



Towards Green Urbanism: Multifunctionality as a contributor

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ABSTRACT

The study investigates the potential of multifunctionality (MF) to contribute to attaining green urbanism (GU) in urban environments. By exploring the interfaces between the planning principles of GU and MF, the study aims to determine whether incorporating MF principles into urban planning could facilitate the establishment of nature-based urban environments and potentially support the materialisation of GU. Employing a qualitative research design, the study first extracts the GU and MF planning principles from the current literature for aggregation into emergent theoretical matrices. It secondly identifies potential interfaces between these principles and converts the emergent theoretical matrices into an assessment matrix to finally illustrate the practical application of these interfaces by assessing a single explorative case study, i.e. the newly planned town of Verkykerskop (Free State Province, South Africa). Following the case study analysis, the research explores the potential of incorporating MF into current urban planning approaches to promote more functional GU attainment. The findings suggest that the implementation of MF principles is conducive towards a GU advent in urban environments. The identified interfaces illustrate that both recent literature and the practical achievability of interfaces in the assessed case study demonstrate synergy between GU and MF, leading to the conclusion that MF could contribute to the advancement of GU in urban environments. The study culminates in the development of an emerging assessment matrix deemed capable of guiding urban planning towards the application of MF principles, thereby contributing to the improved attainment of GU in urban environments.

Keywords

Urban planning, green urbanism, multifunctionality, coding and themes, assessment matrix, multifunctional planning.

OPSOMMING

Die studie ondersoek die potensiaal van multifunksionaliteit (MF) om te kan bydra tot die bereiking van groen urbanisme (GU) in stedelike omgewings. Deur die koppelvlakke tussen die beplannings-beginsels van GU en MF te ondersoek, het die studie ten doel om vas te stel of die insluiting van MF beginsels in stedelike beplanning die vestiging van GU kan fasiliteer en moontlik die totstandkoming daarvan kan ondersteun. Deur 'n kwalitatiewe navorsingsontwerp te gebruik, ekstraheer die studie eers die GU en MF beplanningsbeginsels uit huidige literatuur vir akkumulering daarvan in ontluikende teoretiese matrikse. Vervolgens is moontlike koppelvlakke geïdentifiseer tussen hierdie beginsels en word die ontluikende teoretiese matriks in 'n assesseringsmatriks omskep om die praktiese bereiking van koppelvlakke in 'n enkele verkennende gevallestudie te analiseer, naamlik die nuut-beplande dorp Verkykerskop (Vrystaat Provinsie, Suid-Afrika). Na die gevallestudie-analise verken die studie die inkorporering van MF beginsels in huidige stedelike beplanningsbenaderings om funksionele GU verder te bevorder. Die bevindings dui aan dat die implementering van MF beginsels 'n bevorderlike potensiaal inhou vir die implementering van GU in stedelike omgewings. Die geïdentifiseerde koppelvlakke toon ook aan dat beide onlangse literatuur en die praktiese haalbaarheid van koppelvlakke in die beoordeelde gevallestudie, sinergie tussen GU en MF demonstreer, wat lei tot die gevolgtrekking dat MF 'n bydrae kan lewer tot die bevordering van GU in stedelike omgewings. Die studie sluit af met die daarstelling van 'n ontluikende assesseringsmatriks wat in staat kan wees om stedelike beplanning te rig in die toepassing van MF beginsels, en so kan bydra tot die verbeterde bereiking van GU in stedelike omgewings.

Sleuteltermes

Stedelike beplanning, groen urbanisme, multifunksionaliteit, kodering en temas, assesseringsmatriks, multifunksionele beplanning.

ACRONYMS

<u>Acronym</u>	<u>Definition</u>
ES	Ecosystem Services
GDP	Gross Domestic Product
GI	Green Infrastructure
GIS	Geographic Information Systems
GLC	Green Living Compendium
GU	Green Urbanism
LUS	Land Use Scheme
MENs	Multifunctional Ecological Networks
MF	Multifunctionality
MSDF	Micro Spatial Development Framework
NR	New Ruralism
NU	New Urbanism
SDF	Spatial Development Framework
SDGs	Sustainable Development Goals

Source: Own creation (2024)

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CHAPTER 1 INTRODUCTION

This chapter serves as an introduction to the study and provides a contextual background through a problem statement and motivation for the study (section 1.1). The chapter also outlines the study aims and objectives for the study (section 1.2), serving as a guide for each chapter.

Finally, the research structure (section 1.3) is summarised in a table that stipulates the chapter division with corresponding objectives and the methods used to illustrate how the aim of the study will be attained. The chapter concludes by cataloguing the acronyms (section 1.6) used throughout the study.

1.1 Background and Problem Statement

In the early 21st century, approximately fifty percent (50%) of the world's population was living in urban areas and cities; however, Chirisa (2008:362) predicted that by 2025 this would increase by fifteen percent (15%) and ninety percent (90%) of the expected growth would be in developing countries, for example, South Africa. This is mainly due to the promise of better opportunities and living conditions in cities and an increase in population growth (De Brauw *et al.*, 2014:33). Rapid urbanisation and uncontrolled growth of cities caused by the population boom (Zhao *et al.*, 2010:271) are the most substantial contributors to biodiversity loss. This complicates conservation efforts as cities are moving closer to, or into the natural environment to cater for rapid urban growth (González-García *et al.*, 2022:1). Biodiversity loss is a pertinent environmental challenge faced in the twenty-first century and is a significant side effect of climate change (Barhadiya & Ghosh, 2023:1). The loss of biodiversity and lack of conservation call for urgent changes in urban planning and the expansion of cities as it leads to numerous adverse effects on the residents and the environment (Kosenko *et al.*, 2020:226).

Green Urbanism (GU) is perceived by Lehmann (2011:10) as a multi-disciplined initiative to reduce urban waste, use electricity, and consume natural resources by utilising renewable resources. It harmonises all disciplines in contributing to urban growth, emphasising the reduction in the use of energy and materials. Intensified attempts by scholars and city actors to accelerate the implementation of the planning principles of GU stem from the observed rapid growth in cities, its visible effect on biodiversity loss and the latent understanding and implementation of nature-based solutions when attempting urban planning (Bhargava *et al.*, 2020:103). Zaręba *et al.* (2016:1) accordingly argue that a possible improvement in GU implementation is an amplified biodiversity conservation effort and incorporates nature-based solutions in urban planning.

Considering its historical course and outpacing redundant planning paradigms, Manley and Rose (2014:10) believe that the implementation of GU plays a decisive role in combating climate change. They suggest that the early 2000 climate calamity led to the sustainable city movement, framed by urban planners as GU, aiming to capture the effect of climate change and its contributing factors in the urban landscape and work towards a sustainable future. According to Kosenko *et al.* (2020:226), the movement may only be attainable if city actors are open to a paradigm shift where the focus is back to nature and with sincere consideration of the detrimental impact that urban planning may have on the natural environment. Elevating the lamentations of Kosenko *et al.* (2020:226), to a higher nuance, Van Zyl *et al.* (2021a:122) are resolute that the implementation of the principles of GU, if urban sustainability is to be attained, ought to be solidified in appropriate directives (i.e., policy, legislation, municipal by-laws and planning guidelines).

Urban planning has undergone significant transformation in the past decades (Viviers, 2018:17) that led to a shift in focus to an integrated approach aimed at creating sustainable cities, emigrating from traditional design approaches towards improved and functional zoning within the city (Rodenburg & Nijkamp, 2004:275). Multifunctionality (MF), of late, emerged as a significant alternative planning approach, integrating different functions and activities in urban spaces (Selman, 2009:48) as opposed to an urban planning paradigm that has dominated since the 1940s and 1950s (Katz, 1994:ix) branding urban planning as homogeneous and resulting in spatially separated residential-, working- and commercial areas (Jacobs, 1961:32). MF instead established itself as an approach to urban planning where urban spaces accommodate multiple uses, functions, and activities without compromising the quality of life of its inhabitants (Kajtazi, 2007:4). In this regard, Brom *et al.* (2023:3) allude to the fact that MF gained increasing attention from urban planners and city actors as a possible means to address the challenges of rapid urbanisation, climate change, and social inequalities.

Brom *et al.* (2023:3) are adamant that MF may be able to address the challenges of rapid urbanisation, climate change, and social inequalities and accelerate a GU advent. Regardless of the growing interest in MF, several challenges remain so far as its implementation is concerned (Gallent & Shaw, 2007:623), especially in perceiving its extent, applicability, and practical implementation in urban planning, and as considered in this study, its contribution towards the GU planning approach. Gallent and Shaw (2007:623) continue that there is a pertinent need for a concise definition of MF and its different dimensions, especially when offering its potential benefits to the planning fraternity as possible instruments towards a sustainable future (Manley & Rose, 2014:2).

Scholars and practitioners caution that an improved understanding of MF is required before its incorporation in urban planning, potentially improving the GU planning approach. It is, therefore, inevitable for urban planners (and city actors on a broader scale) to grasp cities as complex social-ecological-technical systems and understanding that an enhanced interpretation of MF may probably contribute towards the accelerated implementation of GU (Van Zyl *et al.*, 2021a:123). This study firstly endeavours to determine the principles of the GU planning approach. Secondly, it considers the principles of MF in urban planning. By nominating the interfaces between the selected MF and GU principles, an investigation will thirdly be launched to determine whether the employment of MF may contribute to a GU advent.

1.2 Research aims and objectives

1.2.1 Aim

This study aims to abstract the principles of the GU planning approach and the principles of MF in urban planning to nominate potential interfaces between GU and MF in determining whether the employment of MF in urban planning could be conducive to a GU advent. In attaining this aim, the following objectives are set:

1.2.2 Objectives

1. To determine the principles of the GU planning approach and urban planning-related principles of MF, for aggregation into an emergent theoretical matrix.
2. To employ the prepared assessment matrix (improvement of the theoretical matrix) by evaluating a selected case study by nominating interfaces between the GU planning approach and the planning-related principles of MF.
3. To formulate multifunctional planning recommendations that may be conducive to improving GU in urban planning.

1.3 Structure of the research

This research project is presented according to the prescribed structure (Table 1.1). The research is presented in seven chapters. Table 1.1 below outlines each chapter and its sub-headings, summarising the purpose of each chapter.

Table 1.1: Research structure

<u>Chapter</u>	<u>Sub-Section</u>	<u>Purpose</u>
1. Introduction	1.1 Background and problem statement	Provides context and motivation for the study
	1.2 Research aim and objectives	Sets the focus for the study by providing a detailed aim and objective
	1.3 Structure of the research	Provides the overall structure and flow of the study and provides the purpose of each chapter and sub-chapter
	1.4 Ethical considerations	Provides proof of the ethical approval for the study
	1.5 Limitations of the study	States the limitations experienced throughout the study along with future limitations of the study
	1.6 Acronyms	Provides a list containing all of the acronyms and abbreviations within the study
2. Methodology	2.1 Research design	Describes the research design, data collection process and analysis of data and how the methodology is employed in attaining the identified aim and objectives
	2.2 Phase 1: Literature review	Sets out the steps followed within the literature review chapters, and outlines the structure of these chapters
	2.3 Phase 2: Empirical phase and conclusion	Provides the structure of the empirical phase, along with why the case study was selected
	2.4 Case study selection	Introduces the case study and provides the rationale for selecting the case
	2.5 Concluding the research	Concludes the research design and methodology and transitions over to the literature phase of the study.

<u>Chapter</u>	<u>Sub-Section</u>	<u>Purpose</u>
3. Literature review: GU	3.1 Origin and involvement of GU	Provides a theoretical background of the GU planning approach and explains the theoretical origin and progression of GU
	3.2 Scientific points of departure	Considers different interpretations serving as a basis for GU and theoretical constructs that influence thought processes
	3.3 Undesired repercussions of GU	Sets out the possible repercussions of GU and considerations for the implementation of GU
	3.4 Principles of the GU planning approach	Outlines the core principles of GU
	3.5 Conclusion	Through a process of coding, the matrix aggregates the principles and themes deemed inherent to GU
4. Literature review: MF	4.1 MF in urban planning	Provides a theoretical background of MF in urban planning
	4.2 Scientific points of departure	Considers different interpretations serving as a basis for MF and theoretical constructs that influence thought processes
	4.3 The MF and GU nexus	Discusses probable links between GU and MF as highlighted in current literature
	4.4 Conclusion	Through a process of coding, the matrix aggregates the principles and themes deemed inherent to MF
5. Empirical investigation	5.1 Methodology of empirical phase	Provides a comprehensive overview of the case study and explains its purposeful selection
	5.2 Location and background of case study	Provides an overview of where the case study is situated along with its unique background and history
	5.3 Selection of case study	States the reason behind the selection of the specific case study by analysing supporting documents

<u>Chapter</u>	<u>Sub-Section</u>	<u>Purpose</u>
	5.4 Assessment matrix	Combines the two theoretical matrices for GU and MF in an assessment matrix proposed for the (i) selection of interfaces and (ii) assessment of the selected case study
	5.5 Interfaces	Identifies interfaces between GU and MF and their practical attainment in an actual and real-world instance
	5.6 Results	Findings of the assessed case are discussed by describing the identified interfaces and how the case study relates to the identified interfaces
6. Conclusion	6.1 Aim concluded 6.2 objectives concluded	Conclusions are drawn on attaining the set aim and objectives, whether the literature review appeared appropriate in proposing the respective theoretical matrices, and whether the assessment matrix served as a helpful instrument to assess the selected case. Conclusions are also drawn on the findings of the case study assessment.
7. Recommendations		Formulates MF planning recommendations that may be conducive to improving GU in urban planning

Source: Own creation (2024).

1.4 Ethical considerations

The North-West University's Faculty of Natural and Agricultural Sciences Research Ethics Committee (FNASREC) approved the research project per ethics number NWU-01245-21-A9. (see Annexure A). The research is categorised as posing “no risk” because there is no possible risk that the study will result in undesirable effects or unexpected negative consequences. The

research merely included desktop studies, open-source data analyses, observations and self-assessment of a case study.

1.5 Limitations of the study

This study investigates the application of multifunctionality in urban planning to determine whether it could enhance implementation of the GU planning approach. GU, in itself, is a comprehensive planning approach, encompassing more than the scope of this study. Today, GU captures the imagination of numerous scholars across a wide range of academic topics, e.g. smart cities, urban ecology, biophilic and edible cities, pluralism, biodiversity loss, adaptive planning, to name a few. Consequently, the study is not intended to examine the GU planning approach but rather to explore whether the application of MF, when considering the planning or regeneration of urban areas, could benefit the GU planning approach. The literature relating to GU and MF is not limited to the content of the prepared theoretical matrices. Still, the matrices provide an emerging overview of what is required to implement GU and MF when considering urban planning. The possibility, therefore, exists that the theoretical matrix may oversimplify complex phenomena or ignore essential nuances. While a high level of saturation was reached in the literature review, and techniques employed to attain it, emphasis is placed on the principles of both concepts and as argued above, a different focus or broader investigation of additional literature or additional cases may yield more insight in the attainability of GU.

Following the introductory chapter, the detailed research structure and methodology selected for this study are presented in the subsequent chapter. These methods have been chosen as the most appropriate to achieve the study's stated aim and objectives.

CHAPTER 2 METHODOLOGY

Expanding on the research structure as presented in the preceding section 1.3, this chapter describes the detailed methodology selected and employed for the study. The research design provides the overarching framework, while the rest of the chapter focuses on the specific methods employed for the literature review, data collection methods and analysis techniques to formulate theoretical matrices and, eventually, an assessment matrix. Through the proposed research design and methodology, the study aims to attain the set research aim and research objectives.

2.1 Research design

The study follows a qualitative research design (Gullion, 2024:7) to (i) abstract the principles of the GU and MF planning approaches (ii) eventually nominate (select or identify) (Cohen *et al.*, 2007:436) potential interfaces between them, (iii) finally assess a case in illustrating how the interfaces are attainable in the “real world”, (iv) thereby ultimately determining whether MF's employment in urban planning could be conducive to a GU advent. The methodology for this study has two distinct phases (see Figure 2.1) before arriving at conclusions and formulating MF planning recommendations that may contribute to improving GU in urban planning.

The first phase comprises the literature review to identify principles inherent in the two planning approaches of GU and MF. In this instance, a thematic analysis (Xiao & Watson, 2019:101) is undertaken to explore the urban planning approaches of GU and MF as portrayed in current literature. The employed methodology is also adopted in agreement with the arguments of Jacobs and Cornelius (2022:107) that a thorough review of literature may result from a thematic analysis. Thematic analysis is attempted by engaging coding processes (Onwuegbuzie *et al.* 2016:130) in finding probable commonalities (Cohen *et al.*, 2018:375) among the identified principles inherent to GU and MF. These commonalities are subsequently grouped into broader themes and aggregated into two theoretical matrices (Murniarti *et al.*, 2018:134) for GU and MF.

The study secondly comprises an empirical phase, commencing with the aggregation of the derived theoretical matrices into an assessment matrix. The assessment matrix is created to assess a selected single exploratory case study (Cohen *et al.*, 2018:375) as described in par. 2.4. For this reason, the research method followed in conducting the empirical phase is described as a “case study method” (Breslin & Buchanan, 2008:37) since a single selected exploratory case study will be assessed from which findings, conclusions, and recommendations follow.

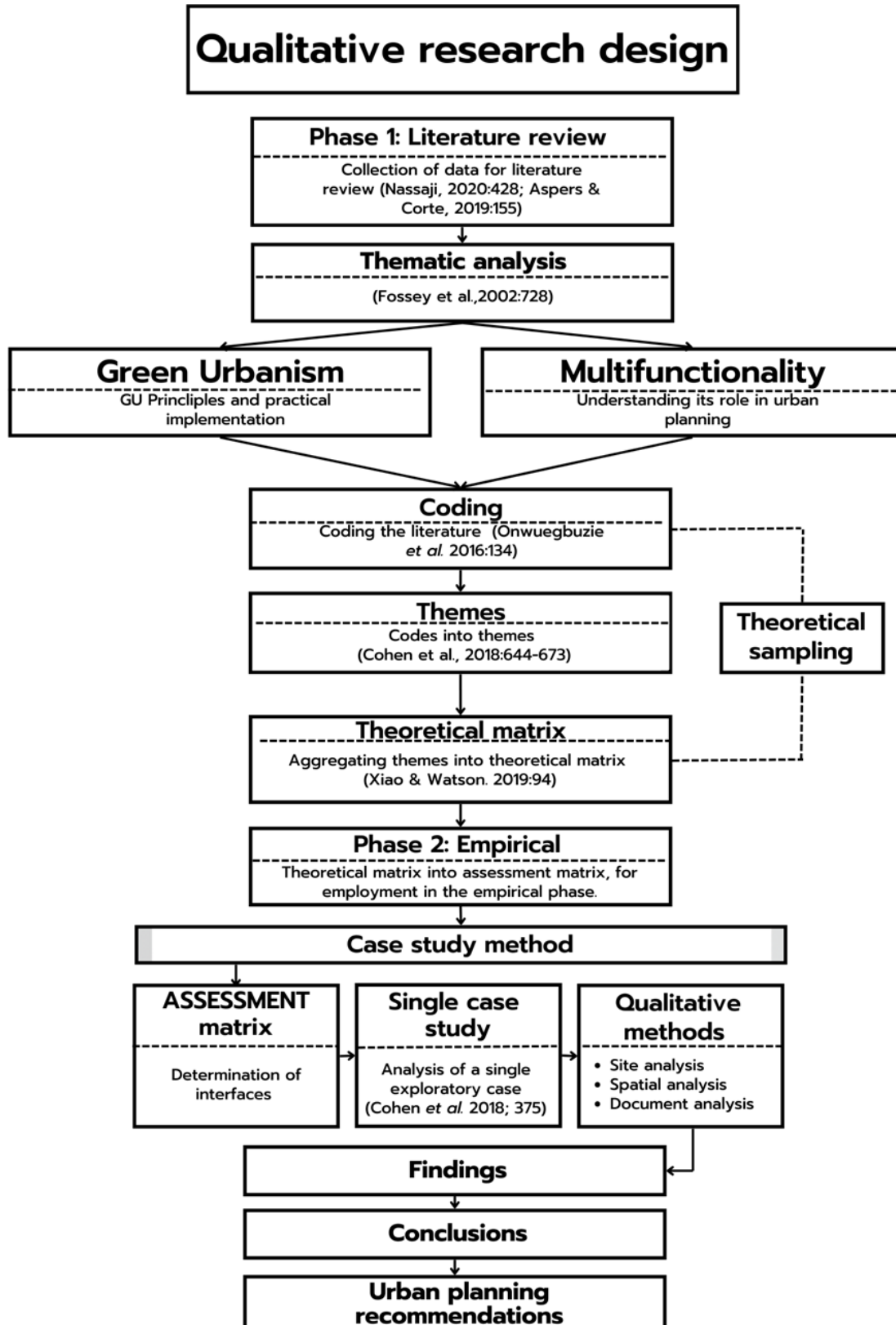


Figure 2.1: Methodology flow chart.

Source: Own creation (2023)

The selected case study is analysed by employing the assessment matrix. Cohen *et al.* (2018:375) perceive a case study assessment as investigating a real-life project to understand its complexity. The empirical phase of the study discusses findings resulting from the case study assessment concluding the second phase. The completion of the study results in its conclusion on attaining the set research aim and objectives, followed by the formulation of multifunctional planning recommendations that may be conducive to improving GU in urban planning.

2.2 Phase 1: Literature review

Phase 1 aims to attain the first research objective, namely:

Objective 1: To determine the principles of the GU planning approach and urban planning-related principles of MF for aggregation into an emergent theoretical matrix

This phase presents a comprehensive review of relevant literature (Paul & Criado, 2020:1), including academic publications, reports, and policy documents, in two separate chapters (see Chapters 3 and 4). Literature relating to GU and MF was reviewed to identify their principles for incorporation into two theoretical matrices at the end of each chapter (see Figure 2.1). In adequately interpreting and reviewing the vast literature resources available regarding the two approaches, coding (Cohen *et al.*, 2018:375) is employed to improve data extraction. The coding process is opted for as an appropriate method to identify the principles of GU and MF and to categorise the principles into themes to ultimately populate the theoretical matrices (Xiao & Watson, 2019:94,101). According to Onwuegbuzie *et al.* (2016:134), the most suitable coding method for this purpose is descriptive coding, which may assist the researcher, in this instance, in selecting the principles of GU and MF for aggregation into a theoretical matrix. The descriptive coding method (Cohen *et al.*, 2018:375) suits the study's purpose as it identifies the principles of GU and MF and ultimately proves valuable in later selecting interfaces between the two approaches. While Elliott (2018:2851) perceives descriptive coding as a process of categorising data integral in facilitating a more complete understanding and interpretation of the data. He, therefore, proposes that the process is also required for transforming raw data into meaningful insights and a more complex analytical technique, in this case, two theoretical matrices (Cohen *et al.*, 2018:375). This includes the principles and themes deemed inherent to GU and MF. Blaikie and Priest (2019) endorse Elliott's perception by arguing that complex and copious raw data must first be converted and categorised to ensure it becomes suitable for analysis.

The literature review described above was not undertaken in a single linear process. Following the compilation of the two theoretical matrices (for GU and MF), deficiencies were identified where the matrices seemed ill-populated and additional literature was assessed until a higher level of

data saturation was attained (see Annexures B and C) (Mwita, 2022:414). This iterative literature review process for both theoretical chapters (Chapter 3 and Chapter 4) resulted in finalising two theoretical matrices at the end of each chapter that represent the principles and themes of both GU and MF. This approach is perceived as characteristic of theoretical sampling (Kosztyn *et al.*, 2021:2) and is considered important in constructing complete matrices.

The final step of the literature review is the preparation of an assessment matrix with two distinct properties: firstly (i) to aggregate the two theoretical matrices prepared for GU and MF into a single matrix and secondly (ii) to determine interfaces between the GU and MF approaches. Once the interfaces are nominated, the assessment matrix becomes an analytical instrument to assess the case study and determine whether the interfaces are detectable in practice. The study's second phase progresses the literature review and its resultant assessment matrix into the empirical phase.

2.3 Phase 2 Empirical phase and conclusion

The empirical phase aims at achieving the following identified objectives:

Objective 2: To employ the prepared assessment matrix by evaluating a selected case study in nominating interfaces between the GU planning approach and the planning-related principles of MF, and

Objective 3: To formulate multifunctional planning recommendations that may be conducive towards improving GU in urban planning.

Prior to the commencement of the empirical phase, three significant steps are necessary:

1. to prepare the assessment matrix for employment in the empirical phase,
2. to identify the interfaces (Flyvbjerg, 2006:2) between the principles and themes of GU and MF,
3. to analyse the selected case to determine the presence of the identified interfaces.

From here onwards, the empirical phase primarily focuses on the case study method selected for this study, i.e. applying qualitative methods (a spatial and document analysis) to assess the available information of the case study:

1. Spatial analysis (geospatial imagery (MacCallum *et al.*, 2019:43)), including available geospatial imagery, detailed urban design and layout plans, ensuing interpretation of a specific research phenomenon,

2. Document analyses (including available grey literature) (Benato, 2018:49), existing reports Micro-SDF (prepared for the case study), municipal SDF, township establishment application, newly prepared LUS (prepared for the case study) Green Living Compendium (GLC)

The assessment matrix is implemented by assessing the case study to link the principles of GU and MF and measure it against the real-life application present in the case study. It finally aims to determine, from the correlation between the planning principles of GU and MF and its presence in the case, whether MF may contribute to and improve the implementation of GU in the urban environment.

2.4 Case study selection

The objectives of the empirical phase are attainable if the indicated case study method is followed, and selecting an appropriate case (Yin, 2018:61) is perceived as essential. The case study method is employed to analyse a phenomenon and to extract real-world lessons (Jacobs & Cornelius, 2022:112; MacCallum *et al.*, 2019:47-48; Yin, 2018:61). To this end, a single exploratory case study (MacCallum *et al.*, 2019:47-48) is selected, namely the newly planned town of Verkykerskop (located between Memel and Harrismith, in the Phumelela Local Municipality). The town of Verkykerskop is selected as a single exploratory case study due to its exemplary application of New Urbanism principles and its historical significance. The selected case was opted for as it is also (i) perceived as a town planned afresh, (ii) provides a narrative relevant to the study (Cohen *et al.*, 2018:376), and (iii) displays emergent attempts to implement GU and MF. While Viviers (2018:17), through his research of Verkykerskop, concludes that New Urbanism (NU), GU, New Ruralism (NR) and MF are attainable in urban planning, he affirms that its feasibility is driven by “numerous benefits for the revitalisation of rural areas” and that the “planning of multifunctional landscapes is an essential constituent of future rural life and ought to be a traversing theme” when urban planning is endeavoured.

As a designated service centre in the Phumelela Municipal SDF (Department: Agriculture, Land Reform and Rural Development, 2021), the proposed new design and proposed layout plan of Verkykerskop incorporates mixed land uses and a commitment to preserving the area’s historic character and natural beauty. These tendencies align closely with the approaches of GU and MF and adhere to the assumptions of Cohen *et al.* (2018:384) that a case study focuses on a unique and representative case. Verkykerskop’s distinctive blend of urban design and planning approaches illustrates how the planning approaches of GU and MF are interrelated and offer practical applications for attaining the planning approaches in the “real world”. This study’s

empirical phase presents a detailed description and illustrative maps of the selected single exploratory case study (see Chapter 5).

2.5 Concluding the research

The study is completed by preparing conclusions regarding the literature review, the empirical results, the achievement of the study's goals and objectives, and proposals for further research. Finally, multifunctional planning recommendations are formulated that may be conducive to improving GU in urban planning.

Following the introduction in Chapter 1, the research structure and methodology portrayed in this chapter, the next chapter comprises a literature review focusing on the principles of the GU planning approach. As outlined in the study's objectives, the endeavoured literature review derives a theoretical matrix of the principles of the GU planning approach to assist the researcher in performing the empirical phase of the study (see Chapter 5).

CHAPTER 3 LITERATURE REVIEW: GREEN URBANISM

This chapter introduces the literature review and aims to address the first part of objective 1 in so far as determining the principles of the GU planning approach is concerned:

Objective 1: To determine the principles of the GU planning approach and urban planning-related principles of MF for aggregation into an emergent theoretical matrix.

3.1 Origin and evolvement of Green Urbanism

The GU advent is traceable to the necessity for more environmentally friendly solutions during industrialisation, with ideas related to the vertical "Green City" emerging (Zhao & Sun, 2023:88). GU evolved in response to environmental challenges and the need for sustainable development as a consequence of GI appearing since 1990. This started as a potential solution to combat urban sprawl and promote sustainable stormwater management. Oktay & Garrison (2022:165-182) additionally states that GI acts as a linkage between ecological and economic well-being. Furthermore, the rise of sustainable development as a guiding principle solidified green urbanism's importance. The study aims to establish a baseline for understanding the GU planning approach and considers the origin and evolvement of GU over time. This approach, *inter alia*, considers integrating green spaces with engineering infrastructure to improve citizens' quality of life and addresses the improvement of the natural environment within the urban environment (Gimeno-Sánchez, 2022:1115-1146). The development of initial green and ecological urban theories has evolved into a global consensus and an ever-expanding range of topics in the form of resilience, low-carbon economies, and green transportation (Pauleit *et al.*, 2020:931-942) and, of late, climate change (Grimm *et al.*, 2013:474). Moreover, numerous global treaties and agreements were finalised in the past decade, addressing the environment in cities, e.g. the Sendai Framework for Disaster Risk Reduction (2015), the Addis Ababa Action Agenda on Financing for Development (2015), the 2030 Agenda for Sustainable Development and its Sustainable Development Goals (SDGs) (2015), the Paris Agreement on climate action (2015), the World Humanitarian Summit (2016), and the New Urban Agenda (2016) (Satterthwaite & Bartlett, 2017:2).

Inadequacies, nonetheless, seem prevalent, and there have, for example, been shortcomings in implementing sustainable building design, with a lack of consideration for energy-saving ideas and climate-sensitive design at the urban scale (Rizzo & Petruccioli, 2023:102-114). In addressing shortfalls, a need is evident for cultural, economic, and behavioural changes coupled with technological solutions (Zhao & Sun, 2023:88). The 21st century's "urban century" is further

facing unprecedented challenges with climate change and natural disasters. Nassar (2013:339) corroborates that the significant modifications cities have undergone over the past half-century led to them experiencing urban sprawl on a scale never seen before. A global consensus towards GU-orientated development resulted, as stated by Zhao and Sun (2023:88). The evolvement of GU seemingly reflects the ongoing efforts and encounters of city actors and society to create environmentally sustainable and resilient cities and to overcome apparent climate changes in a global front. These changes compel urban planners to reconsider their perspectives of cities and how they plan cities. Especially when advancing the GU planning approach to ensure a sustainable future for cities (Nassar, 2013:339) by placing it higher on their agendas. In this regard, Ivanic and Grant (2011:1) affirm that the green agenda, and favouring its consequences, has grown significantly in the planning fraternity. Their view is endorsed by Berke (2008:401), who cautions that the sustainability debate must be revived to develop greener cities in the face of ongoing climate change and biodiversity loss. Presently, GU focuses on key areas, for example, GI, resilience, low-carbon economies, and sustainable buildings and transportation, reflecting a commitment to long-term ecological health for cities (Guan, 2016:103).

The GU planning approach signals a required paradigm shift by emphasising the development of urban GI that may well result in a double dividend; increased flow of benefits from ecosystem services, and the promotion of green economic growth (Bobilev *et al.*, 2022:48; Vargas-Hernández & Zdunek-Wielgolaska, 2021:58). Expanding on this foundation, the integration of green spaces within cities transcends mere aesthetics. Parks, green roofs, and other green elements provide supplementary ecological benefits while simultaneously enhancing economic and social well-being, contributing to a more sustainable urban environment (Wang & Kumari, 2021:163). Parks and green spaces also offer multifunctional ecosystem services that contribute to leisure, education, health, resilience-building, and cultural heritage landscapes, reflecting the socio-economic value of cultural ecosystem services (Andreucci *et al.*, 2019:2). Furthermore, GU embraces innovative technologies to achieve environmental objectives by adopting sustainable energy systems and data-driven smart technologies in eco-cities; for example, Stockholm's Royal Seaport exemplifies how GU could lower energy consumption and advance environmental sustainability (Bibri, 2020:2).

With escalating technological advancements, GU is evolving as a comprehensive strategy for curbing city resource consumption. This approach promotes sustainable practices throughout the urban development lifecycle, e.g. one key mechanism involves integrating systems that incorporates eco points that may incentivise reduced reliance on fossil fuels and non-renewable resources (Grause, 2019:11). Here, eco points refer to a conceptual currency that limits the consumption of non-renewable resources, promoting sustainable production (Grause, 2019:11).

Moloney and Strengers (2014:94) allude that GU, however, evolved beyond technological solutions by also embracing a social practice approach, acknowledging the role of policies, regulations, and infrastructure in shaping residents' everyday behaviours. This focus on social change may significantly alter the current resource-intensive nature of urban living. Herewith, GU emphasises efficient land use patterns, e.g. implementing green development practices for housing that contribute to creating low-carbon eco-cities (Premalatha *et al.*, 2013:661). Premalatha *et al.* (2013:661) reason that this strategy promotes advancements in sustainable construction techniques and industrialisation, advancing energy savings in the building process. Economic models, for example, green Gross Domestic Product (GDP) accounting (Talberth & Bohara, 2006:744), provide valuable tools for GU, and the evolution of its fiscal advantages have also been noticeable over time. As Xu *et al.* (2013:2) explain, economic factors influence resource use within cities and inform the development of effective regulations. The above considerations reinforce the view that employing a comprehensive approach and considering the evolution of GU as a planning approach, offers a promising pathway in urban planning towards controlling resource consumption and advocating a more sustainable future for cities.

3.2 Scientific points of departure

Lehmann (2011:244) indicates that it is essential for urban planners to comprehend GU as they need to adjust to rapid urbanisation where approaches and paradigms of the past may no longer address rapid development and societal needs (Katz, 1994:ix, Jacobs, 1961:32), and agrees that planners are working in a new context that demands a new way of planning cities. Beck (1992: 53) agrees by noting that the “new era of uncertainty” is evolving at the same pace as South Africa’s late technological development, enhancing the need for sustainable development. This quest for sustainable development has spurred a multitude of interpretations of GU amongst professionals, academia and city actors. Planners and researchers seek to understand how to achieve sustainable development practically and perceive GU as a significant step closer to attaining sustainable development goals. Rayan *et al.* (2022:1) observe GU as a planning philosophy aiming at cities' design and planning that prioritises the residents' well-being and the natural environment. This, through incorporating GI, including gardens and parks. Sokolova *et al.* (2024:2) additionally affirm that green spaces contribute to improved air quality, enhanced biodiversity in cities, and provide recreational spaces for residents. This perception endorses GU as a planning approach that advocates resilient cities, focusing on energy efficiency, reducing pollution, and improving quality of life. Myrvold and Wergeland (2018:350) also view GU as a planning approach that emphasises the importance of community involvement within the planning process, ensuring that locals have a voice, and that city development meets their needs.

El-Bastawisy (2023:100) describes the GU planning approach as the art of building cities that focus on the well-being of the environment and the residents' happiness. GU gained momentum at the turn of the 20th century when it offered a more transformative approach than traditional planning. It recognises the importance of incorporating ecological systems and green spaces as they contribute to healthy and resilient cities. Studies suggest that well-managed green spaces may even become tourist attractions that boost a city's local economy (El-Bastawisy, 2023:93-110). Koh *et al.* (2022:1470) reimagine cities as thriving ecosystems that harness the power of green spaces, renewable energy, efficient transportation, and sustainable building design to nurture healthy, environmentally conscious communities. Nilsson (2018:4) delves even deeper into the concept and emphasises the role of GU in managing vegetation across various urban spaces, not merely in open spaces and natural areas. It is, therefore, a planning approach to minimise the negative environmental impacts of urbanisation and build resilience for a sustainable and prosperous urban future.

Beatley and Newman (2013:3328) propose a fundamental shift in the relationship between cities and nature and establish a foundation for a new approach to urban planning. Viviers *et al.* (2017:73-87) highlight the urgency of this alteration, given the pressing predicaments of the 21st century, i.e. dwindling resources, rapid urbanisation, pollution, and climate change. These factors necessitate rethinking how cities should function and be planned. As Tîrlă *et al.* (2014:462) advise, a multi-disciplinary approach is required, encompassing sustainability plans, quieter and cleaner environments, compact communities, and green transportation. GU incorporates these elements by focusing on ecosystem services, urban greening initiatives (parks, gardens, green roofs, urban farms), and renewable energy projects, and promotes a strong sense of place and sustainable lifestyles. While McDonald and Beatley (2020:63) perceive their concept of biophilic cities as a strong point of departure for GU, as it presents a new vision “that puts nature in the centre of design and planning”, they also believe that “biophilic design” (nature as a condition, nearby nature, rewilding, repurpose land to make room for nature, horizontal and vertical nature etcetera) may contribute to a revitalised “generation of urban natural infrastructure”.

Notwithstanding the above, GU also emerges as a significant approach to creating a robust sense of place within cities (Mandal *et al.*, 2021:1; Arellano & Roca, 2022:147). Therefore, this study also explores how the strategic integration of GI (as an essential element of GU) enhances residents' quality of life, promotes community integration, and cultivates a solid human-environment connection. It is comprehensible why Revich (2023:168) denotes that urban green spaces play a multifaceted role in improving well-being, reducing crime rates, and providing opportunities for relaxation and reflection, ultimately promoting mental vitality. Notably, this emphasis on promoting a human-environment relationship through green spaces extends beyond

aesthetics, influencing visitors' sense of place and their commitment to preserving these spaces (Keh *et al.*, 2023:424). Literature underscores the significance of environmental education programmes in establishing the meaning of ecological place. Perdignes *et al.* (2023:156) believe that by nurturing a connection to the natural world within an urban context, these programmes may cultivate pro-environmental behaviours among youth, a crucial step towards a more sustainable future. Advocating GU's integration in urban planning is not merely an aesthetic consideration to be adhered to; it is essential for creating vibrant and sustainable cities where the built and natural environments coexist harmoniously.

3.3 Undesired repercussions of Green Urbanism

Unfortunately, notwithstanding its highlighted and numerous benefits to nature and society, the practical implementation of GU continues to experience several repercussions, preventing its incorporation in urban planning and development processes. Barriers include financial constraints (Khan *et al.*, 2023:141), inadequate engagement with stakeholders (Dahlan *et al.*, 2022:2) and the lack of due policies and frameworks (Hagemann *et al.*, 2020:283) guiding urban planning and development processes. Khan *et al.* (2023:141) appropriately caution that limited funding for GU will result in its inadequate implementation, often due to economic uncertainties, discouraging investment. Hagemann *et al.* (2020:283) affirm that existing policies do not effectively support integration of GU into urban planning and therefore require a holistic approach of intersectoral collaboration to overcome these implementation challenges. Engagement with city actors and citizens remains fundamental, yet often difficult, as stakeholders need convincing of GU's long-term benefits (Benton-Short *et al.*, 2021:65). The lack of community involvement often results in poorly designed green spaces that do not consider beneficiaries' needs (Dahlan *et al.*, 2022:2).

Implementing GU often results in the more complex urban phenomenon of gentrification (Quinton *et al.*, 2022:961). Gentrification is a considerable force in triggering the unnecessary displacement of citizens and occurs when economic and political forces converge to facilitate the displacement of lower-income families (Janoschka & Sequera, 2016:30). As neighbourhoods undergo environmental improvements, they often experience a rise in property value and a shift in demographic composition (Dooling, 2009:622) and ensuing, the displacement of long-time residents, exacerbating social-economic inequalities. Pearsall (2018:329) understandably laments that green gentrification is a double-edged sword as it promotes environmental benefits but raises concerns about social justice. Finally, a notable knowledge gap is frequent regarding the implementation of GU despite its growing interest (Santos *et al.*, 2021:2), primarily due to the lack of specialised knowledge amongst city officials and professionals (e.g. urban planners and engineers) to effectively implement GU (Kabisch *et al.*, 2016:2). According to Silva *et al.* (2023:3)

there is a need for a comprehensive educational program that addresses the complexities of GU. These challenges, amongst others, prompted the undertaking of this study to determine whether the employment of MF in urban planning could overcome some of these difficulties and be conducive towards a GU advent.

3.4 Principles of the Green Urbanism planning approach

The implementation of GU often appears precarious, indicating a need for a better understanding of the underlying principles as a prerequisite for its implementation and enhancement. These principles may guide urban planners and city actors in assessing whether their endeavours are conducive towards GU. Lehmann (2014:221) believes these principles also imply using natural elements, particularly topography and vegetation, to manage temperature, humidity, light, wind, and noise to adapt cities into more sustainable environments. However, according to Bhargava *et al.* (2020:103), comprehension of the three pillars of GU is first necessary, i.e. (i) energy and materials, (ii) water and biodiversity and (iii) urban planning and transport. While each pillar comprises 15 sub-principles (considered conducive towards implementing GU), this study emphasises pillar 3 (urban planning and transport). Of the several listed sub-principles under pillar 3, Lehmann (2014:221) considers the following as the most significant:

1. Social sustainability,
2. Health and walkability,
3. Infrastructure,
4. Mixed land use,
5. Reducing car dependency.

According to the system of sub-principles by Bhargava *et al.* (2020:103), priorities that advocate GU are indeed noticeable and are surmised in Table 3.1. The work of Carter and Henríquez (2021:360) and Lobejko (2017:35) similarly endorse that the GU planning approach underscores principles for creating sustainable cities and highlights three primary principles for urban planner's attention (summarised in Table 3.1). This summary of the above scholarly arguments allows the researcher to draw a comparison between the principles of the GU planning approach and to determine what they ought to entail in practice:

Table 3.1: GU principles summary

<u>Employment of Sub-principles</u> <u>(Bhargava et al., 2020:103)</u>	<u>Employment of framework for creating sustainable cities (Carter & Henríquez, 2021:360)</u>
a. Green buildings and districts: • Using energy-efficient building designs that maximise solar access for new constructions, • Additionally, existing districts are retrofitted to improve sustainability.	a. Designing for the local environment: • Every city's design should consider its unique climate, existing ecosystems, and neighbourhood layouts, • Optimising biodiversity, using natural elements for temperature and noise control, and incorporating sustainable building practices.
b. Density and infill: • GU encourages compact and dense city development with strategies equivalent to urban infill and, • the densification of existing neighbourhoods.	b. Building Compact, Walkable Communities: • GU promotes denser city development with efficient public transportation and pedestrian-friendly infrastructure and, • reduces reliance on cars, minimises sprawl and connects communities (Lobejko, 2017:35).
c. Climate-responsive design: • Sustainable urban design considers the local climate and context (e.g., biodiversity, existing layouts) to optimise building placement and features.	c. Prioritising Renewable Energy and Efficiency: • Green cities strive for zero carbon emissions by utilising renewable energy sources, particularly solar power and by focusing on energy-efficient building design and urban planning.

Source: Bhargava et al. (2020:103), Carter and Henríquez (2021:360), Lobejko (2017:35)

Unfortunately, the identified principles of GU do not go without criticism. Huang and Wey (2019:1), by contrast, argue that the “triple-zero framework” (zero fossil-fuel energy use, zero waste, zero emissions) is neither a realistic nor an effective way of implementing GU in urban planning and lament that (i) Lehmann (2014:221) appears over-optimistic in his radical approach and (ii) that change as drastic as he advocates, could not be sustainable. Nevertheless, they concur with Lehmann (2014:221) and Qian et al. (2023:2) that urban transformation is necessary and that Lehmann's principles offer valuable insights into reimagining urban planning to reflect GU principles. This dialogue underscores the complexity of implementing GU. To address these

challenges, the success of GU, an urban planning approach that emphasises ecological integration, hinges on a multidisciplinary approach (Beber *et al.*, 2023:9) that entails the synergy of diverse fields, e.g. biology, economics, and landscape ecology (Chen *et al.*, 2022:87). While this collaboration may lead to enhanced ecosystem services in urban areas and effective GI, Chen *et al.* (2022:87) assert that the key to a multidisciplinary approach is the development of “qualitative models” to assist in understanding ecosystem services in urban areas, e.g. models could offer valuable insights for urban planners when paired with Geographic Information Systems (GIS).

The collaboration between disciplines creates decision-making toolkits that are rooted in empirical results and assist in guiding GU as a planning approach that extends beyond the initial planning stage (Chen *et al.*, 2022:57). In this regard, the multifunctionality of GI could be characterised and mapped with ecosystem services providing urban planners with an understanding of where improvements are required (Wang *et al.*, 2021:1951) to attain GU in an urban environment. Modelling may possibly empower urban planners to develop their own models that are adaptive towards the environment by enhancing GI’s ability to deliver multiple benefits. Wang *et al.* (2021:1951) assert that a holistic approach ultimately contributes to environmentally friendly cities and improves human health in cities. The ensuing chapter expands this foundation and explores examples of how MF has been implemented to improve the GU planning approach.

Parallel with the collaboration between disciplines, and as earlier alluded to, challenges prevail regarding the training and education of city actors and professionals in terms of implementing the GU planning approach. Stakeholders generally lack the ability to comprehend the multifaceted nature of GU, and an opportunity exists to change this through curriculum development, following successful examples and case studies, and developing strategic frameworks (typically a municipal SDF). Firstly, Hameed (2019:2) is convinced of the importance of curriculum development, for example, in urban planning study fields that play a fundamental role in ensuring the necessary competency for urban planners to incorporate GU within urban planning endeavours or when advice is given to authorities or developers. Secondly, city actors and professionals should extract lessons from case studies and embrace knowledge sharing, e.g. Copenhagen and Freiburg serve as models for successful GU implementation (Beatley & Newman, 2013:3328). Thirdly, strategic frameworks are essential to understand and manage GI and to establish resilient cities, inter alia, through GU implementation (Sinnott *et al.*, 2015:30). Dall’O (2020:17) elaborates that developing a comprehensive planning strategy with a focus on an ecological approach could enhance the implementation and the efficiency of the GU planning approach.

3.5 Conclusion

From the literature reviewed above, a coding process followed (see Annexure A) where GU's main principles and themes were extracted and concluded in the emergent theoretical matrix (see Table 3.2). The process of descriptive coding (Onwuegbuzie *et al.*, 2016:134) was employed, resulting in the reduction of the assessed literature by identifying the principles of the GU planning approach, reorganising them into themes and aggregating them into the emergent theoretical matrix below. Carefully coding the literature resulted in principles and themes establishing the emergent theoretical matrix's vertical axis. The literature review relating to the GU planning approach is concluded in the ensuing emergent theoretical matrix and deemed appropriate in offering numerous principles and themes inherent to GU, enabling the researcher to assess the selected case study. In an ensuing chapter, the matrix is converted into an assessment matrix (see Chapter 5) and employed during the empirical phase of the study to evaluate the selected case study.

Table 3.2: Emergent theoretical matrix of GU

<u>Selected Themes</u>	<u>Coded planning principles deemed inherent to GU</u>
A. Ecological	1. Benefit both humans and nature
	2. Regeneration of ecosystems
B. Resource management	3. Multidisciplinary involvement
	4. Multidimensional solutions
	5. Resource management - reduce consumption
	6. Utilisation of renewable resources
	7. Pollution control emphasis (healthy cities)
C. Spatial planning	8. <i>Transformative Planning</i> approach/ adapting and shaping
	9. Consider an overarching "green framework"
	10. Integrated nature base planning
	11. Consider the quality of life
	12. Compact, walkable and pedestrian-friendly cities
	13. Emphasise public transport (reduce car dependency)
	14. Improve connectivity
	15. Improve recreation
	16. Prioritise mixed land-use
	17. Towards "triple zero"
	18. Prioritise mixed land-use
D. Biodiversity loss	19. Low-carbon economies
	20. Maximise biodiversity
	21. Manage vegetation in urban space
	22. Climate sensitive design
	23. Regularly measure performance

<u>Selected Themes</u>	<u>Coded planning principles deemed inherent to GU</u>
E. Services	24. Ecosystem services
	25. Address implementation challenges
	26. Purposefully designed green spaces
F. Green literacy	27. Educate planners
	28. Educate city actors
	29. Implementation SDGs
	30. "Dumb down" GU

Source: Own creation (2024).

Following the conclusion of this chapter relating to the principles of the GU planning approach, the ensuing Chapter 4 presents a comparable literature review, although now focusing on MF and preparation of an emergent theoretical matrix presenting its urban planning principles. The latter is because this study aims to consider the extent to which MF may contribute to improving the implementation of GU in urban planning.

CHAPTER 4 LITERATURE REVIEW: MULTIFUNCTIONALITY

This chapter commences with the second component of the literature review and aims to address the second part of objective 1 in so far as determining the urban planning-related principles of MF are concerned:

Objective 1: To determine the principles of the GU planning approach and urban planning-related principles of MF for aggregation into an emergent theoretical matrix.

4.1 Multifunctionality in urban planning

The second component of the literature review investigates the urban planning principles of MF and its potential contributions to improving GU in urban environments. Frantzeskaki *et al.* (2022:113) qualify that MF revolutionises urban planning, moving from a single-purpose space to a multifaceted urban area that delivers a “symphony of benefits” beyond the monofunctional paradigms urban planners have grown accustomed to. MF necessitates a seamless integration of functions, including environmental, social and economic (Dmytryk, 2022:70; Pratiwi *et al.*, 2022:414; Van Zyl *et al.*, 2021b:2) and is gaining traction in urban planning as it offers a paradigm shift in how urban planners utilise urban spaces through the implementation of MF practices. Živković *et al.* (2019:205) observe that MF provides a holistic perspective, transcending functionality that considers environmental, social and economic dimensions. MF also serves as an assessment framework for urban planning, design and management of urban areas to enhance biodiversity (Wei, 2017:3). By integrating GI and ecosystem services, MF empowers urban planners to delve deeper into nature-based solutions (Hansen, 2018:5) and allows them to improve the health of ecosystems and residents in urban environments by utilising the multifaceted benefits that GU could provide (Wang *et al.*, 2021:1951). Wei (2017:3) and Wang *et al.* (2021:1951) maintain that urban planners should enhance their spatial planning strategies with a rigorous analysis of the MF typologies and the development of adaptive models, as this approach may well result in urban environments efficiently catering for the needs of the residents and the natural environment.

MF extends beyond environmental benefits as it influences the development of urban areas in other facets, too. Culturally rich and adaptable spaces, as advocated by Zhang *et al.* (2023:2), Vuscan and Muntean (2023:2), and Zhukova and Barsukova (2023:30), contribute to the sustainable development of the landscape and the overall multifunctional use of urban spaces. The revitalisation of industrial areas through “brownfield regeneration” (Dixon *et al.*, 2008:352) and multifunctional complexes may offer a catalyst for urban development that produces a

healthier natural environment and improves the urban fabric (Colglazier, 2015:1048). The urban fabric already presents functional and practical building blocks offering attainable opportunities for GU implementation in a multifunctional manner. Girling and Kellet (2005:19) describe these building blocks as the urban “fabric” and “network” in shades of green and grey, where (i) networks refer to spatial corridors through which people and organisms flow, (ii) fabrics to spaces distributed between and served by networks, while both fabrics and networks are (iii) grey if serving the built and urban environment and (iv) green if serving ecological functions, (v) all in a complex and interwoven and multifunctional relationship (summarised in Table 4.1). By embracing MF, urban planners have the potential to create vibrant, liveable cities that enhance well-being and contribute to achieving the ambitious goals outlined in the 2030 Sustainable Development Agenda (Van Zyl *et al.* , 2021b:3).

Table 4.1: The urban fabric

<u>Building block</u>	<u>Practical implementation</u>
a. Green networks	Protecting, restoring and interconnecting the urban ecological structure
b. Grey networks	Accessible, connective and walkable, tree-lined street networks
c. Grey fabrics	Mixed land uses within walking distance
d. Green fabrics	Preserved remnant forests, tree-lined streets and tree-covered spaces

Source: Girling & Kellett (2005:146, 147)

The MF paradigm shift in urban planning expects a holistic approach to urban planning that is closely aligned with MF's planning principles, where MF is emerging as a cornerstone of city landscape management. D'Ambrogi and Guccione (2021:265) corroborate that MF transcends the aesthetic provision as it offers diverse services that contribute to biodiversity in urban planning. Specht *et al.* (2021:291) implore that the principles of MF as an objective strategy, focused on area-specific functions in sync with planning activities across different landscapes to ensure environmentally friendly cities. This holistic approach, endorsed by Specht *et al.* (2021:291), facilitates regenerated territories and reusing wetlands in and around urban areas. Here, Monteiro *et al.* (2022:3) propose a “multifunctional toolkit” for urban planners where GI becomes the main focus with its cascade of ecosystem services that include improved air and water quality, vibrant habitats, and natural cooling. For the implementation of Multifunctional Ecological Networks (MENS) that promote a balance between the various needs of the city,

Specht *et al.* (2021:291) further convey the importance for urban planners to consider and incorporate the concept of the “spirit of a place” as it prioritises the conservation of biodiversity and natural capital. Živković *et al.* (2019:205) strengthen this notion by recommending that MF principles in urban planning promote environmentally friendly urban development as they establish a balanced collaboration or equilibrium (Geneletti *et al.*, 2020:20) between environmental, social, and economic benefits within the urban environment.

4.2 Scientific points of departure

The term MF and its urban planning principles are observed by Zhang *et al.* (2023:2) as aiding the design of urban spaces to serve multiple purposes and provide various benefits for communities and the environment in urban settlements. Vuscan and Muntean (2023:2) support this definition with their own by offering that MF involves the integration of different functions (ecological, social, and economic) into a single space within the urban environment. Zhukova and Barsukova (2023:30) perceive that the goal of MF is to create liveable urban environments that work towards addressing the complex challenges of modern cities. MF urban spaces could improve the urban fabric, enhance ecosystem services, promote sustainable development, and increase human well-being (Semeraro *et al.*, 2021:105). Guerrout and Mabarki (2023:31) remind us that there is a multi-stakeholder platform in the decision-making process of planning, endorsed by Ricci (2022:1), recognising and applying the concept of MF across various spatial disciplines, including urban planning, landscape architecture, and GI planning.

This collaborative and multifaceted approach aligns with the growing momentum of MF in urban planning, acting as a catalyst for considering multidisciplinary approaches within cities. This approach transcends siloed disciplines by integrating various aspects of sustainability and public health (Živković *et al.*, 2019:207). While the decisive contribution of MF to urban spaces is founded in its ability to deliver a triad of benefits: environmental, social, and economic, ultimately contributing to sustainable urban development, this holistic approach facilitates the creation of public open spaces that promote healthy living environments, aligning well with the principles of “healthy cities” and urban health planning initiatives (Lawrence, 2022:66). Adding to the multi-disciplinary approach of MF, pluralism enhances this understanding by facilitating diverse perspectives and stakeholder engagement. Pluralism allows for a comprehensive understanding of complex urban environments that could lead to effective planning outcomes, and it acknowledges the diverse values, interests, and actors involved in planning processes (Sauzet, 2024:374). Etxano *et al.* (2018:3) affirm that incorporating pluralism could facilitate social participation by allowing stakeholders to voice their needs; essential for incorporating MF principles in planning. Colavitti (2018:55), however, contends that engaging multiple stakeholders

may result in a richer understanding of a community's identity and induce planning resolutions that meet the actual needs of beneficiaries in the “real world”.

As highlighted earlier, the principles of MF encourage the formation of multifunctional complexes through renovation projects in industrial areas. It not only enhances space efficiency but also elevates the ecological quality of urban areas towards a favourable urban ecology and promotes sustainable development in the long term (Dmytryk, 2022:70). Embracing MF may well be conducive towards GU as it considers historical, cultural, and functional aspects of the city to create a more comprehensive and inclusive urban design (Colavitti, 2018:55). The latter approach is deemed essential for addressing the complex issues and transformations impacting the contemporary urban fabric (Levy, 1999:79). Ultimately, incorporating “human-centric design principles” signals the prioritisation of occupant safety and well-being that urban planning ought to evolve towards in establishing a truly interdisciplinary model, ultimately displaying MF principles. According to Kim and Reed (2021:1213), an interdisciplinary model integrates social science research with architectural and engineering disciplines to ensure optimal functionality and well-being within urban environments. Coupled with social sciences, Tzoulas *et al.* (2007:167) advocate that MF is not merely a novelty but should be perceived as prudent to underpin contemporary urban planning approaches, including GI, ecosystem services, and landscape planning. Haaland and van Den Bosch (2015:760) assert that the principles of MF offer a metric (measuring capability) for the performance of urban green spaces and therefore shift the focus towards a holistic perspective on the value of these green spaces.

MF highlights the importance of the relationship between multiple functions in a single land parcel and green spaces and emphasises that it should be considered during the urban planning and design phase of cities (Kabisch *et al.*, 2016:3). Here, MF promotes GU as it provides a framework for understanding the functions and interactions within and surrounding green spaces, with a pertinent emphasis on the human-nature system (Nijnik *et al.*, 2013:185). This understanding of MF offers valuable insights into the strengths and weaknesses of current urban development, providing the potential to guide the future development of green spaces towards a GU advent. (Benedict & McMahon, 2002:12). Wang *et al.* (2021:1953) expand MF's applicability to GI and comprehend MF as the ability of GI to provide a variety of ecosystem services that benefit both urban ecosystems and human health. Here MF further asserts itself as a contributor to the improvement and implementation of GU. Going beyond a single purpose, Wang *et al.* (2021:1953) explore the diverse range of functions and benefits GI could offer, as their research utilises biophysical models and social surveys to map and quantify ecosystem services and identifies areas with high concentrations of services (hotspots) and bundles of services that occur together (Korkou *et al.*, 2023:1). By characterising different types of GI and MF, Korkou *et al.* (2023:1)

advocate an adaptive model to improve its integration into local planning and design practices. This model aims to provide solutions for preserving, restoring, and embedding GI at levels that correspond to its identified multifunctional types (Wang *et al.*, 2021:1953). Pranab and Bansal (2022:18923) agree that these ecosystem services could benefit both humans and the environment, resulting in improved sustainability in urban environments. While GI is considered an essential building block in the development of GU, it is not the only building block. What is determined from the work of Wang *et al.* (2021:1953) is that GI adheres to several MF principles, and a meaningful connection in this way is identified regarding the role that MF is capable of playing in the improvement of GU in the urban environment.

4.3 The Multifunctional and Green Urbanism nexus

From the onset, Dmytryk (2022:72) and Wang *et al.* (2021:1959) are adamant that the urban principles of MF are essential in urban planning as it plays a pivotal role in facilitating sustainability. Daniels *et al.* (2018:1364) observe that within the field of urban planning, MF has emerged as a concept having the potential to guide the design and utilisation of green spaces; this accentuates the potential of parks to deliver a multitude of benefits, moving away from its traditional use as solely a recreational or conservation area. The principles of MF recognise the diverse role green space plays in encompassing air and water purification, temperature control, stormwater management, and biodiversity conservation (Langemeyer *et al.*, 2020:2) above more traditional views as mere recreational space for the well-being of citizens. This holistic perspective of MF seemingly aligns with the principles of GU (further investigated in the empirical phase of the research, Chapter 5) and emerged as a planning approach focusing on enhancing GI, nature-based solutions and water management in cities. Nature-based solutions comprising rain gardens, green roofs, vertical gardens, and permeable pavements contribute to water management as they mitigate flood risk and retain rainwater (Liu *et al.*, 2023:2; Zhang *et al.*, 2023:2; Pochodyła *et al.*, 2021:92). Similarly, Hendricks and Downton (2023:885) inform that GU promotes green roofs, infiltration trenches, wetlands, and permeable pavements, offering a multifaceted array of benefits (reducing stormwater runoff, retaining rainwater, preserving natural water sources, and enhancing local climate resilience). The work of Sitzenfrei *et al.* (2020:1) emphasises that a combined approach that utilises green and grey infrastructure contributes to effective urban water management and is deemed conducive towards attaining GU, founded on employing MF planning principles.

Although not necessarily the aim of this research, it is evident that climate change and continued urbanisation, where the need for a balanced approach is necessary when addressing water-related challenges in cities (Sitzenfrei *et al.*, 2020:1), will largely benefit from a GU advent, inter

alia informed by an MF approach. Within the diverse role green spaces are, of late, playing in the urban environment, MF emerges as a strategy that advocates improved climate control in urban environment and the integration of nature-based solutions and GI to achieve more sustainable objectives (Siehr *et al.*, 2022:447; Rojas-Botero *et al.*, 2023:2). In this regard, Battemarco *et al.* (2022:2) highlight studies where the significance of implementing blue-green infrastructure is evident as it bolsters climate resilience and MF in urban environments, and offers solutions for climate challenges, for example, flooding, drought and pollution. When designing urban green spaces with ecological and multifunctional principles in mind, it could significantly enhance the resilience of urban environments against climate change, as GI (and subsequently GU) has the potential to mitigate the effects of climate change (Gabor *et al.*, 2023:1; Siehr *et al.*, 2022:447). Siehr *et al.* (2022:447) suggest that comprehensive and multifunctional guidelines need to be developed, focusing on the integration of green and blue infrastructure in open spaces to achieve climate, ecological and social resilience, thus facilitating the adaption of GU in urban environments, also to intercept climate changes. Cities ought to pursue a range of benefits when incorporating the planning principles of MF into the urban planning process: benefits that work towards carbon neutrality, climate resilience and improved air and water quality, ultimately enhancing the liveability of urban environments (Rojas-Botero *et al.*, 2023:2) and promoting GU in urban environments.

It is apparent that the planning principles of MF oppose monofunctional urban planning and advocate a higher level of synergy by combining socio-economic and ecosystem functions in the same area (Rietveld & Rodeburg, 2003:1). In doing so, they improve current planning approaches by purposely involving a broader range of disciplines and the rich Indigenous knowledge of the local community (Randrup *et al.*, 2020:924). MF is gradually gaining traction in urban planning as it transcends mere aesthetics and places emphasis on the strategic integration of urban elements to deliver more functions and benefits across the different spheres of the urban environment, i.e. the environmental, social, and economic spheres (Dmytryk, 2022:70; Wang *et al.*, 2021:1951). In integrating ecosystem services, MF is consistent with the principles of sustainable urban development by optimising resource consumption (Dmytryk, 2022:70; Wang *et al.*, 2021:1951; Wei, 2017:3). Scholars (Živković *et al.*, 2019:207; Specht *et al.*, 2021:291) agree that cities could achieve efficient land use management, better air quality, conservation of biodiversity and enhanced economic activities by incorporating MF into the urban design and concur that the MF does not only maximises the value of limited resources but adds to the long-term resilience of cities with efficient resource management. MF ultimately lays the foundation for effective environmental management within cities as it delivers pertinent principles increasingly perceived as conducive to the contentious improvement of GU in urban environments.

By focusing on the GU and MF nexus, Wang *et al.* (2021:1951) believe it is constantly strengthened as GU potentially benefits from the implementation of the principles of MF and its strong influence on the introduction of GI in urban environments and continue that MF-orientated spaces provide multiple ecosystem services that benefit urban ecosystems and human health. Hence, Van Zyl *et al.* (2021b:9) contend that understanding MF is essential prior to its incorporation into GU and ultimately requires broadening the more familiar approaches urban planners grew accustomed to. Here, Korkou *et al.* (2023:3) explicitly underscore bridging the “knowledge gap” before incorporating multifunctional GI in urban planning and identify five focuses of MF that should at least be considered prior to expecting any contribution to improve GU in urban environments, namely:

1. Planning methods for urban GI
2. Assessment approaches of urban GI,
3. Ecosystem services and their benefits,
4. Sustainability and climate adaptation, and
5. Urban agriculture.

For Korkou *et al.* (2023:3), five additional critical elements must be in place for MF to contribute to the attainment of GU: (i) spatial distribution, (ii) optimal distance, (iii) integrated networks, (iv) accessibility, and (v) public participation. Additionally, they recommend future research directions to explore the multifunctionality of GI further and conclude that this information will be essential for urban planning and its endeavours to improve GU in urban environments. Viviers *et al.* (2017:75) previously endorsed the significance of the nexus between GU and MF by verifying that the MF is deeply intertwined with the design principles of GU, especially since GU encourages mixed-use and prioritises diversity in spaces, all being reminiscent of a multifunctional inception. Jacobs (2019:28) similarly alludes to the link between nature-based solutions and GU and corroborates that those solutions, e.g. green roofs, rain gardens and urban agriculture, contribute to urban biodiversity, a form of multifunctional GU, thereby strengthening the GU and MF nexus. The planning approaches of GU and MF seemingly should coincide, as Viviers *et al.* (2017:75) admit and by combining these approaches, urban environments could achieve a higher level of sustainability. Strengthening the nexus by incorporating GU and multifunctional developments is, however, noteworthy as it creates a network of nature within urban areas that supports a wide range of natural and non-natural functions (Breuste, 2023:3). Pietsch *et al.* (2021:345) finally reiterate that the planning principles of MF promote the integration of multiple functions in the urban area that are required to recuperate biodiversity in urban environments.

Scholars (Breuste, 2023:3; Sen, 2020:2689) caution not to create sustainable and multifunctional public areas for aesthetic or pleasing reasons but to integrate GU into the built environment holistically and strategically. In agreeing, Dehof *et al.* (2022:217) warn that GU is more than parks, forests, and green roofs; it should also focus on enhancing the quality of life. Di Vico *et al.* (2017:27) further the notion that GU is more than aesthetics and that green spaces should provide essential ecosystem services consisting of water filtration, air purification, and carbon sequestration. Sen (2020:2689) claims that GU and MF nurture a vibrant urban environment that promotes biodiversity. The well-being of residents is endorsed by Van Zyl *et al.* (2021b:3), as they perceive that MF is centred around the creation of vibrant urban spaces that offers a range of benefits and functions including the natural environment, community and economy of urban environments. Živković *et al.* (2019:205) are convinced that MF is essential for developing strategies to achieve the Sustainable Development Goals (SDGs) and are supported by Hansen (2018:5), mentioning that by mapping GU advances, urban planners may gain insight into areas where improvements are required that may well expedite SDGs accomplishment. When considering the attainment of SDGs, Van Zyl *et al.* (2021b:3) call attention to MF in urban planning and recognise it as a cornerstone to achieve SDGs in urban environments. In concluding this section, urban planners need to implement broadened strategies into urban planning that minimise trade-offs between ecosystem services and urban development. This could be done by maximising the synergy between “man and nature” (Van Zyl *et al.*, 2021b:3; Pranab & Bansal, 2022:18923) in a multifunctional mode that leads to economic opportunities, supports livelihoods, and progresses the quality of life in urban – this all in an attempt to achieve the SDGs (Wang *et al.*, 2021:1951).

4.4 Conclusion

From the literature reviewed above, a coding process follows (see Annexure A), where the urban planning principles of MF and subsequently themes are extracted and aggregated in an emergent theoretical matrix in Table 4.2. As in the instance of GU (Chapter 3), the process of descriptive coding (Onwuegbuzie *et al.*, 2016:134) is, therefore, also employed in this chapter, resulting in the reduction of the assessed literature by identifying the planning principles of MF, reorganised into themes and summarised in the emergent theoretical matrix below. Thorough coding of the literature results in principles and themes relating to MF that establish the emergent theoretical matrix's horizontal axis. The matrix is subsequently converted into an assessment matrix during the ensuing empirical phase of the study (see Chapter 5). It is employed during the empirical phase to evaluate the selected case study. Consequently, the literature review relating to MF is concluded in the theoretical matrix below and deemed appropriate in offering numerous principles

and themes inherent to the planning principles of MF, ultimately enabling the researcher to assess the case study by employing the anticipated assessment matrix.

Table 4.2: Emergent theoretical matrix of MF

<u>Selected Themes</u>	<u>Coded planning principles deemed inherent to MF</u>
I. Community-Based Extract cultural richness adaptability	1. Combine environmental, social and economic functions.
	2. Extract cultural richness and adaptability
	3. Beneficial human and nature
	4. Participatory planning/ multiple stakeholders
	5. Improve the well-being of citizens
II. Spatial planning	6. Divert from generic planning
	7. Reconsider MF/planning nexus
	8. Consider the adaptability of spaces
	9. Involve more disciplines/ Pluralism
	10. Reduce single-use spaces
	11. Parks more as recreational areas
	12. Manage heat island effects
	13. Integrate functions
	14. Revitalise industrial areas
	15. Implement multifunctional complexes
III. Directives	16. Tailored spatial policies
	17. Map and quantify eco-services
	18. Map and record ES (LUS)
	19. Landscape management strategies
	20. Incorporate SDGs
IV. Ecological	21. Benefit humans and nature
	22. Green space must serve an urban area
	23. Manage heat island effects
	24. Resource management
V. Services	25. Multifunctional green infrastructure
	26. Ecosystem services (ES)
	27. Improve the urban fabric (green & grey networks)

Source: Own creation (2024).

Following the conclusion of this chapter relating to the planning principles of MF, Chapter 5 presents the empirical phase of the study during which the prepared emergent theoretical matrices for GU (Chapter 3) and MF (Chapter 4) are aggregated into an assessment matrix and the interfaces between GU and MF identified. Subsequently, the assessment matrix is employed to evaluate the selected single case of the newly planned Verkykerskop.

CHAPTER 5 EMPIRICAL INVESTIGATION

Chapter 5 introduces the empirical investigation and aims to address objective 2:

Objective 2: To employ the prepared assessment matrix by evaluating a selected case study in nominating interfaces between the GU planning approach and the planning-related principles of MF.

5.1 Methodology of the empirical phase

The methodology outlined in Chapter 2 is followed in the empirical phase. It includes specific milestones (see below), following the literature reviews of GU and MF to establish an emerging assessment matrix and assess the selected case study. Concluding the assessment, findings will be prepared and discussed prior to the conclusion of the study. The following milestones are endeavoured in the ensuing sections:

- **Case study:** a comprehensive overview of the case study is provided, and explanations are offered for its purposeful selection,
- **Assessment matrix:** emergent theoretical matrices prepared for GU and FF are aggregated into an assessment matrix proposed for the (i) selection of the interfaces between GU and MF and (ii) evaluation of the selected case study,
- **Interfaces:** (i) evaluate the case study and (ii) illustrate how interfaces between GU and MF are practically attained in an actual and real-world instance,
- **Findings:** the results of the evaluated case are discussed by describing the identified interfaces and how the case study relates to the identified interfaces.

This section does not intend to discuss the proposed methodology in detail, as it was already dealt with in Chapter 2. It is, nonetheless, deemed necessary to highlight the three significant steps, outlined in the methodology that are taken in navigating the empirical process. For completion of the empirical process the following steps are followed:

- Step 1:** Prepare the assessment matrix for employment in the empirical phase by aggregating the prepared emergent theoretical matrices of GU and MF,
- Step 2:** Identify the interfaces between the principles and themes of GU and MF,

Step 3: Evaluate the selected case to determine the presence of the identified interfaces.

From here onwards, the empirical phase primarily focuses on the case study method selected for this study, i.e. applying qualitative methods (a spatial, and document analysis) to assess the available information of the case study:

Table 5.1: Case study analysis

<u>Spatial analysis:</u>	<u>Document analyses:</u>
• Including available geospatial imagery, • i.e. detailed urban design and layout plans, • ensuing interpretation of a specific research phenomenon.	• Including available grey literature i.e. existing reports, • micro-SDF (prepared for the case study), • municipal SDF, township establishment application, • newly prepared LUS (prepared for the case study) • Green Living Compendium (GLC).

Source: Own creation (2024).

The assessment of the case study is concluded by discussing the obtained results, firstly elaborating on the identified interfaces and secondly by conferring the attainment of the identified interface within the case study. This discussion ultimately enables the researcher to conclude the empirical phase of the study.

5.2 Location and background of case study

The selected single exploratory case study, Verkykerskop, is a historic village between Harrismith and Memel in the Free State province (see Figures 5.1 and 5.2) and holds natural, cultural and historical significance. The cultural and historical significances are unique as they present both (i) the Batlokwa and Basia peoples (different tribes within the Sotho/Tswana cluster), perceived as the ancestors of the present-day Sotho peoples and (ii) later colonial influences characterised by early European settlers comprising mainly migratory stock farmers (“trekboere”), (LMV Town Planners, 2009:57).

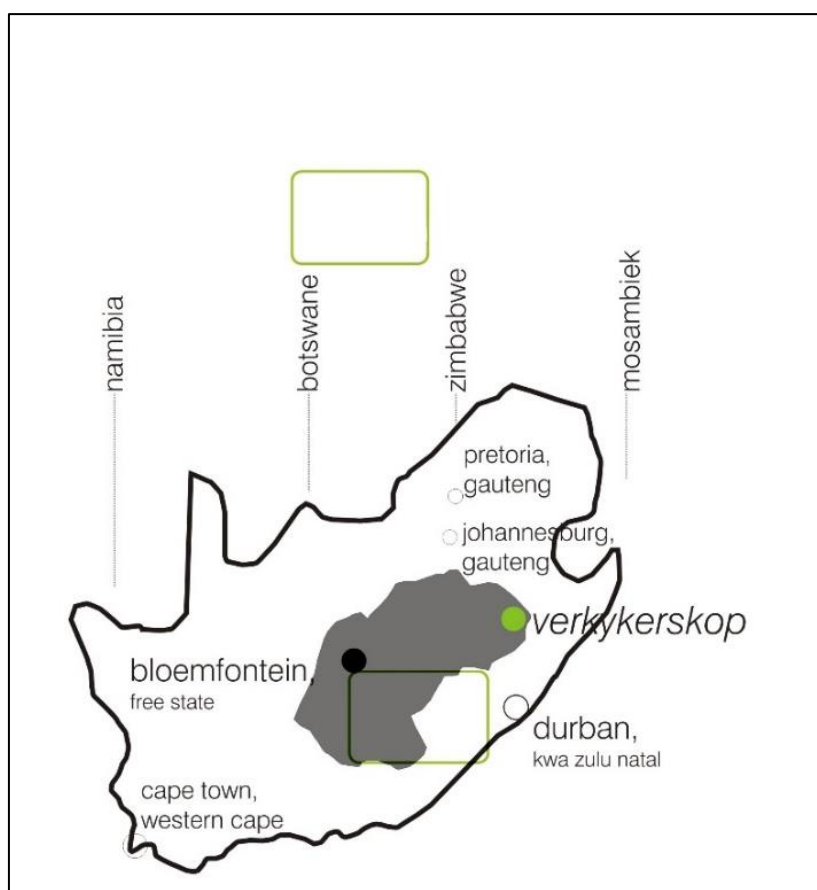


Figure 5.1: Locality map of Verkykerskop – national context.

Source: Own construction

It is a preferred destination for tourists due to its strategic location on the Maloti Tourism Route and its proximity to the Drakensberg Escarpment. The area where the village was later established, dates back to the 1600s and with its unique heritage are believed to be the origin of the Sotho people. The *Difaqane* severely impacted the region and resulted in the displacement of most indigenous communities by the Zulu people.

The region's heritage is further enriched by its strategic location on later historic colonial-related trade routes, including the De Beer and Normandien passes, which made it an important stopping point for travellers and traders between Natal and the Transvaal. Verkykerskop's growth was spurred by the establishment of rest stops for wagons and oxen, and as the importance of the area grew so did the development of essential services leading to the expansion of Verkykerskop into a small rural village. Building of the Van Reenen's Pass in 1856 (now links the interior of South Africa and the Kwa Zulu Natal province) opened trade between the Orange Free State and Natal and was preferred above passes closer to Verkykerskop, resulting in Verkykerskop remaining a small rural village (LMV Town Planners, 2009:57).

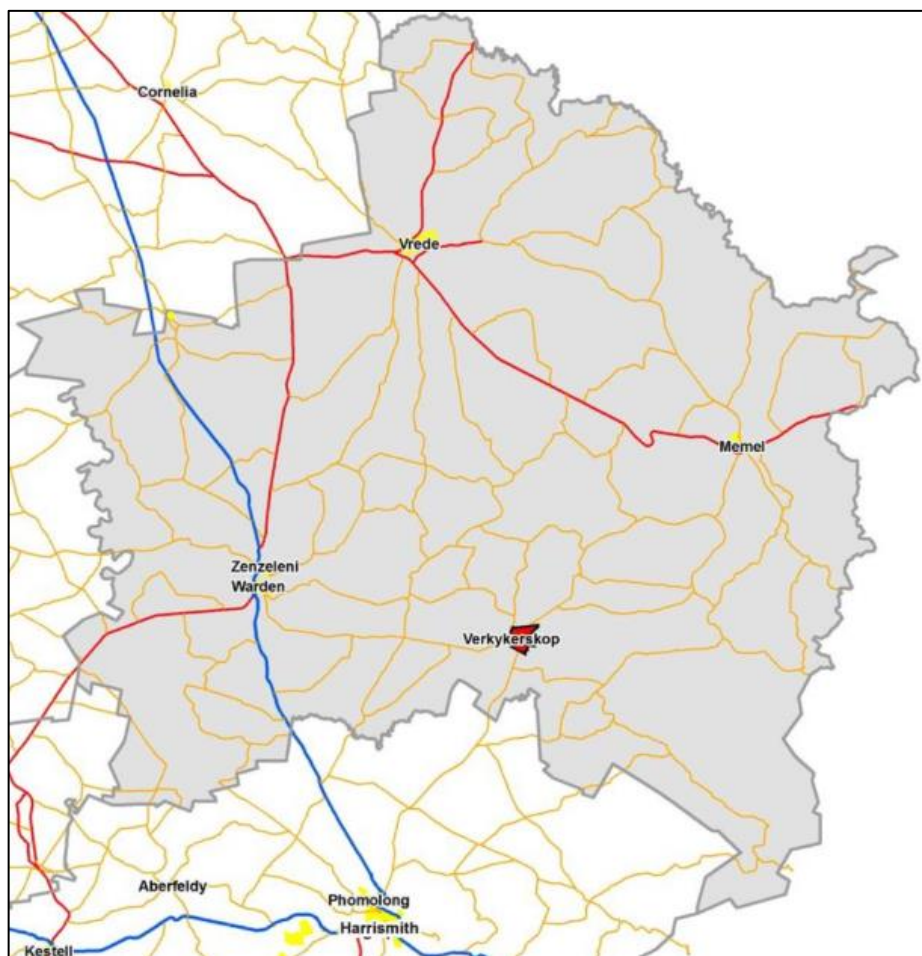


Figure 5.2: Locality map of Verkykerskop – regional context.

Source: LMV Town Planners (2009:6).

According to the memorandum that was prepared for the township establishment application (LMV Town Planners, 2012:7-8) the Verkykerskop Development Consortium initiated a comprehensive development plan aimed at revitalising the village by incorporating mixed land use, including commercial, tourism, and recreational facilities and adopted a special approach to design and planning, other than conventional approaches. In adopting the New Urbanism approach, it is also important to realise the design philosophy (see Figure 5.3) of how the specific design of walkways, urban squares and parks ought to encourage a valuable public life and that the form of buildings and their relationship to these public elements, will further augment the quality of urban living. Residential development is proposed to be clustered and green-belted by open spaces and agricultural land, with an Urban Framework defined by prominent arterials and narrow streets alternating with wider boulevards (LMV Town Planners, 2012:18-23).

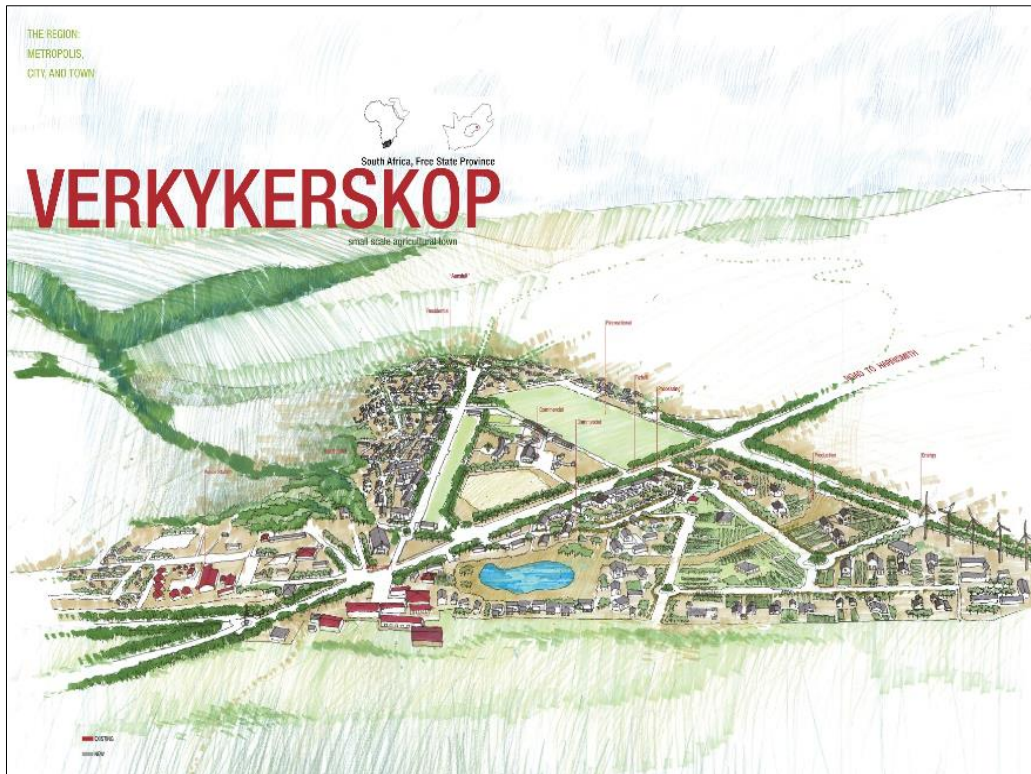


Figure 5.3: Adopted design philosophy of Verkykerskop.

Source: LMV Town Planners (2012:18)

5.3 Selection of the case study

As indicated in Chapter 2, the selected case was opted for as it is (i) is perceived as a town planned afresh, (ii) provides a narrative relevant to the study (Cohen *et al.*, 2018:376), and (iii) displays emergent attempts to implement GU and MF. Selecting the case of Verkykerskop is additionally prompted by two distinctive hallmarks as it provides “rich and vivid descriptions” and highlights the fusion of three idiosyncratic design approaches (Cohen *et al.*, 2018:376), i.e. New Urbanism, GU and MF. Verkykerskop, therefore, offers a compelling case study for exploring the principles of GU and MF, exemplified by its unique blend of historical significance, natural beauty and untapped potential. The latter renders it an appropriate case to evaluate the interplay between heritage preservation, eco-friendly practices and economic development. In this instance, it is apparent that the study (and its empirical phase), is restricted to a single exploratory case study (MacCallum *et al.*, 2019:47-48). The following sections further offer the rationale for deciding on the specific case and limiting the study’s empirical trajectory to a single exploratory case.

5.3.1 Micro Spatial Development Framework

Verkykerskop's approved Micro Spatial Development Framework (MSDF), (LMV Town Planners, 2009:9) portrayed in Figure 5.4, provides a solid foundation for future development and ensures a coordinated and sustainable planning approach for future expansion. The MSDF also emphasises the balance between heritage preservation and modern development, seemingly consistent with the principles of GU and MF (and New Urbanism).

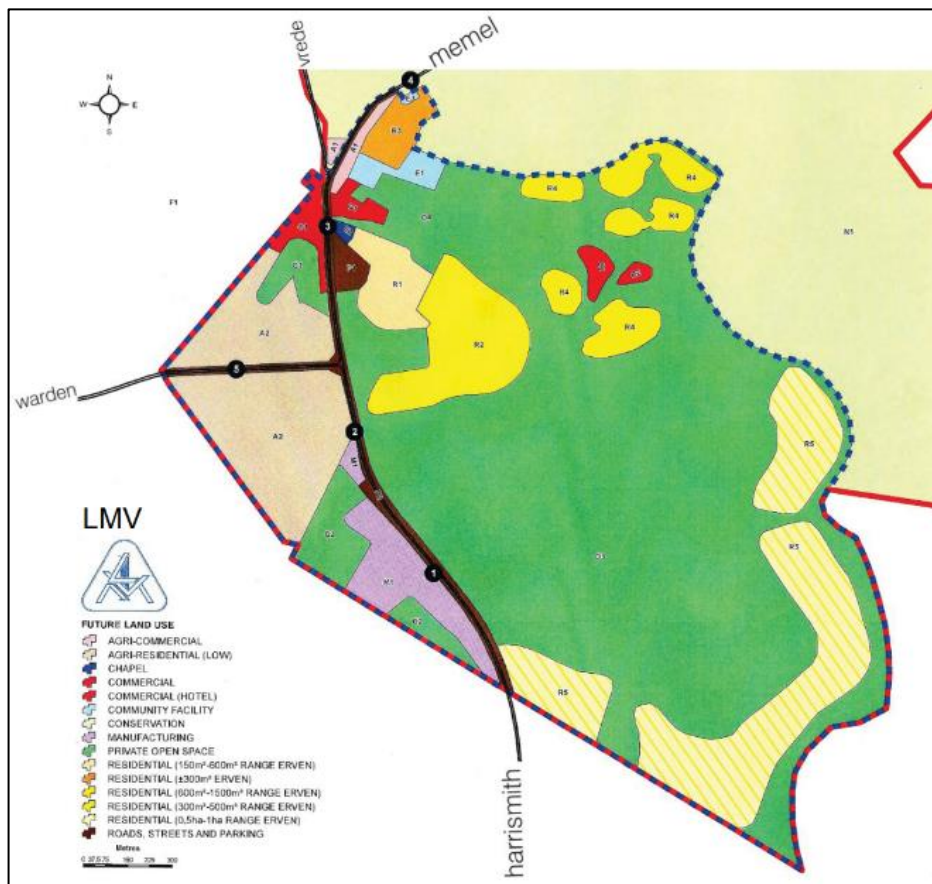


Figure 5.4: Verkykerskop Micro Spatial Development Framework map.

Source: LMV Town Planners (2009:9)

5.3.2 Design Philosophy

Verkykerskop implements a design philosophy that prioritises a harmonious integration of historic elements and contemporary architecture and offers insight into creating visually appealing and multifunctional spaces. This design philosophy focuses on a dense and rustic development that aims to inspire innovative solutions for compact and multifunctional urban design.

5.3.3 Tourism potential

The strategic location of Verkykerskop on the Maloti Tourism Route and its proximity to the Drakensberg Escarpment presents significant opportunities for further development of the tourism sector. Verkykerskop thus stimulates the local economy by leveraging its natural beauty and cultural heritage, attracting visitors and contributing to its multifunctional urban landscape as seen in Figure 5.5.



Figure 5.5: Proposed land use map (partial).

Source: GWA Studio (2014:6)

5.3.4 Green Living Compendium

The Green Living Compendium, 2014 (GLC) prepared for Verkykerskop aims to enhance the implementation of sustainable practices, including renewable energy, water conservation, and eco-friendly building materials. It renders the village ideal for green living initiatives, urban agriculture, and its maintenance as a working farm, suggesting implementing GU and MF planning principles. The GLC serves as a valuable resource for residents and the future development of Verkykerskop. It will serve as a building code, promote environmentally

responsible choices, and enhance the implementation of GU and MF principles, further supported by a newly prepared Land Use Scheme (LUS) for the Village, offering diverse and innovative land uses (see Figure 5.5) provided within the GLC (GWA Studio, 2014:9).

5.4 Assessment matrix

The assessment matrix is presented in Table 5.1 below and is prepared by combining the two emergent theoretical matrices prepared for GU and MF (Chapters 3 and 4). The assessment matrix works towards objective two of the study and, as outlined, deals with three significant steps to (i) prepare the assessment matrix for employment (aggregating the prepared emergent theoretical matrices of GU and MF) in the empirical phase, (ii) nominate the interfaces between the principles and themes of GU and MF, and finally to (iii) evaluate the selected case to determine the presence of the identified interfaces. Also affirmed earlier is the application of two qualitative methods, namely a spatial analysis that includes available geospatial imagery (layout plan), limited photographic analysis, and document analysis, including all the available grey literature relating to the project (i.e. existing reports, an MSDP (prepared for the case study), the Green Living Compendium, (prepared for the case study), the municipal SDF, township establishment application and newly prepared LUS (prepared for the case study)).

5.5 Interfaces

The principles of GU and MF are aggregated into an assessment matrix, respectively, the vertical and horizontal axes. By correlating (Cohen *et al.*, 2018:679) the selected themes and principles, interfaces are selected between GU and MF if they combine ecological principles and urban functionality (GU) with the ability of a space or infrastructure to serve multiple purposes and functions and adapt in the face of changing circumstances (MF). This evaluation is conducted by correlating the principles extracted from the literature review, enabling a systematic comparison between the principles of GU and MF and nominating interfaces. Deriving relationships or interfaces between GU and MF first signals that MF could decisively contribute to implementing GU in urban environments. By improving GU through the planning principles of MF, urban environments establish synergies that benefit both the environment and urban residents. Seeking the interfaces between GU initiatives through the application of the planning principles of MF may well accelerate and improve GU in urban environments and attain higher levels of urban sustainability.

The practical attainment of the identified interfaces is, secondly, investigated by evaluating the selected case study, as the presence of these interfaces in a “real-world” case is perceived as indicative of the feasibility of integrating environmental sustainability with MF, warranting that (i)

GU is not only providing ecological benefits but also social, economic, and cultural values but (ii) will be adaptable to changing needs and unforeseen challenges. Nominating the interfaces and evaluating their presence in a selected case is the existing challenge that follows ensuing.

5.6 Results

In the ensuing section of the empirical phase, the results yielded by the assessment matrix are discussed and presented as findings. As indicated above, the findings on the existence of interfaces between GU and MF will first be addressed, and secondly, the findings relating to the presence of the interfaces in the newly planned Verkykerskop will be presented. In general, through assessment of the literature that ultimately populated the assessment matrix, correlations between GU and MF exist. The assessment matrix (see Table 5.2) achieves the aim of the study as it attempts to illustrate that MF could contribute to GU and that implementing the planning principles of MF may improve GU in urban environments.

Table 5.2: Assessment matrix

	Selected Themes	I. Community based					II. Spatial planning										III. Directives					VI. Ecological				V. Services		
Selected Themes	Coded planning principles deemed Inherent to MF Coded planning principles deemed inherent to GU	1. Combine environmental, social & economic functions	2. Extract cultural richness and adaptability	3. Beneficial human and nature	4. Participatory planning/ multiple stakeholders	5. Improve the well-being of citizens	6. Divert from generic planning	7. Reconsider MF/planning nexus	8. Consider the adaptability of spaces	9. Involve more disciplines/ Pluralism	10. Reduce single-use spaces	11. Parks more as recreational areas	12. Manage heat island effects	13. Integrate functions	14. Revitalise industrial areas	15. Implement multifunctional complexes	16. Tailored spatial policies	17. Map and quantify eco-services	18. Map and record ES (LUS)	19. Landscape management strategies	20. Incorporate SDGs	21. Benefit humans and nature	22. Green space must serve an urban area	23. Manage heat island effects	24. Resource management	25. Multifunctional green infrastructure	26. Ecosystem services (ES)	27. Improve the urban fabric (green& grey networks)
A. Ecological	1. Benefit both humans and nature		▲	▲		▲						▲	▲		▲						▲	▲	▲	▲				▲
	2. Regeneration of ecosystems											▲						▲		▲			▲		▲	▲	▲	▲
B. Resource management	3. Multidisciplinary involvement	▲			▲		▲	▲	▲	▲						▲										▲		▲
	4. Multidimensional solutions	▲			▲		▲	▲	▲	▲	▲			▲		▲										▲	▲	▲
	5. Resource management - reduce consumption					▲					▲		▲						▲					▲	▲		▲	
	6. Utilisation of renewable resources	▲									▲		▲		▲						▲			▲	▲		▲	

	Selected Themes	I. Community based					II. Spatial planning										III. Directives					VI. Ecological					V. Services			
	7. Pollution control emphasis (healthy cities)												▲	▲					▲		▲	▲		▲	▲	▲	▲	▲	▲	
C. Spatial Planning	8. Transformative Planning approach/ adapting and shaping		▲	▲	▲		▲	▲	▲	▲		▲		▲	▲		▲			▲				▲			▲		▲	
	9. Consider an overarching “green framework”								▲				▲	▲			▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	
	10. Integrated nature base planning			▲		▲			▲			▲	▲	▲			▲		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	
	11. Consider quality of life	▲	▲	▲		▲						▲									▲	▲			▲	▲	▲	▲	▲	
	12. Compact, walkable and pedestrian-friendly cities			▲		▲	▲		▲			▲		▲		▲					▲				▲		▲		▲	
	13. Emphasise public transport (reduce car dependency)					▲							▲	▲	▲		▲				▲		▲		▲		▲		▲	
	14. Improve connectivity					▲										▲					▲							▲		
	15. Improve recreation		▲			▲			▲			▲									▲					▲		▲		▲
	16. Prioritise mixed land-use	▲				▲	▲	▲	▲	▲	▲	▲		▲		▲	▲				▲	▲				▲	▲	▲	▲	▲
	17. Towards “triple zero”			▲									▲		▲			▲		▲		▲	▲							
	18. Low-carbon economies												▲								▲		▲	▲	▲	▲	▲			
D. Biodiversity Loss	19. Maximise biodiversity								▲			▲	▲					▲	▲	▲		▲	▲	▲	▲	▲	▲	▲	▲	▲
	20. Manage vegetation in urban space											▲	▲					▲	▲			▲	▲	▲	▲	▲	▲	▲	▲	
	21. Climate sensitive design								▲			▲	▲							▲		▲	▲	▲	▲	▲	▲	▲	▲	

	Selected Themes	I. Community based					II. Spatial planning										III. Directives					VI. Ecological					V. Services		
	22. Regularly measure performance																		▲				▲					▲	▲
E. Services	23. Ecosystem services								▲			▲	▲	▲						▲	▲		▲	▲	▲	▲	▲	▲	▲
	24. Address implementation challenges		▲		▲		▲			▲						▲										▲	▲	▲	▲
	25. Purposefully designed green spaces					▲					▲	▲	▲							▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
F. Green Literacy	26. Educate planners			▲			▲	▲								▲						▲					▲	▲	▲
	27. Educate city actors				▲		▲	▲		▲						▲					▲		▲				▲	▲	▲
	28. Implementation SDGs			▲					▲			▲	▲	▲							▲	▲	▲	▲	▲		▲		▲
	29. “Dum down” GU						▲																			▲	▲	▲	▲

Source: Own creation (2024).

5.6.1 Interface findings

This section delves into the nominated interfaces between the planning principles of MF and the GU planning approach by evaluating (see Table 5.3) the identified MF themes (community bases, spatial planning, directives, ecological, and services) against the identified GU themes (ecological, resource management, spatial planning, biodiversity loss services and green literacy).

Table 5.3: Interface summary

<u>MF Themes</u>	<u>GU Themes</u>	<u>Interfaces discussion</u>
I. Community-based	Ecological	The interface indicates a correlation (Cohen <i>et al.</i> , 2018:679) between the themes when considering community-based planning with ecological implications that benefit humans and nature. Community-based planning contributes to the environmental theme.
	Spatial planning	The interfaces between the themes (community-based and spatial planning) illustrate that the involvement of beneficiaries improves spatial planning as it meets the needs of communities.
II. Spatial planning	Resource management	The interfaces between spatial planning and resource management signal a connection between resource management and spatial planning. The conclusion was made that effective spatial planning contributes to city resource management.
	Spatial planning	With the MF and GU themes being congruent, it is perceived that spatial planning may promote GU and MF and that the planning principles of MF may well contribute to enhanced GU in urban environments.
	Biodiversity loss	The interface between spatial planning and biodiversity loss illustrates that the planning principles of MF may intercept biodiversity loss and the connection between humans and nature.
	Services	Appropriate spatial planning contributes towards effective services and, subsequently, the implementation of ES in urban environments, as supported by the interfaces

<u>MF Themes</u>	<u>GU Themes</u>	<u>Interfaces discussion</u>
		between the themes. It is perceived that the planning principles of MF may also contribute to effective service provision.
	Green Literacy	The correlation between spatial planning and green literacy is strengthened by the identified interfaces indicating that MF's planning principles and appropriate directives (policy, legislation and guidelines) contribute to educating city actors.
III. Directives	Spatial planning	Appropriate directives (policy, legislation and guidelines) do play a significant role in spatial planning, as depicted in the selected interface. Implementing the planning principles of MF and possible directives could contribute to the improvement of GU.
	Biodiversity loss	The interface supporting these themes suggests that the planning principles of MF assist biodiversity conservation and intercept biodiversity loss.
	Green literacy	The planning principles of MF and green literacy also correlate. It supports the notion that educating planners and other specialists is required and could readily be attained by the planning principles of MF.
IV. Ecological	Ecological	Both GU and MF focus on the importance of urban ecology and nature-based solutions in cities. The interface signals that the planning principles of MF may contribute to the improvement of GU.
	Biodiversity loss	The interface links the themes of ecological and biodiversity loss and affirms that the planning principles of MF intercept biodiversity loss and benefit the human/nature equilibrium in urban environments.
	Green literacy	As affirmed earlier, the planning principles of MF and green literacy correlate. The multifunctional incorporation of nature into the urban environment may assist and educate city actors in attaining higher levels of GU.

<u>MF Themes</u>	<u>GU Themes</u>	<u>Interfaces discussion</u>
V. Services	Spatial planning	As alluded to and suggested by this nominated interface, it is perceived that the planning principles of MF may also contribute to improved spatial planning and ensuing improved service provision.
	Biodiversity loss	The interface between the planning principles of MF and biodiversity loss confirms that implementing ES decelerates biodiversity loss in urban environments.
	Services	The interface of both GU and MF services themes confirms that the planning principles of MF contribute to enhanced GU. The MF principles combined with purposefully designed green spaces enhance GU in the urban environment.
	Green literacy	The correlation between service provision and green literacy indicates that MF's planning principles and appropriateness may contribute to educating city actors.

Source: Own creation (2024).

5.6.2 Case study findings

In this section, the selected interfaces are identified in the case study Verkykerskop to assess whether the theoretical principles of GU and MF are present in a real-world case and to determine the practicality of the planning principles of MF, contributing to the implementation and improvement of GU. It is attempted through conducting a spatial and document analysis and includes several significant geospatial imageries (urban design and layout plans) and documents (existing reports, MSDF, township establishment application, newly prepared LUS and the GLC) that resulted from the replanning and design of Verkykerskop. The documents are comprehensive and detailed, and the evaluation attempted in Table 5.4 is not an in-depth analysis of all the documents but rather an effort to detect the nominated interfaces in the assessment matrix in the various supporting documents of the case.

Finally, the replanning of Verkykerskop reveals distinct phases, i.e. (i) a strategic phase during which an MSDF for the larger Verkykerskop region was prepared (see Figure 5.4) and (ii) a detailed design phase (urban design and urban planning), culminating in the GLC. Focus was placed on evaluating the documents of each phase, identified as representing the essence of the case, instead of focusing on every detailed and technical report that was prepared.

Table 5.4: Interfaces of the case study.

<u>Supporting documents</u>	<u>MF themes</u>	<u>Interfaces discussion</u>
MSDF	Community-based	• The MF theme and interface are visible within the MSDF in various sections, including the participation structure and rural framework. The MSDF focuses on preserving the current community through a participation structure and ensuring that the community's requirements are heard. • Its rural framework aims to support the local farming and indigenous farm labourers' communities by including them in all strategic and detailed planning endeavours. • An emphasis on the environmental framework and ecological characteristics aimed at enhancing the well-being of humans and nature in development and promoting the human/nature equilibrium are depicted in the MSDF.
	Spatial planning	• The unique design philosophy supports the interfaces of the MF theme and contributes to GU. This, as the design philosophy, inter alia, focuses on preserving the region's heritage and aims to enhance the town's historical character and vernacular architecture, additionally providing for a new and integrated cultural precinct. • The MSDF also strengthens the spatial planning theme with its future land use framework. The framework focused on moving from traditional planning approaches by incorporating GU through conserving heritage and nature in diverse land uses (see Figure 5.9).
	Directives	• The MSDF is a statutory directive approved by the council that sets a strategic advent for the ensuing town planning process in Verkykerskop. • The latter included a detailed LUS (only for the newly planned) Verkykerskop and an approved layout plan, offering a detailed spatial planning directive. • Hence, the nominated interface is depicted in the case.

<u>Supporting documents</u>	<u>MF themes</u>	<u>Interfaces discussion</u>
	Ecological	• The MSDF aims to enhance the well-being of the human/nature relationship and endorses the GU and MF interface, especially concerning the ecological theme. It strengthens the notion that the planning principles of MF contribute towards an improved GU in the case study. • The interface is also endorsed by the future land use framework (see Figure 5.9), emphasising “green” land uses and environmental well-being.
	Services	• The MF theme highlights ES and sets specific requirements for GU to succeed. This MSDF emphasises the nominated interface given its pertinent environment and production (urban and regional agricultural) focus, inter alia maintaining the initial properties on which Verkykerskop is established as a working farm. • The approach signals the contribution of the planning principles of MF towards improved GU in a regional and urban environment.
Geen Living Comenduium (GLC)	Community-based	• The GLC focus on enhancing the well-being of humans and nature within the city by implementing GI and nature-based solutions within the development. • Similar to the MSDF, the document defines the importance of all involved communities and role-players in the region and provides detailed spatial planning and urban design proposals to meet all their requirements, e.g., the proposed Umgidi Cultural Village (see Figure 5.6). • The GLC duly supports the nominated interface, and the planning principles of MF are additionally depicted in the proposals contained in the document.
	Spatial planning	• The theme of spatial planning is pronounced in the GLC, as it diverts from conventional and familiar layout planning and urban design, emphasising New Urbanism design principles. • A unique and diverse land use mix, comprising multiple functions, endorses the planning principles of MF and is

<u>Supporting documents</u>	<u>MF themes</u>	<u>Interfaces discussion</u>
		green spaces also link to more than recreational functions (i.e. for inclusion of ES and urban agriculture)(see Figure 5.9) • The GLC is also aimed at reducing the consumption of resources and enhancing and controlling pollution within by suggesting several “green building” techniques, the use of green building materials and recycling, thereby underlying the planning principles of MF and its contribution toward a GU advent in Verkykerskop the development and continues to confirm the contribution of MF towards GU. (see Figure 5.7)
	Ecological	• The GLC aims to enhance the well-being of the human/nature relationship and endorses the GU and MF interface, especially concerning the ecological theme. It strengthens the notion that the planning principles of MF contribute towards an improved GU in the case study. • The interface is further endorsed by the “green” framework proposed in the GLC, emphasising “green” land uses and a productive framework in the form of extensive farming, small-scale farming, urban agriculture, and ultimately production-orientated land uses (see Figure 5.8). • The impact of the planning principles of MF is particularly evident in the “green” framework, solidifying its possible enhancement of GU in the urban environment (here, also involving the regional environment).
	Services	• The GLC offers a detailed layout of the level of service for each precinct, highlighting the level of service and whether it will be conventional or grey services (see Figure 5.10 - as an abstract) • As previously outlined, additional provisions are made for onsite ecosystem services, nature-based solutions, and recycling.

<u>Supporting documents</u>	<u>MF themes</u>	<u>Interfaces discussion</u>
		This approach advocates the multifunctional nature of service provision and how it contributes to GU, implying the unique contributions MF's planning principles make in attaining GU in urban environments.

Source: Own creation (2024)

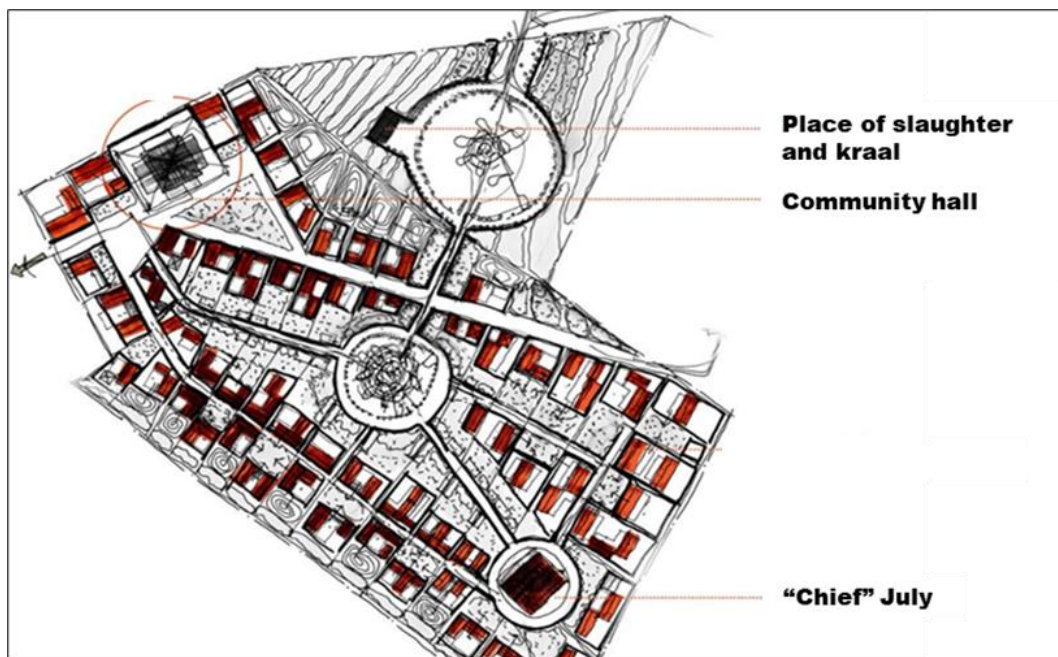


Figure 5.6: Umgidi Culture Village.

Sources: GWA Studio (2014:21)

5.7 Conclusion

The assessment matrix, derived from the two emergent theoretical matrices, served as an instrument to (i) determine the existence of interfaces between GU and MF and (ii) to determine the presence of the interfaces in the newly planned Verkykerskop and proves to be a valuable instrument to the researcher. The literature, reviewed in first preparing the theoretical matrices relating to the principles of GU and MF, and further aggregating both into an assessment matrix, is therefore perceived as appropriate and adequate for the assessment matrix. Application of the assessment matrix allows the researcher to nominate interfaces between GU and MF, suggests a broader understanding of the case study, and facilitates evaluation of the case in detecting the practical attainability of the nominated interfaces in the “real world”. The empirical phase is concluded by reasoning that the assessment matrix may well offer a specific contribution to both

the researcher and likely city actors in creating a better comprehension of the valuable contributions of the planning principles of MF and its potential benefit in accomplishing GU in urban environments

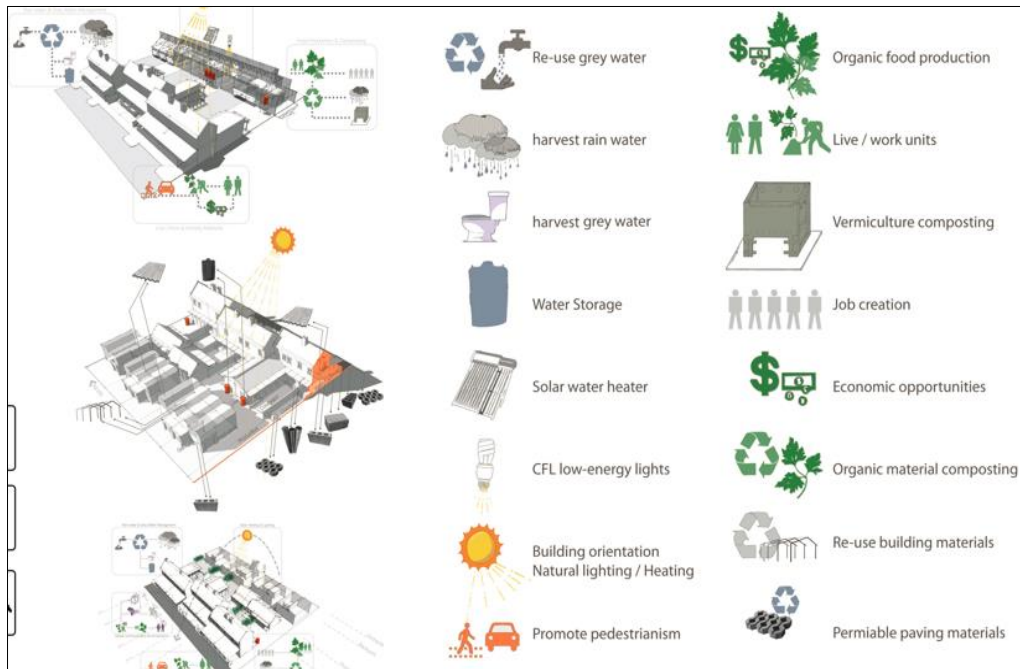


Figure 5.7: Onsite nature-based solutions and recycling

Source: GWA Studio (2014: 48)

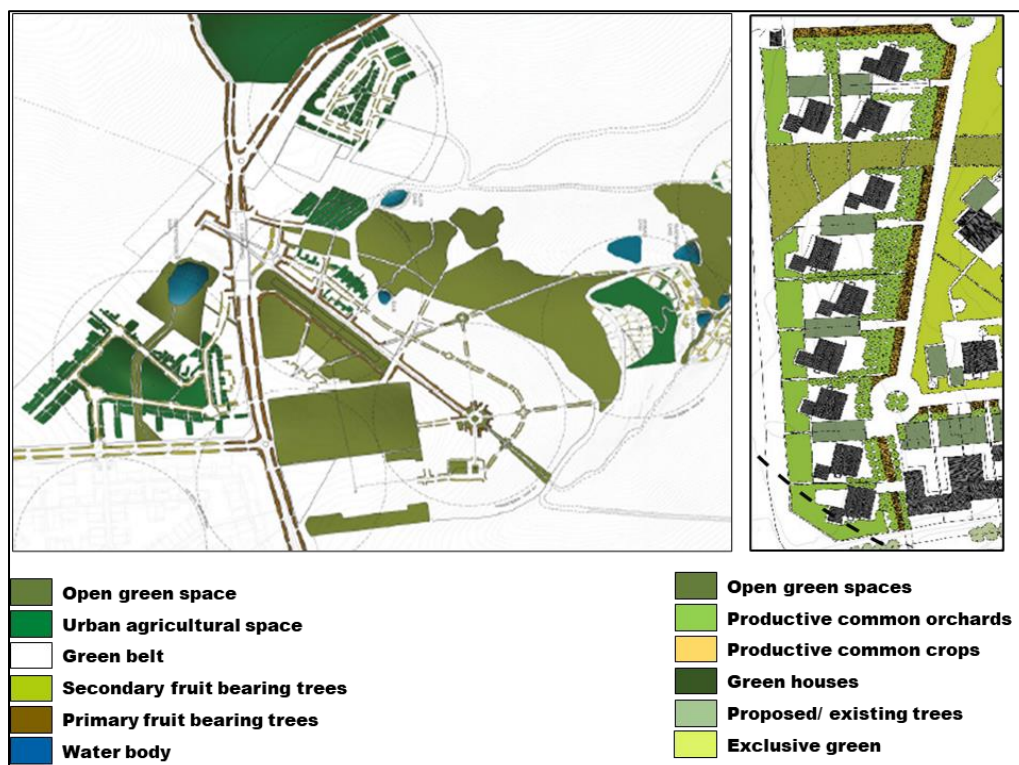


Figure 5.8: Green and production framework.

Source: GWA Studio (2014: 21)



Figure 5.9: Diverse multifunctional land uses and multifunctional green spaces

Source: GWA Studio (2014: 22)

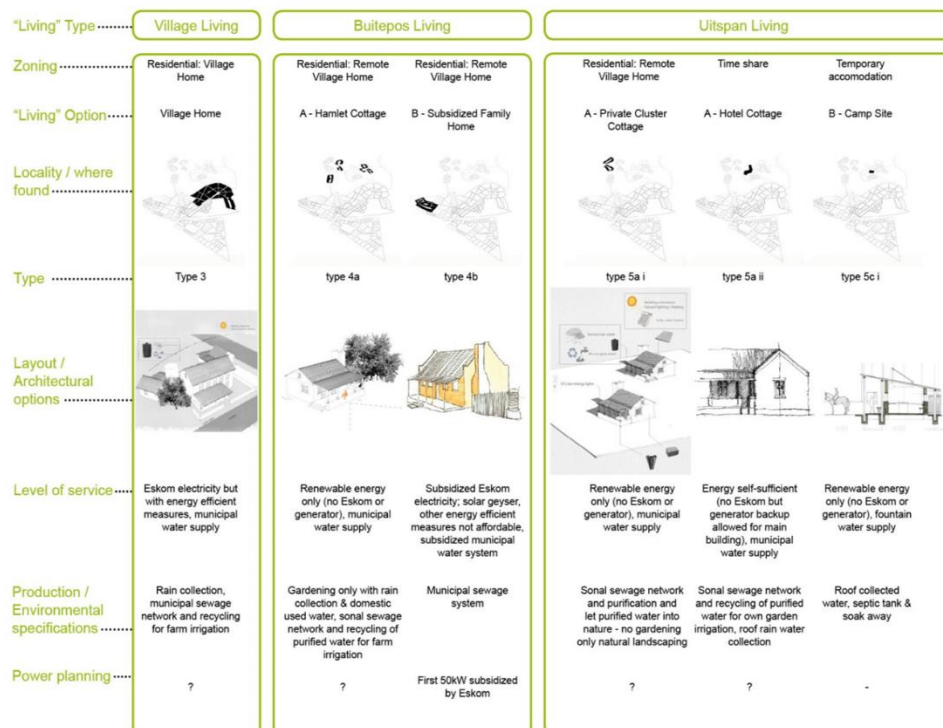


Figure 5.10: Levels of service provision to Verkykerskop precincts.

Source: GWA Studio (2014:21)

CHAPTER 6 CONCLUSION

The following section of the research paper determines whether the aims and objectives outlined in Chapter 1 are accomplished.

6.1 Aim concluded

Aim:

This study aims to abstract the guiding principles of the GU planning approach and the principles of MF in urban planning to nominate potential interfaces between the GU and MF in determining whether the employment of MF in urban planning could be conducive to a GU advent.

In achieving the study's aim, the literature presented in Chapters 3 and 4 provides an overview of both GU and MF principles; that concluded with the formulation of emergent theoretical matrices that condense the principles of GU and MF. The literature is explored through a coding process (see Chapter 2) to extract principles for incorporation in the emergent theoretical matrices. The emergent theoretical matrices from Chapters 3 and 4 are aggregated into the assessment matrix, as presented in Chapter 5. The assessment matrix proves valuable for nominating interfaces between GU and MF and evaluating the selected case study (Verkykerskop) to determine whether nominated interfaces are realistic and attainable in the "real world".

Considering the abstracted principles of GU and MF as presented in Chapters 3 and 4, and the results of the assessment matrix in Chapter 5, the study concludes that the employment of the MF planning principles is conducive to the attainment of GU in urban environments. The latter especially since the nominated interfaces between GU and MF demonstrate alignment, suggesting that the planning principles MF may accelerate GU endeavours in urban environments.

In achieving the aim of the study, the employment of the assessment matrix (Chapter 5) proves to be valuable as it emphasises that interfaces are existing between the principles of GU and MF that are, to an extent, also detected in the selected case, signalling the practical employment of interfaces in attaining higher levels of multifunctional GU.

6.2 Objectives achieved

Objective 1:

To determine the principles of the GU planning approach and urban planning-related principles of MF, for aggregation into an emergent theoretical matrix (literature review).

In achieving this objective, Chapters 3 and 4 serve as a literature review of GU and MF. The literature review described the planning approaches and presented the background to why and how GU and MF originated and what they presently implied for spatial planning. For the purpose of this conclusion, the two chapters are concluded separately.

In Chapter 3 GU, the literature review yielded the background and origins of GU and its scientific points of departure. A coding process (see Chapter 2) followed that delivered the principles of GU. This process also identified gaps (see Annexure B) in the literature that were researched further to ensure saturation. The coded literature is finally reduced in the principles and themes inherent to GU for inclusion in an emergent theoretical matrix.

Chapter 4 follows the same arch as Chapter 3, and the principles of MF are abstracted from the reviewed literature to identify planning principles and themes of MF in an emergent theoretical matrix. The coding process (see Chapter 2) is similarly followed in identifying a gap in the assessed literature (see Annexure C) and initiating additional literature reviews to ensure saturation. Here, an emergent theoretical matrix is also prepared.

In conclusion, preparing emergent theoretical matrices for GU and MF produces condensed literature on the principles deemed inherent to the two approaches (further categorised in themes). Both chapters affirm that the assessed literature delivered applicable information for aggregation into emergent theoretical matrices and that the reviewed literature is perceived to be adequate for attaining objective one.

Objective 2:

To employ the prepared assessment matrix by evaluating a selected case study in nominating interfaces between the GU planning approach and the planning-related principles of MF

Chapter 5 presents and discusses the nominated interfaces between GU and MF in the selected case study, Verkykerskop, and the reasoning behind its selection a case study. In conclusion, the prepared assessment matrix illustrates the nominated interfaces between GU and MF and is deemed equipped for employment in assessing the selected case.

It is further concluded that a correlation between GU and MF is present through preparing the assessment matrix (Chapter 5) and nominating the interfaces between GU and MF within the matrix. The case study is subsequently assessed to determine the presence of the nominated interfaces in the “real world”. The results of the assessment matrix concede proof of detected interfaces that are intertwined with the (i) strategic and (ii) planning and urban design phases. Illustrations are additionally shared to highlight the practical attainment of the selected GU/MF interfaces in Verkykerskop.

This objective determines that the case study, with its supporting documents (a strategic MSDF and forward planning of the region and compulsory and practical GLC, presenting the urban planning and urban design of Verkykerskop, and mandatory guidelines for future development), highlights the employment of the planning principles of MF and portrays the practical attainment of GU. With the selected interfaces observable in both the MSDF and the GLC, it is concluded that the attained interfaces support the planning principles of MF and are perceived as conducive towards GU.

Objective 3:

To formulate multifunctional planning recommendations that may be conducive to improving GU in urban planning

In Chapter 7, recommendations are made for improving GU in urban environments by applying the planning principles of MF. Recommendations are prepared by assessing the emergent theoretical matrixes (Chapters 3 and 4), the assessment matrix, the findings (see Chapter 5) and the conclusion above, in warranting that recommendations are founded on the conducted research and, to prevent generalisation thereof. Chapter 7 achieves this third and final objective of the study by providing possible recommendations for planning that may be conducive to improving GU in urban planning. Recommendations are finally made to guide future research should it be considered. The recommendations presented in Chapter 7 are founded on a scientific methodology and, therefore, deemed appropriate to possibly assist urban planners, urban designers, and city actors in enhancing and expediting GU implementation through MF planning principles.

CHAPTER 7 RECOMMENDATIONS

This chapter proposes planning recommendations, thereby attaining the final objective, namely:

Objective 3: To formulate multifunctional planning recommendations that may be conducive to improving GU in urban planning

A. Emergent theoretical matrices

Although it is recognised that the prepared emerging theoretical matrices are not complete and may well be enhanced through further studies or the review of additional case studies, it is recommended that urban planners and city actors already utilise them as assessment tools to determine (i) what the principles of GU or the planning principles of MF entail, (ii) actions that may be taken in possibly launching or improving GU or MF and (iii) to determine whether GU and MF are attained in a particular urban environment. Although emerging, applying these matrices is recommended to suggest complete principles of the GU planning approach and the planning principles of MF for consideration by the planning fraternity.

B. Assessment matrix

By converging the emergent theoretical matrices into an assessment matrix and further nominating interfaces between GU and MF, ecological principles and urban functionality (GU) are combined with the ability of a space or infrastructure to serve multiple purposes and functions (MF), thereby enhancing the adaptability of urban environments, when facing changing circumstances. The assessment matrix is, therefore, recommended as it is perceived as a valuable instrument to (i) guide urban planners and city actors towards a GU advent or (ii) to the advancement of current GU endeavours.

While accepting that improved matrices are likely attainable, should alternative methodologies be employed, the assessment matrix is considered suitable for use by the planning fraternity, either by using its nominated interfaces or evaluating existing cases. The latter is recommended since research results illustrated its applicability in evaluating “real world” cases and drawing realistic conclusions about the extent to which GU has been achieved.

C. Complexity of GU and MF

Neither GU nor MF are considered simply comprehensible. Scholars' files often overflow with information regarding GU, and numerous publications are already available, but to a lesser extent, the same is valid for MF. It is almost impossible to assess all the available literature and projects to obtain an overview of what these approaches offer in achieving improved biodiversity and achievement of the SDG's. Moreover, scholar's files appear empty when investigating the practical implementation of GU and MF in the "real world". Research undertaken here and the coding processes followed to review copious volumes of literature already provide a foundation for implementing or improving GU. It is therefore recommended that emergent and novel matrices may well contribute to interpreting the approaches of GU and MF, and it is also recommended that their practical feasibility, illustrated in the evaluated case study, may already be supportive to urban planners and city actors.

D. Green literacy

It is recommended that the multifunctional attainment of GU, as scholars have advocated (Van Zyl *et al.*, 2021b:9), be accompanied by a broader awareness of the benefits and piratical attainability of a multifunctional approach toward GU, signalling the training/education of urban planners (on tertiary and professional levels) and city actors (officials). A similar green literacy and awareness is suggested amongst community members, especially during pre- and post-planning endeavours by authorities. It may contribute to the comprehension amongst all city actors (not merely urban planners), professionals, and society regarding the benefits and urgency of higher or improved levels of GU. It is recommended that local authorities and role-player governmental departments/agencies establish enhanced green literacy amongst its urban residents, enlightening them of the significance of GU and the long-term advantages of biodiversity enhancement and the attainment of SDGs.

E. Local authority directives

Apart from limited efforts by civil society in the form of citizen-led initiatives, local authorities remain the implementing agents for, inter alia, sustainable urban planning and "green" developments. Van Zyl *et al.* (2021a:122) similarly also a prerequisite for implementing the principles of GU and planning principles as the preparation of

appropriate directives (i.e., policy, strategic documents, legislation, municipal by-laws and planning guidelines) by local authorities. This recommendation suggests the incorporation of the multifunctional attainment of GU and its associated guidelines and principles in municipal directives (as illustrated in the case of Verkykerskop with a strategic and council-approved MSDF, compulsory GLC and newly approved LUS). By including multifunctional GU in policy documents, city actors and society may be able to comprehend its significance in the urban environment and contribute more fervently to its implementation or improvement. It is consequently recommended that local authorities consider incentives and rebates in their directives when citizens and/ or developers approach development/ home improvements by accomplishing higher levels of GU. In closing this section, it is recommended that municipal-related strategic and development guidelines should (i) allocate areas for potential GU implementation and provide procedures therefore (typical in the Municipal Spatial Development Framework) while (ii) the Municipal Integrated Development Plan should support effective budgeting and the identification of potential municipally initiated projects regarding multifunctional GU accomplishment in the urban environment.

F. Regenerative urbanism

The final recommendation highlights the importance of pluralism (Etxano *et al.*, 2018:3) in achieving GU and the application of the planning principles of MF. The literature review and the empirical study accentuated the importance of a diverse range of specialists, a holistic approach (typically the Verkykerskop MSDF), and the involvement of various role players in achieving tangible multifunctional solutions. Although both GU and MU involve unique and systematic principles, it becomes apparent that the solutions are no longer embedded in familiar paradigms. The study recommends that achieving GU and a higher level of biodiversity in urban environments should rest with various specialists, academics, city actors, stakeholders, and civil society. Although the study centres around GU and MF, New Urbanism, New Ruralism, and several other urban planning approaches were not addressed and may equally contribute to higher biodiversity levels in urban environments. Finally, it is recommended that future development instead follow a strategy of regenerative urbanism, emphasising multifunctional solutions regarding the restoration of the natural environment in urban areas, biophilia and the achievement of net-positive impacts as priorities.

G. Future research

The planning approaches investigated are both complex and comprehensive, and it is recommended that the literature review be expanded to analyse case studies and best-case practices to extract more principles of GU and MF. In the same argument, it is recommended that other types of coding or even co-coding practices be attempted in future research, especially when condensing literature and agreeing on appropriate codes. While this is not applied in this research; appropriate software is recommended for future research, aiding researchers with coding processes (e.g., ATLAS.TI) of vast literature resources and intricate cases. Although this would imply revisiting the assessment matrix, it is deemed essential for future research contributions.

In addition, the case study analysis offered valuable insights, resulting in apt research and the generation of the above recommendations. In the instance of Verkykerskop, there is a corpus of knowledge that could not have been worked through in its entirety, and it is recommended that the case study be evaluated in greater depth in the future. Finally, it is recommended that future research regarding the application of the planning principles of MF not only focus on GU but also include similar planning approaches to improve biodiversity in urban environments.

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ANNEXURES A: CODING PROCESS

Item	Author	Planning principles deemed inherent to GU and MF	Coded category
1.	Bhargava, A., <i>et al.</i>	Green urbanism. It can be reasonably be defined as the practice of creating communities beneficial to human and the environment. Green urbanism is an attempt to shape more sustainable places, communities and lifestyles, and consume less of the world's resources. With the rapid growth of urbanization world over, multi-dimensional problems are a challenge	Benefits human and nature Reduce consumption Multidimensional solution
2.	Viviers, J. <i>et al</i>	In general, green urbanism theory focuses on adjusting the relationship between urban and nature and has emerged as a conceptual and theoretical basis for a new planning paradigm. Beatley and Newman [56], agree we are “desperately trying to learn how to become more sustainable, how to use less and live better, how to regenerate the ecology of the city and its bio-region and, sense of place, means something in a globalised economy, how to make a new economy out of green jobs and so forth further the nexus between Gu and MF by stating that the concept of MF is deeply intertwined with the design principles of GU, this is evident as GU prioritises spaces that serve multiple purposes, reflected in its emphasis on mixed-use diversity. They (Viviers, <i>et al.</i>, 2017;80) imagine vibrant neighbourhoods where residential areas co-exist with shops, cafes and green spaces The nexus of GU and MF is also visible in the planning philosophy of New Urbanism, where the focus is on walkable, mixed-use communities, as well as the concept of New Ruralism, as stated by Viviers <i>et al.</i>(2017; 75), which emphasises sustainable practices and the integration of nature. These planning approaches can work together with Gu to create MF cities, and Viviers <i>et al.</i>(2017:75) end by stating that by combining these approaches cities could achieve a higher level of sustainability	Relationship between urban and nature Use less Regenerate ecology Less consumption of resources Sens of place needed in cities Nexus between GU and MF MF intertwined in Gu design principles GU prioritise mixed use Co-existence of nature and humans Nexus between GU and MF Mixed use communities Integrate nature GU works towards MF cities
3.	Beatley, T. and Newman, P.,	Beatley and Newman agree we are “desperately trying to learn how to become more sustainable, how to use less and live better, how to regenerate the ecology of the city and its bio-region and, sense of place, means something in a globalised economy, how to make a new economy out of green jobs and so forth	Need to learn how plan cities better Control usages/ consumption Create sense of place Green jobs
4.	Muhammad, R	Green urbanism refers to the concept of designing and planning cities in a way that prioritizes sustainability, environmental conservation, and the well-being of both residents and the natural environment.	Plan cities with nature And well being of nature and humans

Item	Author	Planning principles deemed inherent to GU and MF	Coded category
5.	Chhetri, D.M, <i>et al.</i>	Green urbanism refers to the concept of designing and developing cities in a sustainable and environmentally friendly manner, with a focus on reducing energy consumption, minimising pollution, and promoting the use of renewable resources.	Incorporate nature Reduce consumption of energy Use renewable sources
6.	Sin,Y <i>et al</i>	Green urbanism is defined as the deployment of environmentally friendly and sustainable practices in urban development projects. It involves incorporating green spaces, renewable energy sources, efficient transportation systems, and sustainable building designs to create environmentally conscious and liveable cities. Green urbanism aims to mitigate the negative impacts of urbanisation on the environment and promote a more sustainable and resilient urban future.	Plan with nature in urban development Environmentally friendly cities must be multi discipline Mitigate urbanization
7.	Rayan, M, <i>et al.</i>	Green urbanism is a concept that focuses on creating environmentally sustainable cities through various approaches such as green policy impact, practical implementation, smart city ideas, infrastructure development, and green buildings.	Environmentally friendly cities Multi-disciplined Green infrastructure and building
8.	El-Bastawisy, M.M	It aims to address the environmental problems faced by cities and improve the quality of life for their inhabitants. The concept involves incorporating ecological design principles at both the building and urban scale, considering factors such as energy efficiency, climate-sensitive design, use of locally appropriate materials, and the creation of green spaces The development of green urbanism requires a combination of technological advancements and cultural, economic, and behavioural changes It also involves the assessment of urban and environmental issues, the exploration of potential solutions, and the implementation of sustainable practices [5] . Overall, green urbanism aims to create resilient and sustainable cities that promote green growth and improve the well-being of their communities.	Address environmental problems Improve quality of life Ecological design principles Creation of green spaces Combine disciplines Asses urban and environmental issues Implement sustainable practice Improve well-being of communities
9.	El-Bastawisy, M.M.,	GU could be defined as the art of building cities that prioritize sustainability, environmental well-being, and resident happiness (El-Bastawisy, 2023: 93-110). It gained traction around the turn of the century, offering a more transformative approach to urban planning compared to traditional methods. GU recognizes the importance of green spaces and ecological systems as essential infrastructure for healthy, resilient cities. Studies suggest that well-managed green spaces may even become tourist attractions, boosting local economies (El-Bastawisy,, 2023: 93-110).	benefits both humans and nature More transformative planning approach Importance of green spaces Healthy and resilient cities
10.	Zhao, B & Sun, T	Green urbanism and green planning have evolved over time in response to environmental challenges and the need for sustainable development. The concept of green infrastructure	Responds to environmental challenges

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		emerged in the 1990s as a way to combat urban sprawl and promote sustainable stormwater management [1]. This approach considers the integration of green spaces with other urban infrastructure to improve quality of life and address environmental issues [2]. The development of green and ecological urban theories has become a global consensus, with a focus on topics such as resilience, low-carbon economies, and green transportation [3]. However, there have been shortcomings in the implementation of sustainable building design, with a lack of consideration for energy-saving ideas and climate-sensitive design at the urban scale [4]. To address these challenges, there is a need for disruptive cultural, economic, and behavioural changes alongside technological solutions [5]. Overall, the history of green urbanism and green planning reflects the ongoing efforts to create environmentally sustainable and resilient cities	Combats urban sprawl Promotes storm water management Improved quality of life and environmental Low-carbon economies Considers energy saving ideas and climate sensitive design
11.	Nassar, U	Cities and towns have undergone significant transformations over the past fifty years, losing their cultural identity and becoming sprawling urban areas without borders, the development of sustainable green cities is crucial for the future of the Middle East, particularly cities like Cairo.	Green cities is required for future planning
12.	Nassar, U	These changes therefore lead to the need for a change in how we see cities as well as how we plan cities, promoting the concept of GU to ensure a sustainable future for cities	Need to change how we plan cities
13.	Ivanic, E. and Grandt, JL.	The green agenda has grown in the planning community... It has advocated compact, mixed-used, well-designed communities. Further that the green agenda has grown significantly in the planning community and that	Compacted cities Mixed-used communities
14.	Lehmann S	These principles for achieving green urbanism have to be clearly defined and adjusted to an era of rapid urbanisation, especially in the Asia-Pacific Region. In the 21st century, we are working in an entirely new context, for which we need new types of cities. As noted by Ulrich Beck, we have arrived in 'a new era of uncertainty, where energy, water and food supply are critical. 'We live in a world of increasingly non-calculable uncertainty that we create with the same speed of its technological developments.' (Beck, 2000)	Need to learn what Gu is Need new types of cities/ change traditional planning Manage natural resources
15.	Benedict & MCMahon	This understanding offers crucial insights into the strengths and weaknesses of current urban development practices and holds immense potential to guide the development of future green spaces, particularly within the context of Green Infrastructure Planning	Need to assess strengths and weaknesses of current planning Guide for future green spaces
16.	Miller	Furthermore, it provides a valuable framework for understanding the functions and interactions of green spaces from a human-nature system perspective	Framework for understanding function of green spaces Human-nature perspective

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17.	Haaland & van den Bosch	It serves as a metric for the overall performance of urban green spaces, shifting the focus towards a holistic perspective on their value	Measure performance of urban green spaces
18.	Lee, B.X <i>et al.</i>	2023 agenda for sustainable development	Development needs to work towards the SDGs
19.	Huang and Wey	do not go without criticism as seen by Huang and Wey (2019:), as they, by contrast, state that these principles are not a practical or effective way of implementing GU in cities with its triple-zero framework, as Lehmann had an exceptionally drastic approach to solving the climate crisis within cities. With this statement Huang and Wey (2019:5293) merely suggest that Lehmann (2011:104) is too optimistic in his radical approach and that change as drastic as he suggests could not be sustainable, they	Move away from the triple zero framework Need more practical approach of implementing Gu
20.	Lehmann, S	do not go without criticism as seen by Huang and Wey (2019:5293), as they, by contrast, state that these principles are not a practical or effective way of implementing GU in cities with its triple-zero framework, as Lehmann had an exceptionally drastic approach to solving the climate crisis within cities. With this statement Huang and Wey (2019:5293) merely suggest that Lehmann (2011:104) is too optimistic in his radical approach and that change as drastic as he suggests could not be sustainable, they	GU should be made easier to understand and implement
21.	Qian, H, <i>et al.</i>	on the fact that change is needed within cities and that some of the principles he suggested are a good way of starting to change the way people examine cities as well as how urban planners plan cities	Change in cities is required
22.	Jacobs, N. S	tests the links between nature-based solutions and Green Urbanism GU roofs, rain gardens and urban agriculture contribute to urban biodiversity, which is a form of MF GU, and strengthens the nexus between these concepts	Nature based solutions Urban biodiversity
23.	Lehmann & John	therefore, conclude that these principles could involve using natural elements in particular topography and vegetation to manage temperature, humidity, light, wind, and noise, and therefore, these principles aim to transform cities into more sustainable environments.	Planning principles incorporating nature-based solutions Make cities more liveable
24.	Łobejko, S	Building Compact, Walkable Communities: Green urbanism promotes denser city development with efficient public transportation and pedestrian-friendly infrastructure and reduces reliance on cars, minimises sprawl, and creates vibrant, connected communities	Compact and walkable cities Efficient public transport Pedestrian friendly Less reliance on cars Connected communities
25.	Carter, V. & Henríquez, C	share that the planning approach of GU outlines a framework for creating sustainable cities with the three most crucial principles for urban planners: 1. Designing for the Local Environment: Every city's design should consider its unique climate, existing ecosystems, and neighbourhood layouts. This means maximising biodiversity, using natural elements for temperature and noise control, and incorporating sustainable building practices	Design for local environment Maximising biodiversity Control pollution (air, water, noise)

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26.	Rizzo, A. & Petruccioli, A	However, there have been shortcomings in the implementation of sustainable building design, with a lack of consideration for energy-saving ideas and climate-sensitive design at the urban scale	Need to consider energy consumption Climate sensitive design
27.	Zhao, B. & Sun, T	Overall, the history of green urbanism and green planning reflects the ongoing efforts to create environmentally sustainable and resilient cities. The 21st century's "urban century" is facing unprecedented challenges with climate change and natural disasters. This has driven a global consensus towards green urban development, as evidenced by The concept's (GU) roots could be traced back to the need for environmentally friendly solutions during industrialisation, with ideas related to the vertical "Green City" emerging	Create resilient cities Environmentally friendly cities focus on nature based solutions
28.	Berke, P.R	as stated by Berke (2008: 401), the debate on sustainability has been revived due to the need for creating green cities as a result of climate change, and biodiversity loss.	Biodiversity loss calls for revision of green planning
29.	Guan, H.L	Today, green urban planning focuses on key areas for instance green infrastructure, resilience, low-carbon economies, and sustainable buildings and transportation, reflecting a commitment to long-term ecological health for cities	Green infrastructure Reduce consumption of resources Better transportation Long term ecological health
30.	Beck, U.	This is also supported by Beck (1992) who states that the “new era of uncertainty” is evolving at the same pace as our late technological development and thus the need for sustainable development grows ever bigger	Era of uncertainty calls for change in how we plan cities
31.	Rayan, M. <i>et al.</i>	GU is a philosophy for designing and planning cities that prioritises sustainability and the well-being of both residents and the natural environment (Rayan <i>et al.</i> , 2022: 11844). This approach emphasizes incorporating green infrastructure, for example, parks and gardens, into urban areas. Rayan <i>et al.</i> (2022) continue by stating that these green spaces not only enhance biodiversity and improve air quality but also provide recreational opportunities and assist mitigate climate change. Green urbanism aims for resilient cities that are energy-efficient, have reduced pollution, and offer a high quality of life. This involves adopting eco-friendly practices, such as promoting green energy and sustainable urban landscapes. Importantly, green urbanism emphasizes community participation in the planning process, ensuring that local voices are heard, and city development reflects their needs and perspectives.	Focus on the well-being of both humans and nature Incorporate green into cities Enhances biodiversity Provide recreational space for humans Mitigate climate change Reduce pollution Higher quality of life Emphasise community participation
32.	Koh, S.Y, <i>et al.</i>	GU also reimagines cities as thriving ecosystems (Koh <i>et al.</i> , 2021: 1-27). According to Koh <i>et al</i> (2012), it harnesses the power of green spaces, renewable energy, efficient transportation, and sustainable building design to promotes healthy, environmentally conscious communities. This approach aims to not only minimise the negative environmental impacts of urbanisation but also build resilience for a sustainable and prosperous urban future	Cities should be thriving ecosystems Communities should be environmentally conscious Minimise the impact on the environment

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33.	Nilsson, J.,	delves deeper into the concept of urban greening, outlining its role in managing vegetation across various urban spaces	Manage vegetation in urban space
34.	(Mandal, M, <i>et al.</i>) & (Arellano & Roca)	Green urbanism emerges as a critical approach to cultivating a robust sense of place within cities	Sens of place
35.	Revich,	This literature review explores how the strategic integration of green infrastructure enhances residents' quality of life, promotes community integration, and cultivates a strong human-environment connection. Urban green spaces play a multifaceted role. Research suggests they improve well-being, reduce crime rates, and provide opportunities for relaxation and reflection, ultimately promoting mental vitality	Enhance quality of life Strong connection between human and nature
36.	Keh <i>et al</i> ,	Notably, this emphasis on encouraging a human-environment relationship through green spaces extends beyond aesthetics. Studies have shown that a strong connection to these spaces influences visitors' sense of place, including familiarity, attachment, and a willingness to contribute to their preservation	Sens of place
37.	Perdigones <i>et al</i>	This, in turn, is critical for ensuring the long-term sustainability of urban parks Furthermore, the literature underscores the significance of environmental education programs in cultivating ecological place meaning. By nurturing a connection to the natural world within an urban context, these programs can cultivate pro-environmental behaviours among youth, a crucial step towards a more sustainable future	Need to educate on the importance of nature in cities
38.	Breuste & Sen	Green urbanism promotes the development of mixed-use spaces within cities. This approach strategically integrates green infrastructure with built environments, creating not only aesthetically pleasing landscapes but also sustainable and multifunctional public areas	Mix use in cities
39.	Dehof, <i>et al</i>	Urban green spaces, encompassing parks, forests, and green roofs, demonstrably enhance residents' quality of life	Enhance quality of life
40.	Barbara <i>et al</i>	Beyond aesthetics, these spaces provide essential ecosystem services such as carbon sequestration, water filtration, and air purification, contributing significantly to urban sustainability	Ecosystem services
41.	Grause	Green urbanism emerges as a comprehensive strategy for curbing resource consumption in cities. This approach promotes sustainable practices throughout the urban development lifecycle. One key mechanism involves integrating systems like Eco points, which can incentivise reduced reliance on fossil fuels and non-renewable resources	Resource management Energy consumption
42.	Moloney & Strengers	Green urbanism extends beyond technological solutions. By embracing a social practice approach, it acknowledges the role of policies, regulations, and infrastructure in shaping residents' everyday behaviours	Mix use approach
43.	Premalatha <i>et al</i> , 2013: 661	This focus on social change can significantly address the resource-intensive nature of urban living. Furthermore, green urbanism emphasizes efficient land-use patterns. Implementing green development practices for housing can contribute to the creation of low-carbon eco-cities	Resource management

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		This strategy supports advancements in sustainable construction techniques and industrialisation, promoting energy savings throughout the building process	
44.	Xu <i>et al</i>	Economic models, such as green GDP accounting, provide valuable tools for green urbanism. Economic factors influencing resource use within cities and inform the development of effective regulation	Resource management
45.	Beber <i>et al</i>	The success of green urbanism, an urban planning approach emphasising ecological integration, hinges on a multidisciplinary approach	Multi disciplined
46.	Chen <i>et al</i>	This entails the synergy of diverse fields such as biology, economics, and landscape ecology. Such collaboration promotes the enhancement of urban ecosystem services (ES) and the design of effective green infrastructure (GI). A key aspect of this multidisciplinary approach involves the development of innovative quantitative models for understanding urban ES. These models, when combined with Geographic Information Systems (GIS) datasets for specific regional case studies, offer valuable insights for planners and managers. Furthermore, the cross-disciplinary collaboration allows for the creation of decision-making toolkits based on empirical results, guiding sustainable green urbanism practices	Multi disciplined
47.	Wang <i>et al</i>	This emphasis on collaboration extends beyond the initial planning stages. By characterizing and mapping green infrastructure multifunctionality through the lens of ecosystem services, planners gain a crucial understanding of potential areas for improvement. This knowledge empowers them to develop adaptive models that enhance GI's ability to deliver a multitude of benefits. Ultimately, this multidisciplinary approach contributes significantly to achieving sustainable urban environments and promoting human health	Multi disciplined
48.	Liu <i>et al</i> ; Zhang <i>et al</i> ; Pochodyla <i>et al</i>	Green urbanism emerges as a critical approach to enhancing water management in cities through the strategic integration of nature-based solutions (NBS) and green infrastructure (GI). NBS, encompassing rain gardens, green roofs, vertical greening systems, and permeable pavements, demonstrably contribute to urban water management by mitigating flood risks, retaining rainwater, and increasing permeable surfaces	Water management
49.	Dowtin, H	Similarly, green infrastructure, including green roofs, trees, infiltration trenches, wetlands, and permeable pavements, offers a multifaceted array of benefits. These benefits encompass reducing stormwater runoff, retaining rainwater, preserving the natural water balance, and enhancing local climate resilience	Benefits of Green infrastructure Water management
50.	Sitzenfrei <i>et al</i>	The literature emphasizes the significance of a combined approach utilising both green and grey infrastructure for effective urban water management. This is particularly true in the context of climate change and rapid urbanization, where a balanced and sustainable approach is crucial for addressing water-related challenges in cities	Water management

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51.	Bobylev <i>et al</i> ; Vargas-Hernandez & Zdunek-Wielgolaska,	Green urbanism promotes a paradigm shift within ecological economics by emphasizing the development of urban green infrastructure. This strategic approach leads to a double dividend: increased flow of benefits from ecosystem services and the promotion of green economic growth	Eco economics
52.	Wang & Kumari	The integration of green spaces within cities transcends mere aesthetics. Parks, green roofs, and other green elements demonstrably provide ecological benefits while simultaneously enhancing economic and social well-being, contributing to a more sustainable urban environment	Eco economics Enhance well-being
53.	Andreucc	Urban green infrastructure acts as a bridge between ecological and economic well-being. Parks and green spaces offer multi-functional ecosystem services that contribute to leisure, education, health, resilience-building, and cultural heritage landscapes, reflecting the socio-economic value of cultural ecosystem services	Eco economics Multi-function
54.	Bibri	Furthermore, green urbanism embraces innovative technologies to achieve environmental objectives. The adoption of sustainable energy systems and data-driven smart technologies in eco-cities, such as Stockholm's Royal Seaport, exemplifies how green urbanism can lower energy consumption and advance environmental sustainability	Eco economics Energy consumption management
55.	Dmytryk, N; W,D, Pratiwi <i>et al</i> ; B van Zyl <i>et al</i> ; Y Wang <i>et al</i> ; J Zivcovik <i>et al</i>	Multifunctionality in urban planning refers to the concept of designing and utilising urban spaces in a way that they serve multiple purposes and provide a range of benefits to the community and the environment. It involves the integration of different functions, such as ecological, social, and economic, within a single space or area. The goal is to create sustainable and liveable urban environments that address the complex challenges of modern cities. Multifunctional urban spaces can contribute to the improvement of the urban fabric, enhance ecosystem services, promote sustainable development, and increase human well-being. They can also play a role in the preservation of cultural heritage and the creation of a favourable ecology. The concept of multifunctionality is recognised and applied in various spatial disciplines, including urban planning, landscape architecture, and green infrastructure planning	Cities that serve multiple purposes Benefits community and environment Integrate different functions in a single space Enhance nature and liveability in cities Improves the urban fabric Enhance ecosystem services Increase human well-being
56.	Dmytryk, N; W,D, Pratiwi <i>et al</i> ; B van Zyl <i>et al</i> ; Y Wang <i>et al</i> ; J Zivcovik <i>et al</i>	MF is a critical concept in contemporary urban planning, playing a pivotal role in enhancing sustainability and promoting vital ecosystem services within cities It centres on the creation of spaces that offer a multitude of environmental, social, and economic benefits, cultivating a holistic approach to urban development This concept is particularly crucial for developing and protecting green infrastructure, which serves as a cornerstone	Eco services Spaces with a multitude of uses Promotes green infrastructure Achieves SDG

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		for achieving Sustainable Development Goals (SDGs) and creating liveable urban environments	
57.	Dmytryk, N	Multifunctionality refers to the ability of a complex or facility to serve multiple purposes or functions within a given context. It involves the integration of various functions and activities in a single space or structure	Serves multiple purposes Integrates various functions in a single space
58.	Dmytryk, N; Wang <i>et al</i> ; Pratiwi, W.D, <i>et al</i> .	Multifunctionality in urban planning refers to the integration of diverse functions within urban spaces to enhance sustainability and well-being. This concept emphasizes the delivery of multiple ecosystem services, such as environmental, social, and economic benefits, through green infrastructure planning. By creating adaptable and culturally rich spaces, urban planners can address the complexities of peri-urban areas and contribute to sustainable landscape development. Understanding the different types of multifunctional green infrastructure and their spatial challenges is crucial for effective urban planning. Implementing multifunctional complexes in renovated industrial areas can act as urban development attractors, improving the overall urban fabric and promoting a favourable ecological environment. Ultimately, embracing multifunctionality in urban planning can lead to more liveable environments and contribute to achieving Sustainable Development Goals by 2030	Integrate more functions Enhance well-being More ecosystem services Create more adaptable spaces Understanding the implementation of green infrastructure Implement multifunctional complexes Improve urban fabric Enhance liveability of cities Contributes to SDGs
59.	Dmytryk, N	This necessitates the seamless integration of environmental, social, and economic functions within a single space	Integrate multiple functions into one space Combine environmental, social and economic functions
60.	Wang <i>et al</i>	The paper defines multifunctionality as the ability of green infrastructure to provide multiple ecosystem services and characterizes it based on the ecosystem services perspective examine the concept of MF in green infrastructure (GI) and they define MF as the ability of green infrastructure to provide a variety of ecosystem services that benefit both urban ecosystems and human health. Going beyond a single purpose, Wang <i>et al</i> . (2021: 1953) explores the diverse range of functions and benefits GI could offer as their research utilizes biophysical models and social surveys to map and quantify these ecosystem services	Provide multiple ecosystem services Benefits both ecosystems and humans Goes beyond a single purpose Map and quantify eco services

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		state that Gu thrives on the MF of green infrastructure (GI) and that this strengthens the nexus between these two theories. According to them, these MF spaces provide a multitude of ecosystem services that benefit both urban ecosystems and human health., understanding and improving this MF is crucial for achieving urban sustainability, a core goal of GU (Wang, et.al. 2021; 1955).	Strong nexus between GU and MF Eco services that benefit humans and nature
61.	Wei	Multifunctionality in urban planning refers to the concept of urban green spaces serving multiple functions and providing a range of benefits to the community and the environment. It is a comprehensive approach that recognizes the various roles and contributions of green spaces in urban areas.	Urban green spaces Multiple functions Benefits humans and nature Green spaces need to serve urban areas
62.	Langemeyer, <i>et al</i>	This holistic approach recognizes the diverse roles green spaces can play, encompassing air and water purification, temperature regulation, stormwater management, biodiversity conservation, and recreational opportunities	Resource management Climate control
63.	Kowler	Within the field of urban planning, multifunctionality has emerged as a critical concept guiding the design and utilization of green spaces. It transcends the traditional view of parks as solely recreational areas, instead emphasising their significance to deliver a multitude of benefits (ecosystem services) for both the community and the environment	Utilise green spaces with multiple functions Parks more as recreational areas Benefits humans and nature
64.	Kabisch <i>et al</i>	By emphasizing the interconnectedness and interactions between different functions within green spaces, multifunctionality highlights the importance of considering these relationships during urban planning and design	Assessing connections between different functions Strengthen connections with urban planning
65.	Tzoulas, K, <i>et al</i>	Significantly, multifunctionality is not a novel term but rather a key characteristic underpinning contemporary urban planning concepts (typical GU) for example green infrastructure (GI), ecosystem services (ES), and landscape planning	MF plays a key role in urban planning
66.	Madureira, H. & Andresen, T	The paper discusses the importance of locally-defined visions of green infrastructure that are both 'strategic-based' and 'place-based' It emphasizes the need for a shift from generic assumptions to local assessments in planning for multifunctional spatial infrastructure The study focuses on evaluating local temperature regulation and provision of public green spaces as key functions of urban green infrastructure The results suggest spatial synergies and conflicts between different green infrastructure functions, highlighting the need for tailored spatial policies based on favored functions The method developed in the study informs spatial priority areas for green infrastructure planning by considering the assessment of different functions	GU needs to be defined Implement local assessments in planning/ move away from generic planning Regulate temperatures Provide green spaces Tailored spatial policies

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67.	Shi, W. & Woolley, H.,	The paper emphasizes the importance of landscape management in improving urban environments and enhancing the multifunctionality of green infrastructure It argues that effective landscape management is essential for sustainable development and the well-being of citizens The study in Sheffield provides insights into management planning for sustainable development and offers a framework for sustainability impact assessments in other cities The paper explores how landscape multifunctionality can contribute to sustainable development through effective landscape management It highlights the role of green infrastructure in providing multiple social, economic, and environmental benefits within and between urban areas	Landscape management Multifunctional green infrastructure Effective landscape management Human wellbeing Sustainable impact assessment/ measures success Green infrastructure should benefit multiple areas (social, economic, environmental)
68.	Ricci, L	While MF involves the integration of different functions, for example ecological, social, and economic, within a single urban space	Integration of functions Eco, social, economic, all together
69.	Frantzeskaki, N, <i>et al.</i>	posit that MF revolutionizes urban planning by shifting the focus from single-purpose spaces to unlocking the multifaceted potential of urban areas to deliver a "symphony of benefits"	Move away from single use spaces Symphony of benefits
70.	Monteiro, R, <i>et al.</i>	suggest a "multifunctional toolkit" for urban planners. Green spaces, for instance, deliver a cascade of ecosystem services, including improved air and water quality, natural cooling, and vibrant habitats.	Guid for planners is needed More ecosystem services in one space
71.	Zhang, Y.; Vuscan, S. & Muntean, R; Zhukova, I.V. & Barsukova, N.I	The concept of MF extends beyond environmental benefits, influencing the development of peri-urban areas. Culturally rich and adaptable spaces, as advocated by contribute to the sustainable development of the landscape and the overall MF of urban spaces	Benefits the environment and the city Culturally rich and adaptable
72.	Zhang, Y	MF in urban planning refers to the concept of designing and utilizing urban spaces in a way that they serve multiple purposes and provide a range of benefits to the community and the environment	Urban spaces with multiple functions
73.	Vuscan, S. & Muntean, R	Fathers that it involves the integration of different functions, such as ecological, social, and economic, within a single space or area	Combining ecological, social, and economic in one space
74.	Colglazier, W.	The revitalization of industrial areas with multifunctional complexes, as highlighted by Colglazier (2015), can act as a catalyst for urban development, cultivating a healthier ecological environment and revitalizing the urban fabric (Colglazier, 2015, p. 1048). By embracing MF, urban planners have the potential to create vibrant, livable cities that enhance	Revitalise industrial areas Cultivates healthier ecosystems in cities

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		well-being and contribute to achieving the ambitious goals outlined in the 2030 Sustainable Development Agenda. Zhang	Enhance well-being in cities Helps achieve SDGs
75.	Semeraro, T., <i>et al.</i>	MF urban spaces could contribute to the improvement of the urban fabric, enhance ecosystem services, promote sustainable development, and increase human well-being	Improve urban fabric and enhance ecosystem services Enhance well-being
76.	GUERROUT, C. & MEBARKI, A; Ricci, L	state that there is a multi-stakeholder platform in the decision-making process of planning and thus is furthered by (Ricci. 2022:1161) that the concept of multifunctionality is recognized and applied in various spatial disciplines, including urban planning, landscape architecture, and green infrastructure planning	Multiple stakeholders Combined discipline
77.	Korkou, M. <i>et al.</i>	This mapping identifies areas with high concentrations of services (hotspots) and bundles of services that occur together (Korkou <i>et al.</i> , 2023: 127975). By characterizing different types of green infrastructure and multifunctionality, Korkou <i>et al.</i> (2023; 127975) research proposes an adaptive model to improve its integration into local planning and design practices. Additionally, Korkou <i>et al.</i> (2023;127975) state the proposed five-model approach in the study offers strategies for preserving, restoring, and embedding different levels of MF, further aligning green infrastructure design with the specific needs of a particular area.	Map services in cities Integrate local planning and design with nature Cities should preserve, and restore nature
78.	Dong, J, <i>et al.</i>	Characterising and mapping green infrastructure MF can help assess and improve these spaces (Dong <i>et al.</i> 2022; 2), this information provides valuable insights for urban planners and designers, allowing them to develop integrated solutions that maximize the benefits of green infrastructure	Map green infrastructure to assess and improve Make integrated solutions for cities Maximise benefits of GI
79.	Hansen	By characterising and mapping the diverse functionalities of green infrastructure, planners gain valuable insights to identify areas for improvement and implement targeted solutions that optimise urban sustainability	Cities should implement targeted solutions to help green spaces
80.	Van Zyl <i>et al</i>	Multifunctionality in urban planning emerges as a cornerstone for achieving the Sustainable Development Goals (SDGs)	SDG
81.	Pietsch <i>et al</i> ,	This approach emphasises the strategic integration of various functions within urban spaces, promotes enhanced urban sustainability through the provision of multiple ecosystem services	SDG Eco services
82.	Pranab & Bansal	These services benefit both the environment and human well-being, creating a win-win scenario for cities. Multifunctional urban spaces, by integrating diverse functions across time and space, offer a multitude of advantages	SDG Benefit human and nature
83.	Wang <i>et al</i>	They can generate economic opportunities, support traditional livelihoods, and improve residents' quality of life, all while safeguarding the environment. Urban planners can leverage this understanding to design liveable environments. The development of green infrastructure, coupled with the promotion of ecosystem	SDG Enhance well-being in communities

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		services, empowers planners to create cities that are not only functional but also contribute to the overall well-being of communities and support the broader goals of sustainable development	
84.	Van Zyl <i>et al</i> ; Pranab & Bansal,	A critical aspect of achieving sustainable urban development in line with the SDGs involves comprehending the interconnectedness of various ecosystem services. Implementing strategies that maximize synergies and minimize trade-offs between these services is paramount	SDG Eco services
85.	Dmytryk	Multifunctionality in urban planning is gaining traction as a critical approach to enhancing resource management in cities	Resource management
86.	Wang <i>et al</i> ,	This concept transcends mere aesthetics; it emphasises the strategic integration of various urban elements to deliver a broad spectrum of benefits across environmental, social, and economic domains	Resource management Benefit communities
87.	Dmytryk,; Wang <i>et al</i> ; Wei	Notably, multifunctionality aligns perfectly with the principles of sustainable urban development by encouraging the optimisation of resource utilisation through the integration of ecosystem services. This approach not only maximizes the value extracted from limited resources but also contributes to the resilience and long-term sustainability of urban environments	Resource management
88.	Zivkovic <i>et al</i> ; Specht <i>et al</i> ,	Examples of these services include green infrastructure, urban agriculture, and open spaces By incorporating multifunctional elements into urban design, cities can achieve a multitude of objectives. This includes efficient space utilisation, promoting biodiversity, improving air quality, promoting social interaction, and supporting a range of economic activities	Resource management Enhance well-being
89.	Siehr <i>et al</i> ; Rojas-Botero <i>et al</i>	Multifunctionality in urban planning emerges as a critical strategy for cultivating climate control in cities. This approach emphasises the strategic integration of various nature-based solutions (NBS) and green infrastructure (GI) elements to achieve multiple objectives	Climate control Nature-based solutions
90.	Kemp	Studies highlight the significance of Blue-Green Infrastructure (BGI) in bolstering both climate resilience and urban multifunctionality. BGI offers solutions for addressing a range of challenges associated with climate change, including flooding, drought, and pollution	Climate control
91.	Gabor <i>et al</i> ; Siehr <i>et al</i> ,	Urban green spaces, when designed with ecological principles in mind, can significantly enhance their resilience to climate change. Research on urban grasslands demonstrates the potential of GI to mitigate the effects of climate change	Climate control
92.	Siehr <i>et al</i>	Furthermore, the development of comprehensive guidelines focusing on integrating green and blue infrastructure measures within open spaces can contribute to achieving climate, ecological, and social sustainability. This approach facilitates effective climate change adaptation within urban environments	Climate control
93.	Rojas-Botero <i>et al</i>	By incorporating multifunctional elements into urban planning, cities can pursue a range of co-benefits. These benefits encompass carbon neutrality, enhanced climate resilience,	Climate control

Item	Author	Planning principles deemed inherent to GU and MF	Coded category
		improved air and water quality, and ultimately, a more liveable urban environment	
94.	Zivkovic <i>et al</i> ,	Multifunctionality is gaining significant traction within urban planning, offering a paradigm shift in how spatial practices approach urban space utilisation. This approach transcends mere functionality; it promotes a holistic perspective by considering environmental, social, and economic dimensions	Tailored spatial practice.
95.	Wei	Multifunctionality serves as a framework for comprehensive assessment and management of urban design solutions, ultimately enhancing the overall sustainability of urban areas	Tailored spatial practice.
96.	Hansen	By integrating concepts like green infrastructure and ecosystem services, multifunctionality empowers planners to delve deeper	Tailored spatial practice.
97.	Wang <i>et al</i>	This allows them to understand and optimize the multifaceted benefits that urban spaces can provide, ultimately contributing to the health of both urban ecosystems and city dwellers	Tailored spatial practice.
98.	Wei; Wang <i>et al</i>	Through rigorous analysis of different multifunctional typologies and the development of adaptive design models, urban planners and designers can elevate their spatial planning strategies	Tailored spatial practice.
99.	D'Ambrogi & Guccione	Multifunctionality is emerging as a cornerstone of landscape management in cities. This approach transcends the mere provision of aesthetics; it offers a diverse array of functions and services that contribute significantly to sustainable urban development	Landscape management
100.	Specht <i>et al</i>	Multifunctionality integrates strategic objectives based on area-specific functionalities and long-term sustainability into planning activities across various landscape scales	Landscape management
101.	Specht <i>et al</i>	This holistic approach facilitates the regeneration of neglected territories and the reuse of wastelands, particularly in urban and peri-urban areas. By incorporating the concept of genius loci, the unique spirit of a place, and prioritizing the preservation of biodiversity and natural capital, the implementation of Multifunctional Ecological Networks (MENs) promotes a strategic balance between various needs. This approach ultimately enhances the overall resilience of urban territories	Landscape management
102.	Zivkovic <i>et al</i>	Furthermore, multifunctionality in urban planning serves as a powerful tool for promoting sustainable urban development. By cultivating a wider spectrum of environmental, social, and economic benefits within urban areas, multifunctionality creates a more liveable and sustainable urban environment	Landscape management
103.	Zivkovic <i>et al</i>	Multifunctionality is gaining momentum in urban planning, acting as a catalyst for promoting multidisciplinary approaches within cities. This approach transcends siloed disciplines by integrating various aspects of sustainability and public health	Multidisciplined
104.	Lawrence	The core concept of multifunctionality in urban spaces lies in its ability to deliver a triad of benefits: environmental, social, and economic, ultimately contributing to sustainable urban development. This holistic approach facilitates the creation of public open spaces that promote healthy living environments, aligning	Multidisciplined

Item	Author	Planning principles deemed inherent to GU and MF	<u>Coded category</u>
		perfectly with the principles of "healthy cities" and urban health planning initiatives	
105.	Dmytryk	Furthermore, multifunctionality encourages the formation of multifunctional complexes through renovation projects in industrial areas. This not only enhances the space efficiency but also elevates the ecological quality of urban areas, supporting a favourable urban ecology and promoting sustainable development in the long term	Multidisciplined
106.	Colavitti & Colavitti,	The embrace of multifunctionality naturally leads to a multidisciplinary approach to urban planning. This approach necessitates considering historical, cultural, and functional aspects of the city to create a more comprehensive and inclusive urban design	Multidisciplined
107.	Kim & Reed	Such an approach is crucial for addressing the complex issues and transformations impacting contemporary urban fabrics. Ultimately, by incorporating human-centric design principles that prioritise occupant safety and well-being, urban planning can evolve towards a truly interdisciplinary model. This model integrates social science research with architectural and engineering disciplines to ensure optimal functionality and well-being within urban environments	Multidisciplined

ANNEXURES B: GU CODES

Benefits Human and nature	Resource management	Restore ecosystems	Sense of place	Mix use	Integration of nature (environmentally friendly)	Educate planners	Green jobs	Energy consumption	Multi-disciplined	Reduces urbanisation	Green infrastructure	Improved quality of life	Helps environmental challenges (SDGs)	Water management	Eco economies	Move away from traditional planning	Better connections (transport, walk etc)
1.	1.	2	2	2	2	3	3	5	6	6	7	7	8	9	9	13	23
2.	2	7	3	12	4	8	30	9	7	9	9	8	9	38 A	39A	14	28
4	3	17	23	23	5	10		24	30	12	10	9	17	B	B	15	
8	5	18	24	30	6	11		25	37A	19	15	20	18	C	C	18	
9	9	20	34 A	35 A	7	13		36 A	B	23	16	22	21	D	D	20	
15	13	21	B	B	8	14		B	C	24	20	23	22	E	E	22	
18	17	22	C	C	10	18		C		30	22	24	24			26	
23	18	24	D	D	13	19		D			24	26	25			29	
24	21	25	E		14	22					25	28	26				
25	22	26			15	27					26	30	28				
26	24	27			16	29					28	31	30				
28	25	30			17						30		31				
30	28	31			18						31		33				
31	30	32			21						32						
	31				22												
					24												
					25												
					26												
					28												
					30												

	Benefits Human and nature
	Resource management
	Restore ecosystems
	Sense of place
	Mix use
32	Integration of nature (environmentally friendly)
	Educate planners
	Green jobs
	Energy consumption
	Multi-disciplined
	Reduces urbanisation
	Green infrastructure
	Improved quality of life
	Helps environmental challenges (SDGs)
	Water management
	Eco economies
	Move away from traditional planning
	Better connections (transport, walk etc)

ANNEXURES C: MF CODE

Cities with multiple purposes	Benefits human and nature	One space multiple function	Quality of life	Incorporate nature	Ecosystem services	Human well-being	Green infrastructure	SDGs	Adaptable spaces	Multifunctional complex	Enhance urban fabric	Combine environmental, social, and economic	Map and Quantify	Urban Green spaces	Resource management	Climate control	Incorporate with urban planning (train planners)	Move away from traditional planning	Tailored spatial policies	Landscape management	Multi-disciplined
1	1	1	1	1	1	1	1	1	3	3	1	4	5	6	7	7	9	11	11	12	21
2	5	2	3	8	3	3	3	3	16	8	3	6	9	8	19	11	10	14	18	19	
5	6	3	6	11	4	8	6	19	18	12	15	12	11	11	20	19	11	15	23		
8	7	4	7	12	5	12	9		19	13	17	13	12	12		20	15	24	24		
9	8	6	14	15	6	19	11		22	17	18	21	22	15			18				
12	14	8	20	19	7	20	12		23		19		23	19			22				
13	16	9		20	10		22		24		20			22			23				
14	19	12		22	11		23				22			24			24				
15	20	13		23	15		24				24										
17	22	14		24	19																
18	23	15			20																
22		17																			
		18																			