

**The Level of Awareness and Perceptions  
on Rooftop Gardens: Case of eThekweni  
Municipality City Centre**

By

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**February 2017**

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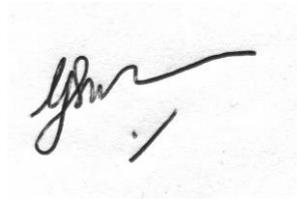
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**GARY STUART DAVID LEONARD**

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**PRINEESA PILLAY**

**17 June 2016**

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## **ABSTRACT**

Currently, cities across the globe experience a number of environmental, economic and social concerns and challenges. Central among these are: climate change, food security and unemployment in the urban centre. This research study looks at the concept of rooftop gardens in the urban centre as a means to mitigate some of these issues. With the current state of dwindling resources in South Africa, re-purposing, recycling and the environmentally-friendly use of city space is of paramount importance. The purposeful design of green cities is one of the ways that a city in the twenty-first century can become increasingly resilient and achieve sustainable growth.

The central aim of the study was to determine the level of awareness and perceptions on rooftop gardens. The area in which the study takes place is eThekweni Municipality city centre. Main objectives of this study are assessing the levels of awareness on rooftop gardens, to examine the perceptions on rooftop gardens and review local and international literature and experiences on rooftop gardens. The use of both qualitative and quantitative data methods were chosen for the methodology of the study and involved the use of questionnaires, interviews, spatial mapping as well as observation. The snowball technique of sampling was prominent in the study in order to achieve the required sample size.

The study revealed that many people have a positive reaction towards urban rooftop gardens. However, the main reason why they not developed on a larger scale in the city is because people do not have extensive information about their overall concept. Not all city rooftops will be able to accommodate rooftop gardens. Accordingly, a full engineering audit needs to be conducted in this regard. There is also a need to look at the existing guidelines so that these can be developed into a formal policy or legislation by the municipal authorities. The recommendations that have been put forward have been based on the results that were collected from the field study.

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## **GLOSSARY OF ACRONYMS AND ABBREVIATIONS**

<b>100 RC</b>	100 Resilient Cities (Rockefeller Foundation)
<b>ANC</b>	African National Congress
<b>CBD</b>	Central Business District
<b>CED</b>	Community Economic Development
<b>CGRIF</b>	Chicago's Green Roof Improvement Fund
<b>FAO</b>	Food and Agricultural Organisation of the United Nations
<b>GBA</b>	Green Buildings Approach
<b>GDA</b>	Green Design Approach
<b>GDT</b>	Green Development Theory
<b>GIS</b>	Geographic Information Systems
<b>IDP</b>	Integrated Development Plan
<b>JDA</b>	Johannesburg Development Agency
<b>JHC</b>	Johannesburg Housing Company
<b>LED</b>	Local Economic Development
<b>MCPP</b>	Municipal Climate Protection Programme
<b>NASA</b>	National Aeronautical and Space Administration
<b>NGO</b>	Non-Governmental Organisation
<b>SLA</b>	Sustainable Livelihoods Approach
<b>SGT</b>	Smart Growth Theory
<b>UHIE</b>	Urban Heat Island Effect
<b>URA</b>	Urban Redevelopment Authority
<b>USA/US</b>	United States of America



# CHAPTER ONE

## INTRODUCTION AND ORIENTATION TO THE STUDY

### 1.1. Introduction

This research project will focus on examining the level of awareness and perceptions on rooftop gardens in the study area: Central Business District of eThekweni Municipality. As Timothy Bealley has stated:

Land use planning to reduce natural hazards is ultimately and fundamentally about promoting a more sustainable human settlement pattern and living more lightly and sensibly on the earth.<sup>1</sup>

The central aims of this study will be to:

- i. Determine the outlook of the general public towards rooftop garden development in the city centre.
- ii. Ascertain whether rooftop gardens can be used successfully on a large scale in the study area chosen.
- iii. Examine whether developing rooftop gardens in the Durban CBD will be a positive use of underutilized roof space.
- iv. Discuss the advantages and limitations to increasing rooftop garden usage in the city centre.
- v. Examine local and international models and designs of urban rooftop gardens.

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<sup>1</sup> Timothy Bealley, Hazards Researcher.

In this chapter, the present researcher will introduce the research topic, the problem statement and the background to the research project. This will include an overview of the aims, objectives and the rationale for the study, and the research questions and sub-questions that will be discussed. Rooftop gardens in city centres are the focus of this study and the case study for this research is located in the city centre of eThekweni Municipality. The central aim of study for this research will focus on the level of awareness and perceptions eThekweni Municipality city residents hold regarding rooftop gardens and its development on city buildings.

This research project will examine the advantages of using this type of strategy to deal with local geo-environmental and socio-economic problems. The focus on the public perception and awareness of rooftop gardens in this study is important for developing appropriate land use guidelines for future studies of the eThekweni city centre as well as developing this method on a larger scale in cities. It is paramount to recognise the level of knowledge and perceptions that the public have on the concept of city rooftop gardening in order to ascertain whether this strategy is an effective and positive use of underutilised roof space in the city.

## **1.2. Background**

The CBD of the city of Durban has large areas of unused roof space and a humid sub-tropical climate that would allow for the planting of fruits and vegetables throughout the year. While eThekweni Metropolitan Municipality considers rooftop gardens in its MCPP, only a guideline for rooftop garden development has been created. In order for eThekweni Metropolitan Municipality to achieve its millennium goal of becoming a sustainable city, urban rooftop gardens need to be brought into the forefront of its discussions and the guidelines need to be transformed into part of an integrated policy document, appropriate by-laws and other legislative measures for the green development of the city.

The coastal city of Durban experiences many environmental and socio-economic issues. These issues include poverty, unemployment, loss of bio-diversity and pollution. Much of these issues can be mitigated with the wider scale development of rooftop gardens in eThekweni Municipality city centre. Currently, the development of

rooftop gardens is low, with roughly three well established gardens within the city centre. In order for this number to increase a number of processes need to occur. It is important to determine the knowledge that the public have about this novel concept. It is also paramount to ascertain the perceptions of inner city rooftop gardens that residents hold.

This study reviews ways in which rooftop gardens are able to contribute positively to a city like eThekweni Municipality which has both socio-economic and environmental issues. The socio-economic problems that are faced by cities can be attributed to the rapid urbanisation process that is occurring worldwide. Environmental problems that result from a lack of proper planning in terms of providing strong linkages between the natural environment and new developments are also prevalent. These processes are discussed using a theoretical framework in order to explain and understand these occurrences. In this research study, the development of city rooftop gardens will be proposed as a scheme to assist with these conditions.

This research study also considered the feasibility of using neglected rooftop space in the Durban CBD to develop gardens and horticultural activities. Such gardens can improve the functionality of a building while providing environmental and socio-economic benefits to individuals and communities that live in the inner city. In this research study, the concept of rooftop gardens will be linked (among others) to the theories of resilient cities, sustainable urbanism, sustainable livelihoods and ecological modernisation.<sup>2</sup> Accordingly, the present researcher will provide a careful and comprehensive examination of how rooftop gardens can contribute to mitigating biodiversity loss, climate change, unemployment and poverty if developed on a larger scale in the eThekweni Metropolitan Municipal area.

### **1.3. Problem Statement**

Currently, there is a lack of studies that focus on the level of knowledge about the concept of rooftop gardens and residents' perceptions on the aspects, especially in a South African context, with a particular focus on the eThekweni Municipality city centre. Hence, this study has been commissioned in order to bridge this gap. This

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<sup>2</sup> See Chapter Three.

research study considers the level of awareness and the level of perceptions that the public have towards rooftop gardening in the city centre. Rooftop gardens in the Durban CBD presently do not get enough encouragement from local government. This has been due in part to the lack of incentives that promote the development of rooftop gardens as well as the lack of knowledge about the concept and its use in the city. The lack of rooftop gardens in the city can also be attributed to the fact that there currently is no formal policy or legislation which takes rooftop gardens into account.

With an urban population of just over 3.4 million and an unemployment rate of 30.2% (Statistics South Africa 2013), eThekweni Metropolitan Municipality is in need of workable strategies to meet the needs of an ever-burgeoning population by increasing the number of job opportunities for those who live in the municipal area. According to the research, large-scale city rooftop gardens are able to bring about an increase in job opportunities by allowing individuals to work in these gardens, making them responsible for maintenance and general upkeep.

Of the 956 713 households in the eThekweni Metropolitan Municipal area, only 11% engage in agricultural production as a means to sustain themselves and their families. In the city, very few individuals, if any, engage in agricultural production. Instead, they are dependent on acquiring the majority of their fresh produce from local fruit and vegetable shops, supermarkets and corner stores within the inner city. In turn, retailers obtain their supplies from local wholesalers who obtain their produce from local growers across South Africa as well as imports from other Southern African and Asian countries (Neikerk *et. al.*, 2011). As a result, transportation costs for moving fresh produce into the city centre are higher which in turn drives up the retail purchase price. Maximising the agricultural potential inherent in rooftop gardens within the urban centre can mitigate this issue.

#### **1.4. Research Objectives**

The objectives of this present research will be:

- i. To assess the level of awareness and perceptions on rooftop gardens.

- ii. To identify the challenges of implementing rooftop gardens.
- iii. To assess the guidelines/policies/legislative instruments on rooftop gardens designing and assess stakeholder roles in implementing rooftop gardens.
- iv. To review local and international literature and experiences on rooftop gardens.
- v. To assess the level of implementation of rooftop gardens in the city centre of eThekweni Municipality.

### **1.5. Main Research Question**

The main research question that will be explored in this research study will be:

**Are rooftop gardens in urban centres an effective way of utilising unused roof space within the Durban CBD?**

#### **1.5.1. Sub-Questions**

From the main question, the following sub-questions that will be posed in this research study will be:

- i. What are the perceptions and level of knowledge of the general public towards the implementation of rooftop gardens in the city centre?
- ii. What ideas can be gleaned from examples in the international, national and local literature that can inform the preparation of policy guidelines for eThekweni Metropolitan Municipality?
- iii. Why are rooftop gardens not used on a larger scale within the Durban CBD and is there legislation that takes rooftop gardens in the city into account?

- iv. Can rooftops in the Durban CBD accommodate the development of rooftop gardens?
- v. What contribution can rooftop gardens make to sustainability, climate change and Local Economic Development (LED) strategies in the Durban CBD?
- vi. What institutional or financial incentives can be provided by the eThekweni Metropolitan Municipality to encourage the establishment of rooftop gardens?

### **1.6. Aim of the Research**

To investigate the level of awareness and perceptions on rooftop gardens within the city centre of eThekweni Municipality.

### **1.7. Rationale for the Study**

The Durban CBD has high levels of unemployment, especially for large numbers of unskilled residents. Furthermore, there is a great deal of under-utilised space above ground level, located on the rooftops of multi-storey buildings in the CBD. Such unused space can provide opportunity for economic and social activity, together with the additional and important spin-off of lowering the carbon footprint of the dense urban inner area through a greening process. Unused roof space can be developed as an environmental and rates-based asset to the eThekweni Metropolitan Municipality, to the benefit of all those who live and work within the urban centre.

Surrounded by concrete high-rise buildings and tarred roads, local residents often lose touch with nature and natural surroundings. There are insufficient green spaces or undisturbed natural areas to create a balance between the natural and built environment. This research study therefore maintains that the establishment of rooftop gardens within the Durban CBD provides a potential solution to this problem. Importantly, rooftop gardens are able to introduce nature back into the city centre, providing the potential to deliver sustainable employment to a sector of unemployed inner-city residents who can sell the produce that is grown. A rooftop garden strategy

is able to benefit inner-city residents who do not have sustainable employment and will allow individuals and families to experience an improved standard of living.

Finally, this research study is important as it can contribute to decreasing poverty in the inner-city as well as improve the economy of the eThekweni Municipal area if developed on a large-enough scale. Green building design, including rooftop gardens, is a twenty-first century development aimed at the future, by minimising the environmental impact of urban development while increasing the functionality of high-rise buildings in the CBD.

## **1.8. Structure**

**Chapter One** will focus on the problem statement, the background and motivation for choosing the research topic, seek answers to the critical questions that will be asked in this research study, thereby meeting the aims and objectives of the work as a whole.

**Chapter Two** will discuss the research methodology chosen for this study, as well as an overview of the techniques and tools that are to be used during the research process as well as why these specific tools were chosen.

**Chapter Three** will concentrate on the theoretical and conceptual framework of the present study. The theoretical departure points will be outlined that relate to a critical analysis of rooftop gardens and the reason for their inclusion within inner city areas. A detailed argument and analysis of the need for rooftop gardens within the Durban CBD will also be provided.

**Chapter Four** contains a literature review on the subject of rooftop gardens. Particular emphasis will be placed on the history, advantages, and challenges of rooftop gardens. In addition, an examination of international and local case studies of rooftop gardens will also be provided.

**Chapter Five** contains the results of the field research, where the understandings, perceptions, benefits and constraints in providing a set of

policy guidelines for the large-scale development of rooftop gardens in the urban centre will be given.

**Chapter Six** will provide concluding comments as well as recommendations towards developing a set of policy guidelines for eThekweni Metropolitan Municipality with respect to the large scale development of rooftop gardens in the urban centre.

## **1.9. Conclusion**

This introductory chapter has focused on the chosen topic of the research and has provided a background and brief overview of what this research dissertation will entail. The aims and objectives of the research have also been discussed as well as the questions and sub-questions that will be answered in the following chapters of this present work.

The focus of this present research work is the wide-scale development of rooftop gardens and the advantages and challenges to this type of garden in the urban centre as well as the strategies, policies and outcomes of such an urban planning exercise. This work will discover why rooftop gardens are currently not used on a large scale in the eThekweni Metropolitan Municipal area and why there is currently no legislation or policy guidelines that takes this type of urban centre planning into account. Finally, the concept of rooftop gardens promulgated in this research project is aimed at mitigating climate change, bio-diversity loss, food security and unemployment in the inner city.

# CHAPTER TWO

## METHODOLOGY

### 2.1. Introduction

This chapter will discuss the research methods that were utilised in the study, the reason for choosing the particular methods, their advantages, and the setbacks experienced during the field study. In addition, a description of how the field research was conducted, the limitations of the study, and the processes that were followed in order to account for the limitations will also be given. The research method that was focussed on in this study was the multi-method approach, using both qualitative and quantitative methods were necessary to answer the research questions put forward in Chapter One.

The research design that was adopted for this study was a case study research design which takes place in eThekweni Municipality city centre. This study made use of both qualitative and quantitative methods in order to achieve the main aim of determining the level of knowledge and to decipher the attitudes that the public have on rooftop gardens in urban centres. The use of questionnaires and interviews were designed for this and to answer the research question and achieve the research objectives. As the central aim of this study is to determine the level of awareness as well as the perceptions that the public have regarding city rooftop gardening, it was necessary to gain information by means of questionnaires including elements of qualitative and quantitative questions.

### 2.2. Understanding Research Methods

Research methodology is a logical or organised way of solving a problem (Rajasekar *et. al.*, 2006), and focuses on studying how the research is to be carried out. In particular, it involves the processes and methods that are used to examine and explain the questions and statements that are described and proposed in a given research topic (Flick 2015). This present research study utilised a multi-method approach, where both qualitative and quantitative research tools were employed.

### ***2.2.1. The Multi-Method Approach: Using Qualitative and Quantitative Research Methods***

This study has made use of both the qualitative and quantitative research tools in order to appropriately answer the main question and the sub-questions and achieve the best outcome for the study.

Qualitative research involves a wide variety of research methods which aim to understand the way people think, their views and opinions on various subjects as well as their own experiences on a particular subject (Hammersley and Campbell 2012). This type of research focuses on the words of the people rather than the numerical factors that are employed in the quantitative method. Examples of qualitative research tools that have been utilised in this study include: interviews, open-ended questionnaires, fieldwork notes, voice recordings and photographs (Saldhana 2011).

For this particular research the qualitative method is being used. The reason for choosing the qualitative research method was to gain an understanding about how people felt about the large-scale development of rooftop gardens in the Durban CBD.

Quantitative research aims to understand the opinions of the people who are involved by addressing the results of the research by analysing the empirical data that was collected by determining the frequency of which the questions were answered (Hammersley and Campbell 2012). The focus of this present research is on numbers rather than words. This research makes use of a multi-method study and the qualitative research guides the close-ended questions that form part of the research questionnaire.

Multi-method study was used in order to address some of the research questions. The quantitative research method was used in order to provide a representative number for the sample. This was done in order to examine different factors and ideas stated in the empirical questions so that generalisations of the questionnaire participants could be made. This type of research was needed in order to apprehend human experiences, knowledge and ideas with regards to the large-scale development of rooftop gardens in the Durban CBD.

The multi-method was used in order to ensure clarity in the findings as the quantitative research questions were backed up by qualitative research. This method has been used as “a tool to attain knowledge...and also to recognise the distinctions that exist between methods and their limitations” (Mthethwa 2012). Each research method accounts for the limitation of the other, which is the reason this method was chosen for this study.

### **2.3. Sources of Data**

A number of sources of data were used in this research study.

#### **2.3.1. Secondary Data Source**

Secondary data refers to information that has already been collected and is used by the researcher (Clark 2013). Secondary data can comprise of information that is available to the public. Examples of secondary data include: government census results, surveys, and previous studies that have previously been conducted (2013). In this present research, the source of the secondary data used was primarily acquired from internet-based resources and included: books, journal articles, municipal publications and other online articles. Secondary information was also gathered from newspaper articles and municipal booklets. The secondary data was utilised in order to assist in answering some of the research questions. The areas covered included:

- i. The main international, national and local debates that provide information on rooftop gardens and their applicability in city centres.
- ii. The ideas which can be gleaned from examples in the international, national and local literature which could inform the preparation of policy guidelines for eThekweni Metropolitan Municipality.
- iii. To explain the advantages of developing rooftop gardens on a large-scale in the Durban CBD.
- iv. To determine what existing research provides about the human perceptions of large-scale rooftop gardens in the urban centre.

### *2.3.2. Primary Data Source*

Primary data refers to information that is collected first-hand by the researcher. It is owned by the researcher and the information that is gained is tailored to the researchers needs (O’Leary 2013). An example of primary data is that of conducting interviews or distributing questionnaires in order to gain knowledge of peoples’ experiences or opinions about a particular subject (2013). For the present research, the primary data collected was acquired through a number of study techniques such as questionnaires, interviews, observation and a site visit. This was done in order to gain an understanding of the perceptions, knowledge and ideas that people have about the development of rooftop gardens on a large-scale in the Durban CBD.

The following research techniques have been used in order to answer the research questions.

#### *2.3.2.1. Questionnaires*

The sampling frame for the questionnaires was acquired from those who live or work in the Durban CBD, the Umhlanga CBD and the Queensburgh area. The reason why questionnaires were given to people who live or work in the Durban CBD was due to the fact that this was the chosen case study area and it was necessary to gain the ideas and opinions of those who live and work in the inner city. Questionnaires were also given out to people who live or work in the Umhlanga CBD because rooftop gardens are being introduced on a large scale there. This fact was discovered during the interview process with one of the key-informants. Questionnaires were forwarded to people in and around the area of Queensburgh because it was known that the people who participated in the questionnaire travelled into the Durban CBD on a regular to semi-regular basis. It was important to gather the opinions of these people so as to have a representation of how people who live outside the CBD feel about developing rooftop gardens in the inner city. The same questionnaire was forwarded to seven built-environment specialists in the provinces of KwaZulu-Natal and Gauteng.

The questionnaire was conducted in order to determine the following:

- i. Whether there is an awareness of the concept of rooftop gardens.

- ii. To gauge the perceptions and ideas of about rooftop gardens in the urban centre.
- iii. Whether people believe that rooftop gardens are an effective way of filling up unused rooftop space in the Durban CBD.
- iv. Whether people believe that rooftop gardens should form part of building legislation or policy of the eThekweni Metropolitan Municipality.

The questionnaires were delivered via the post office and not by hand. Questionnaires were also e-mailed to groups who live or work in the Durban and Umhlanga CBD. Questionnaire were also handed-out to individuals living near or within the Queensburgh area. The sampling method that was used for this group was snowball sampling.<sup>3</sup>

#### 2.3.2.2. *Interviews*

Interviews were conducted with five key-informants. These five key informants had extensive experience with the development of rooftop gardens within the eThekweni Metropolitan Municipality, three of which had been directly involved with constructing the eThekweni Metropolitan Municipality Green Roof Pilot Project Handbook as well as the construction of the rooftop garden itself. One key-informant was an architect who had extensive experience with the development of rooftop gardens across the province of KwaZulu-Natal. An interview was also conducted with an individual who had experience working on the largest rooftop garden in the Durban city centre, this interview being conducted during a site visit to the Priority Zone Rooftop Garden. Three of the five interviews took place face-to-face while the remaining two interviews were by e-mail correspondence as this was a more convenient option for the interviewees.

The information that was provided by these key-informants is described as follows:

- i. The models and materials that were used to design rooftop gardens that the key-informants have been involved in.

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<sup>3</sup> This will be discussed further under Sampling Procedures below.

- i. Provide information of other rooftop garden projects in KwaZulu-Natal and across the country.
- ii. Determine the successes and failures of developing rooftop gardens in the city centre.
- iii. To find out why rooftop gardens are not being used on a large-scale in the eThekweni Metropolitan Municipal area.
- iv. To ascertain what tools can be used to encourage the large-scale development of rooftop gardens in the Durban CBD.

The information that was set out to be discovered was provided during the interview process. The professionals that were interviewed were determined by information that was gathered by the researcher as well as through referrals by the professionals that were interviewed.

#### 2.3.2.3. *Mapping*

The process of mapping was used to survey the case-study area. This was done in order to determine the extent of the study area as well as to find out the extent of the development of rooftop gardens in the Durban CBD.

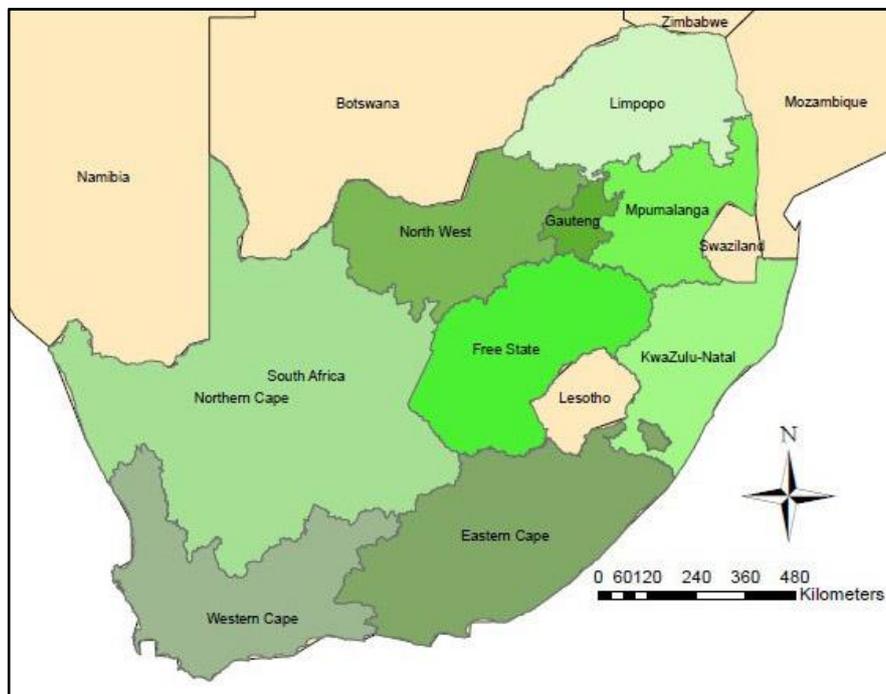
#### 2.3.2.4. *Observation*

Observation is a method of mapping that uses the researchers own senses to gather information about the topic being researched (Kanter *et al.*, 2014). For this present research project, the technique of observation was used to first discover the amount of rooftop space in the Durban CBD that was unused. From this observation it was determined that the large-scale development of rooftop gardens in the Durban CBD would be beneficial for all those who both live and/or work in the urban centre. It was further observed that there were high levels of unemployment and poverty of those living in the Durban CBD and rooftop gardens could be a means to assist with this

socio-economic problem. It was also observed that air temperatures were higher in the Durban CBD and rooftop gardens could be used as a method to mitigate this.

## 2.4. Sampling Procedure

South Africa, which is situated on the continent of Africa, is made up of nine administrative provinces.<sup>4</sup> This study was conducted in the province of KwaZulu-Natal which is situated in the southeast of the country, sharing a long coastline beside the Indian Ocean, bordering three other provinces and the countries of Mozambique, Swaziland and Lesotho.<sup>5</sup> KwaZulu-Natal is made up of a number of metropolitan municipalities and this study focuses on the eThekweni Metropolitan Municipal area and specifically, the CBD of the coastal city of Durban.<sup>6</sup>



**Map 2.1.**

Provincial Map of South Africa  
(Source: ArcGIS, Researcher 2015)

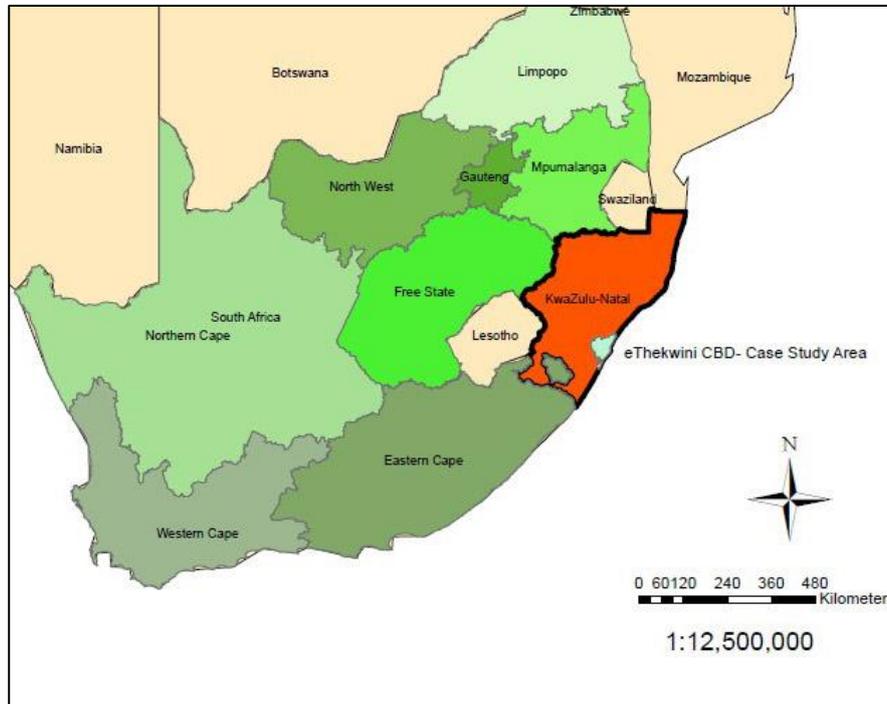
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<sup>4</sup> See Map 2.1. below.

<sup>5</sup> See Map 2.2. below.

<sup>6</sup> See Map 2.2. below.

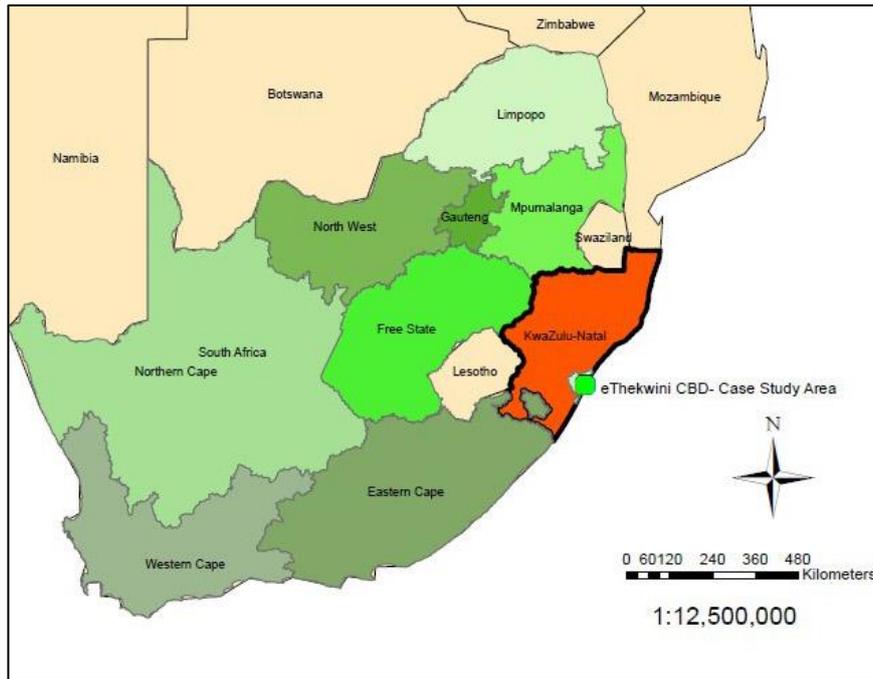
Map 2.1 above showcases the location of the nine provinces of South Africa. This study has its focus in the KwaZulu-Natal province of South Africa which is highlighted in Map 2.2 below. Map 2.3 below highlights the location of this study, that is, the eThekweni Municipality city centre.



**Map 2.2.**

Location of the Province of KwaZulu-Natal and eThekweni / Durban CBD

(Source: ArcGIS, Researcher 2015)



**Map 2.3.**

Location of the Research Study  
 (Source: ArcGIS, Researcher 2015)

#### **2.4.1. Sample Size**

The sampling frame of this study was acquired from those who live/work in the Durban CBD, uMhlanga CBD and residents around the Queensburgh area. In order to achieve the sample size the purposive sampling method was used in order to select the first and known experts and residents who live/work in the case study area. After the initial group was selected for the study, the present researcher thereafter used the snowball sampling method. A sample size of thirty-five was used as it allows for adequate information to be gathered for the study by the researcher. If the number of variables exceeds thirty then the variation and distribution can be seen graphically with the central limit theory (Resnick 2014). This will result in the formation of a bell-shaped graph which will adequately show the distribution of the independent variables (2014). The sample size includes various groups and although will not be representative of the entire population of eThekweni Metropolitan Municipal area, it will allow for an adequate representative sample so as to make an observation and generalisation.

### ***2.4.2. Purposive Sampling***

Purposive sampling involves choosing a sample group for a specific reason in order to meet a criterion of a study (Lewis et.al 2013). Participants are therefore chosen in order to assist in reaching the aims and objectives of the study. The criterion for this present research was that participants chosen were required to either live or work in the eThekweni CBD or uMhlanga CBD.

### ***2.4.3. Snowball Sampling***

Snowball sampling is used for acquiring participants who are suitable for the study. An initial cohort is selected and from this group other relevant people are contacted and invited to participate in the study (Bryman 2012). The snowball sampling method was used in order to acquire the appropriate sample size from groups that were required to have a certain characteristic. In the case of this research, the required characteristic were participants who live or work in the Durban or Umhlanga CBDs. Following the determination of the initial group of participants, others were contacted and invited to participate in the study. The age-span of the selected study participants ranged from 22 to 60 years. The following two tables break down the sample size into gender as well as racial orientation.

<b>Females</b>	<b>Males</b>
23	12

**Table 2.1**  
Number of Male / Female Research Participants

The table above shows a higher number of female participants in the research process, this number occurred as a result of the process of purposive and snowball sampling.

<b>Race</b>	<b>Number of Participants</b>
Indian	20
White	9
Black	4
Coloured	2
Total	35

**Table 2.2**  
Breakdown in Terms of Racial Orientation

The racial breakdown of this study like the gender breakdown mentioned above is attributed to the snowball and purposive sampling method which contributed to the sample of this research.

## **2.5. Data Analysis**

Having collected the data from the questionnaires and interviews, the present researcher reviewed each response and this was tabulated and analysed using Microsoft Word and Microsoft Excel computer software programmes. The responses were analysed in order to answer to study questions and reach the research aims and objectives of discovering the level of awareness and perception that eThekwin city centre residents hold of the concept of rooftop gardens. The questions that were answered by the data analysis included determining the outlook of the general public towards rooftop garden development in the city centre, examining whether developing rooftop gardens in the Durban CBD will be a positive use of underutilized roof space and why rooftop gardens are not used on a larger scale within the Durban CBD and if there is legislation that takes rooftop gardens in the city into account.

The graphs and tables in this study were created by the present researcher using Microsoft Excel to grasp the level of knowledge of the participants regarding the topic of rooftop gardens. The data analysis aided in achieving the aim of this research study

which was to examine the advantages of rooftop gardens and to determine the level of awareness and perceptions of residents in eThekweni Municipality city centre.

## **2.6. Problems Encountered in the Fieldwork**

It was anticipated that a number of limitations might impact the research. These were as follows:

- i. Initially, the researcher planned acquiring a list of buildings in the city centre which would be able to withstand the additional load that would be imposed by rooftop gardens. This list was meant to be retrieved from the eThekweni Engineering Department, but following consultation with city officials it was discovered that such a listing did not exist. This audit has yet to be conducted. In order to deal with this setback, key stakeholders were identified, whereupon interviews were conducted.
- ii. Due to the absence of a list of buildings in the city centre which would be able to withstand the additional load that would be imposed by rooftop gardens, a questionnaire was constructed and given out to individuals who live and/or work in the Durban and Umhlanga CBDs as well as those who reside in the Western suburb of Queensburgh and surrounding areas. A sample size of thirty-five was chosen for reasons that have been explained above.
- iii. A setback that occurred was that a few of the individuals who were asked to participate did not agree to participate in the study.
- iv. To deal with this setback the sample size was increased to ensure that more than enough participants were chosen. This was done by including individuals who live in and around the Queensburgh area.

## **2.7. Conclusion**

This chapter has dealt with the methods that have been utilised in the study in terms of how the questionnaires and interviews were developed and conducted. Reasons were

given as to how they were conducted and what information was expected to be gained through the questionnaire and interview processes. The snowball sampling method was used in the present study in order to gain an adequate number of participants with the necessary characteristics. Questionnaires were distributed to thirty-five willing participants as this was considered to be a sufficient sample to make an observation on the central limits theorem scale and would result in a variety of different opinions and views about the development and existence of rooftop gardens in the city centre.

This chapter also dealt with the problems experienced during the research. The main problem concerned the absence of a recorded list of buildings in the Durban CBD that could withstand the load associated with the development of rooftop gardens. As a consequence, it was necessary to identify various stakeholders of rooftop gardens to discuss their perceptions and determine their ideas of national models of rooftop garden design. There was also a questionnaire conducted with people who live and/or work in the Durban and Umhlanga CBDs. Likewise, questionnaires were given to built-environment professionals identified across the country. Questionnaires were also given to people who reside in and around the Queensburgh area for reasons that have been mentioned in this chapter.

## CHAPTER THREE

### CONCEPTUAL FRAMEWORK

#### 3.1. Introduction

This chapter will focus on the concepts utilised in this study, with special attention paid to their meaning and relevance in the context of the research. The chapter will then discuss several contextual theories that are relevant to the topic as well as why these theories were considered important to this study. Some of the theories that will be discussed in-depth include: the sustainable livelihoods approach, the green design approach, and finally the theory of ecological modernisation. The concepts and theories discussed below assist in understanding the concept of rooftop gardening in the city, reasons for choosing this strategy and how this method can be a useful addition to city rooftops.

#### 3.2. Defining Concepts

There are a number of concepts that have informed the theoretical framework of this research.<sup>7</sup>

##### 3.2.1. Rooftop Gardens

Rooftops gardens, also known as green roofs, have several important aesthetic and environmental functions. These include: decreasing surface temperatures, filtering air and storm-water, providing aesthetic beauty to the urban space as well as increasing the lifespan of rooftop surfaces (Mahdeloie *et al.*, 2012). The vegetation planted in rooftop gardens can consist of flowering plants, fruits, vegetables or other indigenous vegetation. Plants on rooftop gardens are often exposed to extreme weather conditions from the sun as well as windy conditions. Accordingly, the vegetation utilised in rooftop gardens must be able to withstand the harsh weather conditions present in the sub-tropical coastal climate of KwaZulu-Natal.

Plant resilience and compatibility need to be factored into the design of sustainable rooftop areas. In the case of the eThekweni Metropolitan Municipal area, suitable

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<sup>7</sup> Rooftop gardens and green roof concepts will be mentioned interchangeably throughout this study.

plants include *Asparagus densifloris* and *Aloe maculata* among others (Lewis *et al.*, 2012). Rooftop gardens can provide food to those who require it, especially within urban centres.

This study aims to discover the level of awareness and the perceptions that the general public hold with regards to this concept. This will be done in order to determine whether city rooftop gardening can be used successfully on a larger scale in the study area and to examine whether this strategy will be a positive use of space in the eThekweni Metropolitan Municipal city centre.

### ***3.2.2. Urban Heat Island Effect***

The Urban Heat Island Effect (UHIE) refers to an increase in air and surface temperatures within urban areas as a result of the concentration of hard dark surfaces such as asphalt roads, concrete buildings and pavements (Oberndorfer *et al.*, 2007). These dark surfaces absorb the sun's heat during the day and slowly release this warmth at night (Lui 2003). The result is a general increase in surface and air temperatures within the urban centre or in areas where hard surfaces are concentrated.

The UHIE occurs mainly in the summer months when air temperatures reach their highest point. According to satellite studies conducted by the US-based National Aeronautical and Space Administration (NASA), there is at least a five degree centigrade difference in temperature observed between urban centres and the surrounding suburbs (Mahdeloie *et al.*, 2012). The increased heat within city centres results in greater amounts of energy being required to cool buildings down and consequently more money being spent on air-conditioning during the summer months.

The phenomenon of UHIE is related to the study in that rooftop gardens are able to decrease the effects of the urban heat island by decreasing temperatures in the city. This study examines the manner in which the UHIE occurs within urban centres and cities and how the development of rooftop gardens can mitigate it and contribute to sustainability in the city. More green spaces within the city results in less heat being

stored on the hard, dark concrete and asphalt surfaces prominent in a city environment. As a result, cities become cooler. This forms one of the major environmental benefits of rooftop gardens as they are able to mitigate the effects of the UHIE.

### **3.2.3. *Climate Change***

Climate change refers to the general increase of air temperatures around the world which the majority of scientists maintain is due to the increased amount of carbon dioxide in the earth's atmosphere caused mainly by air pollution (Riordan and Rundel 2014). Air pollution has a variety of sources, including: discharges from factories and internal combustion-engined vehicle exhaust systems and other carbon emissions which are in higher concentrations in the atmosphere. Carbon dioxide and the burning of fossil fuels such as oil, coal and gas become trapped in the atmosphere and absorb the heat from the sun. This absorption of heat results in increased air temperatures which is often referred to as climate change (Williams *et al.*, 2010).

The establishment of rooftop gardens can contribute to a decrease in the impact of climate change by reducing the carbon footprint of the city centre (Greenstone 2009). This is why the concept of climate change is relevant to this study. Rooftop gardens are able to mitigate the effects of climate change at a local level as these gardens result in cooling ambient air temperatures. Accordingly, there will be an effective decrease in air temperatures as well as an attendant decrease in air pollution if rooftop gardens are constructed on a large-scale throughout city centres across South Africa and in Durban in particular.<sup>8</sup>

### **3.2.4. *Urban Ecology***

Urban ecology focuses on the relationship that humankind and other living organisms residing in urban areas have with their surrounding natural environment (McIntyre *et al.*, 2000). In particular, urban ecology views urban areas as ecosystems with ecological functions and analyses the relationships that exist between plant and animal species within the urban environment and how humans influence this relationship (Langner 2009). Urban ecology relates to this research study because rooftop gardens in urban centres are able to strengthen the relationship between plant and animal

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<sup>8</sup> International case studies described in chapter four describe how rooftop gardens have contributed in this way to improving the city environment.

species and the urban environment as a whole. They are also able to strengthen that relationship (Greenstone 2009). This can be done by bringing city residents closer to the natural environment in the concrete-dominated urban centres through participation in community initiatives in developing their own rooftop gardens.

### **3.2.5. Storm-water Management**

Storm-water refers to the water generated when rain falls to the ground but is not absorbed due to the types of materials that the surface is made out of. These surface materials can be concrete rooftops and pavements or asphalt roads, among other impenetrable materials (D'Annunzio 2010). Barren rooftops create great surface run-offs for storm-water which can put great pressure on storm-water management systems within cities. These management systems include storm-water drains and pipework below the pavement and ground surface to direct the storm-water into rivers (Oberndorfer *et al.*, 2007). In relation to this study, rooftop gardens will aid storm-water management by absorbing the storm-water and preventing excess run-off. Rooftop gardens can also act as filters, filtering out pollutants from the water and making the water cleaner that runs out into the city's storm-water management systems (2007). This water running into storm-water management systems results in cleaner water going into river systems, assisting in the maintenance of a balanced, non-polluted ecosystem.

### **3.2.6. Sustainability**

Sustainability refers to the conservation and preservation of natural resources that meet the requirements of the present generation without compromising the ability of future generations in meeting their own needs (Bouma 2010). Within the context of this study, sustainability is used to connect the need for the creation of sustainable livelihoods for people within urban centres. This is achieved through strategies that maintain food security on arable land outside of the city and by making use of unused space within the urban centre for rooftop gardens and the production of food.

### **3.2.7. Urban Agriculture**

Urban agriculture refers to making efficient and sustainable use of spaces and land in urban centres, through the production of food (Drescher 2001). For this study, urban

space refers to under-utilised rooftops within the city centre. Growing vegetation on rooftop gardens can be used by residents who live and/or work in the city centre. The existence of urban agriculture can contribute to improving the lifestyles of the poor and less fortunate in urban centres through contributing to food security and providing employment opportunities.

### **3.2.8. *Urban Design***

In this research study, urban design will be linked to environmental sustainability. Urban design focuses on strategically creating and developing areas and buildings that can be associated with a particular city's goals and objectives (Larice and Macdonald 2013). One of the goals of the eThekweni Metropolitan Municipality is to become an increasingly-sustainable city focused on greening and environmentally-friendly developments (eThekweni Metropolitan Municipality 2012). The design of the urban centre is critical to achieving such an environmentally-friendly goal. One of the methods of urban design that can contribute to achieving environmental sustainability is the large-scale development of rooftop gardens. These gardens have a variety of environmental advantages that, if created on a large-enough scale in the city centre, can contribute positively to achieving sustainable development.

## **3.3. Theoretical Framework**

This study utilises a number of theoretical debates and approaches to achieve its stated goal. These include, sustainable design, resilient cities, and green design approaches. The research design will also utilise the sustainable livelihoods debate to link the potential economic opportunities that rooftop gardens can provide for residents of the urban centre. Each of these theories will now be discussed in greater detail below.

### **3.3.1. *Resilient Cities***

The term 'resilient cities' began to grow in use during the late-1990s, when major cities in East Asia began experiencing burgeoning urbanisation as well as environmental disasters such as earthquakes and floods (Prasad 2009). Accordingly, there was a need for cities to be structured appropriately in order to manage an ever-growing urban population and their vulnerability to environmental, social and economic problems (2009). Cities needed to be restructured in order to accommodate

these changes and this resulted in the term ‘resilient cities.’ According to Pickett *et al.*, (2004) the concept of resilient cities can be used as a metaphor which can lead to the development of models. For this research, using this interpretation of resilient cities, a legislative model is followed which promotes policy documents, building regulations and by-laws that lead to the development of rooftop gardens on a large-scale in the Durban CBD.

Resilient cities can be described as cities that are flexible and adaptable to social, environmental and economic factors (Pickett *et al.*, 2004). The social factor that is currently being experienced in the Durban CBD is that of poverty. The environment and economic issues being faced include: climate change, pollution and lack of job opportunities (Greenstone 2009). The large-scale development of rooftop gardens in the Durban CBD can assist with this, by providing job opportunities for people to work in and maintain rooftop gardens, by assisting with environmental issues, by assisting with city air pollution, and reducing the urban heat island effect. Additionally, the growing of fruits and vegetables on rooftop gardens will assist the poor in the city centre by providing food.

In 2013, the city of Durban became part of the Rockefeller Foundation’s International 100 Resilient Cities (100RC) (eThekweni Metropolitan Municipality official website 2011). Becoming included in this foundation means that Durban is assisted by the Rockefeller Foundation to develop resilient cities that will be protected from social stresses, including: unemployment, inequality, and environmental issues that may arise in the future such as floods or environmental degradation. Being a coastal city, Durban is more prone to flooding and needs to be prepared for all the challenges currently being experienced and those experienced in the future due to the rigours of climate change (Greenstone *et.al* 2010). These include: sea level rise, changes in the frequency and intensity of storms; increases in precipitation; coastal erosion, and warmer ocean temperatures. The programmatic involvement of eThekweni Metropolitan Municipality in the 100RC allows for the sharing of local ideas and advancements on an international scale and *vice versa*. Developing rooftop gardens in the city centre on a large scale can be a way forward for Durban to become a resilient city.

City centres have to be prepared with special tools to deal with climate change. There is a need to build and manage cities in different ways in order to cater for the future effects of climate change. Prasad (2009: xiv) maintains that the future effects of climate change will be felt most intensely in “urban areas where people, resources and infrastructure are concentrated.” This means that city centres will bear the brunt of climate change impacts because of the high population densities, infrastructure and resources.

Urban centres in East Asia, such as in China and Indonesia will inevitably experience the effects of climate change to a much larger degree than others. Accordingly, there is a greater responsibility upon these countries to develop strategies and projects that will result in the creation of resilient cities. This can be applied to the city of Durban due to the ever-burgeoning levels of urbanisation it experiences and the concomitant stress on infrastructure. As a result, there are not enough resources to handle the number of people who are coming into the city. Furthermore, unemployment, poverty and environmental degradation continuously affect the city. The development of rooftop gardens on a wider scale can assist with this, contributing to the development of a resilient city. Rooftop garden development on a large scale should form a part of an effective eThekweni 100RC programme.

### ***3.3.2. Green Development Theory***

Green development theory (GDT) grew with the concept of sustainable development in the 1980s and 1990s (Adams 2008). In order for cities and nation states to become sustainable there was a need for cleaner energy and decreased water use. Accordingly, GDT was developed. Currently, many countries around the world are engaged in some form of green development as issues of climate change and poverty are being brought increasingly into the forefront. GDT with its primary focus on sustainable development can be used to explain the reason why developing rooftop gardens in the urban centre is an important way forward to ensure the sustainable development of a region (Adams 2008).

The sustainable development that Adams (2008) as well as the Worcester Polytechnic Institute (2013) discuss takes a variety of interests into account, including:

environmental, economic and social sustainability and how these factors can work together to create the sustainable development of a region. Working together, elements such as creating employment opportunities, public participation and bottom-up approaches to development and conservation and preservation of environmental spaces can prove particularly advantageous. There is also a focus on rational planning and holistic thinking with regards to sustainable development. This theory, if used correctly, can positively assist with the social and environmental challenges that are currently being faced by eThekweni Metropolitan Municipality.

Rooftop gardens can be a meaningful way of linking the environment, economic and social development together. This is because rooftop gardens in the urban centre have important advantages inherent within them, including: creating employment, economic opportunities, the social benefits of community building and public involvement. Conservation of biodiversity and contributing to making the urban centre a healthier and increasingly appealing environment is another major benefit. Accordingly, GDT is relevant when discussing the development of rooftop gardens on a large-scale in the Durban CBD.

The city centre is an area where people, buildings and resources are concentrated in close proximities and high densities. This means that the city centre experiences very high energy usage, storm water run-off and degradation of the natural environment. The eThekweni Metropolitan Municipality Energy Office has a number of operational programmes including solar traffic lights and solar panels on city building rooftops that aim to decrease energy usage in the city. However, the development of rooftop gardens in the city does not form any part of these programmes. Green development can assist with this by slowing climate change, decreasing energy use, and enabling the sustainable management of available resources within the city (Choi 2008).

Green development in the form of rooftop gardens is able to reduce energy costs and usage, in terms of reducing the absorption of sunlight by dark-surfaced rooftops, thus reducing the need for heating or air-conditioning. Rooftop gardens can increase the value of property by being aesthetically appealing as well as productive. They are able to provide employment for individuals in the city centre. GDT is important for

meeting the goals of the eThekweni Metropolitan Municipality by making the city of Durban a sustainable and self-reliant city.

### ***3.3.3. The Green Design Approach***

Since the 1990s there has been a drive to create buildings that are increasingly multi-purpose and thereby contribute to improving the state of the natural environment (Kibert 2016). With increasing human made environmental problems such as climate change, there was a need to create buildings that were less harmful to the environment (Fullerton and Wu 1998). Buildings in their very design, need to reduce their energy footprint and water usage so as to be beneficial to the environment. It was in this way that the Green Design Approach (GDA) was developed.

The GDA focuses on urban designs that work in conjunction with the environment or are created to be beneficial to the environment and the people within that environment (Kibert 2016). This approach can be executed with the creation of rooftop gardens in the urban centres. The main principle of the GDA is that a building must save money by using less energy and be beneficial to the environment (Fullerton and Wu 1998). With this in mind, subsidies were given to companies that engage in recycling or recyclable designs. Recyclable designs can be applied to the development of rooftop gardens in terms of their potential to recycle storm-water or utilise recycled materials when building rooftop gardens. A current example of this recycling regimen is present in the Priority Zone Rooftop Garden project. According to information provided by key-informants during the interview process in 2015, the majority of water used in the Priority Zone Rooftop Garden project is recycled with very little reliance being placed on municipal water supplies.

The Priority Zone Rooftop Garden project makes use of discarded items that have been found on city streets to grow vegetation in (Botes 2013a). In the context of this research, the GDA in the urban centre can be achieved through rooftop gardens. The GDA also brings the issue of energy efficiency to the forefront (Kwok and Grondzik 2007). Rooftop gardens contribute to decreasing overall temperatures of a host-building and therefore reduce reliance upon air conditioning systems, thus contributing to decreasing its overall energy consumption.

Rooftop gardens in the Durban CBD are used on a small-scale in both municipal and non-municipal projects. Rooftop gardening should be included in municipal guidelines, policies, regulations and by-laws as a means of creating employment, conserving resources, and combating climate change.

With the GDA it is important to take into account the actual design and professionals involved as well as engage in methods that achieve optimum results (Kwok and Grondzik 2007). This is to ensure the successful development of the rooftop garden. When beginning to develop rooftop gardens, the first step of the process is to call an engineer in order to determine the load-bearing capacity of the building rooftop (Greenstone et al 2010). If the load of a rooftop garden can be handled by a building then the design and development of the garden can continue. It is also of great importance to get expert opinion on the correct varieties of indigenous vegetation to be planted so as to achieve optimal growth.

Creating sustainable buildings is one of the major principles of the GDA (Fullerton and Wu 1998) and rooftop gardens are one of the methods that can achieve this goal if developed correctly. Energy savings, enhanced productivity and performances, and improved quality of life are benefits characteristic of green designs (Edwards *et al.*, 2013). Rooftop gardens are able to provide these benefits and more.

#### **3.3.4. Sustainable Livelihoods Approach**

Rooftop gardens can contribute to an urban strategy for the creation of sustainable livelihoods through the generation of employment opportunities and the production of fresh produce to those who require it in the urban centre (Archinal *et al.*, 2012). The Sustainable Livelihoods Approach (SLA) is viewed as a method of connecting socio-economic and environmental concerns (Brocklesby and Fisher 2003). This approach grew in relevance in the early twentieth-century as environmental concerns such as the degradation and deterioration of natural environments came to the fore as well as the need to create strategies and tools to assist in poverty reduction.

Cities have an immense ecological footprint (Deelstra and Girardet 2000). This means that the development of urban centres has impacted negatively on the natural environment, severely disrupting the ecological systems that were once present. Durban CBD is consistent with this understanding. While there are limited green spaces within the city centre, plant and animal life that once thrived in the area are no longer present as a result of urban development. Bringing flora and fauna back into the city will increase biodiversity and assist the city meet its goal of sustainability. Green spaces can be introduced into the city by means of rooftop gardens within the city centre. Current rooftop gardens such as the Priority Zone Garden and the rooftop garden on top of the City Engineers building in the Durban CBD has resulted in various species of insects, butterflies and birds being drawn back into the urban centre (Greenstone *et al.*, 2010).

Persha *et al.*, (2011) maintains that it is difficult to link the social to the ecological because of the great inequalities that exist within human livelihoods. Accordingly, policies that link human livelihoods to the environment are often hazy because the policies created are not of themselves holistic, i.e., they do not consider all necessary factors of the environment and are more biased towards human livelihoods. In the case of rooftop gardens, there are many success stories. Policies have been created in Tokyo, Japan and Chicago in the US which state that all new urban developments must make provision for rooftop gardens. These policies have had much success in linking social and environmental concerns.

The Priority Zone Garden in the Durban CBD is a great local example of linking human livelihoods, biodiversity and conservation. All produce grown in the Priority Zone Garden is donated to the poor. All vegetation within the garden is indigenous so that contributes to increasing biodiversity in the area. If the Priority Zone model is used on a larger scale within the city centre then the benefits will be much greater.

The SLA focuses on how people can contribute to the creation of positive and sustainable change in their lives (Brocklesby and Fisher 2003). This approach is focussed on community development and the reduction of poverty among the poorest of society. This SLA is relevant to this present research because it links socio-economic problems. Accordingly, the development of rooftop gardens focuses on the

human self-potential for improving lives through activities which can contribute to the creation of sustainable livelihoods.

### ***3.3.5. Ecological Modernisation***

This present research will make use of ecological modernisation in order to explain the difference in population densities in the inner city and the surrounding areas, why there is a continuous influx of people into the city centre, as well as the increase of environmental issues over time. This term was first used around in the 1980s by Martin Jänicke and Joseph Huber and was later developed into theory by Arthur Mol and Gert Spaargaren in the 1990s (Mol et. al. 2016). The theory focussed on how people and businesses integrated environmental issues into their lives and business in general. It maintained that countries in Africa were less-developed (also referred to as periphery or semi-periphery countries) than those in Europe (also referred to as core countries) therefore technology to deal with environmental issues would be created in core countries and these systems would then move to periphery countries like those in Africa (Bonds and Downey 2015). This was because there was a failure in the industrialisation process and a lack of technological advancement due to the traditional nature of these periphery and semi-periphery countries. At a world level the difference between these core and periphery countries resulted in great inequalities as periphery countries seem to bear the brunt of environmental issues because of the lack of funding and technology to deal with these issues. While core countries tend to exploit periphery countries for natural resources resulting in massive environmental degradation of periphery and semi-periphery countries.

On a local level, within the South African context, long-term technology and infrastructure to deal with environmental crises are highly under-developed. This is because there is insufficient capital investment being put in by the state to develop strategies to deal with potential environmental issues. Instead, state capital investment is being utilised mainly for socio-economic concerns which are also prominent in the country. However, this puts South Africa in a vulnerable situation when environmental issues do face the country. Within this present research, South Africa as a country in the developing world should follow the work that is being done in core countries such as the United States of America (USA) in terms of developing rooftop

gardens. The case studies of Chicago and Singapore that will be discussed in chapter four, reveal success stories of rooftop gardens in urban centres. In particular, they reveal how roof-gardens contribute to the reduction of socio-economic issues in urban centres through food production and employment creation.

In South Africa, the socio-economic issues and the differences that exist between rural and urban areas can be attributed to the apartheid era which ended in 1994. This resulted in a segregation of people in terms of the colour of their skin to different parts of the country (Beck 2013). The apartheid government placed the white minority groups in developed regions and focused on planning and development mainly in these regions (Clark and Worger 2016). The majority of the remaining population were placed on the outskirts of the city where little or no development occurred. Once the apartheid era ended these majority groups began moving *en masse* into the city centres and peri-urban areas of South Africa (Beck 2013) looking for work and shelter. This is the major reason that urbanisation is still occurring at such a rapid rate across the country. The cities are the most developed areas of the country and are therefore are viewed as the main sources of employment which explains the great rural-urban migration.

The industrialisation process and environmental technological advancements which occurred in developing countries provided employment in urban centres with great potential for industrial development (Masvaure 2013). Business and residential activities grew-up around these centres providing employment opportunities for people outside these. This resulted in a mass influx of people from outlying rural areas into these new urban business centres. However, in the case of developing countries such as South Africa, the state was not able to keep up with the supply and demand of jobs (2013). People nevertheless continued to move into these urban centres despite the lack of job opportunities. Due to this mass urbanisation there was a growth in unemployment and poverty within the urban centres. Therefore the focus was on dealing with the great socio-economic issues rather than the potential environmental threats that the country experienced.

As a result of the rise of technological advancements many mistakenly thought that only business activities occur in the urban centres and that agricultural activities are meant to be outside of the centre, in the rural areas of the country. Many of the

research participants revealed that they were not sure whether rooftop gardens will become part of Durban city life. A transformation of attitude is necessary to ensure the success of this concept. People need to understand that all people consume food and engage in some form of gardening and this does not need to occur only in the outskirts of the city. It can exist where the majority of people exist, which is in the city. Rooftop gardens are a multi-purpose method of creating sustainable livelihoods for inner-city residents.

### **3.3.6. Sustainable Urbanism**

Sustainable urbanism was created from the urban development theories of smart growth, new urbanism and green building (Farr 2011). The smart growth theory (SGT) focuses on maximising the use of high-density, compact buildings; while new urbanism focuses on creating more walkable and pedestrian-orientated developments with mixed-land uses (2011). The green buildings approach (GBA) is similar to the green design approach (GDA) in that it focuses on making buildings environmentally friendly, reducing their carbon footprint, and making them increasingly able to sustain themselves.

Sustainable urbanism was created to link all three of the above mentioned theories because as they are isolated, they may hinder the progress and success of green-building theory. For example, a building that is classified with a green design would not be successful if were to be surrounded and dominated by vehicle-oriented developments. There is a need for the inter-linking of the three theories in order to achieve a sustainable urban centre. Giles *et al.*, (2013) concurs that many of the existing cities do not give a great deal of consideration to the transforming environment and climate change that is being experienced globally today. The development of urban centres has to be prioritised for the diverse needs of future generations (Lehmann 2016). These needs are based on the conservation and preservation of resources and the environment. There is also a need for current and future developments to take account of the environmental and social issues that are being experienced in modern cities.

Integrating urban development with the environment is of paramount importance to ensure that urban communities and buildings are able to become sustainable and decrease their carbon and ecological footprint. Linking the urban to the environment can be beneficial as one will not harm the other if the impacts of both are considered. The modern world is moving towards being increasingly environmentally friendly. Accordingly, the linkage of the urban centre with the environment is essential for achieving sustainable development within the urban centre.

The development of rooftop gardens in the urban centre contributes to sustainable urbanism as it focuses on the need to preserve and conserve resources and the environment for present and future generations. This is a sustainability method that can be applied on a large scale in the Durban CBD for current and future urban planning and design. Sustainable urbanism can form part of a strategy for the inner city for community development, environmental and economic sustainability. If done on a greater scale, rooftop gardens can assist in green urban design and planning which is sustainable.

### **3.4. Conclusion**

In this chapter, various theories and concepts referred to throughout this research project were discussed. For example, in reference to the concept of rooftop gardens, this refers to a space on the roof of a building where both vegetables and indigenous plants can grow and be reared. Another important concept that was discussed is that of urban ecology. This refers to the relationship between human beings and other organisms such as plants and animals; such a relationship extends to the surrounding environment as found in an urban setting.

All the concepts and theories discussed above play an important role in the current debate about rooftop gardens in the urban centre, and the important role that the public play in the expansion of its development. In particular, they try and explain how the wider development of rooftop gardens can be a positive step in dealing with various socio-economic, ecological, bio-physical and other geo-strategic challenges, such as a loss of biodiversity and food security, that are continuously faced within the urban environment.

# CHAPTER FOUR

## LITERATURE REVIEW

### 4.1. Introduction

This chapter will discuss the current literature and debates about rooftop gardens in city centres. The history of rooftop gardens on a world scale will be discussed and how they have evolved and developed over time. It is important to look at the evolution of rooftop gardens in order to discover methods in rooftop gardening that were the most successful so these ideas can be used to further develop rooftop gardens locally and on a greater scale. This chapter will also discuss the advantages and challenges that come with developing rooftop gardens on buildings within the urban centre. International as well as local examples of rooftop gardens will be described in detail as well as what materials and vegetation is being grown on rooftop gardens that currently exist in the urban centre. Both the international and local examples give a small indication of the public attitudes towards city rooftop gardening, this information allows this research study to expand on that idea to provide greater information on the level of awareness and perceptions of the public, in particular, eThekweni Municipality city centre.

### 4.2. A Brief History of Rooftop City Gardens

Rooftop gardens are spaces which can be utilised for a multitude of purposes. In urban centres, garden precincts bring nature into densely-populated areas. In the past, rooftop gardens had the function of beautifying the environment as well as for food production (Rahman and Ahmad 2011). Contemporary cities contain high-rise buildings and limited ground space due to the requirement of dense development, improvements in building technology, and the compactness of cities (Roodvoets 2010). This resulted in a mass decrease and destruction of biodiversity and ecological systems in urban centres.

Rooftop gardens have been around for millennia (Shimmin 2012). Such gardens were created to bring nature into the urbanised or built environment (Donell-Kilmer 2011). Historically, rooftop gardens were also used for food production, as a means to show

wealth or hierarchy, a technique for controlling floods, as well as a method of camouflage to provide protection for people (Shimmin 2012). Early rooftop gardens include the Hanging Gardens of Babylon and the Villa of the Mysterious in Pompeii (Rahman and Ahmad 2011).

#### 4.2.1. *The Hanging Gardens of Babylon*



**Map 4.1.**

Locality Map – Hanging Gardens of Babylon<sup>9</sup>

Map 4.1 shows the location of the gardens of Babylon. The Hanging Gardens of Babylon is one of the most popularly known rooftop gardens and is recognized as the foundation of knowledge and development of rooftop gardens (Dalley 1993). These hanging gardens were created high-up on the terraces of the buildings which gave it the name “the hanging gardens” (1993). The gardens consisted of various types of vegetation that was supported by the development of thick walls upon which they stood.

The image 4.1 below shows the Hanging Gardens of Babylon in its present day. The stepped terrace structures can clearly be seen in the image and this is where the hanging gardens would have existed.

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<sup>9</sup> <[http://i.dailymail.co.uk/i/pix/2013/11/26/article-2513819-19A74F1200000578-830\\_622x397.jpg](http://i.dailymail.co.uk/i/pix/2013/11/26/article-2513819-19A74F1200000578-830_622x397.jpg)>. [Accessed 12 June 2016].



**Image 4.1.**

The Gardens of Babylon<sup>10</sup>



**Map 4.2.**

City Map and Hanging Gardens<sup>11</sup>

Source: [http://www.imninalu.net/Babylon\\_file/Babylon.map.jpg](http://www.imninalu.net/Babylon_file/Babylon.map.jpg)

<sup>10</sup> <<http://www.syl.ru/misc/i/ai/75032/101222.jpg/>>. [Accessed 12 June 2016].

<sup>11</sup> <[http://www.imninalu.net/Babylon\\_file/Babylon.map.jpg/](http://www.imninalu.net/Babylon_file/Babylon.map.jpg/)>. [Accessed 12 June 2016].

The map above demonstrates the method of irrigation that was used in these gardens. These hanging gardens were irrigated using systems that were concealed below the walls and were out of view from people who observed the gardens from the outside (Halley 1965 cited in McDonald 2016). The irrigation system for the Hanging Gardens of Babylon comprised of large cylinders and screws which lifted water from the canals below, which were fed by water from the mountains to the vegetation above (Dalley 1993). This system of irrigation resulted in successful vegetation growth in the hanging gardens.

#### **4.2.2 *The Villa of Mysteries***

The Villa of Mysteries in Pompeii was also known to have had rooftop gardens. The volcanic ash and other debris that covered the city of Pompeii following the eruption of Mount Vesuvius in 79 CE resulted in the preservation of the buildings and the history of the region under the lava and ash (Kuttner 1999). The city remains were discovered in the eighteenth-century. Later excavations revealed how the people of Pompeii lived and died. It was home to around 10 000 people (1999).

Vegetables and crops existed in immense quantities on the foothills of Mount Vesuvius, and the courtyards of Pompeii were filled with gardens (Shimmin 2012). Indeed, archaeological excavations revealed that rooftop gardens were an important part of the life of Roman civilization and architecture. Pompeii's rooftop gardens appear to be extended from the living rooms of the buildings and were a space to which household members could escape during hot summer months as well as provide social spaces where people gathered to have meals and enjoy the space (2012). It is unclear as to whether edible vegetation was planted on these rooftop gardens.

Image 4.2 below shows the Villa of Mysteries in Pompeii after the restoration following the volcanic eruption. The restored gardens are visible in the image and replicate gardens and structures prior to the eruption.



**Image 4.2.**

Restored Villa of Mysteries, Pompeii<sup>12</sup>

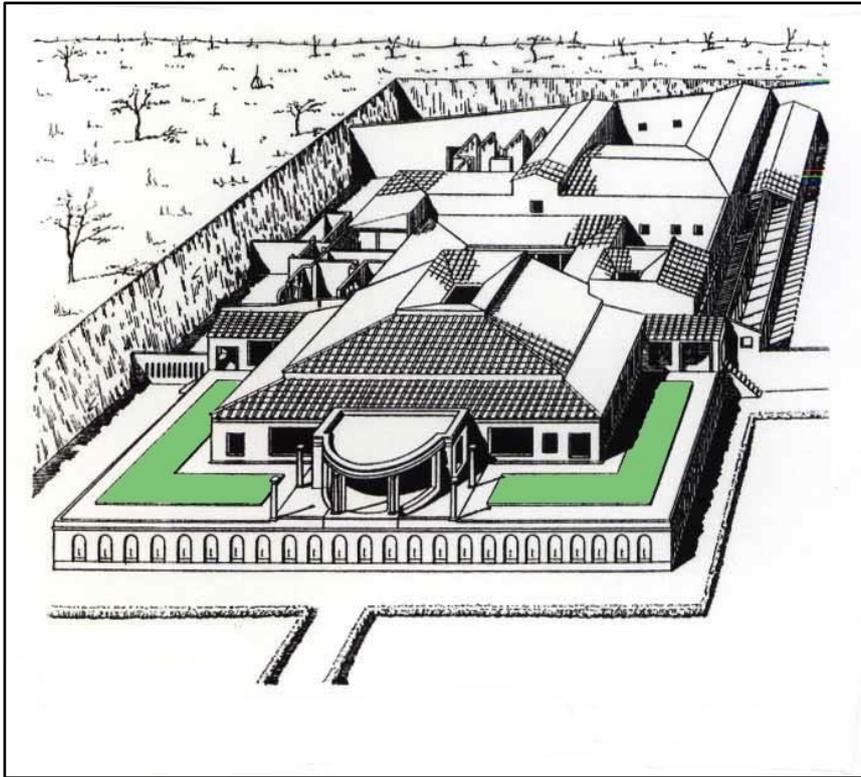
Rooftop gardens were also established as a means of providing heat insulation during the cold winter months in Scandinavia (Engelhard 2010). Rooftop gardens continued to gain popularity from the fifteenth to the seventeenth century throughout Europe, in countries such as France and Italy (2010). These gardens included the Renaissance Garden, the Mont-Saint Michel gardens in France and the Piccolomini and Medici Roof Garden in Italy (Rahman and Ahmad 2011).

There was an increase in the popularity of green roofs around the seventeenth-century (Donell-Kilmer 2011). This was due to using combustible building materials in rooftop construction. Such materials included tar and other flammable materials which resulted in intense fires being started on building rooftops (Rahman and Ahmad 2011). These fires were very harmful and could destroy residential blocks at a quick pace. Eventually, as a means to reducing rooftop fires, rooftop gardens were installed as a means of fire-proofing and protection from the weather elements.

Image 4.3 below shows what the Villa of Mysteries would have looked like before the volcanic eruption. Gardens would have been created on balconies as seen in the image. South Africa, eThekweni Municipality in particular, could expand on this concept in order to make it relevant to the needs of the city.

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<sup>12</sup> <[http://mr\\_sedivy.tripod.com/pompeii/p\\_mystery.jpg/](http://mr_sedivy.tripod.com/pompeii/p_mystery.jpg/)> [Accessed 12 June 2016].



**Image 4.3.**

Artistic Impression of the Villa of Mysteries<sup>13</sup>

Rooftop gardens continued to grow in popularity in the twentieth-century through innovative rooftop garden designs by German architects (Oberndorfer 2007). These rooftop gardens were the beginning of the development of the modern rooftop gardens that exist today. These gardens contained plants that would absorb harmful radiation from the sun which would otherwise damage to the concrete rooftops of buildings (2007). This resulted in the lifespan of rooftops being increased. The technology being used in Germany involved placing sand over the concrete and bitumen rooftops, thereby decreasing or indeed eliminating the incidence of fires (Roodvoets 2010). Rooftop gardens in Germany were an economically sound and effective way of preventing building rooftops catching fire. This strategy also added aesthetic beauty to the city centre by the creation of a variety of green spaces.

Following Germany's lead, Japan began developing their own rooftop garden spaces (Yuen and Hien 2005). Rooftop gardens grew in popularity in Tokyo because of the

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<sup>13</sup> <<http://www.heathershimmin.com/wp-content/uploads/2012/07/Villa-of-Mysteries.jpg/>>. [Accessed 12 June 2016].

lack of available building land; accordingly, private gardens were established on the balconies of private homes. Another important design concern was to reduce the UHIE phenomenon within the Tokyo CBD. The UHIE phenomenon was a result of the increased city centre population resulting in an increase in activities thereby increasing inner city temperatures (Yuen and Hien 2005). The addition of these green spaces into the urban centre assisted in maintaining a balance in the air temperature.

The use, methods, and form of rooftop gardens have evolved over time, from simply providing aesthetic beauty and shade in the Hanging Gardens of Babylon to mitigating the UHIE by reducing temperatures in the Tokyo CBD. Today, rooftop gardens in urban centres can be used for a multitude of activities such as the production of food and the absorption of storm-water to prevent run-off and flooding in city centres.

### **4.3. International Examples of Rooftop Gardens**

Reviewing both international and examples of rooftop gardens forms an objective and central aim of this study, mentioned in chapter one. Rooftop gardens are becoming an increasingly prominent addition in cities for a variety of reasons. Examples from Singapore and Chicago in the US will be discussed in detail below. These international examples were chosen due to their wide-scale development and success. Local Government and Municipalities in these cities have developed legislation and initiatives that incorporate rooftop gardens in their building requirements. The reasons as to why the numbers of rooftop gardens have expanded at such a great rate in these cities will also be examined.

#### **4.3.1 Asia—Singapore**

Singapore is an island located on the southern-most tip of the Malay Peninsula in Southeast Asia, between the Indian Ocean and the South China Sea. With a land area of 689 km<sup>2</sup>, Singapore is one of the smallest countries in the world, yet with an estimated multi-ethnic population of some 5.4 million (Zakaria *et al.*, 2014). Singapore's climate is tropical in nature, consisting of warm summer temperatures and high rainfall. The map below points out the location of Singapore on the island.



**Map 4.3.**

Location of Singapore<sup>14</sup>

Singapore city is recognised for its wide-use of rooftop gardens and hence is often referred to as a Garden City (Newman 2014). Singapore’s rooftop gardens were specifically developed to mitigate the UHIE as a result of its high rate of urbanisation. The urban population in Singapore has continued to increase at a rapid rate during the twenty-first-century. The government of Singapore had to identify innovative strategies that would aid with the UHIE caused by the increased urban population as well as the increase in the density of development (Wong *et al* 2003b). This brought about the decision to cover the city’s rooftops with a variety of vegetation.

The rooftop gardens in Singapore were specifically designed to overcome the environmental and ecological challenges that the urban centre was experiencing (Yuen and Hien 2005). That said, Singapore did not face any negative food security issues; hence, there was no need to grow food on its rooftop gardens (Agri-Food and Veterinary Authority of Singapore 2013). However, in a country that imports about

<sup>14</sup> <<http://www.lib.utexas.edu/>> [Accessed 12 June 2016].

90% of its food (2013), growing food crops on Singapore's green city roofs may be a way of enhancing the Island's independency.

The image below provides an example of the rooftop gardens that are developed in the Singapore city centre which can be utilized for a multitude of purposes. Image 4.4 is an example of how rooftops in the city can be developed extensively for rooftop gardens which can be used as spaces for relaxation and recreation, among others.



**Image 4.4.**

Rooftop Gardens in Singapore<sup>15</sup>

The National Parks Board in Singapore created the Skyrise Greenery Approach/Programme (Newman 2014). This approach/programme aimed to promote the development of green buildings which includes growing vegetation on rooftops, balconies or terraces and having landscaped gardens established on its city-centre buildings. The main objectives of the Skyrise Greenery Programme included providing aesthetic beauty to the dense and compact urban centre in order to develop a true garden city concept (Yuen and Hein 2005). Other objectives included: improving the quality of air in the urban centre, mitigating the UHIE, and providing green spaces within which people can relax, socialise and appreciate. Singapore's Urban Redevelopment Authority (URA) is responsible for the overall planning of its roof top

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<sup>15</sup> <<http://keepoaklandbeautiful.org/wp-content/uploads/roof-garden-3.jpg/>>. [Accessed 12 June 2016].

gardens and has been active in identifying bare unutilised flat rooftops for garden development (2005). The National Planning Authority in Singapore has provided agency oversight for development and land-use guidelines and has made increased provision and flexibility in future rooftop garden design (Wong *et al.*, 2003b).

In April 2000, the local government of Tokyo passed legislation that involved rooftop gardens being a requirement for all buildings that had a floor area of 1000 m<sup>2</sup> or larger for the planting of vegetation (Yuen and Hien 2005). The Singaporean government was inspired by this and began installing rooftop gardens on all public buildings in the city (2005). People living, owning and working in these buildings with green roofs are benefiting greatly as they add to property value, decrease electricity dependency on air-conditioning, provide aesthetic beauty, and provide environmental benefits to the urban centre within which they exist. As the public witness the positive impacts of rooftop gardens the attitudes and perceptions about these concept and these developments become increasingly positive.

A study of the thermal performance of rooftop garden systems in tropical climates by Wong *et al.*, (2003) indicated that vegetation-shaded rooftop gardens decreased the surface temperatures of rooftop of buildings when compared to those that were bare and simply covered in bitumen and concrete. The net effect was a decrease in temperature of about eighteen degrees centigrade (2003). Additional research also found that rooftop gardens decreased the energy consumption for cooling by around 1 to 15% (2003). Rooftop vegetation and foliage absorbed the heat of the sun resulting in the overall temperature of the buildings being reduced thereby reducing the need for excessive heating or cooling within buildings. This research shows that the addition of rooftop gardens in the city is able to contribute to decreasing city temperatures, thereby reducing the UHIE. The larger the scale of development of rooftop gardens, the greater the positive effects experienced.

The main stakeholders of rooftop gardens in Singapore is the government and affiliated organisations. Corporations and businesses that promote their own rooftop gardens are rewarded by the government (Newman 2014). South Africa could learn

from this example. The success of rooftop gardens in Singapore is a result of the government taking climate change and the UHIE in the urban centre seriously. South Africa could use this method to ensure that rooftop garden development occurs on a large scale in city centres as this could be a way forward of achieving some of the environmental, ecological and socio-economic goals for its cities.

#### **4.3.2. USA—City of Chicago, Illinois**

The city of Chicago is located in the south-west region of Illinois in the United States of America. It is situated on the south-western shore of Lake Michigan, which forms one of the Great Lakes (Roche 2016). The population of Chicago in 2013 is estimated at just over 2.7 million (in 2013). Chicago is known for its tall skyscrapers and experiences a humid continental climate. This city has made purposeful use of much of the vacant roof space in the city by constructing gardens on top of them. The rooftop gardens in Chicago were initially developed as a means to mitigate environmental concerns (Yang *et al.*, 2008). According to 2013 estimates, some 11% of its population experiences low to very low food security levels (Coleman-Jensen *et al.*, 2014). Growing food on rooftop gardens is able to mitigate against this.

Accordingly, the city of Chicago has around three hundred of its buildings covered in rooftop gardens, where a majority of its municipal buildings are utilised in this way. This is one of highest ranked number of rooftop gardens in a city in the US (Yang *et al.*, 2008). Rooftop gardens contribute on a massive scale to improving the energy efficiency of its buildings. The rooftop garden that exists on City Hall significantly reduces the heat entering the building as compared with other buildings in the area with asphalt or concrete roofs (Spivey 2002). The storm-water absorbed by green roofs on these buildings is about 90% higher than of those rooftops without vegetation grown on them (2002). The reduced storm-water flowing into the city systems results in a much lower incidence of flooding within the city. The map below indicates the city extent of Chicago.



**Map 4.4.**

Map of Chicago, IL.<sup>16</sup>

The rooftop gardens in the city of Chicago consists of intensive (substrate layers deeper than 20 cm), extensive (substrates 15 cm or less) and semi-intensive (in-between 15 - 20 cm) substrates (Yang *et al.*, 2008). Chicago and its environs is characterised by having a lack of green space and a city filled with high-rise buildings. The concept of rooftop gardens was developed as a strategy to address this lack by making use of un-utilised rooftop space and to soften the hard urban edges of the city (Velazquez 2003). Consequently, the city is highly-invested in gardens being installed on the roofs of buildings. There are several programmes in place, one of which is the Eco-Roof programme which encourages the development of rooftop gardens in urban centres and supplies information and research that has been done on rooftop gardens to the public which keeps citizens informed (Worden *et al.*, 2004).

Rooftop garden development in Chicago is proceeding on an immense scale as a means to deal with the UHIE that the city experiences (Yang *et al.*, 2008). There is a great variation in the temperature experienced within the CBD when compared with the city suburbs. This difference in temperature is so extreme that it has been

<sup>16</sup> <<http://www.gdi-solutions.com/>>. [Accessed 12 June 2016].

classified as a public health issue (Solomon 2003). The resultant health issues are mainly respiratory in nature and include asthma, lung cancer and emphysema (Spivey 2002). The then mayor, Richard M. Daley engaged in discussions with the Department of Environment in Chicago to look into ways to reduce the UHIE (Solomon 2003). This resulted in the establishment of a 20 300 square-foot green rooftop on Chicago's City Hall (Spivey 2002).

The city of Chicago has policies, regulations and funding in place that encourages the development of green roofs on its city's high-rise rooftops. These include the Green Roof Improvement Fund, Chicago Grant Fund and the Green Permit Programme (Plant Connection Inc., 2015). In Chicago, floor area credits are offered to buildings that have 50% or 2000 square feet of the building roof space covered with a garden (2015). Chicago's Green Roof Improvement Fund (CGRIF) is a fund of about US\$500 that encourages companies to install rooftop gardens or green roofs on their buildings (Loder 2007). Incentives are offered to people who choose to green their building rooftops. The Chicago Grant Fund (which is not taking applications presently) offered to cover up to 50% of the cost or US\$100 000 towards the development of rooftop gardens (Plant Connection Inc., 2015). Chicago Department of Buildings created the Green Permit Programme. This programme expedites building permits for developments that make use of green developments (2015). As a result, the greening of rooftops in Chicago is done on an immense scale because it is integrated into various strategies and supported by policies and funding.

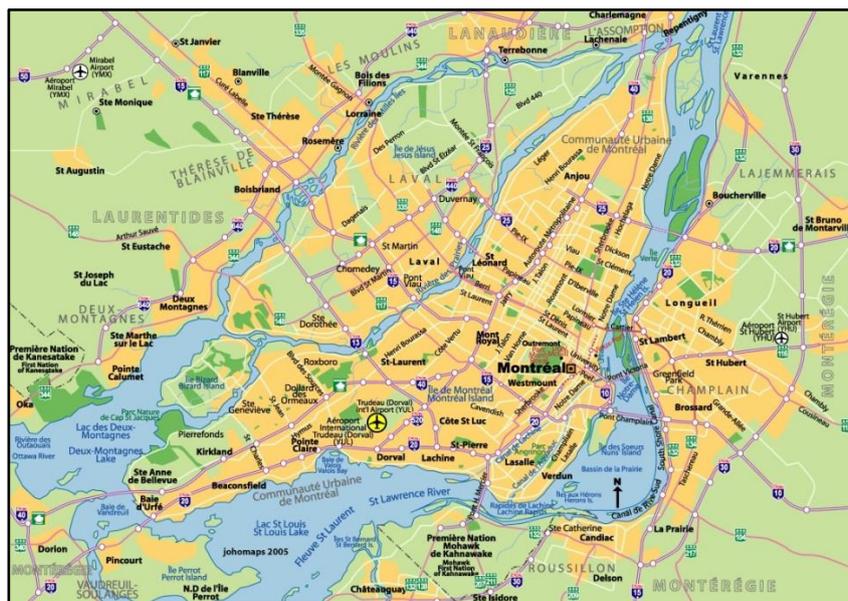
The main stakeholder of rooftop gardens in Chicago is the City and Federal authorities. They decided the environmental problems experienced in the city centre were too extreme and the solution was the large-scale establishment of rooftop gardens. As a result, City Hall as well as Federal authorities developed a number of initiatives and legislative provisions. South Africa could learn much from this example. The process begins with national and provincial government and then local municipalities. Once rooftop gardens are seen as a solution to some of the problems faced in South Africa's cities then steps can be taken by the state to create funding initiatives, programmes and legislation so that rooftop gardens form an important part of a city's future.

#### 4.4. International Models of Rooftop Gardens

There are a number of models from around the world that show how rooftop gardens can be effectively run, who should be responsible, and what the purpose of the rooftop garden is. The rooftop garden models that have been chosen for this study include the Montreal and Shanghai models. These were chosen because they can be replicated in a local context here in South Africa for the same or similar reasons.

##### 4.4.1. The Montreal Model

Montreal is a city in the Canadian State of Quebec. The city is on the Island of Montreal and is the largest city in Quebec. Montreal experiences a continental climate with hot summers and very cold winters with snow. In 2011, the population of Montreal Metro was just over 3.8 million and has a land area of 4258.31 km<sup>2</sup> (Statistics Canada 2016). The city of Montreal can be seen in the map below.



Map 4.5.

Map of Montreal, Quebec, Canada<sup>17</sup>

Municipal gardens in Montreal CBD began in the mid-1970s and were allotted to the community for public use (Janvier and Doucet 2015). Volunteer garden committees were created in order to manage the various garden spaces as well as determine the use and needs from each garden (2015). As available space in the city decreased, there

<sup>17</sup> <[www.johomaps.com/](http://www.johomaps.com/)>. [Accessed 12 June 2016].

was a need to take gardens to a new level. As a result, rooftop gardens began to be developed across Montreal.

Models of rooftop gardens in Montreal, Canada, are based on community initiatives and development. Communities in Montreal grow their own food on small rooftops in the city. One such project is the Rooftop Garden Project (Canadian CED Network 2011). This project has resulted in bringing community members closer together through the process of greening urban spaces in a productive manner and producing food for the community. The project has been implemented as a result of the partnership between two companies: Santropol Roulant and Alternatives which focuses on community development through the production of food and ensuring food security (2011).

The Communication Network for International Development which works with over thirty countries on an international scale sponsoring community development projects to overcome social, economic and political issues that a community may face (2011). The Rooftop Garden Project was created in order to foster community development and provide a sustainable food network in and for those living the city of Montreal. The Montreal model for rooftop gardens can be replicated for use in the Durban CBD and could provide food for the poor living in the city as well as selling some of the produce to local shops and businesses. Providing community initiatives will assist in bringing residents closer together based on something that can be highly beneficial and contribute towards improving the standard of living in city centres.

#### ***4.4.2. The Shanghai Model***

Shanghai is the largest city in China and is located on the Huangpu River. It is a port city alongside the East China Sea as can be seen in Map 4.6 below. The population of the city of Shanghai in 2010 stood at just over 20.2 million and the city spans an area of 6 200 km<sup>2</sup> (China National Bureau of Statistics 2010). Shanghai has many urban agricultural developments including the Fengxian Modern Agriculture Zone and the Jiashan Market (Travel China Guide 2016).



**Map 4.6.**

Location Map of Shanghai, China<sup>18</sup>

The rooftop garden created on the Jiashan Market utilised buildings that were previously textile mills. With the help of urbanists, engineers and architects these were repurposed into environmentally-conscious mixed-use buildings (Bergman 2011). There are three rooftop gardens in the Jiashan Market development (2011). This model for rooftop gardens is based on creating a sustainable city through the development of more green space. This model acknowledges the many benefits and potentials of the development of rooftop gardens including the provision of food and aesthetic beauty, thus reducing the energy consumption of buildings by providing insulation from heat and tempering the city's brutish landscape.

In this model, the produce that is grown on rooftop gardens can be utilised by the surrounding residents and restaurants. In addition, the rooftop garden allows children to learn about the potentials of rooftop gardens through programmes that create awareness about the environment and associated eco-systems (Bergman 2011). Surrounding residents of Jiashan Market can visit the rooftop garden and socialise or relax within the green space provided and also tend to the garden if they so desire (Rolfe 2014). This model shows that green spaces can be successful in even the

<sup>18</sup> <[www.yangtze-river-cruises.com/](http://www.yangtze-river-cruises.com/)>. [Accessed 12 June 2016].

densest of urban environments. The Shanghai model can be applied to the eThekweni Metropolitan Municipality as it encompasses the creation of a sustainable environment in the dense urban centre of Durban. This model also encompasses mixed-use development in the urban centre. The Durban CBD could benefit from applying this model at a local level.

#### **4.5. City Rooftop Gardens in Africa**

For the present, rooftop gardens are a fairly new concept to most countries in Africa and are thus not developed on a large scale. That said, the concept is slowly gaining popularity as authorities and entrepreneurs realise the importance of greening the city centre as well as finding workable solutions to the problems resulting from rapid rates of urbanisation. Egypt is one of the countries in Africa where rooftop gardens are increasingly being used.

##### **4.5.1. Egypt—Cairo**

Egypt is located on the far northern portion of the African continent. Cairo is the capital city of Egypt and is located along the banks of the Nile River. The population of Cairo, according to the Egypt Demographic Profile produced by Index Mundi in 2014, stands at about eleven million. The area of the city of Cairo is 214.2 km<sup>2</sup> and has a hot, dry climate with rainfall being a rare occurrence (Tour Egypt 2011).

Rooftop gardens in Cairo began as a means of motivating the urban city population to eat healthier (Food and Agriculture Organisation of the United Nations 2015). The diet of those living in the city did not contain enough nutrients because people did not eat enough fresh fruit and vegetables (2015). Accordingly, the Egyptian government developed a programme to encourage people to develop rooftop gardens so as to provide themselves with healthier food alternatives. This programme was mainly developed for poor families as a means to provide food as well as income generation from selling produce (2015). The Food and Agriculture Organisation of the United Nations assisted with this programme by training people to develop their own rooftop gardens and teaching them how to use hydroponic systems among other methods for

growing food on the rooftops of buildings. Map 4.7 below shows the location of Cairo along the Nile River in Egypt.



**Map 4.7.**  
Location of Cairo, Egypt<sup>19</sup>

Sherif Hosny, Tarek Hosny and Abdulraheem Ali are the founders of a project called Schaduf. This project encourages the development of green systems, including rooftop gardens and thereby introduces more green spaces into the city (Maniusyte 2014). Hydroponic growing mediums are used on a large scale for rooftop gardens due to the arid climate of the city and where water is in critical supply. Hydroponic systems provide adequate supplies of water and nutrients for the successful growth of fruit and vegetables (2014). Fruit and vegetables grown on rooftop gardens in Cairo include: eggplants, tomatoes, lettuce and spinach (Food and Agriculture Organisation of the United Nations 2015). Other benefits of developing rooftop gardens include cooling building temperatures and providing social meeting places. This further encourages the citizens of Cairo to engage in rooftop gardens on a larger scale.

<sup>19</sup> <lahistoriaconmapas.com/>. [Accessed 12 June 2016].

The Ministry of Agriculture and Land Reclamation is determined to implement the roof-greening programme on a larger scale because it has been successful in Cairo (Food and Agriculture Organisation of the United Nations 2015). The main stakeholders of rooftop gardens projects in Cairo are the United Nations, the Egyptian Government, and private organisations. The eThekweni Metropolitan Municipality could make use of parts of this international case-study to form policies or develop programmes that will encourage the wide-scale development of rooftop gardens in the Durban CBD. With KwaZulu-Natal presently experiencing drought conditions, the use of hydroponic foam as a growth medium would be greatly beneficial. Although Cairo does not currently have any legislation with regards to rooftop gardens, it can be used as an example to show the success of food crop production on rooftop gardens in an arid climate that experiences extreme weather conditions. Residents of Cairo generally have a positive outlook regarding rooftop garden development, and this has contributed, in part, to the expansion of this type of garden.

#### **4.6. City Rooftop Gardens in South Africa**

South Africa is a country on the southern tip of Africa and has an area of 760 062 6 km<sup>2</sup> (Beck 2013). The country is bordered by the Atlantic Ocean on its West Coast and the Indian Ocean on its South-Eastern Coast. South Africa is made up of nine administrative provinces. Of these, the major cities of three provinces will be discussed in relation to rooftop gardens, namely: Cape Town (Western Cape), Johannesburg (Gauteng) and Durban (KwaZulu-Natal). South Africa faces many challenges, including: poverty, climate change, environmental degradation, unemployment, food insecurity and high levels of rural-urban migration. The country also experiences high levels of inequality, crime, corruption and civil unrest (Levinsohn *et al.*, 2014). Many of these problems can be attributed to its colonial past and later white minority rule during the apartheid era (2014). The apartheid era in South Africa was from 1948-1994 (Beck 2013). Apartheid resulted in the separation of people in terms of their racial orientation. The White minority held power over the majority Indian, Black and Coloured population. Each race group was assigned to particular areas within which they could live. The Black majority were assigned to areas far away from the city centre and were given poor quality services from the government while the ruling minority were given the best services and access to the

best places (2013). This apartheid history of South Africa has resulted in the country now having high levels of income inequality and poverty which the democratically-elected ANC government is currently trying to be correct.

According to Statistics South Africa, South Africa has an unemployment rate of 24.9%. The rate of economic growth has decreased from 5 to 2% from 2004 to 2007 respectively (Statistics South Africa 2013). This places the country in a poor position in providing sufficient employment opportunities to the citizens. KwaZulu-Natal, the Western Cape and Gauteng contribute over 60% of the value added to the country's economy which is why the cities in these provinces are discussed. Some 56.8% of the South African population live in poverty (2013). This also negatively affects economic growth. Rooftop garden development could form a solution to this problem by providing food and/or employment to those who need it as food security is a major problem for a large number of South Africans. The lack of available land, especially in the urban centres, makes city centre rooftop gardens an effective way of addressing these problems, at least in part.

The international models of rooftop gardens have been adapted for use in South Africa and a number of the metropolitan cities such as Cape Town, Johannesburg and eThekweni have established gardens on building rooftops in their inner city areas. Currently, there are only a few programmes that educate the public further about the concept of rooftop gardens as well as ways that residents can create their own rooftop gardens. Rooftop gardens, if developed on a large scale in city centres could assist with solving many of the environmental and economic problems that South Africa presently faces.

#### ***4.6.1. Cape Town***

Cape Town is one of the larger cities of South Africa in terms of population size and is located in the Western Cape Province in the South-West of the country (Refer to Map 2.1). The Indian and Pacific Oceans meet at this province resulting in a Mediterranean-type climate. Accordingly, Cape Town receives much of its rainfall during the cold, blustery winter months while summers are hot and humid. According to the 2011 Cape Town Census Data compiled by Strategic Development Information

and GIS Department of Cape Town, its population stands at 3.7 million. The unemployment rate of Cape Town is at 23.88% according to the same data source.

Initially, the Worcester Polytechnic Institute in the City of Cape Town established a series of pilot rooftop garden projects to test their feasibility, all of which were successful (Archinal *et al.*, 2012). The City of Cape Town acknowledges the importance of rooftop gardens in its 2011 position paper entitled: “Sustainable Landscapes, Practices and Guidelines for Facilities Management.” Here, the city states that the Cape Town Civic Centre has several very successful rooftop gardens, all of which have been beneficial to the environment, are aesthetically pleasing, and have contributed to a marked reduction in energy costs. They also bring vegetated areas to a populated area where land has competing demands made upon it and the provision of green space is difficult.

There is a project in Cape Town called Rooftop Gardens for Sustainable Livelihoods in Cape Town. The basis for creating rooftop gardens under this project was to create employment opportunities for those families living in the Cape Town CBD and thereby help alleviate the high levels of unemployment (Worcester Polytechnic Institute 2013). The goal of this project was aimed at getting stakeholders involved in discussions about rooftop gardens in the city as well as creating employment opportunities and increasing food security. This resulted in the development of a rooftop garden on the building situated at 44 Wale Street in the Cape Town CBD, which today is both thriving and productive (Phillip 2013). This rooftop garden is enjoyed by the staff as a place of relaxation and enjoyment. This garden utilises crates as a tool to grow vegetables and indigenous plants.

The company organises educational gatherings with the staff to help cultivate the plants and learn more about rooftop gardens. Staff choose a crate of either vegetables or other plants to take care of for the year and generally assist with the maintenance of the gardens (2013). This creates positive perceptions and awareness about the benefits of having rooftop gardens as well as getting the staff involved in a wide-array of activities which they can enjoy. The major outcome of the rooftop garden project was that it resulted in the creation of awareness among the people involved. It developed a framework for a rooftop gardens programme that is sustainable in terms of food

production and job creation. The project identified potential roof spaces that would be able to accommodate gardens and was able to generate funding for future rooftop garden projects on buildings within the city (Worcester Polytechnic Institute 2013).

Although the development of rooftop gardens in Cape Town have been undertaken on a small scale, the approach formally acknowledges it as a method for improving environmental, social and economic conditions. This means that the work has provided lessons for a good practice model which can be translated into a set of guidelines for use in other towns and cities across South Africa. The work can also be used to inform urban policy frameworks and strategies for climate change mitigation and sustainable cities.

#### ***4.6.2. City of Johannesburg***

The city of Johannesburg is in the province of Gauteng, South Africa.<sup>20</sup> Gauteng is a landlocked province which experiences hot summers and cold winters. The area of Johannesburg is 1645 km<sup>2</sup> with a population of 4.4 million, making it the largest city in South Africa by population (Statistics South Africa 2013). This city has an unemployment rate of 25%. If rooftop garden development were to be implemented on a large-scale, it could decrease this percentage by providing more employment to those living in the city.

The city of Johannesburg has a few rooftop gardens. The Johannesburg Development Agency (JDA) has worked together with the Johannesburg Housing Company (JHC) to create a rooftop garden on a building in the city centre called the Lake Success Rooftop Food Garden (Johannesburg Development Agency 2014). The JDA has three other rooftop garden projects on its buildings while the JHC has four such projects. These rooftop gardens were developed in order to promote healthy eating, provide nutritious food, create awareness and assist with unemployment (2014). Vegetables that have grown successfully in these gardens include: spinach, beetroot, tomatoes and beans (JDA 2014). These edible produce have been grown successfully on other rooftop gardens around South Africa and should be used as benchmarks for food crops to be grown on rooftop gardens in South African cities in the future.

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<sup>20</sup> See Map 2.1.

Rooftop gardens in Johannesburg form part of a strategy to become a resilient city by 2040 (Labuschagne, 2016). Rooftop gardens are able to assist in the creation of sustainable livelihoods, especially to the poor. They also contribute to making Johannesburg a greener city to live in.

For rooftop gardens in Johannesburg, plans for their maintenance are in place, including the training of horticulturalists (JDA 2014). There is also a strategy in place that teaches and motivates people to create their own rooftop gardens and develop personal business skills in order to generate an income from the projects. This introduces sustainability and the ability of people to take care of themselves. Sustainability plays an important role in ensuring the creation of a resilient city and the JDA and JHC know that showing people how to create their own gardens—be they rooftop or ground-level gardens—can contribute to achieving sustainability (2014).

The green roofs in Johannesburg are modelled around community development initiatives. People learn skills from one-another and from the plan that has been put in place. People are able to sell the produce that is grown and they can socialise while working in the garden which encourages community building. This is an important method of increasing the level of awareness and perceptions that people have about this novel concept and should be replicated to allow for greater rooftop garden development.

#### ***4.6.3. The eThekweni Metropolitan Municipal Area***

The eThekweni Metropolitan Municipality is in the province of KwaZulu-Natal, within whose boundaries is the coastal city of Durban. This is the chosen area where the case study for this research took place.

<sup>1</sup> The eThekweni Metropolitan Municipality recognises that the natural environment is continuously being detrimentally disturbed, transformed or altered as a result of human activities. The 2012/2013 Integrated Development Plan (IDP) for the eThekweni Metropolitan Municipality makes important reference to the natural environment and the need to conserve and preserve the bio-diversity that exists in the area. It is acknowledged in this document that the natural environment is deteriorating

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<sup>1</sup> See Map 2.3.

rapidly and mechanisms need urgently to be put in place so that sustainable programmes are put in place to protect these natural eco-systems.

The 2012/2013 IDP for eThekweni Metropolitan Municipality also mentions the need to develop green infrastructures which can conserve bio-diversity while having positive impacts to the economy of the city. Rooftop gardens in the Durban CBD can be considered as a form of green infrastructure. Rooftop gardens increase bio-diversity in urban centres as the plants that are grown in these gardens attract indigenous flora and fauna back into the urban centre which is one of the key objectives of the IDP. Rooftop gardens also contribute positively to the economy of the city by creating employment opportunities through the maintenance and control of rooftop gardens. The produce grown can be sold to businesses that require it or it can be donated to the poor who reside within the CBD, resulting in increased food security in the urban centre.

In the eThekweni Metropolitan Municipal area, green roofs form part of the Municipal Climate Control Programme for the city of Durban. Within this programme there is the Green Roof Pilot Project which is currently being monitored and is of a small scale. The Green Roof Pilot Project aims to lower building temperatures and the surrounding environment (Lewis *et al.*, 2012). It further aims to reduce storm-water runoff through the vegetation absorbing much of the storm-water. As an effective mechanism in mitigating climate change, the central aim of the project is to increase the bio-diversity of the Durban CBD (2012).

As a pilot project, the Green Roof Pilot Project was developed on the City Engineers side of the building located at Fort Road at the edge of the Durban CBD. It has been noted that an increased number of insects are being attracted to the garden (Greenstone *et al.*, 2011). This is an indicator of improved bio-diversity. Although the project is sponsored and supported by eThekweni Metropolitan Municipality, it has not been translated into a set of guidelines or form an urban spatial policy framework. As a matter of priority, the lessons learned from this pilot project need to be officially documented in order that similar rooftop gardens can be developed in the CBD. Other examples of rooftop gardens within the Durban CBD include the Priority Zone rooftop

garden which is on a building on Monty Naiker Street and the Mr Price Group rooftop garden at the Durban Station.

The Priority Zone rooftop garden consists of succulent vegetation, vegetables, fruit trees and landscaped gardens (Priority Zone Durban 2013). The rooftop garden space was built for people to enjoy as well as a source of environmental education. On the rooftop garden there are chairs and tables for people to relax and there is also a chessboard that was built to increase the functionality of the space. The produce that is grown on the rooftop garden is either sold to local businesses or is donated to local inner-city charities (2013). The Priority Zone rooftop garden has also created employment opportunities through the maintenance of these gardens. This garden is therefore moving towards sustainability through the creation of jobs and contributing to food security in the city centre.

The Mr. Price Group decided to convert one of the barren rooftops in the Durban Station into a rooftop garden. The idea of this rooftop garden was aimed at providing aesthetic beauty to the area and affording a space where the staff of the company can socialise or have meetings (Botes 2013). The plants that are grown in this garden consist of herbs, vegetables, as well as various succulent plants (2013). The produce that is grown in these gardens is either used in the canteen or consumed by the staff when they are in the garden. This creates a sense of sustainability within the building as the food grown is used by its staff.

In eThekweni Municipality city centre there are not enough programmes for rooftop garden education. There is a need to increase the number of programmes and make educational tools widely available to those who choose to learn more and develop their own rooftop gardens. Improving knowledge and awareness aids in the expansion of the development of this method.

#### **4.7. Rooftop Gardens and Legislation**

The international case studies and models of rooftop gardens which have been discussed above touch on some of the policies that countries have developed with regard to rooftop gardens in the urban centre. Tokyo city passed legislation that

requires all buildings in the city centre that have a floor area of 1000 m<sup>2</sup> and above to create a rooftop garden (Yuen and Hien 2005). The Singapore government realised the benefits of rooftop gardens from this and covered public buildings in the city with gardens. Rooftop garden legislation was also discussed in Chicago, IL. This city has a number of reward programmes for those who make provision for rooftop gardens on their buildings and these have been discussed above. South Africa could learn from the examples that have been put forward in this study. Creating formal legislation will allow rooftop gardens in the city centre to occur on a much larger scale.

Another example of a city that takes rooftop gardens into account is that of Kathmandu city in the central development region of Nepal, India. Due to rapid urbanisation there has been an increase in environmental problems within the city and surrounding areas. As a result, there has been a marked decrease in available agricultural land and an attendant loss of grain-crops, vegetable production and livestock (Gurung 2014). Accordingly, the city has to import much of its food from India or China, making it dependent on these countries. Accordingly, there was a need to find other solutions which would result in increased food production. This led to the growing of food in built-up areas, specifically on building rooftops (Nepal Forum for Environmental Journalism 2014). Rooftop gardens can solve the many environmental problems that result from a rapid urbanisation process. While the policy is currently in its draft stages (Gurung 2014), it does offer hope to the population of Kathmandu that they will soon benefit from more rooftop garden developments.

This policy has been designed to include public-private partnerships, non-governmental organisations (NGOs) as well as the private sector so that the development is both cost-efficient and effective (Nepal Forum for Environmental Journalism 2014). It also includes the management and planning of rooftop gardens, including the resources to be used, vegetation to be planted and construction methods used—a focus which uses local resources (2014). This policy came out of a previously developed guideline. Within the draft policy, grant funding is available for those projects that are community-based, while as far as possible, the initial costs should be taken care of by those involved. Funding may also come from international funding agencies and the larger Kathmandu Metropolitan Council area (2014).

The eThekweni Metropolitan Municipality should seriously consider these policy initiatives and develop a policy document that will work on a local scale. The policy of Singapore could be applied locally, where new or existing developments or buildings that have a floor area of 1000 m<sup>2</sup> or more could be ear-marked for rooftop garden development. Awarding various funding and reward schemes could also be a possibility as is the case of Chicago, IL. The eThekweni Metropolitan Municipality should also study carefully the programme in place in the city of Kathmandu, Nepal, India.

#### **4.8. General Perceptions of Rooftop Gardens**

A study was carried out by Yuen and Hien (2005) using information on high-rise as well as high-density areas within Singapore's inner-city. The study examined in particular the number of rooftop gardens, the reasons why people visit rooftop gardens, and the perceived benefits of having rooftop gardens in a dense urban environment. The majority of those interviewed stated that if a rooftop garden existed on their building they would make effective use of it (2005).

The study further showed that people were more likely to visit a rooftop garden if there were a number of activities present to attract them. Such activities tend to attract a wider array of people if there are activities such as games to gain the interest of people. The study also showed that many individuals found Singapore's rooftop gardens a source of relaxation, providing a way to escape the intensity of city life. Rooftop gardens were also viewed as a place for exercise, such walking, yoga or meditation within the rooftop garden. The rooftop garden is very convenient because people who want to visit the garden just have to walk up the stairs or use an elevator to visit the garden. While the study suggested that rooftop gardens should be installed on a greater scale, it also revealed that only half or so of the respondents within a given building make use of its rooftop garden (Yuen and Hien 2005). This poses a setback in terms of the feasibility of having rooftop gardens on a greater scale on city-centre buildings. Creating recreational spaces within a rooftop gardens could increase the number of people who visit the gardens, creatively designed gardens are important for increasing the attraction to these gardens. Examples for increasing the functionality of

rooftop gardens include adding cafés or chess tables so visitors are able to engage in other activities while in the garden.

It is paramount for residents to have a positive outlook on rooftop gardens to ensure the expansion of this concept in cities, especially in Durban. A way to change the way people feel about rooftop gardens is education and involving the public to create rooftop gardens that will be functional and serve their particular needs.

#### **4.9. Substrates and Materials Required for Rooftop Garden Development**

When constructing a rooftop garden there are four main components or layers that are required for the successful growth of vegetation (D'Annunzio 2010). The first is the drainage layer which ensures that water flows through the rooftop garden and does not accumulate or clog-up in certain areas. The next is the substrate drain layer which assists in slowing down the storm-water run-off from the rooftop gardens into the storm-water management systems within the city centre (2013). Then comes the drainage medium which prevents rotting by allowing for excess water to flow through the rooftop garden (2013). A filter fabric layer is added (Greenstone *et al.*, 2011) in place to reduce substrate run-off and hold the plant roots in place. The addition of these layers and substrates will result in the successful growth of vegetation on a rooftop garden.

The substrates that are required for growing produce on rooftop gardens are required to be light in weight, should not be easy to chemically or physically breakdown, and should have ideal aeration and filtration so that the roots of the plants will not rot due to being saturated with water (Greenstone *et al.*, 2011). In order to keep up with these requirements most substrates that are used for plant growth on rooftop gardens have a high mineral content so that the vegetation grown receives the required amount of nutrients for successful growth (Williams *et al.*, 2010). In Europe and North America, these materials include recycled materials such as roof tiles, mashed bricks and pumice stone. If the substrate is made up of too much organic material then this causes it to breakdown quickly resulting in a loss of nutrients for the plants. It is important therefore to utilise inorganic substrates that will support successful plant growth on rooftop gardens.

Rooftop gardens for food production utilise a semi-intensive or intensive gardening technique that has substrates at least 15 - 20 cm deep, so as to ensure successful growth (D'Annunzio 2013). The soil that is used for plant growth on rooftop gardens can be around 60% lighter than soil that is used when growing vegetation on the ground. That said, if rooftops are not able to handle the additional load of rooftop gardens then they are required to undergo some level of reinforcement.

Substrates are able to hold more water than conventional soil types and have good water filtering qualities, thus ensuring the successful growth of plants. These customised substrates are usually made up of vermiculite and perlite, as in the case of the pilot rooftop garden constructed on the City Engineers building on the fringe of the Durban CBD (Greenstone *et al.*, 2011). Intensive and semi-intensive rooftop gardens require irrigation on a regular basis (Oberndofer *et al.*, 2007). Irrigation is through the collection of rainwater by installing Jojo water tanks or other water storage options.

Hydroponic foam can also be used as a much lighter alternative to soil. This is developed from hydrophilic polyurethane and is produced in Australia (Practical Hydroponics and Greenhouses 2014). The foam is clean and light in weight, yet is highly absorbent, being able to take as much as thirty times its own weight (Farm Service Agency 2013). It also possesses a stable structure that will not change in form. This type of foam has great drainage capacity and the materials used to develop the foam do not contaminate the vegetation within which it is grown (Practical Hydroponics and Greenhouses 2014). This makes hydroponic foam an excellent medium for the growth of edible plants on rooftop gardens. The light weight of this growing medium could result in an increase in the development of rooftop gardens, as the additional weight of rooftop gardens has been a factor that hinders the wider scale development of these gardens in the city.

Hydroponic foam is used in Spain with gardens constructed on top of buses that travel around the city centre (Farm Service Agency 2013). With the hydroponic foam system there are waterproofing systems that are placed below the foam including baffles which restrain the flow of the water and prevent the clogging of water in the garden. Hydroponic foam is highly beneficial for the growth of vegetation on rooftop

gardens as it is light in weight, has good air spaces for the efficient flow of water, has a good drainage capacity, but is also very absorbent so that nutrients and minerals can be easily stored for successful plant growth.

Modular container systems are also common systems that are used in rooftop garden horticultural practice (Greenstone 2009). Container systems are able to hold most types of vegetation depending on the size of the container. That said, most container systems are used for non-edible plants as the container limits root development. Container systems should therefore be used simply to add more green spaces in an urban centre rather than specifically for food production. If modular container systems are not utilised, the growing medium is applied directly onto a drainage layer which protects the roof membrane. This can be made out of a geotextile fabric mesh such as is used on the City Engineers building in eThekweni Metropolitan Municipality (Greenstone *et al.*, 2011).

For the production of edible vegetation on rooftop gardens it is important to use the direct method of applying the substrate layers to the protection and drainage layers on rooftops so that the roots of the plants will not be constrained and will be free to grow.

The Priority Zone Rooftop Garden Project as well as the Mr. Price rooftop garden was constructed out of recycled materials including old tyres, steel drums and plastic pallets within which various vegetables and herbs were planted. This rooftop garden makes use of rainwater to irrigate the plants which is collected and stored on the rooftop of the building using Jojo rainwater collection tanks and containers.

#### **4.10. Advantages and Challenges of Rooftop Gardens in Urban Centres**

This section assists in achieving central aim (iv) stated in chapter one. There are many advantages of developing rooftop gardens on a wide-scale within urban centres. There are however a few challenges that need to be overcome in order to ensure rooftop gardens are established and successfully form part of a land-use model for Durban CBD. These environmental, economic and social advantages and challenges will be discussed in detail below. Environmental advantages refer to occurrences that will

affect both the environment and people in the city in a positive manner. The same can be said for social and economic advantages.

#### ***4.10.1. Environmental Advantages***

##### *4.10.1.1. Contribution to the Mitigation of the Urban Heat Island Effect*

The UHIE is created when measured average temperatures within urban centres are greater than those recorded outside the urban centre. The difference and increased temperature can be attributed to dark surfaces. Concrete and asphalt surfaces absorb heat quickly and slowly release this heat at night (Carpenter 2008). Temperature differences can be as much as 7-10 degrees Centigrade warmer than those recorded in the outer areas of the city (Laurence Berkeley National Laboratory cited in Carpenter 2008). This also applies to eThekweni Metropolitan Municipality. Establishing rooftop gardens will lower temperatures in the CBD as vegetation does not absorb heat. Instead it will translate into part of the growing process.

##### *4.10.1.2. Filtering Dust and other Pollutant Particles in the Air*

The vegetation in rooftop gardens cleanses the city air by absorbing pollutants such as carbon dioxide and carbon monoxide (Bouma 2010). The pollutants and particles that are created by various forms of air pollution will be purified by the vegetation on green roofs. As a by-product of photosynthesis, plants transform carbon dioxide into oxygen thereby reducing the levels of pollutants found in the atmosphere (2010). Developing rooftop gardens in the Durban CBD will contribute to cleaner air and a healthier environment for those who live and/or work in the city.

##### *4.10.1.3. Introducing Bio-diversity into the City*

Rooftop gardens can contain a variety of vegetation that may attract animal species into the area. The existence of a variety of vegetation types will bring increased varieties of insects, spiders, birds and beetles into the urban centre, thereby conserving local plant and animal species (Obendofer *et. al.*, 2007). Their return to the urban environment needs to be encouraged if the full productive potential of rooftops as food

producing hubs can be achieved. The conservation of plant and animal species forms part of the IDP and the Environmental Management Plan of the eThekweni Metropolitan Municipality (eThekweni Metropolitan Municipality 2012), which is a reason to promote the establishment of rooftop gardens on a much larger scale within the Durban CBD.

#### *4.10.1.4. Filtering and Reducing Storm-water Run-off*

Storm-water generally refers to rainwater. Rainwater that reaches rooftops is channelled to the ground through gutters and downpipes which eventually end up in street and specially constructed storm-water drains. From there the water is lead into rivers and the ocean. This run-off carries water-borne pollutants along the way, comprising of various metals, oils, petrol and other chemical contaminants (Lye 2009). These pollutants are carried through storm-water systems and are channelled into river systems which contain important plant and animal life. These pollutants greatly affect the environmental cycle by contaminating it, resulting in the death of plant and animal life that exists in the river systems and oceans (2009). It therefore has a negative impact on the natural environment.

Rooftop gardens can contribute to the process of filtering out these contaminants/pollutants as they pass through the soil substrates resulting in cleaner water going into rivers (Lewis 2012). The greater of soil depth within which vegetation is planted, the greater the effectiveness of the filtering process (Greenstone *et. al.*, 2011). This is possible because plant soil may contain various layers, getting finer and increasingly dense as the soil gets deeper. As water passes through these layers, the different soil particles trap the contaminant particles resulting in cleaner water entering storm-water systems (Francis and Lorimer 2011).

The particles that the soil traps can be used as a form of plant nutrition thereby aiding successful growth (Francis and Lorimer 2011). Rooftop gardens reduce the amount of storm-water that goes into storm-water management systems by about 90% (D'Annunzio 2010). As a result, there is a decreased burden put on storm-water management systems and thereby reduces the chance that these systems will overflow and cause flooding within the city.

Rooftop gardens can also contribute to the reduction of water going into storm-water management systems by collecting rain water for use in rooftop gardens. Rainwater can be collected in drums on rooftops and then used for irrigating the plants. Another mechanism through which rooftop gardens can reduce storm-water flow is the absorption of rain by the plants whereby the roots of plants absorb water from the soil for growth resulting in a reduction of run-off. Due to this process, there is a decrease in the amount of water that exits the building through downpipes and drainage systems and thus a reduction in the storm-water flowing into the municipal systems.

#### **4.10.2. Economic Advantages**

There are a number of economic benefits that emerge from the establishment of rooftop gardens in inner city areas and these are outlined in more detail below. These benefits contribute to the notion of sustainable livelihoods for city dwellers.

##### **4.10.2.1. Food Production in the City**

It is assumed that cities acquire much of their fresh fruit and vegetable produce from regions located away from the city centre. This is because there is a shortage of land in urban centres and the surrounding areas to engage in agricultural activities. Fresh produce is therefore grown in rural areas where there is adequate space for agriculture (Oberndorfer *et al.*, 2007). These regions are usually rural areas which exist at least an hour away from the city centre. Fresh produce being grown such a distance away from the city centre results in great transportation costs in terms of fuel as well as congestion in the city centre as large, heavy vehicles have to transport produce into the city.

In the case of the Durban CBD, much of the fresh produce that is going into the city will arrive from areas around Pietermaritzburg, the KwaZulu-Natal midlands and even further away. Pietermaritzburg is at least one and-a-half-hours away from the city centre. The amount of money spent on travelling is today exceptionally high as the produce has often to travel great distances before it reaches its final destination in the city centre.

Rooftop gardens can be highly beneficial to the city as there is much under-utilised rooftop space that may have the potential to be used for rooftop gardens and food production in the city. City rooftop garden food production can also reduce transportation costs for those who require fresh produce normally grown in areas far away from the city. Through such ways, rooftop gardens are able to provide an adequate supply of fresh vegetables for those living in the urban centre.

#### *4.10.2.2. Increase in Property Prices*

Rooftop gardens can add up to 20% to the value of a property (Pedersen 2002). Rooftop gardens also provide aesthetic beauty as well as spaces for socialising and enjoyment. This is especially valuable to buildings within the city centre within which there is little ground-level green space that can provide aesthetic beauty due to the compact building design of the Durban CBD, as well as city centres in general.

#### *4.10.2.3. Lower Building Costs*

Utility costs are greatly reduced in terms of heating and cooling mechanisms because rooftop gardens will reduce the heat of the building thereby reducing dependency on air-conditioning units (Oberndorfer *et al.*, 2007). Overall heat reduction is due to the plants on rooftop gardens reflecting or absorbing the heat of the sun. The sun's energy is reflected by the vegetation due to the green chlorophyll that exists in plants, plants also require this sunlight for growth due to the process of photosynthesis in which plants convert the energy from the sun to produce food (Lye 2009). People living in buildings that have rooftop gardens will therefore pay less for heating or cooling systems, thereby lowering energy costs for themselves. This will be especially beneficial for a country such as South Africa that has been experiencing severe energy problems in the past few years. It will also save people who live and/or work in the city centre a great deal of money in the long-term which should form a promoting strategy for the expansion of rooftop gardens in the Durban CBD.

### ***4.10.3. Social Advantages***

Rooftop gardens provide social advantages for inner-city residents in the following ways.

#### *4.10.3.1. Social Meeting Places*

Rooftop gardens provide a relaxing space where people can meet and socialise. Rooftop gardens can provide a tranquil space for people to appreciate and enjoy. Rooftop gardens may also provide a space for community projects by bringing people within the CBD closer together by creating a sense of community for everyone. This is the case with the rooftop garden on the Mr. Price Store building in the Durban CBD. Within this rooftop garden, people gather to have business meetings or just come out on to the garden terraces to relax (Botes 2013). This can be applied on a large-scale in the Durban CBD and can take different forms such as restaurants or tea-gardens.

#### *4.10.3.2. Aesthetic Beauty*

Rooftop gardens in any form add great beauty to the monotony of the large numbers of grey pre-stressed concrete high-rise buildings that exist in the city centre. The colours of the vegetation provide great contrast to the drab grey-coloured concrete roofing that is common within the Durban CBD. The pleasing sight of city-centre rooftop garden can be relaxing as well as calming to all those who live and/or work in the urban centre.

### ***4.10.4. Challenges***

#### *4.10.4.1. The Cost of Rooftop Gardens*

There are two costs that have to be considered in the development and maintenance of rooftop gardens. The first short-term investment is the initial cost to setup the rooftop garden in terms of waterproofing systems and providing substrates for the plants to grow successfully (Lewis *et. al.*, 2012). The second longer-term cost relates to the maintenance of the rooftop garden itself, providing organic compost, recycling

materials and acquiring new plants. Related costs include the payment of a supervisor/horticulturalist to manage the garden and an engineer to perform building audits as a part of an on-going maintenance programme (Priority Zone Durban 2013).

#### *4.10.4.2. Access to Rooftops*

Lack of proper entrances to rooftops may be a challenge when transporting materials to the roof during the development of rooftop gardens. This can be addressed by the use of a crane or hoist but in the longer-term, access to the garden will have to be user-friendly and secure. Some buildings may not have lifts installed. Buildings without lifts will make it increasingly difficult to transport the necessary materials on to the roofs, resulting in greater costs in time and money. In some buildings in the Durban CBD, there are no proper doors to access the roofs of buildings which can be a challenge during the construction process (Greenstone 2009).

#### *4.10.4.3. Building Load of Roof Structures*

Not all rooftops in the Durban CBD were designed to handle the additional load associated with the establishment of a rooftop garden and thus part of the initial feasibility study for a rooftop garden would be to check the engineering specifications and waterproofing requirements associated with each proposed rooftop garden project. In order to be able to install a green roof that would be fully supported there may be the need to reinforce the building roof so that load of the rooftop gardens will be managed and the rooftop will not cave-in or cause excessive damage to the building.

With extensive rooftop garden systems with substrate layers that are 5-15 cm deep, this will add approximately 70-170kg per m<sup>2</sup> to the load of the roof. With intensive rooftop gardens and layers that are deeper than 15 cm, the additional load will add up to about 290-970 kg per m<sup>2</sup> (Dunnett and Kingsbury 2004). Accordingly, if retrofitting rooftop gardens onto existing buildings is required, then there will be a need for a structural engineer to examine the load capacity of the building to determine whether the building requires additional support.

Additional support could consist of beams or columns that are placed in strategic places that will manage the extra load. Accordingly, the heavier components of the rooftop garden may be placed near or around these structures (Dunnett and Kingsbury 2004). Image 4.5 below gives some detail as to the additional substrate weight that will be added to the load-bearing of buildings. Using these calculations assists in the initial development of a rooftop garden; these numbers can be converted to an engineer who can then determine what kind of rooftop garden can be created depending on the load bearing capacity of the building rooftop.

Module depth (cm)	Weight (kg)	Weight per m <sup>2</sup> (kg)
7.5	15-25	80
10	30-40	85
20	40-50	90

**Image 4.5.**

Additional Weight from Rooftop Gardens with Substrate Depths

Source: (Greenstone *et. al.*, 2011:6)

#### 4.10.4.4. *Materials Used*

There is a need to search for suitable growing substrates so that the breakdown of materials is lengthened and soil does not lose its nutrient-levels at a rapid pace (Greenstone 2009). There is also a need to search for the most efficient and effective waterproofing systems, irrigation systems and soils when planning and installing rooftop gardens on buildings in the Durban CBD and in other South African cities. Hydroponic foam could be used in future rooftop garden developments due to its composition, the lightweight is a great advantage.

As indicated above, the advantages of developing rooftop gardens in urban centres are significant and far outweigh the disadvantages. Although there are a few challenges with the development of rooftop gardens, these can be overcome with proper planning and development. The advantages of rooftop gardens should be made easily accessible to the public so that residents' level of knowledge and their perceptions can be

improved and made to be increasingly positive. If this is achieved, the rooftop garden strategy can be expanded throughout the city.

#### **4.11. Conclusion**

This chapter has dealt with the evolution of rooftop gardens from past to present on a global scale. This chapter has also outlined the advantages that have been experienced and the challenges involved with the development of rooftop gardens in the urban centre which forms one of the central aims to this. In addition, international examples of rooftop gardens from Singapore and Chicago have been reviewed, which are executed on a large scale and thereby experience optimum benefits. This chapter has outlined local examples in Cape Town, Johannesburg and Durban, which are executed on a much smaller scale compared to the international examples. South Africa can learn many lessons from the international case studies and models that have been discussed. For example, introducing building credits and other rewards as offered in Singapore and Chicago for those who make provision for rooftop gardens in their buildings can be replicated in this country. The Shanghai model shows the success of retrofitting rooftop gardens to an existing building. This can also be achieved on a large scale in the Durban CBD.

The various materials that are used in the successful installation and development of rooftop gardens has also been discussed as well as the type of vegetation that is suitable for the KZN-coastal climate and which can give exceptional growth in the Durban CBD.

In conclusion, it has been shown that the benefits of rooftop gardens in the urban centre greatly outweigh the challenges which can be overcome with proper planning, management and expertise in developing successful rooftop gardens on buildings within the Durban CBD. Providing the public with the aforementioned information will allow the perceptions of this method to improve thereby increasing the level of awareness on the concept of rooftop gardens in the eThekweni Municipality city centre.

# CHAPTER FIVE

## RESEARCH FINDINGS

### 5.1. Introduction

This chapter will discuss the findings that were collected during the research and data collection process using the methods discussed above in chapter two. During the data collection process, the Key-Informants were interviewed in order to determine their views, opinions and experiences, with regard to rooftop gardens. This was done to ascertain whether it will be feasible to develop rooftop gardens extensively in the eThekweni Metropolitan Municipal area, with special interest being placed on the Durban CBD. The results from those interviews and questionnaires are presented in this chapter.

This chapter focuses on the responses that were acquired during the interview and questionnaire process which focuses on answering some of the sub-questions from chapter one as well as reaching some of the stated central aims and objectives of this study. The responses were analysed and the information tabulated and put into graph form to support the conclusions made. The information from this chapter has assisted providing greater knowledge about the existence and development of rooftop gardens in the urban centre as well as the level of awareness and the perceptions that the public hold on the rooftop garden concept and method.

In addition this chapter will also discuss the current issues surrounding rooftop gardens from the perspective of the general public as well as professionals in the field. Issues that are discussed in this chapter include the perceptions that people have about rooftop gardens, the level of awareness, whether there are any policies or legislation that takes urban centre rooftop gardens into account and the type of vegetation that should be planted in rooftop gardens in the Durban CBD. Other information that was collected included rooftop gardens and its contribution to local economic development as well as the mitigation of climate and environmental challenges.

## 5.2. Participants' Knowledge of Rooftop Gardens

Survey Groups	Yes	No	Unsure
Number of participants who live or work in the Umhlanga/Durban CBD and from Queensburgh who know about rooftop gardens	94%	0%	6%
Number of built-environment professionals who know what rooftop gardens are	100%	0%	0%

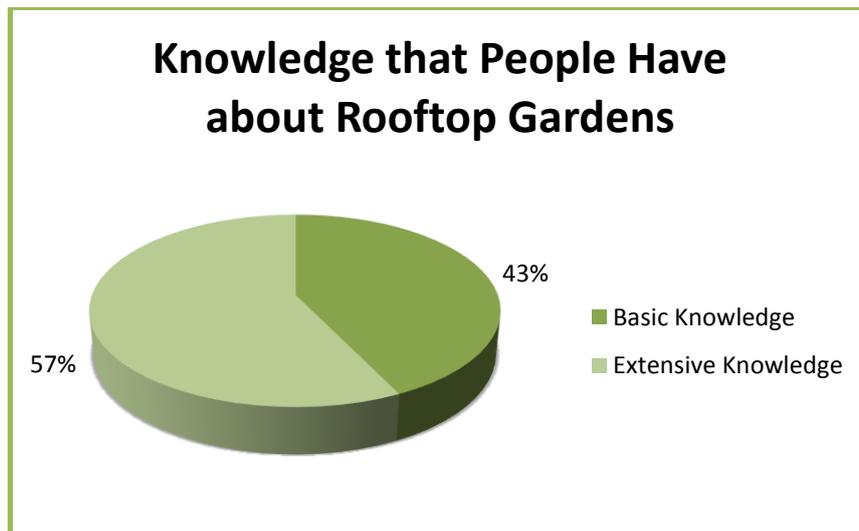
**Table 5.1.**  
Knowledge of Rooftop Gardens

From Table 5.1 above it can be seen that over 90% of the research participants had knowledge of roof gardens in the urban centre. However, when asked the question “What do you know about rooftop gardens?” fifteen out of the thirty-five participants could only provide a basic answer. A basic answer in this context refers to a statement that is lacking detail and involves the simple answer that rooftop gardens are fruit/vegetables/plant gardens which are developed on the roofs of buildings.

The remaining twenty research participants gave a more complex range of answers that contained much more detail. This will be referred to as extensive knowledge. Extensive knowledge answers provided by the research participants included providing temperature control in urban centres, aesthetic and food production benefits to reduce the impact of urbanisation, as well as introducing green spaces into the city. The graph below shows the percentage of research participants who were able to provide detailed information about rooftop gardens.

From Figure 5.1 below it can be observed that less than half of the research participants, excluding the built-environment professionals, lacked extensive knowledge about rooftop gardens in urban areas. All seven built-environment professionals who participated in the questionnaire had an extensive knowledge of rooftop gardens. The built-environment professionals mentioned the challenges associated with rooftop gardens, including irrigation and maintenance, but also the

environmental benefits that are associated with rooftop garden development in urban centres.



**Figure 5.1.**  
Knowledge of Rooftop Gardens

The number of individuals who lacked knowledge about rooftop gardens is representative of what was discussed during the interview process with the Key-Informants. As a result, there were many individuals who were not aware of the numerous benefits that rooftop gardens can provide. For example, many are not aware of how the challenges of developing a rooftop garden can be easily overcome with proper maintenance and management plans. Hence, there is an urgent need to provide extensive information about rooftop gardens to the people resident and/or working in the eThekweni Metropolitan Municipal area as well as the country as a whole. Citizens need to be provided with sufficient information about the benefits of rooftop gardens and their application in urban centres such as Durban CBD. Such knowledge will promote the wide-scale development of rooftop gardens in the Durban CBD as well as other urban centres across South Africa.

This is an extremely important finding as the main aim and one of the objectives of this study was to determine the level of awareness that the public have regarding rooftop gardens. Thus, this aim and objective was reached through the interview and questionnaire process.

### **5.3. Rooftop Gardens Filling Un-used Roof Space in the City**

The desk research phase revealed that rooftop gardens are an effective method for making use of unused rooftop space within the city centre. An effective method in this context refers to a strategy or plan that can have a host of benefits for its users. The strategy with regards to this present study is the establishment of rooftop gardens.

This finding relates to the main question of this study which was ‘Are rooftop gardens in urban centres an effective way of utilising unused roof space within the Durban CBD’ and one of the central aims of examining whether developing rooftop gardens in the Durban CBD will be a positive use of underutilized roof space outlined in chapter one. Those who have been directly involved in the development of rooftop gardens confirm that they have many benefits, especially if developed on a large-scale within the Durban CBD.

Key-Informant A, who was involved in the eThekweni Metropolitan Municipality Green Roof Pilot Project stated that:

*Rooftop gardens can aid in increasing biodiversity and insects in the city, climate change, storm-water absorption and used for energy saving.*

Key-Informant E also reported that:

*Rooftop gardens have aesthetic benefits and can be a positive addition to the city.*

Other beneficial factors that were mentioned include air quality control, noise reduction, green areas in which birds and insects can feed, effective storm-water run-off management, and reducing the energy footprint for air-conditioning.

In most of the green roof project that the research participants were involved in, few failures were mentioned and yet there were many success stories. In the case of the City Engineers Green Roof Project, Key-Informant B reported that:

*Everything that was set to be achieved was achieved; all plants in this garden have achieved successful growth, and continues to achieve this successful growth.*

One of the sub-questions of this present study was to determine if a rooftop in the city could hold the additional weight of a garden and whether it would successfully meet its environmental and socio-economic objectives. Across all the interviews conducted,

the failure of a rooftop garden was determined on the engineering design and the materials that were used in its construction.

Key-Informant D stated that:

*Many green roofs are not designed properly in terms of access to the green roof or rooftop garden and this makes it difficult to maintain and manage the rooftop garden.*

Possible failures that were revealed by Key-Informant A included lack of maintenance of materials and incorrect building materials. For example:

*If materials like wood or some plastics have been used then after a period of time, these materials would need to be replaced; therefore a comprehensive maintenance and management plan will need to be put in place to ensure the long-term success of the rooftop garden.*

Another possible failure discovered during the interviews was that of storm-water damage due to poor drainage systems being in place in the rooftop garden and/or regular maintenance. The drains need to be cleared from weeds and soil run-off so as to prevent blockages from occurring. As Key-Informant A reported:

*Layers are important in the construction of a rooftop garden to ensure a well-functioning drainage system.*

Some of these failures can be corrected with proper long-term maintenance plans being put in place. As Key-Informant D was to state:

*During the construction process of the rooftop garden there is a need to engage in consultation with individuals who have had extensive experience with successful rooftop gardens particular to the area so that the proper plants and materials are chosen in order to achieve a successful rooftop garden.*

This is an important factor to consider when planning the development of a rooftop garden.

On the City Engineers rooftop garden the growth of both edible and inedible plants were successful. Key-Informant A recounted that:

*The most successful edible plants were found to be the hardier greens like spinach, kale and spring onion; other successful edible plants include onions, green peppers, chillies and tomatoes.*

There is an avenue for increasing this type of food garden such as on the Priority Zone Rooftop Garden. Increasing the number of edible plants within a rooftop garden can be advantageous and would greatly decrease the carbon footprint of the Durban CBD. An attractive benefit would be the contribution it would make to food security in the eThekweni Metropolitan Municipal area.

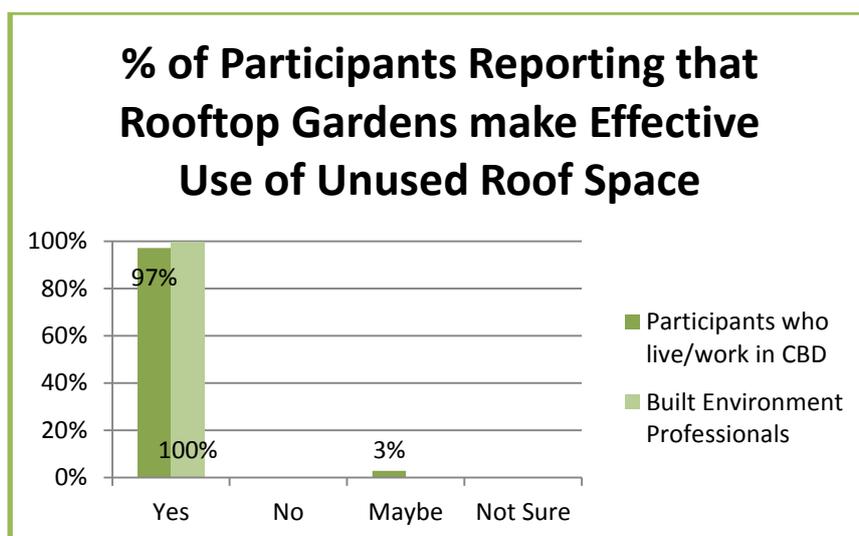
Key-Informants B and C held that it will be a long time until eThekweni Metropolitan Municipality will be able to make extensive use of rooftop gardens. Accordingly, Key-Informant C reported that:

*Some departments in eThekweni Metropolitan Municipality have a negative reaction towards the wide spread use of rooftop gardens in the [Durban] CBD of eThekweni Metropolitan Municipality.*

Such negativity hinders the progress of developing this concept on a wide-scale in the Durban CBD.

There is much room for change. Hence, the need to make the benefits of developing rooftop gardens on a large-scale in the Durban CBD more well-known.

When asked whether the development of rooftop gardens could be a functional way of filling-up under-used rooftop space in the city centre, a majority of the participants answered positively.



**Figure 5.2.**

Rooftop Gardens as a Method to Utilise Under-used Roof Space in the City Centre

From Figure 5.2 above it can be seen that all the built-environment professionals who participated in the research held that rooftop gardens are an effective way of making use of under-used rooftop spaces in the urban centre. Of the thirty-five respondents from the first sample group, one participant (i.e., 3% of the total sample) reported that it was possible that the development of rooftop gardens could be useful, while the rest of the respondents (i.e., 97% of the sample) agreed that it would definitely be a useful method to make use of barren rooftops in the Durban CBD. All the built-environment professionals who participated agreed that rooftop gardens are a good use of space in the city.

In chapter four , the benefits of rooftop gardens in reducing the amount of storm-water run-off entering the city’s storm-water drainage system by well over 70% was discussed in depth. The results below show the number of the participants who held that this was possible.

Rooftop gardens will absorb rain water and decrease pressure put on storm-water drainage systems	Participants who live/work in the CBD and Queensburgh	%	Built-Environment Professionals	%	Total	%
Strongly Agree	13	37	2	29	15	36
Agree	12	34	4	57	16	38
Neutral	6	17	0	0	6	14
Disagree	1	3	1	14	2	5
Strongly Disagree	3	9	0	0	3	7
Totals	35	100	7	100	42	100

**Table 5.2.**

Rooftop Gardens and Absorption of Rain Water

Table 5.2 above states that over 70% of the total respondents gave a positive response to rooftop gardens providing excellent absorption of storm-water and thereby reduce the pressure put on municipal drainage systems. The remaining 26% were either neutral or did not agree that it would be beneficial. This figure of just over a quarter of

the respondents could be attributed to the fact that they did not have the necessary knowledge about rooftop gardens. Since the concept of rooftop gardens is just beginning to grow in Durban and South Africa as a whole, the general public are not widely informed on the concept of rooftop gardens.

#### **5.4. Rooftop Gardens as Local Economic Development and Environmental Mitigation Measures**

From the interviews conducted there were mixed reactions towards the possibility of rooftop gardens contributing to Local Economic Development (LED) and for environmental mitigation measures. From an LED perspective, there are many people migrating daily from the rural areas into the city looking for work and accommodation. This finding is important in answering the sub-question from chapter one ‘What contribution can rooftop gardens make to sustainability, climate change and Local Economic Development (LED) strategies in the Durban CBD?’. Currently, there are not enough job opportunities to meet this growing urban population. This leads to people begging on the city streets due to the lack of money and food insecurity.

Rooftop gardens can help assist with poverty alleviation within the city by providing people with jobs as well as with food that is grown in the gardens. Key-Informant E, who is involved in the Priority Zone Rooftop Garden, maintained strongly that rooftop gardens can assist with local economic development within the city. Key-Informant E confirmed that:

*The individuals who work in this garden have steady jobs working here and are able to take some of the produce that is grown in the garden, most of the vegetation that is grown on this rooftop garden is donated to the less fortunate.*

This is a model that can be replicated on a large-scale in the Durban CBD.

From a site visit, it was witnessed that all the vegetation that was planted on the rooftop garden were thriving. Green vegetables such as spinach and lettuce, various herbs, radish, onions, spring onions and tomatoes have all been grown successfully. Key-Informant E stated that everything that had been planted enjoyed successful

growth on the rooftop garden with the exception of carrots. Key-Informant E also reported that:

*A variety of insects, including butterflies have been introduced into the garden because of all the vegetation that has been planted.*

This provides clear evidence that rooftop gardens in the city centre can contribute to increasing the bio-diversity of the area. Key-Informants A, D and E held that if done in the right way and using the correct methods and materials and on a large scale, rooftop gardens can contribute positively to local economic development and environmental mitigation.



**Image 5.1.**

Priority Zone Rooftop Garden, Plants are thriving

Source: Photograph by Researcher, August, 2015

Image 5.1 above and 5.2 below shows a number of consumable as well as inedible indigenous plant species growing on the rooftop. All vegetation grown on this rooftop garden was thriving at the time of the site visit by the present researcher. This garden demonstrates the successful growth of a wide variety of plants and vegetation.

The vegetation on rooftop gardens are able to filter the air from pollutants	Participants who live/work in the CBD and Queensburgh	%	Built Environment Professionals	%	Total	%
Strongly Agree	11	31	1	14	12	29
Agree	12	34	3	43	15	35
Neutral	8	23	3	43	11	26
Disagree	2	6	0	0	2	5
Strongly Disagree	2	6	0	0	2	5
Totals	35	100	7	100	42	100

**Table 5.3.**

Rooftop Gardens Filtering Air Pollutants

Table 5.3 above shows that over half of the respondents agreed that vegetables grown on rooftop gardens are able to filter out air pollutants in the urban environment. Bouma (2010) proves that this is possible. However, just under half of the research participants were neutral as to whether this was possible. This proves that there is not enough information that is being circulated regarding the benefits of inner-city rooftop gardens. This further demonstrates that the level of awareness regarding city rooftop gardening is low.



**Image 5.2.**

Priority Zone Rooftop Garden, Edible Vegetation

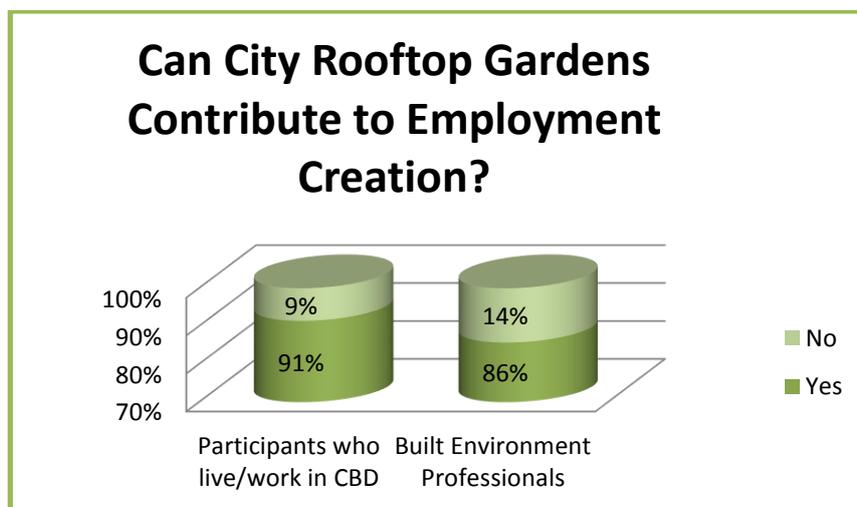
Source: Photograph by Researcher, August, 2015

Image 5.2 above indicates more of the vegetation variety in the Priority Zone garden. Key-Informant B maintained that the area of eThekweni Metropolitan Municipality is too small to experience any kind of environmental mitigation through the large-scale development of rooftop gardens. Key-Informant B further held that only the large-scale development of rooftop gardens can contribute to LED in the Durban CBD. Accordingly, Key-Informant B reported that this could be achieved by:

*Constructing restaurants on rooftops alongside rooftop gardens, but it should be done in such a way that everything that is grown in the garden is protected from the harsh elements. This is done at a great scale in Japan along with putt-putt greens on rooftop gardens.*

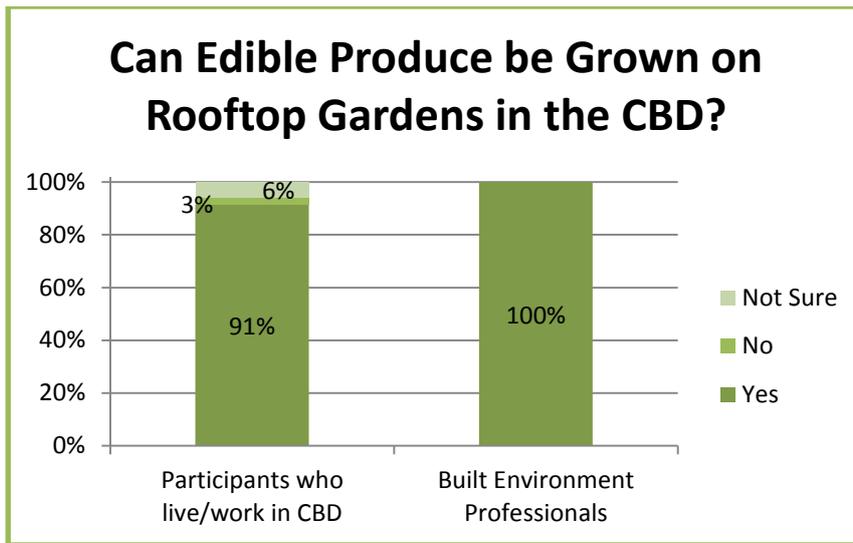
In the research questionnaire, it was asked if the development of rooftop gardens could contribute to job creation as well as food security, if the food grown on rooftop gardens could be sold or donated to the poor. The results for those questions are presented and explained below.

Figure 5.3 below shows that 91% of the participants maintained that rooftop gardens can contribute to job creation. One of the respondents said that individuals could also develop maintenance and management businesses for rooftop gardens in the city centre. This could effectively reduce poverty levels in the CBD by creating employment opportunities. It is also possible to grow edible plants on rooftop gardens, as was shown in the Priority Zone, Mr Price and City Engineers rooftop gardens. When asked if respondents thought it is possible to grow fruits and vegetables on city rooftop gardens, participants said the following.



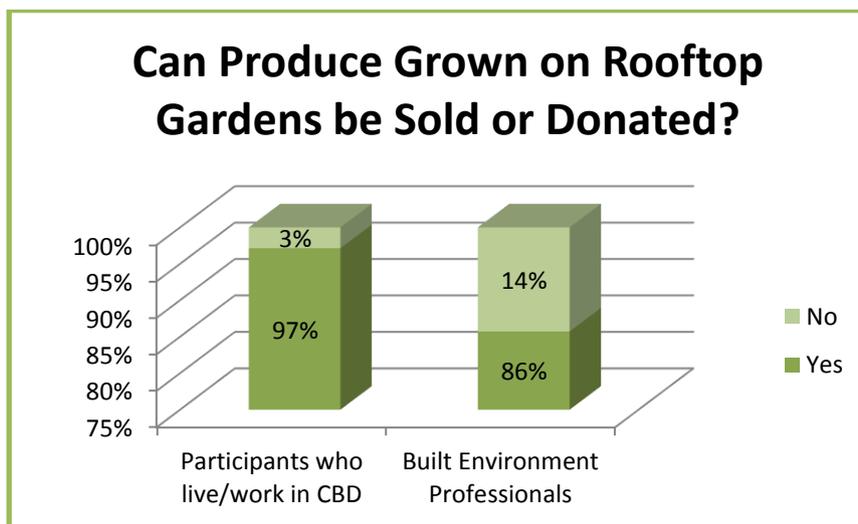
**Figure 5.3.**

Rooftop Gardens and Employment Creation



**Figure 5.4.**  
Growing Edible Produce on Urban Centre Rooftop Gardens

Figure 5.4 shows that majority of the sample are aware that edible produce can be grown on rooftop gardens. The fruits and vegetables that can be grown on rooftop gardens could be sold to restaurants in order to raise revenue for the maintenance and some of the produce could also be donated. The following chart shows how many respondents saw this as a good idea.



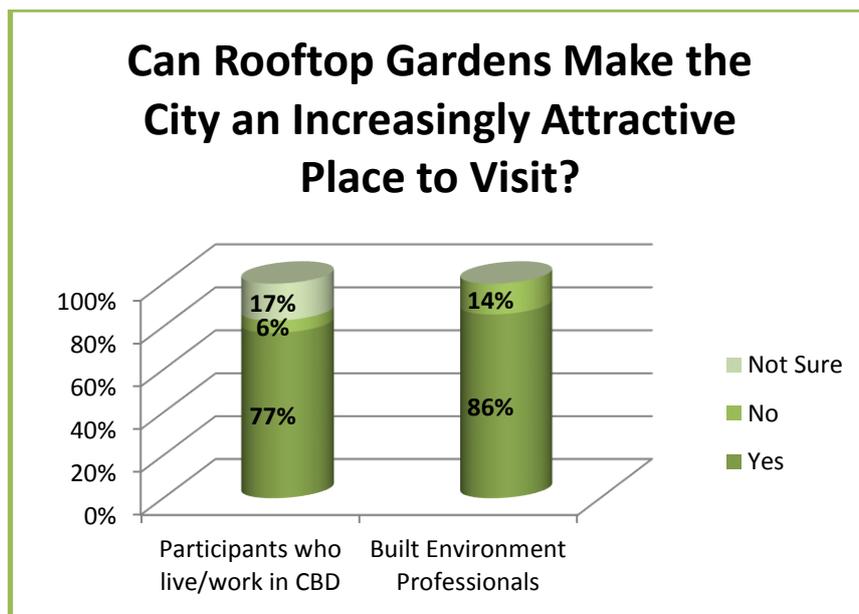
**Figure 5.5.**  
Produce Grown on Rooftop Gardens Can be Sold or Donated

Figure 5.5 above shows that of the forty-two research participants, over 90% thought that the fruits or vegetables that are grown on rooftop gardens could be donated or sold. That said, more of the research participants leaned towards the idea that produce could be donated to the poor. The Priority Zone Rooftop Garden, as discussed above, donates the majority of its produce to the poor, while a small portion is sold so as to raise revenue for the maintenance of the garden (Botes 2013). This should be replicated on a large-scale so that the rooftop garden can pay for itself and only the initial start-up costs would have to be catered for.

Making rooftop gardens publicly accessible as in the Priority Zone Rooftop Garden Project, provides a means of showcasing the idea to a wider audience, thereby advancing the development of rooftop garden on a wider scale. According to Key-Informant E the aim is:

*To create environmental education and show people how they can sustain themselves in the city centre by replicating this idea.*

The Priority Zone Rooftop Garden Project is open to visitors as well and therefore directly promotes tourism. This can also assist in making the city centre a more attractive place to visit. Below are the results of what the research participants thought with respect to rooftop gardens promoting tourism.



**Figure 5.6.**

Increasing Tourism with Large-Scale CBD Roof Gardens

Figure 5.6 above shows that 79% of the respondents agreed that the large-scale development of rooftop gardens could make the city centre an increasingly attractive place to visit, while about 10% of the forty-two research participants said that it would not. About the same number of respondents from the total sample was not sure about this.

If more people were aware of all the advantages of rooftop gardens then more people would be accepting of the idea. If rooftop gardens, as discussed above in chapter four, are able to increase tourism activities as is the case in Singapore and Chicago, then tourism will increase, bringing much needed income into the urban centre. Rooftop gardens are designed to be aesthetically pleasing so that people will want to visit them, while adding recreational amenities such as restaurants or rooftop markets will result in an increased amount of people wanting to come into these gardens, creating tourism and generating revenue.

Key-Informant A reported that:

*There are many derelict buildings which can be transformed into rooftop gardens, so that the elderly and children, who spend majority of the time at home, will spend most of the time on these rooftop gardens.*

Rooftop Gardens can be used as a community development tool. The materials for establishing rooftop gardens can be produced locally so that local business development will benefit. Although there are many advantages attached to rooftop gardens in the urban centre, its large-scale development has yet to be implemented in the Durban CBD. The reasons for this will be discussed in the section which follows.

### **5.5. Reasons Why Rooftop Gardens are not used on a Large-scale in Durban**

This finding relates to answering the main aim and objective of this research study, that is ‘To investigate the level of awareness and perceptions on rooftop gardens within the city centre of eThekweni Municipality’, the first part of sub-question (iii) ‘Why are rooftop gardens not used on a larger scale within the Durban CBD?’ as well as research objective (v) of assessing the level of implementation of rooftop gardens in the city centre of eThekweni Municipality stated in chapter one of this study. This

section also assists with reaching objective (ii) of identifying the challenges of implementing rooftop gardens.

#### ***5.5.1. Lack of Awareness and Knowledge about the Benefits of Rooftop Gardens***

This finding directly relates to the main aim of this study, as mentioned previously. From the questionnaires that were conducted with the sample group of people who live and/or work in the city centre, many respondents understood that the concept of rooftop gardens in the city centre was a fairly new concept. They stated that there was not enough information about the numerous benefits of rooftop gardens. As a result, entrepreneurs and business owners are not so willing to develop rooftop gardens on a large-scale because they do not have the correct information. The most popular concerns voiced by the research participants involved transporting equipment to rooftops, the structural and building loads for gardens, proper drainage systems and people being afraid that placing a green roof on a building may cause water leaks to occur. People's attitudes towards rooftop gardens needs to be refreshed. This can only be achieved by providing more information about the concept of rooftop gardens. Environmental education should also be promoted as society, government officials and other interested parties should be informed. This will result in some creating rooftop gardens for themselves.

#### ***5.5.2. Concern about the Additional Cost of Constructing Rooftop Gardens***

Because of the additional materials needed to construct a green roof and the resultant increase in load, structural engineers need to assess the structural integrity of the roof, and its ability to handle the additional weight. From the research, the additional construction costs and professional fees was also a major concern. This provides evidence as to why local government departments and building owners are unwilling to develop rooftop gardens extensively. One of the research participants reported that:

*There are no local government incentives in place to encourage the use of building rooftops for green purposes.*

Because of this, there is little if any motivation for people to engage in greening building rooftops.

People need to be informed that the benefits of rooftop gardens outweigh the challenges. By using materials that are recycled or repurposing materials for use in a rooftop garden development, overall construction costs can be kept down. Key-Informant D stated that a major issue was that:

*The city is not properly rolling out the development of rooftop gardens therefore private companies and stakeholders are not using the proper tools and systems and are not making use of indigenous plants.*

This results in rooftop gardens not being installed and developed correctly which causes additional costs in post-installation maintenance and repair.

In order for rooftop gardens to be developed and installed correctly it is of the greatest of importance to consult with professionals who have experience with developing rooftop gardens in a specific area. The same is true in receiving the correct horticultural advice. Key-Informant B reported that:

*Many developers in the city centre are concerned with return investments when developing buildings.*

As a result, many landlords, owners and businesses do not consider adding a rooftop garden to their building. However, rooftop gardens can be beneficial to the city as a whole and can contribute to the eThekweni Metropolitan Municipality's goal of becoming a greener and healthier city.

### **5.5.3. Lack of Legislation allowing Rooftop Gardens**

This finding relates, in part, to objective (iii) outlined in chapter one of assessing the guidelines/policies/legislative instruments on rooftop gardens designing. Currently, there is no form of legislation or policy that takes rooftop gardens into account in the Durban CBD. Accordingly, there is the need to create by-laws from the guidelines that have already been created in order for landlords, building owners, entrepreneurs and local government departments to be persuaded of the many benefits and of developing rooftop gardens on a large-scale in the city centre. Key-Informant A reported:

*With the lack of parking space in the city and more people entering the city centre on a daily basis, this development usually takes precedence over greening issues.*

Here, there is need to bring the greening of the city centre to the forefront so as to achieve the sustainability goals of eThekweni Metropolitan Municipality. Key informant D reported that:

*Clients as well as the government are looking for cost effective buildings, such as maximum payback on the building so that they are rewarded the maximum financial benefits. They are not necessarily looking at innovative designs or green building developments that will result in achieving environmentally friendly and sustainable buildings.*

One of the research participants reported that:

*The development of rooftop gardens may be seen as creating extra work for people within the buildings.*

If a rooftop garden is constructed properly after the first few months of development then little maintenance is needed. People could also be hired to work in these gardens.

A further research participant reported that “*access to the roof may be problem.*” Unless proper access to the roof is provided, it will make be difficult to transport the necessary materials needed to create the rooftop garden and subsequently plant the garden. It will also make it difficult to maintain the rooftop garden on a regular basis.

Key-Informant B asserted that:

*Not all buildings currently in the city centre are able to handle the additional weight that comes with developing rooftop gardens.*

One of the built-environment professionals who participated in the questionnaire was of the opinion that:

*There is a need for environmentalists, environmental planners as well as architects to cooperate.*

If this were to take place then the building plans would be able to accommodate rooftop gardens and thereby make it easy for such an incentive to be implemented.

## **5.6. Legislation and Rooftop Gardens in the eThekweni Metropolitan Municipality**

This finding directly relates to objective (iii): ‘To assess the guidelines/policies/legislative instruments on rooftop gardens designing’ and objective

(v) ‘To assess the level of implementation of rooftop gardens in the city centre of eThekweni Municipality’, in chapter one. In eThekweni Metropolitan Municipality there is currently no legislation that takes the development of rooftop gardens into account. However, as Key-Informant A reported:

*[The] eThekweni Municipality is the only city in South Africa that has included rooftop gardens in a municipal plan.*

Rooftop gardens are included in the eThekweni Climate Protection Plan, as has been discussed in chapter four above. The cities of Cape Town and Johannesburg have not developed such a programme. The furthest that eThekweni Metropolitan Municipality has come in promoting the development of rooftop gardens in the CBD is the creation of a policy guideline. This guideline contains all the information that is necessary to build a rooftop garden. It includes what plants enjoy the most successful growth in the area as well as the additional weight that would be added by a rooftop garden after construction is completed.

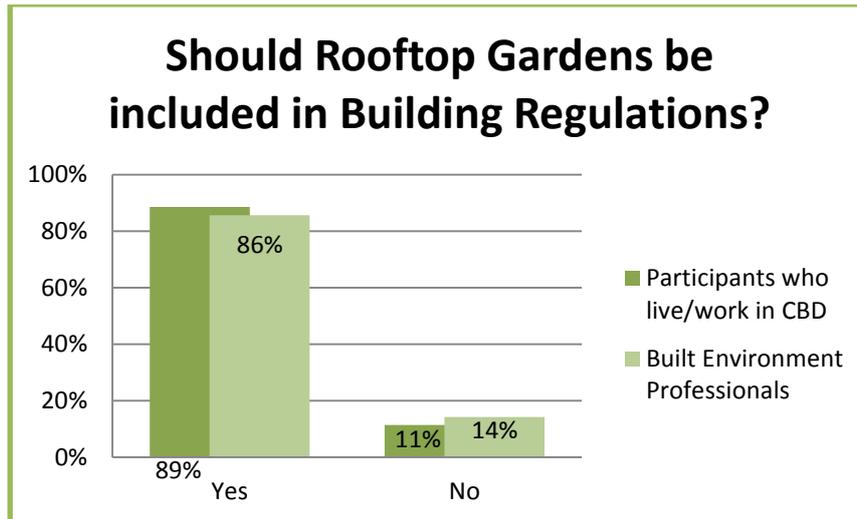
Key-Informant A was of the opinion that there was “[a] need to translate this guideline into legislation or a policy,” thereby ensuring rooftop gardens are developed on a large-scale in the Durban CBD. Key-Informant B mentions the Dube TradePort City in KwaZulu-Natal. All new developments in this area need to contain some form of greening such as a green wall or green roof. This same legislation needs to be applied to the Durban CBD, such as all new building developments being required to make provision for the installation of a rooftop garden. Existing buildings also need to be examined as to whether they are able to handle the additional weight of a rooftop garden. Buildings that are able to handle the additional load should be given financial incentives by the municipality for the development of rooftop gardens.

The municipality should include rooftop gardens in building policies	Research Participants who live/work in the CBD and Queensburgh	%	Built-Environment Professionals	%	Total	%
Strongly Agree	19	54	3	43	22	52
Agree	7	20	3	43	10	24
Neutral	7	20	0	0	7	17
Disagree	0	0	0	0	0	0
Strongly Disagree	2	6	1	14	3	7
Totals	35	100	7	100	42	100

**Table 5.4**

Rooftop Gardens Included and Building Policy

It can be seen from Table 5.4 above that the majority of research participants in the questionnaire agree that the eThekweni Metropolitan Municipality should include rooftop gardens in its general building policy. The research participants understood that the wide-scale development of rooftop gardens in the Durban CBD can be highly beneficial and can contribute to eradicating poverty in the city by providing employment and food to those who require it the most. When asked whether rooftop gardens should be included in building legislation, the following results were obtained.



**Figure 5.7.**

Graph showing whether Rooftop Gardens should be included in Building Regulations

From Table 5.4 and Figure 5.7 above it can be seen that 89% of the sample agreed that building regulations should make provision for the development of rooftop gardens. The research sample also understood that rooftop gardens can add a positive element to the Durban CBD.

One of the Research Participants was of the opinion that:

*There would be a need to implement projects all over the [Durban] CBD and the success of these would depend on the construction, maintenance and management of these gardens.*

Rooftop gardens should be included in building regulations as a means to decrease the city's carbon footprint. One of the built-environment professionals provided the following answer to the question posed in the questionnaire:

*There is a need to come up with regulations for rooftop gardens in terms of what will be grown and for what purpose the rooftop garden will be used for in each case if developed on a larger scale.*

A guideline containing this information has been created for eThekweni Metropolitan Municipality, but this now needs to form part of its policy or legislation.

The research participants who disagreed or were neutral, thought that developers or building owners should not be forced to accommodate a rooftop garden on their property; but instead, it should be their own choice. The eThekweni Metropolitan

Municipality should however include provision for rooftop gardens in its building regulations so as to achieve the goals of the climate protection programme.

The government should provide incentives for the wider use of rooftop gardens	Participants who live/work in the CBD and Queensburgh	%	Built-Environment Professionals	%	Total	%
Strongly Agree	18	51	4	57	22	52
Agree	9	26	3	43	12	29
Neutral	5	14	0	0	5	12
Disagree	0	0	0	0	0	0
Strongly Disagree	3	9	0	0	3	7
Totals	35	100	7	100	42	100

**Table 5.5.**

Government Providing Incentives for Wide-Scale Rooftop Garden Use

Table 5.5 above shows that over 80% of the research participants that took part in the questionnaire maintained that the South African Government should provide incentives to develop rooftop gardens on a large-scale. If people are motivated and encouraged to develop more rooftop gardens in the CBD, it will eventually become a widespread reality. The eThekweni Metropolitan Municipality has the power to introduce by-laws and provide incentives to ensure the success of the climate protection programme by the greening of rooftops in the Durban CBD.

### **5.7. Rooftops in the Durban CBD Accommodating Gardens**

This finding answers sub-question (iv) ‘Can rooftops in the Durban CBD can accommodate the development of rooftop gardens?’ mentioned in chapter one. Key-Informants A and B as well as a number of other research participants stated that not all of the existing buildings in the Durban CBD would be able to handle the additional load produced by intensive rooftop gardens. Intensive rooftop gardens could be constructed on a large scale but with very thin soil layers so as to limit the additional weight added to the roof load. Key-Informant B reported that “*it would be difficult to*

*retrofit rooftop gardens*” which contain edible plants because edible plants do usually require thicker soil layers. If edible plants or intensive rooftop gardens were to be planted on a rooftop then engineers would need to be consulted to determine the load bearing capacity of the building. Plants that require thin soils and little maintenance would possibly be the easiest option. This includes some edible vegetation such as herbs, or lettuce.

### **5.8. Edible Produce that can be grown**

This finding assists in reaching one of the central aims of this study mentioned in chapter one, that is, ‘Ascertain whether rooftop gardens can be used successfully on a large scale in the study area chosen’. Key-Informant A discussed the vegetation that was planted in a pilot study of the rooftop garden situated on the City Engineering building of eThekweni Metropolitan Municipality in the Durban CBD. This rooftop garden was developed in 2008 and is currently still being monitored. The research informant stated that the edible produce that has been grown on this rooftop garden, *“includes tomatoes, peppers, rocket, runner beans and eggplants.”* These plants have grown successfully according to city officials involved in the Green Roof Pilot Project.

Informant E reported that every plant species that has been trialled on the Priority Zone Rooftop Garden has been successful, with the exception of carrots. Accordingly, this Key-Informant reported that:

*Tomatoes, a variety of greens and even watermelon have grown in this rooftop garden.*

On the Mr. Price rooftop garden, various salad herbs and even strawberries were planted successfully (Botes 2013). There are a wide variety of fruits, vegetables and other plants which can grow successfully in the Durban CBD climate.



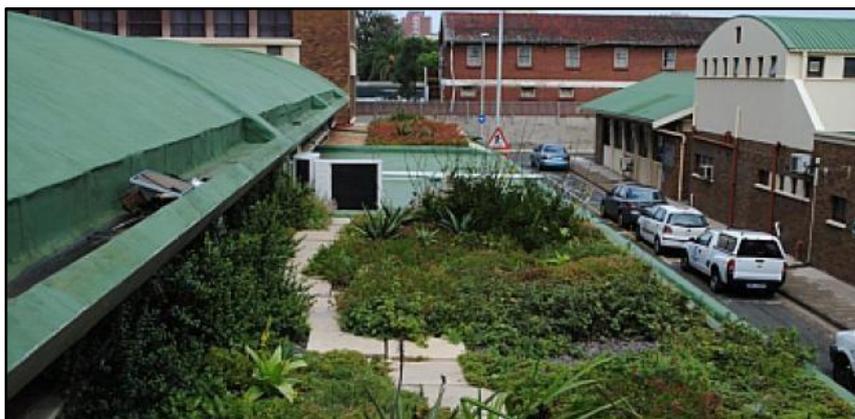
**Image 5.3.**

Edible Produce Grown on the Priority Zone Rooftop Garden

Source: Photograph by Researcher, August, 2015

Edible produce including spinach and cabbage can be seen clearly in image above of the Priority Zone Rooftop garden. The utilization of recycled materials is also visible in the image.

The image of the City Engineers rooftop development below clearly shows the succulents and other indigenous plant species being grown successfully on the rooftop.



**Image 5.4.**

City Engineers Department, Rooftop Garden<sup>1</sup>

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<sup>1</sup> <[www.urbanearth.co.za/](http://www.urbanearth.co.za/)>. {Accessed 12 June 2016}.

The municipal guidelines contains a list of such plants, both edible and inedible. The municipality needs to rollout this development so that the environmental, social and economic issues that are experienced in the city centre can be reduced.

### 5.9. The Perceptions about Rooftop Gardens in the Durban CBD

This finding directly relates to reaching the main aim, one of the objectives and sub-questions of this study regarding the perceptions that the public have on rooftop gardening.

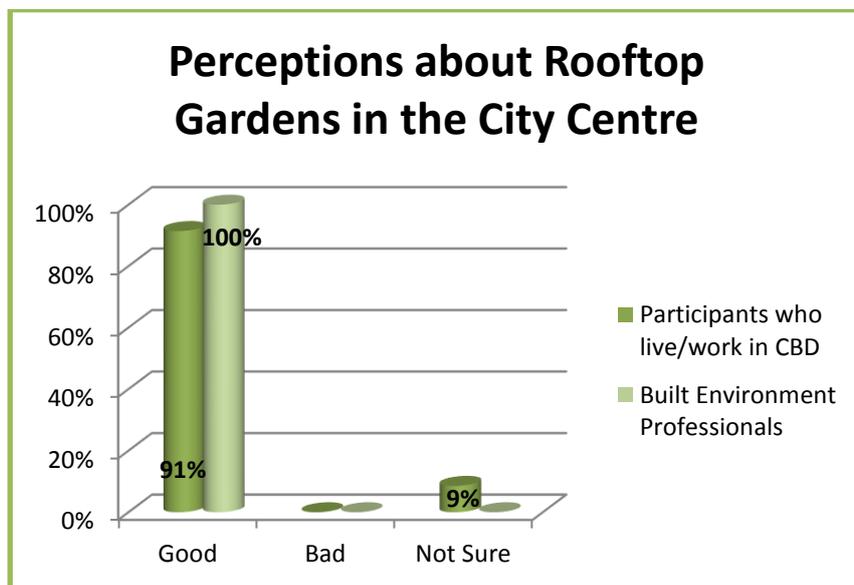


Figure 5.8.

Perceptions about Rooftop Gardens in the City Centre

Figure 5.8 above reveals that over 90% of the total sample maintained that having rooftop gardens in the city centre is a good and innovative idea to make use of space that would otherwise not be used for other activities. The remaining 9% are unsure about the idea, a few stating that they, “do not have enough information about the concept of rooftop gardens” to make a meaningful decision. One respondent who was unsure reported that:

*Rooftops are not secure and with the development of a rooftop garden, an increase of crime within the building may be experienced.*

This can however be overcome if proper security measures are put in place so that people using the building and visiting the rooftop garden are protected. The research

participants that maintained that rooftop garden development in the city centre is a good idea stated a variety of reasons for their answers.

Rooftop gardens are a practical and effective use of space, especially in a built-environment where unused land is difficult or impossible to find. Accordingly, the development of rooftop gardens in the city centre maximises available urban space in a way that is highly beneficial. Another respondent reported that there were many people in the city who love horticulture, but are unaware of this concept. Accordingly, there is a great need for widespread education on the concept of rooftop gardens. Many of the research respondents had a good knowledge of some of the benefits of rooftop gardens but not all aspects of it. Research participants mentioned that apart from the many benefits which aid in improving the environment of the city, rooftop gardens provide an eco-friendly vibe in the midst of a concrete jungle. Rooftop gardens can be beautiful if maintained properly as well as being an excellent technology for cleaning the air in the city centre. Respondents also stated that in private rooftop gardens residents can save money on food by growing their own food.

With regard to the built-environment professionals who participated in the questionnaire, a number of advantages and concerns were brought up. There was a major concern over the initial capital sum needed to create a rooftop garden, as well as the attendant maintenance costs, which are much higher than a traditional roofing structure. One of the built-environment professionals maintained that:

*If the cost of developing rooftop gardens was reduced then this would make it easier to sell the idea to users.*

There was also much concern voiced over the long-term cost of rooftop gardens. Yet, with a properly structured maintenance and management plan, the initial and long-term cost of having a rooftop garden is not as great as many people would think. Indeed, as discussed above, there are methods that can be put in place to reduce construction costs. Even though this was a voiced concern, there was overall agreement that it was a good idea and these types of gardens should be encouraged across the country as the advantages of rooftop gardens far outweigh the disadvantages and challenges which can be easily overcome.

## **5.10. Possible Incentives that could be provided by eThekweni Metropolitan Municipality**

During the interview and questionnaire process a number of options were highlighted as to what incentives could be provided by the municipality to promote the development of rooftop gardens in the city centre. This finding answers sub-question (iv) mentioned in chapter one which is, ‘What institutional or financial incentives can be provided by the eThekweni Metropolitan Municipality to encourage the establishment of rooftop gardens?’.

### **5.10.1. Rate Rebates**

Key-Informant A reported that:

*This can be awarded to buildings that have a rooftop garden or any form of greenery on a building. Green building rates rebates are done throughout the US for buildings that save on energy costs and make use of renewable energy. There are numerous programmes like this across the country.*

All these programmes result in the government making available financial incentives and other benefits to developers and building owners to increase the energy efficiency of buildings. An example of such programmes is the Appalachians Voices Energy Savings Action Centre (Plant Connection Inc., 2015). These programmes and others like it, provide loans to developers who want to create energy-efficient buildings.

Another initiative is the Duke Progress Programme which offers money-saving initiatives for developers who want to engage in energy conservation projects (Plant Connection Inc., 2015). This motivates developers, building owners and entrepreneurs to become greener in their thinking and develop buildings that are greener and more environmentally-friendly. Rebates on municipal rates and business taxes can be given in order to promote the development of rooftop gardens in the city centre. As rooftop gardens are able to contribute to decreasing the energy use of buildings, they also decrease storm-water run-off to such an extent and they can contribute to reducing air temperatures in the urban centre.

### **5.10.2. Introducing Building Credits**

Currently, the Green Building Council exists to award points to buildings that make use of a variety of green-building techniques (Lewis *et al.*, 2012). This council has standards and specifications for green buildings within the South Africa context which have been developed from the Australian Green Building Council. There is a need for the eThekweni Metropolitan Municipality to transform these standards into local by-laws and building regulations so that green-building and in particular, rooftop gardens can be developed on a large-scale in the Durban CBD. The point system can be developed so that buildings that incorporate rooftop gardens or other green-building initiatives are awarded benefits such as speeding up the process of acquiring building permits as in the case of the city of Chicago (Yang *et al.*, 2008).

Key-Informant A reported that developers and owners should be able to rely on extra floor credits for specifically the roof. Indeed, using specific legislation, floor credits can be granted on roof-space used for green purposes and this method is followed by various states in the US. Key-Informant A also stated that:

*The municipality can also enforce a storm-water management fee; if the building is impermeable then the people should pay more.*

Through rolling-out more awareness campaigns, and installing rooftop gardens on city-owned public buildings, and encouraging visits by the general public, the concept would gain leverage. Currently, this is what is being rolled-out in the Priority Zone Rooftop Garden Project. As Key-Informant A reported:

*Rooftop gardens will also be able to prevent a building from being demolished which helps with reusing and recycling old buildings and in some cases these buildings could become nature reserves in the city.*

This would greatly benefit the city from an environmental point-of-view.

Key-Informant B stated that:

*In Germany the government will not allow any new development to occur if there are no provisions made for rooftop gardens and a percentage is determined of how much space will be used for vegetation.*

This method needs to be translated into a building legislation or policy by the eThekweni Metropolitan Municipality. The same informant reported that it would not

take much effort to make provision for all new buildings to accommodate rooftop gardens.

### **5.10.3. Training**

Key-Informant A reported that:

*There is a need to teach people the correct methods, materials and plants that will be used in a rooftop garden.*

This highlights the importance of training practitioners in installing rooftop gardens, be they large or small. Key-Informant E suggested that there was a need to teach people how to be self-sustainable by replicating what they see in the Priority Zone Rooftop Garden Project.

## **5.11. Rooftop Gardens and the Mitigation of Climate Change**

This finding relates, in part, to discussing the advantages of increasing rooftop gardens in the city which forms part of the central aims (central aim iv) of this study which have been outlined in chapter one.

During the interview process Key-Informants A and E reported that the development of rooftop gardens could assist with decreasing air temperatures. Informant B stated that because the city of Durban, as well as being a coastal city, is small in comparison to other cities, the development of *“rooftop gardens on a larger scale will not play that much of a role in decreasing air temperatures.”* All the professionals who were interviewed maintained that rooftop gardens, if created on a large-enough scale in the city centre, would be able to assist or form part of an environmental strategy. The aforementioned informants were in agreement that rooftop gardens can to a great extent, assist with storm-water management and run-off, and also act as a filter, filtering out impurities in the water entering the city’s storm-water management systems and eventually going into the rivers and sea. This results in cleaner water entering river systems. During the questionnaire process the following results were collected.

Rooftop gardens will decrease the overall temperatures of cities	People who live or work in the CBD (Durban and Umhlanga)	%	Built - Environment Professionals	%	Total	%
Strongly Agree	10	28	2	29	12	28
Agree	8	23	4	57	12	29
Neutral	9	26	1	14	10	24
Disagree	3	9		0	3	7
Strongly Disagree	5	14		0	5	12
Totals	35	100	7	100	42	100

**Table 5.6.**

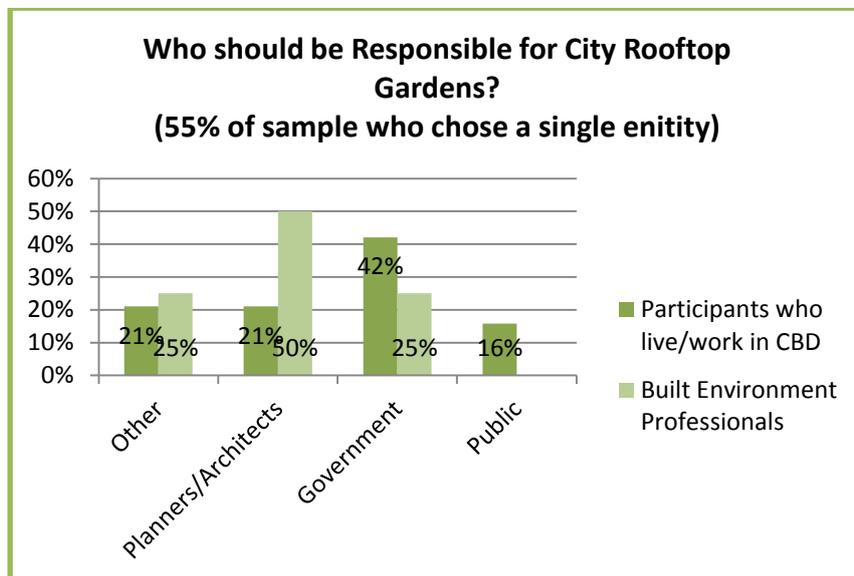
Rooftop Gardens Contribute to Decreasing Overall City Temperatures

From Table 5.6 above it can be observed that just over 50% of the research participants maintained that rooftop gardens can decrease overall temperatures in the city centre. The research participants who disagreed with this contention, or who are neutral in the matter were fairly equal in number. This can be attributed to the fact that people are not provided with enough information about the advantages that rooftop gardens are able to provide. The professionals all agreed that rooftop gardens are able to contribute to decreasing overall temperatures in the city centre. This is because they have the knowledge and the facts about developing rooftop gardens on a large-scale in the city centre. It can be seen from the above results that the public do not have all the information about rooftop gardens. Environmental education is of paramount importance so that the idea of rooftop gardens in the urban centre can spread and can eventually result in the development of by-laws and legislation that includes rooftop gardens in building regulations and policy.

### **5.12. Bodies that should be Responsible Rooftop Garden Development in the City**

This finding assists this study in reaching objective (iii) of assessing stakeholder roles in implementing rooftop gardens. In the questionnaire, the question of which layer of government should be responsible for the development of rooftop gardens was asked.

The options provided included the public, government, planners, architects, or any other body. 45% of the total sample said that more than one entity should be responsible for rooftop garden developments. Of the 45%, 19% said that both the public and the government should be jointly responsible for rooftop gardens. Some 17% of that 45% said that the public, government, planners and architects should be involved. Some 5% of respondents were of the opinion that the public and planners/architects should have the responsibility. The remaining 4% chose the above options with the ‘other’ box ticked. Some 55% of the total sample chose a single entity that should be responsible for the development of rooftop gardens. This information will be presented and explained below.

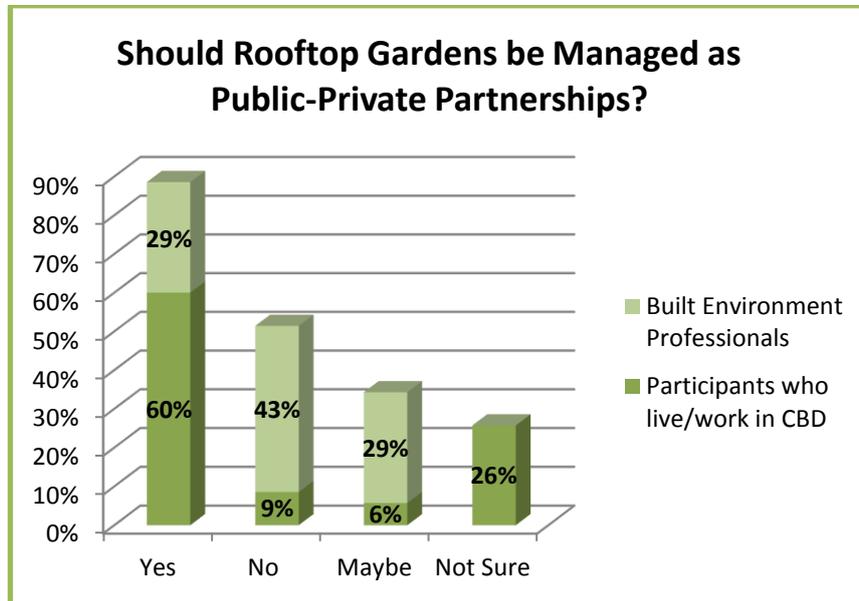


**Figure 5.9.**

Who should be Responsible for City Rooftop Gardens?

Figure 5.9 above shows that 55% of the research participants thought that the government should be responsible for this development. Planners/architects and other entities follow with 32% and 26% respectively. The respondents from the sample who live and/or work in and around the CBD who selected the ‘other’ option did not provide any detail as to which other entity could be responsible for rooftop garden development. The one built-environment professional who included the ‘other’ option in their answer stated that home-owners together with all the mentioned entities should share the responsibility of the rooftop garden. Many of the research participants

reported that the government should take charge of the project so that it can be developed on a large-scale across the country.



**Figure 5.10.**

Management of Rooftop Gardens

As can be seen from Figure 5.10, when asked if rooftop gardens should be managed as a public-private partnership, over 50% of the research participants were in the affirmative. This number closely relates to the figures in the set of results stating that many people preferred a government/public or planners/architects and public responsibility for rooftop gardens.

### **5.13. Conclusion**

This chapter has dealt with the results that were obtained during the field work research part of the study. This field research was aimed at reaching the main and central aims of this study. Also, answering the main and sub-research questions as well as meeting the objectives that were outlined in chapter one of this present research study. A majority of the participants had knowledge of what a rooftop garden was, but not all respondents knew all the information that is publicly available on the concept. An extremely important finding that was revealed in the study was that majority of the participants had only a basic knowledge of the concept of rooftop gardens. These participants were only able to provide a simple answer of this concept

stating that it is an area upon building rooftops where vegetation is grown. Only a few participants were able to provide complex answers including areas for food production and climate control. The results acquired have achieved the main aim of this study, which was to determine the level of awareness and perceptions of rooftop gardens. The study revealed that the level of awareness of rooftop gardens is low. However, the participants generally tended to have a positive attitude towards rooftop gardens and would favour further development of this strategy in the city. This chapter has helped ascertain the perceptions people have about rooftop gardens as well as whether people believe that the wide-scale development of rooftop gardens is an effective method in utilising under-used roofing space in the Durban CBD

The research participants generally offered positive feedback with respect to developing rooftop gardens in the city centre, while a few had some concerns, all of which have been covered in the present chapter. Possible incentives that could be offered by eThekweni Metropolitan Municipality to encourage owners, entrepreneurs and developers to invest in rooftop gardens in the city have also been thoroughly discussed. An important note was the value of environmental education, which is generally lacking with regards to the concept of rooftop gardens. People need to be provided with the necessary information and training so that existing rooftop gardens can be replicated on a large-scale in the Durban CBD. If owners, developers and entrepreneurs knew of the advantages of rooftop gardens then there would be more motivation to create rooftop gardens in the urban centre. There is a much need for a change of attitude among various local government and municipal departments towards rooftop gardens and this can only be done through environmental education.

Participants held that rooftop gardens should be included in building policy and legislation and that the eThekweni Metropolitan Municipality should provide financial incentives for the wider-development of rooftop gardens. If done on a large-enough scale in the city centre, people who live and/or work in there would experience great advantages, not only in terms of job opportunities, food security, poverty alleviation, but also cleaner air, rivers and ocean.

## **CHAPTER SIX**

### **RECOMMENDATIONS AND CONCLUSIONS**

#### **6.1. Introduction**

This final chapter will review the research objectives and research questions that were discussed in chapter one of this research study. A summary of the research findings that were discussed in the previous chapter will also be provided. Finally, recommendations based on the aims, objectives and research findings of this study will be put forward with respect to the larger-scale development of rooftop gardens in the Durban CBD. The central aim of this study, which was, determining the perceptions and level of awareness of the public has been achieved and is discussed further in this chapter.

#### **6.2. Major Findings**

In the previous chapter, the field research results offered a variety of insights into the way the research participants felt about the development of rooftop gardens in the urban centre. Over 90% of those who participated in the interview and questionnaire process believed that rooftop garden development in the city centre would be a positive addition to those living and/or working in the Durban CBD. Accordingly, the research revealed that there is a strong future for rooftop gardens within the eThekweni Metropolitan Municipal area.

An important finding that was produced by the results was that of the low level of awareness of the concept of rooftop gardens, majority of the participants were unable to mention multiple purposes of rooftop gardens and were only able to provide a simple answer stating that rooftop gardens are spaces on building rooftops within which a variety of vegetation is planted. As discussed previously in chapter five, only a few of the participants were able to include other uses of rooftop gardens, including temperature control in urban areas, introducing green spaces into the city and as a method of food production. This result revealed a great need for environmental education concerning rooftop gardens. Those living and/or working in the city centre

may not have sufficient knowledge about the concept of rooftop gardening. Consequently, there is much need for the roll-out of a comprehensive education programme to inform the public about the advantages of rooftop gardens. Indeed, the research has shown conclusively that rooftop gardens can provide a host of solutions to the environmental, social and economic problems that the city centre faces. The results also revealed that participants generally held a positive attitude towards developing rooftop gardens further and believed that this method would be a beneficial addition to the city.

Currently, there is no formal legislation promulgated by the eThekweni Metropolitan Municipality that governs rooftop gardening in the Durban CBD—a fact that 85% of the research participants felt should be urgently addressed. Indeed, the research revealed that that rooftop gardens are a good method of dealing with a number of environmental and socio-economic challenges that are experienced in the Durban CBD. Accordingly, there was positive feedback on the general concept of rooftop gardens and their contribution to employment, food security and reversing biodiversity loss in the city centre. The majority of the research participants reported that rooftop gardens can be a very positive addition to the city environment in that rooftop gardens are able to keep buildings cool, be a source of fresh food, and provide good natural spaces within an otherwise concrete city environment.

From the research that was conducted it, it was shown that city rooftop gardens are an excellent method of making use of under-utilised roofing space. Indeed, it was shown that rooftop gardens can be used for a multitude of activities, as well as alleviating many of economic and environmental challenges that the city of Durban experiences. Rooftop gardens are also able to provide societal advantages such as social meeting places for business people and the general public as well as adding aesthetic beauty to the monotony of the city environment.

If more people were to accept the establishment of city rooftop gardens then this idea would take-off and be developed on a large-scale in eThekweni Metropolitan Municipality. Linking the urban environment to the natural is important in achieving bio-diversity in the city. In addition, rooftop gardens contribute to sustainable livelihoods for those who live and/or work in the city.

By reviewing both local and international experiences and examples of rooftop gardens, municipalities can incorporate these ideas into a legislation or policy that would result in the increased development of city rooftop gardens.

### **6.3. Review of Research Questions and Objectives**

The research questions that underpin this research study were aimed at determining the level of awareness and perceptions of rooftop gardens. Hence, it was important to ascertain the level of knowledge and perceptions of people who live and/or work in and around the Durban CBD. Ultimately, this research project was intended to gauge whether the public believe that constructing rooftop gardens in the Durban CBD is an effective method of filling-up under-used rooftop space. In chapters four and five, these questions were thoroughly addressed. The numerous benefits of green roofs have been discussed throughout this work which has led to the researched conclusion that rooftop gardens are a functional method to fill-up under-used rooftop space in the Durban CBD. Rooftop gardens can aid in storm-water management in the city, provide food (currently occurring on a very small scale in Durban CBD) to the poor as well as form part of an environmental mitigation strategy to aid in reducing the impacts of climate change and the UHIE.

The eThekweni Metropolitan Municipality currently has no formal regulation in place or building policy that is inclusive of rooftop garden development. The formation of the green roof guideline is the closest the municipality has come to including rooftop gardens in a formal municipal document. The research participants were more in favour of including this type of development into a policy or building legislation as they were mindful of the numerous advantages that arise from developing such gardens in the Durban CBD. However, there is a need for all entities to work together in order to achieve this transformation. The current eThekweni Metropolitan Municipality Green Roof Pilot Project and Priority Zone Rooftop Garden Project can pave the way for the large-scale development rooftop gardens in the city centre, sooner rather than later.

## **6.4. Recommendations**

Based upon the research, the following recommendations are suggested as a way to encourage the large-scale development of rooftop gardens in the Durban CBD.

### ***6.4.1. Role of Local Government, Planners and Architects***

There is a need for interested stakeholders to come forward and take on various roles in implementing rooftop gardens in the city. Municipality officials, planners, architects, environmentalists as well as the general public need to work together to ensure the success of the wide-spread development of rooftop gardens. Transforming the attitudes of necessary departments towards rooftop gardens is paramount for the concept to be utilised successfully. The research showed conclusively that the public has a positive outlook with regard to the large-scale construction of rooftop gardens in the Durban CBD. If such a programme is rolled-out by eThekweni Metropolitan Municipality in cooperation with other stakeholders and interested parties, then this goal can be achieved. The city will then be able to meet one of its goals in becoming a green city. Rooftop garden development can form a large part of the future of the city in becoming green and sustainable in that it can rely on itself for food and job creation. This will result in a greener and more liveable city.

As a further step forward towards this goal, eThekweni Metropolitan Municipality needs to perform audits on existing buildings in the Durban CBD. This should be done in order to determine which buildings will be able to handle the additional load of a rooftop garden—be it an extensive, light-weight garden or an intensive, heavier-load garden. Once this step is made, it will be possible for the local authority to develop a policy and raft of regulatory provisions and guidelines so that existing and proposed buildings in the Durban CBD can host rooftop gardens thereby fulling-up under-used roofing space.

### ***6.4.2. Provide Greater Knowledge about Rooftop Gardens to the Public and other Stakeholders***

This study revealed that the public have a low level of awareness of rooftop gardens, although this is a novel concept in South Africa, it is slowly growing in importance as

people realise that this method has a multitude of benefits in the city environment. The success of this project will greatly be impacted by the knowledge and attitudes that people have regarding this idea. If people are provided with all the correct information about rooftop gardens then the idea can grow into an effective programme that could be run by the municipality and managed by the various stakeholders. Environmental education is a necessary step forward in developing a greener city and with that, an extensive use of rooftop gardens.

#### ***6.4.3. Training***

Through reviewing local literature and examining the experiences with inner city rooftop gardening, the study revealed that training those responsible to work in rooftop garden ensures the success of the garden itself. Providing training is important for individuals who want to develop their own gardens on their building rooftops. To ensure that plants or produce are grown successfully on a rooftop garden, people need to know exactly what goes into maintaining a rooftop garden correctly. With a rooftop garden in the city, vegetation experiences harsher climates. People need to be provided with training so that they can understand which vegetation is more suitable for a city climate and what mediums the plants can be grown in. Individuals who choose to establish their own rooftop gardens in the city should be provided with educational courses or training. This is because developing a rooftop garden does not only assist the people involved with its development, but also greatly benefits the city as a whole, from an environmental as well as socio-economic perspective.

#### ***6.4.4. Providing Incentives***

The study revealed that the level of implementation of rooftop gardens is very low in eThekweni Municipality city centre, due to a number of reasons which have been addressed in chapters four and five of this study. In order to encourage the development of rooftop gardens, people or organisations should be provided with some form of incentives by the municipality. These incentives were discussed in the research findings in the previous chapter. Some of the incentives that were mentioned included rate rebates for those who have rooftop gardens on their buildings; introducing building credits is another option. With storm-water management,

buildings which are impermeable should pay more than those which are not. Another incentive is to provide training or courses on the development and maintenance of a rooftop garden so that people are provided with the correct information about rooftop gardens in the city centre.

#### ***6.4.5. Include Rooftop Gardens in Building Regulations for all New Buildings***

This study maintained that there is no formal legislation or policy that takes city rooftop gardening in eThekweni Municipality city centre. If key stakeholders such as the eThekweni Municipality, planners, architects and environmentalists push for the expansion of these types of gardens in the city centre, the city will be able to experience the host of advantages that come with the wide-scale development of rooftop gardens. There is a need to transform the existing eThekweni Metropolitan Municipality Rooftop Garden Guideline into a policy framework or legislative measure. Only then will people take rooftop gardening on a large-scale seriously. This, together with environmental education and the provision of various incentives will the large-scale development of rooftop gardens in the Durban CBD be successful.

### **6.5. Limitations**

The following limitations should be noted.

#### ***6.5.1. Initial Funding for Development***

During the interview and questionnaire process and as discussed in the research findings chapter above, a major concern that was brought up on multiple occasions was the issue of funding. The research participants expressed their concern about the additional costs of maintaining and managing a rooftop garden. If the eThekweni Metropolitan Municipality were to provide an incentive system then this will address some of the financial concerns that many individuals have. The construction of a rooftop garden does not necessarily have to be an expensive process. Rooftop garden construction can be recycle, reused, and repurpose building and other materials as is the case of the Priority Zone Rooftop Garden Project. In this rooftop garden, very little or no municipal water is used unless there is a severe drought. Instead, all water used in irrigating the garden is recycled and reused.

From this research it can be seen that there a wide number of ways to reduce the expenditure of developing a rooftop garden. There is a need for professional advice on rooftop gardens and the establishment of a good maintenance and management plans. Post-installation costs will not be great if the initial plans are drawn up by professional architects in the field and the installation is carried out by civil contractors knowledgeable in rooftop garden construction.

## **6.6. Final Conclusion**

This research study was aimed at determining the level of awareness and perceptions of rooftop gardens in city centres. It was discovered that the level of knowledge that the public have regarding this concept is low as majority of participants did not have a complex knowledge of the benefits of rooftop gardens in the city. This level of awareness can be raised through the introduction of environmental programmes and training that focus on rooftop gardens in the city centre.

This study also examined whether rooftop gardens will be a positive and functional use of unused rooftop space in the city. From the literature review and the research findings it can be said that rooftop gardens are a multi-purpose method of utilising roofing space in the city for the purposes of a greener environment. This research also assessed why rooftop gardens are not developed on a larger scale in the Durban CBD. The field research ascertained that this was mainly due to ignorance of the numerous benefits that roof gardens in the inner city can offer. With environmental education programmes in the Durban CBD, rooftop gardens will be able to achieve optimal growth and expansion. The literature review chapter discussed a number of rooftop garden models and methods from Singapore and Chicago as well as local examples. Some of these methods can be transferred into a model that is specific to eThekweni Metropolitan Municipality and which contributes to achieving some of its goals in the Durban CBD.

It is possible for rooftop gardens to be used across the city centre, be they small or large gardens. The development of such gardens will deliver a wide-variety of positive impacts for those who live and/or work in the city. Rooftop gardens are also able to

promote tourism especially if unique gardens are created with additional recreational amenities such as restaurants or tea gardens. The positive benefits of rooftop gardens are immense and the challenges that exist can be easily overcome with proper construction, maintenance and management.

Finally, rooftop gardens should be included in all future building legislation as they can pave the way into the future for environmental conservation, climate control and food production in the urban centre environment.

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# APPENDIX 1

## RESEARCH PARTICIPANT QUESTIONNAIRE

*Developing Appropriate Land Use Guidelines for Developing Rooftop Gardens on a Large-scale in the Durban Central Business District of the eThekweni Metropolitan Municipality*

### Questionnaire

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1. Are you aware of the concept of rooftops gardens?

Yes/ No/ Not sure

2. What do know about them?

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3. What are your perceptions of rooftop gardens?

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4. Do you believe that rooftop gardens are an effective way for filling up underused rooftop space in the city centre?

Yes	No	Maybe	Not sure
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5. Do you think that growing food on rooftop gardens in the city is possible? If yes, what would be the benefits of this form of food production?

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6. Please indicate your views on the following statements by choosing a number that represents your feelings: 1-Strongly Disagree 2- Disagree 3- Neutral 4-Agree 5- Strongly Agree.

Statements	Rating				
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Rooftop gardens will decrease the overall temperatures of cities					
Rooftop gardens will absorb rain water which will decrease the pressure put on storm-water drainage systems					
The vegetation on rooftop gardens are able to filter the air from pollutants					
The city centre needs more green spaces					
Will rooftop gardens beautify the city centre?					
Rooftop gardens can provide food for the poor in the city					
The government should provide incentives for the wider use of rooftop gardens					
The municipality should include rooftop gardens in building policies					

7. Are you aware of any form of legislation or policy that encourages the wider use of rooftop gardens?  
Yes / No

8. What do you think are the setbacks or challenges for rooftop gardens being developed on a larger scale in the city centre?

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9. Do you think that the wider use of rooftop gardens in the city centre would make the city an increasingly attractive place to visit?  
Yes/ No/ Not Sure

10. What, in your opinion can a rooftop garden be used for?

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11. Do you think that rooftop gardens in the city centre can contribute to providing employment for people in the city?

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12. Do you think that it is possible to sell the produce grown on rooftop gardens to restaurants or to donate the produce to the less fortunate?

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13. Who should be responsible for these rooftop gardens?

Public	Government	Planners/Architects	Other
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14. Should rooftop gardens be managed as a Public Private Partnership?

Yes	No	Maybe	Not sure
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15. Do you think that rooftop gardens should be included in building legislation?

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16. Any other information or comments?

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## **APPENDIX 2**

### **INTERVIEW SHEET FOR KEY-INFORMANT A (17 JUNE 2015)**

1. What is your professional background and how did you become involved in rooftop gardens?
2. What is your involvement in rooftop gardens in the eThekweni Metropolitan Municipal area?
3. How long have you been involved in the eThekweni Metropolitan Municipality Green Roof Pilot Project?
4. Was there a specific model you used in creating the rooftop garden or is the project your own design?
5. Are there similar projects elsewhere in Durban or in other South African cities that you are aware of?
6. What have been the successes and failures of the pilot garden on top of the City Engineers building?
7. Has edible vegetation been planted on the rooftop garden? If so, what plants were these?
8. Is this rooftop garden monitored on regular basis?
9. Are you aware of any national models for the development of rooftop gardens?
10. Are rooftop gardens a feasible option to be developed on a large-scale in the eThekweni Metropolitan Municipal area?
11. Do you think that this is a possible a way forward for the city to meet some of its goals of becoming a sustainable city?

12. Can rooftop gardens assist with Local Economic Development in the eThekweni Metropolitan Municipal area? And if so, how?
13. Should rooftop gardens be part of the city's environmental mitigation strategy or Local Economic Development strategy?
14. What tools should the city use to encourage this development?
15. Any other information or referral to reports/other potential persons to interview?

## **APPENDIX 3**

### **INTERVIEW SHEET FOR KEY-INFORMANT B (24 JUNE 2015)**

1. What is your professional background and how did you become involved in rooftop gardens?
2. What is your involvement in rooftop gardens in the eThekweni Metropolitan Municipal area?
3. How long have you been involved in the eThekweni Metropolitan Green Roof Pilot Project?
4. Was there a specific model you used in creating the rooftop garden or is the project your own design?
5. Are there similar projects elsewhere in the eThekweni Metropolitan Municipal area or in other South African cities that you are aware of?
6. What have been the successes and failures of the pilot garden on top of the City Engineers building?
7. What costs have been considered in the development of this rooftop garden?
8. Are you aware of any national models for the development of rooftop gardens?
9. Do you think that rooftop gardens are feasible to be developed on a large-scale in the eThekweni Metropolitan Municipal area?
10. Do you think that this is a possible way forward for the city to meet some of its goals of becoming a sustainable city?

11. Can rooftop gardens assist with Local Economic Development in the eThekweni Metropolitan Municipal area? And if so, how?
12. Should rooftop gardens be part of the city's environmental mitigation strategy or Local Economic Development strategy?
13. What tools should the city use to encourage this development?

## **APPENDIX 4**

### **INTERVIEW SHEET FOR KEY INFORMANT C (25 JUNE 2015)**

1. What is your professional background and how did you become involved in rooftop gardens?
2. What is your involvement in rooftop gardens in the eThekweni Metropolitan Municipal area?
3. Are you aware of any national models for the development of rooftop gardens?
4. What have been the successes and failures of the rooftop gardens that you have been involved in?
5. Do you think that rooftop gardens are feasible to be developed on a large-scale in the eThekweni Metropolitan Municipal area?
6. What costs have been considered in the rooftop gardens that you have been involved in?
7. Do you think that this is a possible a way forward for the city to meet some of its goals of becoming a sustainable city?
8. Can rooftop gardens assist with Local Economic Development in eThekweni and if so how?
9. Should rooftop gardens be part of the city's environmental mitigation strategy or Local Economic Development strategy?
10. What tools should the city use to encourage this development?

## **APPENDIX 5**

### **INTERVIEW SHEET FOR KEY INFORMANT D (11 JULY 2015)**

1. What is your professional background and how did you become involved in rooftop gardens?
2. What is your involvement in rooftop gardens in the eThekweni Metropolitan Municipal area?
3. Are you aware of any national models for the development of rooftop gardens?
4. Of the vegetation that has been planted on the rooftop gardens that you have been involved in which plants have had the most successful growth?
5. What have been the successes and failures of the rooftop gardens that you have been involved in?
6. Do you think that rooftop gardens are feasible to be developed on a large-scale in the eThekweni Metropolitan Municipal area?
7. What were the overall costs (i.e., soils, systems, materials) that were considered in the development of the rooftop gardens that you have been involved in?
8. Can rooftop gardens assist with Local Economic Development in the Durban CBD and if so how?
9. Should rooftop gardens be part of the city's environmental mitigation strategy or Local Economic Development strategy?
10. What tools should the city use to encourage this development?
11. Any other information or referral to reports/other potential persons to interview?

## **APPENDIX 6**

### **INTERVIEW SHEET FOR KEY INFORMANT E (24 JULY 2015)**

1. What is your professional background and how did you become involved in rooftop gardens?
2. Where did the model or design for this rooftop garden come from?
3. Of the edible vegetation that has been planted on the rooftop gardens that you have been involved in which plants have had the most successful growth?
4. How often is this rooftop garden maintained?
5. What have been the successes and failures of this rooftop garden?
6. Do you think that rooftop gardens are feasible to be developed on a large-scale in the eThekweni Metropolitan Municipal area?
7. What were the overall costs (i.e., soils, systems, materials) that were considered in the development of the rooftop gardens that you have been involved in?
8. Can rooftop gardens assist with Local Economic Development in the Durban CBD and if so how?
9. Should rooftop gardens be part of the city's environmental mitigation strategy or Local Economic Development strategy?
10. What tools should the city use to encourage this development?
11. Any other information or referral to reports/other potential persons to interview?