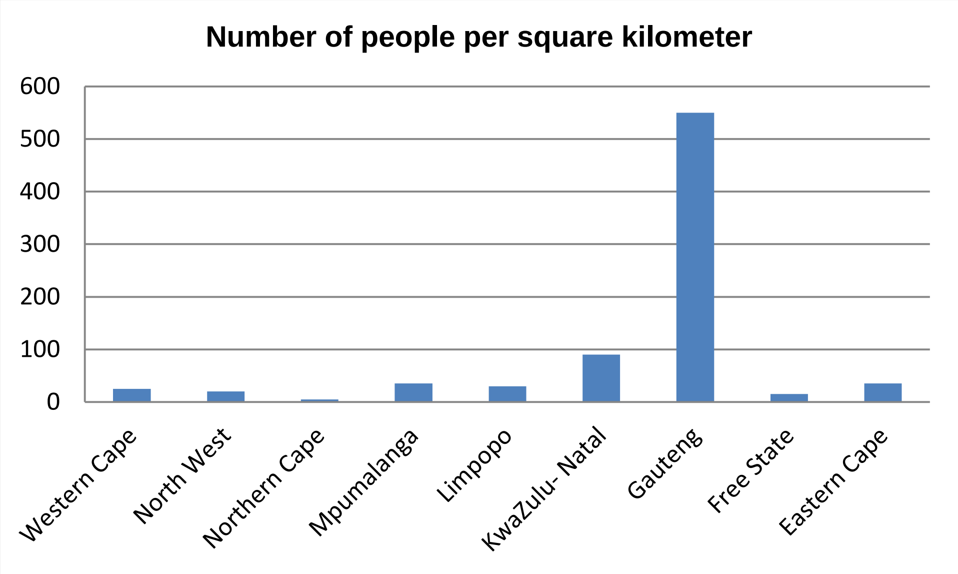

Figure 3-2: Number of people per square kilometre

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 notice that the largest age group of people in the Free State is the 10-14 years group, which is 11% of the total population of the province estimated at a number of 2 824 500 (Statistics South Africa, 2011).

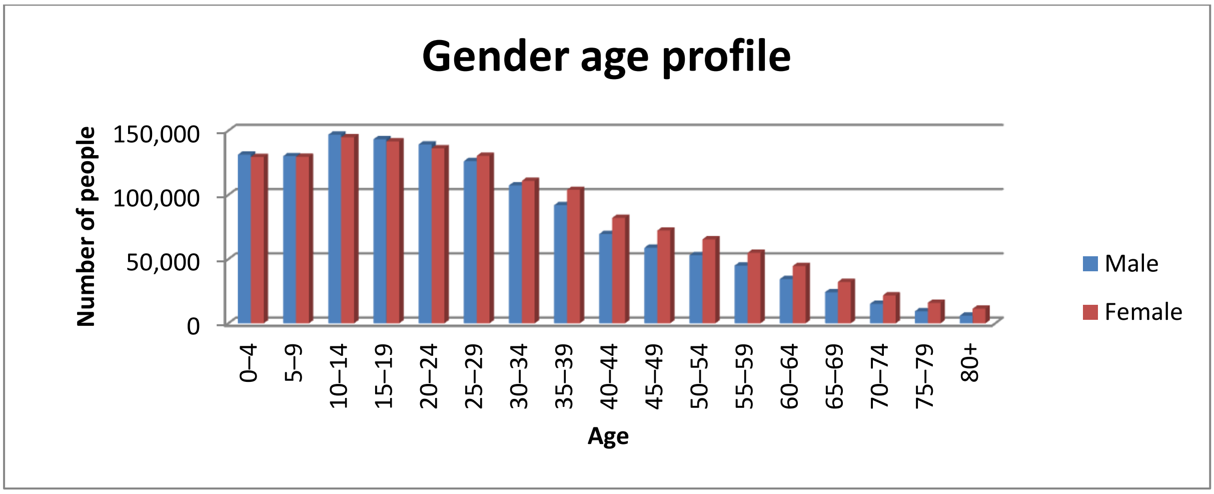

Figure 3-3: Gender and Age profile of residents in the Free State by age group

A clear decline in numbers can be observed in the age groups from 14 to 80 years where each of these age groups is currently displaying a decrease of 2%. Of interest is that the male population up until the age of 24 years is slightly larger than the female population whereas from the age of 24 to 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 900 000 people) live in and around Bloemfontein. The age and gender profile of the city apparently follow the trend of the province.

Table 3-1 below displays a detailed age and gender distribution of the population of the city of Bloemfontein.

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

From Table 3-1 it is clear that more than 30% of the population is composed of the age groups between 10 and 24 years and about 19% of the population of the age groups between 0 and 9 years. This implies that about 49% of the population is aged 24 years and younger. It should also be noted that about 24% of the population is between the age groups of 25 and 39 years, which means that about 73% of the population of the province is 39 years and younger. This proves that a large portion of the population is still young and in need of outdoor recreational activities. and it can be deduced that the majority of the population in the study area are potential users of public parks in residential areas (Baur, Tynon, & Gómez, 2013).

3.4 SOCIAL FUNCTIONS: EDUCATION AND HEALTH SCENARIOS

The literacy rate of South Africa for adults is estimated to be between 80% and 89% whereas the literacy rate of the younger population is estimated to be between 90% and 100%. These rates are on par with the global literacy rates which are 84% for adults and 89% for the youth (UNESCO, 2015). The literacy trend in the study area is the same as the literacy trend of the country. Bloemfontein is well-known for a number of schools and institutions of higher education that offer a high standard of education, such as Grey College, Eunice Girls High, Sentraal High, Oranje Meisies School, St Andrews, St Michaels, the Central University of Technology, and the University of the Free State. Almost every residential area in Bloemfontein has either a primary school and/or a high school. The two universities located in Bloemfontein have a student population of more than 50000. The education infrastructure of Bloemfontein is responsible for the high literacy rate it currently enjoys.

The city of Bloemfontein is well known for its health facilities in the central region of the country. In general it follows the trends set by national health and adheres to the standards set by the minister of health. The life expectancy of residents in the study area is 54.9 years for males and 59.1 years for females (Statistics South Africa, 2011). It has several advanced health care facilities which include three large private hospitals, three public hospitals and thirteen health clinics that provide health care to citizens.

3.5 ECONOMY

Figure 3-4 shows the economic distribution of the nine provinces in South Africa. Economic distribution of South Africa follows the trend of population distribution of the country. The province with the highest population density (Gauteng) also has the highest GDP. The most populated province Gauteng contributes the maximum (33%) and the Northern Cape Province, which has the lowest population, contributes the minimum (2%) the GDP of the country. Following the similar trend the Free State has the second lowest contribution (6%) to the national GDP. Bloemfontein is the largest populated city of the province, causing it to be the economic hub of the province and allowing the city to be the biggest economic contributor of the province. (Mcdonald and Valente, 2005). The major economic activities of the city are industrial, commercial and service activities. A number of industrial areas are located in and around the city. However commercial activities and service functions like governance activities, education and health related activities are observed to be predominant economic activities. The city of Bloemfontein is also influenced by the agricultural activities from the agricultural and dairy farms located around the city.

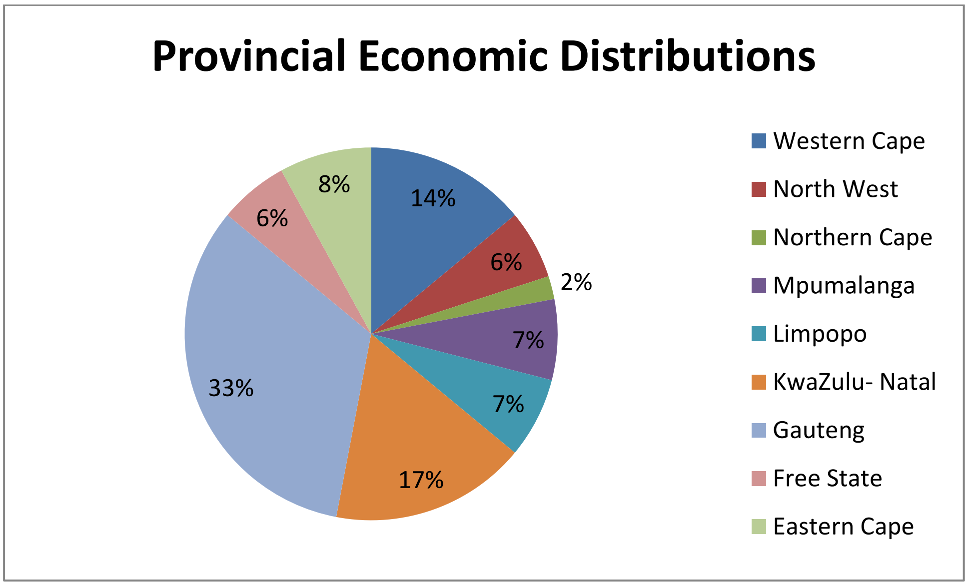

Figure 3-4: Economic balance in South Africa (Statistics South Africa, 2011)

3.5.1 Employment and Occupation

The three main sources of income of the Free State province are mining, agriculture and industrial activities. There are various mines in the northern parts of the Free State where mainly gold and coal are mined. The 12 gold mines of the Free State provide 30% of the country's reserves and about 20% of the world's gold stack. Almost all the farming disciplines are covered in the Free State and majority of the land in all of the Free State is mainly used for agricultural activities. The industrial sector of the Free State is mainly based on import and export of high-tech materials which include petroleum and different waxes. However, as mentioned earlier Bloemfontein has a predominantly commercial-based economy with a few industries and farms located in and around the city. Due to the population growth in the study area, the labour force of the area has increased, which has resulted in a greater demand for work than the actual jobs available. This problem regarding unemployment greatly influences the economy of the Free State.

As seen from Figure 3.5 about half of the population (46%) works in the private sector. About 30% work in public sectors such as in government offices, and 17% have their own enterprises. However, the unemployment in Bloemfontein is very meager (about 1%).

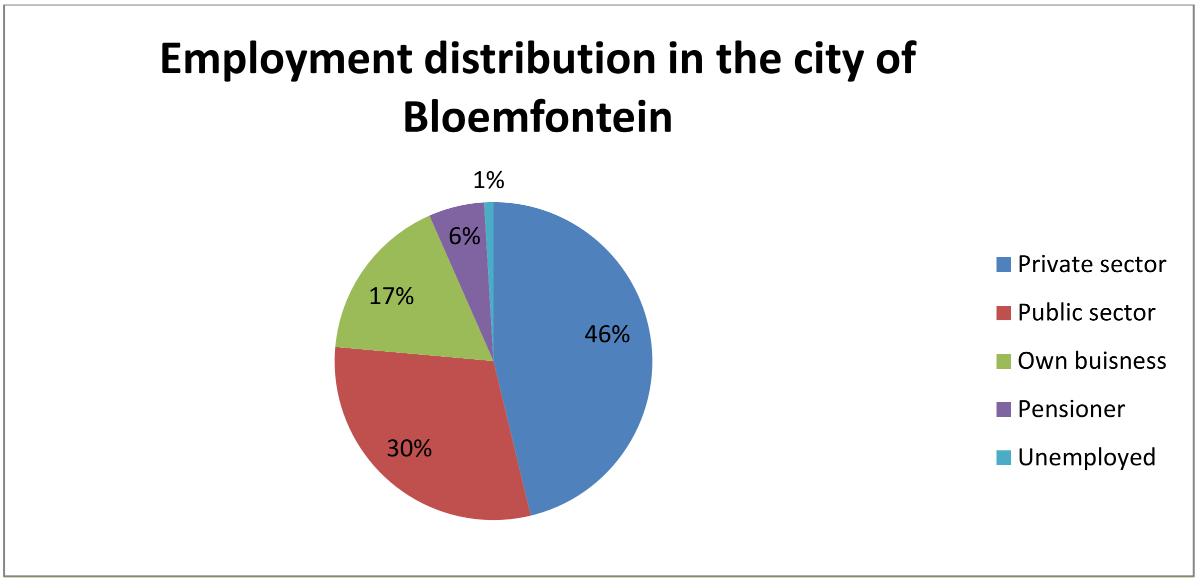

Figure 3-5: Employment Distribution in the city of Bloemfontein
(Source: Household survey, 2015).

3.6 BASIC INFRASTRUCTURE AND HOUSING

The basic infrastructure and services in the study area constitute road transportation network, railways 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. Housing form the major built infrastructure in the city. During the physical survey of the study area, it was observed that about 58% of the dwellings are stand-alone houses for single families and 42% of the dwellings are apartment flats, townhouses, duplex flats and cluster homes

3.7 URBAN MORPHOLOGY

The urban morphology of the study area indicates the relationship between land use and urban patterns of the area. Each residential area in Bloemfontein differs in characteristics and functions which causes these residential areas to have unique urban patterns and land use. This section explains the urban pattern and land uses of the city in general; however focuses on the residential areas selected for the survey of this study, namely Langenhovenpark, Universitas, Batho, and Lourier Park.

3.7.1 **Urban Patterns**

The road network of an urban area generally forms the framework and structure of the urban pattern of the area. The road network in an urban area depends on the availability of roads in a hierarchical manner. The combination of these roads create a pattern which ultimately forms the urban pattern of the area (Zhu & Zhang, 2008). In South African cities the roads are classified according to COTO 2012. They range from urban principal major arterials (U1), urban major arterials (U2), urban minor arterials (U3), urban collector streets (U4), urban local streets (U5) and urban walkways (U6) (TRH, 26, COTO 2012). The Class U1 arterials are used to serve as connectors to rural Class R1 routes. They 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 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 road network. They bring traffic to within one kilometre of its final destination. They also serve economic activity centres that are not served by Class 1 or 2 arterials. The collector streets penetrate the local neighbourhoods with the purpose of collecting (and distributing) traffic between local streets and the arterial system. The streets are usually intended to serve an access function with limited mobility and traffic volumes; trip lengths and continuity must be limited. Urban local streets provide access to individual properties and both traffic volumes and trip lengths must be limited in these streets. Pedestrians are given priority at all times without the need for signs and road markings on all walkways (TRH, 26, COTO 2012).

Bloemfontein has a hierarchical road network comprising of all the six types of roads in the city. However, major arterial (U2) and minor arterials (U3) roads form the nervous system of the city providing connectivity to all parts of the city. The road network layout and urban pattern of Bloemfontein is illustrated in Figure 3-6.

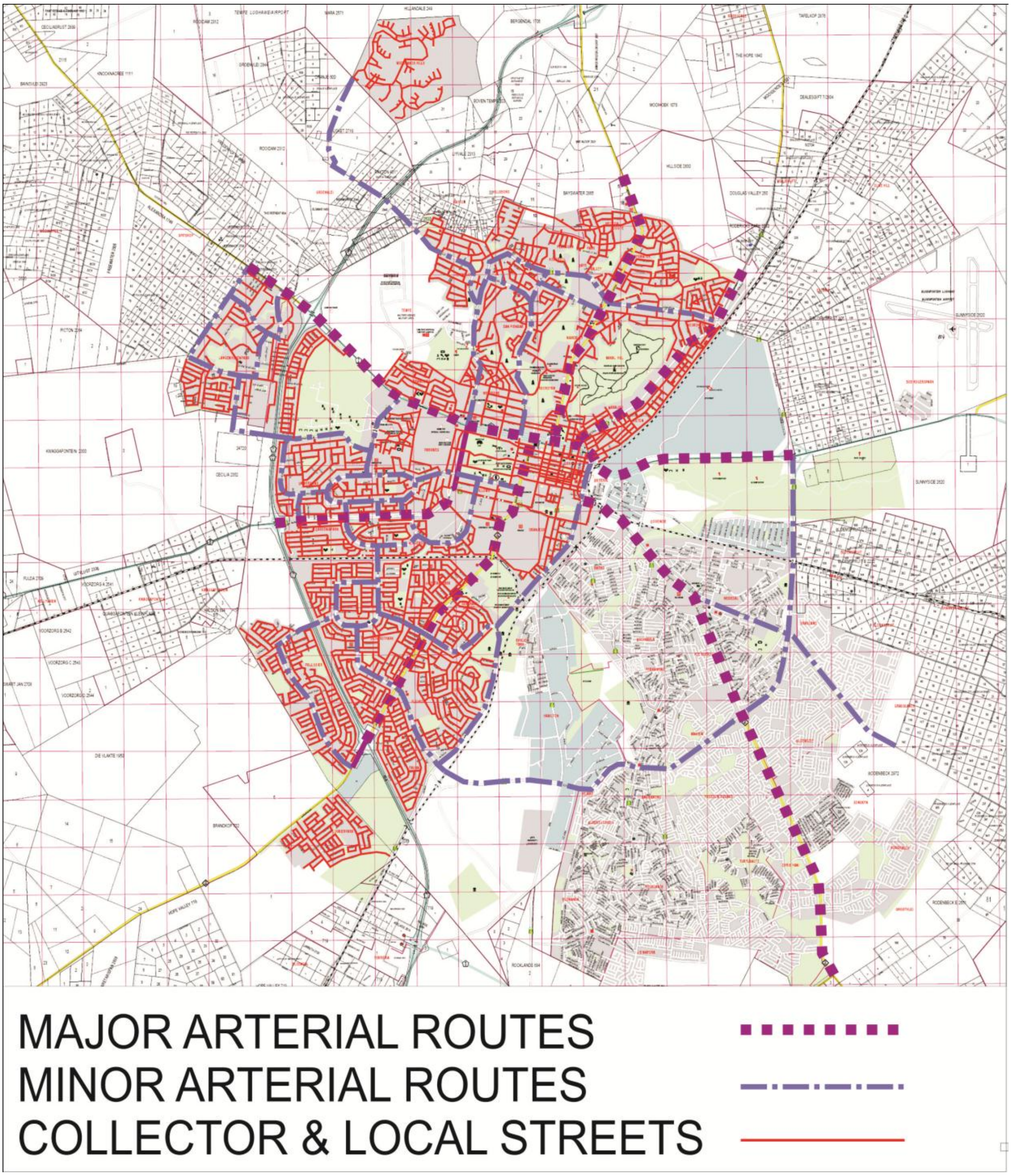

Figure 3-6: Road network and urban pattern of Bloemfontein (Mapsource © GIS Software)

Figure 3-6 clearly shows how the major arterial roads originate in the city centre and spread out to the outer parts of the city. The urban areas of the city are divided by these major arterial roads which are accessed with ease from different areas through minor arterial routes, which in turn are accessed through collector streets. It is noted that the major arterial roads in the city have a linear pattern, whereas the minor arterial roads are either configured in a linear or loop pattern. The smaller collector streets are configured in different types of road patterns such as loops; gridiron; combination of a loop and gridiron; and cull-de sacs with occasional loop patterns. The city centre is configured primarily in a gridiron pattern, which changes to a radial pattern combined with a gridiron pattern as one moves outward, away from the city central area.

The functional use of a land area is referred to as the land use of that area. The city of Bloemfontein is divided into various land uses namely residential, commercial, industrial, civic, open space and mixed land uses. Bloemfontein is no different from most cities in South Africa in its pattern of land uses, with the exception of the large military base. Various areas in the city have a mixed land uses pattern serving multiple functions. Figure 3-7 shows the location and types of land uses in the city of Bloemfontein.

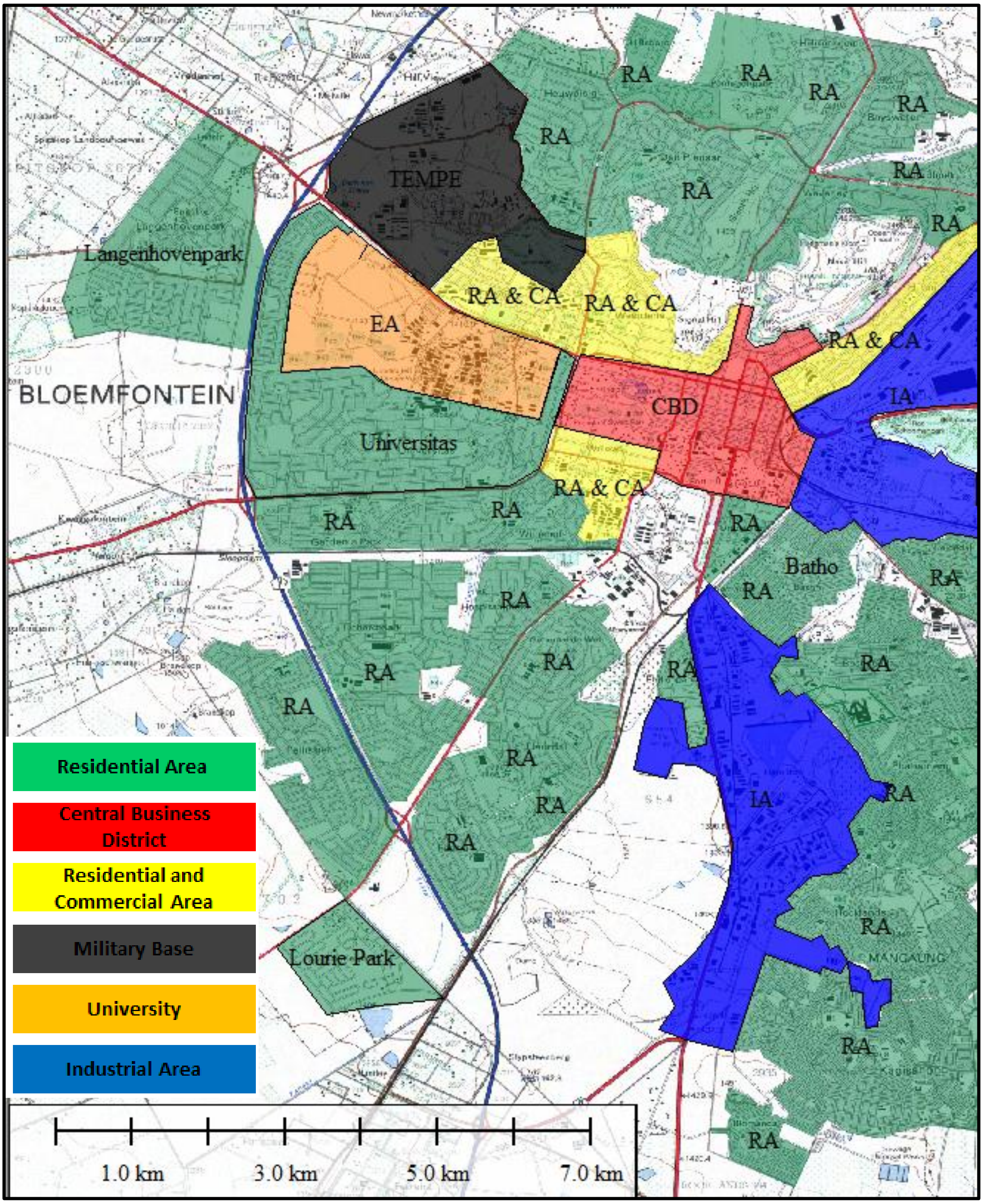

Figure 3-7: Land Use in Bloemfontein (Mapsource © GIS Software)

From Figure 3-7 it is seen that the central business district of the city is surrounded by commercial areas combined with residential areas. The residential areas of the city surround the commercial areas and the university. Figure 3-7 also shows that the industrial areas of the city are confined to the outer Eastern parts of the city and surrounded by low-class residential areas. Tempe military base is situated on the outer North-Western part of the city.

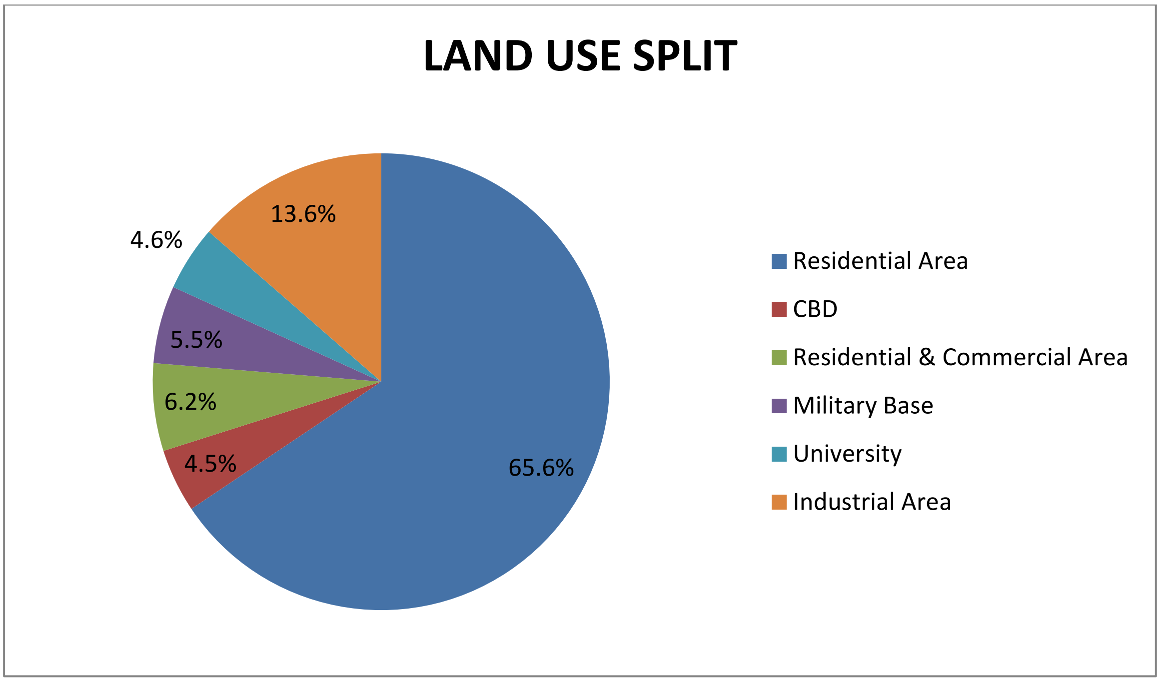

Figure 3-8: Bloemfontein Land Use Composition

The general land use composition of the city is illustrated in Figure 3-8. Residential areas with mixed land use have taken up the majority of land space (65.6%) in the city. In comparison to size of the rest of the city, the CBD area is fairly small, which constitutes about 4.5% of the total land area of the city. About 13.6% of the total land area is used for industrial purposes. There are also two prominent areas set aside in 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. The public parks and organized open recreational areas form an integral part of 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 3-6 the city is comprised of major arterials (U2), minor arterials (U3), collector roads (U4) and local streets (U5) with occasional culls-de sac. Most of the roads in the city are paved but some roads in the lower-class residential areas are unpaved. These unpaved roads receive less attention due to the lower number of vehicles travelling on these roads. The outer suburbs of the city are connected to the city center through a network of major arterials.

Some residential areas are used as thoroughfares to other residential and commercial areas, which are 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 to all the roads in the city ranges from 80km/h for certain major arterial roads, to 40km/h for certain collector roads where frequent pedestrians 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 street lights. The city has a well functional traffic control and management system. Majority of the junctions are controlled by automated traffic signaling system. Minor or unimportant junctions are managed by stop signs. Most the traffic movements on the roads are managed by appropriate road signs, pavement marking, on street, off street parking systems and traffic calming measures.

3.8.2 **Types and Number of Vehicles**

The evolution in types and modes of transport in the city of Bloemfontein has followed the same trend as the rest of the country. About 62% of the commuters in the city make use of their privately owned vehicles, and the remaining 38% of the commuters make use of public transport such as taxis, mini-buses and buses (Merven, Stone, Hughes, & Cohen, 2012). Currently the city does not have any train commuting system or network apart from providing commuters opportunities to travel to other cities and towns in the country.

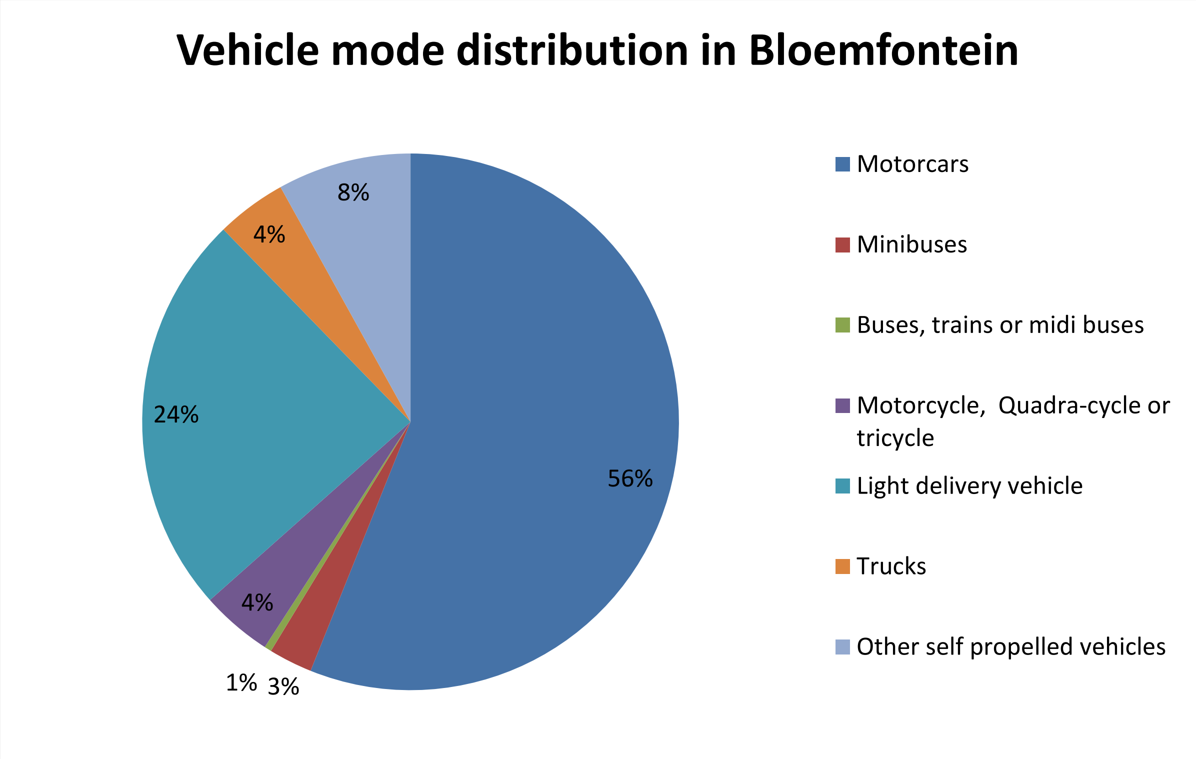

Figure 3-9: Vehicle mode distribution in Bloemfontein

Figure 3-9 shows the vehicle mode distribution in the city of Bloemfontein. At 56%, the use of motorcars is significantly higher than other modes of transport in the city with light delivery vehicles at 24% being the second most frequent mode of transport. .

3.8.3 **Public Transportation System**

Bloemfontein has an interstate bus system that operates on predetermined routes and provides commuters access to all the residential areas of the city. The bus system has various stops located along all the main and minor arterial roads of the city, thus commuters making use of public transport are expected to walk from collector roads to main- and minor arterial roads in order to be picked up. Commuters are able to pay on a weekly or monthly basis in order to make use of the buses. Most of the commuters who make use of the bus system travel from the eastern parts of the city to the central and western parts of the city in the mornings and vice versa in the afternoons. The bus system operates according to a schedule and commuters are expected to be aware of the bus schedule if they are to make use of it.

Mini buses also operate on a large scale in the city, but in an informal fashion. They stop not only at designated stops for commuters to embark/disembark, but also wherever a commuter is waiting along the road to be picked up. Commuters pay mini buses per trip.

These buses travel on all major and minor arterial routes and do not drive according to schedules like the city bus system. They only embark once the bus is filled with commuters or no more commuters are expected to come. Commuters waiting for mini buses or buses often make use of neighbourhood parks and public parks as a waiting point. Only a small number of commuters make use of private taxis that pick them up and drop them off on any level of public road.

3.9 OPEN SPACES AND RECREATIONAL FACILITIES

There are numerous organized open spaces in the city of Bloemfontein, with every residential area being equipped with public parks and neighbourhood parks. The city has a variety of sport fields (stadiums, sport arenas, and sport facilities) that are categorized under public recreational facilities, but because of the limited/private access these facilities provide, they will not be considered in this study. Only accessibility of open spaces that offer free access to the public will be considered in this study. Nature reserves, zoos and botanical gardens that require the public to pay a certain fee in order to gain access are out of 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 which are free to access, but only 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 3-10 shows the two main central public parks of the city of Bloemfontein. These two public parks are surrounded by the city zoo; the sports arena that includes the rugby as well as cricket stadium; tennis courts; the swimming pool arena; and the athletics stadium. These two public parks are free to access on a daily basis between 8am and 8pm. Access to the surrounding recreational is restricted to members and ticket holders. The public parks servicing the CBD area are being utilized by citizens on a regular basis and have higher accessibility due to the surrounding land use and urban functions. These two public parks in the CBD area of the city cover an area of 100 000m²; are well-kept and maintained; and are equipped with all the features and amenities expected of a proper public parks (Figure 3-11 and 3-12).

In 2010 a few games of the FIFA soccer world cup were hosted in the stadium next to the public parks of the CBD. This event ensured the upgrade and rehabilitation of service and level of accessibility to the stadium in the years preceding 2010. These upgrades and rehabilitation projects also affected the level and quality of the public parks next to the stadium.

Figure 3-10: Parks and Recreation facilities of the Bloemfontein City CBD Area (Mapsource © GIS Software)

Figure 3-11: Public Park 1 in the Bloemfontein CBD Area

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Figure 3-12: Public Park 2 in the Bloemfontein CBD Area

Each of the 35 residential areas in Bloemfontein has public parks that are situated at various locations within these residential areas. Some residential areas have more public parks due to their larger population and geographical size. However, some public parks in lower class residential areas are found to be encroached to form illegal settlements (Marais & Ntema, 2013).

3.10 PUBLIC PARK DISTRIBUTION IN RESIDENTIAL AREAS

Figure 3-13 shows the distribution and sizes of the public parks in the city of Bloemfontein. It can be seen that the city has a well-distributed network of public parks in all the residential areas. There are about 202 public parks in the city, covering an area of 167 km^2, which means that for every square kilometer of the city there are on an average 1.2 public parks. The city of Bloemfontein has ensured in its planning that there is a public park within 1km walking distance from every residential dwelling. With such availability of public parks to the residents of the city, one should expect these public parks to be vibrant and busy, but as experienced that is not the case. Thus, it is necessary to assess and analyze the accessibility to these public parks in order to identify solutions and guidelines for improving the use of these public parks.

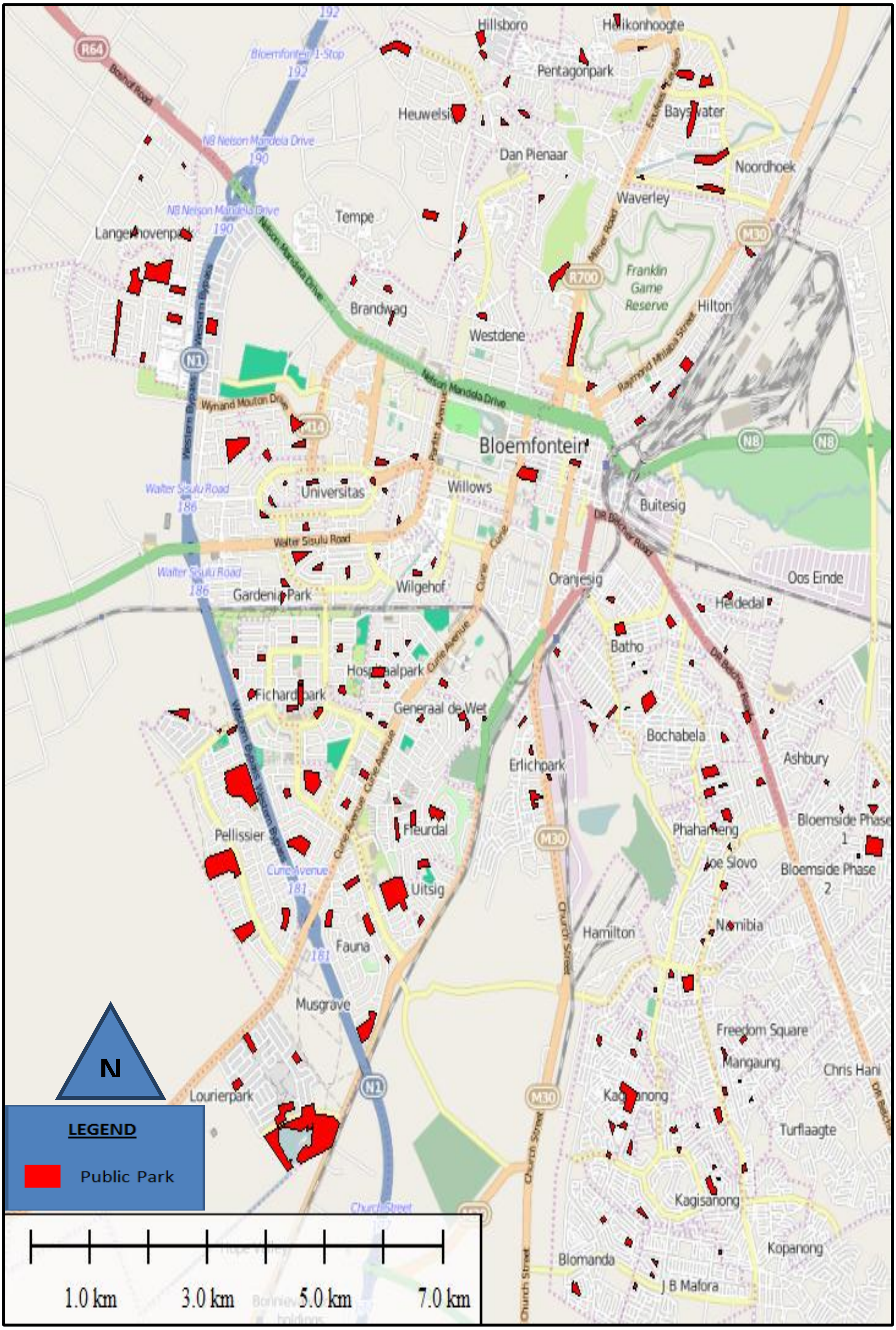

Figure 3-13: Public Parks in Bloemfontein City (Mapsource © GIS Software)

3.10.1 **Public Parks in the Four Selected Residential Areas**

The public parks in the residential areas of Langenhovenpark (Figure 3.14), Univeristas (Figure 3.15), Batho (Figure 3.16) and Lourier Park (Figure 3.17) have been selected to represent the public parks of all the residential areas in the city, due to their location, characteristics and demographics which essentially seem to represent those of the rest of the of the residential areas in the city.

Table 3-2 shows that the four selected residential areas have a different number of public parks. It also presents the difference in the ratios of the total land area in the residential area to the combined land area of the public parks. Of the total land area of Langenhovenpark, about 4.8% of the area is used as public parks. Since the University of the Free State have its own parks as a service to its students, only 1.8% of the total land area of Universitas is used for public parks in the suburb. However, the total area of public parks (including the parks of the university) in Univeritas amounts to 11.8% of the total land area. The university provided the general public access to their parks up until 2014, but have since then restricted access to the university grounds to students, staff and service providers only. A large number of the residents in Universitas are students, who still have free access to the parks of the university. About 6.6% of Batho's total land area is used as public parks and 25.7% of the total land area of Lourier Park is used as public parks.

Table 3-2 Public Park Details of Four Selected Residential Areas of Bloemfontein

Public Parks in the Four Selected Residential Areas				
Name of Residential Areas	**Number of Public Parks**	**Total Land Area of Residential Areas (m^2)**	**Combined Land Area of Public Parks in Residential Areas (m^2)**	**Access type to Residential Areas**
Langenhovenpark	11	45 x10^{5}	220 000	Limited
Universitas	16	97 x10^{5}	169 800	Thoroughfare
Batho	7	1 x10^{6}	65 900	Thoroughfare
Lourierpark	5	15 x10^{5}	385 200	Limited

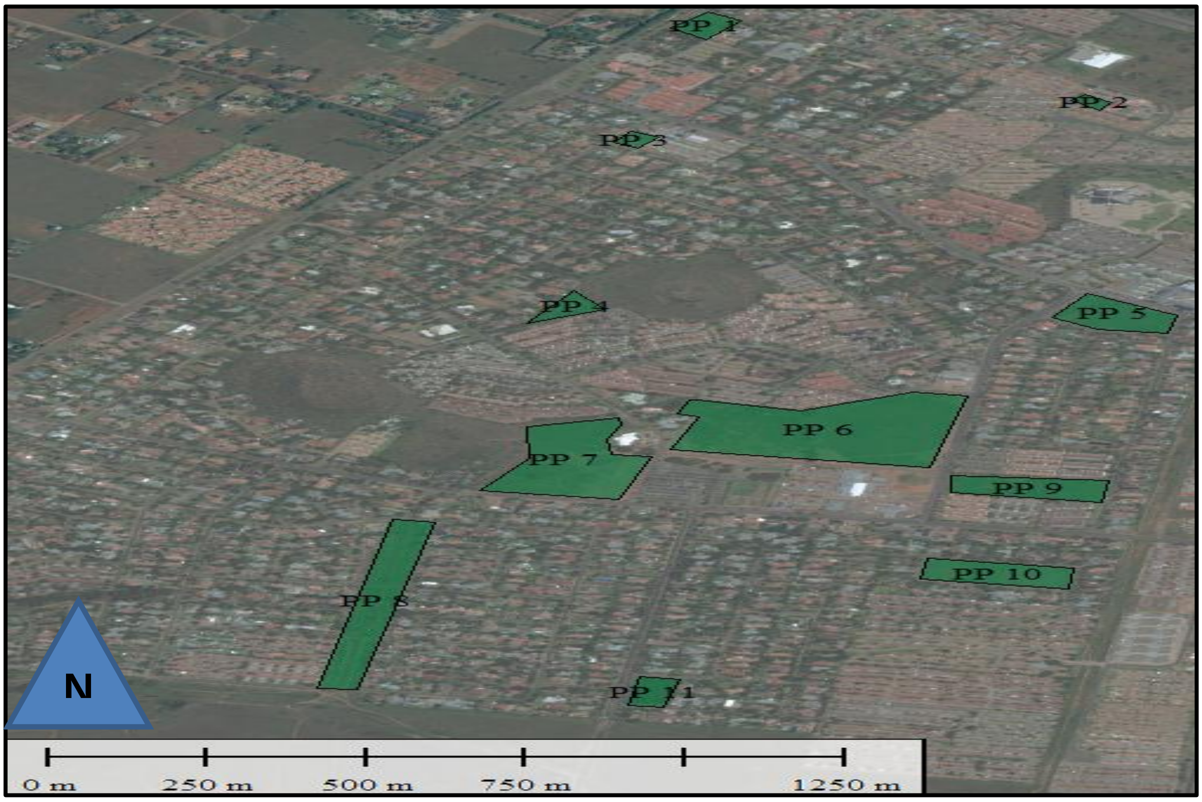

Figure 3-14: Public Parks in Langenhovenpark (Mapsource © GIS Software)

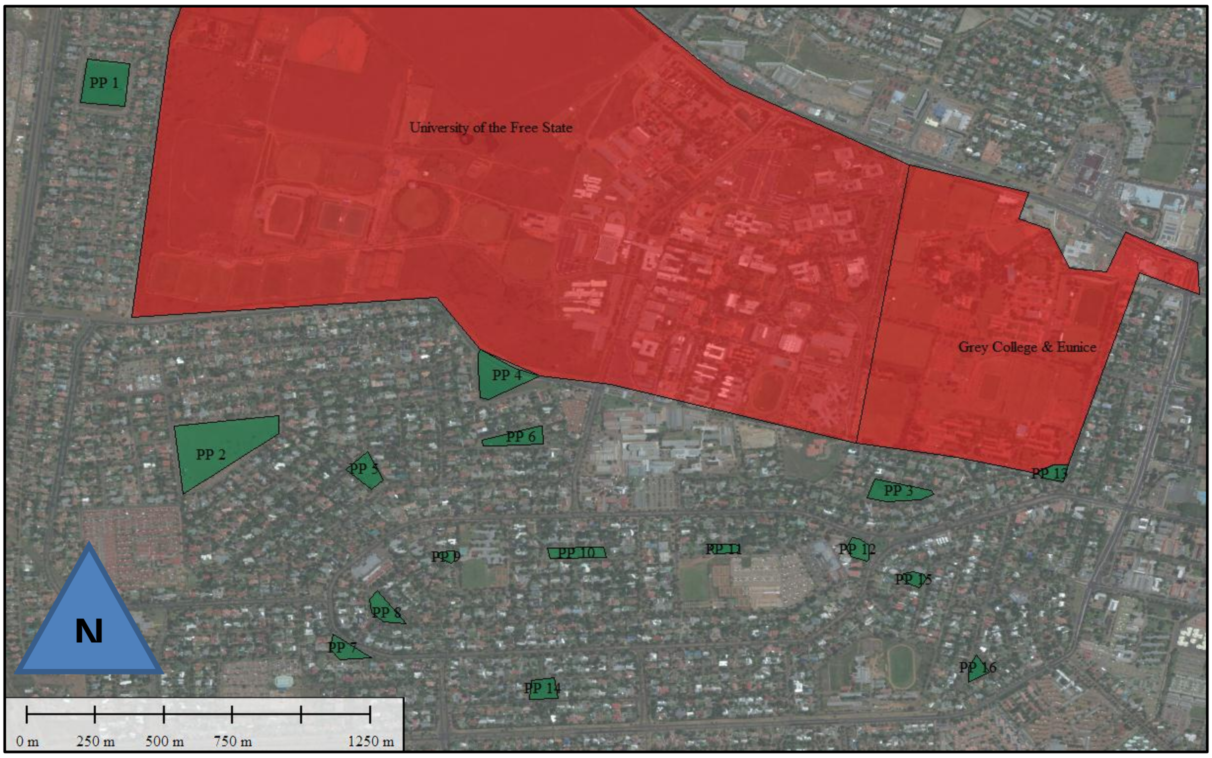

Figure 3-15: Public Parks in Universitas (Mapsource © GIS Software)

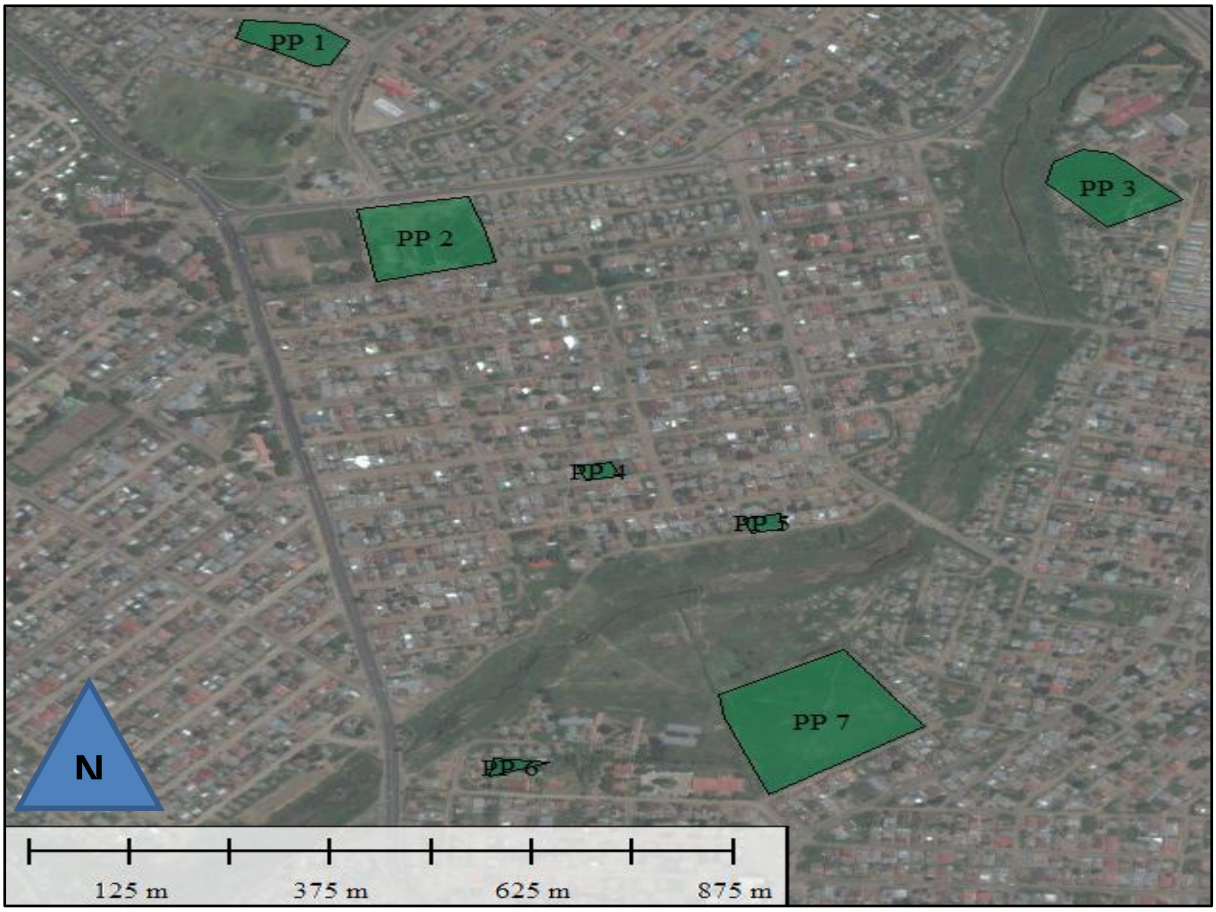

Figure 3-16: Pubic Parks in Batho (Mapsource © GIS Software)

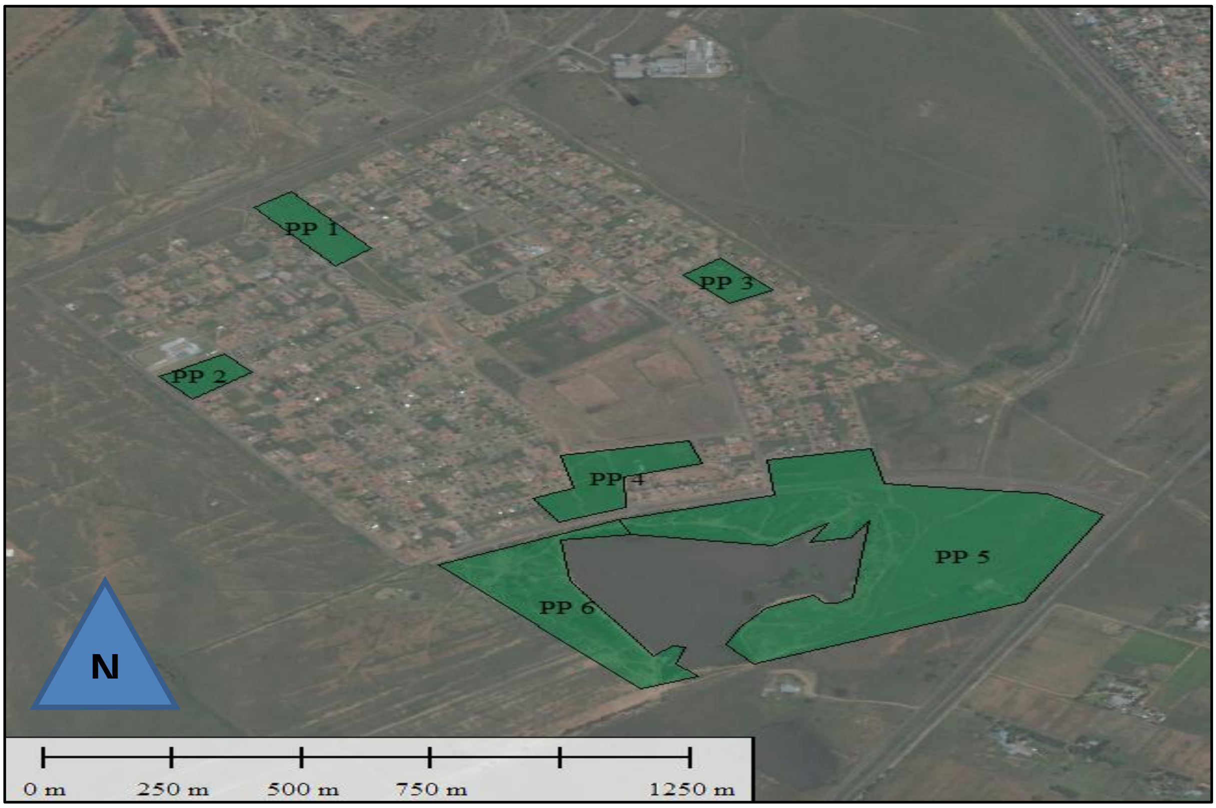

Figure 3-17: Public Parks in Lourier Park (Mapsource © GIS Software)

3.11 SUMMARY

The analysis of the Bloemfontein City study area indicated the following important aspects:

- The Free State province has the second lowest population density in South Africa, with the Mangaung (Bloemfontein and surrounding areas) district consisting of 900 000 residents.
- About 74% of the population of the study area is below the age of 40 years, of which more than 30% is between the ages of 10 to 24 years. Only about 26% of the population is older than 40 years. This indicates that the majority of the city's population is in an active age group that needs recreational activities and leisure.
- The educational institutions of the city of Bloemfontein such as schools, colleges and universities are spread over the entire city. Clinics and large hospitals (Universitas Hospital and Rosepark Hospital) are all located within residential areas.
- The general unemployment rate of the country is at 25% (Statistics South Africa, 2011). However, the unemployment rate in the study area is moderate, and majority of the people work in the private sector.
- The road patterns of Bloemfontein City comprise of a linear system of major and minor arterials which are linked to different urban areas. The minor arterials and local

streets from grid iron, loop or linear system of road network at the suburban area level of the city.

- Bloemfontein has a public transportation system ranging from a bus system to a mini bus system which travels from and to several locations over the entire city. However, the public transportation system is mainly used by residents residing in low-class residential areas, which is causing a lob-sided public transportation system with majority (62%) of the commuters still making use of their own private vehicle.
- There are two major public parks having all the facilities and amenities situated in the CBD area of Bloemfontein, which are significantly utilised by the people. These parks are also not included in the study as they have different characteristics and purposes to that of public parks located in the residential areas. .
- Also, a number of recreational facilities and open spaces such as stadiums, sports grounds, zoos, nature reserves and botanical gardens are also available in the city; however, they are not included in this study, due to the limited access of these facilities to public.
- There are a sufficient number of public parks in the city of Bloemfontein with an average number of 1.2 public parks per every square kilometre. However, as observed from survey, these parks are not used to their full potentials. There are a number of factors which contribute to their underutilisation among which accessibility is a major reason
- Residents in the residential areas of Bloemfontein are all within walking distance of a public parks in their area, which raises concern as to why there are not as many residents using these public parks, which necessitated this investigation.

4. CHAPTER 4: DATA ANALYSIS, RESULTS AND DISCUSSION

4.1 INTRODUCTION

In this chapter an attempt was made to investigate the socio-economic environment; physical -and visual accessibility; transportation network; and traffic-related conditions of the study area and their influence on the accessibility to public parks. Survey research methods (c.f Section 1.6.2) have been utilized to collect data, which were then statistically analysed to comprehend the various major control parameters influencing accessibility to public parks in the study area. Once all the necessary data were collected, all the schedules were vetted and then cross checked. All of the analytical public park data collected was checked for accuracy through using GIS software and doing physical surveys at all the sites. All discrepancies were then corrected before the data were subsequently transferred into code sheets to avoid errors. Thereafter, the data were transferred to Microsoft Excel sheets and relevant statistical analyses were done. The various analyses done include:

- A socio-economic scenario of the study area
- An analysis based on a physical survey of the access systems to the public parks
- The relation between accessibility to public parks and the number of frequent users
- The relation between land use and the accessibility of the public parks
- The relation between transportation networks and the accessibility of the public parks
- Parameterisation (delineating major control parameters influencing public parks accessibility in the study area)
- Modelling and simulation for prediction of public parks accessibility in the study area
- Predictions on accessibility to public parks in the study area

4.2 SOCIO-ECONOMIC SCENARIO OF THE STUDY AREA

The socio-economic conditions of the study area were analysed to understand the socio-economic status and social behaviour of the potential public parks users. The reason being that income, demographic characteristics, availability of social infrastructure, living style, daily activities, travel behaviour, and the use of various transportation modes for daily movement of these potential users all have a direct or indirect influence on the accessibility users have to public parks in the study area. The analysis was conducted based on a range of variables including: (a) household income; (b) age; (c) age vs. public park usage; (d) academic qualification; (e) occupation; (f) type of dwelling/ house; (g) property ownership; (h) number and type of vehicles; (i) travel distance to public parks; (j) commuting trips; (k) expenditure on transportation, and l) public parks utilization frequency.

4.2.1 Income of Households

The residential area where a household resides is mostly based on the income of that household, and usually a household in a higher income bracket can experience better living conditions. Most household parameters such as purchasing and spending power, personal transportation modes, recreational equipment and expenditures, as well as the daily activities that involve costs, are dictated by the income of the household. Thus household income is directly related to the socio-economic and recreational functions of the household.

Based on the data collected on household income, the households and residential study areas were divided into income groups for the purpose of analysis. Preliminary examinations were conducted on the individual households as well as the income range variations of all the households. Income groups were then compiled according to income ranges. The income class intervals were kept uniform in order to ensure error-free and easy unambiguous analysis. Five annual income groups were subsequently created and presented in ascending order of income from R 0-60000, R 60001-120000, R 120001-180000, R180001-240000, R240001-300000, R300001-360000, and R360001 and above.

The number of families in the various income groups is presented in Table 4-1. The table shows that the majority of the households surveyed (about 88%) have a general income of below R180000 per year. About 29% of the households are within the income range that is below R18000, followed by 32% of households in the income range less than R60000, and 27% of households between R60001 to R180000. Only 12% of households fall into each of the last two income groups: between R180001-R360000 and R360000 and above. Thus it can be seen that the majority of the households surveyed (88%) belong to lower income groups (< R180000); about 9% of households belong to the middle-income groups (R180001-R360000); while only a little more than 3% of the households belong to the high-income category. Differences in household income classes can also be noticed between the different residential areas. Batho and Lourier Park have a larger number of households in the low income category whereas Langenhovenpark has households that are more evenly spread across the income categories. Universitas has uniquely distributed income categories due to the high number of non-working students residing in the area.

4.2.2 Socio-Economic and Demographic Conditions of the Study Area

This section will focus on the general socio-economic background of the study area and its various demographic and socio-economic parameters. The selected parameters that are analyzed and discussed are employment, age, level of academic qualifications, occupations, different types of living arrangements, property ownership, transport modes, distance travelled to public parks by each household, number of visits to the public parks per household, expenditure on transportation and number of public parks users in the households.

4.2.2.1 General Socio-Economic Background of the Households Surveyed In the Study Area

Table 4-1 shows the socio-economic background of the four residential areas that were surveyed. The purpose of this analysis is to observe variations and patterns in the socio-economic parameters such as the number of households, the average number of vehicles per household, the average number of people per household, the number of property owners, the average commuting trips to public parks per household, and the average number of kilometres travelled by households to public parks under each income category.

Table 4-1: Socio-Economic Background of the Residential Areas

Income Per Annum	No. of House-Holds	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	-
Langenhovenpark						
R 0 - 60000	18 (36%)	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	3 (6%)	2	2	3	1	1km
R240001-R300000	3 (6%)	2	2	3	1	1km
R300001-R360000	3 (6%)	2	3	3	0	1km
> R360 000	2 (4%)	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	-

The table reveals that:

- The number of people per dwelling houses in higher income households tends to be higher than those in lower income households.
- The average number of vehicles per household for the four different areas varies. The higher income group have higher number of vehicles.
- All the households surveyed claim to travel 1km or less to a public park in their area, which is in line with the GIS data survey conducted in this study.
- Households with no vehicles are more inclined to visit public parks in their area.
- In all four residential areas higher income households tend to travel significantly less distance to visit to public parks than those of lower income. However, there is no clear relation between the number of property owners and the frequency of household visits to public parks.
- Similarly people in lower income groups visit public parks more frequently than people in higher income groups.
- There seems to be a relation between the average monthly distance travelled to public parks and the average monthly frequency of visits to public parks.

4.2.3 Age

The age of the population in any society determines the activeness, mobility, social ability and recreational tendencies of the people. Based on the household surveys of the four residential areas, public parks are being utilized by people of employment age just as frequently as people aged below 18 (Worpole, n.d.). Bearing this information in mind, the investigation sought to understand the age group of the various family members in the households of the study area. The outcomes are presented in Table 4-2.

Table 4-2: 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%**
Langenhovenpark	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%**
Average	**12%**	**11%**	**12%**	**12%**	**27%**	**18%**	**8%**	**100%**

From Table 4-2, it is found that about 57% of the population in the study areas fall in the age group of 19-60 years, 35% are in the of 0-18 years age group out of which 12% are infants (i.e. below 6 years), and only 8% are above 60 years of age. This indicates that the study area have a significant number of active population including children (6 to 18 years of age group) and elders (>60 years old) who can potentially use the public parks. Therefore, public parks need to be made more accessible to people of all age groups considering the importance of frequent recreational activities of people of all ages.

4.2.4 Population of Study Areas

As public parks are generally used by the people residing in the area of the public parks, the population of a residential area can give a proper indication of the potential number of users of the public parks in that area. It is therefore important to know the number of residents in each of the selected residential areas in order to see how it relates to the actual number of public parks users in these areas.

Table 4-3: Population of Study Areas

Residential Study Area	Male Population	Female Population	Total Population
Batho	3218	3376	6594
Langenhovenpark	5192	6176	11368
Lourier Park	1483	1694	3177
Universitas	4159	4198	8357

(Statistics South Africa, 2011)

Table 4-3 shows that Langenhovenpark has the highest number of residents whereas Lourier Park has much fewer residents. This can be attributed to the fact that Lourier Park is the youngest established residential area of the four selected areas. However, Universitas has a higher number of public parks than Langenhovenpark even though it has a slightly lower number of residents. This is due to some public parks in Langenhovenpark being rezoned for commercial and residential use. A comparative analysis of Table 4-2 and Table 4-3 revealed that the number of public parks per residential area is almost directly related to the number of residents per residential area.

4.2.5 Academic Qualifications

Education is a crucial requirement for development of human resources. Because it is a major determinant in the functions of a city, it is frequently utilized as a tool to measure the social and economic development of an area. In the study area in particular, education plays a major role in the development of these residential areas, therefore this investigation attempted to explore the academic development of residents in the study area. The academic qualifications and education levels of residents in the study area are presented in Table 4-4.

Table 4-4: 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 4-4 shows the educational background of most residents in different income range between R0 and R360000.00, which includes secondary school and people with an undergraduate degree. However, only a few households have post graduate and technical education. The majority of people in the income range above R360000 have an undergraduate or a post-graduate degree.

It is also revealed that about 34% of the people surveyed in the study areas have secondary school level qualification. It also shows that 28% of the people surveyed in these residential areas have an undergraduate degree, while 15% have a post-graduate degree and 24% are artisans or technicians. It is also noted that 81% of the individuals in the higher income bracket (more than R360000 per annum) have either an undergraduate or postgraduate degree. However, 69% of the people earning less than R60000 per annum have only a secondary school or technical qualification.

4.2.6 Dwelling Type

The type of dwelling is an indication of the background to the living conditions in the study area. This also reflects on the recreational restrictions a household may experience due to the amount of space available to them at their dwelling.

Table 4-5: 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%)
Langenhovenpark	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%)
TOTAL	113 (57%)	8 (4%)	16 (8%)	3 (2%)	22 (11%)	38 (19%)	200 (100%)

From Table 4-5, it can be observed that the majority of dwellings in the study areas (57%) are houses, followed by informal settlements (19%) while the remainder of the dwellings (24%) is flats, student houses, duplexes or townhouses. Houses are the preferred type of dwelling in all four selected residential areas.

4.2.7 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 of active people in the study area who can use public parks.
- The potential numbers of public park users are larger among adults 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.
- Residential areas with a higher population do not necessarily have a higher number of public park users.

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

In order to establish the parameters affecting accessibility to public parks, a total of 14 public parks were physically surveyed which included 4 public parks in Universitas, 4 public parks in Langenhovenpark, 3 public parks in Batho and 3 public parks in Lourier Park. Table 4-6 shows the different attributes of the public parks such as the coordinates, area, service area, and population of each selected public parks as well as average number of monthly users that obtained from the video surveillance data.

Table 4-6: 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
Langenhovenpark					
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

4.3.1 Area of Public Parks in Study Areas

By using GIS software and data obtained from the municipality, the area of each public park in Bloemfontein was established. Knowledge of the area of each public park is important in the development of the model. The different physical areas of the public parks in the study areas are presented in Table 4.6. It is observed that the size of public parks varies between 0.002 km^2 (minimum) to 0.241 km^2 (maximum). The size of the majority of the parks ranges between 0.006 km^2 and 0.016 km^2. However, some of the parks are of a little larger size and ranges between 0.033 km^2 to 0.054 km^2. This indicated that the size of parks in the residential areas varies from small to larger ones. However majority of them have relatively similar sizes that varies between 0.006 km^2 to 0.016 km^2.

4.3.2 Service Area of Public Parks in Study Areas

Each public park is meant to be accessible to residential homes that are situated within a certain radius from that public park. By making use of GIS software, the service area of each public park in the study area was measured and tabulated (Table 4-6). The boundary lines of each service area were determined by drawing lines equal in distance from the congruent public parks. The population of each service area was also established from census data and is presented in Table 4-6. As observed from Table 4-6, the service area of public parks varies between 0.12 km^2 (minimum) to 0.78 km^2 (maximum). However most of the parks have a service area that ranges between 0.19 km^2 to 0.40 km^2. Thus, it is observed that public parks are well-spaced all across residential areas.

4.4 ACCESSIBILITY PARAMETERS TO PUBLIC PARKS IN STUDY AREAS

There are various physical conditions which influence the commuting accessibility of public parks for users. Potential public parks users will be deterred from using public parks if the journey towards the public parks poses too much discomfort due to physical obstructions. Accessibility parameters to public parks consists of both parameters that are leading towards the public parks (number of access streets leading towards the public park, pavement infrastructure and conditions, sidewalk infrastructure and condition, traffic, etc.) as well as parameters situated within the public park itself (fences, number of access points to the public park, physical barricades at entrance points, maintenance condition of public park, etc.).

4.4.1 Road and Pavement Conditions

Most public parks users commute on foot from their homes to public parks. It is therefore important to analyze the road and pavement conditions that pedestrians will make use of when commuting to public parks. Table 4-7 shows the various determinants observed when analyzing the road and pavement conditions of the public parks in the study areas.

Table 4-7: Road and Pavement Conditions

Public Park Reference Number	Service Area Pavement Network Length (meters)	Road Network To Pavement Network Ratio (%)	Average Lane Widths (meters)	Average Pavement Width (meters)	Road Lane Condition*	Pedestrian Pavement 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

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

Table 4-8 Qualitative Condition of Road Condition And Pedestrian Pavements Condition Leading To Public Parks

Condition	Road condition		Pedestrian pavement condition	
	Share leading to public parks		Share leading to public parks	
	Number	%	Number	%
Very Bad	1	7.1	0	0
Bad	1	7.1	5	35.8
Acceptable	1	7.1	9	64.2
Good	11	78.7	0	0
Very good	0	0	0	0
Total	14	100	14	100

Figure 4-1: Obstructed Pavement Network (Google Earth, 2013)

The service area pavement network length was measured by using GIS software and is shown in Table 4-7. It was necessary to measure the pavement network length in order to establish the road network to pavement network ratio. It is observed that the road network and pavement network ratio varies between 83% and 95% in the study area. This means that pavements are available along the majority of the roads leading to the public parks. However, the major challenge observed is the obstructions on the pavements. Pedestrians are expected to commute to public parks on the pavement network instead of on the road reserved for vehicles. However, this is often not the case due to the pavement network being obstructed for various reasons such as home owners building right up against the road or plants and rocks being in the way. Often pedestrians are forced to commute on the road due to unavailable space on the pavement. Figure 4-1 shows an example of how the pavement network in the study area is obstructed. In Table 4-7 it can be seen that as much as 17% of the pavement network in a public parks service area is obstructed and unnavigable. It is also found that all the pavement networks leading to public parks in the study areas are 5% or more obstructed, which means that pedestrians commuting to public parks in the study areas are not able to remain on the pavement without having to go into the adjacent road at some stage of their journey.

The average pavement width and road lane width were also measured using GIS software. From Table 4-7 it can be observed that all the road lane widths (varying between 3.6m and 4.8m) are sufficient for vehicular movement in both directions, yet they pose danger in situations where the road is shared with vehicles from both direction and pedestrians. The pavement widths in the service areas are also sufficient (varying between 3.0 m and 3.5 m) for pedestrians to commute on, provided that the pavements are not obstructed.

A rating system was employed to summarize the road and pavement conditions in the service areas of public parks. This rating system was based on the frequency of the road or pavement being in a state of deterioration as well as the frequency of the road or pavement being obstructed to pedestrians. Table 4-7 show these ratings where: 1 = Very Bad; 2 = Bad; 3 = Acceptable; 4 = Good; and 5 = Very Good. From the Table 4.8, it is observed that none of the roads in the service areas was in a very good condition, yet most of them (78.7%) are in a good condition and 7.1% are in acceptable condition. However, about 14.2% of roads are in a bad or very bad state. The pedestrian pavement conditions in the service areas are found to be varying between being acceptable and bad. About 64.2% pedestrian pavements are in acceptable condition and about 35.8% of the pavements are in a bad condition.

4.4.2 Pedestrian and Vehicular Access to Public Parks in Study Area

Although most public parks users prefer to walk instead of drive to public parks, they are still required to facilitate vehicle access for groups coming from further away, or people that prefer to drive to public parks instead of walking. The condition and design of vehicular access to public parks need to be assessed and analyzed to determine its influence on accessibility public parks. Table 4-9 presents the current type of parking found at the public parks in the study areas, the number of parking spaces available at each public park, and the type of access the park provides for users.

Table 4-9 Pedestrian and Vehicular 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

** **(1=gated with limited access points; 2=one-sided access;**

3= two-sided access; 4= three-sided access; 5=all-round access

Table 4-10 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	14.3	On street	9	64.3
One-sided access	3	21.4	Designated off street	1	7.1
Two-sided access	3	21.4	Both	4	28.6
Three-sided access	2	14.3	Total	14	100
All-round access	4	28.6			
Total	14	100			

Table 4-10 shows that most public parks (64.3%) only allow for vehicles to park in the street. However, about 28.6% of the public parks have both on street and off street parking facilities. 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 types of physical entrance. Table 4-9 shows that the type of entrance access to the public parks in the study areas varies from one-sided, two-sided, three-sided, four-sided, and gated access. It is observed that about 28.6% of the parks have all-round access, about 42.8% of the public parks have either one-sided (21.4%) or two-sided access (21.4%), about 14.3% of the public parks have three-sided access, and 14.3% of the parks have limited access. Thus it is found that majority of parks (71.8%) have access from more than two sides.

4.4.3 Commuting Access to Public Parks in Study Areas

Since most users of the public parks in the study areas prefer to walk instead of drive to the public parks, an evaluation on the average travelling time, longest and shortest sight distance of commuter to public parks, and the number of access streets leading into the public parks was necessary. Table 4-11 summarizes the findings of this evaluation.

Table 4-11: 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

The average travel time was calculated by measuring the average travel distance of a commuter to the public parks and then calculating it from the average walking speed of a person. Table 4-11 shows that the average person does not take longer than 13 minutes to commute from his residence to public parks with a minimum travel time of about 4 minutes. However, the travel time to most of the public parks varies between 6 to 9 minutes on an average.

The longest sight distance is determined by measuring the longest distance from which a person commuting to a public park would have a clear line of sight of the public park. The shortest sight distance to a public park refers to the shortest line of sight that a person would have when standing outside his residence. Table 4-11 shows that there is a public park that can be seen from a distance as far as 704 meters, whereas another public park is only visible from a distance of 98 meters. However, the longest sight distance for majority of the public parks ranges from 150m to 400m. Similarly, the shortest sight distance ranges from 7m to 50m. This indicates that most of the parks are visually accessible from a fairly long distance.

The number of streets that leads into a public parks ranges from a minimum of 2 to a maximum of 9 access streets. A close examination of Table 4-11 shows that about 36% of the public parks are connected by 4 access streets followed by 21.5% of parks that are connected by 5 access streets. Similarly, 21.5% of parks are accessed by 2 streets and 14% of the parks are accessed by 3 streets. However, only 7% of the parks are accessed by 9 streets. Thus it is found that majority (78.5%) of public parks are accessed by more than 3 access streets. While comparing Table 4-11 with Table 4-6, it can be seen that the number of access streets leading into public parks has a clear influence on the number of monthly users of the public parks as the higher the number of access streets, the higher the number of users of the public parks.

4.4.4 Maintenance of Public Parks in Study Areas

It is important to evaluate the maintenance condition of the public parks in the study area, as it influences the symbolic, visual, and physical access of the public parks. Table 4-12 shows a qualitative description of the maintained condition of the public parks in the study areas.

Table 4-12: 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	3
LHPP1	3
LHPP2	4
LHPP3	3
LHPP4	4
LPP1	2
LPP2	2
LPP3	2
UP1	3
UP2	4
UP3	3
UP4	4

Table 4-13 Maintained Condition of Public Parks in Study Areas

Maintenance Condition of Public Parks	Number	%
Very bad	0	0
Bad	5	35.7
Acceptable	5	35.7
Good	4	28.6
Very good	0	0

The maintenance condition of public parks refers to its measure of usability in terms of mowed lawns, working playground apparatus and benches, and the condition of walkways and gardens. Tables 4-12 and 4-13 show that none of the public parks in the study areas are in a very good maintained state. About 28.6% of the public parks are found to be in a good maintained state, whereas the maintenance condition of another 35.7% of the public parks are acceptable. However, 35.7% of the public parks are not properly maintained. Thus it is concluded that although maintenance condition of the majority of the public parks are acceptable to good, a sizable number of parks are not properly maintained.

4.4.5 Illumination of Public Parks in the Study Areas

All possible determinants of accessibility to public parks in the study areas were meticulously investigated and the level of lighting was found to be a key determinant in improving or reducing accessibility to these public parks. Through household and physical surveys it was established that residents generally prefer to use public parks from late afternoons onwards to evenings.

Table 4-14 shows the illumination condition of the public parks in the evening hours, measured in Lumens (lux). The measurements were obtained by using the same light meters during the same time of the evening (6:30pm, October 2015) in all 14 public parks.

Table 4-14: 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

Table 4-14 shows that the highest level of light in public parks is 9.43 lux, which is similar to 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. Figure 4-2 shows a logarithmic scale of light intensity to give a better understanding of how low the light levels in the public parks of the study areas actually are.

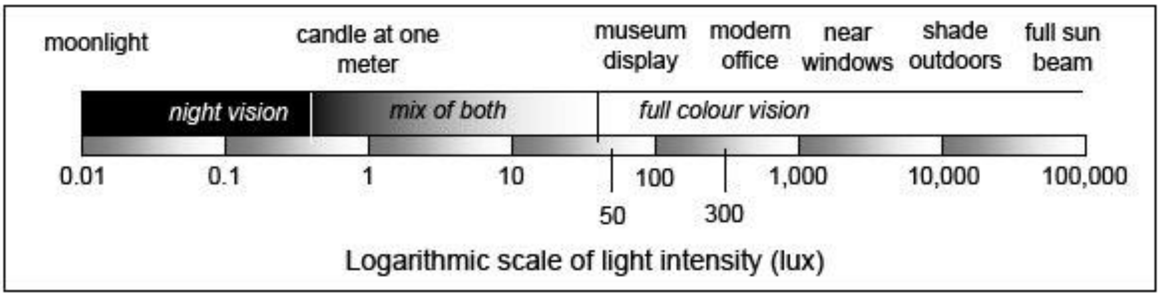

Figure 4-2: Logarithmic Scale of Light Intensity (lux) (Encyclopedia of Occupational Health and Safety, n.d.)

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

4.4.6 Available Playground Facilities at the Public Parks in the Study Areas

Because playground facilities in public parks provide a symbolic access for potential users, the presence of playgrounds in the selected public parks was assessed.

Table 4-15: 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

Note: Y= Yes; N=No

Table 4-16 Summary of Public Parks Equipped With Playgrounds

Availability Of Play Grounds In Public Parks	**Number**	**%**
Yes	8	57.14
No	6	42.86
Total	14	100

Table 4-16 shows that only 8 (57.14%) of the 14 public parks have playgrounds. However, while comparing Table 4-6 with Table 4-15, it is observed that no real linkage can be established between the average number users of public parks and the presence or absence of playgrounds.

4.4.7 Average Vehicle Speed around Public Parks in the Study Areas

The physical access of pedestrians can be deterred by vehicles travelling at excessive speeds in the service area of the public parks. Table 4-17 indicates the average travelling speed of vehicles in each of the service areas of the selected public parks. The data were obtained by measuring the speed of vehicles commuting on the access roads of public parks during a full operational day and then calculating the average vehicle speed of each service area.

Table 4-17: 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

Table 4-18 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	42.86
Within speed limits	8	57.14
Total	14	100

Table 4-17 and 4-18 show that vehicles travel faster than the maximum speed limit (60 Km/h promulgated by the Mangaung Metro Municipality on about 42.86% of the roads passing near the public parks. However, the vehicles stay within the speed limits on about 57.14% of the roads near the public parks.

4.5 PERCEPTION OF PEOPLE ON FACTORS INFLUENCING USAGE OF PUBLIC PARKS

From the 208 household surveys that were conducted in the study areas, the investigator was able to summarise a list of index factors influencing the usability of public parks based on the perceptions of the users (Table 4.19).

Table 4-19 Factors Influencing Usability of Public Parks Based on Perceptions of People

Factors influencing usability of public parks	PI = (∑ NiXi)/N
Walk to public parks	0.99
Use 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

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

As shown in Table 4-19 people perceive walking to the public parks, safety, walking distance, visiting the parks in the afternoon or evening hours, illumination level of the parks, as the major factors which influence the use of parks in the residential areas of the study area. It was found that quality of parks, vehicular access, usage of parks in morning and mid-day, walking distance satisfaction (in terms of availability of safe and smooth walking facilities like walking tracks) and entry fees, are the factors which influence the usability of parks to a lesser extent.

1.5.1.1 Walk to Public Parks, Walking Distance and Vehicular Uses

Walking to public parks (PI= 0.99) was found to be the most preferred way for users to access these public parks. People also perceive that the walking distance (PI= 0.69) fairly influences their decision to make use of these public parks. It is also found that vehicular use has the least (PI=0.01) influence on people's decision to make use of public parks. Since most of the parks in the residential areas are located within 1 to 2 km from every potential user's house as well as the maximum walking time being about 13 minutes, most people prefer to walk to the parks.

4.1.1.2 Level of Safety in Public Parks

It is found that people perceive safety as a very important factor which influences use of parks in the study area. Table 4.19 shows that users perceive that the lack of safety in public parks (PI= 0.80) as one of the most important reasons for not making use of the public parks. Although it is necessary to note the importance of safety at public parks, this investigation only focussed on the accessibility aspects to public parks and safety issues are kept out of the scope of the investigation.

4.1.1.3 Preferred Time of Day when Accessing Public Parks

According to the surveyed people's perception, afternoons and evenings (5pm-8pm) (PI= 0.75) are the most preferred period of the day to make use of public parks. Some people prefer morning hours (PI=0.20). Mid-day periods (PI= 0.05) are the least preferred times to visit parks in the study area (Table 4-19).

4.1.1.4 Perceptions of Park Illumination Levels for Evening Users

Since the evening and afternoon hours are the most preferred time for users to go to public parks, it was important to investigate the influence that lighting levels have on users accessing the public parks in the evenings. As shown in Table 4-19, most users are influenced by the level of illumination in the public parks (PI=0.62). Insufficient illumination of public parks during evening hours when users still want to be in the public parks can be deemed as an accessibility factor.

4.1.1.5 Perception of Users Having to Pay to Access Public Parks

As shown in Table 4-19, it is very clear that all the people surveyed, entry fees is the least influential factor due to most of the parks being accessible for free. However, it is also found that people prefer not to pay an entrance fee in order to access a public park.

4.6 PREDICTION OF THE NUMBER OF PUBLIC PARK USERS

Usability of a public park is determined by the number of user of the park. The usability of the parks is influenced by many socio-economic, physical and infrastructural factors. However, accessibility is one of the major determinant factors because the number of potential users of public parks is directly affected by the level of accessibility users have towards the public parks they wish to visit. As discussed in the literature review, it is clear that there are many determinants that influence the level of accessibility to public parks. These determinants can be categorized into visual, physical, and symbolic accessibility. The average number of users can be affected by determinants from any of the three categories of accessibility. Therefore, it is necessary to delineate the most influential control parameters and variables, which would influence the usability of the public parks and then develop a model to simulate various scenarios that would assist in evolving suitable policy interventions for higher usability of the public parks.

The following sections deal with the delineation of the major control parameters and variables which influence the usability 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. For this purpose, various statistical techniques, such as correlation coefficients, Variance Inverse Factors (VIF) test and significance tests were conducted 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 number of users of the public parks in the study area. For this purpose, the average number of users of public parks per month was considered as the measured dependent variable of the usability of the parks.

1.6.1 **Current Usability of the Public Parks Surveyed**

As mentioned in the section 1.6 the usability of the public parks is measured by the number of users of the parks (in the present context of the study average monthly user of the public parks is used as the proxy for usability of the parks). The data about the number of users in the different public parks surveyed in the current scenario were collected through use of continuous time lapse videos (c.f. section 1.6.2). For the purpose cameras were installed in each selected public parks and videos were recorded during the same season to ensure that all the parameters affecting accessibility can be related and compared. Adequate care was taken in obtaining the actual average number of monthly users at each public park as these values are crucial to the successful delineation of control variables influencing the usability and formulation of the models. However, the seasonal variations have not been considered as the study area does not experience any extreme weather conditions that would influence the usage of public parks by the residents. The average number of monthly users obtained from the video surveillance data is presented in Table 4-20.

It is observed that the average number of users of public parks in the study area range from a minimum of 13 users per month to a maximum of 882 users per month with an average of 234 users per month. However, 50% of the parks recorded number of users that ranges between 134 and 294 users per month and about 14.3% of the public parks have more than 700 users per month. However about 35.7% of the parks have users less than 50 users per month, which is observed to be very low (Table 4-21).

Table 4-20 Average Number Users of Public Parks in the Selected Study Areas

Public Park Reference Number	Average Users Per Month
BP1	706
BP2	206
BP3	134
LHPP1	294
LHPP2	168
LHPP3	34
LHPP4	34
LPP1	882
LPP2	147
LPP3	294
UP1	34
UP2	294
UP3	13
UP4	38
Average	**234**

Table 4-21 A Share of Public Parks for Different Range Of Users

Range Of Number Of Users	Share Of Public Parks In The Study Area
0-100	35.7.0%
101-300	50.0%
>300	14.3%

1.6.2 Correlation Coefficients

The correlation coefficient was used to analyse the parameters, which have a significant influence on the level of accessibility to public parks in the study area. The data collected from the surveys 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 monthly users of each public park in the study area were considered as the dependent variable and the various parameters related to accessibility were considered as independent variables. The accessibility parameters considered as independent variables include average travel distance in service area (meter), service area pavement network length (meter) to service area road network length (meter) ratio, average lane widths (meter), average pavement width (meter), parking type, number of parking spaces, road lane condition, pedestrian pavement condition, park access type, average vehicle speed (km/hour), presence of playgrounds, maintenance condition of public parks, area of public parks (km^2), service area of public parks (km^2), population in service area; average travel time (minutes), longest sight distance to public parks (meter), shortest sight distance (meter), illumination levels of public parks (in evenings/at night) (lux), number of access streets into park, and road network to pavement network ratio (%). The correlations between the dependent variable i.e., average number monthly users of each public park in the study areas and various independent variables were established and presented below. Furthermore, in order to check the mutual exclusiveness and significance of the independent variables, Variance Inverse Factor (VIF) tests were conducted. The variables with a significant correlation coefficient, which influence the average number monthly users of each public park in the study areas were chosen as the control variables and employed for further analysis and model development. The correlation coefficient between the variables is presented in Table 4-22.

Table 4-23 presents only those variables with the most significant correlation coefficients, as the variables having lower or insignificant correlation coefficients were ignored for further analysis. The average number of public parks users per month in the study areas correlates highly with the following parameters listed in descending order of correlation: the road network to pavement network ratio (%) (0.76), the number of access streets into park (0.61), the area (size) of the park (m^2) (0.55), and illumination of the park in evenings/at night (0.79).

Table 4-22 Correlation Coefficients between Average Number of Public Park Users and Accessibility Variables

	Average Number Users Per Month	**Pavement to Road Network Ratio (%)**	**Number of Access Streets Into Park**	**Number of Access Streets Into Park**	***Area of Park (m^2)***	***Longest Sight Distance (meter)***	***Light of Park In Evenings Measured In Lumens (lux)***
Average # Users Per Month	1.00						
Pavement To Road Network Ratio (%)	0.76	1.00					
Average Pavement Width (m)	0.55	0.73	1.00				
Number of Access Streets Into Park	0.61	0.29	0.17	1.00			
Area of Park (m^2)	0.69	0.40	0.38	0.16	1.00		
Longest Sight Distance (meter)	0.91	0.69	0.65	0.48	0.74	1.00	
Light of Park In Evenings Measured in Lumens (lux)	0.79	0.64	0.51	0.52	0.31	0.75	1.00

Table 4-23 Variables with the Most Significant Correlation Coefficients

Independent Variables	Pavement Network to Road Network Ratio (%)	Number of Access Streets Into Park	Area (Size) of Park (M^2)	Illumination of Park In Evenings/At Night Measured In Lumens (lux)
Average Number Users Per Month	0.76	0.61	0.69	0.79

The high correlation coefficient (0.79) between the illumination of the park at night and the average number of public parks users per month supports the premise that the higher the illumination levels of the public parks, the higher will be the average number monthly users of those public parks. The high correlation between the average number public parks users per month and the pavement network to road network ratio (0.76) means that the more complete the pavement network in the service areas, the higher will be the average number of public parks users per month. Though variables such as number of access streets into park (0.61) and area (size) of park (0.69) have relatively lower correlation coefficients with the average number of public parks users per month, they are also significant (>0.6), and thus influence the average number public parks users per month in the study area. Variables with very insignificant correlation coefficients (<0.5), such as the average pavement widths, number of parking spaces, pavement condition and maintained condition of the public parks were not considered as major control variables for the influencing the users to visit the public parks (see Appendix G). Although the longest sight distance towards public parks has a higher correlation coefficient (0.9), it is largely dependent on the size of public parks indicating its co-linearity with the area (size) of public parks, so it was not considered as an independent variable for further analysis. Furthermore, VIF test results (Table 4-25) presents the interdependency among the independent variables. It is observed that all the independent variables considered such as road network to pavement network ratio (%); the number of access streets into the park; the area/size of the park (m^2) and illumination of the park at night are fairly independent and mutually exclusive of each other as the VIF factors between the independent variables are found to be 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 road network to pavement network ratio (%); the number of access streets into the park; the area/size of the park (m^2) and illumination of the park at night.

Table 4-24 Variance Inverse Factors (VIF) Test Results on Selected Variables

	Public Park Reference Number	Road Network To Pavement Network Ratio	Number Of Access Streets Into Park	Area Of Park	Illumination Of Park In Evenings Measured
Public Park Reference Number	23.11	-7.17	-6.80	-9.85	-7.14
Pavement Network to Road Network Ratio	-7.17	4.07	2.21	2.65	1.11
Number of Access Streets into Park	-6.80	2.21	3.38	2.88	1.32
Area of Park	-9.85	2.65	2.88	5.39	2.94
Illumination of Park in Evenings	-7.14	1.11	1.32	2.94	4.36

4.7 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 month in the study area under varied scenarios Accordingly, regression models were developed by using the survey data and major control variables that influence the number of users of public parks in the study area. The models were used to develop various scenarios under different simulated conditions. Plausible policy guidelines were then evolved to enhance the usability of the public parks in the study area.

4.8 REGRESSION ANALYSIS OF VARIABLES

A regression analysis was conducted by using the selected variables to illustrate the significance of each variable and also to develop the model. Table 4-25 presents the regression statistics and ANOVA results of the tested variables.

Table 4-25 Regression Analysis of Selected Parameters

Regression Statistics	
Multiple R	0.98
R Square	0.96
Adjusted R Square	0.94
Standard Error	65.17
Observations	14

ANOVA

	df	*SS*	*MS*	*F*	*Sig-F*
Regression	4.00	845224.05	211306.01	49.75	3.86975 E-06
Residual	9.00	38229.66	4247.74		
Total	13.00	883453.71			

	Coeff	*Std.Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-1567.7877	407.6548	-3.8459	0.0039	-2489.96	-645.6	-2489.	-645.6
Road network to pavement network ratio	1584.8412	480.8371	3.2960	0.0093	497.112	2672.	497.1	2672
Number of access streets into park	42.6538	11.8123	3.6110	0.0057	15.9324	69.37	15.93	69.37
Area (Size) of park	0.0018	0.0003	5.6288	0.0003	0.0011	0.002	0.001	0.002
Illumination of park in evenings/at night?	34.9638	11.5060	3.0388	0.0140	8.9355	60.99	8.935	60.99

Table 4-25 shows that all the variables have a p value below 0.05 (for $\alpha < 0.5$) and a r square of 0.96, which indicates that all the independent variables are statistically significant, there is no co-linearity among them and are independent of each other. Thus, they can be used for development of a multiple regression model to predict the number of users.

4.8.1 Influence of Control Variables on the Usability of Public Parks

Each selected variable was individually analysed with the dependent variable (number of users) in a regression analysis to understand the level of influence each variable on the number of users of public parks in the study area.

4.8.1.1 Influence of Pavement Network to Road Network Ratio on the Number of Users of Public Parks in the Study Areas

Figure 4-3 shows the relation between the pavement network to road network ratio and the average number monthly users of the public parks in the study areas. The relationship is presented in the equation 1 (Eq.1).

y_1=0.0001x_1+0.8637 ……………………………Eq. 1

r^2 =0.58

p=0.0093

y_1 = Number of public park users per month

x_1 = Pavement network to road network ratio

Equation 1 reveals that the average number of monthly users increases considerably along with improvement in the pavement network. For instance, it is found that with 5% enhancement of pavement network to road network ratio, an increase of 79 users per month to public parks can be observed

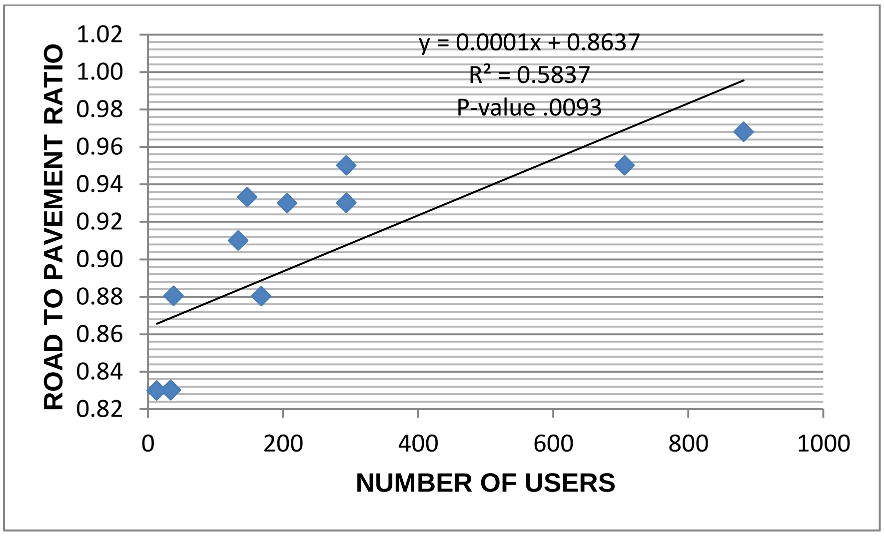

Figure 4-3: Influence of Pavement Network to Road Network Ratio on the Number of Users of Public Parks

4.8.1.2 Influence of the Number of Access Streets Leading into the Public Parks in the Study Areas

Figure 4-4 shows the relationship between the number of access streets leading to the public parks and the average number monthly users of the public parks in the study areas. The relationship is presented in the equation 2 (Eq.2).

$y_1=0.0042x_2+3.0098$ ……………………………Eq. 2

$r^2 =0.38$

$p=0.0057$

y_1 = Number of public park users per month

x_2 = number of access streets

The relation posits that the average number of monthly users also increases along with an increase in the number of access streets leading towards the public parks. It was found that the increase of one accessible street, will cause an increase of 42 users per month in the public parks of the study area

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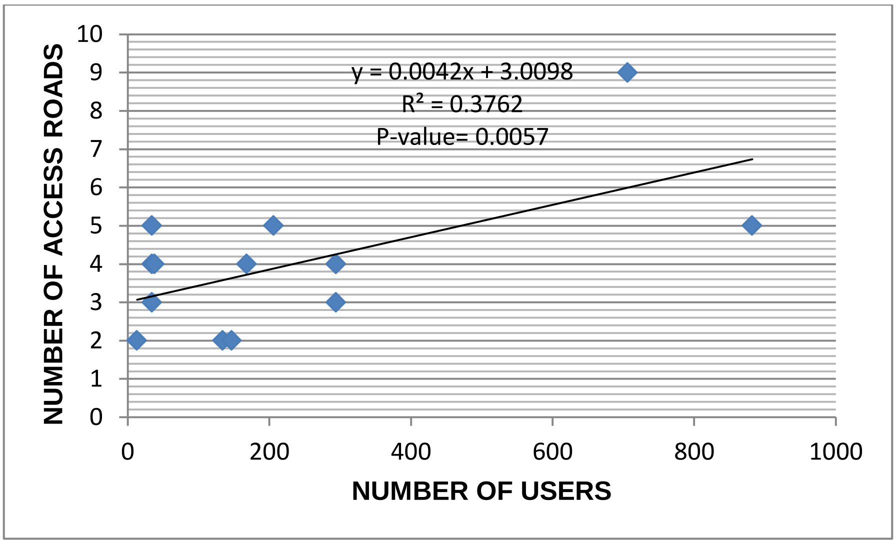


Figure 4-4: Influence of the Number of Access Streets Leading to the Public Parks on the Number of Users of Public Parks

4.8.1.3 Influence of the Area (Size) of the Public Park in the Study Areas

Figure 4-5 shows the relationship between the area (size) of the public parks and the average number monthly users of the public parks in the study areas. The relationship is presented in the equation 3 (Eq.3).

$y_1=165.75x_3-5523.7$ ……………………………Eq.3

Eq.3

$r^2 =0.48$

$p=0.0003$

y_1 = Number of public park users per month

x_3 = Area of parks in m²

It is observed that an increase of about 9 monthly users will be observed with every increase of a 1000 m² of the area of the public parks, which may seem to be meagre. This indicates that an increase in the area of public parks may not necessarily increase the number of users significantly.

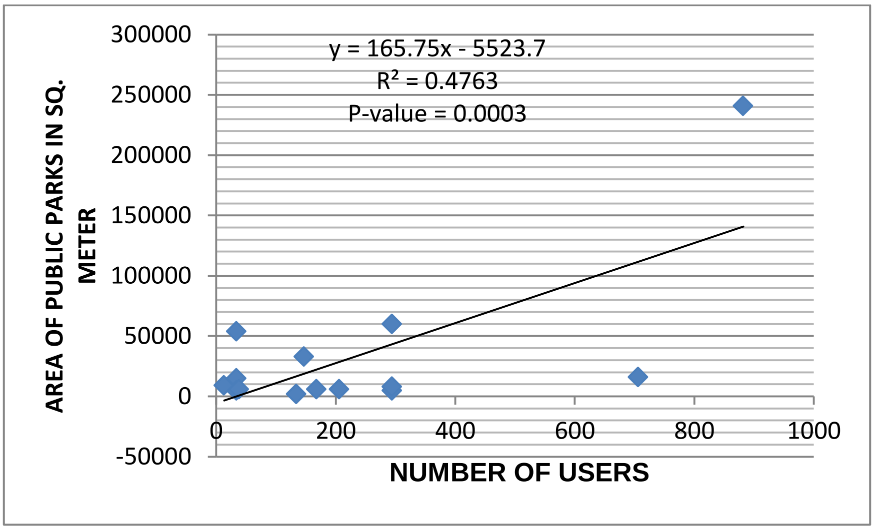


Figure 4-5: Influence of the Area (Size) of the Public Park on Number of Users of Public Parks

4.8.1.4 Influence of the Level of Evening Illumination of Public Parks in the Study Areas

Figure 4-6 shows the relationship between the illumination levels in the evenings and the average number of monthly users of the public parks in the study areas. The relationship is presented in the equation 4 (Eq.4).

y_1=0.007x_4+ 2.5905 ……………………………Eq. 4

Eq.4

r^2 =0.63

p=0.014

y_1 = Number of public park users per month

x_4 = Illumination level in parks in lux

The relationship proves that the average number of monthly users also increases along with an increase in the level of evening illumination of the public parks. As found out with increase in 1 lux in illumination level in the parks, an increase of 35 users can be experienced.

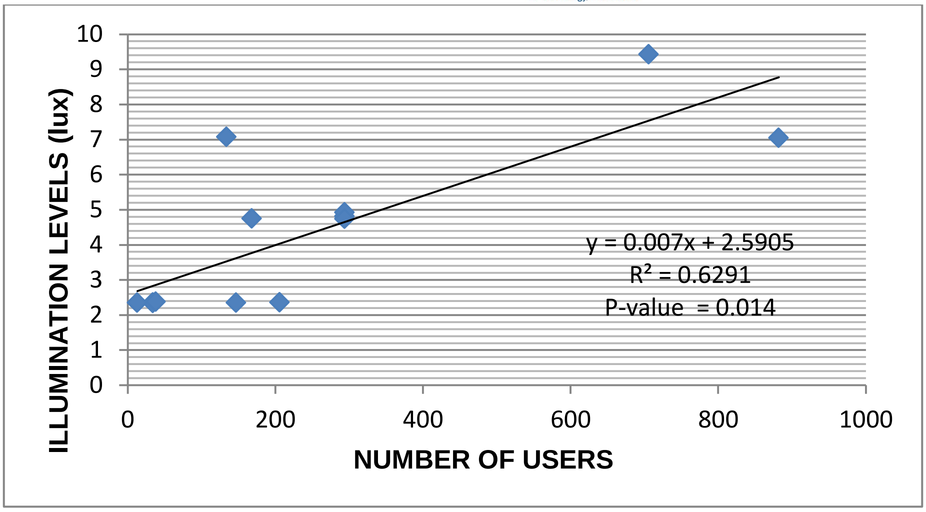


Figure 4-6: Influence of the Level of Evening Illumination of Public Parks on the Number of Users of Public Parks

4.9 MODELLING FOR PREDICTION OF AVERAGE NUMBER USERS OF PUBLIC PARKS IN THE STUDY AREAS

By considering the major control parameters influencing the average number monthly users of the public parks in the study areas, an attempt was made to develop a model which would be able to predict the average number monthly users of the public parks in the study areas under varied conditions. Accordingly, a close examination of the various available modelling approaches (literature review section 2.5) was done. Having examined the available data, the various major control parameters influencing accessibility and the consequent applicability of the various models for the prediction monthly 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 monthly 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 were evolved to increase the number of monthly public park users and to improve the accessibility of public parks in the study area.

4.10 MULTIPLE REGRESSION MODEL

A multiple regression model was established by considering the average number monthly users of the public parks in the study areas as the dependent variable and the most influential independent variables such as the road network to pavement network ratio, the number of access streets leading into the public park, the area (size) of the public parks, and illumination levels of the public parks in the evenings. The values of the road network to pavement network ratio were calculated as decimals; the area of the public parks was considered in square meters; and illumination levels of the public parks in the evenings were measured in lumens (lux). All the public parks having an average number of monthly users and the related parameters observed from physical surveys were utilised for the development of the model. The model was built by using SPSS software. The functional equation for the multiple regression model is presented as follows

$$y = f(x_1, x_2, x_3, \ldots x_n)$$

$$\text{or} \quad y = \alpha x_1+\beta x_2+\gamma x_3+\delta x_4+\ldots+\zeta x_n+\varepsilon$$

Where

y = dependent variable

$x_1, x_2, x_3, \ldots x_n$ are independent variables.

$\alpha, \beta, \gamma, \delta, \ldots \zeta$ are regression coefficients

ε = the standard error

Based on the functional equation, the multiple regression model established is given in equation 5. The regression variables of the model are presented in Table 4-6.

$$y = 1584.8412\, x_1 + 42.6538\, x_2 + 0.0018\, x_3 + 34.9638\, x_4 - 1567.7877 \qquad \ldots\text{Eq. 5}$$

Where:

y = Average number of users per month

x_1 = Pavement network to road network ratio (%)

x_2 = Number of access streets into park

x_3 = Area of park (m^2)

x_4 = Level of light in the park during evenings, measured in lumens (lux)

$r^2 = 0.96$

Table 4-26 Regression Variables

Regression variables		
r^2 =		0.96
Adjusted r^2		0.98
F		*49.75 >(Critical F value 3.63) for α<0.05*
df		*13*
t Stat	*P*-value*	*P**-value*
-3.8459	0.0039	0.0078
3.2960	0.0093	0.0186
3.6110	0.0057	0.0114
5.6288	0.0003	0.0006
3.0388	0.0140	0.028

Note: *single tailed; ** two tailed

4.10.1 Validation of the Model

Before employing the established model for future predictions and scenario analyses, its suitability and correctness was validated. 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 α <0.05). Extra 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 which were not considered in the survey and subsequent analysis with the actual number of users (obtained from physical survey).

The regression variables (Table 4-26) show that the actual F-value found from the regression analysis (49.75) is much higher that the critical F value (3.63). Both the single and two tailed p-values are less than 0.05 for α <0.05 indicating the validity and correctness of the model.

A close examination of the compared results between actual users and simulated users in three different parks revealed that the results vary between a range of only 7.04% and 8.33% (Table 4-27, Figure 4-7), thereby validating the applicability of the model for the prediction number of users of public parks under different scenarios.

Table 4-27 Validation of Model

Public Park	**Coordinates**	**x_1**	**x_2**	**x_3**	**x_4**	**Actual number of users**	**Simulated number of user**	**Variations (%)**
Van Rooy Avenue	29.07.29.25 S 26.10.50.86 E	0.85	6	9000	4.79	156	145	7.05
Anna M Louw St	29.06.11.83 S 26.09.39.03 E	0.87	3	16000	3.42	81	87	7.4
Welwitchia Road	29.10.45.60 S 26.10.46.27 E	0.91	3	11730	2.01	72	78	8.33

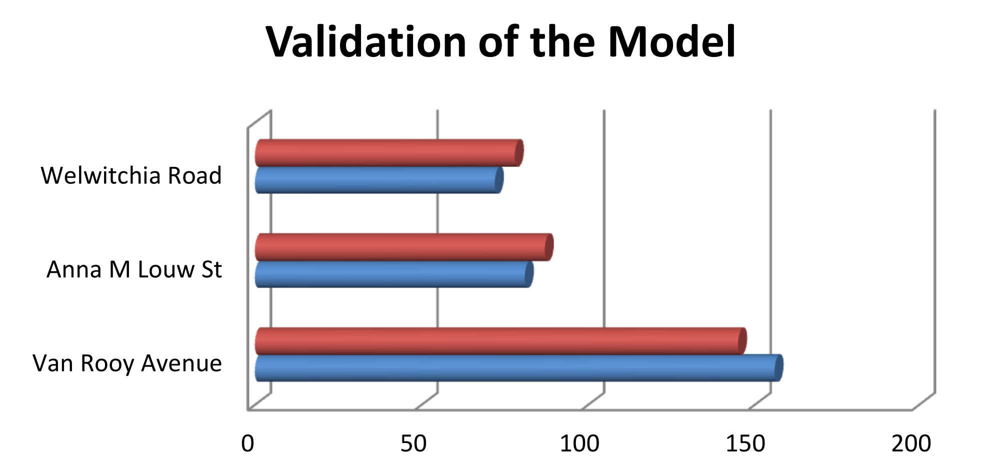
Where:

x_1 = Pavement network to road network ratio (%)

x_2 = Number of access streets into park

x_3 = Area of park (m²)

x_4 = Level of light in the park during evenings, measured in lumens (lux)



	Van Rooy Avenue	Anna M Louw St	Welwitchia Road
Simulated	145	87	78
Current	156	81	72

Figure 4-7 Validation of Model

4.10.2 Forecasting Of the Average Number Monthly Users of Public Parks

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

4.11 SIMULATIONS

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

- Pavement network to road network ratio (%)
- Number of access streets to public parks
- Area (Size) of public parks (m²)
- Level of illumination in the park during evenings, measured in lumens (lux)

The simulation of conditions and the variation in independent variables forming the prediction of the average number monthly users of public parks are presented in the Table 4-28.

Table 4-28 Simulation Conditions for Prediction the Average Number Monthly Users of Public Parks in the Study Area

No.	Simulation conditions of variables	Variation in conditions
1	Pavement network to Road network ratio (%)	Varied from a minimum of 0.50 to a maximum of 1.0 at every 0.05 increment
2	Number of access streets to public parks	Varied from a minimum of 1.0 to a maximum of 10 at every one increment
3	Area/Size of public park (m^2)	Varied from a minimum of 1500m^2 to a maximum of 50000m^2 at every 500m^2 increment
4	Level of illumination in the public parks during evenings, measured in lumens (lux)	Varied from a minimum of 1.0 lux to a maximum of 20 lux with an increment of 1 lux per simulation

A number of simulation runs were conducted by considering the variables individually and in combination with one another (presented in appendix E). From the total number of 250 simulated scenarios developed the 15 most important and feasible scenarios (Table 4-28) were considered and discussed for the development of strategies to improve accessibility to public parks and increase the average number monthly users of public parks. In the first stage of simulation every variable is considered and analysed separately to determine its individual impact. The next stage consists of combining variables (simultaneous changes to multiple variables in a planned sequence). This sequence starts by considering two variables, then three, then finally all four variables respectively in that order. When single or multiple parameters are changed for the purpose of the simulation, the remainder of parameters are kept on their average values. Appendix E illustrates the different simulations that were conducted. All the simulations were evaluated and the most feasible scenarios (Table 4-29) were considered for policy analysis.

Table 4-29 Plausible Simulated Policy Scenarios

Scenarios	Simulation Number	Average Number Users Per Month	Pavement Network to Road Network Ratio (%)	Number of Access Streets Into Park	Area of Park (m²)	Illumination of Park In Evenings Measured In Lumens (lux)	Increase in Park Users from Average Number of Users (%).
	AVERAGE	**235**	**0.90**	**4**	**33000**	**4.232**	
1	11	396	1.00	4	33000	4.232	68.51
2	16	493	0.90	10	33000	4.232	109.79
3	119	267	0.90	4	50000	4.232	13.62
4	139	788	0.90	4	33000	20	235.32
5	151	651	1.00	10	33286	4.232	177.02
6	162	426	1.00	4	50000	4.232	81.28
7	173	947	1.00	4	33000	20	302.98
8	183	523	0.90	10	50000	4.232	122.55
9	193	1044	0.90	10	33000	20	344.26
10	205	818	0.90	4	50000	20	248.09
11	216	682	1.00	10	50000	4	190.21
12	227	1012	1.00	4	50000	20	330.64
13	249	1203	1.00	10	33000	20	411.91
14	238	1109	0.90	10	50000	20	371.91
15	140	1233	1.00	10	50000	20	424.68

Table 4-29 illustrates that by altering the independent variables, the expected average number monthly users of a public park can be increased from 235 to 1233 (and increase of about 424.68%), which is a quite significant. It can also be clearly seen that the level of illumination in the park during evenings is the most influential independent variable which can increase the average number monthly users by up to 235.32% without altering any other variables. All 15 scenarios are compared and shown in Figure 4-8.

4.11.1 Scenario 1 (Pavement network to road network ratio increased to 1.0)

In scenario 1, only the road network to pavement network ratio is increase to 1.0 (100%). That means the all the roads are accompanied by adequate pavements. It is revealed that the potential number of monthly users would increase significantly (68.51%) from the current scenario (235 users to 396 users). This indicates that pavement networks in the service areas of public parks have an importance role to play in enhancing the usability of the parks.

4.11.2 Scenario 2 (Number of access streets leading into the public park increased to 10)

In scenario 2, only the number of access streets leading to the public park is altered to 10 from the current scenario. By altering this variable only, the potential number of monthly users is increased from the current average users of 235 numbers to 493 users indicating an embankment of about 109.79%. This significant increase indicates the importance of access streets leading towards public parks. Though it is not always possible to have more access streets to public parks, it is obvious that potential users will be more inclined to go to a public parks if there were more streets running along their residential homes that lead to the public parks.

4.11.3 Scenario 3 (Area of the public parks is enhanced to 50000m²)

In scenario 3, only the size of the public parks is altered to 50000m² from its current average size. By altering this variable only, the potential number monthly users are increased by 13.62% (from current users of 235 to predicted users of 267). This may not seem as a significant increase, but increasing the size of the public parks contributes to the possibility of increasing other influential variables, such as sight distance and number of access streets leading towards the public parks.

4.11.4 Scenario 4 (Level of illumination in the park during evenings is altered to a level of 20 lux)

In scenario 4, only the level of light in the park during evenings measured in lumens (lux) is enhanced to a level of 20lux. By altering this variable only, the potential number monthly users are significantly increased (235.32%) from the current 235 users to 788 users. This increase indicates that the level of illumination in public parks is the most influential accessibility factor. As stated earlier in this investigation (4.5.4), we can see that most public park users prefer to go to the public parks during the evening hours, which explains why the illumination these public parks are so important.

4.11.5 Scenario 5 (Combination of pavement to road network ratio (1.0) and the number of access streets (10) leading to the public parks)

In scenario 5, the pavement to road network ratio and the number of access streets leading into the public parks are set at 1.0 (100%) and 10 respectively. By changing these two variables, the average number of monthly users increases from 235 to 651, which is a

177.02% increase. It shows that this scenario offers a useful scenario for new public park developments where new access streets and pavements are to be constructed.

4.11.6 Scenario 6 (Combination of pavement to road network ratio (1.0) and the area of the public parks is set at 50000m^2)

In scenario 6, the pavement to road network ratio and the area (size) of the public parks are set at the levels of 1.0 (100%) and 50000m^2 respectively. By changing these two variables, the average number of monthly users increases from 235 to 426, which accounts to 81.28% increase. This indicates that adequate size of public parks and construction of pavement need to be considered while developing new public parks in the residential areas.

4.11.7 Scenario 7 (Combination of pavement to road network ratio (1.0) and the illumination of public parks in the evenings is set at 20 lux)

In scenario 7, the pavement to road network ratio and the illumination of public parks in the evenings (lux) are set at a levels of 1.0 (100%) and 20 lux respectively in combination. By changing these two variables, the average number of monthly users increases from 235 to 947, which is a 302.98% increase. Therefore it is observed that a combination of increase in pavement to road network ration along with increase in illumination level in parks would enhance the park users significantly.

4.11.8 Scenario 8 (Combination of number of access streets leading into the park (10) and the area of the park is set at 50000m^2)

In scenario 8, the number of access streets leading into the park and the area of the park are set on their optimum levels of 10 and 50000m^2 respectively in combination. By changing these two variables, the average number of monthly users increases from 235 to 523, which is about 122.55% increase. This signifies that for extra access streets and additional allocation of public park space can assist in encouraging more people to public parks.

4.11.9 Scenario 9 (Combination of number of access streets leading into the park (10) and the illumination of public parks in the evenings is set at 20 lux)

In scenario 9, the number of access streets leading into the park and the illumination of public parks in the evenings (lux) are set at 10 and 20 lux respectively in combination. This scenario shows that, the average number of monthly users' increases from 235 to 1044, which is a 444.26% increase. Therefore, it is construed that a combination of an increase in access streets and illumination level will enhance the park uses significantly.

4.11.10 Scenario 10 (Combination of increase of area of the park to 50000m^2 and the illumination level of public parks to 20 lux)

In scenario 10, the area of the park and the illumination of public parks in the evenings (lux) are set at levels of 50000m^2 and 20 lux respectively. This scenario reveals that the average number of monthly users increases from 235 to 818, which is about 348.09% enhancement. It shows that size of parks and illumination level in combination contributes significantly to the uses of parks.

4.11.11 Scenario 11 (Combination of pavement network to road network ratio (1.0), the area of the park (50000m^2), and the number of access streets (10))

In scenario 11, the pavement network to road network ratio, the area of the park, and the number of access streets are set at levels of 1.0 (100%), 50000m^2 and 10 respectively in combination. By changing these three variables, the average number of monthly users increases from 235 to 682, which is a 290.21% increase.

4.11.12 Scenario 12 (Combination of pavement network to road network ratio (1.0), the area of the park (50000m^2, and the illumination of public parks in the evenings (20 lux))

In scenario 12, the pavement network to road network ratio, the area of the park, and the illumination of public parks in the evenings (lux) are set at levels of 1.0 (100%), 50000m^2 and 20 lux respectively in combination. By changing these three variables, the average number of monthly users increases by 330.64% (from average 235 users to 1012 users), which is very significant. Therefore while improvement of parks are considered the above three parameters need to be considered together appropriately.

4.11.13 Scenario 13 (Combination of pavement network to road network ratio (1.0), the number of access streets (10), and the illumination of public parks in the evenings (20 lux))

In scenario 13, the pavement network to road network ratio, the number of access streets, and the illumination of public parks in the evenings (lux) are considered at levels of 1.0 (100%), 10 and 20 lux respectively in combination. This scenario will lead to an enhancement of about 411.91% (current average 235 users to 1203 users) of users of public parks, which is highly significant, which needs to be considered for planning of new public parks and improving of existing parks.

4.11.14 Scenario 14 (Combination of number of access streets (10), the area of the park (50000m^2), and the illumination of public parks in the evenings (20 lux))

In scenario 14, the number of access streets, the area of the park, and the illumination of public parks in the evenings (lux) are increased to levels of 10, 50000m^2 and 20 lux respectively in combination. Findings suggest that by improving these three variables, the average number of monthly users will increase by 371.91% (increases from current average users of 235 to 1109 users).

4.11.15 Scenario 15 (Combination of all four variables: pavement network to road network ratio (1.0), number of access streets (10), the area of the park (50000m^2), and the illumination of public parks in the evenings (20 lux))

In scenario 15, all four variables were considered in combination. The pavement network to road network ratio is taken at 1.0, number of access streets is set at 10, the area of the park is increased to 50000m^2, and the illumination of public parks in the evenings is taken at 20 lux. Under this scenario it is observed that, the number of uses will be enhanced from the current average number of users (235) to a predicted number of users of 1233, indicating an increase of 424.68%. This is highly significant and is the scenario deemed to deliver the most significant enchantment in users of public parks in the study area. Thus, Scenario 15 clearly shows the significant increase in the average number of monthly users a public park may experience if all four variables are set up to their optimum conditions.

4.12 HYPOTHESIS TESTING

From the validated regression model obtained, a test was done to prove if the hypothesis is either true or false. Table 4-30 illustrates the results of the hypothesis testing, which was done by varying three variables i.e., the pavement network to road network ratio, number of access streets and illumination level of the public parks independently and keeping all other variables unchanged (average values of the surveyed results of various variables).

Table 4-30 Hypothesis Testing

Pavement network to road network ratio	Number of users	Number of access street	Number of park users	Illumination level (lux)	No of public park users
0.80	79	3	194	16	649
0.85	158	4	237	17	683
0.90	237	5	280	18	718
0.95	316	6	322	19	753
1.00	396	7	365	20	788

Table 4-30 shows that, with an improvement of accessibility parameters, the number of users of public parks is increased. This proves the hypothesis considered in this investigation that availability of adequate access infrastructure will improve the utilization of public parks and open recreational areas in the study area.

4.12.1 Comparative Analysis of Various Scenarios

Figure 4-8 presents a comparative analysis of the various scenarios obtained and discussed. The comparative analysis was conducted to observe the most suitable scenario(s), which could be considered for general scenario formulation to increase the average number of monthly users in public parks in the study area.

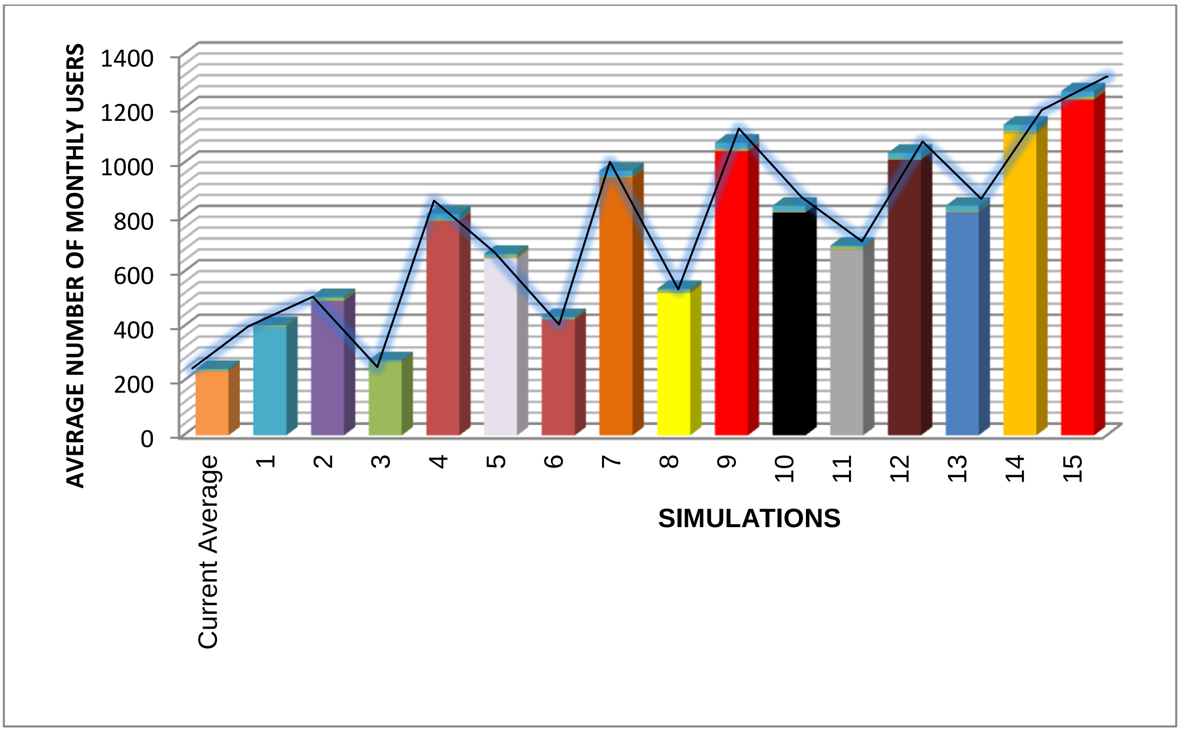


Figure 4-8: Comparative Analysis of Various Scenarios

This comparative analysis reveals that, in scenario 15, the public parks in the study areas would experience a very high average number of monthly users. This would automatically promote scenario 15 for consideration in future policy development. Similarly, under scenarios 4, 7, 9, 10, 12, 13, 14, and 15, the average number of monthly users are raised significantly and can all be used as recommendation for designing for accessibility to public parks. All other scenarios (scenarios 1, 2, 3, 5, 6, and 8) provide similar trends of increase in average monthly users although it is not as high as the other scenarios. However, scenario 15 scenarios greatly increases the average number of monthly users and can be considered appropriate for evolving policy guidelines for the increase of monthly users to public parks and the improvement of accessibility to public parks in the study areas. Scenarios like 7, 9, 12, and 14 may also be considered and need to be examined while develop policies.

4.12.2 Summary of Scenarios

The comparative scenario analysis revealed that how the four accessibility variables, in different combinations, alter the expected number of monthly users. Although, illumination and pavement network to road network independently influence the increase in park users significantly, it is found that the combined scenarios are more effective in improving the monthly number of users of the parks in the study area. It is found that scenario 15, which is a combination of the enhancement of all the four variables together, would yield most significant improvement in the park uses in the study area. It is however, not always possible to control or change all four variables at every public park being designed. Therefore, other scenarios which can deliver appropriate improvements need to be considered to increase the number of parks users in the public parks according to the constraints and specific context of the park.

5. CHAPTER 5: FINDINGS, POLICY GUIDELINES, AND CONCLUSION

5.1 INTRODUCTION

The development of a set of planning and design guidelines to improve accessibility to public parks in the suburban residential areas of the city Bloemfontein in South Africa, required an investigation that evaluated the existing socio-economic environment as well as the physical, symbolic and visual access scenarios in the city. Therefore, for the purposes of this investigation, existing literature was reviewed and different kinds of statistical analyses were done at various stages, which included analyses of data both from survey and secondary sources. The causes of hindrances to accessibility of public parks were then evaluated and then a regression model was developed for prediction of the average number monthly users of public parks under various simulated scenarios.

In this chapter, inferences are drawn from the results of the analyses conducted, followed by the development of a planning concept for the improvement of accessibility to public parks. The inferences drawn and development concept were used to evolve policy guidelines and plausible recommendations for the improvement of accessibility to public parks in the residential areas of the study area. These inferences are presented in the following section.

5.2 INFERENCES FROM LITERATURE REVIEW

The following inferences can be made:

- 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 in which potential users of the neighbourhood can effectively partake in recreational activities.
- Public parks that function effectively will then ensure that the people of the neighbourhood enjoy a healthy physical and social lifestyle.
- Public parks need to be carefully planned and placed within residential areas in order to ensure that there is a sufficient amount of open and free recreational facilities for the various types of users in the area.
- Standard procedures for the planning and placement of public parks in residential areas have been followed by urban planners for many years.

- Old established residential areas in South Africa normally have a sufficient amount of public parks to service the area, but new developments, rezoning of land uses and socio-economic transformations have changed these old established residential areas. These changes can be perceived to have negatively affected the level of accessibility to these public parks for users.
- Along with the transformations happening in and around old established residential areas, public parks in new developing residential areas are still being planned and placed using conventional planning methods. This may not be sufficient in determining the future accessibility requirements to make these public parks successful.
- Accessibility is observed to be one of the major determinates of successful usability of the public parks.
- There are three forms of access (physical, visual and symbolic access) which are generally considered with respect to accessibility of public parks.
- Spatial accessibility on the proximity, location and size of the parks contribute to the usability of the parks.
- A successful public park needs to be easily accessed via foot or vehicle as well as be clearly visible from a distance as well as up close.
- Traffic networks around the facilities are observed to be a measure of the level of accessibility of the facility.
- Access to public transportation is also identified as a major enabler for park access.
- Rapid growth of 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 observed as constraints in the accessibility of the parks in cities.
- The time it takes to walk from home and the walking distance are observed to be some of the most important preconditions for access and usability of public parks.
- Pedestrian safety is a major concern with regards to accessibility to public parks.
- Basic public park access in residential areas of a city is based on the spatial configuration of parks, the number of parks and their spatial distribution across neighborhood areas or local regions.
- Land use-planning is considered to provide facilities and services that would ensure continuous and safe access. This can increase access to public parks.

- Interior visibility, usability, 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.
- Census tract models, proximity models, service area analysis models, Geographic Information Science (GISc) frameworks in addition to different statistical techniques are some of the models which were used prominently to analyse accessibility challenges to public parks. These models are applicable either at aggregate city level or individual parks level.
- Models which are completely applicable to the current demographic situations and developments encountered with accessibility of public parks at residential areas of a city in South Africa are scarce.
- A public park that is transformed to become fully accessible (safe, easy, and convenient) to its potential users, should have a positive effect on the quality of its surrounding neighbourhood due to the fact that the park becomes more vibrant with users and an attraction to the neighbourhood.

5.3 INFERENCES FROM SURVEYS, SPATIAL ANALYSES AND THE REGRESSION MODEL IN THE STUDY AREA

The inferences drawn from the various surveys conducted in the study area, the spatial analyses and statistical modelling are presented below:

- The average household size in the study area is 2.95.
- The average number of vehicles per household in the study area is 1.18.
- The majority of dwellings in the study areas are houses (57%), followed by informal settlements (19%) while the remainder of the dwellings (24%) is flats, student houses, duplexes or townhouses.
- More than 57% of the population in the study areas belongs to the 19-60 years age (active age) group.
- About 88% of the people in residential areas are the potential users of parks, which includes 57% adults (19-60 Years), 23% children (6-18%) and 8% of people being more than 60 years of age. With regard to the importance of frequent recreational activities to people of all ages, this implies that public parks need to be made more accessible to all age groups of people.
- Lower income households tend to have a higher number of infants than higher income households.

- The potential number users of public parks are larger among adults 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.
- Residential areas with a higher population do not necessarily have a higher number of public park users.
- Most users of public parks commute on foot from their homes to public parks.
- Pedestrians should be expected to commute to public parks on the pavement network instead of on the road reserved for vehicles. This is often not the case due to the pavement network being obstructed for various reasons such as home owners building right up against the road or plants and rocks that are in the way.
- As much as 17% of the pavement network in the service area of the public parks in the study area is obstructed and unavailable.
- The pavement widths in the service areas are sufficient for pedestrians to commute on provided that the pavements are not obstructed.
- None of the roads in the service areas was very good, yet most were in an acceptable or good condition.
- The conditions of the majority share (64.2%) of pavements in the service areas are acceptable; however more than one third of the pavements are in a bad state of condition.
- Vehicles are parked on street near the majority of the public parks. Only about 28% of the public parks have both on street and off street parking facilities. The parking spaces allocated for vehicles around public parks vary from 0 to 200 meters. However, the parking facilities provided near the public parks are found to have no real pattern.
- The average time it takes users to commute by walk to public parks from their residential home is no longer than 13 minutes.
- Some of the public parks in the study area can be seen from a distance of 704 meters while others are only visible from a distance of 98 meters due to the placement, size and topography of the public parks in the study area.
- According to the perception of the people surveyed, walking to public parks and walking distance are perceived to be measure indicators of accessibility.
- None of the public parks in the study areas is very well maintained. The majority of them (74.3%) are in either an acceptable or good condition; however more than one third of the parks surveyed are found to be in a bad condition.

- According to the perception of the people of the study area, evenings and afternoons is the most preferred period of the day to visit public parks (75% people visit the public parks during these periods). Only about one fifth of the users prefer to visit the public parks during the morning hours and about 5% of the people prefer to visit the parks during mid-day period.
- During early evenings, all the public parks in the study areas are 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 observed from the perceptions of the people surveyed.
- More than half of the public parks surveyed have playgounds and only about 42.86% of the public parks do not have any playgounds.
- About 57.14 % of the vehicles were found to travel within the speed limits of the city in and around the public parks. There are however, 42.86% of the vehicles that exceed the speed limits of 60 km/h on the roads in and around the public parks. This is a cause of concern for public park user safety.
- According to the perception of the people surveyed, the presence or absence of entertainment facilities and playgrounds do not have real bearing on the accessibility and usability of public parks in the study area.
- Safety is major concern in the accessibility and use of parks.
- The major accessibility parameters which were found to be mostly influencing public park usability are pavement network and road network ratio, number of access roads, illumination level of parks and size of parks. It was found that these parameters are the major contributors to use of public parks in the residential areas of the study area.

From this investigation, it is observed that the four accessibility parameters as discussed above (pavement network and road network ratio, number of access roads, illumination level of parks and size of parks) are crucial to improve the usability of the public parks in the study area. All these parameters influence the number of users of parks to a varied extent (individually and in combination). It is found that the more complete the pavement network in the service areas, the higher the average number of public parks users per month. For instance, with 5% enhancement of pavement network to road network ratio, an increase of 80 users per month to public parks can be observed. The more the access streets leading towards a public park, the higher the average number of public park users per month. Similarly, an increase of one accessible street can lead to an enhancement of 85 monthly users in public parks. Also, the higher the illumination levels of the public parks, the higher the average number of monthly users in the public parks. An increase of 1 lux in illumination will facilitate about 35 more users per month. It is also observed that the larger the area (size) of the public parks, the higher the average number of monthly users. However, the enhancement of monthly users by increasing the size (area) of the public parks is relatively meagre compared to the influence of the other three variables. Only an increase of 9 users per month can be experienced with a size increase of a 1000 m^2.

A significant increase of monthly users at public parks in the study area can be experienced if the four accessibility parameters are considered in an optimal combination. For instance, by combining the effect of an optimal pavement network to road network ratio of 1.0, increasing to a number of 10 accessible streets leading towards the public parks, adjusting to the illumination level of 20 lux and increasing a park size to 50000 m^2, can lead to a monthly increase of users by 425% from their current scenario.

5.4 PLANNING CONCEPT

A concept to enhance accessibility to public parks and increase the average number monthly users of public parks has been devised for the study area, based on the major control parameters influencing the average number monthly users of the study area. This investigation reveals that good management of the pavement network with relation to the road network, the illumination levels during early evenings, the number of access streets leading towards the public parks, and the size of the public parks, would not only contribute to increasing the average number of monthly users, but also to improving accessibility to public parks in the study area. However, improvement and development of such infrastructure would require effective planning and policy interventions. Therefore, in order to develop a broad set of policy guidelines and plausible recommendations, the following broad planning concept strategies have been adopted:

1. The lack of a pavement network in the service area of a public park deters many potential users from commuting to the public parks. Many users are composed of families with children and do not wish to commute on the road due to the pavement not being accessible or in a proper condition. Many residential homes in the study area have developed gardens and driveways on their front pavement, which prevents pedestrians from commuting on them. A pavement network does not belong to the owners of the lots along which the pavement lies and should not be utilized and developed by these owners in such a way that the pavement loses its pedestrian functionality. Therefore, appropriate policy interventions for provision

of adequate, well maintained and unobstructed pavements commensurate to the roads leading to the public parks in the residential areas are one of the foremost requirements.

2. The number of access streets to a public park is essential for easy and convent access of users to public parks. It is found that number of access streets to public parks in the study area vary from 2 to 9. However a sizable number of parks are accessed by a 2 to 3 number of streets, which cause inconvenience to the park users to travel top parks either by walk or by vehicles as they have to travel more distance. More access streets to public parks also provide more potential users a clear line of sight and awareness of the about the public parks near them. As evidenced from these investigation public parks with fewer access streets have a very low number of users as against the public parks having higher number access streets, it is essential to have a reasonably higher number of access streets to parks in order to enhance the number of monthly users.
3. The area (size) of a public park is a primary visual accessibility factor. As found out from this investigation larger public parks tend to have more monthly users. Public parks should not be too small that they are hidden from potential users, and should be large enough to give users a feeling of openness and space. The larger the public parks, the more the activities that can be enjoyed in the parks and therefore becomes vital while planning and designing public parks in the study area.
4. The level of illumination in a public park during evenings is found to be the most influential determinant affecting the monthly number of users. The illumination level of a public park provides users with a sense of visual accessibility as well as safety. As soon as a public park becomes too dark, users cannot safely navigate through the public parks and tend to leave or not go to the public parks at all. It is found that none of public parks are provided with the minimum standard requirement of 20 lux of illumination in the evenings. Therefore, improvement of the illumination level to a minimum of 20 lux through effective artificial lighting need to be considered as a vital component of all public parks, which will essentially largely enhance the accessibility and users of public parks in the study area. .

5.5 ALTERNATIVE POLICIES

Based on this planning concept and the different of simulated scenarios developed using the developed model to predict the number of park users, a number of alternative policy scenarios were devised and are presented below.

- Policy 1 - The pavement network to road network ratio need to be 1.0 (100%). This scenario will enhance the potential number monthly users of public parks by about 65.51%.
- Policy 2 - The number of access streets leading into the public parks may be increased to 10. This scenario would result in 109.79% enhancement in the potential number monthly users of public parks. However, this policy would be more beneficial to public parks which are to be developed in future as increase of access streets in existing areas may need change in the road network system, which could prove difficult.
- Policy 3 - The area of the public parks may be increased to a size of 50000m². The number of potential users is expected to increase by 13.62% under this scenario.
- Policy 4 - The level of illumination in the park during evenings measured in lumens (lux) need to be increased to a recommended level of 20 lux. This would result in increase in the potential number of monthly users by 235.32%.
- Policy 5 - A policy has been developed that takes into account combination of pavement to road network ratio (1.0) and the number of access streets (10) leading into the public parks. This would result in a 177.02% increase in park users in the study area.
- Policy 6 - A policy has been developed that takes into account the combination of pavement to road network ratio (1.0) and the area of the public parks is set at 50000m². This policy will account in 81.28% increase in public park users.
- Policy 7 - A policy has been developed that takes into account the combination of pavement to road network ratio (1.0) and the illumination of public parks in the evenings is set at 20 lux. An increase of 302.98% of park users is expected under this policy.
- Policy 8 - A policy has been developed that takes into account the combination of number of access streets leading into the park (10) and the area of the park is set at 50000m². Under this policy the amount of public park users is expected to enhance by 122.55%.
- Policy 9 - A policy has been developed that takes into account the combination of number of access streets leading into the park (10) and the illumination of public parks in the evenings is set at 20 lux. This policy will assist in increasing the public park users by 344.26%.
- Policy 10 - A policy has been developed that takes into account the combination of the number of access streets leading into the park (10) and the illumination of

public parks in the evenings is set at 20 lux. This policy will assist in increasing the public park users by 248.09%.

- Policy 11 - A policy has been developed that takes into account the combination of pavement network to road network ratio (1.0), the area of the park (50000m^2), and the number of access streets (10). This policy will increase the public park users by assist in increasing the public park users by 190.21%%.
- Policy 12 - A policy has been developed that takes into account the combination of pavement network to road network ratio (1.0), the area of the park (50000m^2), and the illumination of public parks in the evenings (20 lux)) An increase of 330.64% of park users is expected under this policy scenario.
- Policy 13 - A policy has been developed that takes into account the combination of pavement network to road network ratio (1.0), the number of access streets (10), and the illumination of public parks in the evenings (20 lux). Under this policy scenario the number of park users will be increased by 411.91%.
- Policy 14 - A policy has been developed that takes into account combination of number of access streets (10), the area of the park (50000m^2), and the illumination of public parks in the evenings (20 lux). This policy scenario will result in an increase of 371.91% in the park users in the study area.
- Policy 15 - A policy has been developed that takes into account the combination of all four variables: Pavement network to road network ratio (1.0), number of access streets (10), the area of the park (50000m^2), and the illumination of public parks in the evenings (20 lux). This policy will lead to an increase of 424.68% in the parks users in the study area.

5.5.1 **Recommended Policies**

Based on the detailed analysis of the policies and their results, it was concluded that policy number 15 offers the possibility of the maximum increase in users and would be most suitable for increasing the average number monthly users of public parks. The policy has been developed based on the composite scenario of ensuring that a 100% of the pavement network in the service area is accessible to pedestrians; that there are 10 access streets leading towards the public parks in the service area; that the size of the public parks is designed and constructed to be 50000m^2; and that the level of luminance in the public parks at evening hours is set at 20 lux. However, this policy may not always be feasible to implement due to one or more of the four determinants not being possible to alter; therefore, one of the other policies may need to be considered according to the constraints and potentials of the residential area, public parks and context of park use. Policy 1, 4 and 7 are more suitable for existing public parks as well as public parks still in their planning and design phase, whereas policy 2, 3, 5, 6, 8, 9, 10, 11, 12, 13, 14, and 15 are more applicable to public parks that are still in their planning and design phase. However, for this reason policy 7 would be the most suitable for public parks that have already been constructed, which can increase the average number of users by 302.98%.

5.6 PLAUSIBLE PLANNING GUIDELINES AND RECOMMENDATIONS

The focus of this study has been to find ways in which to enhance the level of accessibility to public parks and increase the average number of public park users in residential areas of Bloemfontein city. Based on the analysis of various determinants, literature review, the results of the surveys, discussions of experts, opinions of people surveyed and observations made to increase the number of public park users in the study area, the following feasible recommendations are proposed in addition to the policy guidelines presented above.

- The paths adjacent to the roads leading to public parks need to be paved fully. Care need to be taken to make the pavement unobstructed and well maintained.
- The illumination levels of all public parks need to be improved substantially in order to improve the accessibility in the afternoon and evening hours.
- The area of public parks should be made of adequate size so as to encompass different activities and to make the public parks visually accessible.
- The parks need to be made more physically accessible by increasing the number of access streets at a local level.
- The speeding of vehicles on roads close to parks need to be constrained to improve pedestrian safety.
- Public parks should not be designed to be located along major arterials or excessively busy roads. It was found that public parks located next to busy roads have almost no users due to the safety risk they pose from the vast and frequent vehicles travelling past them.
- Public parks that are not utilized efficiently should not be re-zoned for other use such as residential or commercial uses, but should rather be improved by addressing the level of accessibility as well as the level of safety.
- More symbolic themes should be installed in public parks as it has been proven that if a community has a sense of ownership towards an open space, they will utilize it more and take care of it. Symbolic access to public parks is mostly lacking in the public parks of the residential areas.
- A large portion of the population comprises of adult public parks users which contribute to the level of safety in public parks. Therefore, due to the fact that

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.

- Public parks with dense bushes and hidden zones should be avoided. A public parks user must be able to see all the areas of the public parks by standing anywhere in the public parks. This ensures proper visual access to all the areas of the public parks as well as improves the level of safety in the public parks.
- The physical conditions of public parks need to be improved. Regular maintenance should be conducted on public parks to ensure that the physical, visual, and symbolic accesses of these public parks are always up to standard.
- No entry fees should be charged in order to access to all the parks in the study area, particularly in the residential areas of the study area.

5.7 CONCLUSION, LIMITATIONS, AND FUTURE RESEARCH

The necessity of public parks in residential areas is properly justified when looking at the benefits that vibrant public parks provide to the communities situated around them. However, the public parks in the urban areas of the central region of South Africa are observed to have lost their vibrancy and purpose. Therefore, the decreasing number of public park users and the deterioration of public parks in the urban areas of the central region of South Africa warranted an investigation to identify the accessibility constraints of public parks and to explore the ways to improve accessibility and consequent usability of public parks in the urban areas of the region.

For this purpose, a case study of residential areas of Bloemfontein city of South Africa was conducted. To realise the aim of the study, a survey research methodology was used for the collection of data and subsequent statistical analyses were conducted. Regression models including a multiple regression were developed to evolve scenarios under different simulated conditions which would assist in engendering policies and strategic interventions that can improve accessibility to public parks and ultimately increase the number of users a park experiences. The investigation revealed that pavement network to road network ratio, the number of access streets leading to public parks, size of parks and illumination level of public parks are the major accessible parameters which influence the uses of the public parks in the study area.

Based on the statistical analyses and regression models, a hypothesis was tested that availability of quality infrastructure would increase the number of users in the public parks.

Several alternate policy scenarios were developed, based on the simulated model results. Plausible planning guidelines were recommended to improve accessibility and user increase at public parks in the study area. Findings suggest that a combined enhancement in all the four major variables (increasing the pavement network to road network ratio to 1.0, increasing the number of access streets to 10, increasing the area of the park to 50000m^2, and improving the illumination of public parks in the evenings to 20 lux) would increase the average number of users of public parks per month by 424.68%. This is substantial compared to the current scenario. It is also envisaged that this scenario may not become feasible in all cases. Therefore, alternative policies such as a combination of enhancement of pavement to road network ratio to 1.0 and improvement of the illumination level of public parks in the evenings to 20 lux can be considered, which would result in significant increase (302.98%) in the number of monthly users at public parks in the study area. Concurrently, context specific policies based on the constraints and potentials of the suburban areas are needed to improve the accessibility and number of public parks users in the study area.

The investigation also has certain limitations; one of which is the limited nature of the surveys being conducted in the study area. They were conducted in a small number of selected residential areas because of a shortage of manpower, limited time and budgetary constraints. The study also suffered from the lack of availability of structured statistical data pertaining to the study area. Furthermore, the scope of the research was confined to the city of Bloemfontein. In order to generalize the implications of this research, similar investigations in other cities of the region and country are needed. Also, extensive surveys are required for thorough understanding of the detailed scenarios. The models being developed only focus on the access and linkage aspects of public parks and therefore will not be able to evolve scenarios on various other aspects such as socio-economic, cultural and behavioural aspects, which may influence the vibrancy of public parks.

The scope of the investigation was confined to assessment of accessibility parameters only. So, socio-economic, cultural, behavioral, crime and safety issues were kept out of the scope of the investigation, which offer opportunities for further research.

This study also offers several opportunities for further research. Some of the possibilities for further research include:

- Expanding the models to include the other three areas contributing to successful public parks, namely the uses and activities, the sociability, and the comfort and image of a public park.

- An investigation at individual micro level (public park) to complement the macro level analysis.
- Detailed investigation of influence of individual parameters like walking, pedestrianisation, safety, activity and behavioural pattern of people on the uses of public parks.

However, it is envisaged that if the plausible policy and planning guidelines developed by the current investigation are implemented, the level of accessibility to public parks will improve substantially and the average number of monthly users of public parks in the residential areas of Bloemfontein city will increase.

6. REFERENCES

Abercrombie, L.C., J.F. Sallis, T.L. Conway, L.D. Frank, B.E. Saelens, and J.E. Chapman., (2008). Income and racial disparities in access to public parks and private recreation facilities. American Journal of Preventive Medicine 34(1):9-15.

Alex Y.H. Lo C.Y., (2010). Jim Differential community effects on perception and use of urban green spaces. Cities 27 430–442.

Ariane L., Bedimo R., Mowen A.J., Deborah A., Cohen, M., (2005). The Significance of Parks to Physical Activity and, 28. doi:10.1016/j.ampre.2004.10.024.

Atiqul H.S., (2011). Urban Green Spaces and an Integrative Approach to Sustainable Environment. Journal of Environmental Protection, 2011, 2, 601-608, doi:10.4236/jep.2011.25069 Published Online July (http://www.scirp.org/journal/jep).

Barber, A., (2002). Planning: Past, Present and Future. Urban Parks Forum, Reading. Berkshire.

Baur, J. W. R., Tynon, J. F., & Gómez, E., (2013). Attitudes about urban nature parks: A case study of users and nonusers in Portland, Oregon. Landscape and Urban Planning, 117, 100–111. doi:10.1016/j.landurbplan.2013.04.015

Bedimo-Rung, A.L., Mowen, A.J., Cohen, D.A., (2005). The significance of parks to physical activity and public health: a conceptual model. American Journal of Preventive Medicine 28, 159–168.

Ben Dor, T., Westervelt, J., Song, Y., & Sexton, J. O., (2013). Modeling park development through regional land use change simulation. Land Use Policy, 30(1), 1–12. doi:10.1016/j.landusepol.2012.01.012

Benton, T., (2008) Environmental values and human purposes. Environmental Values 17, 201 220.

Bolund P. and Sven H., (1999). Ecological Services in Urban Areas. Elsevier Sciences: Ecological Economics 29, 293-301. doi:10.1016/S0921-8009(99)00013-0.

Boone, C. G., Fragkias, M., Buckley, G. L., & Grove, J. M., (2014). A long view of polluting industry and environmental justice in Baltimore. Cities, 36, 41–49. doi:10.1016/j.cities.2013.09.004

Boone, C.G., G.L. Buckley, J.M. Grove, C. Sister., (2009). Parks and People: An Environmental Justice Inquiry in Baltimore, Maryland. Annals of the Association of American Geographers 99(4):767- 787.

Bryant, B., (1995). Environmental justice: Issues, policies, and solutions. Island Press. Washington, DC.

Burgess, J, Harrison, C.M. and Limb, M., (1988). People, parks and the urban green: a study of popular meanings and values for open spaces in the city. Urban Studies 25, 455–473.

Carr, S., Francis, M., Rivlin, L. G., & Stone, A. M., (1993). Public space. Cambridge, New York: Cambridge University Press.

Chang, H.S. and Liao, C.-H., (2011). Exploring an integrated method for measuring the relative spatial equity in public facilities in the context of urban parks. Cities, 28(5), 361–371. doi:10.1016/j.cities.2011.04.002

Coen, S., Ross, N., (2006). Exploring the material basis for health: characteristics of parks in Montreal neighborhoods with contrasting health outcomes. Health and Place 12, 361–371.

Cohen, D.A., T.L. McKenzie, A. Sehgal, S. Williamson, D. Golinelli, and N. Lurie., (2007). Contribution of public parks to physical activity. American Journal of Public Health 97(3):509 514.

COTO, South Africa's Transport Network., (2012). SouthAfrica.info. Retrieved September 18, 2013, from http://www.southafrica.info/business/economy/infrastructure/transport.htm#.UjlvEjaQ7e.

Cutt, H., Giles-Corti, B., Wood, L., Knuiman, M., Burke, V., (2008). Barriers and motivators for owners walking their dog: results from qualitative research. Health Promotion Journal of Australia 19, 118–124.

Cutts, B.B., K.J. Darby, C.G. Boone, A. Brewis., (2009). City structure, obesity, and environmental justice: an integrated analysis of physical and social barriers to walkable streets and park access. Social Science & Medicine 69(9): 1314-1322.

Cybriwsky, R., (1999) Changing patterns of urban public space. Observations and assessments from the Tokyo and New York metropolitan areas. Cities 16(4), 223–231.

Das, D., (2014). Evaluation of Control Parameters for Smart Mobility in the Context of a South African City- A Case of Bloemfontein City, Conference Proceedings: Planning Africa 2014 - Making Great Places, 19th-22nd October, 2014, International Convention Centre (ICC), Durban, South Africa, pp. 138-151. ISBN: 978-0-86970-781-4.

Day, R., (2008). Local environments and older people's health: dimensions from a comparative qualitative study in Scotland. Health and Place 14, 299–312.

Dempsey, N., (2012). Neighbourhood Design: Green Space and Parks. International Encyclopedia of Housing and Home (Vol. 5, pp. 12–20). Elsevier Ltd. doi:10.1016/B978-0-08-047163-1.00540-3.

Department of Peacekeeping Operations Cartographic Section., (2007). Map of South Africa. Map No. 3768 Rev. 6. Retrieved from http://www.un.org/Depts/Cartographic/map/profile/southafr.pdf

Department of Science and Technology South Africa., (2011). South African Risk and Vulnerability Atlas (1st ed.). Sun Press.

Deshpande, A.D., Baker, E.A., Lovegreen, S.L., Brownson, R.C., (2005). Environmental correlates of physical activity among individuals with diabetes in the rural midwest. Diabetes Care 28, 1012–1018.

Donovan, R.J., (2005). Increasing walking: how important is distance to, attractiveness, and size of public open space?. American Journal of Preventive Medicine 28, 169–176.

Dooling, S, Simon, G and Yocom, K., (2006) Place-based urban ecology: a century of park planning in Seattle. Urban Ecosystem 9, 299–321.

Encyclopedia of Occupational Health and Safety. (n.d.). Chapter 46 - Lighting. Fourth Edition. Retrieved October 28, 2015, from http://www.ilocis.org/documents/chpt46e.htm

Erkip, E., (1997) The distribution of urban public services: the case of parks and recreational services in Ankara. Cities 6, 353–361.

Estabrooks, P., R.E. Lee, and N.C. Gyurcsik., (2003). Resources for physical activity participation: Does availability and accessibility differ by neighborhood SES? Annals of Behavioral Medicine 2003, 25:100-104.

Etzioni, A., (1998). The Essential Communitarian Reader, Rowman and Littlefield, Lanham.

Evcil, A. N., (2012). Raising Awareness about Accessibility. Procedia - Social and Behavioral Sciences, 47, 490–494. doi:10.1016/j.sbspro.2012.06.686.

Ferre´, M., Guitart,A.,Ferret, M., (2006). Children and playgrounds in Mediterranean cities. Children's Geographies 4,173–183.

Fink, A., (2012). How to Conduct Surveys: A Step-by-Step Guide: A Step-by-Step Guide. Sage Publications.

Floyd, M.F., Spengler, J.O., Maddock, J.E., Gobster, P.H., Suau, L.J., (2008). Park-based physical activity in diverse communities of two U.S. cities. An observational study. American Journal of Preventive Medicine 34, 299–305.

Gehl, J., (1971). Life between buildings: Using public space. Danish Architecture Press, Distributed by Island Press.

Gehl, J., & Gemzøe, L., (2004). Public spaces, public life, Copenhagen. Copenhagen: Danish Architectural Press and the Royal Danish Academy of Fine Arts, School of Architecture Publishers.

Giles-Corti, B., Broomhall, M.H., Knuiman, M., Collins, C., Douglas, K., Ng, K., Lange, A., Gobster, P.H., (2002). Managing urban parks for a racially and ethnically diverse clientele. Leisure Sciences 24, 143–159.

Gobster, P.H., (1998) Urban parks as green walls or green magnets? Interracial relations in neighborhood boundary parks. Landscape and Urban Planning 41, 43–55.

Google Earth., (2013). Google Earth 7.1.2.2041. Public Parks Iin Bloemfontein. Retrieved December 10, 2014, from http://www.google.com/earth/index.html

Guideline, I.H.T., (2005). Validation of analytical procedures: text and methodology. Q2 (R1), 1.

Guo, H., Wang, W., Guo, W., Jiang, X., & Bubb, H., (2012). Reliability analysis of pedestrian safety crossing in urban traffic environment. Safety Science, 50(4), 968–973. doi:10.1016/j.ssci.2011.12.027.

Grahn P. and Stigsdotter U. A., (2003). Landscape Planning and Stress. Urban Forest: Urban for Urban Green 2, 001-018.

Hakim, A. A., Petrovitch, H., Burchfiel, C. M., Ross, G. W., Rodriguez, B. L., White, L. R., et al., (1998). Effects of walking on mortality among nonsmoking retired men. New England Journal of Medicine 338, 94–99.

Hass-Klau, C., (1993). Impact of pedestrianisation and traffic calming on retailing: A review of the evidence from Germany. Transport Policy, 1(1), 21–31.

Hayward, D., Weitzer, W., (1984). The public image of urban parks: past amenity, present ambivalence, uncertain future. Urban Ecology 8, 243–268.

Heidt V. and M. Neef M., (2008). Benefits of Urban Space for Improving Urban Climate, Ecology, Planning and Management of Urban Forests: International Perspective.

Herzele and Wiedeman T., (2003). A Monitoring Tool for the Provision for Accessible and= Attractive Green Spaces. Elsevier Sciences: Landscape and Urban Planning 63(2), 109-126. doi:10.1016/S0169-2046(02)00192-5.

Huang D., Lu C.C. and Wang G., (2009). Integrated Management of Urban Green Space: The Case in Guangzhou China, 45th ISOCARP Congress.

Jacobs, J., (1972). The death and life of great American cities. Harmondsworth: Penguin.

Jay, M. and Schraml, U., (2009) Understanding the role of urban forests for migrants: uses, perception and integrative potential. Urban Forestry and Urban Greening 8, 283–294.

Kaczynski, A., Henderson, K., (2007). Environmental correlates of physical activity: a review of evidence about parks and recreation. Leisure Sciences 29, 315–354.

Kaczynski, A.T., Potwarka, L.R., Saelens, B.E., (2008). Association of park size, distance, and features with physical activity in neighborhood parks. American Journal of Public Health 98, 1451–1456.

Kelley, K., Clark, B., Brown, V. and Sitzia, J., (2003). Good practice in the conduct and reporting of survey research. International Journal for Quality in Health Care, 15(3), 261-266.

Khotdee, M., Singhirunnusorn, W., & Sahachaisaeree, N., (2012). Effects of Green Open Space on Social Health and Behaviour of Urban Residents: A Case Study of Communities in Bangkok. Procedia - Social and Behavioral Sciences, 36, 449–455. doi:10.1016/j.sbspro.2012.03.049

Kumar, S. and Phrommathed, P., (2005). Research methodology Springer US. pp. 43-50.

La Rosa, D., (2014). Accessibility to greenspaces: GIS based indicators for sustainable planning in a dense urban context. Ecological Indicators 42, 122–134. doi:10.1016/j.ecolind.2013.11.011

Lalli, M., (1992) Urban related identity: theory, measurement and empirical findings. Journal of Environmental Psychology 12, 285–303.

Lam, K.C., Baniassad, E, Hui, W.C., and Chow, K., (2004). Parks, People and the Environment: A Study of the Environmental Quality and Visitor Behavior in Parks and Open Spaces in Hong Kong. Centre for Environmental Policy and Resource Management, Chinese University of Hong Kong, Hong Kong.

Lambert, D., (2002) Urban Parks Programme. Heritage Lottery Fund, London.

Landman, K., & Ntombela, N., (2006). Opening up spaces for the poor in the urban form: trends, challenges and their implications for access to urban land, (November).

Larsen, J., A. El-Geneidy, and F. Yasmin., (2010). Beyond the quarter mile: Re-examining travel distances by active transportation. Canadian Journal of Urban Research: Canadian Planning and Policy (supplement) 19(1), 70-88.

Lawrence R.J., (1996) Wanted: designs for health in the urban environment. World Health Forum ;17:363–6. Bureau of City Planning, 2000.Tokyo Metropolitan Government. Green master plan of Tokyo. Tokyo: Tokyo Metropolitan Government.

Lee, J and Yip, N.M., (2006). Public housing and family life in East Asia: housing history and social change in Hong Kong, 1953–1990. Journal of Family History 31, 66–82.

Lo, A.Y. and Jim, C.Y., (2010). Willingness of residents to pay and motives for conservation of urban green spaces in the compact city of Hong Kong. Urban Forestry & Urban Greening 9, 113–120.

Loukaitou-Sideris, A., (2006). Is it safe to walk? Neighborhood safety and security considerations and their effects on walking. Journal of Planning Literature 20(3), 219-232.

Luoma, J., & Peltola, H. (2013). Does facing traffic improve pedestrian safety? Accident; analysis and prevention, 50, 1207–10. doi:10.1016/j.aap.2012.09.023.

Maantay, J. and A. Maroko., (2009). Mapping urban risk: Flood hazards, race, & environmental justice in New York. Applied Geography 29:111-124.

Maantay, J.A., A.R. Maroko, and C. Herrmann., (2007). Mapping population distribution in the urban environment: The cadastral-based expert dasymetric system (CEDS). Cartography and Geographic Information Science 34(2), 77-102.

Madanipour, A., (2003) Public and Private Spaces of the City. Routledge, London.

Marais, L., & Ntema, J., (2013). The upgrading of an informal settlement in South Africa: Two decades onwards. Habitat International, 39, 85–95. doi:10.1016/j.habitatint.2012.11.001

Marcus, C. C., & Francis, C., (1998). People places – Design guidelines for urban open space. New York: Wiley & Sons, Inc.

Maroko, A.R., J.A. Maantay, N.L. Sohler, K.L. Grady, and P.S. Arno., (2009). The complexities of measuring access to parks and physical activity sites in New York City: a quantitative and qualitative approach. International Journal of Health Geographics 8(1), 34-56.

Maruani, T., & Amit-Cohen, I., (2007). Open space planning models: A review of approaches and methods. Landscape and Urban Planning 81(1–2), 1–13.

Mcdonald, S., & Valente, C., (2005). A profile of the Free State province: Demographics, poverty, inequality and unemployment, 1(August).

McCormack G.R., Rock M., M.Toohey A., Hignel D., (2010) Characteristics of urban parks associated with park use and physical activity: A review of qualitative research Health & Place 16 712–726.

Merven, B., Stone, A., Hughes, A., & Cohen, B., (2012). Quantifying the energy needs of the transport sector for South Africa: A bottom - up model, (June).

Miyake Keith K., Maroko Andrew R., Grady, Kristen L. Maantay, Juliana A. and Arno Peter S., (2010). Not Just a Walk in the Park: Methodological Improvements for Determining Environmental Justice Implications of Park Access in New York City for the Promotion of Physical Activity Cities and the Environment (CATE), 3(1), Art. 8, 1-17.

Moore, L.V., A.V. Diez Roux A, K.R. Evenson, A.P. McGinn, and S.J. Brines., (2008). Availability of recreational resources in minority and low socioeconomic status areas. American Journal of Preventive Medicine 34(1), 16-22.

Moughtin, C. and P. Shirley, P., (2005). Urban Design: Green Dimension, Elsevier.

Morency, C., Paez, A., & Galfan, M. R., (2013). Accessibility to Urban Parks in Montreal from the Perspective of Children.

Muller-Perband, E., (1979). The modern town park in Germany. In Nature in Cities, IC Laurie (ed.), pp. 297–326. Wiley, New York.

Nambuusi, B. B., Hermans, E., Brijsa, T., & Wets, G., (2010). Sensitivity of road safety outcomes to uncertainties in the computational model for assessing the impact of policy measures at the regional level. Procedia - Social and Behavioral Sciences 2(6), 7714–7715. doi:10.1016/j.sbspro.2010.05.193.

Nevhutanda, A., (2007). Impact of Rapid Urbanization of South African Cities on their Transport Policies: A Theoretical Perspective, 26th Annual Southern African Transport Conference, pp. 457–465.

Neuvonen M., Sievanen T., Susan T. and Terhi K., (2007). Access to Green Areas and the Frequency of Visits: A Case Study in Helsinki. Elsevier: Urban Forestry and Urban Greening, 6(4), 235-247.

New York, the City of New York City, (2007). PlaNYC: A Greener, Greater New York. http://www.nyc.gov/planyc (accessed on 10/10/2010).

Nicholls, S., (2001). Measuring the accessibility and equity of public parks: A case study using GIS. Managing Leisure 6:201-219.

Nikolopoulou, M., & Lykoudis, S., (2007). Use of outdoor spaces and microclimate in a Mediterranean urban area. Building and Environment, 42(10), 3691–3707.

Payne, L., Orsega-Smith, E., Roy, M., Godbey, G., (2005). Local park use and personal health among older adults: an exploratory study. Journal of Park and Recreation Administration 23, 1 20.

Perovic, S., & Folic, N. K., (2012). Visual Perception of Public Open Spaces in Niksic. Procedia - Social and Behavioral Sciences 68, 921–933. doi:10.1016/j.sbspro.2012.12.277

Potwarka, L.R., Kaczynski, A.T., Flack, A.L., (2008). Places to play: association of park space and facilities with healthy weight status among children. Journal of Community Health 33, 344 350.

Project for Public Spaces, (2013). No Title. What Makes a Successful Place? Retrieved September 18, 2013, from https://www.pps.org/reference/grplacefeat

Pulido, L., (2000). Rethinking Environmental Racism: white privilege and urban development in Southern California. Annals of the Association of American Geographers 90(1):12-40.

Punter, J.V., (1990) The privatization of the public realm. Planning Practice and Research 5(3), 8–16.

Reed, J.A., Arant, C.A., Wells, P., Stevens, K., Hagen, S., Harring, H., 2008. A descriptive examination of the most frequently used activity settings in 25 community parks using direct observation. Journal of Physical Activity and Health 5 (1), S183–S195.

Regional Plan Association, (1997). Building Transit-Friendly Communities a Design and Development Strategy for the Tri-State Metropolitan Region. New York, New Jersey, Connecticut.

Ries, A.V., Voorhees, C.C., Roche, K.M., Gittelsohn, J., Yan, A.F., Astone, N.M., (2009). A quantitative examination of park characteristics related to park use and physical activity among urban youth. Journal of Adolescent Health 45, S64–S70.

Ritter, P., (1964). Planning for Man and Motor. Pergamon Press. New York.

Riva, M., Gauvin, L., Apparicio, P., & Brodeur, J.M., (2009). Disentangling the relative influence of built and socioeconomic environments on walking: the contribution of areas homogenous along exposures of interest. Social science & medicine (1982), 69(9), 1296–305. doi:10.1016/j.socscimed.2009.07.019

Sallis, J. F., Frank, L. D., Saelens, B. E., & Kraft, M. K., (2004). Active transportation and physical activity: opportunities for collaboration on transportation and public health research. Transportation Research Part A: Policy and Practice, 38(4), 249–268. doi:10.1016/j.tra.2003.11.003

Sendi R. and Golicˇnik Marusˇic B., (2012). Neighbourhood Design: Public Spaces, 21–28. doi:10.1016/B978-0-08-047163-1.00541-5

Setyowati, E., Harani, A. R., & Falah, Y. N., (2013). The Application of Pedestrian Ways Design Concepts as an Implementation of Sustainable Urban Open Spaces. Procedia - Social and Behavioral Sciences, 85, 345–355. doi:10.1016/j.sbspro.2013.08.364

Shields, R., (1991). Places on the Margin. Alternative Geographies of Modernity. Routledge, London.

Shores, K.A., West, S.T., (2008). The relationship between built park environments and physical activity in four park locations. Journal of Public Health Management and Practice 14, e9–16.

Sorensen M., Smit J., Barzetti V. and WilliamsJ., (1997). Good Practices for Urban Greening, Inter-American Development Bank,. http://www.iadb.org/sds/doc/ENV109KKeipiE.pdf.

Spocter, M., (2004). A macro analysis and GIS application of urban public space closures in Cape Town, 1975 — 2004, 90–113.

Staeheli, L.A. and Mitchell, D., (2006). USA's destiny? Regulating space and creating community in American shopping malls. Urban Studies 43(5–6), 977–992.

Statistics South Africa., (2011). Statistical Release Mid-year Population Estimates, (July).

Stevens, N., & Salmon, P., (2015). Reprint of "Safe places for pedestrians: Using cognitive work analysis to consider the relationships between the engineering and urban design of footpaths". Accident; analysis and prevention, 74, 339–49. doi:10.1016/j.aap.2014.10.011

Sugiyama, T., Leslie, E., Giles-Corti, B., Owen, N., (2008). Associations of neighbourhood greenness with physical and mental health: do walking, social coherence and local social interaction explain the relationships. Journal of Epidemiology and Community Health, 62-69.

Sugiyama, T., Paquet, C., Howard, N. J., Coffee, N. T., Taylor, A. W., Adams, R. J., & Daniel, M., (2014). Public open spaces and walking for recreation: moderation by attributes of pedestrian environments. Preventive medicine, 62, 25–9. doi:10.1016/j.ypmed.2014.01.030.

Szeremeta, B., & Zannin, P. H. T., (2009). Analysis and evaluation of soundscapes in public parks through interviews and measurement of noise. The Science of the total environment, 407(24), 6143–9. doi:10.1016/j.scitotenv.2009.08.039.

Takano K., Nakamura K., Watanabe M., (2002). Urban residential environments and senior citizens' longevity in megacity areas: the importance of walkable green spaces J Epidemiol Community Health 56, 913–918.

Talen, E., (1997). The social equity of urban service distribution: An exploration of park access in Pueblo, Colorado, and Macon, Georgia. Urban Geography 18(6), 521-541.

Talen, E. and Anselin L., (1998). Assessing spatial equity: An evaluation of measures of accessibility to public playgrounds. Environment and Planning A 30, 595-613.

Talen, E., Allen, E., Bosse, A., Ahmann, J., Koschinsky, J., Wentz, E., & Anselin, L., (2013). LEED-ND as an urban metric. Landscape and Urban Planning, 119, 20–34. doi:10.1016/j.landurbplan.2013.06.008.

Temelova, J., (2007) Flagship developments and the physical upgrading of the post-socialist inner city: the Golden Angel project in Prague. Geografiska Annaler B 89(2), 169–181.

Thompson, C. W., Aspinall, P., & Roe, J., (2014). Access to Green Space in Disadvantaged Urban Communities: Evidence of Salutogenic Effects Based on Biomarker and Self-report Measures of Wellbeing. Procedia - Social and Behavioral Sciences 153, 10–22. doi:10.1016/j.sbspro.2014.10.036.

Timperio, A., K. Ball, J. Salmon, R. Roberts, and D. Crawford., (2007). Is availability of public open space equitable across areas? Health & Place 13(2), 335-340.

Tucker, P., Gilliland, J., Irwin, J., (2007). Splash pads, swings, and shade: parents' preferences for neighbourhood parks. Canadian Journal of Public Health 98, 198–202.

UNESCO., (2015). Adult and Youth Literacy, 1990-2015 Analysis of data for 41 selected countries (pp. 1990–2015).

URGE, (2002). http://www.urge-project.org. Retrieved September 18, 2013, from http://www.urge-project.org

Van Melik Rianne, Van Aalst Irina, Van Weesep Jan., (2009). The private sector and public space in Dutch city centers, Cities 26, 202–209.

Van Melik, R, Van Aalst, I and Van Weesep, J., (2007). Fear and fantasy in the public domain: the development of secured and themed public space. Journal of Urban Design 12(1), 25–42.

Vanolo A., (2008). The image of the creative city: Some reflections on urban branding in Turin. Cities 25 370–382, doi:10.1016/j.cities.2008.08.001.

Veitch, J., Ball, K., Crawford, D., Abbott, G., & Salmon, J., (2013). Is park visitation associated with leisure-time and transportation physical activity?. Preventive medicine 57(5), 732–4. doi:10.1016/j.ypmed.2013.08.001.

Weiss, C. C., Purciel, M., Bader, M., Quinn, J. W., Lovasi, G., Neckerman, K. M., & Rundle, A. G., (2011). Reconsidering access: park facilities and neighborhood disamenities in New York City. Journal of urban health: bulletin of the New York Academy of Medicine 88(2), 297–310. doi:10.1007/s11524-011-9551-z

Whyte, W. H., (1988). City: Rediscovering the center. New York: Doubleday.

Wilbur, J., Chandler, P., Dancy, B., Choi, J., Plonczynski, D., (2002). Environmental, policy, and cultural factors related to physical activity in urban, African– American women. Women and Health 36, 17–28.

Wilson, J., (2007). Park Congestion and Strategies to Increase Park Equity, (December).

Wolch, J., J.P. Wilson, and J. Fehrenback. (2005). Parks and park funding in Los Angeles: An equity mapping analysis. Urban Geography 26(1), 4-35.

World Health Organization., (2013). Pedestrian safety: a road safety manual for decision makers and practitioners. 1st ed. Italy: WHO Library Cataloguing-in-Publication Data.

Worpole, K. (n.d.). The social value of public spaces.

Wright Wendel, H. E., Zarger, R. K., & Mihelcic, J. R., (2012). Accessibility and usability: Green space preferences, perceptions, and barriers in a rapidly urbanizing city in Latin America. Landscape and Urban Planning, 107(3), 272–282. doi:10.1016/j.landurbplan.2012.06.003

Young, RA and Flowers, M.L., (1982). Users of an Urban Natural Area: their Characteristics, Use Patterns, Satisfactions, and Recommendations. Forestry Research Report, Department of Forestry, Agricultural Experiment Station, University of Illinois at Urbana-Champaign.

Zhang, X., Holt, J. B., Lu, H., Onufrak, S., Yang, J., French, S. P., & Sui, D. Z., (2014). Neighborhood commuting environment and obesity in the United States: an urban-rural stratified multilevel analysis. Preventive medicine, 59, 31–6. doi:10.1016/j.ypmed.2013.11.004.

Zhu, J., & Zhang, N., (2008). Modeling Road Network Capacity and Service Level under Variable Demand Pattern. Systems Engineering - Theory & Practice 28(6), 170–176. doi:10.1016/S1874-8651(09)60027-2.

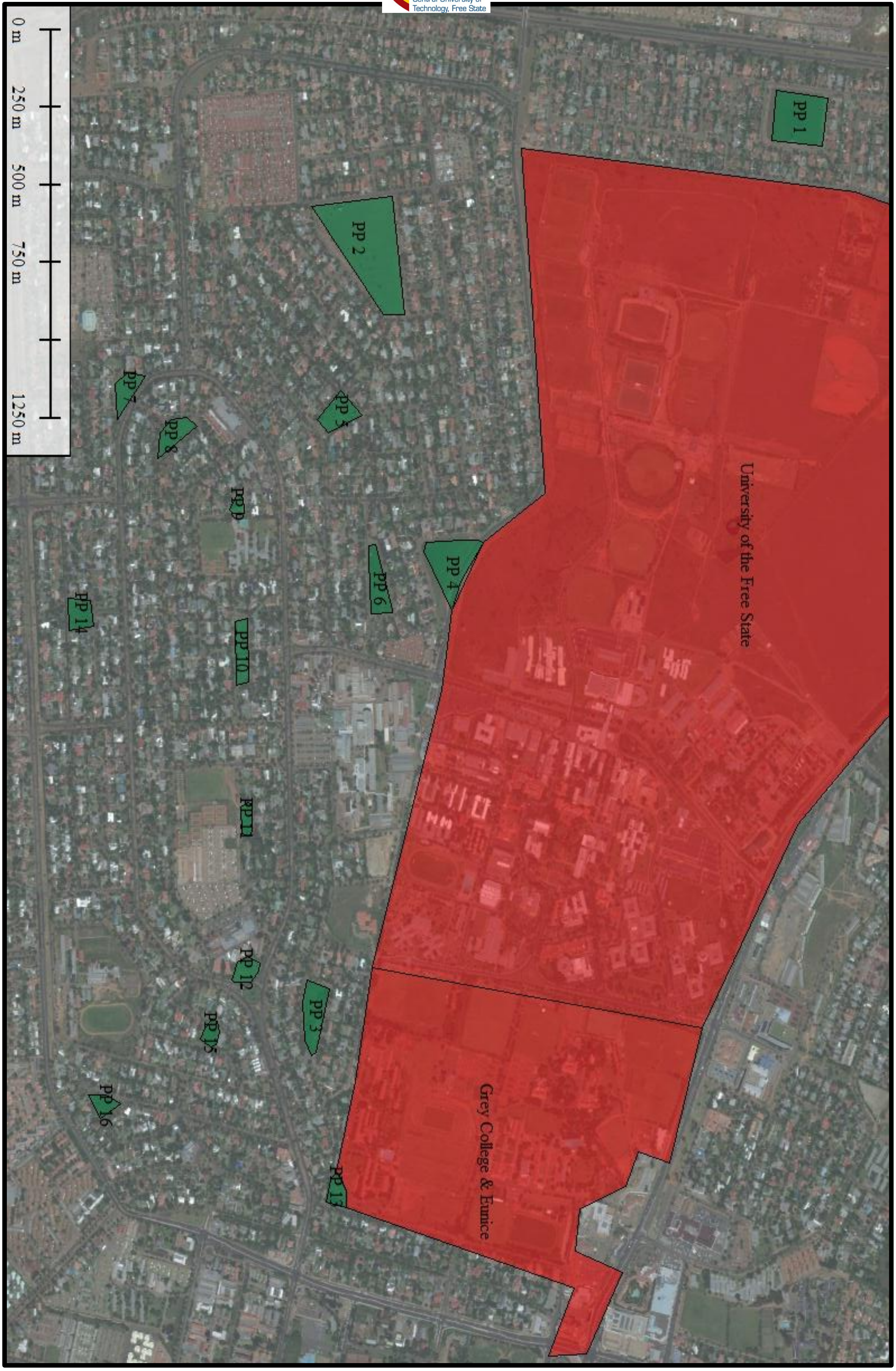
ANNEXURE A

Public Parks Langenhovenpark

Annexure A (Mapsource © GIS Software)

Central University of Technology, Free State

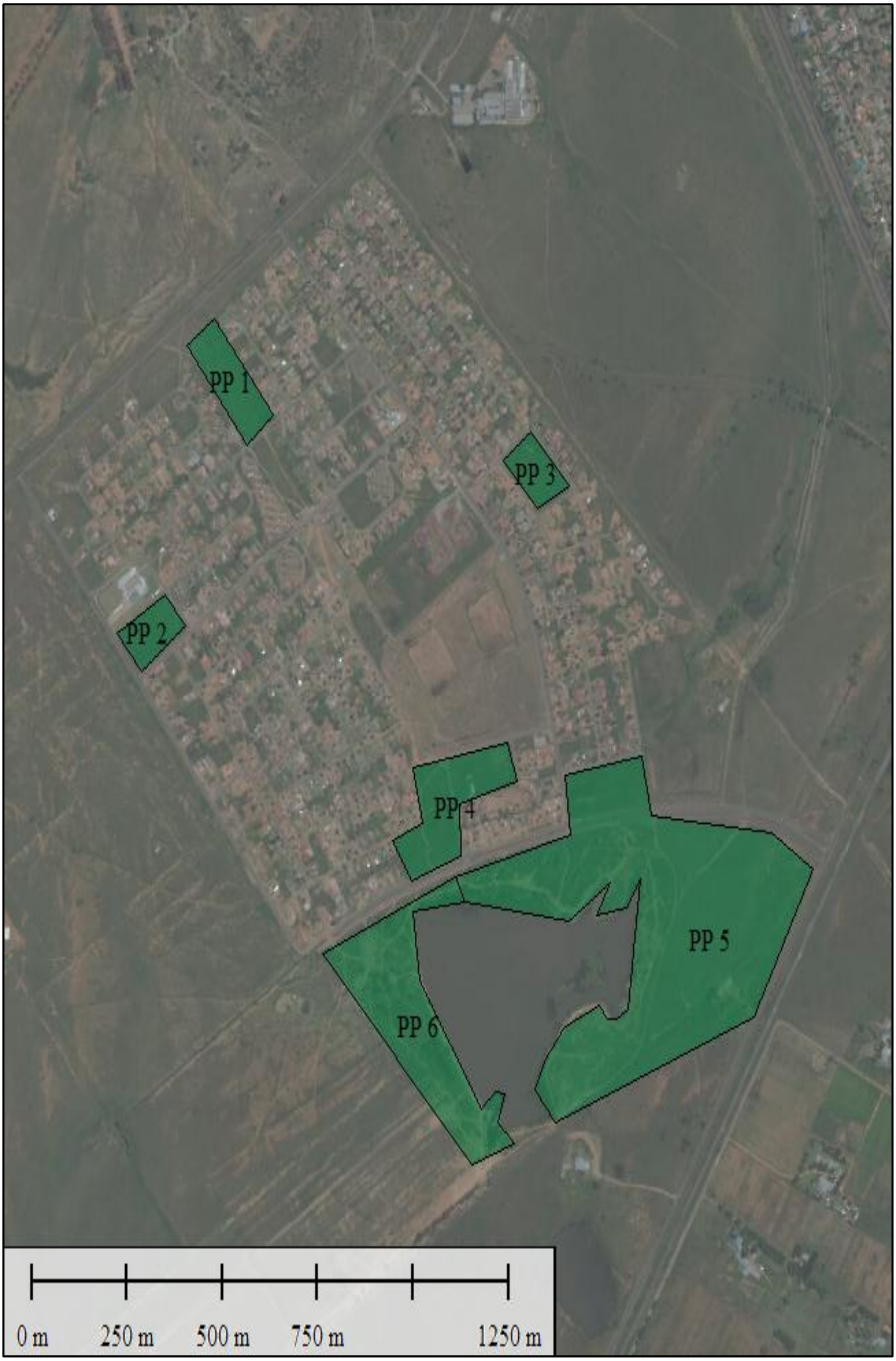
ANNEXURE B
Public Parks Universitas


0 m
250 m
500 m
750 m
1250 m
PP 1
PP 2
PP 3
PP 4
PP 5
PP 6
PP 7
PP 8
PP 9
PP 10
PP 11
PP 12
PP 13
PP 14
PP 15
PP 16
University of the Free State
Grey College & Eunice

ANNEXURE C
Public Parks Batho

PP 1
PP 2
PP 3
PP 4
PP 5
PP 6
PP 7
125 m
375 m
625 m
875 m

ANNEXURE D
Public Parks Lourie Park


PP 1
PP 2
PP 3
PP 4
PP 5
PP 6
0 m
250 m
500 m
750 m
1250 m

Central University of Technology, Free State

ANNEXURE E
Household Survey

PUBLIC PARKS IN URBAN RESIDENTIAL 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 the open recreational 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 (usability)					
Comfort and image					
Sociability					
Proximity					
Convenience					

6. How important are the following characteristics when making 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 (usability)					
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 improve the 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
- ○ Living with house mates

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 monthly 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?

ANNEXURE F
Model Simulations

Constant = 1567.7877	
Coefficients	
X1	**1584.8412**
X2	**42.6538**
X3	**0.0018**
X4	**34.9638**

Y= -1567.7877 (Constant) + 1584.8412(X1) + 42.6538(X2) + 0.0018 (X3) + 34.9638(X4)

SIMULATION #	**AVERAGE # USERS PER MONTH**	**ROAD NETWORK TO PAVEMENT NETWORK RATIO (%)**	**NUMBER OF ACCESS STREETS INTO PARK**	**AREA OF PARK (m²)**	**LIGHT OF PARK IN EVENINGS MEASURED IN LUMENS (lux)**
	Y	**x1**	**x2**	**x3**	**x4**
AVEARGE	**235**	**0.90**	**4**	**33286**	**4.232**
1	**0**	0.50	4	33286	4.232
2	**0**	0.55	4	33286	4.232
3	**0**	0.60	4	33286	4.232
4	**0**	0.65	4	33286	4.232
5	**0**	0.70	4	33286	4.232
6	**0**	0.75	4	33286	4.232
7	**79**	0.80	4	33286	4.232
8	**158**	0.85	4	33286	4.232
9	**237**	0.90	4	33286	4.232
10	**316**	0.95	4	33286	4.232
11	**396**	1.00	4	33286	4.232
12	**109**	0.90	1	33286	4.232
13	**152**	0.90	2	33286	4.232
14	**194**	0.90	3	33286	4.232
15	**237**	0.90	4	33286	4.232
16	**280**	0.90	5	33286	4.232
17	**322**	0.90	6	33286	4.232
18	**365**	0.90	7	33286	4.232
19	**408**	0.90	8	33286	4.232
20	**450**	0.90	9	33286	4.232
21	**493**	0.90	10	33286	4.232
22	**180**	0.90	4	1500	4.232

23	**181**	0.90	4	2000	4.232
24	**182**	0.90	4	2500	4.232
25	**183**	0.90	4	3000	4.232
26	**183**	0.90	4	3500	4.232
27	**184**	0.90	4	4000	4.232
28	**185**	0.90	4	4500	4.232
29	**186**	0.90	4	5000	4.232
30	**187**	0.90	4	5500	4.232
31	**188**	0.90	4	6000	4.232
32	**189**	0.90	4	6500	4.232
33	**190**	0.90	4	7000	4.232
34	**191**	0.90	4	7500	4.232
35	**192**	0.90	4	8000	4.232
36	**192**	0.90	4	8500	4.232
37	**193**	0.90	4	9000	4.232
38	**194**	0.90	4	9500	4.232
39	**195**	0.90	4	10000	4.232
40	**196**	0.90	4	10500	4.232
41	**197**	0.90	4	11000	4.232
42	**198**	0.90	4	11500	4.232
43	**199**	0.90	4	12000	4.232
44	**200**	0.90	4	12500	4.232
45	**201**	0.90	4	13000	4.232
46	**201**	0.90	4	13500	4.232
47	**202**	0.90	4	14000	4.232
48	**203**	0.90	4	14500	4.232
49	**204**	0.90	4	15000	4.232
50	**205**	0.90	4	15500	4.232
51	**206**	0.90	4	16000	4.232
52	**207**	0.90	4	16500	4.232
53	**208**	0.90	4	17000	4.232
54	**209**	0.90	4	17500	4.232
55	**210**	0.90	4	18000	4.232
56	**210**	0.90	4	18500	4.232
57	**211**	0.90	4	19000	4.232
58	**212**	0.90	4	19500	4.232

59	**213**	0.90	4	20000	4.232
60	**214**	0.90	4	20500	4.232
61	**215**	0.90	4	21000	4.232
62	**216**	0.90	4	21500	4.232
63	**217**	0.90	4	22000	4.232
64	**218**	0.90	4	22500	4.232
65	**219**	0.90	4	23000	4.232
66	**219**	0.90	4	23500	4.232
67	**220**	0.90	4	24000	4.232
68	**221**	0.90	4	24500	4.232
69	**222**	0.90	4	25000	4.232
70	**223**	0.90	4	25500	4.232
71	**224**	0.90	4	26000	4.232
72	**225**	0.90	4	26500	4.232
73	**226**	0.90	4	27000	4.232
74	**227**	0.90	4	27500	4.232
75	**228**	0.90	4	28000	4.232
76	**228**	0.90	4	28500	4.232
77	**229**	0.90	4	29000	4.232
78	**230**	0.90	4	29500	4.232
79	**231**	0.90	4	30000	4.232
80	**232**	0.90	4	30500	4.232
81	**233**	0.90	4	31000	4.232
82	**234**	0.90	4	31500	4.232
83	**235**	0.90	4	32000	4.232
84	**236**	0.90	4	32500	4.232
85	**237**	0.90	4	33000	4.232
86	**237**	0.90	4	33500	4.232
87	**238**	0.90	4	34000	4.232
88	**239**	0.90	4	34500	4.232
89	**240**	0.90	4	35000	4.232
90	**241**	0.90	4	35500	4.232
91	**242**	0.90	4	36000	4.232
92	**243**	0.90	4	36500	4.232
93	**244**	0.90	4	37000	4.232
94	**245**	0.90	4	37500	4.232

95	**246**	0.90	4	38000	4.232
96	**246**	0.90	4	38500	4.232
97	**247**	0.90	4	39000	4.232
98	**248**	0.90	4	39500	4.232
99	**249**	0.90	4	40000	4.232
100	**250**	0.90	4	40500	4.232
101	**251**	0.90	4	41000	4.232
102	**252**	0.90	4	41500	4.232
103	**253**	0.90	4	42000	4.232
104	**254**	0.90	4	42500	4.232
105	**255**	0.90	4	43000	4.232
106	**255**	0.90	4	43500	4.232
107	**256**	0.90	4	44000	4.232
108	**257**	0.90	4	44500	4.232
109	**258**	0.90	4	45000	4.232
110	**259**	0.90	4	45500	4.232
111	**260**	0.90	4	46000	4.232
112	**261**	0.90	4	46500	4.232
113	**262**	0.90	4	47000	4.232
114	**263**	0.90	4	47500	4.232
115	**264**	0.90	4	48000	4.232
116	**264**	0.90	4	48500	4.232
117	**265**	0.90	4	49000	4.232
118	**266**	0.90	4	49500	4.232
119	**267**	0.90	4	50000	4.232
120	**124**	0.90	4	33286	1
121	**159**	0.90	4	33286	2
122	**194**	0.90	4	33286	3
123	**229**	0.90	4	33286	4
124	**264**	0.90	4	33286	5
125	**299**	0.90	4	33286	6
126	**334**	0.90	4	33286	7
127	**369**	0.90	4	33286	8
128	**404**	0.90	4	33286	9
129	**439**	0.90	4	33286	10
130	**474**	0.90	4	33286	11

131	**509**	0.90	4	33286	12
132	**544**	0.90	4	33286	13
133	**579**	0.90	4	33286	14
134	**614**	0.90	4	33286	15
135	**649**	0.90	4	33286	16
136	**683**	0.90	4	33286	17
137	**718**	0.90	4	33286	18
138	**753**	0.90	4	33286	19
139	**788**	0.90	4	33286	20
140	**1000**	1	5	39000	20
141	**0**	0.50	4	33286	4.232
142	**0**	0.55	1	33286	4.232
143	**0**	0.60	2	33286	4.232
144	**0**	0.65	3	33286	4.232
145	**0**	0.70	4	33286	4.232
146	**42**	0.75	5	33286	4.232
147	**164**	0.80	6	33286	4.232
148	**286**	0.85	7	33286	4.232
149	**408**	0.90	8	33286	4.232
150	**530**	0.95	9	33286	4.232
151	**438**	1.00	5	33286	4.232
152	**0**	0.50	4	1500	4.232
153	**0**	0.55	4	6350	4.232
154	**0**	0.60	4	11200	4.232
155	**0**	0.65	4	16050	4.232
156	**0**	0.70	4	20900	4.232
157	**0**	0.75	4	25750	4.232
158	**74**	0.80	4	30600	4.232
159	**162**	0.85	4	35450	4.232
160	**250**	0.90	4	40300	4.232
161	**338**	0.95	4	45150	4.232
162	**426**	1.00	4	50000	4.232
163	**0**	0.50	4	33286	1.000
164	**-0**	0.55	4	33286	3.000
165	**0**	0.60	4	33286	5.000
166	**0**	0.65	4	33286	7.000

167	**87**	0.70	4	33286	9.000
168	**236**	0.75	4	33286	11.000
169	**385**	0.80	4	33286	13.000
170	**534**	0.85	4	33286	15.000
171	**683**	0.90	4	33286	17.000
172	**833**	0.95	4	33286	19.000
173	**947**	1.00	4	33286	20.000
174	**52**	0.90	1	1500	4.232
175	**103**	0.90	2	6350	4.232
176	**155**	0.90	3	11200	4.232
177	**206**	0.90	4	16050	4.232
178	**257**	0.90	5	20900	4.232
179	**309**	0.90	6	25750	4.232
180	**360**	0.90	7	30600	4.232
181	**412**	0.90	8	35450	4.232
182	**463**	0.90	9	40300	4.232
183	**310**	0.90	5	50000	4.232
184	**0**	0.90	1	33286	1.000
185	**109**	0.90	2	33286	3.000
186	**221**	0.90	3	33286	5.000
187	**334**	0.90	4	33286	7.000
188	**446**	0.90	5	33286	9.000
189	**559**	0.90	6	33286	11.000
190	**672**	0.90	7	33286	13.000
191	**784**	0.90	8	33286	15.000
192	**897**	0.90	9	33286	17.000
193	**1009**	0.90	10	33286	19.000
194	**831**	0.90	5	33286	20.000
195	**67**	0.90	4	1500	1.000
196	**146**	0.90	4	6350	3.000
197	**224**	0.90	4	11200	5.000
198	**303**	0.90	4	16050	7.000
199	**381**	0.90	4	20900	9.000
200	**460**	0.90	4	25750	11.000
201	**539**	0.90	4	30600	13.000
202	**617**	0.90	4	35450	15.000

203	**696**	0.90	4	40300	17.000
204	**775**	0.90	4	45150	19.000
205	**818**	0.90	4	50000	20.000
206	**0**	0.50	4	1500	4.232
207	**0**	0.55	1	6350	4.232
208	**0**	0.60	2	11200	4.232
209	**0**	0.65	3	16050	4.232
210	**0**	0.70	4	20900	4.232
211	**28**	0.75	5	25750	4.232
212	**159**	0.80	6	30600	4.232
213	**290**	0.85	7	35450	4.232
214	**420**	0.90	8	40300	4.232
215	**551**	0.95	9	45150	4.232
216	**682**	1.00	10	50000	4.232
217	**0**	0.50	4	1500	1.000
218	**0**	0.55	4	6350	3.000
219	**0**	0.60	4	11200	5.000
220	**0**	0.65	4	16050	7.000
221	**65**	0.70	4	20900	9.000
222	**222**	0.75	4	25750	11.000
223	**380**	0.80	4	30600	13.000
224	**538**	0.85	4	35450	15.000
225	**696**	0.90	4	40300	17.000
226	**854**	0.95	4	45150	19.000
227	**1012**	1.00	4	50000	21.000
228	**67**	0.90	4	1500	1.000
229	**18**	0.90	1	6350	3.000
230	**139**	0.90	2	11200	5.000
231	**260**	0.90	3	16050	7.000
232	**381**	0.90	4	20900	9.000
233	**503**	0.90	5	25750	11.000
234	**624**	0.90	6	30600	13.000
235	**745**	0.90	7	35450	15.000
236	**867**	0.90	8	40300	17.000
237	**988**	0.90	9	45150	19.000
238	**1109**	0.90	10	50000	21.000

239	**0**	0.50	4	33286	1.000
240	**0**	0.55	1	33286	3.000
241	**0**	0.60	2	33286	5.000
242	**0**	0.65	3	33286	7.000
243	**87**	0.70	4	33286	9.000
244	**279**	0.75	5	33286	11.000
245	**470**	0.80	6	33286	13.000
246	**662**	0.85	7	33286	15.000
247	**854**	0.90	8	33286	17.000
248	**1046**	0.95	9	33286	19.000
249	**1238**	1.00	10	33286	21.000
250	**145**	0.83	5	9000	4.790
251	**87**	0.87	3	16000	3.420
252	**78**	0.90	3	11730	2.010

ANNEXURE G

Correlation Coefficients of the Surveyed Variables

Reference	*Surveyed Variables*
a	AVERAGE # USERS PER MONTH
b	AVERAGE TRAVEL DISTANCE IN SERVICE AREA
c	SERVICE AREA ROAD NETWORK LENGTH
d	SERVICE AREA PAVEMENT NETWORK LENGTH
e	ROAD NETWORK TO PAVEMENT NETWORK RATIO (%)
f	AVERAGE LANE WIDTHS
g	AVERAGE PAVEMENT WIDTH
h	PARKING TYPE
i	# OF PARKING SPACES
j	ROAD LANE CONDITION
k	PEDESTRIAN PAVEMENT CONDITION
l	PARK ACCESS TYPE
m	AVERAGE VEHICLE SPEED
n	PLAYGROUND?
o	MAINTAINED CONDITION
p	AREA
q	SERVICE AREA
r	POPULATION IN SERVICE AREA
s	AVERAGE TRAVEL TIME
t	LONGEST SIGHT DISTANCE (meter)
u	SHORTEST SIGHT DISTANCE
v	LIGHT OF PARK AT NIGHT IN LUMENS (lux)
w	NUMBER OF ACCESS STREETS INTO PARK

CORRELATION MATRIX (Pearson's r)

	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w
a	1.0																						
b	-0.3	1.0																					
c	0.1	0.5	1.0																				
d	0.2	0.5	1.0	1.0																			
e	0.8	-0.3	-0.1	0.0	1.0																		
f	0.5	-0.1	-0.1	0.0	0.6	1.0																	
g	0.6	-0.2	0.1	0.1	0.7	0.7	1.0																
h	-0.1	0.4	0.3	0.3	-0.2	0.2	-0.1	1.0															
i	0.6	0.3	0.5	0.5	0.3	0.5	0.3	0.4	1.0														
j	0.0	0.0	0.0	-0.1	-0.2	0.1	-0.5	0.3	0.2	1.0													
k	0.6	-0.4	-0.1	-0.1	0.9	0.5	0.6	-0.1	0.1	-0.4	1.0												
l	0.0	0.3	0.1	0.0	-0.1	0.1	-0.3	0.0	0.4	0.5	-0.2	1.0											
m	0.1	-0.2	0.0	0.0	0.1	-0.2	-0.3	0.2	-0.1	0.3	0.3	-0.1	1.0										
n	-0.2	0.0	0.1	0.1	0.1	-0.4	-0.1	-0.4	-0.3	-0.3	0.2	-0.1	0.3	1.0									
o	-0.5	0.2	-0.3	-0.3	-0.6	-0.7	-0.8	0.2	-0.4	0.3	-0.4	0.1	0.2	0.1	1.0								
p	0.7	0.1	0.1	0.2	0.4	0.7	0.4	0.3	0.9	0.2	0.2	0.4	-0.2	-0.5	-0.4	1.0							
q	0.2	0.6	0.9	0.8	-0.1	0.0	-0.1	0.5	0.8	0.2	-0.2	0.4	0.0	-0.1	-0.1	0.5	1.0						
r	0.3	0.3	0.9	0.9	0.1	-0.1	0.3	0.1	0.5	-0.4	0.1	-0.2	0.0	0.2	-0.4	0.1	0.7	1.0					
s	-0.3	1.0	0.5	0.5	-0.3	-0.1	0.0	0.4	0.3	-0.1	-0.4	0.2	-0.3	0.0	0.2	0.1	0.5	0.4	1.0				
t	0.9	-0.3	0.1	0.2	0.7	0.7	0.7	0.1	0.7	0.0	0.5	0.0	0.0	-0.3	-0.6	0.7	0.2	0.2	-0.2	1.0			
u	0.4	0.0	-0.1	-0.1	0.5	0.9	0.7	0.0	0.5	-0.1	0.4	0.2	-0.4	-0.3	-0.7	0.7	0.0	-0.1	0.1	0.6	1.0		
v	0.8	-0.4	0.0	0.1	0.6	0.2	0.5	-0.1	0.3	-0.4	0.6	-0.2	0.2	0.0	-0.3	0.3	0.0	0.3	-0.3	0.8	0.2	1.0	
w	0.6	0.0	0.5	0.6	0.3	-0.1	0.2	0.0	0.4	0.0	0.2	-0.2	0.3	0.3	-0.3	0.2	0.3	0.7	0.0	0.5	-0.2	0.5	1.0