Spatial dynamics and morphological relations in the emergence of urban forms in Dire Dawa.

By Samuel Asfaw Zelelew

A Dissertation Submitted to the Chair of Urban and Regional Planning, Ethiopian Institute of Architecture, Building Construction and City Development (EiABC), Addis Ababa University, presented in Fulfilment of the Requirements for the Degree of Doctor of Philosophy in Urban and Regional Planning

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Approval and Signature Sheet

Addis Ababa University

School of Graduate Studies

This is to certify that the dissertation titled “Spatial dynamics and morphological relations in the emergence of urban forms in Dire Dawa” prepared by Samuel Asfaw Zelelew has been submitted in fulfilment of the requirements for the Degree of Doctor of Philosophy (Urban and Regional Planning). The dissertation complies with the regulations of the University and meets the accepted standards in terms of originality and quality.

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Dedication

This dissertation is dedicated to my father, Ato Asfaw Zelelew, who laid the foundation for my growth and development in all aspects of life. Although he is no longer with us to see his aspirations and dreams for me come to fruition, his influence and guidance remain a constant source of inspiration and direction for me.

Statement of Author

I, Samuel Asfaw, solemnly declare that this dissertation titled " **Spatial dynamics and morphological relations in the emergence of urban forms in Dire Dawa** " represents my own work. It has not been submitted to any other institution or university for the award of any degree, diploma, or certificate. All the information and ideas expressed in this manuscript have been sourced and duly acknowledged.

Name: Samuel Asfaw Zelelew

Signed: _____

Date of Submission: /09/2024

This Ph.D. dissertation has been submitted for examination with my approval as University Advisor.

Advisor‘s Name: Dr.-Ing. Zegeye Cherenet Mamo

Signature: _____

Date: /09/2024

DISSERTATION ORGANIZATION AND LIST OF PUBLISHED PAPERS

This dissertation is structured in accordance with the article/paper compilation based dissertation style based on the dissertation guidelines of Addis Ababa University, AAU (2021) and is organized around the following four papers.

Paper 1: Zelelew, S. A. & Mamo, Z. C. (2023). Use-mix intensity and open-space ratio for sustainable urban form: the case of Dire Dawa, Ethiopia. Proceedings of the Institution of Civil Engineers-Urban Design and Planning, 176(1), 35-46. https://doi.org/10.1680/jurdp.22.00014 (Published)

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LIST OF ACRONYMS AND ABBREVIATIONS

AAU	Addis Ababa University
AD	Anno Domini
ArcGIS	A geographic information system (GIS) software suite developed by Esri (Environmental Systems Research Institute)
BAR	Building Area Ratio
DOI	Digital Object Identifier
ECL	Emerging City Lab
EFDRE	Federal Democratic Republic of Ethiopia
EiABC	Ethiopian Institute of Architecture Building Construction and City Development
EOTC	Ethiopian Orthodox Tewahido Church
FAR	Floor Area Ratio
FGD	Focus Group Discussion
FPI	Formal Planning Intervention
FSI	Floor Space Index
GIS	Geographic Information System
GSI	Ground Space Index
IBM	International Business Machines Corporation
L	Average Height of Buildings
MXI	Mixed Use Index
OLR	Ordered logistic regression

OSR	Open Space Ratio
PhD	Doctor of Philosophy
SD	Spontaneous Development
SPSS	Statistical Package for the Social Sciences
St.	Saint
SUF	Sustainable Urban Form
UF	Urban Form
UN-Habitat	United Nations Human Settlement Program
US	United States

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Spatial dynamics and morphological relations in the emergence of urban forms in Dire Dawa

ABSTRACT

This dissertation delves into the morphogenesis of Ethiopian cities, focusing on Dire Dawa. Leveraging Conzen's morphological evolutionary technique, the study conducts a meticulous physical examination of Dire Dawa's morphology, augmented by maps and detailed interviews to reconstruct its early spatial organization. Exploring the sustainability of land-use transformations, the research scrutinizes consequences of formal and organic planning interventions. Analyzing land-use mix and open space ratio across six cases from three morphological periods, a declining trend in mixed-land use intensity is observed, particularly at the plot scale. Moreover, a shift from the historic core to the periphery correlates with reduced mixed-land use intensity at the neighborhood level, emphasizing challenges in maintaining sustainable urban form. To address this, integration of principles from organic development and formal planning is advocated, emphasizing the importance of balanced mix of uses. Furthermore, the study investigates spatial transformation events and emergent urban forms in Dire Dawa, examining interplay between formal planning intervention and spontaneous developments. Utilizing Spacematrix software, the research identifies dominance of point-type low-rise developments in organically developed areas, contrasting with prevalence of block-type low-rise and mid-rise forms in plan-driven developments. Rising trends in floor space index and spatial coverage patterns indicate growing concern for space efficiency and sustainable development, particularly in outlying areas. However, density of street network in organically developed portions surpasses formally planned areas, highlighting relevance of organic development concepts. Lastly, the dissertation examines correlation between street width and land use patterns, elucidating impact of street hierarchy on land use intensity across different developmental periods. Utilizing mixed-methods case study design, four land use categories are identified and their relationship with street width evaluated. Findings underscore variability of this connection based on morphological periods and urban planning interventions, advocating for well-designed land use policies accommodating both formal and informal developments.

Keywords: *Morphological evolution, Urban morphology, Sustainability, Land-use transformation, Spatial dynamics, Street hierarchy, Dire Dawa, Ethiopia*.

CHAPTER ONE

1. GENERAL INTRODUCTION

This dissertation, organized as a collection of articles, explores the dynamic urban landscape of Dire Dawa, Ethiopia, undergoing rapid transformation. The primary objective is to understand this evolution and guide future development toward a sustainable urban form (SUF). This introductory chapter sets the stage for examining Dire Dawa's urban morphogenesis, the process through which its urban form has developed.

Beginning with a detailed statement of the problem, this chapter identifies specific challenges and knowledge gaps related to Dire Dawa's urban form, followed by research questions addressing the central inquiry: How do spatial arrangements and historical development patterns shape the creation of a sustainable urban form? These questions guide the exploration of the city's spatial dynamics, the role of street hierarchies, and factors influencing SUF.

The chapter outlines the study's general and specific objectives, emphasizing the importance of this research for urban planning and sustainable development in Dire Dawa and beyond. It concludes with a clear definition of the study's scope, detailing geographical and thematic boundaries while acknowledging limitations. An overview of the dissertation's structure is presented, outlining sections covering the background and justification, literature review, delimitations and scope, significance, limitations, and ethical considerations of the research.

This structured approach ensures a focused investigation into the complex relationship between Dire Dawa's spatial arrangements, historical development patterns, and its potential for achieving a sustainable urban future.

1.1 Background and Justification

In recent decades, urbanization has surged worldwide, with developing countries experiencing particularly notable growth. Projections suggest that by 2050, urban areas will host over 66% of the global population (X. Li et al., 2019). This trend has become pervasive and unstoppable, gaining significant traction in the developing world and showing no signs of slowing (Chen et al., 2021; Nia, 2021). Ethiopia, like many other

developing nations, is undergoing rapid urban expansion and development (Ayele & Tarekegn, 2020; Farrell, 2017; Mekuria, 2018).

Urban morphological transformations are a key feature of urbanization, especially in cities of the Global South like Ethiopia. The rate of urban morphogenesis is closely tied to urbanization, with developed countries experiencing relatively stable urban forms, while cities in the Global South continue to undergo significant changes, reflecting ongoing growth (Dede et al., 2022; Hu et al., 2020; Kamalipour & Iranmanesh, 2021). These transformations affect land use, economic shifts, street patterns, settlement growth, and the urban microenvironment. For example, street pattern typologies highlight how a city's character can be seen through its neighborhoods' distinct features (Louf & Barthelemy, 2014). Additionally, the morphogenesis of new settlements has been studied to map building changes and the effects of urban sprawl on development (Dede et al., 2022; Kamalipour & Iranmanesh, 2021).

Urban morphology examines physical, economic, and social urban aspects. The Conzonian school of thought identifies three core elements: the town plan (site, streets, plots, and blocks), building fabric (three-dimensional form), and land/building use (Conzen, 1960). This approach is crucial for understanding urban structures and their functions (Bechtel et al., 2015). Integrating morphological analysis with urban planning can enhance placemaking strategies (Ni'mah & Priyoga, 2022), while the concept of urban morphogenesis provides insights into the dynamic evolution of cities (Venerandi et al., 2017). Urban morphology also investigates the origins and development of urban forms (Eckardt & AlSadaty, 2023).

Historically, studies of urban form have predominantly relied on qualitative attributes, gradually transitioning towards qualitative analysis. Over the past century, urban morphologists have pioneered more effective techniques for investigating and elucidating the physical shape of urban landscapes, commonly referred to as the townscape or urban landscape. Among these techniques, the morphogenetic approach has garnered considerable attention, particularly among scholars influenced by the works of geographer M.R.G. Conzen (Birkhamshaw & Whitehand, 2012). This method involves examining the historical and geographical evolution of urban landscapes to understand their development patterns.

However, recent advancements have introduced quantitative tools for studying urban forms, expanding the analytical toolkit available to researchers. These tools include the space matrix, agent-based modeling, space syntax, fractal analysis, mixed-use index (MXI), and others. The incorporation of quantitative methods alongside qualitative approaches offers a more comprehensive understanding of urban morphology.

Furthermore, beyond the limited studies conducted in the area from a global south perspective, the morphogenesis of urban areas varies significantly based on factors such as history, culture, and economy. This diversity is particularly pronounced in Ethiopia, where the urbanization scenario boasts its own distinctive characteristics and dimensions. Dating back to the early first century AD, Ethiopia's urbanization trajectory diverges from that of many other world civilizations, as sedentary lifestyles had not yet taken root in most areas (Kabiso et al., 2022; Z. C. Mamo, 2015; Zewde, 2000).

Ethiopia's unique history and geography have shaped its urban morphogenesis, with cities typically developing on hilltops rather than near water bodies, and experiencing minimal colonization influence (Appelhans, 2016; Z. C. Mamo, 2015). This distinct pattern highlights the need to explore the factors influencing urban forms in Ethiopia. Additionally, the absence of a national urban land use policy to regulate land in urban areas further emphasizes the importance of such studies.

Dire Dawa was chosen as a case study due to its significance as Ethiopia’s second-largest city (Worldometer, 2022b) and its rapid growth in both formal and informal settlements. Positioned on the eastern edge of the country along the Ethio-Djibouti railway, it is shaped by unique environmental, cultural, and historical influences. As a key transportation hub and economic center with a diverse population, Dire Dawa's urban transformation, strategic location, and socio-economic importance make it an ideal site for studying urban morphology in Ethiopia.

Urban areas in developing countries often exhibit distinct morphological characteristics due to the interplay of formal planning interventions and spontaneous development. The rapid increase in urban land area, as observed globally Seto et al. (2011), is often accompanied by anarchic and spontaneous development. This SD results in irregular, informal, and illegal settlements (McCartney & Krishnamurthy, 2018), where infrastructure and housing conditions are hardly adequate (Huong & Kieu, 2021).

Furthermore, the legalization of informal settlements and urban transformation has led to an increase in formal developments and activities in these areas (Sadikoglu Asan & Ozsoy, 2018). Infilling, edge-expansion, and spontaneous growth are common forms of urban expansion, with the latter signifying the formation of new urban areas without direct spatial connection to existing ones (Liu et al., 2014).

The urbanization process in developing countries is dynamic, with high rates of urbanization leading to fast and spontaneous physical development in urban peripheries, significantly altering peri-urban morphology (Amoateng et al., 2013). Additionally, the role of planners in facilitating urban social functions through planned physical interventions is crucial, especially in assessing the effects of development on urban residents (Misra & Monnai, 2013).

Thus, the urban morphology of developing countries reflects a complex interplay between formal planning interventions (FPI) and spontaneous development (SD), leading to distinct urban characteristics. The rapid and dynamic nature of urbanization in these regions necessitates a holistic approach that considers economic, social, and environmental factors to ensure sustainable urban development.

Having been established in 1902, Dire Dawa boasts a developmental history spanning over a century, marking its existence for 120 years (Gebreyesus, 2019). Throughout this period, it has likely undergone various developmental trajectories. Assessing the morphological evolution of a city over different epochs requires a comprehensive examination of the spatial and environmental impacts of its growth. Urban morphology, which encompasses the physical structure and spatial organization of cities, is heavily influenced by factors such as governance periods (Damte, 1993) and ecological footprints (Ke et al., 2022). These factors are instrumental in deciphering the spatial morphological imprint left by different stages of the city's development. Moreover, the spatial distribution of street patterns, plot sizes, and building types plays a pivotal role in shaping urban form (Berghauser Pont, Stavroulaki, & Marcus, 2019). Understanding the historical processes that have shaped the urban morphology of traditional cities is of paramount importance for policymakers and urban planners (Barau et al., 2015).

Additionally, the study of urban morphology extends beyond contemporary cities to include historical urban contexts. The morphological legacy of different developmental

eras is evident in the urban fabric, characterized by building footprints and open spaces (Hamaina et al., 2012). Furthermore, the spatial and physical characterization of urban areas, including neighborhoods and institutional structures, provides methodologies for quantification and classification, which are crucial for understanding the morphological impact of various developmental periods (Serra et al., 2018).

Therefore, assessing the morphological imprint of different developmental epochs of a city requires a holistic understanding of multiple factors, including carbon emissions, ecological footprints, innovation efficiency, and urban typologies. These elements collectively contribute to the spatial and environmental consequences of urban development, shaping the physical structure and spatial arrangement of cities over time.

This thesis examines the early morphological development of Dire Dawa, focusing on its urban morphogenesis through various developmental stages and planning interventions, with an emphasis on physical urban form. While the economic and social dimensions are equally important, they are not included due to the challenges of integrating these factors, which demand more diverse data, time, and financial resources.

Additionally, the study's focus on Dire Dawa limits the generalizability of its findings. These limitations highlight the need for further research to explore the broader aspects of urban morphology and expand the geographical scope for more comprehensive insights.

1.2 Statement of the Problem

Dire Dawa, Ethiopia, has experienced rapid urbanization, leading to significant transformations in its urban landscape. While this growth brings economic opportunities and a more vibrant city life, it also poses substantial challenges in achieving a sustainable urban form (SUF). The rapid expansion has outpaced the city's ability to plan and manage its development effectively, resulting in a fragmented urban form that lacks coherence and sustainability. Furthermore, the city's periphery is becoming increasingly infested by informal developments, while denser development patterns are evolving within the city, necessitating a thorough assessment of its sustainable urban form.

Existing research on Dire Dawa's urban morphology offers limited insight into the intricate relationships between various urban elements that have driven the city's morphogenesis. Critical questions remain unanswered, such as: How have land-use patterns and the allocation of open spaces influenced the city's development? What impact have different physical densities had on the evolving urban form? How do historical planning interventions, both planned and organic, influence the current relationship between street hierarchies and specific land-use functions at the plot level?

Addressing these knowledge gaps is crucial for guiding Dire Dawa towards a sustainable urban future. Understanding the spatial dynamics underlying the city's urban form will provide valuable insights for policymakers and urban planners. Such knowledge is essential for formulating strategies that promote sustainable growth, improve public health, protect the environment, utilize resources efficiently, and ensure equitable access to services and opportunities for all residents.

A well-planned city must embrace SUF principles, including proper open space ratios, compact and mixed-use development, and human-scale developments. By incorporating these principles, Dire Dawa can enhance its urban livability and resilience. This research aims to shed light on the complex interplay between spatial arrangements and morphological elements in Dire Dawa. By delving into the city's historical development and analyzing the impact of land-use patterns, open space allocation, physical densities, street hierarchies, and planning interventions, this study will provide a comprehensive understanding of Dire Dawa's urban form. The findings will offer a roadmap for achieving a more sustainable and resilient urban future, ensuring that Dire Dawa can grow in a way that benefits all its inhabitants while preserving its unique character and heritage.

1.3 Objectives

The objectives of the study provide a roadmap for the exploration ahead. The general objective outlines the study’s overarching aim, while specific objectives dissect the study into manageable components, focusing on key aspects of urban morphogenesis in Dire Dawa.

The significance of any research endeavor lies in its overarching objectives, which guide the investigation towards a purposeful and structured outcome. In the pursuit of

knowledge and understanding, researchers establish a framework to direct their efforts effectively. This section will delve into the primary aim of the research, unraveling the broader intentions that drive the inquiry. The subsequent subtopics will further expound upon the research's general objective, presenting a comprehensive view of the study's overall purpose, and the specific objectives, delineating the precise goals and milestones that contribute to the overarching mission. Together, these elements lay the groundwork for a focused and purpose-driven exploration, enriching the scholarly landscape with valuable insights and findings.

1.3.1 General Objective

To comprehensively investigate the spatial dynamics underlying the emergence of urban forms in the context of Dire Dawa, Ethiopia, and to analyze the intricate relationships among morphological elements during the city's morphogenesis toward a sustainable urban form.

1.3.2 Specific Objectives

1. To investigate the spatial transformation pattern of use-mix intensity and open space ratio in the morphogenesis of Dire Dawa City and examining its influence on the development of a sustainable urban form (SUF).

2. To conduct an analysis of the emerging urban forms in the urban transformation of Dire Dawa City by examining their physical density attributes, considering diverse planning interventions, including both planned and organic approaches, throughout its historical development.

3. To analyze the relationship between Street Hierarchy and Land Use Functions at the plot level in Dire Dawa, considering different developmental periods and planning interventions.

1.4 Research Questions

The dynamic city of Dire Dawa, Ethiopia, undergoes rapid transformation. Understanding this evolution and guiding its future development necessitates a well-defined research question. This question serves as a compass, directing the investigation towards a deeper understanding of Dire Dawa's morphological history and its potential for sustainable growth. The central question guiding this research is: How

do the spatial arrangements and historical development patterns of Dire Dawa, Ethiopia, influence the creation of a sustainable urban form (SUF)?

By posing a series of targeted questions that dissect this central inquiry, the research aims to illuminate the intricate relationships between various urban elements. These specific questions will be explored in subsequent sections, dissecting the city's morphological evolution and ultimately providing a roadmap for a more sustainable future for Dire Dawa.

Research Questions:

1. What are the spatial transformation patterns in the morphogenesis of Dire Dawa city, and how do these factors influence the development of a sustainable urban form?

2. How do the physical density attributes of emerging urban forms in the urban transformation of Dire Dawa city differ, considering different planning interventions (both planned and organic) throughout its historical development?

3. How does street hierarchy influence land use patterns at the plot level in Dire Dawa, Ethiopia, considering various planning interventions and the developmental age of the areas?

1.5 Delimitation and Scope of the Study

Every study operates within defined boundaries. This section delineates the scope of our research, identifying the geographical, thematic, and temporal limits within which our exploration of Dire Dawa's urban morphogenesis unfolds.

Spatial Scope:

The study will focus on Dire Dawa, a city located in eastern Ethiopia, examining its urban morphology, spatial organization, and development patterns. Specifically, the spatial scope will encompass the entire urban area of Dire Dawa, including its formal and informal settlements, major landmarks, transportation networks, and open spaces.

Thematic Scope:

The thematic scope of the study will include various aspects of urban morphology, sustainable development, and urban planning interventions. Key thematic areas to be explored include:

- ✓ **Urban Form (UF)**: Analysing the physical structure and layout of Dire Dawa, including land use patterns, building density, street hierarchy, and public spaces.
- ✓ **Sustainable Urban Form (SUF)**: Investigating how urban form influences sustainability outcomes in Dire Dawa, including environmental impact, and social equity perspectives.
- ✓ **Planning Interventions**: Examining the role of formal planning intervention (FPI) and spontaneous development (SD) in shaping Dire Dawa's urban form and sustainable development trajectory.

Temporal Scope:

The study will adopt a temporal scope that spans multiple time periods to capture the historical evolution and contemporary dynamics of Dire Dawa. Key temporal phases to be considered include:

- ✓ Early Morphogenesis: Exploring the initial establishment and growth of Dire Dawa as a trading post and transportation hub from 1902 till 1941.
- ✓ Intermediate Periods: Examining significant periods of urban development and transformation in Dire Dawa, including colonial influences, post-independence initiatives, and recent urbanization trends from 1942 till 1991.
- ✓ Contemporary Context: Analysing the current state of Dire Dawa's urban form and its implications for sustainable development, considering present-day challenges and opportunities since 1992.

Generally, the scope of the study on Dire Dawa encompasses a comprehensive analysis of its spatial, thematic, and temporal dimensions, aiming to provide valuable insights for urban planners, policymakers, and stakeholders involved in shaping the city's future development.

1.6 Significance of the Study

This section underscores the broader implications of our research, emphasizing the relevance of the assessment of the morphogenesis of Dire Dawa for urban planning,

sustainable development, and the harmonious coexistence of historical legacy and contemporary progress in the city.

By comprehensively investigating the spatial dynamics of Dire Dawa, this research has the potential to make significant contributions in several areas:

- ✓ Urban planning and policy: Inform sustainable and inclusive development strategies that respect the city's historical character and respond to the needs of its diverse population.
- ✓ Urban design: Promote sensitive interventions that enhance the city's livability, public spaces, and connectivity.
- ✓ Urban history and geography: Deepen our understanding of the complex factors shaping African cities and the role of morphological elements in urban development.
- ✓ Another important aspect of this study is to empirically analyze relevant theories, thereby making a scholarly contribution through testing and examination.

By delving into the fascinating history of Dire Dawa's urban form, this research helped to advance the existing knowledge of African cities and contribute to their transformation into more sustainable, resilient, and vibrant spaces for all.

1.7 Limitations of the Study

Research, by its nature, is constrained. Acknowledging these limitations transparently, this section outlines the potential challenges and constraints that may influence the scope and depth of our findings.

Limitations of the study arise from various aspects that may influence the scope and depth of the findings. Firstly, the research primarily focuses on the physical aspect of urban form, overlooking the social and economic dimensions. While this approach provides valuable insights into the spatial structure of Dire Dawa, it may overlook important factors shaping urban life and development. Future research could explore the interplay between physical form and socio-economic dynamics to provide a more holistic understanding of urban morphology.

Secondly, the study relies heavily on old maps and historical information for the early and intermediate morphogenesis periods. While these sources offer valuable historical

context, they may be incomplete or inaccurate, leading to potential data gaps or errors. To mitigate this limitation, the researchers conducted focus group discussions (FGDs) and conducted an exhaustive review of earlier documents and maps. However, despite these efforts, the possibility of error in the data remains, highlighting the need for caution in interpreting the findings.

Additionally, the constraints of time and resources posed challenges in conducting a comprehensive analysis of all aspects of urban morphology. Due to these limitations, the study prioritized the physical form aspect, deferring the examination of social and economic dimensions to future research. While this approach allowed for a detailed exploration of spatial patterns and transformations, it may limit the generalizability of the findings and overlook important nuances in the urban fabric.

Therefore, while this study offers valuable insights into Dire Dawa's urban morphology, it is important to recognize its limitations. Addressing these limitations requires a multidisciplinary approach that integrates physical, social, and economic perspectives, as well as continued efforts to validate and refine the data sources and analytical methods used. By acknowledging and addressing these constraints, future research can build upon the findings of this study and contribute to a more comprehensive understanding of urban morphology in Ethiopian cities.

1.8 Ethical Considerations

In conducting the research on Spatial dynamics and morphological relations in the emergence of urban forms in Dire Dawa, several ethical considerations were paramount to ensure the integrity, fairness, and respect for all involved parties. The following ethical considerations have been adhered to throughout the dissertation process.

Informed consent:

When conducting interviews, surveys, or collecting any form of data from human participants, informed consent was obtained. Participants were informed about the purpose of the study, the nature of their involvement, and how the data would be used. Anonymity and confidentiality were assured to all participants, and they were informed of their right to withdraw from the study at any point without any repercussions.

Data integrity and authenticity:

All data collected and presented in the dissertation was done so honestly and accurately. Efforts were made to ensure that the data sources were reliable and credible. Any manipulation or misrepresentation of data was strictly avoided to maintain the integrity and authenticity of the research findings.

Cultural sensitivity:

Given the cultural context of Dire Dawa, cultural sensitivity was maintained throughout the research process. Local customs, traditions, and norms were respected and considered in the interpretation and presentation of the research findings. Collaboration and consultation with local stakeholders and community members were sought to ensure that the research was conducted in a culturally appropriate manner.

Transparency and accountability:

The research methods, procedures, and findings were presented transparently and accurately in the dissertation. Feedback and peer reviews were welcomed to ensure accountability and to enhance the quality and credibility of the research.

Beneficence and non-maleficence:

The research aimed to benefit the community of Dire Dawa by providing valuable insights and recommendations for sustainable urban development. Potential harms and risks to participants or the community were minimized and mitigated to ensure non-maleficence.

Respect for intellectual property:

Proper acknowledgment and citation were given to all sources, references, and intellectual contributions that informed the research and its findings. Plagiarism and unauthorized use of others' work were avoided, and all intellectual property rights were respected.

Environmental responsibility:

In the context of researching sustainable urban form (SUF), environmental responsibility was maintained by promoting and advocating for environmentally friendly and sustainable urban development practices. Efforts were made to minimize

any negative environmental impacts associated with the research activities and dissemination of findings.

Therefore, these considerations ensured that the research was conducted with integrity, fairness, and respect for all involved parties, contributing to the validity, credibility, and positive impact of the dissertation.

1.9 Literature Review

The literature review in this dissertation offers a comprehensive exploration of urbanization and urban form, particularly focusing on Ethiopian cities. It begins with the foundations of urbanization and proceeds to a historical development of urban morphology and a theoretical literature review covering historical development of urban morphology, definitions, theories, and the evolution of urban morphology. The empirical literature review examines factors shaping Ethiopian urbanization, urban morphological traditions, and the validation of various urban form theories. This includes insights from sustainable urban form (SUF) related theories and specific street connectivity and classification theories. Lastly, a theoretical and conceptual framework is presented, linking urban form elements to sustainable development.

1.9.1 Foundations of Urbanization

Urbanization is a multifaceted phenomenon with intricate dimensions, encompassing social, economic, and spatial dynamics (Fu et al., 2019). The term "urban" originates from the Latin word "urbs," signifying a space for settlement, and cities are recognized as vital social structures propelling economic expansion (Angelo & Wachsmuth, 2015). Mumford's work rejects a static city definition, acknowledging its diverse manifestations and transformations, further elucidating the link between urban and rural distinctions to the concept of self-sufficiency (Mumford, 1961; Wong & Brown, 2009). Urbanization extends beyond physical transformation to impact residents' livelihoods, and the United Nations' categorization adds depth to comprehending urban areas (Fu et al., 2019). The definition of urban areas undergoes significant variations globally, with countries employing distinct population thresholds, administrative criteria, and economic characteristics (Fu et al., 2019).

Urbanization, a phenomenon of intricate dimensions, resists a singular definition, evolving through the intricate interplay of social, economic, and spatial dynamics. This

exploration delves into the global facets of urbanization, extending from overarching perspectives to specific viewpoints in Africa and Ethiopia.

Urbanization extends beyond physical transformation to impact residents' livelihoods (Qin & Zhang, 2014). The United Nations' categorization, relying on quantitative indicators like population size, adds depth to comprehending urban areas (Qin & Zhang, 2014). Urbanity, acknowledged as a social construct, intricately intertwines with the spatial form of urban centres (Ye, 2015). Jane Jacobs emphasizes the organized complexity of cities, Kropf views them as neither modest nor chaotic, and Lefebvare distinguishes between urban and city, associating the former with physical elements and the latter with immaterial life within the city (Jacobs, 1961; Kropf, 2014).

Globally, the definition of urban areas undergoes significant variations, with countries employing distinct population thresholds, administrative criteria, and economic characteristics (Potts, 2017). China's nuanced understanding, associating 'urban' with non-agricultural work, exemplifies the diversity in global perspectives (Potts, 2017). Beyond population thresholds, administrative status, and density, the definition of urban areas includes economic characteristics, albeit with varying emphases globally (Potts, 2017).

Africa's determination of urban centres varies, relying on disparate population thresholds and administrative factors, contributing to a potentially inflated perception of urbanization. The lack of uniformity in definitions poses challenges for accurate international comparisons (Potts, 2017). Ethiopian urbanization mirrors demographic shifts, economic changes, socio-cultural organization, spatial configurations, and political structures (Z. C. Mamo, 2015). The city, in its historical context, embodies distinct socio-cultural characteristics (Ünlü, 2019).

Morphologically, urban centres emerge as complex entities shaped by ever-changing forms through processes of accumulation, adaptation, and replacement (V. Oliveira, 2016; Ünlü, 2019). Urban environments, viewed as highly complex systems, result from the interactions of various social, economic, and physical elements (Penn & Turner, 2003).

Challenges to generalizations about African urbanization arise in Ethiopia, which, unlike many African nations, was not colonized (Z. C. Mamo, 2015). Ethiopia's long-

standing urban environment, primarily cantered in the highlands, poses challenges to conventional definitions of African urbanization (Z. C. Mamo, 2015). While the Ethiopian government defines an "Urban Centre" based on population size and engagement in non-agricultural activities, (FDRE, 2008), there is still a need for a comprehensive study on Ethiopia's urban phenomena (Antonsich, 2000; Ehrlich, 2018).

In conclusion, this comprehensive exploration of urbanization traverses global, African, and Ethiopian perspectives, unveiling the intricate nature of this multifaceted phenomenon. Urbanization's dynamic nature demands nuanced definitions that consider socio-cultural, economic, and morphological dynamics. Understanding these complexities is crucial for effective urban planning and development in diverse contexts.

1.9.2 Theoretical Literature Review

Theoretical literature review provides an overview of existing theoretical frameworks, concepts, models, and hypotheses relevant to the research topic. It establishes the theoretical foundation upon which the research is built. Theoretical reviews synthesize and analyse existing literature to develop a theoretical framework that guides the research questions, hypotheses, and methodology (Creswell & Creswell, 2018). The theoretical literature review of this study encompasses concepts and theories of urban morphogenesis and morphological transformation of urban areas. For these purposes different relevant theories have been explored.

1.9.2.1 Definition and Concepts of Urban Morphogenesis and Morphological Transformation of Cities

Urban morphogenesis and the morphological transformation of cities represent fundamental concepts in urban studies, elucidating the dynamic processes by which cities develop, evolve, and adapt over time. In this section, the research delves into the definitions and concepts underpinning these crucial aspects of urban development. By comprehensively understanding these concepts, contributes to gain valuable insights into the complex dynamics driving urban growth and change, laying a solid foundation for exploring their implications on contemporary urban environments.

Urban morphogenesis refers to the study of the processes and mechanisms that lead to the formation and transformation of urban forms and structures over time (AlSadaty,

2022). It encompasses the evolution of urban networks, urban sprawl, and the interplay of socio-economic interactions in shaping the physical and functional aspects of cities (Louf & Barthelemy, 2014). It involves tracing the historical roots of spatial and functional structures to understand the transformation processes of urban contexture (Navastara, 2017). Furthermore, urban morphogenesis addresses the tangible outcomes of social and economic forces, reflecting the intentions and ideas that shape the city (Kamalipour & Zaroudi, 2014).

Similarly, the study of urban morphogenesis involves identifying repeating patterns in the structure, formation, and transformation of the built environment to comprehend how elements work together to meet human needs and accommodate human culture (Coşkun & Kubat, 2022). It also contributes to understanding the processes of urban transformation, from the geometric city to the modern metropolis, by utilizing urban morphology as an explanatory tool (Al-Saffar, 2018). Additionally, urban morphogenesis models capture interactions between networks and territories, aiming to understand underlying dynamical processes and to be applied in urban planning (Raimbault, 2019).

For a thorough understanding of urban morphology, one must recognize its multidimensional nature, which encompasses social, economic, and physical aspects (Marshall & Çalişkan, 2011). This field draws from various disciplines, including spatial analysis, configurational studies, process typology, and historico-geography (Gao et al., 2020). The intricate interplay of these dimensions contributes to the complex formation of urban form (Marshall & Çalişkan, 2011). A fundamental component of urban morphology is the spatial arrangement of land use within urban areas (Gao et al., 2020). Moreover, urban morphology plays a crucial role in urban landscape management and informs urban policy decisions, as landscape metrics offer insights into different urban development patterns (Ronchi et al., 2018). The morphological structures of urban landscapes reflect specific social, political-economic, and technological processes (Gu, 2020). While all dimensions are significant, emphasis on the physical aspect is paramount, given its pronounced influence on urban morphology.

Overall, urban morphogenesis is a multidisciplinary field that integrates concepts from urban planning, geography, sociology, and economics to comprehensively analyze the processes and transformations that shape cities over time.

1.9.2.2 Concepts of Land use Intensity and Building Density: A Multi-Layered Approach to Understanding Urban Form

Building Density

Building density is a cornerstone concept in analysing urban form. Its understanding has become increasingly nuanced over time. Pont and Haupt (2010), pushed the boundaries beyond simple population density by emphasizing built-up density. This concept acknowledges that building structures occupy space in both two and three dimensions, fundamentally shaping the character of a city (Ye & Van Nes, 2014a).

Building density isn't a singular value, but rather a multifaceted concept with far-reaching consequences for urban areas. As per Pont and Haupt (2010), it manifests at multiple scales, influencing everything from the layout of individual plots to the overall character of neighbourhoods. Key factors that contribute to building density include:

- ✓ **Floor Space Index (FSI)**: This metric measures the total floor area of a building compared to the size of the plot it occupies. High FSI signifies a building with multiple stories, contributing to a denser urban environment. It is also signified as floor area ratio (FAR)
- ✓ **Ground Space Index (GSI)**: In contrast to FSI, GSI focuses on the building's footprint relative to the plot size. It provides insights into how much of the land is actually covered by structures. It is also signified as building area ratio (BAR).
- ✓ **Open Space Ratio (OSR)**: This metric highlights the crucial role of green spaces within a development. A high OSR indicates a healthy balance between built structures and open areas, promoting a more balanced, livable and sustainable urban landscape.
- ✓ **Building Height**: Building height is a readily apparent aspect of density. High-rise buildings contribute significantly to a dense urban fabric, while low-rise structures create a more spread-out feel.

By analyzing these factors at both the plot and neighborhood levels, planners and urban designers gain a comprehensive understanding of building density. This knowledge

empowers them to create urban environments that cater to diverse needs. High-density neighborhoods with a mix of FSI, GSI, OSR, and building heights can promote walkability, foster a sense of community, and optimize land use – all crucial ingredients for a vibrant and sustainable city.

Land Use Intensity

Urban land use density and land use mix intensity are fundamental concepts in urban planning that significantly influence the structure of cities. Land use mix intensity focuses on the variety of activities within a defined space, surpassing the mere number of land uses to create lively and dynamic areas (Güneralp et al., 2020). Understanding these concepts enables urban planners to develop cities that meet the diverse needs of residents, fostering walkable, vibrant, and sustainable environments (Güneralp et al., 2020).

Van den Hoek (2008) emphasizes the profound influence density has on the overall urban form, shaping everything from transportation networks to the character of a neighborhood. Dense areas often foster walkability and a sense of community, while low-density areas can necessitate car dependence and create a disconnected feel.

Land use mix intensity, also known as use-mix intensity, takes center stage. It delves into the diversity of activities within a given space, not just the sheer number of land uses. A high use-mix intensity area might feature a mixed-use building with apartments above shops and restaurants, creating a vibrant hub of activity throughout the day. Conversely, a low use-mix intensity area might have a purely residential street devoid of commercial activity, leading to a quieter but potentially less dynamic atmosphere (Ye & Van Nes, 2014a).

To assess the land use mix intensity a Mixed-use Index (MXI), developed by Van den Hoek (2008), and it is a tool used in urban planning to classify and analyze the functional composition of urban areas based on the integration of different land uses. It divides land uses into the following categories:

1. Living: This refers to residential areas, where the primary function is housing. These areas are designed for people to live, and typically include homes and apartments.

2. Working: This category includes commercial and industrial where economic activities occur. These areas are designated for jobs and business operations.
3. Amenity: This refers to spaces dedicated to public services and leisure. It includes parks, schools, health institutions, administrations, cultural institutions, religious institutions, and recreational facilities. These areas enhance the quality of life by offering services and recreational opportunities.
4. Mixed-use: This describes areas where multiple functions, such as living, working, and/or amenities, coexist within the same space or development. Mixed-use areas promote urban diversity by integrating residential, commercial, and public functions, often within the same plotss, blocks and neighbourhoods.

The MXI helps planners and researchers understand how urban areas are functionally organized, contributing to more efficient land use and better urban design by promoting a balance of different activities within neighborhoods.

1.9.2.3 Theories of Urban Form

Theories of Urban Form offer a comprehensive examination of the diverse conceptual frameworks and perspectives that shape our understanding of urban landscapes. From historical theories tracing the evolution of cities to contemporary approaches addressing current urban challenges, this exploration delves into the multifaceted dimensions of urban form theory. Historico-geographical perspectives and morphological dimensions of agent-based modelling, space syntax, and space matrix each provides unique insights into the intricate fabric of urban morphology. Furthermore, the discourse encompasses theories related to sustainable urban form (SUF), such as the Compact City Theory and New Urbanism Theory, shedding light on strategies for creating environmentally resilient and socially inclusive cities. Additionally, Appleyard's Street Connectivity and Land Use Intensity Theory, along with the Functional Street Classification Theory, offer valuable perspectives on the relationship between street design and urban development patterns. Through an examination of the evolution and transformation of urban morphology, as well as an exploration of the elemental components of urban form, this discourse navigates the rich tapestry of theories that underpin our understanding of urban landscapes.

A. Historico-Geographical Theory and the Morphological Dimensions

Historico-geographical theory, pioneered by M.R.G Conzen, offers a comprehensive framework for understanding urban form through the intertwined lenses of historical evolution and geographical context. At its core, this theory emphasizes the significance of analyzing the historical processes and geographical conditions that have shaped the built environment of cities over time. The theory highlights the importance of categorizing cities into morphological units based on their distinct development periods, layout configurations, and architectural styles. In addition, it emphasizes the historical continuity of urban form, highlighting how layers of past influences shape present-day configurations(Conzen, 1960, 1966). By meticulously tracing the chronological sequence of development that could enable to identify key turning points and shifts that molded distinct morphologies.

The Historico-Geographical approach in urban morphology has been widely recognized as a fundamental framework for understanding the physical form of cities and how it evolves over time (Oliveira & Yaygın, 2020). Conzen's work has provided founding concepts and a comprehensive framework for the study of cities' urban form, emphasizing the internal drivers and motives of space from a Historico-Geographical perspective (AlSadaty, 2022). The method of articulating the historico-geographical structure of urban landscapes has been considered fundamental to urban morphology research and practice (Whitehand, 2009). In addition, the integration of green-space development into historico-geographical thinking has been highlighted, emphasizing its value in research and practice (Whitehand, 2019).

Furthermore, the theory recognizes the influence of geographical determinism, acknowledging how factors like terrain, resources, and transportation routes guide urban layout (Conzen, 1960). However, the theory goes beyond mere geographical determinism. Analysing differences in economic activities, social structures, and political contexts between the cities can yield crucial insights. The theory also encourages identification of agents of change. Specific historical figures, policies, or events can significantly impact urban form (Conzen, 1960). Pinpointing such agents in each city's early development can shed light on their unique trajectories.

By applying the Historico-Geographical Theory and delving into relevant historical and geographical sources specific to a city and its counterparts, one can gain a deeper understanding of their distinctive urban forms. This comparative analysis requires

incorporating detailed historical timelines, geographical features, socio-economic contexts, and identifying key agents of change in each city's early development.

The historico-geographical urban form theory of Conzen is a seminal approach that has significantly influenced the study of urban morphology. Conzen's work has been foundational in identifying the principles and scope of the historico-geographical approach, emphasizing the importance of town plan, land uses, and building fabric as the fundamental elements of urban landscape (Silva et al., 2014; Ünlü, 2021). This approach has been instrumental in shaping the understanding of urban form and has been widely used in the analysis of urban morphology.

A study by Zhang et al. (2021) established a new quantification system based on Conzen's theory and quantified the urban landscape using indicators from city plan, building forms, and land use patterns (Zhang et al., 2021). Furthermore, the theory of urban form has evolved to encompass diverse perspectives and methodologies. For instance, the study of urban form has extended to include the examination of spatial heterogeneity in the determinants of urban form, as evidenced by S. Li et al. (2019) who employed a geographically weighted regression (GWR) method to analyze the spatial heterogeneity in the determinants of urban form for Chinese cities S. Li et al. (2019).

In addition to Conzen, the six-dimensional framework proposed by Matthew Carmona and his team introduces a comprehensive approach to understanding urban form, extending beyond traditional morphological analysis to incorporate diverse social, cultural, and environmental factors (Fleischmann et al., 2020). At its core, the Morphological Dimension of this framework delves into the physical structure and arrangement of the built environment, encompassing elements such as buildings, streets, squares, and parks (Carmona et al., 2018). By examining factors like density, grain, massing, and layout, this dimension provides crucial insights into how the physical form shapes the character and functionality of cities.

Expanding upon this framework, researchers have identified the need for a more systematic and quantitative analysis of urban form at a global scale, aiming to address existing inconsistencies in urban morphology research (Fleischmann et al., 2020). By leveraging advanced computational methods, this approach enhances our ability to

categorize and understand the diverse morphological patterns present in cities, thereby informing more effective urban planning and management strategies.

Moreover, the holistic nature of Carmona's framework lends itself well to addressing the multi-layered complexities of mixed urban streets, where diverse activities and functions intersect (Carmona et al., 2018). This aspect of the framework proves invaluable in research focused on street improvements, as it enables a nuanced analysis of how different urban form elements interact and influence one another. As cities continue to evolve and grow, the utilization of such comprehensive frameworks becomes increasingly essential for fostering sustainable, resilient, and inclusive urban environments.

B. Theories Related to Sustainable Urban Form (SUF) – Compact City Theory and New Urbanism Theory

Compact City Theory

The Compact City Theory, pioneered by Peter Calthorpe (1993), presents high-density, mixed-use development as a fundamental strategy for enhancing resource efficiency and promoting environmental sustainability within urban areas (Hoppenbrouwer & Louw, 2005). This approach calls for a meticulous analysis of the spatial distribution of land uses, evaluating the intensity of mixed-use integration, and discerning the intricate connections between density patterns and existing urban infrastructure (Hoppenbrouwer & Louw, 2005). By prioritizing densification and strategic mixed-use development, cities can potentially reduce their dependence on private vehicles, optimize resource allocation, and mitigate environmental degradation (Hoppenbrouwer & Louw, 2005).

The Compact City Theory, which advocates for high-density, mixed-use urban development, has been widely recognized as a key strategy for achieving sustainable urban forms (Charehjoo & Siong, 2013). It is argued that compact cities promote sustainable development by efficiently using land, curbing urban sprawl, reducing reliance on mass transport, and creating socially interactive environments with vibrant activities (Kotharkar et al., 2014). Moreover, the theory of compact cities has been associated with environmentally friendly mobility and a decrease in the carbon footprint, making it a paradigm for sustainable urban forms (Hernandez-Palacio, 2015).

The intellectual origins of sustainability have been analyzed to determine whether the theory supports the compact city hypothesis, with the conclusion that compact urban forms are more sustainable compared to sprawl (Neuman, 2005).

Hoppenbrouwer and Louw (2005) further underscore that while the concept of mixing land uses appears straightforward, a deeper examination reveals multiple conceptual levels within the objectives and strategies advocated by proponents of mixed-use development. This complexity necessitates a structured approach towards assessing and implementing mixed-use policies within urban contexts (Ghosh & Raval, 2021). Ghosh and Raval (2021) emphasize the absence of a standardized methodology for evaluating the spatial distribution of mixed land uses at the city level, highlighting the need for a more systematic framework in this regard.

In essence, the Compact City Theory emphasizes the significance of comprehensively understanding mixed-use development and its spatial arrangement within urban settings. This approach stresses the importance of adopting structured methodologies for assessing and implementing high-density, mixed-use strategies to foster sustainable urban environments. By integrating insights from research on urban land use dynamics and policy implementation, cities can effectively navigate the complexities of mixed-use development and advance towards more resilient and environmentally sustainable futures.

New Urbanism Theory

New Urbanism Theory, championed by Katz (1994) and Lynch (1960), represents a holistic approach to urban planning that seeks to revitalize communities by prioritizing human-scale, walkable neighborhoods with a mix of land uses and ample public spaces. At its core, New Urbanism aims to create environments conducive to social interaction, pedestrian mobility, and a high quality of life (Takano et al., 2002). This theory emphasizes the importance of designing cities and neighborhoods that accommodate diverse populations and activities, fostering a sense of community and belonging. By promoting compact, mixed-use developments, New Urbanism aims to reduce dependence on automobiles, mitigate urban sprawl, and enhance overall environmental sustainability.

Additionally, New Urbanism places a strong emphasis on preserving historical heritage and architectural character while embracing innovative design principles to address contemporary urban challenges (Katz, 1994). Through its focus on creating vibrant, livable spaces, New Urbanism theory offers a comprehensive framework for achieving sustainable urban development in the 21st century.

Thus, the New Urbanism theory provides a valuable framework for creating sustainable and livable neighborhoods. By considering the insights from research on the built environment's impact on longevity, active living, happiness, loneliness, sustainable urban renewal, social norms, and health, urban planners can make informed decisions to enhance the quality of life in Dire Dawa.

The New Urbanism Theory, which promotes walkable neighborhoods with a mix of housing and commercial spaces, has been identified as one of the sustainable urban forms (Jabareen, 2006). It emphasizes neotraditional development, urban containment, and eco-city models, all of which align with the idea of creating sustainable urban forms through the mix of different uses and ample open space allocation (Jabareen, 2006). The theory of New Urbanism has been influential in legitimizing compact cities as a form of sustainable development, based on the argument regarding the relationship between urban form and emissions (Kjærås, 2021).

By exploring how these features relate to use-mix intensity and open space ratios in different areas, it can gain valuable insights into the city's potential for fostering sustainable living. Understanding the connections between built environment characteristics and social interaction, mobility, and quality of life helps guide recommendations for creating more sustainable and liveable neighbourhoods.

As a result, one can note from the theories of Compact City and New Urbanism as they play a significant role in shaping sustainable urban forms by emphasizing the mix of different uses and allocating ample open space ratio. Therefore, both the Compact City Theory and New Urbanism Theory are significant in shaping sustainable urban forms by advocating for high-density, mixed-use development and walkable neighborhoods. These theories emphasize the efficient use of land, reduction of urban sprawl, and the creation of socially interactive environments, all of which contribute to the creation of sustainable urban forms.

Although the Compact City Theory and New Urbanism share some common goals, particularly their focus on promoting sustainable urban development, they differ in key aspects. Compact City Theory emphasizes **density** and **urban compactness**, advocating for higher population density, mixed land use, and the reduction of urban sprawl to create more efficient and sustainable cities. In contrast, New Urbanism focuses on **human-scale design**, prioritizing walkability, community-centered neighborhoods, and urban form. It seeks to create pedestrian-friendly neighborhoods with a mix of housing types, public spaces, and local services.

C. Theories related to the correlation of land use and street hierarchy - Functional Street Classification Theory and Appleyard's Street Connectivity and Land Use Intensity Theory

Functional Street Classification Theory

Michael Southworth's concept of street hierarchies is a framework that provides a systematic way to understand and categorize streets based on their width, capacity, and primary functions within urban settings (Southworth, 2005). This classification is instrumental in organizing the urban fabric, defining the role of each type of street in accommodating different activities, and influencing land use patterns. Primary streets, characterized by their wider width and high capacity, are strategically positioned to facilitate smooth vehicular traffic flow. They typically serve commercial zones that demand enhanced accessibility. Secondary streets, with a moderate width and capacity, play a connecting role between neighborhoods and grant access to mixed-use areas. Local streets, often narrower, prioritize pedestrian access and primarily serve residential zones, contributing to a quieter and more localized environment (Southworth & Ben-Joseph, 2003).

Southworth's theory has far-reaching implications for urban planning, with its emphasis on how street hierarchies shape the overall urban form and influence the trajectory of urban sprawl over time. The work of Barrington-Leigh and Millard-Ball (2015) supports this perspective by underlining the enduring impact of street hierarchies on the spatial layout of cities.

Jiang (2009) adds depth to the discussion by pointing out that a minority of streets, which constitute the hierarchical network, bear the major share of traffic flow. This

observation aligns with the 80/20 principle, suggesting that a relatively small percentage of streets handle the majority of urban mobility.

Furthermore, Tripathy et al. (2021) stress the importance of visualizing street hierarchies as a tool for enhancing public understanding of urban structures. This visualization aids both planners and residents in comprehending the organization of streets, fostering effective urban planning, and contributing to well-designed cities.

Appleyard's Street Connectivity and Land Use Intensity Theory

The theory proposed by Donald Appleyard, which suggests that the intensity of land use at the plot level is determined by the accessibility and connectivity of the surrounding street network, has been a crucial concept in urban planning and development (Appleyard, 1972). This theory emphasizes the impact of street design and traffic flow on the development of urban areas. Appleyard's work in San Francisco in 1972 demonstrated that the physical presence of traffic, especially heavy goods vehicles, disrupts the interpersonal networks and social contacts of residents, highlighting the influence of street traffic on urban social dynamics (Appleyard, 1980; Mindell & Karlsen, 2012).

Furthermore, the writings of eminent planning and urban design scholars such as Donald Appleyard continue to inspire planners in the physical urban space, indicating the enduring relevance and influence of Appleyard's work in contemporary urban planning and design (Apostol et al., 2013). Additionally, the impact of Western urban planning theory and practice on modern urban development has been a subject of study, and Appleyard's contributions are likely to have played a significant role in shaping urban planning theories and practices (Wang, 2023).

Moreover, the relationship between street connectivity and land use has been a topic of interest in urban planning. Studies have shown that increased street connectivity is associated with more walking, biking, and transit use, indicating the importance of street network design in promoting sustainable and active transportation modes (Marshall & Garrick, 2010; Tasic et al., 2015). This aligns with Appleyard's theory, as it underscores the significance of street connectivity in influencing urban activities and land use patterns.

In summary, Donald Appleyard's theory on the intensity of land use at the plot level being determined by the accessibility and connectivity of the surrounding street network has been supported by empirical evidence and continues to be influential in urban planning and development.

D. Space Syntax Theory

Space Syntax theory serves as a critical framework for understanding urban morphology by emphasizing the intricate relationship between spatial configuration and social behavior. Developed in the 1980s by Bill Hillier and colleagues, the theory posits that the arrangement of urban spaces significantly influences how individuals navigate and interact within those spaces (Hillier et al., 1984). It provides a quantitative approach to analyzing urban layouts, offering a method to assess the impact of spatial structures on social integration, segregation, and movement patterns (Pafka et al., 2020). Central to this theory is the idea that urban spaces are not just physical constructs but also socially charged environments that shape community dynamics and human behavior (Hillier, 2007; Hillier et al., 1984).

The application of Space Syntax has expanded beyond traditional urban analysis, especially with the integration of Geographic Information Systems (GIS). This integration has proven to be instrumental in enhancing the understanding of urban morphology by providing more detailed insights into how spatial configurations affect pedestrian movement, traffic patterns, and social interactions (Abou El Seoud, 2014; Othman et al., 2020). Studies leveraging this combination have revealed how spatial arrangements can either foster or impede social connectivity (Sheng et al., 2021).

The methodological rigor of Space Syntax is also reflected in its application across diverse urban contexts. For instance, research has shown how the global urban grid influences local public spaces, highlighting the role of spatial configurations in dictating movement and social interactions (Thinnakorn & Chanklap, 2010), studies demonstrate that urban parks designed using Space Syntax principles promote social interactions, ultimately enhancing community well-being (Sheng et al., 2021). These examples underscore the importance of considering spatial configurations in urban design as a direct factor in shaping the social fabric of neighborhoods.

Historically, Space Syntax has provided invaluable insights into the evolution of urban forms across cultures and time periods. Research on historical capitals, such as those of the Tang and Song dynasties, reveals how changes in urban planning over time have influenced both spatial structures and social dynamics (Berhanu, 1994; Yin et al., 2021). This historical perspective enriches our understanding of urban morphology, demonstrating the necessity of examining both contemporary and historical contexts when analyzing urban spaces (Yin et al., 2021).

Space Syntax theory offers a robust framework for analyzing urban morphology by linking spatial configurations to social behaviors and interactions. Its integration with GIS and its application across various urban contexts demonstrate its versatility and relevance in contemporary urban studies. As cities evolve, the insights derived from Space Syntax will be crucial in informing urban design and planning strategies that promote social cohesion and accessibility. Bill Hillier's work in the late 20th century laid the groundwork for this theory by demonstrating how spatial layouts can either facilitate or hinder social connectivity within urban areas (Hillier et al., 1984; Hillier, 2007). The theory's focus on the socio-spatial dynamics of urban environments aligns with broader urban morphology discourse, emphasizing the relationship between physical space and human activity (Berhanu, 1994). This perspective underscores the importance of models in analyzing urban spaces and understanding how spatial configurations shape community interactions.

E. Informal Urbanism Theory: A Lens for Understanding Unplanned Growth in Cities

Informal urbanism is not simply a theory, but a powerful lens through which one can examine the dynamic and often spontaneous processes of urban development, particularly prevalent in developing nations. It delves into the emergence and evolution of informal settlements, vibrant yet sometimes precarious communities that arise organically to fulfil the needs of migrants and low-income residents who are often locked out of formal housing markets.

These settlements are a testament to human resilience and resourcefulness. In the absence of formal planning and infrastructure, residents self-organize to create homes, businesses, and social networks. This self-construction results in unplanned, yet

functional, neighborhoods that weave themselves into the fabric of the city. As McCartney and Krishnamurthy (2018) highlight, these settlements become unplanned extensions of the urban landscape, a stark contrast to the often-rigid blueprints of planned development.

Informal urbanism challenges traditional urban theories, which were often developed in the context of more developed regions. Kamalipour (2017) argues that these theories fail to capture the unique dynamics of rapid urban expansion and informal development unfolding in the global South. Here, cities are not simply planned entities, but rather complex ecosystems where formal and informal systems constantly interact and influence each other.

The evolution of informal settlements is shaped by a complex interplay of factors. Governmental policies, for instance, can play a surprising role. Moya et al. (2022) point out that policies allowing low-income populations to occupy unused land can inadvertently fuel informal urban expansion. This highlights a fascinating symbiosis between the urban environment and political structures. As Magnusson (2014) suggests, this interplay creates a unique dance between order and chaos, where self-organizing principles lead to the emergence of intricate, yet seemingly unplanned, urban systems.

Therefore, informal urbanism offers a critical perspective on how cities grow and adapt, particularly in the developing world. By understanding the forces that drive informal settlements and the unique dynamics at play, one can better develop planning and policy approaches that are inclusive, sustainable, and responsive to the needs of all urban residents.

1.9.2.4 Evolution and Transformation of Urban Morphology

The study of urban morphology focuses on understanding the evolution and transformation of urban forms over time, offering insights that are invaluable for both historical analysis and contemporary urban planning and design. This field explores how cities evolve, influenced by a complex interplay of historical, cultural, economic, and social factors, shaping the urban landscape.

The exploration of urban morphology has evolved significantly since the early theories proposed before the 1990s, laying a foundational understanding for urban morphogenesis. Key figures in this field, such as Kevin Lynch, Jane Jacobs, and Christopher Alexander, have contributed critical insights that shaped the discourse around urban form and its implications for urban planning and design.

Kevin Lynch's seminal works in 1960 and 1981 introduced the concept of "imageability" in urban environments, emphasizing how the physical form of cities influences the way individuals perceive and navigate them. Lynch argued that urban spaces should be designed to enhance their legibility, which he categorized into five elements: paths, edges, districts, nodes, and landmarks (Lynch, 1960, 1981). This framework has been instrumental in guiding urban planners to create spaces that are not only functional but also aesthetically pleasing and easy to navigate . Jane Jacobs, in her 1961 work "The Death and Life of Great American Cities," challenged the prevailing urban planning paradigms of her time. She advocated for the importance of mixed-use developments and the organic growth of neighborhoods, arguing that vibrant urban spaces arise from the interaction of diverse activities and the presence of a robust street life. Jacobs' emphasis on the social aspects of urban form complements Lynch's focus on physical characteristics, highlighting the need for a holistic approach to urban design(Jacobs, 1961).

Christopher Alexander's 1964 book "Notes on the Synthesis of Form" further contributed to the understanding of urban morphology by introducing the idea of design patterns that can be observed in successful urban environments. Alexander posited that these patterns could serve as templates for creating livable urban spaces, thus bridging the gap between theory and practical application in urban planning (Alexander, 1964). His work has influenced subsequent generations of architects and urban designers, encouraging them to consider the underlying principles that govern successful urban form.

Additionally, the contributions of scholars like Bill Hillier, who introduced the concept of space syntax in 1984, have provided tools for analyzing the spatial configuration of urban environments. Hillier's work emphasizes the relationship between spatial layout and social behavior, suggesting that the morphology of urban spaces can significantly influence patterns of movement and interaction (Hillier et al., 1984). This perspective

aligns with the earlier ideas of Lynch and Jacobs, reinforcing the notion that urban morphology is not merely a matter of aesthetics but is deeply intertwined with social dynamics.

The historical context of urban morphology has also been enriched by the insights of Clullen G. in 1971, who explored the generative processes that shape urban forms over time. His work highlighted the importance of understanding the historical and cultural contexts that inform urban development, thus providing a more nuanced view of urban morphology (Cullen, 1971). This historical perspective is essential for contemporary urban planners who seek to create spaces that resonate with the identity and heritage of communities.

A key concept in urban morphology is self-organization, which posits that urban forms emerge not solely through top-down planning but through the collective actions of various actors and processes. This idea, although challenging for traditional urban planning to fully embrace, highlights the complex and often unpredictable changes that characterize urban development (Dibble et al., 2019).

The foundations of urban morphology as a formal discipline were laid in the early 20th century, with the contributions of scholars like M.R.G. Conzen and Saverio Muratori. Conzen's seminal work on Alnwick in the 1960s introduced the concept of the "urban landscape unit," breaking down cities into three key components: the town plan (comprising streets, plots, and building blocks), the building fabric (the three-dimensional structure of the city), and land use. This division remains central to the study of urban morphology, providing a structured way to analyze the physical form of cities and their development over time (Conzen, 1960).

In parallel, Muratori's studies, particularly of Italian cities like Venice, emphasized the organic growth of cities through the process of building renewal and transformation. He demonstrated how urban forms evolve incrementally, reinforcing the idea that cities develop continuously rather than through sudden changes (Muratori, 1960). Together, Conzen and Muratori's contributions laid the groundwork for viewing cities as dynamic entities shaped by both internal and external forces.

Key concepts like morphogenesis and typomorphology frame the analysis of urban forms. Morphogenesis refers to the process by which urban forms evolve, considering both internal dynamics (e.g., land subdivision, street patterns, building types) and external influences (e.g., economic shifts, planning interventions, cultural changes) (Kropf, 1996). Typomorphology, closely linked to Muratori's work, focuses on the classification of building types and how these reflect broader patterns of urban development. This approach helps trace the continuity of forms and provides insights into the historical and cultural contexts behind specific urban configurations (Caniggia & Maffei, 2001).

Another critical concept is the fringe belt, introduced by Conzen, which refers to zones at the edges of urban growth characterized by mixed uses and lower-density development. These areas provide insight into how cities expand and consolidate over time, often revealing cycles of growth and stagnation (Conzen, 1960; Whitehand, 1987).

Urban morphology has evolved through various schools of thought. The Conzenian school emphasizes a historic-geographical approach, using detailed maps and plans to track changes in street layouts, plot patterns, and building fabric, offering a long-term perspective on urban transformations (Conzen, 1960). In contrast, the Italian school, rooted in Muratori's typological studies, focuses more on the architectural and typological aspects, exploring how cities evolve incrementally while maintaining certain structural characteristics over time (Muratori, 1960). The French school, led by scholars like Pierre Merlin and Jean Castex, incorporates sociological and anthropological perspectives into the study of urban form, analyzing the relationship between physical space and social life (Oliveira, 2024).

Examining the three-dimensional morphology of urban areas has proven essential for understanding the processes and mechanisms underlying urban development. By studying how buildings, streets, and public spaces interact and evolve, researchers can gain insights that inform urban design strategies, land use planning, and policy interventions aimed at fostering sustainable and livable cities (Qiao et al., 2019).

The evolution and transformation of urban morphology are thus shaped by various schools of thought and key concepts, all of which provide a comprehensive framework

for understanding the dynamic nature of cities. Through these insights, urban morphology continues to serve as a vital tool for addressing contemporary urban challenges and shaping the future of cities.

1.9.2.5 Elements of Urban Form

The theory of urban form, rooted in the Conzonian school, offers a nuanced understanding of the intricate connections between different components of the cityscape, including streets, transportation networks, and pedestrian pathways. Scholars such as, Larkham, and Oliveira have delineated urban form into four primary components: building structure, street pattern, land-use pattern, and plot pattern. This theoretical framework provides a foundational basis for assessing urban form and understanding the historical evolution of the built environment (Conzen, 1960; Larkham & Conzen, 2014; Oliveira et al., 2018).

Recent studies acknowledge that urban form comprises various elements crucial for understanding and analyzing urban morphology, which can be traced back to the Conzenian school of thought in urban morphological assessment. These elements encompass diverse facets such as street patterns, block sizes, street design, building forms, transportation infrastructure, land utilization patterns, building patterns, and open spaces (Han et al., 2019; Moudon, 2019; Ünlü, 2019). Each of these elements contributes uniquely to the physical structure and layout of a city, impacting human perception and visual complexity (Huq et al., 2019). While dealing with the physical aspects of urban form, these Conzenian elements serve as foundational components, although additional considerations may be necessary when addressing the social and economic dimensions of urban form.

Moreover, the complexity of urban form can be evaluated through various measures including temporal, visual, spatial, scaling, and connectivity dimensions (Boeing, 2018). These metrics offer insights into the dynamic interplay of urban elements and their impact on the city's overall form and function.

The significance of these elements extends to sustainable urban design and planning efforts, as they underpin the creation of walkable, accessible, and well-designed urban spaces with diverse uses and mixed-use developments. Historical urban form analysis often centers on understanding these elements, shedding light on the evolution of cities

over time and informing contemporary design principles for sustainable urban development (Ahmed, 2017).

Furthermore, the relationship between urban form elements and urban aesthetics is profound, influencing the visual appeal of the built environment and human perceptions of urban spaces (Huq et al., 2019). Recognizing and leveraging these relationships are essential for crafting aesthetically pleasing and socially enriching urban landscapes.

To sum up, the elements constituting urban form are multifaceted and essential for understanding the complexity of urban environments. These elements, including building structure, street pattern, land-use pattern, and plot pattern, play pivotal roles in sustainable urban development, historical analysis, and the creation of aesthetically pleasing and functional cities. Leveraging statistical clustering methods enhances our capacity to identify typologies and patterns within urban form, thereby empowering informed decision-making in urban planning and design across various urban contexts.

1.9.3 Empirical Literature Review

The empirical literature review section of this dissertation delves into various aspects crucial to understanding Ethiopian urbanization and urban form. This section encompasses studies related to the factors shaping Ethiopian urbanization and the country's unique urban morphological tradition. It also examines the empirical validation of Conzen's Historico-Geographical Theory and the morphological dimensions proposed by Carmona and his team. Furthermore, the review provides empirical insights from sustainable urban form (SUF) theories, specifically focusing on the empirical support for Appleyard's Street Connectivity and Land Use Theory and the Functional Street Classification Theory.

1.9.3.1 Factors Shaping Ethiopian Urbanization

Urbanization across nations unfolds through diverse driving elements, with political, economic, and religious factors often standing out prominently. In the context of Ethiopia, Antonsich identifies political and military supremacy as the major driving force (Antonsich, 2000). The historical backdrop reveals cyclical shifts in the location of Ethiopian capitals, persisting until the nineteenth century. From the fourteenth century until the establishment of the permanent capital in Addis Ababa, military camps served as the seats of Ethiopian sovereigns, a testament to the intricate connection between power and urbanization (Antonsich, 2000; Wolde-Michael, 1973).

The choice between building *Sefer* or *Ketema*, temporary or permanent settlements, was a decision made by military leaders. *Sefer*, existing for only a few days, depended on factors like water availability, firewood, and suitability for erecting temporary structures. In contrast, *Ketema*, focused on defence, was strategically located on elevated points of hills and mountains (Antonsich, 2000). The morphological distinction between *Sefer* (Hamlet) and *Ketema* (town) was minimal (Antonsich, 2000).

Ethiopian cities are repositories of a rich historical narrative, woven with a plethora of events and influences that have intricately shaped their morphological evolution over time. Beyond their mere physicality, these cities are steeped in profound historical significance, reaching far beyond their geographical confines. They are indelibly intertwined with ancient trade routes, where legendary figures like the Queen of Sheba have left an enduring legacy, enriching Ethiopia's cultural tapestry and heritage (Igolkina et al., 2021).

Moreover, the political landscape of Ethiopian cities is a dynamic interplay of competing Muslim legacies and the constitutional recognition of ethnolinguistic nationalities, as meticulously explored by (Osmond, 2014). These multifaceted factors intricately contribute to the complex tapestry of political dynamics, which in turn shapes governance structures and societal interactions within urban centers across Ethiopia. Consequently, Ethiopian cities emerge not merely as static physical entities but as vibrant reflections of a nuanced interplay of historical, religious, developmental, and political forces that continue to sculpt their identity and trajectory.

The urban morphology of northern and central Ethiopia bears the indelible imprint of common historical factors, notably the profound influence of the church and royal establishments (Antonsich, 2000; Gebregiorgis, 2011; Ghiorghis & Gérard, 2007). The *Gibi* (royal palace) stands as a testament to this influence, strategically perched atop elevated hilltops for both prestige and security (Antonsich, 2000). Surrounding these pivotal centers of power, military leaders and troops organized themselves into circular quarters, establishing a spatial hierarchy around the central *Gibi* (Antonsich, 2000). Furthermore, religious structures, intricately intertwined with rulership, were strategically positioned on commanding sites, underscoring the close relationship between faith and governance (Cerulli, 1974; Tamrat, 1972).

The predilection for elevated locations in urban settlements reflects a strategic endeavor to oversee surroundings and integrate natural features into urban landscapes. Notably, features like the eucalyptus forests in Addis Ababa and Dire Dawa became integral components of urban design, serving both aesthetic and practical purposes as features and barriers (Antonsich, 2000). Ethiopian cities, serving as administrative hubs, attracted traders from both national and international arenas due to the presence of key political figures (Crummey, 1980).

Early human settlements in Ethiopia followed a migratory pattern, gravitating towards resources such as water and fertile terrain. This relocation dynamic was dictated by resource availability, illustrating the symbiotic relationship between human settlement and environmental factors (Caves, 2004). Notably, Ethiopian urban areas deviated from the traditional global norm by being situated in elevated areas away from water bodies, driven by a multitude of factors (Mamo, 2015). This preference for elevated locations

aimed to facilitate gradual settlement development while ensuring the security and well-being of inhabitants (Caves, 2004).

While the industrial revolution catalyzed significant global shifts in urban development, with a transition from agrarian to industrial economies, the morphological aspects of classical cities have often been overshadowed in research efforts, impeding a comprehensive understanding of spatial integration with inhabitants (Ehrlich, 2018). Nevertheless, an inexorable trend towards high-density urban development is noted, particularly in developing countries where the majority of future population growth is anticipated (Xu et al., 2017).

In essence, Ethiopian urbanization is a multifaceted tapestry intricately woven with threads of politics, culture, religion, and geography. Beyond their physical structures, Ethiopian cities encapsulate profound historical significance, reflecting the intricate dynamics of trade, ethnic politics, and religious transformations. The morphogenesis of these cities is deeply rooted in historical events, natural features, and the strategic decisions of military leaders and rulers. Recognizing and comprehending these multifarious factors is imperative for understanding the complexity of Ethiopian urbanization and formulating effective urban development strategies for the future.

1.9.3.2 Ethiopian Urban Morphological Tradition

The Ethiopian urban morphological tradition, as evidenced by various scholars continues to evolve, drawing from a rich historical tapestry of military camps, early kingdom settlements, and the spatial configurations of the Ethiopian Orthodox Church (Akalou, 1967; Alem, 2016a; Antonsich, 2000; Pankhurst, 1982, 1985; Wolde-Michael, 1973). Notably, the Ethiopian Orthodox Church's close association with the monarchy, administering a significant portion of the king's territory as indicated by Cerulli (1974) and Tamrat (1972) has exerted considerable influence on Ethiopia's urbanization trajectory (Alem, 2016a).

The layout of early settlements in northern and central Ethiopia, as depicted in historical maps offers valuable insights into the morphological evolution of urban centers (Alem, 2016a; Ghiorghis & Gérard, 2007; Griaule, 1934; Tufa, 2008). Additionally, models illustrating the spatial arrangement of the Ethiopian Orthodox Church (Alem, 2016a) and the settlement patterns of Emperor Menelik II's *Sefer* or camp during the Adwa

expedition (Antonsich, 2000) provide further understanding of Ethiopia's established morphological philosophy.

1.9.3.3 Empirical Validation of Conzen's Historico-Geographical Theory and the Morphological Dimensions of Carmona and His Team

M.R.G. Conzen's Historico-Geographical Theory of Urban Form posits that the physical form of cities is fundamentally shaped by historical processes and spatial evolution. This essay delves into empirical evidence supporting this theory, showcasing diverse studies and methodologies that validate its core principles.

The ability to quantify and analyze urban form based on historical legacies is a key strength of Conzen's theory. Zhang et al. (2021) developed a novel quantification system using indicators derived from city plans, building forms, and land-use patterns, successfully quantifying the urban landscape of Chinese cities (Zhang et al., 2021). Similarly, Mohamed et al. (2018) demonstrated the theory's practical application in urban design and heritage conservation through their analysis of Islamic Cairo, where historical maps and spatial analysis guided conservation efforts (Mohamed et al., 2018).

Furthermore, the theory acknowledges the influence of spatial heterogeneity. S. Li et al. (2019) employed a geographically weighted regression method to reveal variations in how economic development, land use policy, and topography impact urban form across different regions of China, highlighting the theory's adaptability to diverse spatial contexts (S. Li et al., 2019).

Empirical evidence from diverse studies across various contexts supports the enduring relevance and validity of the Historico-Geographical Theory of Urban Form. Its ability to quantify and analyze spatial patterns, its emphasis on historical context and spatial heterogeneity, and its adaptability to various cultural and geographical settings solidify its position as a valuable framework for understanding and shaping urban landscapes. By acknowledging the interplay of historical legacies and contemporary forces, the theory provides valuable insights for future urban planning and design, aiming to create sustainable and resilient cities.

The morphological dimension of Matthew Carmona and his team's framework has been empirically supported by several studies. Alawneh and Rashid (2022) highlight the framework's contribution to urban resilience research, particularly in urban refugee

neighborhoods facing demographic changes. (Baud et al., 2021) emphasize its role in understanding urban governance complexity and enhancing transitions to greater sustainability in cities. Harun et al. (2022) provide a methodological framework for analyzing urban morphology, focusing on producing dynamic adaptability in historic towns. Shukla et al. (2023) demonstrates the framework's use in assessing urban form resilience, particularly in the Global South, using proxies such as diversity, connectivity, redundancy, modularity, and efficiency. Romice et al. (2017) also support the framework's contribution to urban design and quality of life, emphasizing the reciprocal relationship between aspects of quality of life and urban spatial structure.

In addition to these references, several other studies provide further literature supporting the empirical evidence for the morphological dimension of Carmona and his team's framework. For instance, Zhou et al. (2016) portray the temporal dynamics of urban spatial divisions using a complex network approach, while Lu et al. (2020) map urban spatial structure based on Point of Interest (POI) data Fang and Wang (2015), offer quantitative diagnoses and comprehensive evaluations of the rationality of Chinese urban development patterns, shedding light on the rationality of urban spatial structure. Furthermore, Huang and Liao (2021) explore the impact of polycentric and monocentric spatial structures on promoting the green economy, providing insights into the relationship between spatial structure and economic factors.

1.9.3.4 Empirical Insights from Sustainable Urban form Related Theories

Empirical evidence from various studies highlights the profound impact of urban form on sustainability, emphasizing its role in shaping environmental, economic, social, and even cultural dimensions of urban development (Cho & Choi, 2014; Huang et al., 2020). Notably, research by Cho and Choi (2014) in Korea underscores how compact urban development can mitigate air pollution, illustrating the pivotal influence of urban form on environmental sustainability. Similarly, Huang et al. (2020) emphasize the significance of the compact city theory in fostering environmentally and economically resilient urban landscapes, further illuminating the multifaceted impact of urban form on sustainable development.

Examining the economic sustainability of urban areas, Xiao et al. (2022) conducted empirical analysis in China, revealing intricate connections between urban spatial configuration and employment growth, emphasizing the crucial role of urban form in

economic sustainability. Moreover, Li et al. (2022) underscores the importance of urban compactness in enhancing both urban sustainability and the efficiency of public transportation systems, elucidating the diverse dimensions of sustainable urban development influenced by urban form.

The Compact City Theory, a cornerstone in contemporary urban planning, advocates for high-density, mixed-use development to foster sustainable urban environments (Bagheri, 2015). Supported by empirical evidence demonstrating reduced energy consumption and greenhouse gas emissions (Batsuuri et al., 2020; Holden & Norland, 2005), this approach has gained traction for its potential to mitigate urban sprawl and enhance urban sustainability (Adachi et al., 2014; Hassan & Lee, 2015; Van Niekerk, 2018). However, divergent perspectives exist regarding the theory's benefits and drawbacks, necessitating ongoing refinement and adaptation to address the diverse characteristics of different cities (Huang & Li, 2021; Kain et al., 2020).

Furthermore, the relationship between new urbanism theory and sustainable urban form is elucidated through empirical evidence related to land use, particularly in promoting mixed use and enhancing density while providing ample public open space. Studies by Im and Choi (2019), Koster and Rouwendal (2012), and Huang and Tsai (2013) collectively underscore the significance of mixed land use in the context of new urbanism theory and its relationship with sustainable urban form (SUF). These findings emphasize the need to consider diverse urban contexts, contemporary planning policies, density, the availability of massive data, as well as socio-cultural aspects in evaluating the impact of mixed land use on sustainable urban development, paving the way for more informed and effective urban planning strategies.

In conclusion, empirical evidence from various studies underscores the multifaceted impact of urban form on sustainability, encompassing environmental, economic, social, and cultural dimensions. As urbanization continues to accelerate globally, it is imperative for urban planners, policymakers, and researchers to leverage this knowledge to develop holistic, context-sensitive approaches to urban development. By embracing interdisciplinary perspectives, integrating socio-cultural considerations, and fostering community participation, one can create more resilient, equitable, and culturally vibrant cities that thrive in the face of diverse challenges and uncertainties.

1.9.3.5 Empirical Support to Theories Related to the Correlation of Land Use and Street Hierarchy

A. Empirical Support for Appleyard's Street Connectivity and Land Use Theory

Donald Appleyard's theory on street connectivity and its impact on land use has garnered empirical support from various studies (Appleyard, 1972). For instance, research has shown a positive correlation between pedestrian-friendly design features and increased land use intensity, aligning with Appleyard's argument that enhanced accessibility fosters denser development (Mouratidis, 2018). Moreover, studies have indicated a negative relationship between traffic volume and land use intensity, particularly for residential and commercial areas, supporting Appleyard's observations regarding the disruptive effects of heavy traffic (Mouratidis, 2018).

Furthermore, investigations into walkable neighborhoods and social interaction have underscored positive associations between pedestrian-friendly environments and heightened social capital within communities. This aligns with Appleyard's concerns about traffic disruptions eroding social connections (Knudsen & Clark, 2013). Additionally, the integrated sustainable urban planning framework proposed for achieving sustainable urban development emphasizes the importance of considering cultural and contextual factors in the relationship between street design, traffic flow, and land use (Rasoolimanesh et al., 2022).

Moreover, examining the historical development and comparison of urban planning theories provides valuable insights into the evolution of concepts related to street connectivity and land use (Zulfiqar & Kausar). Additionally, the reframing of planning theory with the concept of urban resilience holds promise for enhancing the application of planning theory in urban design and development (Ni'mah & Setiawan, 2022). It suggests that teaching planning theory as part of urban planning education is crucial for preparing planners to understand the pivotal role of street connectivity in shaping land use patterns and fostering sustainable urban environments (Olesen, 2018).

B. Empirical Support for Functional Street Classification Theory

The Functional Street Classification Theory, pioneered by Southworth and Ben-Joseph (2003), asserts that the classification of streets according to their width, capacity, and

primary function significantly influences urban form and traffic dynamics. Empirical studies lend robust support to this theory across diverse urban contexts.

For instance, research by Jiang (2009) illustrates the practical application of the 80/20 principle, where a small proportion of streets handle the majority of traffic volume. This observation resonates with the theory's distinction between primary, secondary, and local streets based on traffic intensity. Similarly, Han et al. (2020) employ spatial syntax analysis to establish strong correlations between street hierarchy and traffic flow in Chinese cities, reinforcing the theory's functional differentiation.

The relationship between street hierarchy and land use patterns is explored in studies such as those by Barrington-Leigh and Millard-Ball (2015) in the US and Ma et al. (2020) in Chinese cities. These studies suggest that well-defined street hierarchies can mitigate urban sprawl and promote mixed-use development along secondary streets, aligning with the theory's principles of functional differentiation.

Regarding urban form, Tripathy et al. (2021) demonstrate that visualizing street hierarchies enhances public comprehension of urban environments, underscoring the theory's potential to shape human interaction with cities. Southworth and Ben-Joseph (2003) provide extensive case studies showcasing the global applicability of the theory in shaping diverse urban landscapes.

Furthermore, Han et al. (2020) and Ma et al. (2020) emphasize the importance of utilizing street networks collectively to differentiate cities within the same scaling hierarchy, enriching our understanding of urban morphology. These findings underscore the theory's relevance in analysing the hierarchical and functional structure of urban environments.

In summary, the Functional Street Classification Theory, supported by empirical evidence, provides a valuable framework for comprehending the intricate relationships between street design, traffic flow, land use, and urban morphology.

1.9.3.6 Empirical Evidence on Informal Urbanism

Informal urbanism represents a dynamic and often spontaneous form of urban development that emerges outside the formal planning and regulatory frameworks of a city. Rooted in the self-organizing efforts of local communities, informal urbanism is a

testament to the adaptability, resilience, and resourcefulness of urban dwellers, particularly in rapidly growing and developing contexts. This organic growth leads to a unique urban form characterized by diverse architectural styles, flexible land use patterns, and a vibrant street life. The urban form shaped by spontaneous development (SD) not only reflects the immediate needs and aspirations of the inhabitants but also embodies a complex interplay between cultural, economic, and social factors. This form of urban development challenges conventional planning paradigms, emphasizing the importance of recognizing and integrating the unique characteristics of informal settlements into broader urban planning strategies.

Recent studies have emphasized the pivotal role of informal settlements in various global regions, with a particular focus on Sub-Saharan Africa. In these contexts, informal modes of urban development are not merely peripheral but are deemed essential contributors to the urban fabric (Mottelson & Venerandi, 2020). The relationship between self-organizing processes and institutional regulations within urban settings has been increasingly recognized. This relationship underscores that these two elements are intricately intertwined, operating in a symbiotic manner rather than existing as isolated entities (Zhang et al., 2015).

Moreover, research has delved deeper into the sustainability and living conditions prevalent within informal settlements. There has been a significant emphasis on understanding the self-construction techniques employed by residents and the decision-making processes they undertake to improve and sustain their quality of life in these communities (Caballero Moreno et al., 2019). Such research sheds light on the resilience and adaptability inherent in informal urbanism.

Thus, the concept of informal urbanism provides invaluable insights into the organic and spontaneous growth patterns of urban areas, particularly in the context of developing countries. The complex interplay between self-organization, institutional frameworks, and governmental policies plays a crucial role in shaping the formation, evolution, and sustainability of informal settlements. This highlights the pressing need for urban planning strategies that are not only flexible and adaptive but also tailored to recognize and harness the unique dynamics and strengths of informal urban development.

1.9.4 Theoretical and Conceptual Framework: Relating Urban Form Elements to Sustainable Development

The theoretical and conceptual framework delves into the intricate relationship between various elements of urban form and the overarching goal of sustainable development within the realm of urban planning and design. This framework acknowledges the multifaceted influences of both formal and informal interventions on urban landscapes and endeavours to provide guidance toward achieving more sustainable outcomes in urban development initiatives.

At its core, the framework sets out several key elements that constitute urban form:

A. Land Use/Building Use Density: This refers to the mixture and intensity of different land uses (residential, commercial, industrial, etc.) and the volume of plots/buildings within a given area. The density and diversity of land uses impact spatial efficiency and resource consumption within urban environments.
B. Building Density: This metric quantifies the size and volume of buildings per unit area, influencing factors such as urban sprawl, infrastructure demand, and resource utilization.

C. Street Hierarchy: The organization of streets based on their function and capacity plays a pivotal role in shaping urban mobility, accessibility, and the quality of public spaces.

The framework further categorizes urban planning intervention types into two main categories:

1. **Spontaneous Development (SD)**: This refers to the organic growth of urban areas influenced by market forces and individual decisions, often occurring without formal planning control. While spontaneous development can foster adaptability and community-driven solutions, it may also lead to inefficiencies, social inequalities, and environmental pressures.

2. **Formal Planning Intervention (FPI)**: This involves the deliberate shaping of urban form through government-led planning initiatives and regulatory frameworks. While formal planning interventions can promote sustainability

and control development, they may also be rigid and top-down, potentially disregarding local needs and context.

Among the three dimensions of sustainability—social, environmental, and economic—this study primarily focuses on the environmental sustainability perspective. In the context of urban planning and design, the framework highlights the importance of strategies that promote compact cities, mixed-use development, proper accessibility, and adequate open space. These principles serve as key guidelines for decision-making, ensuring that urban development aligns with sustainable urban form goals.

The framework highlights the complex relationships between urban form elements, types of planning interventions, and the dimensions of sustainable development. By providing insights into these interconnections, the framework aims to address the core objectives of the research.

Analysis Framework Application:

1. **Analysis of Existing Urban Forms:**

✓ Utilize existing urban form theories, spatial data, and assessments to analyze current urban forms in Dire Dawa City.

✓ Consider factors such as land use, building density, street hierarchy, and dominant intervention types.

2. **Analysis of the Emerging Urban Forms in Dire Dawa City:**

✓ Conduct an analysis of the emerging urban forms in the urban transformation of Dire Dawa City by examining their physical density attributes.

✓ Consider diverse planning interventions, including both planned and organic approaches, throughout its historical development.

3. **Evaluation of Impact on Sustainable Urban Form:**

✓ Evaluate the impact of urban form elements on the physical and environmental aspects of sustainable development in Dire Dawa City.

✓ Identify opportunities and challenges for transforming urban form towards sustainability based on the analysis conducted.

4. **Analysis of the Relationships among Urban Form Elements:**

- ✓ Analyze the relationship among different urban form elements in Dire Dawa City to identify cohesive and synergistic relationships between various urban form elements.

5. **Development of Conclusions and Recommendations:**

- ✓ Develop urban planning and design conclusions and recommendations for Dire Dawa City.
- ✓ Take into account the specific context, stakeholder needs, and desired sustainable outcomes.
- ✓ Tailor recommendations to address the challenges and leverage the opportunities identified during the analysis and forward research ideas for future research

Additional Considerations:

- **Adaptability**: The framework is adaptable to different scales and contexts, necessitating nuanced interpretations based on local conditions. This adaptability ensures that the framework remains relevant and applicable across diverse urban settings.

- **Technological Advancements**: Incorporate technological advancements and innovative solutions to contribute to achieving sustainable urban form. By leveraging new technologies, urban planners and designers can enhance their ability to create more efficient, resilient, and environmentally friendly urban environments.

Overall, this frameworks, As indicated in Table 1-1 serves as valuable starting point for understanding the complex relationships between urban form elements, sustainable urban form, and urban planning practices. By actively considering these connections and implementing the recommendations generated through this framework, cities can move towards creating more sustainable and resilient urban environments for the future.

Table 1-1: Matrix Representation of Conceptual Framework:

S/N	Research Objective	Theoretical Gaps	Research Focus	Approach/Methods	Relevant Theories
1	Investigate the spatial transformation pattern of use-mix intensity and open space ratio in Dire Dawa's morphogenesis and its impact on sustainable urban form (SUF).	Limited understanding of how use-mix intensity and open space ratios impact SUF in East African cities, particularly in the context of mixed-use and density. Most research on use-mix intensity focuses on Western urban models.	Investigate the evolution of land use and open space ratios and their contribution to SUF in Dire Dawa over time. Focus on how historical planning and organic growth patterns have shaped these transformations at plot and neighbourhood levels	- GIS mapping of use-mix intensity and open spaces across different morphogenesis periods. - Mixed use index (MXI) - Space matrix for OSR - Satellite images, historic maps and aerial photographs - Interviews and FGD with urban planners and selected individuals. - Field observations.	Hitorico-geographical urban form Compact City Theory - New Urbanism
2	Analyze emerging urban forms in Dire Dawa by examining physical density attributes, considering diverse planning interventions (both planned and organic) over the city's historical development.	Existing literature on urban form and density lacks depth on the coexistence and interaction between planned and organic growth in East African cities. The long-term impact of these processes on sustainability is underexplored.	Explore how both planned and organic development have influenced urban density patterns and forms over different morphogenesis periods in Dire Dawa at both plot and neighbourhood levels. Assess how these changes align	- GIS mapping of density attributes - Space matrix - Satellite imagery and historical records to map urban density. - Interviews and FGD with urban planners and	Hitorico-geographical urban form Compact City Theory - New Urbanism

S/N	Research Objective	Theoretical Gaps	Research Focus	Approach/Methods	Relevant Theories
			with the goals of sustainable urban form.	selected individuals. - Field observations.	
3	Analyze the relationship between Street Hierarchy and Land Use Functions at the plot level in Dire Dawa, considering different developmental periods and planning interventions.	Limited research on the interaction between street hierarchy and land use functions in rapidly growing cities like Dire Dawa, especially during different stages of urban transformation.	Investigate how the street network hierarchy and land use functions have evolved across various planning periods, and how these changes have influenced these different urban form elements.	- Spatial analysis of street hierarchy and land use functions using GIS. - Analysis of historical data on street development and land use patterns. - Field observations.	- Hitorico-geographical urban form - **Functional classification of streets** Streets connectivity and land use intensity theory

1.10 Research Approach and Methodology

1.10.1 Introduction

The methodology employed in this research aims to delve into the intricate process of urban morphogenesis in Dire Dawa, Ethiopia. By adopting a case study approach, the study endeavors to provide a comprehensive understanding of the spatial dynamics and morphological relationships that have shaped the urban landscape of Dire Dawa over time. This section delineates the research approach, materials and methods utilized in this endeavor.

1.10.2 Research Approach

The research approach and philosophy are crucial in shaping the trajectory and depth of a study. They guide researchers in formulating research questions, selecting data collection and analysis methods, and interpreting findings. The methodology used in research is essential for systematically acquiring new knowledge and interpreting information effectively (Garg, 2016). In this study on Ethiopian urbanization and its morphological tradition, the research approach and philosophy are intricately woven to provide a comprehensive understanding of the factors shaping urban development, the historical and geographical evolution of Ethiopian cities, and the validation of theoretical frameworks.

Pragmatism, as a research philosophy, emphasizes the practical application of research findings and the consideration of multiple perspectives and methodologies to address complex research questions. This approach is highlighted in various fields such as social research, educational research, and language studies. Morgan (2014) argues that pragmatism can serve as a philosophical program for social research, irrespective of the methods used. Wendler (2015) discusses the need for in-depth research consent in pragmatic clinical trials. Furthermore, Hammer (2017) points out the ethical challenges in conducting pragmatic trials, especially concerning informed consent. Norwich (2020) suggests that classical pragmatist philosophy justifies knowledge based on practical applicability rather than truthfulness, supporting the mixed methods research approach.

The pragmatic approach to research is versatile and applicable across various disciplines, promoting a practical and inclusive perspective that values the real-world implications of research findings. In this study, the researchers appears to adopt a

pragmatic stance by utilizing a mix of qualitative and quantitative methods to explore the urban morphology of Dire Dawa City and its implications for sustainable development. By integrating various data sources, including published articles, spatial data, and assessments, the study seeks to provide practical insights that can inform urban planning and design practices. Additionally, the researcher's emphasis on developing recommendations based on the findings further underscores the pragmatic orientation of the study, aiming to offer actionable insights for policymakers, practitioners, and stakeholders involved in urban development initiatives. Overall, the pragmatic research philosophy adopted in this study allows for a flexible and context-sensitive approach to investigating complex urban issues, ultimately contributing to the advancement of knowledge and the improvement of urban environments.

1.10.3 Case Study Approach

The research adopts a case study design to facilitate an in-depth exploration of the evolution of urban forms within the real-world context of Dire Dawa. Case studies are particularly apt for investigating complex phenomena within their specific settings, allowing for a nuanced analysis of the urban morphology (Yin, 2018; Gerring & Cojocaru, 2016; Gillham, 2000).

The adoption of a case study design in researching the evolution of urban forms in Dire Dawa is due to the complexity of urban phenomena and the need for an in-depth exploration of specific contexts. Case studies are particularly effective for examining intricate social, cultural, and environmental dynamics within their real-world settings, as they allow researchers to capture the nuances of urban morphology and development (Noor et al., 2014). This methodological approach is supported by the assertion that urban morphology encompasses the physical and spatial components of urban structures, which are essential for understanding the dynamics of urban growth and transformation (Nor et al., 2014).

Focusing on Dire Dawa, a city characterized by its diverse cultural influences and historical significance, enhances the study's relevance. The city serves as a microcosm of broader urban development trends in Ethiopia, reflecting unique socio-economic and environmental factors that shape urban forms. The historical context of Dire Dawa, coupled with its role as a cultural melting pot, provides a rich backdrop for analyzing urban development patterns and their implications for sustainability and governance.

Furthermore, the case study approach facilitates a comprehensive examination of local conditions, enabling researchers to identify specific challenges and opportunities (Osman et al., 2016).

Moreover, the case study design allows for the integration of multiple data sources and methods, which is crucial for capturing the multifaceted nature of urban development. By employing qualitative techniques such as interviews and observations alongside quantitative data, researchers can triangulate findings and develop a more holistic understanding of urban morphology in Dire Dawa. This methodological flexibility is particularly important in contexts where urban dynamics are influenced by a variety of factors, including socio-economic disparities, cultural practices, and environmental conditions (Osman et al., 2016).

As a result, the case study design is well-suited for exploring the evolution of urban forms in Dire Dawa, as it provides a framework for in-depth analysis of complex urban phenomena within their specific contexts. This approach not only enhances the understanding of urban morphology but also contributes to the broader discourse on sustainable urban development in Ethiopia.

1.10.4 Selection of Representative Cases

Dire Dawa's urban growth is historically segmented into distinct eras, each characterized by unique governance structures and planning interventions. To encapsulate the diverse morphological patterns that have emerged over time, representative samples are meticulously chosen from each morphological era. This ensures a comprehensive portrayal of the city's urban fabric, encompassing both organically evolved and formally planned areas.

Case studies are a valuable research method for exploring complex phenomena within their real-world contexts, offering in-depth investigations that combine various forms of observation to address specific research questions (Yin, 2018; Gerring & Cojocaru, 2016; Gillham, 2000). In the field of urban morphology, case studies are widely used to compare individual areas and develop or validate theories based on observed spatial trends. Scheer (2017) highlights the two primary comparison approaches—synchronic (comparing two locations at the same time) and diachronic (comparing the same location at different times). Often, researchers employ multiple case studies to enable broader comparisons and gain a deeper understanding of urban transformation patterns

(Conzen et al., 2012; Larkham & Conzen, 2014; Pont & Haupt, 2007). Yin (2018) also supports the use of multiple-case research to strengthen theoretical replication.

In this study, a multiple case study approach is adopted to investigate the emerging urban forms in Dire Dawa. By selecting representative samples from various parts of the city, the study seeks to capture the complex spatial transformations that have occurred throughout its history. According to Gerring and Cojocaru (2016), representative cases reflect a larger group of instances and enable cross-case synthesis, which helps to identify patterns across findings. This approach aligns with existing literature on urban morphology (Gerring & Cojocaru, 2016; Yin, 2018).

The selection of case study areas is driven by the need to capture the city's diverse urban evolution, which has been shaped by distinct historical, governance, and planning contexts. Dire Dawa's urban growth can be segmented into various eras, each marked by unique socio-political and economic developments that have influenced its spatial structure (Gebreyesus, 2019). By strategically selecting samples from these different morphological eras, the study ensures a comprehensive portrayal of Dire Dawa's urban fabric, including both organically evolved and formally planned areas.

The inclusion of both organically developed areas and formally planned neighborhoods provides a balanced understanding of Dire Dawa's urban morphology. Organic areas, which evolved without formal planning, offer insights into informal processes of urban growth and land use, while formally planned neighborhoods, introduced during government-led urban development initiatives, reflect structured planning's impact on the city's layout and functionality (Hillier & Vaughan, 2007). By including both types of areas, the study provides a holistic analysis of the city's development, capturing the forces that have shaped its spatial evolution.

The selection of representative samples is not random but methodologically designed to reflect the spatial diversity of Dire Dawa. This approach is consistent with best practices in urban morphological research, where diverse yet representative samples are chosen to provide a complete and accurate analysis of the urban landscape (J. W. R. Whitehand, 2001). The chosen areas cover various morphological eras and enable a detailed examination of the spatial patterns, building structures, street networks, and land use dynamics that characterize the city's development.

A sequential exploratory design was employed to select the research case areas, following the approach outlined by Creswell and Creswell (2018). This design involves three phases: qualitative data collection and analysis, identification of key features for further assessment, and quantitative evaluation of these features, culminating in the interpretation of results. For this study, a qualitative database representing Dire Dawa's historical transformation was used to assess the spatial changes that occurred during its different development periods. Representative samples were chosen based on the distinct spatial patterns observed in each period, followed by a quantitative assessment of the city's emerging urban forms using these selected cases.

The classification of Dire Dawa's urban growth history into distinct historical periods, tied to shifts in governance and planning philosophies, is essential for understanding how changes in administrative structures have shaped the city's-built environment. Damte (1993) categorizes Ethiopian urbanization into three major phases: pre-Italian (1900–1935), Italian occupation (1935–1941), and post-Italian (from the 1950s onward). While this framework provides a broad overview, it may overlook key spatial forms that emerged during the post-Italian period. This study seeks to explore how changes in governance philosophies influenced urban planning, leading to distinct spatial patterns over time.

The governance eras of Dire Dawa are closely linked to national shifts, making them an appropriate lens through which to examine the city's morphogenesis. The first period, referred to as the early morphogenesis era, includes both the city's early establishment (from 1902 to 1935) and the Italian occupation (1936–1941). The second period, known as the intermediate morphogenesis era, encompasses the Imperial regime following the Italian occupation (1942–1974) and the Dergue period (1975–1991). The final period is the recent morphogenesis era, which spans from 1992 to the present day.

The spatial transformation history of the city was analyzed using historic maps, satellite images from various periods, and discussions with city representatives identified through consultations with urban planning experts. Different transformation periods were mapped, and representative samples from each period were purposively selected to ensure adequate representation. As a result, two sites from each transformation period were chosen, totaling six case areas.

When identifying specific case study sites within Dire Dawa for each development period, the following points were considered:

1. **Historical Significance**: Choose sites that reflect key historical milestones or significant events in the city's development.
2. **Development Patterns**: Focus on sites that represent typical development patterns of each period.
3. **Socioeconomic contexts**: Consider sites that reflect changes in socioeconomic conditions, such as shifts in population density, income levels, or social amenities. This might include areas with varying residential and commercial development.
4. **Urban Planning Policies**: Choose areas that illustrate the impact of urban planning policies and regulations over time.
5. **Physical and Environmental Changes**: Look for sites that showcase physical changes to the urban landscape, such as reclamation of land, changes in green spaces, or environmental management efforts.
6. **Representative Samples**: Ensure that selected sites cover a range of development types, locations and contexts within the city, reflecting different stages of urban growth and transformation.
7. **Accessibility and Data Availability**: Choose sites where data and information are readily available for analysis, including historic maps, satellite imagery, and other relevant records.

Using these criteria, the case study sites were selected to represent different developmental periods in Dire Dawa's history. Megala and Kezira were chosen to represent the early morphogenesis era, spanning from 1902 to 1941. For the intermediate morphogenesis era, covering 1942 to 1991, Legehare and Sabian were selected. Finally, Gende Gerada and St. Mariam Sefer were identified as representatives of the recent morphogenesis period, extending from 1992 to 2022. Each site reflects key developmental changes and trends pertinent to its respective era.

While the selected case study sites are concentrated in the eastern part of the city, this focus reflects the area's more advanced development. The western side is still under development and, although it falls within the city's urban jurisdiction, it is not as fully built up. Therefore, this study emphasizes the more developed, built-up areas.

In summary, the case study area selection in Dire Dawa is based on a methodologically sound approach that captures the city's diverse urban forms, shaped by distinct historical, governance, and planning contexts. By including representative samples from different morphological eras, the study provides a comprehensive analysis of Dire Dawa's spatial evolution. This approach enables a deeper understanding of both organically evolved and formally planned areas, contributing valuable insights into the forces shaping urban morphology in the city.

1.10.5 Sampling Technique

The study utilized a combination of complete census and purposive sampling techniques. A comprehensive census was carried out within the selected case areas to gather detailed data, necessitating considerable effort to accurately reconstruct each location's historical context. This task was challenging due to the complexities involved in recreating past conditions. As a result, data on land use, plot patterns, building conditions, and street layouts were meticulously collected.

For the qualitative component, ten elderly participants were purposively selected for their deep knowledge of the areas and their pivotal role in the reconstruction of these case areas. Their extensive experience allowed them to reflect on the existing situations based on the specific morphological eras under study. These individuals were chosen for their ability to provide valuable insights into both historical and current conditions, with their selection made in collaboration with the city's urban planning team to ensure alignment with the study's objectives.

Additionally, seven professionals from various city departments were purposefully selected for interviews. This group included one representative each from the culture and tourism bureau, the land management office, and the road and transport bureau, as well as two individuals from the urban planning office and two from the city council. Each interviewee had over ten years of experience in their respective fields, ensuring a deep understanding of both historical and contemporary aspects of the city.

1.10.6 Quantitative Analysis of Density

Density serves as a pivotal metric in assessing urban form and is scrutinized through a multifaceted lens. The Mixed-use Index (MXI) is employed to categorize land uses into living, working, amenity and mixed use functions, providing insights into the functional

composition of urban areas (Van den Hoek, 2008). Complementing this analysis, the Spacematrix tool facilitates the calculation of the Ground Space Index (GSI) and Floor Space Index (FSI), shedding light on the spatial configuration of built and unbuilt areas within Dire Dawa. Moreover, the Open Space Ratio (OSR) is computed to gauge the intensity of natural land cover utilization, enriching the understanding of spatial dynamics.

1.10.7 Evaluation of Urban Form Relationships

The study delves into the intricate interplay between density and various urban form elements, including street layouts and plot patterns. Network density is assessed to discern the concentration of networks within the case study areas, elucidating the spatial organization of the city. Leveraging the Spacematrix tool, the analysis comprehensively examines density factors, unraveling the intricate relationships that underpin urban morphogenesis.

1.10.8 Historical Classification and Analysis

Dire Dawa's morphological evolution is contextualized within the framework of its historical development eras, delineated by shifts in governance structures and planning paradigms. Representative samples are thoroughly curated from each era, encompassing both spontaneously evolved and formally planned locales. This ensures a holistic portrayal of the city's morphological trajectory, capturing the nuances of its urban fabric across different historical epochs.

1.10.9 Data Collection and Analysis

To gain a nuanced understanding of Dire Dawa's urban morphology, the study employs a multifaceted data collection strategy that weaves together both quantitative and qualitative methods.

For the historical perspective, the research delves into historical maps to reconstruct past configurations of selected sites. These reconstructions are then corroborated through focus group discussions with individuals possessing a deep knowledge of the city's history. Building details like heights, uses, and plot settings are meticulously documented alongside historical photographs and maps. This data is further verified through focus groups with knowledgeable residents, ensuring its accuracy.

Additionally, a comprehensive desk review of relevant historical documents provides further context and strengthens the analysis.

Shifting to the recent developments, the study utilizes recent cadastral data to generate up-to-date maps of the city. Building details such as height, use, and street widths are meticulously collected, with plot and building settings cross-checked against on-the-ground observations. This detailed data collection process, akin to a large-scale census, allows for a comprehensive understanding of the city's current physical layout.

Focus group discussions and individual interviews, guided by pre-designed questions, delve into residents' perceptions and lived experiences of Dire Dawa's urban form. This qualitative data enriches the understanding by revealing how people interact with and navigate the city, providing insights beyond its physical characteristics.

Finally, the data collection process is further bolstered by desk reviews of relevant literature and extensive field observations. Desk reviews offer essential historical context, while field observations provide firsthand experience of the city's current state. This combination of quantitative, qualitative, and historical data collection methods ensures a rich and comprehensive understanding of Dire Dawa's urban morphology, allowing the study to paint a complete picture of the city's form and evolution.

This rich dataset is then subjected to a multi-faceted analysis. Geographic Information Systems (GIS) software serves as a powerful tool, allowing us to visualize and analyze the spatial relationships between these elements. By creating insightful maps, one can see how different urban features are distributed throughout the city. Additionally, robust statistical analyses are conducted using IBM SPSS Statistics 26 software. This helps us identify trends and patterns within the data, revealing hidden insights about the city's development. Furthermore, the study delves deeper into the spatial configuration of Dire Dawa by utilizing Spacematrix software, a program specifically designed for spatial analyses. The research also employ the Mixed-Use Index to quantify the intensity of different land use combinations within the city. Finally, to understand how these various urban form elements interact and evolve over time, Pearson Product-Moment correlation analysis is used. This statistical technique helps us identify significant relationships between elements, strengthening the overall rigor of the study by providing a more holistic understanding of Dire Dawa's urban morphology.

1.10.10 Results and Discussion

The findings are presented through a myriad of visual aids, including maps, graphs, and narratives, elucidating trends in urban form evolution and density patterns across disparate morphological eras. Through nuanced discussions, the implications of the findings for urban planning and sustainable development in Dire Dawa and analogous contexts are expounded upon, fostering a deeper appreciation of the intricate interplay between urban morphology and sustainable urban development.

Thus, the research methodology outlined herein furnishes valuable insights into the morphological transformation of Dire Dawa and its ramifications for sustainable urban development. By unraveling the spatial dynamics and analyzing morphological relationships, the study enriches our understanding of urban morphology, thereby furnishing indispensable guidance for future planning interventions aimed at fostering sustainable urban growth and development.

1.11 Structure of the Dissertation

The dissertation is structured as follows. This section provides a brief overview of the subsequent chapters, which explore the narrative of Dire Dawa's morphological evolution. Each chapter contributes to our understanding of urban morphogenesis in this Ethiopian city.

The dissertation adheres to the structure outlined in the dissertation guidelines of Addis Ababa University, AAU (2021), following the format of an article-based dissertation. This approach offers two modalities: the Monograph-based PhD dissertation and the Article-Compilation Based PhD Dissertation. The former typically comprises a minimum of two articles, one published and one accepted, while the latter necessitates at least three articles, with two published and one accepted.

In line with this framework, this dissertation consists of three specific objectives, each addressed in a separate chapter representing a published article in reputable journals. Given this arrangement, the Article-Compilation based PhD dissertation format is adopted, wherein an introductory chapter precedes the individual articles, followed by a discussion synthesis and concluding chapters encompassing general discussion, conclusions, and recommendations.

Chapter One serves as the general introduction, encompassing background and justification, literature review, statement of the problem, research questions, objectives, significance of the study, scope, limitations, Ethical consideration, Literature review, methodology of the study, and a section detailing the dissertation structure.

Subsequent chapters correspond to each specific objective, with **Chapter Two** focusing on the analysis of land-use mix intensity and open space ratio towards sustainable urban form, with a focus on the spatio-temporal transformation of cities in sub-Saharan Africa. This article was published in the Urban Design and Planning journal by Proceedings of the Institution of Civil Engineers in 2023 (Volume 176, DOI: 10.1680/jurdp.22.00014).

Chapter Three examines urban transformation and associated emerging urban forms, particularly addressing physical density from the perspective of planning interventions. This article was published in the Journal of Regional and City Planning by the Institut Teknologi Bandung in 2023 (Volume 34, DOI: 10.5614/jpwk.2023.34.1.3).

Chapter Four investigates the relationship between street hierarchy and land use functions in developing countries, focusing on Dire Dawa, Ethiopia. This article was published in the African Geographical Review Journal by Tailor and Fransis in 2024 (Volume 43, DOI: 10.1080/19376812.2024.2315059).

Chapter Five encapsulated the integration of discussions and implications, serving as a foundation for the overall discussion, conclusions, and recommendations drawn from the research findings. This chapter facilitated an in-depth examination of the study's implications, enhancing comprehension of the research context and its wider relevance.

Chapter Six presented the conclusions as the culminating section. Additionally, the recommendations arising from these conclusions provide actionable insights for future research avenues and practical applications, thereby enriching the advancement of knowledge in the field.

In addition to these seven primary chapters, the dissertation incorporates supplementary components aimed at enriching the overall structure and content. These supplementary elements, including abstracts, references, annexes, and related materials, provide additional context and support for the main chapters, enhancing the depth and breadth

of the dissertation's coverage. Together, these components ensure a robust and comprehensive presentation of the research, fulfilling the requirements of academic scholarship and facilitating further inquiry into the subject matter.

CHAPTER TWO

2. USE-MIX INTENSITY AND OPEN SPACE RATIO TOWARDS SUSTAINABLE URBAN FORM: SPATIO-TEMPORAL TRANSFORMATION OF CITIES FROM SUB SAHARAN AFRICA PERSPECTIVE

***Abstract**: A sustainable urban form is supposed to accommodate a mix of varied compatible land uses with an ample open space ratio though going through transformation. This study thus aimed to examine the sustainability of the pattern of land-use transformations from the perspective of Sub-Saharan African cities. It also looked at the consequences from the formal and organic planning interventions' perspective and each case area's position with respect to the inner city. To this goal, the land-use mix and open space ratio are compared over time on both plot and neighborhood levels, which is both scholarly and practical. Six cases from three morphological periods are studied. The results indicate that the intensity of mixed-land use has declined over time on the scale of plots, but not in neighborhoods. Besides, moving from the historic core to the periphery reduces the intensity of mixed-land use at the neighborhood level, subjected to the potential development of the space. The trend of mixed-land use intensity is decreasing, reflecting a reduction in the sustainable urban form. To avert this, cities need to integrate principles from both the organic development and formal planning act and consider a balanced mix of uses at both plot and neighborhood levels.*

Key Words: Urban form; land-use transformation; sustainable urban form; mixed-land use; open space ratio

2.1 Introduction

Numerous academics in the field of urban morphology have their theoretical roots in the Conzonian school, which separated urban form into four components: building structure, street pattern, land-use pattern, and plot pattern (Conzen, 1960; Larkham & Conzen, 2014; Oliveira et al., 2018; Van Nes et al., 2012; Ye, 2015). These Conzen's morphological elements would be used to assess urban form for a better understanding of the built form via the historical process of constructing cities (Ahmadi et al., 2017). Based on a similar notion, Madanipour (1996) defined urban morphology as the systematic study of urban form, which includes the shape, plan, structure, and functions of the built fabric of towns and cities. Grounding on this Conzonian school, which is a qualitative one, recent urban morphology studies have sought to measure these components alone or in combination, depending on the examination's purpose. The purpose of this study is thus to examine the sustainability of the land-use transformation trend based on one of the components of Conzenian urban form elements through the morphogenesis of the case city, Dire Dawa. In addition, it attempts to examine the results from the perspective of the planning interventions (formal and organic) and the location of the case area with respect to the whole city. To fulfill the research's purpose, the mixed-land use and open space ratio are used to investigate the city's trend toward sustainable land use development by comparing the intensity of mixed-land use and the open space ratio (OSR) of the parcels under investigation over time.

Different recent studies have given prior emphasis for sustainable urban form (SUF) like: emphasizing the significance of compact urban form from sustainable urbanism perspective (Rice, 2010); attempting to link nature with urban form (Alizadeh et al., 2019), efforts towards the development of sustainable smart cities (Sameer et al., 2022), and sustainable urbanism as an evolving trend (Balsas, 2022) would be some of them. This study however, attempted to look towards sustainable urban form through the transformation of mixed-land use intensity and open space ratio with in the morphogenesis eras of a Sub-Saharan city, Dire Dawa.

Many cities in Africa, especially in Sub-Saharan Africa, were not purposefully formed or reconstructed in order to have a regular shape; rather, they were developed and refurbished through a piecemeal approach so that one could witness both the planned and the organically developed nature at once (Musakwa & Van Niekerk, 2013). Similarly, the case study city, Dire Dawa, which has been established by Ras Mekonen,

the father of the late Emperor Haile Silasie I, in 1902 at the Eastern part of Ethiopia, has exhibited such a character (Gebreyesus, 2019). The reason for its establishment was to function as an intermediate maintenance and inspection station for the Ethio-Djibouti railway (Wolde-Michael, 1973). Dire Dawa is the country's second largest city (UN-Habitat, 2008; Worldometer, 2022a), and the only chartered city of Ethiopia next to the capital Addis Ababa (Łykowska, 2011). It hosts the largest industrial park of the nation where its first phase has been completed (Gebreyesus, 2019). In addition, the city serves as an import and export gateway of Ethiopia through Port Djibouti following the newly built standard gage train station, dry port and a highway, which thus gave rise to have immense social and economic significance not only in the country but also in Eastern Africa region. A study of this situation would therefore provide fresh light on the academic environment, which has been the subject of just a few studies before.

Land-use studies in Africa, especially in Ethiopia, have traditionally focused on horizontal spatial dimensions, overlooking the vertical perspective. Urban plans often resemble simple zoning maps, with different colors representing various land uses. By incorporating a vertical dimension into the analysis, one can gain a more comprehensive understanding of urban development in the region. This approach, while not entirely novel globally, offers a fresh perspective for research in Africa.

Apart from the contextual peculiarity, the research topic is also novel in the sense that, to the best of the authors' knowledge, most previous studies and approaches focused on street density, linkage, junction, and land-use intensity while disregarding the open space ratio or addressing it individually from the perspective of density. Thus, this study aims to see the sustainability of the development trend of Dire Dawa city considering representative cases of its different development eras since its establishment. Sustainable urban development is a subject of study and practice that is constantly evolving (Balsas, 2022). In areas where the concept of sustainable development has become an evolving trend, addressing the issue would help to see its different perspectives.

Mixing complementing land-uses has been an increasingly significant objective in urban development interventions of recent decades considering its sustainability benefits. This intensity of mixed-land use has been proven to affect travel behavior, health outcomes, and neighborhood-level quality of life which in general influences

sustainability of an area's development (Manaugh & Kreider, 2013). Musakwa and Van Niekerk (2013) have also illustrated the significant positive correlation between the intensity of mixed-land use and sustainable urbanism. Besides, Chiaradia et al. (2013) argued that walking is most strongly connected to metrics of mixed-land use intensity among others, and the number of destinations within walking distance which in turn has implication on sustainability.

The relationship between mixed land use intensity and sustainable urbanism is a significant area of inquiry in urban planning. Although there is no definitive study pinpointing the optimum level of mixed land use that ensures sustainable urban forms (SUF), a consensus exists that higher mixed land use intensity correlates positively with achieving sustainable urban environments.

This assertion is supported by various studies that highlight the benefits of mixed land use for sustainable urbanizm. Mixed land use is widely recognized as a fundamental principle of sustainable urban development. For instance, UN-Habitat emphasizes that integrating residential, commercial, and recreational spaces can contribute in enhancing urban livability (Dong & Zhang, 2022). Furthermore, the compact city model, which advocates for density and mixed land use, is seen as a leading paradigm for sustainable urbanism, (Bibri & Krogstie, 2020). This model is reinforced by findings that suggest mixed land use configurations lead to increased activity intensities, thereby improving urban vitality and quality of life (Jacobs-Crisioni et al., 2014).

Moreover, the integration of mixed land use is linked to various sustainability outcomes. Research indicates that mixed-use developments can enhance social sustainability by fostering community interactions and improving safety through increased street activity (Ghosh & Raval, 2022).

As a result, while the exact optimum level of mixed land use intensity for sustainable urbanism remains undetermined, the prevailing evidence suggests that a well-planned mix of land uses is essential for achieving sustainable urban forms. The integration of diverse land uses not only enhances urban vitality and social interactions but also contributes to environmental sustainability, making it a critical focus for urban planners and policymakers. Apart from this, existence of open spaces in one's area is also one sustainability indicator as it allows for better circulation, recreation and breathing (Manaugh & Kreider, 2013).

The usual approach of such studies bases on neighborhood level assessments whereas this study attempts to look at the scenario both from neighborhood and plot levels perspective. In addition, an assessment of change in the open space ratio (OSR) through the different spatial transformation eras of the city is made so as to comprehend the trend of open space provision and ultimately to assess the sustainability of the development trend. Alongside with this, the comparison considers the formally planned areas and the organically developed parts of the city with in a morphological era where appropriate. As a result, this study will have a multi-faceted contribution to both the academic world and in the practical urban planning and design interventions for practitioners.

2.2 Materials and Methods

The method employed here in this article is a case study method. A case study is an empirical approach that explores a current occurrence the "case" in-depth and within its real-world environment, particularly when the boundaries between phenomenon and context are unclear (Yin, 2018). It requires a thorough investigation, by combining various observations (Gerring & Cojocaru, 2016). Similarly, Gillham has defined a case study as one that analyzes a study case in order to answer particular research questions and seeks a variety of various types of pieces of evidence (Gillham, 2000) which thus made this study method appropriate for this type of research. Also, Scheer (2017) has further emphasized that case studies are commonly used in urban morphology research to compare information about individual areas and formulate theories based on observed trends.

The function of the built fabric, which is land/building use is considered as a significant element and determinant factor of urban form (Conzen et al., 2012; Conzen, 1960; Larkham & Conzen, 2014; Oliveira et al., 2018) and it has been attempted to be studied from different perspectives where the study approach of Van den Hoek (2008), MXI (Mixed-use Index), has got prior significance and used by different researchers of the area of this period (Carpio-Pinedo et al., 2021; Manaugh & Kreider, 2013; Van Den Hoek, 2009; Van Nes et al., 2012; Ye & Van Nes, 2014a; Ye & Van Nes, 2014b; Zhuo et al., 2019). Some of the studies have modified or combined it with other methods depending on the specific need of individual studies where some have also linked it with sustainable development denoting the mixed-land use as one aspect of sustainable

urban form (Dawodu et al., 2022; Ferrari et al., 2022; Yigitcanlar et al., 2015). This study has used a Mixed-use Index (MXI) which is a quantitative-based analysis instrument that helps to assess the concept of "mix," or the functional composition and mix of applications categorizing the sets of different functions under three categories as living, working and amenity (Van den Hoek, 2008). Besides, Spacematrix, a spatial analysis instrument developed by Berghauser Pont and Haupt (2010), is employed so as to detect the open space ratio (OSR) of the parcels in the case sites throughout the various morphological eras of the city.

The case city, Dire Dawa is the second largest city in Ethiopia and is located at the eastern edge of the nation which also has an influence in the horn of Africa (see Figure 2-1). Methods to urban growth management are dependent on advances in our understanding of the causes, timing, and impact of the urbanization process, as well as its driving factors (Longley & Mesev, 2000). This study thus has attempted first to assess the density of mixed-land use in the selected sites of this case city in both horizontal and vertical manner employing mixed-use index (MXI) as an instrument. Secondly, an examination of the sustainability of the urban form is made through the trend of land-use development of the city during its different morphological eras. Finally, an assessment of the open space ratio (OSR) provision of the different period developments is made to compliment the assessment of the sustainable urbanism development trend. This is made through a comparison among the selected case sites.

Comparing sustainable urban forms over time within the same city or across cities at the same time is possible (Pili et al., 2017). This research looked at this from the viewpoint of a single case city across different times. A city level study like Bekkering et al. (2019) have made on Wuhan would be possible in cases where there could be data availability that describe each periods development. In this study however, the required data are detailed as well as of different periods and thus it is difficult to address this study at a city-wide level. To this purpose, the researchers sought to classify the city's morphogenesis period into several morphological eras in order to comprehend the morphological features of each of the city's development phases throughout history and to determine the city's current morphological position. Then, for each of the morphological eras, the land-use patterns were identified. This was a challenging undertaking to do, but with the assistance of interviews and participants in focus group

discussions plotted on a map and a site visit, it became achievable. Additionally, this strategy assisted in identifying the plot patterns and building structure of each case area, allowing for reconstruction of each case site in conjunction with historical maps, pictures, and Google timeline images.

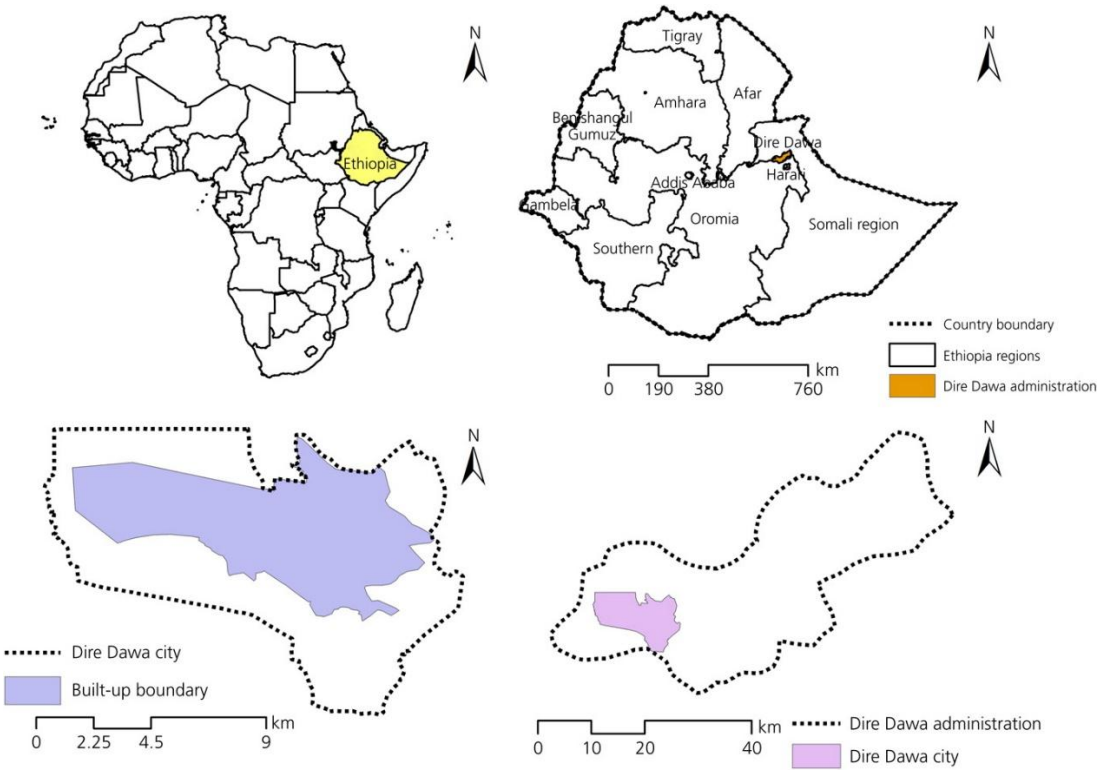

Figure 2-1: Location Map of Dire Dawa City

The level of mix of the different land-uses identified in this study has been seen from the perspective of the trend of development of the city of Dire Dawa dividing the city's life period in to three different morphological eras. This has been done considering six representative samples based on the influence of each of the periods so that the cases are demonstrative of the respective morphological eras and to identify the trend of development with respect to sustainable land-use considerations.

The governance eras of the city are inextricably linked to those of the nation, and thus preferred to be used to classify the periods of morphogenesis of the city. With this respect, the first one is the early morphogenesis era including both the early establishment period of the city (from 1902 to 1935), and Italian occupation (1936 - 1941); the second one is the intermediate morphogenesis era encompassing the Imperial

regime following the Italian occupation (1942-1974) and the Dergue period (1975 - 1991); and the last one is the recent morphogenesis era which encompasses the period since 1992. The selected sites may seem to be concentrated to the eastern part of the city but the development in the western side is in progress and is not well developed yet though it is under the urban jurisdiction of the city and thus the cases emphasize on the built-up area, see Figure 2-2.

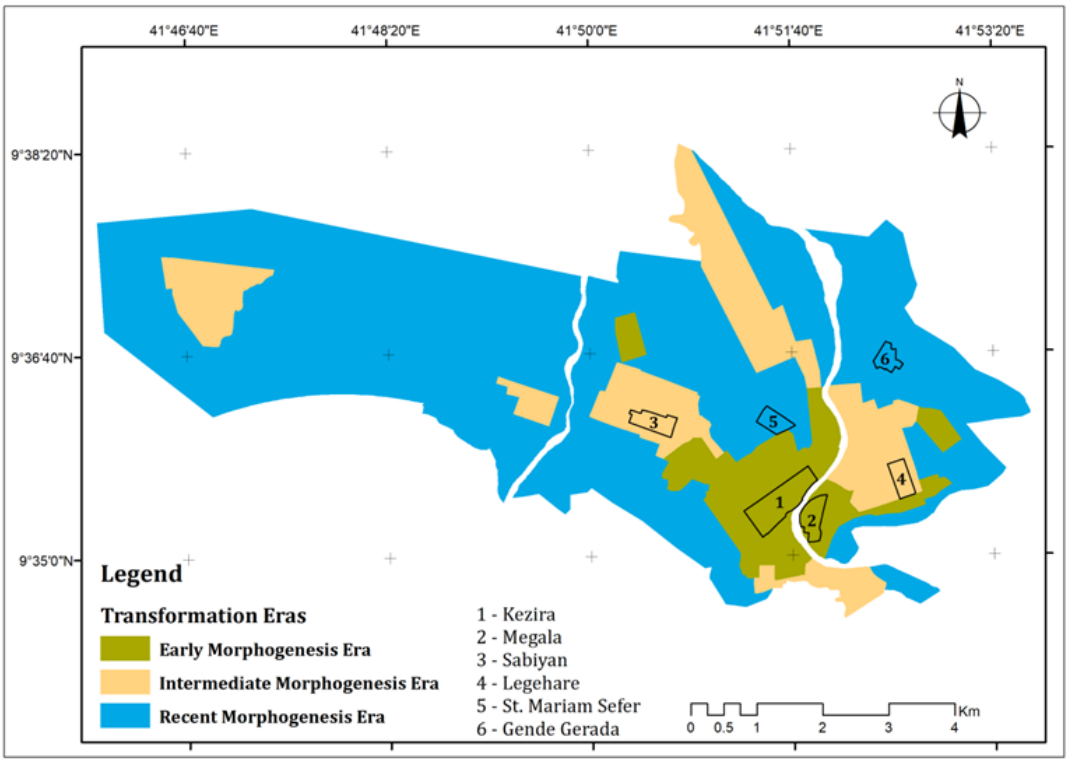

Figure 2-2: Case areas of the study from the different transformation periods of Dire Dawa

Source: Dire Dawa city municipality processed on Arc GIS 10.4

Identifying the land-uses of each of the parcels in the case areas was difficult, especially of those which are in the first two morphological transformation periods of the city. The archival resources would not be able to tell as to what the uses of those parcels have been during their early existence period in-depth. The problem is aggravated further being coupled with the less resilient nature of the land and building uses in comparison with other urban form elements. To tackle this problem the researchers have considered the master plans developed for the area during the early establishment period by French Architects and later during the Italian occupation by the Italians assuming that the plans have been implemented with few alterations. A desk review

and in-depth interviews were conducted to supplement this and to minimize the errors. The assumption was made based on the assessment conducted in the *Kezira* area (one of the case sites) which has witnessed the implementation of the first plan in its physical perspective and has existed for long despite some alterations which are being made in recent periods. Due to the similarities in the interventions made, early evolutionary period and the Italian occupation era are accounted as one morphological era.

For the periods after the withdrawal of Italians, surveys of the earlier and the current uses of the premises were inquired from the householders and rectified by the cadastral data of the city. The shares of the different uses in the case of mixed-use plots are identified basing on the shares of the building floor areas that they have assumed leaving the communal areas aside.

After having identified the land-use, the building footprints and the heights of the buildings within each plot in the case study sites, then it would become possible to identify the floor space index (FSI) and the ground space index (GSI). These helped to identify the open space ratio (OSR) based on the identified figures for each FSI and GSI. According to Pont and Haupt (2010) open space ratio (OSR) is sometimes known as spaciousness, quantifies the amount of unbuilt space at ground level per square meter of gross floor area. This graph indicates the amount of non-built space that is under pressure. OSR is measured in m^2/m^2.

$$OSR=(1–GSIx)/FSIx$$

Therefore, a comparative analysis of the case study areas is made so that it could be possible to examine the trend of development of the city from a sustainability perspective. The level of correlation of the land-use intensity and the open space ratio in the different morphological epochs of the case city could enable to identify the cross-case scenario and establish a theory based on the different periods. In doing so, the formal planning context of the sites and the location implication of the case areas are attempted to be addressed which is thought to have a significant influence on the land-use intensity of the city among other factors. The influence of these factors is also sought to be identified in the process. The result is thus displayed in a map and graph which could signify the level of correlation identified from the study. These are also described in narrations supported by theoretical and empirical evidence from studies

conducted so far.

2.3 Results

The data are arranged chronologically in accordance with the morphological eras investigated in this study. The goal of this research is to examine the sustainability of the morphological transformations seen throughout the city's morphogenesis depending on land-use intensity at both the plot and neighborhood level and the trend in the provision of open space ratio at each plot. In doing so, it has attempted to evaluate the relationships between the functional intensity of plots and neighborhoods along with their respective open space ratio and of course make a comparative analysis across the chronologically ordered case areas.

2.3.1 Early Morphogenesis Era (1902 -1941)

The early morphogenesis era encompasses the period from the early establishment of the city till the withdrawal of Italians. The selected case areas representing this morphogenesis era are Megalla and *Kezira* where the former one is an organically developed part while the latter is formally planned part of the city. Both are located in the historic core of the city where they are separated by the Dechatu dry river bed.

As shown in Figure 2-3, the ternary diagrams illustrate the three components of land use: Living, Working, and Amenity. The distribution of each area across these categories is represented within the triangles. These diagrams effectively visualize the proportion and balance of different land uses within each area. Specifically, the ternary plots highlight the relative proportions of the three land use categories in two areas of Dire Dawa: Kezira and Megala. Each vertex of the triangle represents 100% of one land use category, while the interior points reflect combinations of all three.

The ternary plot for Kezira shows that the land use mix is primarily concentrated along the living and amenity axes. Many points are clustered near the living vertex, highlighting a good proportion of residential land use. Additionally, there is a noticeable spread of points along the amenity as well as the working axis, indicating that a substantial portion of Kezira’s land is dedicated to amenities and working. In contrast, the points for Megala are more widely dispersed across the triangle, reflecting a more varied distribution of land uses among living, amenity, and working. A significant concentration of points is located toward the middle and lower parts of the

plot, suggesting that many areas in Megala have a balanced mix of living, working and amenity use. However, there are fewer points near the working vertex, indicating that purely working areas are less prominent in Megala.

Thus, as illustrated in Figure 2-3, the early stages of Dire Dawa's morphogenesis from the standpoint of land-use intensity acknowledged the importance of mixed-land use in both the formally planned and spontaneously evolved parts of the city. *Megala*, the organically developed section, appears to have placed a greater emphasis on higher land-use intensity during the city's early establishment period. Conversely, *Kezira*, which was fundamentally based on the city's train station, has some level of land-use intensity but to a lesser extent than its organically developed counterpart. *Megala*'s organic development has enabled it to accommodate several functions, establishing working, living, and amenity at a plot level. There are still a significant number of dual-use plots in addition to the monofunctional ones located on the periphery, which are mostly used for residential purposes. Conversely, in the planned component of the city, *Kezira*, there are a few dual-functioning plots among the bulk of single-use plots.

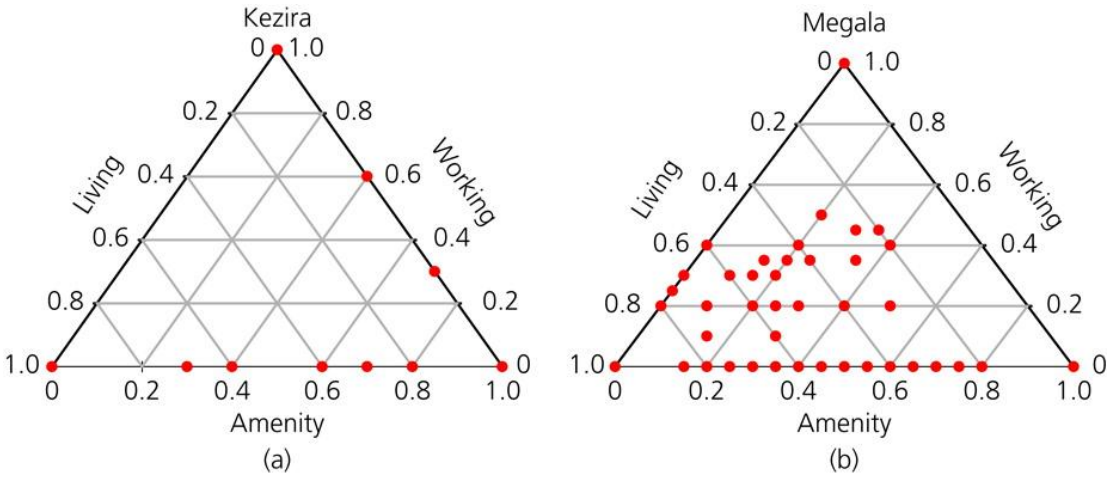

Figure 2-3: Mixed-use Index results of *Kezira* (a) and that of *Megala*(b)

2.3.2 Intermediate Morphogenesis Era (1942 -1991)

The next morphological era considered in this study enclaves the period referring to the last Imperial administration of the nation since the withdrawal of Italians and then the Dergue period which was a socialist administration. This morphological era is represented by two distinct cases, *Legehar* and *Sabiyan*. Both of these cases are formally planned areas. Due to the strict control of the governments of the period it was

difficult to find a full-fledged organically developed settlement emerged in this period as a result areas developed with a formal plan have been considered as cases. In terms of location, the case area representing the final Imperial era, *Legehar*, is situated east of the city's current geographical configuration near the outskirt, but the subsequent governance period, representing the Dergue administration, *Sabiyan*, is placed close to the city's current geographic center.

Figure 2-4 depicts that the points on Legehar's ternary plot show that most of the land in Legehar is allocated to residential use. The proportions of land dedicated to working and amenity purposes are relatively low. The clustering of data points near the Living vertex highlights the area's strong focus on residential land use. In contrast, Sabiyan, while also having a significant proportion of residential land, displays a more balanced distribution. The proportions of land for working and amenity purposes are higher in Sabiyan, indicating a more diverse range of land uses compared to Legehar.

In both cases, as indicated in Figure 2-4, dual functioning mixed-land uses are located on distinct plots inside the case areas, while it is uncommon to find a multi-functional plot that combines three of the purposes, dwelling, amenity, and working. In the *Legehar* neighborhood, few traces of a tri-functional plot living, working, and amenity have been discovered. However, the majority of plots are monofunctional, with the living function taking precedence. In the case of *Sabiyan*, this is an area where it is aiming to compete with the city's historic core, *Kezira*, and *Megala*, for the position of central function. Almost all of the dual mixed purposes are a combination of amenity and living, followed by working and living; it is uncommon to find a plot that operates as both working and amenity.

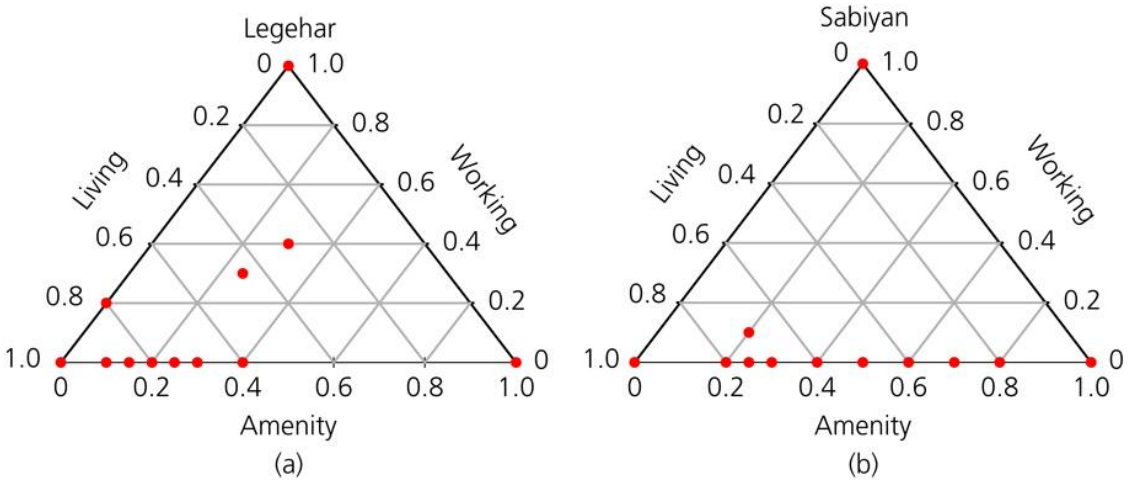

Figure 2-4: Mixed-use Index results of *Legehar* (a) and that of *Sabiyan* (b)

2.3.3. Recent Morphogenesis Era (Since 1992)

The other morphological era considered in this study is the city's recent transformation period since the end of the Dergu socialist administration. This is an era of growth during which the city has experienced many changes, resulting in a massive expansion that allowed the city to more than double its former size. Due to the size of the geographical sphere of the city's growth, two case areas were chosen, Mariam *Sefer* and *Gende Gerada*. To ensure that the samples are representative of the morphological era's development scenario, the former one is taken from the formally planned development while the latter one represents the organically developed part.

Figure 2-5 depicts that Most of the land in St. Mariam Sefer is allocated to residential use, with relatively small proportions dedicated to working and amenity purposes. The data points are clustered near the Living vertex, reflecting a strong focus on residential land, though there is also a notable presence of both living and working spaces. In comparison, Gende Gerada also has a substantial amount of residential land but shows a more balanced land use distribution. The proportions of working and amenity land in Gende Gerada are higher than in St. Mariam Sefer, suggesting greater diversity in land use. The data points in Gende Gerada are more spread across the plot, indicating a broader mix of land uses and less concentration on residential areas.

The first site, as indicated in Figure 2-5, Mariam *Sefer*, is being developed via a mix of real estate, government-managed condominium housing, and privately developed commercial and service premises. This case area was developed in a formally planned manner and is located in between the city's historic core (*Megala* and *Kezira*) and the city's geographic center at its present size (*Sabiyan* area). While it is uncommon to find a plot that serves all three functions, amenity, working, and living, simultaneously in this case areas, dual functional plots are prevalent. As previously said, the majority of dual-functional uses involve a combination of living and amenity, however, others represent a combination of working and living; nonetheless, it is uncommon to find a combination of working and amenity at the same time. There are also plots dedicated to a specific purpose, such as housing, amenity, or working.

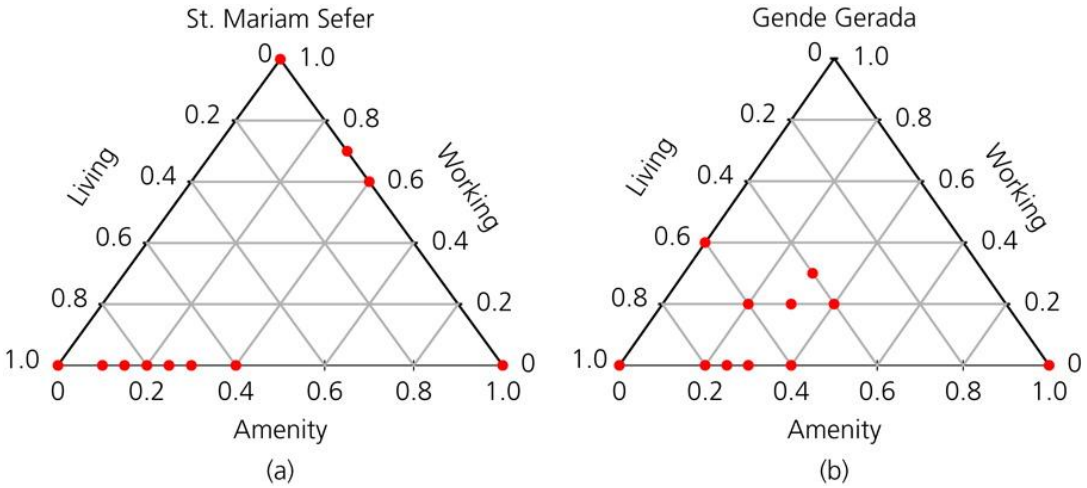

Figure 2-5: Mixed-use Index results of St. Mariam *Sefer* (a) and that of *Gende Gerada* (b)

On the other side, the *Gende Gerada* case area is situated on the city's northeastern outskirts, where the town expanded haphazardly without a formal planning intervention throughout its prior existence, though some regularization measures have been made. This region is mostly residential; however, some plots have a mix of various purposes, indicating a greater land use intensity than the Mariam *Sefer* in terms of entertaining amenities, living and working in the same plot. The plots designated for amenity purposes take up the majority of the plot size, followed by working areas. Plots with a dual use do have a bigger area than those with an exclusive dwelling purpose. In relative terms, multi-functional plots occupy a bigger area than dual-purpose plots.

Apart from the plot level evaluation, a neighborhood assessment is conducted to further simplify the mixed-land use intensity on a larger geographical scale and to get a new perspective on the issue. Similarly, the open space ratio (OSR) is also discussed, which takes both the ground floor index (GSI) and the floor space index (FSI) into consideration. The mean of the open space ratios of each plot is used to calculate the neighborhood-level open space ratio.

At a neighborhood level assessment, during the early morphological period, it is determined that the *Kezira* district, which is the historic core and the formally designed portion of the city, has the highest degree of mixed-land use. Whereas *Megala*, the city's organic historic center, advanced to the next rung on the ladder of use mix. The neighborhood level intensity of mixed-land use in the intermediate period (the last

Imperial and the Socialist periods), on the other hand, has recorded a lower level of intensity than the early morphogenesis period with minor distinctions between the two observed cases as can be seen in Figure 2-6. The *Sabiyan* case area seems to have a higher level of mixed-land use, while *Legehar* appears to have a lower level. Similarly, the recent transformation period has indicated a lower rate of mixed-land use intensity where there are some distinctions in between the considered two cases of these morphogenesis periods.

The open space ratio as shown in the city's various morphological phases in **Table 2-1**, indicates a general decline in the proportion of open space provided from the early to the present morphological periods. There is an exception in the instance of the *Gende Gerada* region on the periphery, which has evolved spontaneously with no formal planning intervention, allowing for a high open space ratio. Otherwise, there is a general downward tendency in the open space ratio from the distant past to the present, particularly in the trend of formally designed neighborhood scenarios.

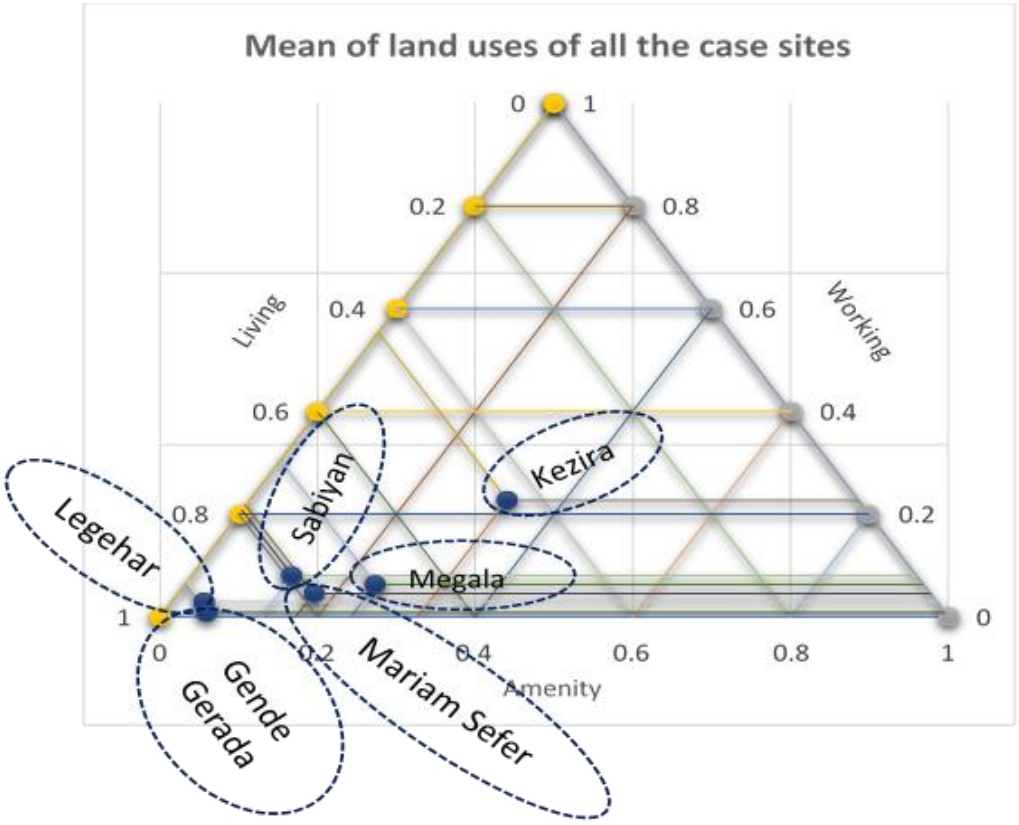

Figure 2-6: The trend of the mean of land use mix intensity in the morphogenesis of the city

Table 2-1: Mean of the mix of uses and their respective open space ratio in different morphological periods

S/N	Case Areas	Morphological era	Amenity	Working	Living	OSR
1	*Kezira*	1902-1941	0.327	0.227	0.446	1.688
2	*Megala*	1902-1941	0.242	0.063	0.695	1.26
3	*Legehar*	1942-1975	0.04	0.029	0.931	1.23
4	*Sabiyan*	1976-1991	0.128	0.08	0.792	1.21
5	St, Mariam *Sefer*	Since 1991	0.172	0.045	0.783	0.69
6	*Gende Gerada*	Since 1991	0.056	0.008	0.936	6.57

2.4 Discussion

The purpose of this research is to determine the sustainability of the land-use transformation trend observed throughout the morphogenesis of the case study city. Additionally, it examines the effects from the standpoint of the planning intervention (formal and organic) and the case area's position with respect to the inner part of the city. To accomplish the research's objective, the mixed-land use intensity and open space ratios of the case areas are compared over time to determine the city's trajectory toward sustainable urban form in the study area. The study is made on the basis of two spatial spheres, one at plot level and the other at neighborhood scale so as to visualize the scenario from different perspectives. The discussion is presented in a sequence beginning with the plot level examination and progressing to the neighborhood level.

During the first stage of development (1902 - 1941), *Kezira* and *Megala* are the two case sites that have been the city's significant development centres and continue to be the historic urban cores that underlie everything around them. Both of these instance areas, *Kezira* and *Megala*, are located in the historic center of the city and are separated by a dry river bed of *Dechatu*. Despite the fact that they were built at the same time, they have demonstrated a distinct historic scenario in their growth. The former is the result of a formal plan related to the construction of a train station in this area, whilst

the latter is an organic equivalent that had less official planning intervention. This period's formal planning practice was fond of land-use segregation and stringent zoning laws although mixed-land use approaches are now preferred (Dempsey et al., 2010; Grant, 2002; Van Den Hoek, 2009). The results of these case areas indicate that the planning intervention made in this period could have an influence on the level of mixed-land use intensity of the formally planned area while the organic one follows the traditional development trend where urban settlements are developed in a mixed manner responding to the demands.

Van Nes et al. (2012) has described that the historic core of cities tends to accommodate all the three functions, working, amenity, and living in comparison to the other parts of a city. However, as has been noted from the plot level examination of mixed-land use, it seems here that formal planning act and the period of development have got prior influence on the urban form of this case areas than the centrality issue.

The other cases representing the intermediate morphogenesis period, the latter Imperial governance after the evacuation of the Italians (1941 - 1973) and the Dergue period, a socialist Ethiopia (1974 - 1991), are *Legehar* and *Sabiyan* areas of the city. The case areas do have all the three functions, living, working and amenity assuming their own individual plots. Furthermore, there is an abundance of land-use mixes, particularly residential and amenity, in both case areas, indicating fewer, if any, instances of a blend of the three uses in one plot. Because of possible negative externalities, planners have historically sought to segregate land-uses (Dempsey et al., 2010; Van Den Hoek, 2009). Both of these places were developed in a planned way, with regular plot divisions based on the plans produced for each development era. This would have resulted in less mixing of all three uses at the same time.

The fundamental difference between these two cases is the proportion of the use mix, with the former reflecting a bigger percentage of living than amenity and the latter reflecting a more equal distribution of spatial use of mix in between living and amenity. According to Ibrahim and Omer (2014), locational importance plays a role in defining the shapes of urban areas, with one having a stronger significance than the other and so taking on a distinct form. Similarly, the disparity in the share of the mix of uses in the cases of *Legehar* and *Sabiyan* would result from the two cases' different locations: the former is located near the city's outskirt to the east, while the latter is located at the

geographic center of the current expanse of the city. *Sabiyan* case area is thus fighting with the historic core to establish itself as one of the city's subcenters, but *Legehar* is unable to attract developers owing to its location, which does not allow for future growth in this direction. In both situations, formal planning practice has hampered the occurrence of a multiple use mix at the plot level, where there is no difference in this regard. However, locational variances have contributed to variations in the intensity of mixed-land use, implying that location may also have an impact on the assignment of sustainable land-uses across a city region.

The last two cases that illustrate the recent morphological era since 1992 are two because of the reason that this morphological era has witnessed extensive spatial development coverage. The case areas to represent this morphological era are St. Mariam *Sefer* and *Gende Gerada* localities. St Mariam *Sefer* is located at a good proximity to the center in between *Sabiyan*, the geographic center of the city and *Megala* and *Kezira*, the historic core of the city. This case area has been developed following a strict and formal plan intervention. Whereas *Gende Gerada* is located at the north eastern outskirt of the city which has been developed organically with no formal planning intervention. The former does not show evidence of a blend of the three functions, but the later has seen this on multiple occasions. This morphological era has indicated a clear division made by formal planning act in the mixed-land use distribution. As has been seen earlier, studies have emphasized the significance of location and its influence on land use mix (Dong et al., 2019; Van Nes et al., 2012). Similarly the formal planning interventions do have an influence on the forms of settlements (DeLisle & Grissom, 2013; Van Den Hoek, 2009). The intensity of mixed-land use exhibited in this morphological era could be attributed to those two factors: the first is connected to the official planning process in the two locations, and the second is related to their location.

In the second sphere of research, the study examines the trend in the level of land-use mix and the trend in the open space ratio in relation to neighborhood level sustainable development. Choguill (2008) describes neighborhoods as the fundamental building blocks of cities, with the total sustainability of a city dependent on the neighborhood's sustainability and thus he promotes to see sustainability from neighborhood perspective. Rice (2010) added also that walkable mixed-use neighbourhoods would be

more suited to sustaining a sustainable urbanism. Although plot level land-use mix has its own significance in accessing living, amenity and working at once, neighborhood level land-use mix also contribute in accessing these different functions in a walking distance. Therefore, apart from the plot level examination, neighborhood level assessment of the scenario would help to give a good insight over what already has been identified in the plot level analysis result.

The neighborhood level assessment, during the early morphological period, has indicated that the *Kezira* district, has the highest degree of mixed-land use while *Megala*, the city's organic historic center, advanced to the next tire. The basic reason for this would be the reason that the city had only these two areas to accommodate all its activities where thus the rate of mixed-land use has become higher in *Megala* and *Kezira* during the first morphological era. As a result, the level of use mix in the area from the neighborhood perspective has become higher due to the basic reason that it has accommodated every function of the city with in this boundary in these two areas which thus has exhibited its own specific character.

In the planned historic core mixed-land use at plot level is rare where one could find higher level of mixed-land use at neighborhood level. On the other hand, in the organic historic core of the city the use mix at plot level is very prominent and at the same time it also reflects a better level of mixed-land use at neighborhood level with a lesser amount compared to the planned historic core. The claim of Van Nes et al. (2012) which described that the historic core of cities tends to accommodate all the three functions, working, amenity, and living in comparison to the other parts of a city is reflected in the level of neighborhood though not significantly witnessed at the examination made at plot level.

On the other hand, the neighbourhood level intensity of mixed-land use during the intermediate era (the last Imperial and the Socialist periods) was lower than the one exhibited during the early morphogenesis period, with small differences between the two observed case scenarios. *Sabiyan* seems to have a larger degree of use diversity, while *Legehar* appears to have a lesser degree of use diversity being dominated by living function. This period's development is guided by a formal plan where the difference from this perspective at neighbourhood level analysis would be minimal. The main reason for this would basically be the location of the two sites where the

former is located to the area where the city expansion is directed to while the latter is located in an area where the city would be unable to expand further due to the presence of a large textile factory and a topographic barrier. In this morphological era, thus, the observed scenarios at plot level and neighbourhood level do exhibit a analogous situation.

Similarly, the recent transformation era, where St. Mariam *Sefer* and *Gende Gerada* are the case areas, has shown a decreasing rate of usage mix intensity, with some differences between the two examples analyzed during this morphogenesis period. The data has indicated that the former case area, which is developed in a formally planned manner and located at close proximity to the inner city has a better use mix than the latter one which is developed in an organic manner and located at the periphery of the city's existing expanse. The neighbourhood level examination of this period seems basically influenced by both location and formal planning act.

Beyond the analysis of land-use mix, another critical dimension considered in this study is the open space ratio in each of the case study neighborhoods. Open spaces, such as parks, green areas, and public plazas, play a vital role in urban environments by enhancing the quality of life, supporting environmental sustainability, and promoting social interaction. Through the analysis, it has been observed that there is a general decline in the share of open space ratio over different periods of the neighborhoods' development, reflecting changes in urban morphology. One key factor contributing to this decline is the increasing trend of built-up areas—as urban development progresses, more land is consumed for construction, reducing the amount of open space available. However, while this increase in built-up areas is a logical explanation for the reduced open space ratio, it is crucial to emphasize that neighborhood-level planning should account for and preserve open spaces as part of a balanced urban growth strategy. By doing so, urban planners can ensure that there is an equitable distribution of open spaces over time, which is essential for maintaining livability and ecological balance in urban areas. Thus, the study highlights the importance of comparative allotment of open space ratios across different morphological periods. This approach ensures that even as cities evolve and grow, there remains adequate and accessible open space in each neighborhood to serve the needs of the community and mitigate the effects of dense urbanization.

In general, when examining the mean density of mixed-land use at the neighbourhood level, there seems to be some pattern of growth in the intensity of use mix throughout the course of the city's existence. *Kezira* and *Megala*, which form the city's ancient centre, have the largest density of uses, followed by *Sabiyan* and St. Mariam *Sefer*, and finally *Legehar* and *Gende Gerada*. According to the neighbourhood level research, moving out from the historic centre of the city to the periphery results in a decline in the intensity of mixed-land use regardless of the planning interventions made and the morphological periods of the studied instances.

Many writers have suggested mixed-land uses and spatially concentrated functions as one aspect of sustainable urban form (Dawodu et al., 2022; Ferrari et al., 2022; Westerink et al., 2013) where course these functions are compatible to each other. Furthermore, Madanipour (2011) has mentioned various elements in his research on sustainable development and urban form in Tehran, including the diversified pattern of land-use, which contributes to the sustainable development of urban areas, among others. Besides, Talen (2011) has also stated that a mix of land-uses is one of the pillars for guaranteeing a sustainable urban form. As this sustainable land-use form increases, transit and pedestrian use would also increase (Frank & Pivo, 1994). In addition, empirical evidence from Japan, the United Kingdom, and the United States demonstrates that it is feasible to obtain the benefits of land-use mix by offering a diversity of uses within walking distance at the neighborhood level, hence promoting sustainability (Sharifi & Murayama, 2014).

Sustainable cities are a priority for many governments' development objectives, but are especially critical in developing countries facing dangerously high rates of urbanization (UN-Habitat, 2009). Considering this, the majority of emerging cities and municipalities strive for sustainable development, though little is being done to operationalize the notion. Clearly, new concepts and strategies are required to assist in the management of sustainable land-use in those fast growing cities (Musakwa & Van Niekerk, 2013).

Looking the analysis at a broader scale from the perspective of sustainably, it would show the significance of the trend of development and footprint of each period’s urban form towards sustainable urban transformation. The basicconcept of sustainability dates back to 1970s since the publication of the Brundtland report (Komeily & Srinivasan,

2015) while sustainable neighbourhood planning has gained momentum since the turn of the century (Sharifi & Murayama, 2014). In this respect, Madanipour (2011) has signified the important conjugation of urban form and sustainability basically from the perspective of land-use. Besides, Madanipour (1996) has also described the significance of addressing urban form studies on the basis of the origin and evolution of their urban fabric across time. Similarly, this study has attempted to examine land-use intensity based on the mixed-use index through different time periods of morphological eras and assess the sustainability of the land-use transformation of the cases since the primary evolution till the current once but shaping it from both neighborhood and plot levels and integrating it with OSR.

At neighborhood level proximity to multiple functions at a walking distance is considered as a good indicator of better level of use mix (Ferrari et al., 2022; Sharifi & Murayama, 2014) which thus could be accounted as an indicator of sustainable urban form. Mixed-land use is also regarded as one of the cornerstones for urban sustainability (Carpio-Pinedo et al., 2021). With this notion, the assessment of the land-use development trend of the city indicates that there is a general decrease in the trend of intensity of mixed-land use which reflects as there would be a similar decrease in the attainment of sustainable urban form. This tendency is also exhibited in the trend of open space ratio provision of the study cases which thus make the situation worse.

Over-strict zoning separation of land-uses has resulted in a variety of unforeseen consequences, which planners and other policymakers are actively working to remedy by supporting mixed-land use development (Song et al., 2013). Studying the sustainability of land-use transformation across different time periods would have lots of significances. These would be observed from the effects of mixed-land use on the three different pillars of sustainability: economic, social, and environmental. From an economic standpoint, a diversified land-use pattern tends to reduce travel times, improve accessibility, reduce travel costs, and promote a more diverse work mix. Additionally, it promotes spatial and community integration, as well as physical activity, from social dimension, while also promoting environmental sustainability by encouraging non-motorized mobility, increasing transit use, and reducing car miles driven, resulting in reduced emissions and energy consumption, as well as land consumption (Musakwa & Van Niekerk, 2013). Thus, the presence of a trend of varied

range of land uses promotes sustainable urban growth. In the context of the case areas, the formal planning act has witnessed a decreasing trend in the intensity of mixed-land use over time at plot level while there is no regular pattern exhibited in the trend of intensity of mixed-land use at neighborhood level over time. There is also a decreasing trend in the mixed-land use intensity while going from inner city outwards which is subjected to the expansion potential of the space along that direction.

2.5 Conclusion

By examining the spatiotemporal features of urban forms in Sub Saharan Africa, one may acquire a better knowledge of the trend of urban morphogenesis and argue for future urban design, planning, and sustainable development policies. Though Ethiopia and the rest of Sub-Saharan Africa did not witness the industrial revolution in its entirety, the era's planning system had a profound effect on them as a result of their adoption of European and North American planning theories. As a result, they have highlighted mixed-land use as a critical component of their urban planning and design ideas and practices, despite the fact that their organic development tendency has been a strong advocate for mixed-land use in general.

The level of compatibility for the mix of different uses must be depicted in order to further streamline the degree of sustainability for the mix of uses. Additionally, there should be an optimum level of usage mix that would be deemed appropriate for a certain location. These two areas need further studies in order to bolster the development of sustainable land-use in Sub-Saharan Africa's ever-changing urbanization scenario.

Finally, it is recommended for the formal planning act to consider: balancing plot-level and neighborhood-level mixed-land-use intensity, achieving a responsive level of open space ratio at the neighborhood level, integrating concepts from organic development empirical experience and formal planning exercise in order to achieve a sustainable urban development with a sustainable urban form.

CHAPTER THREE

3. URBAN TRANSFORMATION AND ASSOCIATED EMERGING URBAN FORMS: AN EXAMINATION OF PHYSICAL DENSITY FROM PLANNING INTERVENTIONS PERSPECTIVE

***Abstract**: Rapid urbanization frequently results in unanticipated morphological traits that could have multifaceted consequences, especially in the urban physical transformation of cities in developing countries. This study aims to examine these spatial transformation events and identify the related emergent urban forms in the morphogenesis of Dire Dawa from the perspective of plan-led and spontaneous developments. The researchers conducted a thorough on-site investigation to gather the necessary physical information and supplemented it with a desk review and focus group discussion. The study utilized Spacematrix software to examine the data and pinpoint the evolving urban structures of different time periods. The overall, research demonstrates that point-type low-rise development dominates organically developed sites, whereas plan-driven developments are dominated by block-type low-rise and block-type midrise forms. Furthermore, except for the outlying areas, there is a rising trend in the floor space index and spatial coverage patterns over the course of the city's morphological eras. This may indicate a growing concern for space efficiency and sustainable development. The density of the street network in organically developed portions, on the other hand, is greater than those formally planned areas. This thus shows the relevance of considering the concept behind organic development in the planning and designing interventions besides the formal western planning philosophy.*

Keywords: Ethiopia; morphological transformation; physical density; formal planning; spontaneous development

3.1 Introduction

Cities are dynamic entities whose settlements change throughout time along with their form (Trisciuoglio et al., 2021), and they have been playing a central role in the political, economic, social, and intellectual developments throughout history (Zegeye Cherenet Mamo, 2015). In recent periods, the ever-increasing level of urbanization is posing difficulties in urban planning and design exercises (Qin & Zhang, 2014), where its effect may grow in tandem with the pace of urbanization. This rapid urbanization in sub-Saharan African countries, including Ethiopia, allows for massive spatial transformation in their cities (Agyemang et al., 2019). Such fast urbanization usually results in morphological patterns that are unanticipated and, in some cases, counterintuitive to expectations (Xie et al., 2007). These situations necessitate to conduct more investigations. The purpose of this research is thus to analyze these spatial form transformation events and the related emergent urban forms across history, taking six case areas of Dire Dawa city. This would allow us to answer the following two questions: What characteristics do formally planned and organically produced areas of the city display in their emergent urban forms as a result of the city's morphogenesis? Does the city's morphogenetic trend represent a sustainable pattern of development from the physical density perspective? The answers to the two questions could be a representative response for the scenarios exhibited in the second tier of cities in Ethiopia as well as in Sub-Saharan Africa.

The spatial form transformation of cities could be defined as the study of the effects of transformational changes in urban systems (Hölscher & Frantzeskaki, 2021). The vast majority of cities needed more and more land as the process of urbanization progressed. They crept up to the outskirts of villages, engulfing them, and this is how the urban transformation is taking place laterally (Chandra & Mukherjee, 2015). In the course of such transformations of cities, there would be urban expansion, which could include morphological additions to the city as well as certain adjustments in the previously existing areas. The essence of urban transition, on the other hand, may be expressed in the form of shrinking urban areas with associated changes in urban form, as the case of some developed countries (Cunningham-Sabot & Fol, 2009; Pallagst, 2009). In the context of this study, “urban morphologic transformation” refers to the changes in the urban texture of cities, both internally and externally, resulting in associated urban form

modifications in their morphogenesis. The primary goal of urbanism should thus be to effect urban transformation (Inam, 2013), which could bring about changes at various scales (Hölscher & Frantzeskaki, 2021). To ensure sustainable development, however, it is critical to have accurate information on the rate and patterns of this urban morphological transformation (Das & Angadi, 2021).

Several agents and agencies are accountable for and have an impact on, the complicated processes of urban spatial form transformation (Vítor Oliveira, 2016). Along with this urban spatial form transformation, the components that make up urban form are constantly transformed and replaced (Moudon, 1997). According to Bentley (2004), the process of form-production is characterized by a complex pattern of negotiation and conflict among several parties. These complex patterns of relationships can manifest in both organically developed and formally planned urban development cases. For instance, an urban form study conducted in slum areas in America, Africa, and Asia pointed out that organic urban development offers various opportunities to explore sustainable urban forms (Zappulla et al., 2014). Whereas urban form studies about the formally developed parts of cities are not uncommon. Urban form is commonly allied with the development of formal urban figures (Zappulla et al., 2014) while the organic one did not get proper coverage. However, Dabbour (2021) has studied the organic development of Islamic cities from Damascus perspective and in another context Zappulla et al. (2014) have seen the scenario of organic development from slum areas perspective. Therefore, it would highlight some perspectives from either side and enable for comparison of the two scenarios apart from exploring the morphological trend and the associated urban forms.

Urban morphology arose as a field of study concerned with the urban landscape around the end of the nineteenth century. It has its beginnings mostly in central Europe (Whitehand, 2007). From the end of the nineteenth century, substantial breakthroughs in the theoretical and analytical elements of urban morphology have been made. The contributions of Conzen's English 'school' have an immense influence on the study of urban morphology (Gauthiez, 2004). Many researchers have conducted their research on urban form and the spatio-temporal physical transformation of urban areas based on Conzen's school of thought.

However, research on urban morphology in Africa, especially in Sub-Saharan Africa,

is scant. There have been a few studies on their urban development characteristics, but very few have examined them from a morphological perspective. For instance, a previous research has been conducted in the study area with similar cases considering their use mix intensity, employing the mixed-use index (MXI) developed by Van den Hoek (2008) along with an assessment of neighborhood level open space ratio (OSR) (Asfaw & Chernet, 2023). On the other hand, this research approached its assessment of urban transformation from the physical density perspective, taking into account the floor space index (FSI), ground space index (GSI), network density, and open space ratio (OSR) at plot level. From the perspective of urban physical form, this study could be considered a micro-level assessment of the urban texture based on the formally planned and spontaneously developed scenarios.

Thus, this study would help in understanding the spatio-temporal transformation of urban morphological phenomena from the perspective of formally planned and spontaneously developed parts of cities in the developing world. This, in turn, aids in recognizing modern-day changes and their impact on historic areas of cities, as well as changes in urban life as a result of the built environment. In addition, such studies, according to Scheer (2017) contribute significantly to urban design and planning practices and policy modification.

Therefore, studying urban transformation and the associated emerging urban forms have significant policy and academic implications. The use of spatial analysis tools such as Spacematrix can provide insights into the physical density of urban areas and help planners to develop effective interventions. Understanding the urban transformation trend is also critical to sustainable urban development, and policymakers must understand the implications of urban change for the well-being of city dwellers. Emerging urban forms reflecting the combination of low-rise, mid-rise, or high-rise buildings and point-type or block-type developments can also have a significant impact on the sustainability of urban areas. From academic perspective, studying emerging urban forms can provide intuitions into the drivers of urban change and the implications of these changes for urban sustainability. From these insights, it can be understood that this research could have both policy and academic significances. As a result, this study could contribute to making policy modification, reshaping building codes and planning regulations depending on the result.

3.2 Materials and Methods

The evaluation of urban forms may take several forms, depending on the study purpose. One technique for studying urban form in its three-dimensional manifestation is to evaluate the built environment's density. It is obvious that urban areas, during their physical transformation, reflect different scenarios in their built environment density. The density of a built environment is highly related to the sustainable development of an area.

Many people believe that increasing density in urban design and planning is a good strategy to achieve socioeconomic and environmental sustainability (Bolton, 2021). There are also some negative reflections regarding increasing density and compact development, claiming its consumption of natural cover and environmental damage (Gren et al., 2019). On the other hand, these effects could be counterbalanced through the significant impact of compact development and higher density through reduced energy use and emissions (Calthorpe, 1993; Gordon, 2008; Jenks et al., 2000; Xu et al., 2020). From the standpoint of developing-country cities, where horizontal expansion predominates over vertical development, the researchers argue that densified and compact development could be beneficial, at least until their current state of development. In this sense, evaluating density in the morphological transformation of urban areas may indicate whether or not the city's development route is sustainable.

Nevertheless, individual perceptions of density may differ from formal definitions, making it difficult to deduce information from one to the other. Thus, in keeping with the study's objective of emphasizing the morphology of cities, this research examines density via the lens of physical/spatial dimensions. This allows for the assessment of the tactile and quantifiable aspects of the built form. Based on this aspect of density this study attempts to examine the morphological characteristics of the study city. While doing so, it assesses the emergent urban forms exhibited through the spatial form transformation of urban areas through their development trend with the perspective of physical density using a case study method. For this purpose, the researchers have employed desk review, focus group discussions, and physical surveys of the study area.

A case study is an empirical approach that explores a current occurrence (the "case") in depth and within its real-world environment, particularly when the boundaries between

phenomenon and context are unclear (Yin, 2018). It requires a thorough investigation, by combining various observations (Gerring & Cojocaru, 2016). Similarly, Gillham has defined a case study as one that analyzes a study case in order to answer particular research questions and seeks a variety of different types of pieces of evidence (Gillham, 2000). Also Scheer (2017) has further emphasized as case studies are commonly used in urban morphology research to compare information about individual areas and formulate theories based on observed trends.

In urban form studies, Scheer (2017) has suggested that the most popular comparison approaches are to compare two locations that exist at nearly the same time (synchronic) or to compare the same location at different times (diachronic). However, different studies in urban morphological analysis are still being conducted based on more than two cases for broader comparison and understanding of circumstances depending on the intentions of the studies (Clifton et al., 2008; Conzen et al., 2012; Larkham & Conzen, 2014; Pont & Haupt, 2007). In addition, Yin (Yin, 2018) has also described that the theoretical replication favors multiple-case research over a single case one.

Therefore, this study aims to use multiple case studies by selecting representative samples from the case study city. This would allow for a better understanding of the emerging urban forms created through the spatial form transformation of the city across its various parts. Representative cases, according to Gerring and Cojocaru (2016), are those that are meant to reflect a larger group of instances in some way. A cross-case synthesis is used in this study by reviewing the findings of each of the cases and then noting the pattern of results across the case studies. This approach is propagated by different literature sources from the early till the recent ones (Bethesda, 1983; Gerring & Cojocaru, 2016; Herriott & Firestone, 1983; Yin, 2018).

Dire Dawa, as seen in **Figure 3-1**, is a city on Ethiopia's eastern border, a nation situated in the Horn of Africa. It was chosen as a case study city because it is Ethiopia's second-largest city after Addis Ababa, the capital, which is a primate city with more research experience than the country's second-tier cities. It represents both the western urban structure and the traditional Islamic towns of the Middle East, reflecting both scenarios and allowing for comparisons. To the selection of specific sites, Berghauser Pont and Haupt (2009) identified three sample selection criteria, one of which requires representation of all historical eras of development. The other criteria are that the

morphological patterns in the city are representative, and that the samples have a particular geographical and cultural dispersion. These would enable an examination of structural similarities and differences across the different spatio-temporal dimensions of the city. With these consents, the city's historical development eras are examined in order to draw representative samples that may reflect the city's diverse morphological patterns.

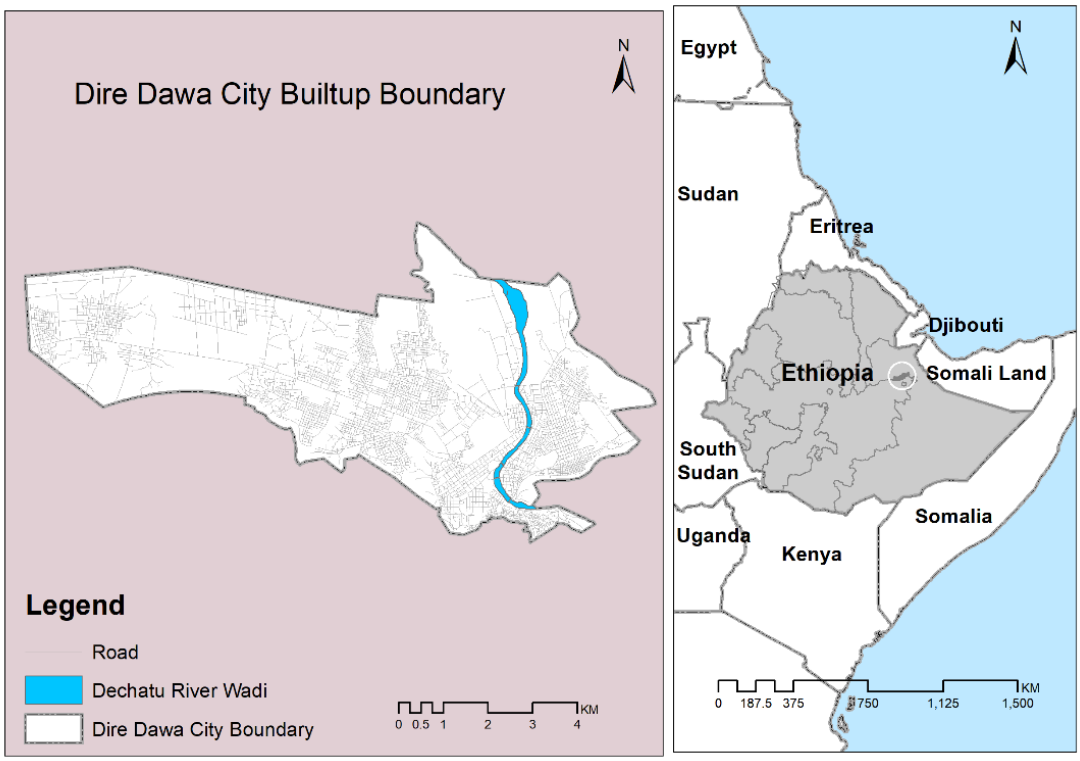

Figure 3-1: Location map of case study city

Source: Dire Dawa city administration urban planning bureau, 2022

The research case areas were chosen sequentially using an approach called exploratory sequential design by Creswell and Creswell (2018). Based on the three parameters identified above, in this design, qualitative data is collected and analyzed first, followed by the identification of features for further assessment using new instruments in the second phase. In the third phase, a quantitative assessment of the test features is followed, and finally, the results are interpreted. Similarly, the spatial transformations exhibited at the various development periods of Dire Dawa are assessed using a qualitative database that represents its historical transformation. Representative samples are chosen for each of the development periods based on the exhibited spatial

transformation scenarios throughout the city. A quantitative assessment of the city's emerging urban forms would then be produced based on the selected cases.

To select representative samples from the city's many historic periods, the city's urban growth scenario must be classified historically in such a manner that it demonstrates the various historic imprints on the city's-built form. Ethiopian urban reforms are linked to either the creation of a new government or changes in the organization of an existing administration. Thus, the transformation of the case city might be matched with changes in the government structure, which in most circumstances would result in urban reforms that would leave their own imprint. For instance Damte (1993) classified Ethiopian urbanization into three eras based on government structures: pre-Italian (1900–1935), Italian occupation (1935–1941), and post-Italian (since the 1950s) on his study conducted nearly three decades back. This seems to have encapsulated the evolution of urban areas after the departure of Italians in a single cup, concealing certain significant spatial forms that arose during that time period. Given that this is a study of the spatial transformation of urban forms, it would be beneficial to examine the different emerging forms throughout time. The assumption is that these changes result in changes in administrative philosophy and, consequently, in changes in the built form.

It is self-evident that urban transformation will have an influence on various parts of cities at various times. Certain urban structural features, on the other hand, are generally resistant to these temporal-based physical changes. Morphologists discovered that settlements could be seen in terms of many essential features, the most significant of which were, land usage, building structures, plot pattern, and street layout (Conzen, 1960). The least resilient features are generally buildings and the land use they accommodate. The street layout is more resistant to changes over time, followed by the plot pattern (Ahmed et al., 2014; Carmona et al., 2003; Vítor Oliveira, 2016). This study thus aims to evaluate the urban form of the study city by assessing the relationship between the more resistant elements of urban form; the street layout and the density of the respective plots using spacematrix.

Berghauser Pont and Haupt (2010) demonstrated that the combination of four density factors, derived from streets, plots and buildings, could be used to describe urban forms in a way that the individual variables alone could not. The variables are well-known indicators of density. The Ground Space Index (GSI) describing the use of the ground

in two dimensions and the Floor Space Index (FSI) describing the intensity of ground-floor use by stacking floor space in the third dimension. This brings us to the third variable: the average height (i.e., number of floors) of the buildings (L). A fourth element, spaciousness (also known as the Open Space Ratio, OSR), indicates the intensity of utilization of natural land cover. All four variables, as can be seen in **Figure 3-2,** may be displayed concurrently in a scatter graph dubbed 'Spacemate,' with FSI on the y-axis and GSI on the x-axis; OSR and L are fanning gradients.

As indicated in the subsequent sections, Berghauser Pont and Haupt (2010) have indicated the equations to examine each of the parameters to be used in the assessment of the urban forms of the study cases. The study employed the Spacematrix 2010 software produced by Meta Berghauser Pont and Per Haupt.

The Floor space index (FSI), which is also called as floor area ratio (FAR), represents building intensity independent of thematic composition and is computed as follows:

$FSIx = Fx/Ax$ where Fx = gross floor area (m^2), Ax = area of aggregation x (m^2) and x = aggregation. This index uses the unit square meters per square meters (m^2/m^2), (1)

Ground space index (GSI), which is also called block area ratio (BAR), signifies the coverage of the built area or the footprint illustrating the connection between constructed and natural land cover. It is computed as follows:

$GSIx = Bx/Ax$ where Bx = footprint area (m^2), Ax = area of aggregation x (m^2) and x = aggregation plot. This index uses the unit square meters per square meters (m^2/m^2 (2)

Open space ratio (OSR) is often known as spaciousness, measures the amount of natural land cover at ground level per square meter of gross floor area.

$OSR = (1 - GSIx)/FSIx$ where GSI refers to the ground space index, FSI refers to the floor space index and X stands for aggregation. This graph depicts the amount of non-built space that is under pressure. OSR is measured in m^2/m^2, (3)

Network density, N, refers to the concentration of networks in a certain area, in this instance the case study areas. A network's density is defined as network length per square meter of base land area (m/m^2). It is computed as the sum of the whole internal network and half the length of the network used to demarcate the base land area. The

output is measured in meters of network per square meter of case area.

$Nf = (\Sigma li + (\Sigma le)/2)/Af$ where li = length of interior network (m), le = length of edge network (m) and Af = area of the case study (m^2) (4)

Spacemate is a design and planning tool based on a mix of density notions that may aid planners in comprehending the capacity of space and in creating adequate circumstances for mainly unexpected growth (Berghauser Pont & Haupt, 2007). As indicated in **Figure 3-2** the FSI on the y-axis gives an indication of the intensity in an area and the GSI on the x-axis reflects its compactness.

In addition, Berghauser Pont and Haupt (2009) define low-rise to be lower and equal to three story, and mid-rise as four to seven story, whereas the high-rise to be more than this considering those which demand elevators. The different urban form scenarios are then indicated in **Figure 3-2,** which represents different patterns of spatial structures. This could allow for the association of the different periods' emerging urban forms based on their respective locations in the FSI-GSI graphs of this figure. The dots represent the presence of a particular type of urban form typology, where the size signifies the intensity of the presence. The type of the typology could be defined based on its position on the FSI-GSI graph.

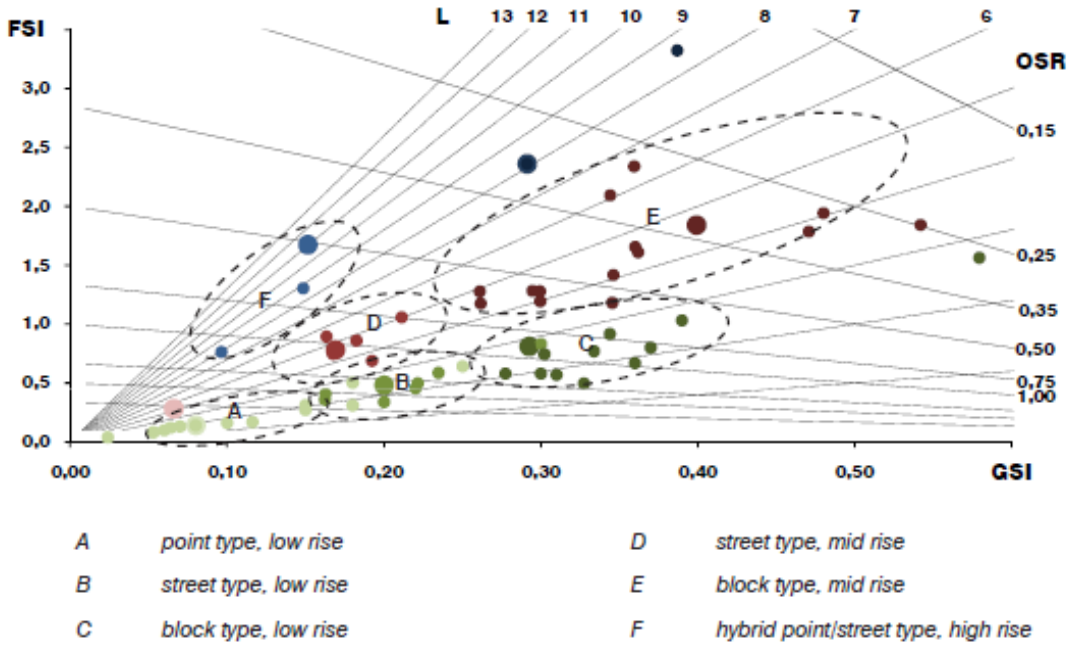

Figure 3-2: Spacemate plot developed by Berghauser Pont and Haupt, 2010

Considering the governance periods of the city, a pre-analysis was made which shows that the period from the early development and the Italian occupation are almost similar which thus is labeled as early morphological era. Similarly, the development period during the imperial era after the Italian occupation and the socialist Ethiopia are similar. Thus, it is labeled as the intermediate morphological era while the recent one since 1992 is accounted as recent morphological era. The different development eras are indicated in **Figure 3-3.**

The different governance periods have left their own footprints in the morphology of the city due to their influence inflicted through spatial transformations. To examine the morphological transformation of Dire Dawa through time in relation to the various governance eras, it would be prudent to pick representative sample regions from each of the morphological transformation periods. As a result, sample sites from each of the three epochs were identified and then rectified across the city's evolutionary map. Following that, the sites were further refined by a rigorous debate among the participants in a focus group discussion. The case study sites are thus selected using a purposive process that recognized the representativeness of each of the sites. The six case areas as indicated in **Figure 3-3** and Table 3-1 also describes the selected sites. The city's historic core has two distinct parts developed in the early morphogenesis of the city reflecting a formally planned segment and an organically developed area. Correspondingly, in terms of morphology, the Italian occupation period has followed a similar development pattern as an extension of the already produced over those two parts of the city. Therefore, *Megala* and *Kezira* areas could represent these periods witnessing their own morphological makeup which has been signified as early morphogenesis era. For the intermediate morphological period, two samples are selected which are representative for the two administrative eras (Late Imperial period after the withdrawal of Italians and the Socialist period). The last one, which is the recent morphological era of the city, two samples were selected due to the reason that the transformation was much wider from the rest of its counterparts.

The study examines six case study sites, each representing various types of urban development. These case studies include *Megala* and *Kezira*, which respectively represent an organically developed and formally planned area in the early morphogenesis period. The third case study, *Legehar*e, is a formally planned area in the

intermediate morphogenesis period, and the fourth, *Sabiyan*, is another formally planned area in the early morphogenesis period. As the informal development during the intermediate morphogenesis period is minimal, the study takes two samples of formally developed areas. The fifth case study is *Gende Gerada*, an organically developed area in the recent morphogenesis period, and the last case study is St. Mariam *Sefer*, a formally planned area in the recent morphogenesis period, as indicated in **Figure 3-3**, and **Table 3-1**.

In general, as indicated in **Figure 3-3** and **Table 3-1**, there are a total of six sample cases as a component in this multiple case study. The results and discussion part made based on the selected six sites representing three morphological transformation periods are presented in the following section.

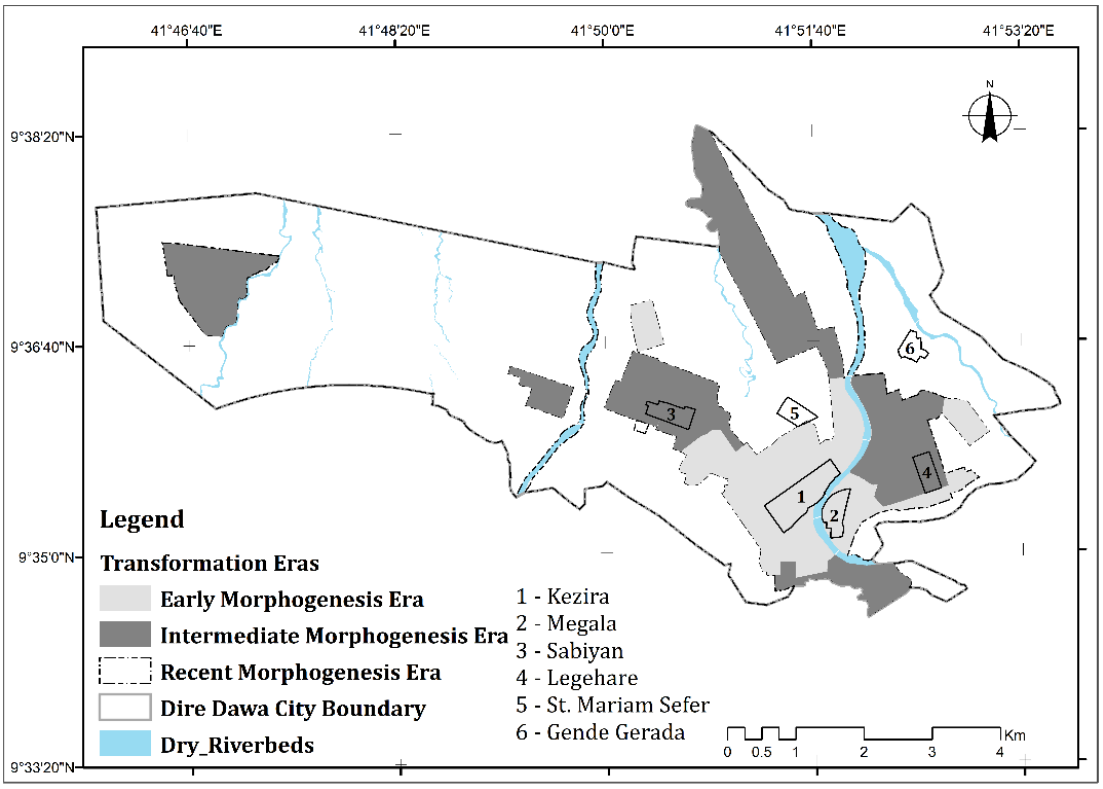

Figure 3-3: Development extent in the morphogenesis eras of Dire Dawa and selected case study sites

Source: A study made by the same authors on the case of Dire Dawa

Table 3-1: Description of the study area

S/N	Case Study Area	Morphological period	Planning Intervention
1	*Kezira*	1st Morphogenesis era (1902-1941)	Formal Planning
2	*Megala*	1st Morphogenesis era (1902-1941)	Organically Developed
3	*Legehar*e	2nd Morphogenesis era (1942-1991)	Formal Planning
4	*Sabiyan*	2nd Morphogenesis era (1942-1991)	Formal Planning
5	*Gende Gerada*	3rd Morphogenesis era (Since 1992)	Organically Developed
6	St. Mariam *Sefer*	3rd Morphogenesis era (Since 1992)	Formal Planning

Figure 3-4 provides an analytical framework that serves as a roadmap for conducting the research and brings clarity to the study process. As indicated in the figure, the research aims to investigate the physical density of the city through both formal and spontaneous developments during its three morphogenesis periods. Within each of these periods, four factors - ground space index, floor space index, open space ratio, and network density - will be evaluated to depict the evolving urban physical structure.

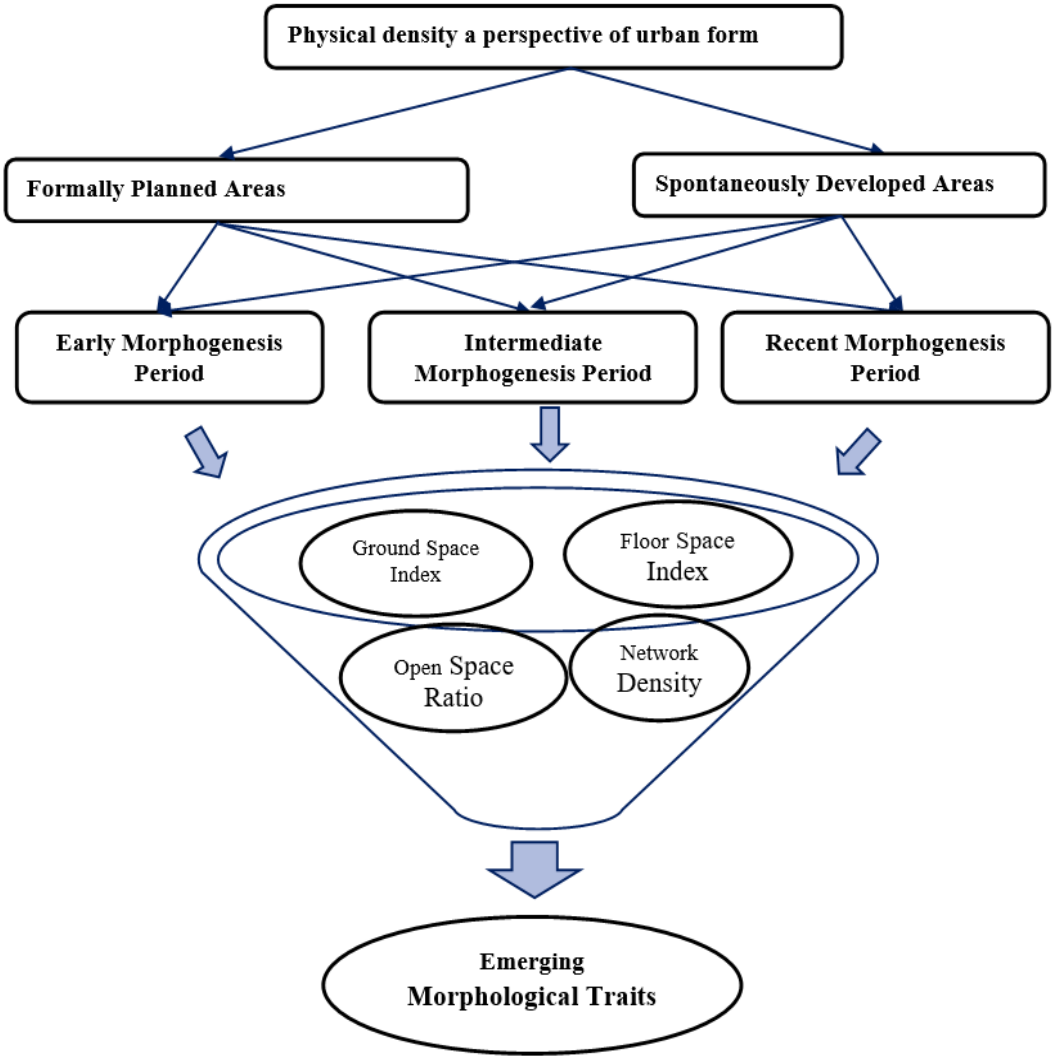

Figure 3-4: Analytical framework of the study

3.3 Results and Discussions

The result and discussion part of this study is stated in a comparative manner by considering two cases which are representing cases of the same period assumed to represent the morphological transformation of that era. Following this, a general development period comparison is made to visualize the emerging urban forms through the urban transformation periods. It begins with the assessment of the first period development then followed by a comparison of two cases representing the intermediate period then finally two cases from the recent development period representing the recent morphological period.

3.3.1 Early Morphogenesis Era (1902-1941)

Kezira and *Megala* are the selected cases for this morphological period where the former is a formally planned one while the latter is organically developed. These two neighborhoods were constructed in the early years of the city's growth, beginning in 1902, and have become the city's historic centre (Zelelew & Mamo, 2023). Both are believed to symbolize the time of early development (1902-1935) and the Italian occupation (1936-1941). These two case areas, as can be seen in **Figure 3-5**, are found near each other, separated by the *Dechatu* river wadi.

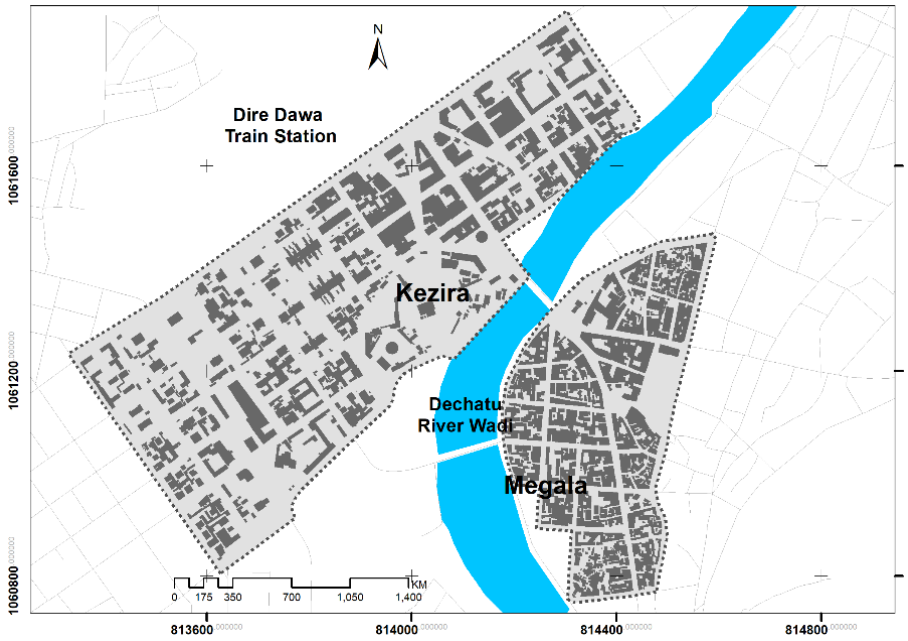

Figure 3-5: *Kezira* and *Megala* areas in reference to the Dechatu Rived Wadi and Dire Dawa Train Station

Source: reconstructed from the data obtained from the master plan of 1902, 1936, and Dire Dawa culture and tourism bureau

As indicated in **Table 3-2** and additionally illustrated in **Figure 3-6, Figure 3-7** and **Figure 3-8**, *Kezira*'s floor space index (FSI) or floor area ratio (FAR) is 0.729 when the average FSI of each plot is considered, which is more than *Megala*'s FSI of 0.671. *Kezira*, on the other hand, has an average street network density of 0.03m/m2, whereas *Megala* has a higher density of 0.07m/m2. This could be due to the relatively longer street access length for plots in *Megala*, which allowed a plot to be accessed from both

the front and back, whereas plots in *Kezira* are only accessed from the frontage. Similarly, *Kezira*'s coverage (ground space index - GSI) is 0.536, which is less than that of *Megala*'s, 0.604. Though the *Kezira* region is dominated by ground-level structures, it does have a considerable number of two and three floored buildings.

In addition to the previous results, the open space ratio (OSR), which indicates the sites' spaciousness, shows that *Kezira* has a greater open space ratio (1.688) than *Megala* (1.26). However, *Kezira* has a disproportionate number of plots with an OSR of less than or equal to 0.25, whereas Megal has relatively few.

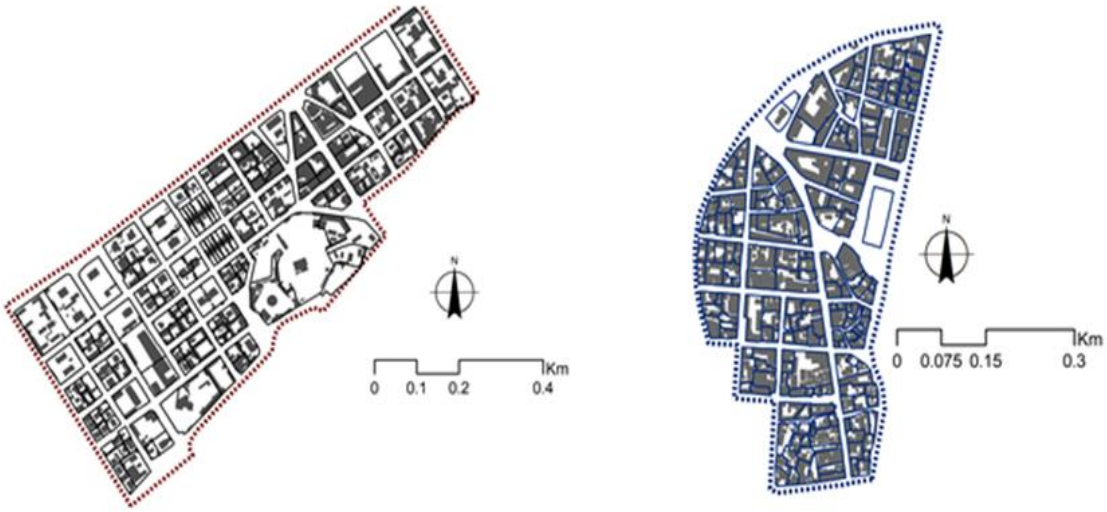

Figure 3-6: Morphologic map *Kezira* (Left) and *Megala* (Right) (1902-1941)

Source: reconstructed from the data obtained from the master plan of 1902, 1936, and Dire Dawa culture and tourism Bureau

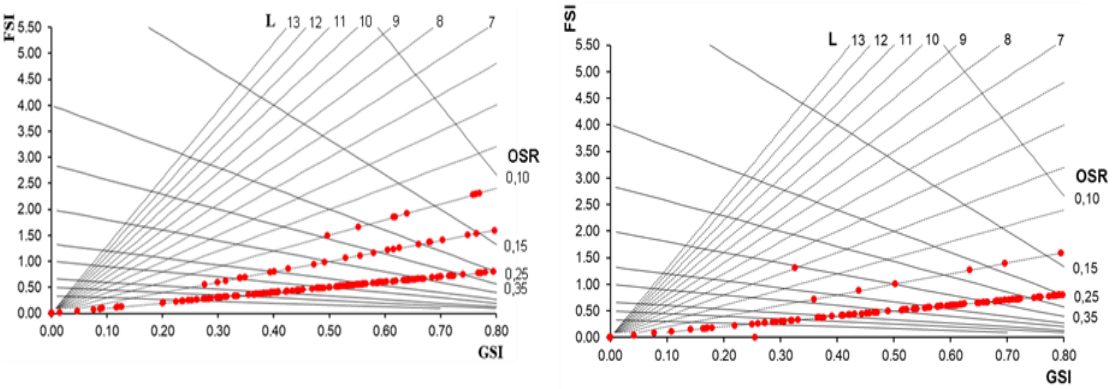

Figure 3-7: *Kezira* case study site (left) and *Megala* case study site (right)

Kezira's spacemate result indicates that the site's morphology is a combination of street type low-rise and block type low-rise forms, as well as point type low-rise and block type midrise forms (See Figure 3-7 and **Figure 3-8**). These indicate that the site's inclination to display high-rise structures is very uncommon. The street network reflects the grid-iron pattern form of the western urban planning philosophy. This emanates from the construction of Ethio-Djibuti railway station in *Kezira* which gave raise for the first area to be developed following formal plan in the nation. *Megala*, on the other hand, has a street-type low-rise morphology with a predominance of block-type low-rise forms which has similarity with the context of Arab Islamic cities. The traditional Islamic Arab cities, as described by Dabbour (2021) assumes to have a series of homes turned towards the street, which were later supplemented by a back-to-back construction of closed courtyard buildings surrounding the property boundary. *Megala* was inhabited by locals, Arabs, and Indians and grew organically under the administration of Ethiopians. *Kezira*, on the other hand, was populated by Europeans (primarily French, Italians, Greeks, and Armenians) and built according to a formal plan (Dire-Dawa-City-Administration, 2017). As a result, the developmental distinctions between the two regions may change.

The buildings in the early morphogenesis era (the early development period and the Italians occupation period), neglecting the morphological transformation that has been induced recently, is dominated by a mix of point type low-rise and block type low rise. While looking at the morphologic traits of the two cases, the organically developed part (*Megala*) seems to reflect lesser consideration towards open space provision while the formally planned counterpart (*Kezira*) has emphasized open space provision better. On the other hand, the organically developed part has witnessed a better level of street network density than the formally planed part (*Kezira*). This result will also further be seen from the other cases in the intermediate morphogenesis period and the recent morphological periods for comparison.

Figure 3-8: Partial view of *Kezira* (left) and *Megala* (right)

Source: Dire Dawa culture and tourism bureau

Table 3-2: Average of the spacematrix results of FSI, GSI, network density and OSR

S/N	Case Study Areas	Average Floor space index	Average Ground space index	Average street network density	Average open space ratio
1	*Kezira*	0.729	0.671	0.03m/m2	1.688
2	*Megala*	0.604	0.536	0.07m/m2	1.26
3	*Legehar*e	0.602	0.560	0.03m/m2	1.23
4	*Sabiyan*	0.685	0.544	0.01m/m2	1.21
5	*Gende Gerada*	0.255	0.228	0.06m/m2	6.57
6	St. Mariam *Sefer*	1.06	0.46	0.05m/m2	0.69

3.3.2 The Intermediate Morphological era (The post-Italian Haile-Selassie period (1942-1974) and the Dergue period (1975-1991))

*Legehar*e is a neighborhood located east of the city that is regarded as a microcosm of the Haile Selassie Era after the Italian occupation (1942-1974). It is found close to the eastern border of the city's current state, near the *Megala* neighborhood. The other case

area, *Sabiyan*, on the other hand, is situated west of *Kezira*, though far from it, and is considered to represent the morphological makeup of the Dergue governance period (1975-1991). It is physically placed roughly halfway between the city's existing western and eastern boundaries, and hence might be considered the city's geographic center with respect to the current expanse of the city.

*Legehar*e and *Sabiyan* are both accessible through the city's major roads, which connect it to Djibouti and Addis Ababa, respectively. As can be seen in Table 3-2 and illustrated in Figure 3-9, Figure 3-10 and Figure 3-11, when the average FSI of each plot is evaluated, *Sabiyan*'s FSI is 0.685, which is more than *Legehar*e's FSI of 0.602. On the other side, *Sabiyan* has an average street network density of 0.01m/m^2, whereas *Legehar*e has a somewhat greater density (0.03m/m^2). Additionally, *Sabiyan*'s Ground Space Index (GSI) is 0.544, somewhat less than that of *Legehar*e, which is 0.560. Though the majority of buildings in *Legehar*e are one-story, there are a few mid-rise structures scattered around. While the *Sabiyan* neighborhood is dominated by one-story structures, it also has a substantial number of midrise structures as well.

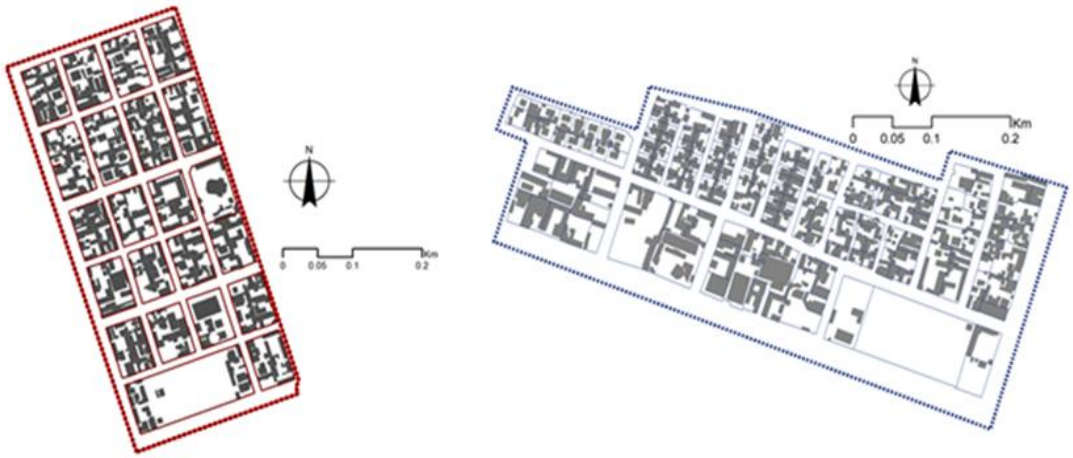

Figure 3-9: Morphologic map *Legehar* (Left) and *Sabiyan* (Right) (1942-1991)

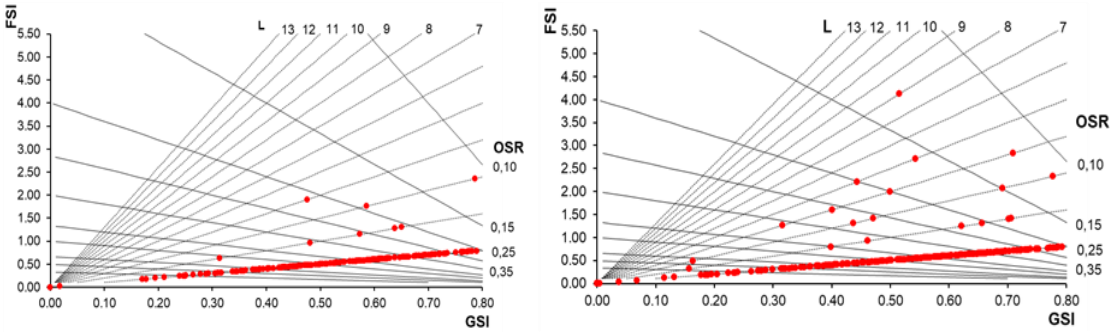

Figure 3-10: *Legehar* case study site (left) and *Sabiyan* case study site (right)

Figure 3-11: Partial view of *Legehar*e (left) and *Sabiyan* (right)

Source: Mr. Gizaw Haile, a senior culture and tourism expert in Dire Dawa

Furthermore, the open space ratio (OSR), which measures the spaciousness of the sites, suggests that *Sabiyan* has somehow a lower open space ratio (1.21) than *Legehar*e (1.23). There are a disproportionately enormous number of plots in *Sabiyan* with an OSR of less than or equal to 0.25, while *Legehar*e has a small amount.

The urban structure of the city is governed by a formal plan-led development during this period, with minimal informal development; thus, both cases representing this period are formally developed parts of the city. This would not allow for a comparison between the formal and organic development scenarios. However, because it is a part of the city's morphogenesis period, it must be investigated in order to evaluate the urban form of this era. As a result, *Legehar*e's spacemate analysis suggests that the site's morphology is mostly block-type low-rise with some street-type low-rise forms. Sbayan's situation confirms that the urban form of this case area is dominated by block-type low-rise structures and block-type mid-rise structures. As has been evidenced from

the focus group discussion, the form of Dire Dawa during the Haile Selassie regime was influenced by the available construction technology in the area and the site's location with respect to the historic core. In terms of the situation in *Sabiyan*, this is a region that is geographically central to the recent Dire Dawa. In this scenario, the percentage of open space is decreasing while the FSI has somewhat climbed, indicating that awareness of space efficiency has increased from past periods, coupled with some other extra factors.

3.3.3 The Recent Morphological Era (Since 1992)

The areas of St. Mariam *Sefer* and *Gende Gerada* are used to illustrate the urban transformation that has occurred in the recent period after the end of the Dergue era (since 1992). The development of this era has had significant spatial coverage. The city has expanded to the west due to the development of an industrial park and a new train terminal at its western edge. These areas are not yet well developed, but it can be seen that they are attracting the city's development to the west. To examine the evolving urban forms throughout this time of spatial transformation, two case study areas were purposefully chosen: one near the geographic center and another close to the periphery.

Participants in the focus group discussion have shown that the evolution of Dire Dawa had two faces in this morphological era. The first scenario is for the city's core and intermediate areas, while the second scenario is for the city's outskirts. Formal planning enforcement is frequent in the center and intermediate areas. On the contrary, the periphery is heavily impacted by informal development, which may span a similar area to the formal development. This situation along with the cases of *Kezira*'s and *Megala*'s case could be a clear indication that illustrates different planning practices will end up with different results. According to their assessment, this is due to the administration's reluctance to control the issue.

As indicated in Table 3-2 and illustrated in Figure 3-12, Figure 3-13 and Figure 3-14, the sample in the geographic center, Mariam *Sefer*, has an average FSI of 1.06, which is greater than not only *Gende Gerada*'s (0.255) but also all of the case locations studied in this research. On the other hand, St. Mariam *Sefer* has an average street network density of 0.05 m/m^2, while *Gende Gerada* has a slightly higher density (0.06 m/m^2). Furthermore, Mariam *Sefer*'s Ground Space Index (GSI) is 0.46, which is higher than

Gende Gerada's 0.228. While the bulk of buildings in the Mariam *Sefer* are two-story, there are a substantial number of four- and five-story structures. On the contrary, the bulk of buildings in the *Gende Gerada* neighborhood are single-story, with just a handful having two.

Aside from that, the open space ratio (OSR), which reflects the spaciousness of the sites, reveals that St. Mariam *Sefer* has a lower open space ratio (0.69) than *Gende Gerada* (which has the highest open space ratio of all the case study sites), indicating that it is spacious (6.57). Because land is less expensive in the periphery than it is in the center, the coverage (GSI) and floor space index are low, even though the plot sizes and open space ratios are larger. In contrast, in locations near to the center, both the ground space index and the floor space index are fairly large in order to optimize the utilization of available space in an efficient manner.

According to the spacemate data, *Gende Gerada*'s morphology is largely point type low rise, with some street type low rise forms thrown in for good measure (See Figure 3-13 **left**). St. Mariam *Sefer*'s circumstance, on the other hand, reveals that this case area's form is dominated by block type low-rise buildings, with block type mid-rise structures serving as a secondary characteristic (See Figure 3-13 **right**). In terms of the planning characteristics of these two case regions, S. Mariam *Sefer* is a formally planned area, while *Gende Gerada* is not. The land utilization intensity of the organically built site may differ from that of the formally planned and constructed area. Furthermore, the focus group participants affirm that there are concerns about legality, which may lead to the destruction of structures via legal enforcement procedures, discouraging builders from erecting buildings with greater GSI and FSI. This may also be related to the location of the area, which is positioned near the periphery.

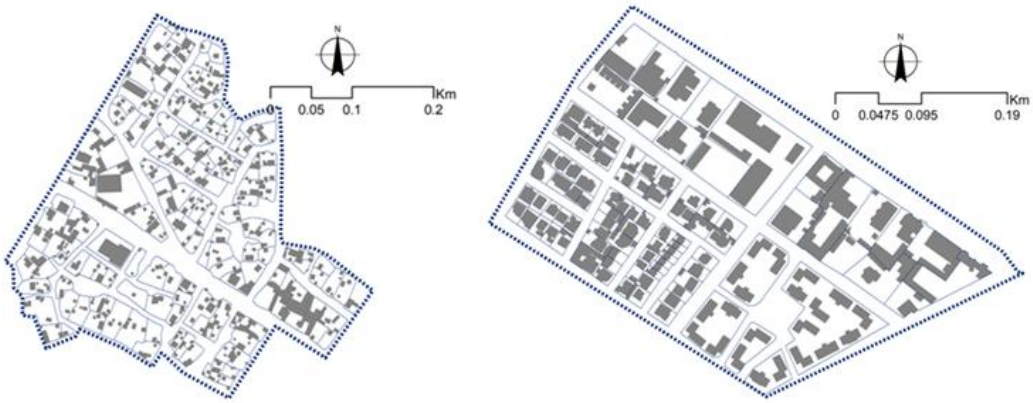

Figure 3-12: Morphologic map *Gende Gerada* (Left) and St. Mariam *Sefer* (Right) (Since 1992)

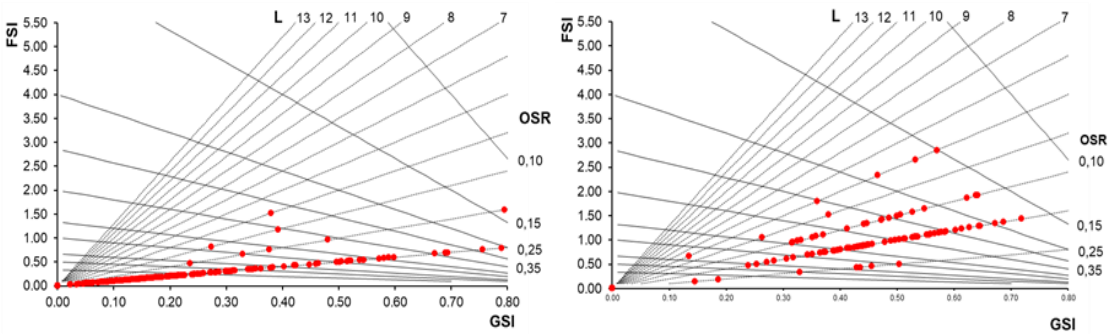

Figure 3-13: *Gende Gerada* case study site (left) and St. Mariam *Sefer* case study site (right)

Figure 3-14: Partial view of *Gende Gerada* (left) and St. Mariam *Sefer* (right)

Source: Authors, 2021

Cities' history plays a basic role in their future and allows a good platform to learn from (Agirbas & Ardaman, 2015). This study has helped to identify the changes in the urban form of Dire Dawa through its different eras of governance, along with the associated urban habituation patterns. This would be a representative case for the secondary tire cities in sub-Saharan Africa. Different urban patterns, for example, planned vs. organic, treelike vs. grid-like, are claimed to perform differently in terms of flow intensity and distribution, building density, and land uses (Berghauser Pont et al., 2017). As can be seen in **Figure 3-15**, the cases in the study have exhibited that the organically developed and the formally planned areas do have different patterns of urban form. The morphological transformation trend has been identified as it deviates from the form in its portions from its foundation, similar to what Dabbour (2021) has identified. It has also been reported that the majority of Ethiopian cities and towns have horizontal physical growth with low urban density (Jenberu & Admasu, 2020). This has also been revealed from this study's output, though there are improvements exhibited following the chronological time frame.

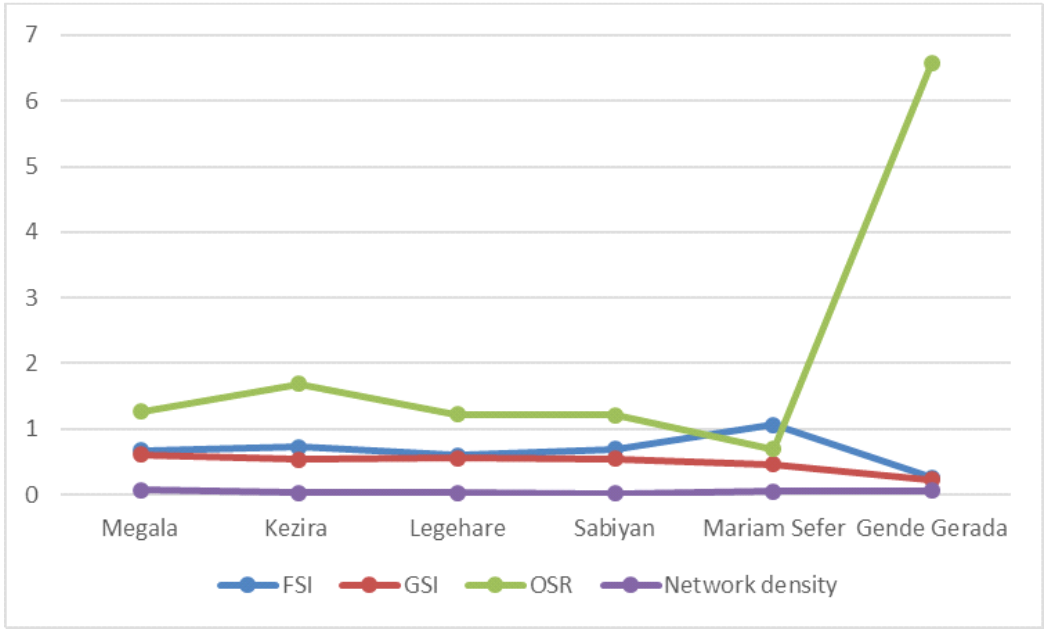

Figure 3-15: Average GSI, FSI, OSR and Network density of all the case study sites

The current urban planning scenario has indicated that increasing density, or the compactness of cities, is the path to sustainable growth (Nielsen, 2019). There is a gradual decline in the open space ratio from the historic evolution period of the city to the recent one. As a result of the morphogenesis trend, it seems that the secondary tire

cities, as in the case of Dire Dawa, have given emphasis to compact and dense development, especially in their formally planned sections. This shows that they are on a good path towards sustainable development, though the level of density in the compact development requires additional assessment.

3.4 Conclusion

The primary objective of this study is to identify the emerging the morphology of urban transformation and assess its impact on urban sustainability, with a particular focus on physical density and emerging urban forms. To achieve this, the study utilizes the Spacemate method to investigate the variations in density and urban forms across different development scenarios. The research delves into the morphological features that influence the growth tendencies of the city, such as Gross Site Index (GSI), Floor Space Index (FSI), Open Space Ratio (OSR), and street network density. The aim is to evaluate how these factors affect the overall urban sustainability of the city. By examining changes in urban form and habituation patterns over time, the study seeks to identify how the city of Dire Dawa has transformed under different eras of governance. This includes an assessment of the city's growth trajectory and how it has evolved in terms of morphological features.

The study reveals that organically evolved sites are typically characterized by point-type low-rise development, while plan-driven developments tend to feature block-type low-rise and block-type mid-rise forms. Moreover, the floor space index and spatial coverage patterns of the city have tended to increase over time, indicating a growing concern for space efficiency and sustainable development. Apart from these, in locations near the historic core of the city, both the ground space index and the floor space index are generally quite large, suggesting that planners are prioritizing the efficient use of available space.

In addition, the street network density of organically developed areas is generally higher than that of formally planned areas, indicating that organically constructed elements of the city offer better accessibility. However, it is important to note that the Spacematrix approach used in the study does not consider street width, which is a crucial factor in determining traffic capacity and may impact accessibility.

Given these insights, it is crucial to assess the trend of morphogenesis in urban areas

and take measures to ensure that future developments are responsive to sustainability concerns. Urban planning policies and guidelines should also consider the benefits of organic development and strive to incorporate local knowledge into formal planning efforts. This approach can help to promote sustainable urban growth and enhance the quality of life for urban residents.

CHAPTER FOUR

4. EXPLORING THE RELATIONSHIP BETWEEN STREET HIERARCHY AND LAND USE FUNCTIONS IN DEVELOPING COUNTRIES: THE CASE OF DIRE DAWA, ETHIOPIA

Abstracts: *This article examines the correlation between street width and land use patterns in Dire Dawa, Ethiopia, analyzing the impact of street hierarchy on land use intensity during different developmental periods of the city, including organic and formally planned areas. Utilizing a mixed-methods case study design, the study identifies four land use categories and evaluates their relationship with street width. The results indicate that the connection between street width and land use varies based on the city's morphological period and the type of urban planning intervention. The study suggests that urban planners should devise strategies that account for both formal and informal developments and create well-designed land use policies to facilitate effective urban planning and morphology. The article concludes by underscoring the need for additional research to obtain a more comprehensive understanding of the relationship between street hierarchy and land use functions in developing countries' cities.*

Key Words: Street width; Land use patterns; Mixed-methods case study design; Urban planning; Land use policy; Developing countries.

4.1 Introduction

Several scholars have indicated that the fundamental components of the urban form include land uses, streets, plots, and buildings (Berghauser Pont, Stavroulaki, Bobkova, et al., 2019; Birkhamshaw & Whitehand, 2012; Conzen, 1960; Haynes, 2020; V. Oliveira, 2016). Understanding the relationships among these elements of urban form can aid in comprehending their characteristics and their impact on the urban texture of a particular area in a city. Additionally, it can help identify an area's urban form identity and guide interventions necessary for urban planning and design.

As per the study conducted by Wang, Antipova, and Porta on street centrality and land use intensity, results indicate that population and employment densities are highly correlated with street centrality values. This confirms that street centrality captures location advantage in a city and plays a crucial role in shaping the intraurban variation of land use intensity (Wang et al., 2011). This study looked at the proximity of streets in a given area in relation to land use density. Other studies have attempted to investigate the relationship between land use and access street length (Berghauser Pont, Stavroulaki, Bobkova, et al., 2019). It was also identified that different urban layouts, such as planned vs. organic, are said to function differently in terms of pedestrian flow intensity and distribution, building density, and land uses (Berghauser Pont et al., 2017).

All cities and their tissues are made up of a collection of features such as urban street blocks, plots, and buildings. However, these streets, blocks, plots, and buildings are mixed differently in each city, resulting in distinct sorts of tissues (Vítor Oliveira, 2016). The arrangement and capacity of these features are crucial factors in the built environment (Moudon, 1994; Vítor Oliveira, 2016; Schirmer & Axhausen, 2016). Their configuration could also create a significant impact on the urban fabric, affecting both land use and social behaviour (Remali, 2014). As a result, examining urban form and the interconnectedness of its elements is crucial in the field of urban planning and design. Although some studies have been conducted, it is important to understand that the relationship between these elements can vary based on the city's characteristics and the planning approach used. Consequently, it's essential to analyze the association among various urban design components to advance both practical and theoretical significance, emphasizing the need for further research in this field. The objective of this research thus is to explore the relationship between street width and land use

functions at the plot level in Dire Dawa city, Ethiopia. Specifically, the study seeks to investigate how the width of access streets, which is tied to a street hierarchy, impacts land use patterns. Additionally, the study will examine any variations in street width and land use functions during different developmental periods of the city.

Land use, one of the elements of urban form considered in this study, is an abstract concept which has various functional distinctions under it that would vary from town to town depending on various factors. For instance, from the Ethiopian perspective urban land use categories, according to the Structural plan manual developed by the Ministry of Urban Development and Housing (2018), are categorized into ten different classes. This classification is necessary to define categories according to the different purposes of land use. If the number of groups in a land-use category is too small, the evaluation of land use will be inaccurate. Conversely, if the number of groups is too large, it becomes difficult to detect the land use features of an area. In relation to this, studies have structured land use of a city into four categories to reduce the complexity of assessments. These are Living, Working, Amenities and a Mix of any other functions with living functions (Van den Hoek, 2008; Van Nes et al., 2012).

The other element of urban form considered in this study is a street hierarchy which involves the categorization of streets according to numerous factors such as their purpose, capacity, and degree of connectivity. This approach helps to define the roles that streets play in urban transportation and to prioritize investments in infrastructure and transportation planning. One important aspect of street hierarchy is the capacity of a street, which refers to its ability to accommodate different modes of transportation and levels of traffic. This capacity is often closely related to the width of the street, which affects the number of lanes, sidewalks, and other features that can be included. This study emphasizes basically on the capacity of the street perspective connoting street hierarchy with the width of the street.

The aim of this study is to explore the correlation between the width of adjoining streets and the intensity of land function over different periods of city development. This investigation takes into account the diverse morphogenesis stages of the city and examines the relationship between organic and formally planned areas. By adopting a spatiotemporal morphological transformation approach and a broader view of planning interventions, the study can offer valuable insights into the interaction between street

and land use planning interventions and highlight their experiential connections. The results of this research in Dire Dawa city can provide practitioners and scholars with practical experience-based knowledge, inform them of the current situation, guide the development of context-specific interventions, and establish policy frameworks to support them.

The research approach examines this scenario from different time periods' perspectives in the history of the city of Dire Dawa. A statistical correlation method is employed in the analysis of this study.

4.2 Materials and Methods

Dire Dawa, a city in Ethiopia, is renowned for its diversity, comprising a blend of nationalities, including Europeans such as Greeks, Armenians, and French, Middle Eastern nationals like Yemenis and Israelis, and Indians. The city's multicultural makeup can be attributed to the arrival of European workers brought in by the French company, which was tasked by Emperor Minilik II to develop the railway line. This influx of people, combined with the economic activity and industries developed in the city, attracted merchants from the Middle East and India, resulting in a melting pot of cultures. Given the city's unique blend of nationalities, it presents an intriguing case study for other cities in Ethiopia, potentially due to its size, population, or urban development.

Given its status as a secondary-level city with a population of approximately 350,000 individuals (worldometer, 2022b), the city in question could serve as a suitable model for other comparable cities in the region. Valuable knowledge gleaned from its growth and progress could be adapted for use by other secondary-level and tertiary cities, as well as the primate city, Addis Ababa. All in all, this city plays a distinctive role in representing the urban landscape of the nation and offering valuable takeaways and advice for other cities to benefit from.

The physical features that make up built-up regions, such as the shape, size, density, and arrangement of settlements, are referred to as urban forms. It can be evaluated on a variety of sizes, including regional, urban, neighborhood, ‘block,' and street levels (Williams, 2014). Along with buildings and streets, French typomorphologists consider

the plot to be one of the most important aspects of the urban environment (Moudon, 1994). Consequently, the materials to be used for this study include plots and their respective access road segments representing the different case areas. The plot uses considered both the vertical and horizontal dimensions of the building used in the plots with more than one floor, while the horizontal dimensions are considered in plots with ground-level buildings. From the street segment perspective, the width of the different streets and the length of each of the access segments for each of the plots are considered.

To investigate the morphological transformation of Dire Dawa over time in relation to the various governance eras, representative sample regions were chosen from each morphological transformation period. The sample sites were identified and rectified on the city's evolutionary map and then refined through a rigorous debate among participants in a focus group discussion. The six case areas selected using a purposive process were displayed in **Figure 4-2**.

The favored approach to conducting research is the mixed-methods case study. This design combines both quantitative and qualitative data collection, analysis, and integration to provide comprehensive insights into a particular case or cases, as well as to construct instances for comparative analysis (Creswell & Creswell, 2018). It entails a thorough analysis by combining several observations (Gerring & Cojocaru, 2016). Moreover, Gillham (2000) defines a case study as one that analyses a study case to answer specific research questions and seeks a range of different sorts of evidence, making this study approach suited for this type of research. Scheer (2017) further explained that case studies are often used in urban morphology research to compare facts about particular places and build hypotheses based on observed trends. She has also suggested that the most popular comparison in case study approaches is to compare two locations that exist at nearly the same time (synchronic) or to compare the same location at different times (diachronic). However, several studies in the urban morphological analysis have been conducted on more than two cases for wider comparison and understanding of circumstances depending on the study's intentions (Clifton et al., 2008; Conzen et al., 2012; Larkham & Conzen, 2014; Pont & Haupt, 2007). In addition, Yin (2018) has also described that the theoretical replication favours multiple-case research over a single-case one.

Consequently, this study aims to gain a deeper understanding of the emergent urban

forms that arise from the spatial alteration of a city during its morphogenesis. To achieve this, multiple case studies will be conducted, each featuring representative samples from the city. According to Gerring and Cojocaru (2016), representative cases are those that reflect a broader range of circumstances. The findings of each case will be evaluated, and a cross-case synthesis will be employed to note any patterns of outcomes across the studies. This technique is supported by various literary sources, including ancient and modern works (Bethesda, 1983; Gerring & Cojocaru, 2016; Herriott & Firestone, 1983; Yin, 2018).

4.2.1 Case City Selection

This case is based on Dire Dawa city, which is located on the eastern edge of Ethiopia, an East African country located in the horn of Africa. It is Ethiopia's second-largest city, after Addis Ababa, and is situated on the country's eastern border, 318 kilometres from Djibouti and 452 kilometres from Addis Ababa. The city was founded in 1902 to serve as a station and workshop for the ancient railway line, which ran for 780 kilometres from Djibouti to Addis Ababa. See **Figure 4-1**.

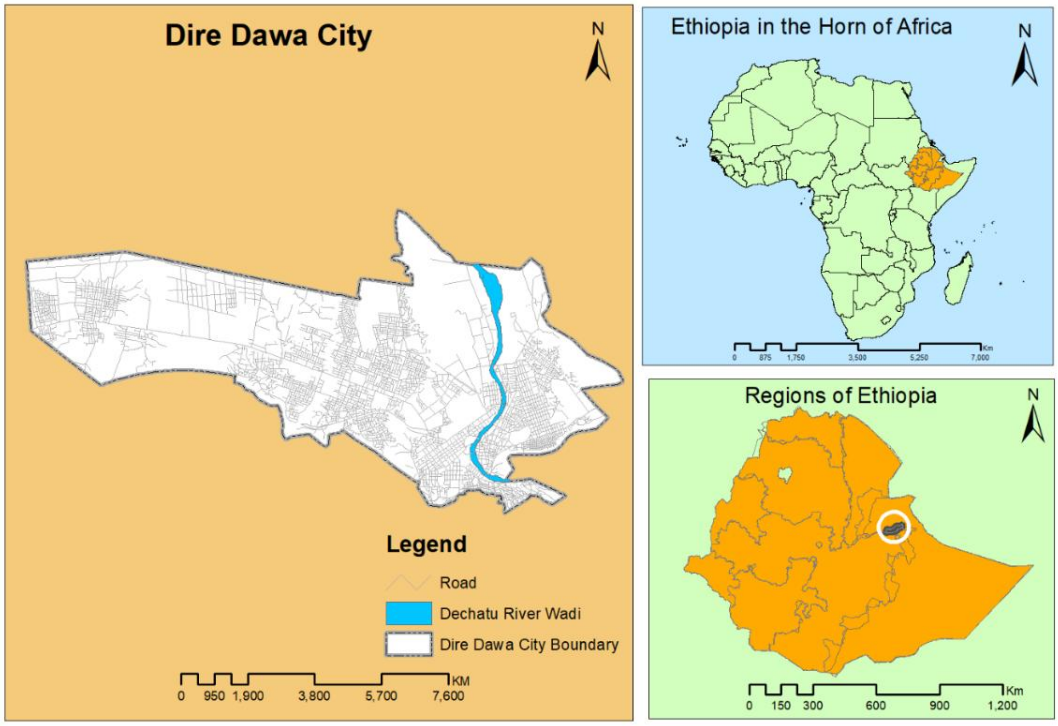

Figure 4-1: Location Map of Dire Dawa City

Separated by the *Dechatu* dry river wadi, this city boasts two unique historic centers. *Megala*, situated east of the wadi, was built organically and is a distinctive quarter.

Kezira, located west of the wadi, was constructed with a formal urban plan from scratch (Zelelew & Mamo, 2023). Both centers developed almost simultaneously, but the city grew in various directions due to different administrations over time, leaving their spatial marks primarily to the east and west.

When determining the urban morphological bounds of an area, its cultural periods can be viewed as a morphological period for historico-geographical study. This is because each epoch leaves distinct material imprints on the landscape, as noted by (Conzen, 1960). Haynes (2020) explains that urban forms are constantly evolving, necessitating historical study to comprehend them. In order to analyze the morphogenesis of Dire Dawa and its historic development, the development periods were categorized into clusters for better comprehension. An initial analysis was conducted to examine the governance periods of Dire Dawa. The city's first development era spans from the beginning of its growth in 1902 until the Italians' departure in 1941 after a five-year occupation. The subsequent period covers the years from 1942 to 1991, including the post-Italian occupation period of Haile Selassie the first and the Dergue period. These two regimes had different political ideologies, but their spatial imprint on the city was similar, which led to their classification under one morphological period. The third morphogenesis period covers the time from 1992 to the present, which exhibits a similar morphological imprint on the city. Each governance period has left a unique mark on the city's morphology through spatial transformations.

Yet again, spatial studies need to have clearly defined physical territories within which the study entities' characteristics could be assessed. Spatial data can be mapped in metropolitan areas at various scales, from cadastral plots to vast communities (Grippa et al., 2018). This study is made at a cadastral plots level which could be accounted as a lower level of resolution from a spatial planning perspective. The cadastral plots, whereby the relationships of their urban form elements are to be assessed, are identified on the basis of the city's different morphological periods and the urban planning interventions perspective. This study thus planned to use small and manageable sample cases from the case study city that could represent the different morphologic eras that the city has undergone through its development and its urban planning experience.

The city's urban planning practices have varied throughout its history. During certain growth periods, strict planning regulations were enforced, while during others, organic

development was allowed to thrive with less influence from urban plans. To account for this, two case areas were selected for each morphological period - one from an organically developed area and the other from a formally planned development site, depending on the prevailing scenario during that era. As indicated in **Figure 4-2** the selected sites include Megalla and *Kezira* for the first period, *Sabiyan* and *Legehar* for the second period, and St. Mariam *Sefer* and *Gende Gerada* for the recent period. These case eras were also utilized in a related study by the same authors (Asfaw & Chernet, 2023).

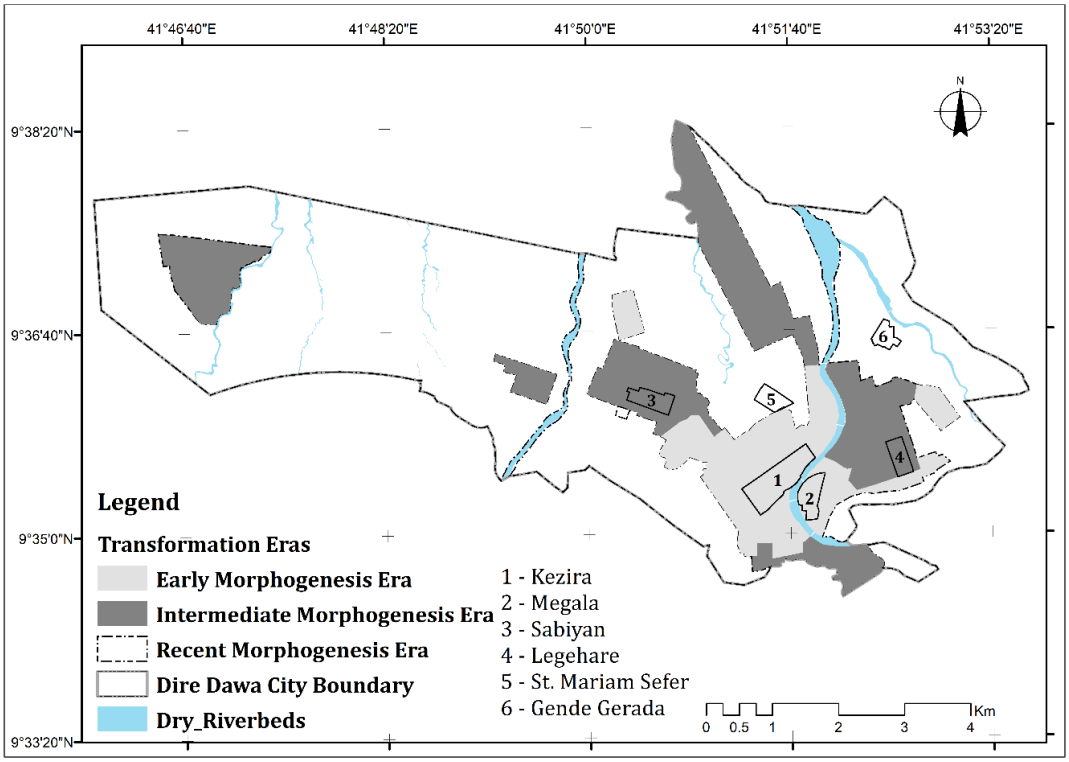

Figure 4-2: Case areas of the study in Dire Dawa

Source: Asfaw and Chernet (2023)

A city is the end result of a historical process. As a result, all cultural processes that contribute to a city's current position should be explored, particularly in cities with a solid historical base (Conzen, 1960). Conzen's essential contribution to urban plan analysis is often recognized as the zenith of the urban morphological research tradition, and he is widely acknowledged as the most prominent researcher in British urban morphology (Larkham, 2006). Conzen regards a city's land use, building fabric, and transport network as major historic traits that might demonstrate its morphogenesis

(Conzen, 1960; Larkham, 2006; Larkham & Conzen, 2014). To better comprehend the city's morphogenesis, this study examines its morphological landscape based on assessing the correlation between its land use and transportation network. From these, it relies on road width, road length, building footprint, plot size, and land uses.

4.3 Data Collection and Analysis

The urban environment is a living record of human activity. This reflects both the current society's efforts and those of its forefathers (Birkhamshaw & Whitehand, 2012). To address the objective of this study thus requires an assessment of the effects inflicted at different periods of human activities in the development of the city at different periods. To this end, a chronological structuring of the development periods of the city is important to visualize the periodic changes in the morphogenesis of the city.

In each of the case study areas, a census-like approach was taken to collect data from all of the plots, resulting in an average of around 200 plots per area. The data was analyzed using IBM SPSS Statistics 26 software to evaluate the correlation between various elements of urban form, taking into account the different morphological eras of the city from a planning intervention perspective. The elements of the urban form are identified based on the renowned study of Conzen (1960) which is very popular as the father of the British urban morphology school of thought (J. W. Whitehand, 2001).

The building uses of the case areas are identified through an onsite survey, supported by focus group discussion and desk review for the earlier periods of the study. The length and width of each of the access streets for the respective plots in the case areas are identified from an image of the city with respect to its period supported by the cadastral map. These maps are made to be representative of their respective periods, allowing for focus group discussions with representative individuals from the city, supported by the maps and photographs of early periods along with additional secondary materials. This would allow for a comparative plot-based analysis to be made among the different case areas based on the land use class and their corresponding defined variables, street width.

Land use classifications vary depending on the purpose of the study. For example, in

Ethiopia, the FDRE Ministry of Urban Development and Housing (2018) has established ten land use groups for urban areas to guide urban planning. However, for the purpose of analysis, it is often convenient to group different land use classes into broader categories. Van den Hoek (2008) and Van Nes et al. (2012), for instance, have categorized land use classes into four types based on their functions: working, amenity, living, and a combination of these.

Analyzing a wide range of functional classes can be challenging, hence, to make the research more comprehensible, it is preferable to group the ten land use classes of Ethiopia into the four categories mentioned above. By doing so, the analysis becomes more accessible, and patterns in land use can be identified more easily. Land use classifications provide a means to better understand the different uses of land, and help planners and policymakers make informed decisions on how to use land in a sustainable and effective manner.

In this study, various maps were utilized to obtain information on the different case areas. The *Kezira* sector was depicted in a 1902 map obtained from the city's historical archives, while both the *Kezira* and *Megala* sectors were shown in a 1937 map created by the Italians during their occupation of Ethiopia. For the remaining case areas, Google images from the corresponding periods, along with the base maps utilized for plan preparation at different times and the recent map of the city from the planning bureau, were employed. The images were reconstructed in consultation with planning bureau experts to ensure the accuracy and representativeness of their respective study periods.

Through a thorough evaluation and ongoing consultation with a focus group, the plots have been successfully identified in their original state. Despite the challenges faced by earlier eras in obtaining necessary data, the focus group discussion greatly aided in reconstructing the buildings to their original state and determining their original purposes. Furthermore, it was possible to pinpoint the precise plot areas and building footprints for each case study. The adjacent street segments were reconstructed for each plot and determined their respective widths and lengths. Obtaining data from recent eras of development was less challenging, as the information was readily available from their respective base maps. However, have prepared thrir respective plans for each period separately.

Due to the categorical nature of the building use data, conducting quantitative analysis is challenging. However, the street segment, pot area, and building footprint data are purely quantitative and can be used for correlational analysis. To simplify this analysis, the four building use categories were reclassified and coded as a dummy variable. This is important for both correlational and regression analysis.

Finally, a Pearson Product-Moment correlation analysis is conducted based on Conzon's approach to examine the urban form characteristics of a city. The analysis is performed in two layers. The first layer investigates the relationship between street width and the usage of adjacent buildings. The second layer evaluates the correlation among street width, plot area, building footprint, and street width over time to identify any trends in their association. Additionally, the study explores planned and spontaneously developed scenarios. The outcomes and discussions are presented in subsequent sections.

4.4 Results

4.4.1 Relationship Between Land Use and Street Width

To evaluate the correlation between street width and land use, a Pearson Product-Moment correlation analysis is conducted for each sample site. The width of streets, which is typically related to their hierarchy, is compared to the use type of the properties adjacent to them. The degree and direction of correlation between the two sets of data is then determined. Specifically, the correlation coefficient is calculated between the plot area coverage of each use aspect and the width of the street that provides access to it. This assessment is performed across various morphological periods of the city to gauge any changes in the relationship between street width and land use over time. Furthermore, an additional assessment is made to examine the correlation among street width, plot area, building footprint, and access street length of plots.

The morphological transformation period of the city begins with the early morphogenesis period (1902–1941), continues with the intermediate morphogenesis period (1942–1991), and ends with the recent morphogenesis period (1992–to date). Data from representative cases of each period is presented in chronological order hereunder.

1. *Kezira* Area

The findings of this study, as presented in **Table 4-1** and displayed in **Figure 4-3**, reveal that street width has a statistically significant and positive correlation with mixed residential uses. However, in the specific area of *Kezira*, this relationship is relatively weak, with a coefficient of only 0.223. On the other hand, for all other types of land uses, there is no statistically significant association with street width, as indicated by a P-value of 0.01. Furthermore, the study also examined the relationship among different land uses in the *Kezira* area. The results demonstrate that there is no statistically significant correlation between them. In other words, the presence or absence of a particular type of land use in the area does not affect the likelihood of other types of land uses being present.

Table 4-1: Correlation between land use and street width of *Kezira* area

	Street Width	Mixed	Living	Amenities	Working Area
Street Width	1.000				
Mixed Residence	.223**	1.000			
Pure Residence	-.063	-.016	1.000		
Amenities	-.028	-.007	-.011	1.000	
Working Area	-.028	-.007	-.011	-.005	1.000

**. Correlation is significant at the 0.01 level (2-tailed).

Overall, these findings suggest that street width is an important factor in promoting mixed residential uses, particularly in areas outside of *Kezira*. However, the relationship between street width and land use may be influenced by other factors in the specific context of *Kezira*, warranting further investigation. Additionally, the lack of a significant relationship between different land uses in *Kezira* implies that other factors may be at play in determining the spatial distribution of various land uses in this area.

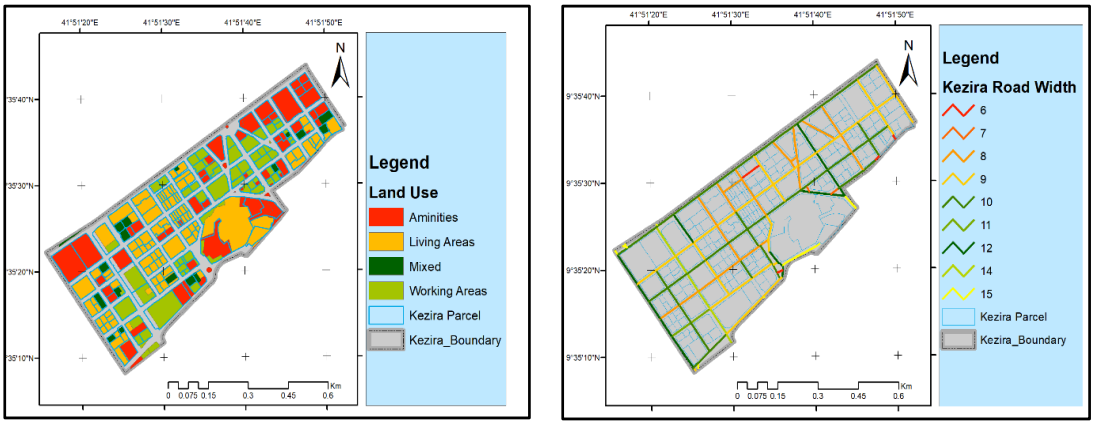

Figure 4-3:Land Use (left) and Street width (right) of *Kezira* area

2. *Megala* Area

Table 4-2 displays the results of our analysis on the relationship between road width and various aspects of the land uses in *Megala*. The land use and the road network of the site is indicated in **Figure 4-4**. Our findings suggest that the road width of the plots has a statistically significant and positive relationship with both the amenity and living area at a significance level of P = 0.01. This indicates that as the road width increases, so does the amenity and living area of the properties located on those plots.

Conversely, it was identified that the association between road access width and living area is negative. This means that as the road access width increases, the living area of the properties decreases. It was also observed a statistically significant and positive relationship between road width and working area at a significance level of P = 0.05, although this association was weaker compared to the road width-amenity/living area relationship.

Table 4-2: Correlation between land use and street width of *Megala* area

	Street Width	Amenity	Working Area	Living	Mixed
Steer Width	1.000				
Amenity	.389**	1.000			
Working Area	.139*	-.104	1.000		
Living	-.438**	-.566**	-.282**	1.000	

Mixed	.098	-.208**	-.104	-.566**	1.000

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Furthermore, the research discovered that the mixed residential and amenity uses have a medium-level opposing relationship with road width, which suggests that as road width increases, these uses tend to decrease. On the other hand, the working area function has a lower-level negative relationship with road width, meaning that as the road width increases, the working area tends to decrease.

Lastly, our analysis revealed that there is a statistically significant association between access road width and mixed residence in the study area. This implies that the width of the access road plays a role in determining the type of residences that are present in the area.

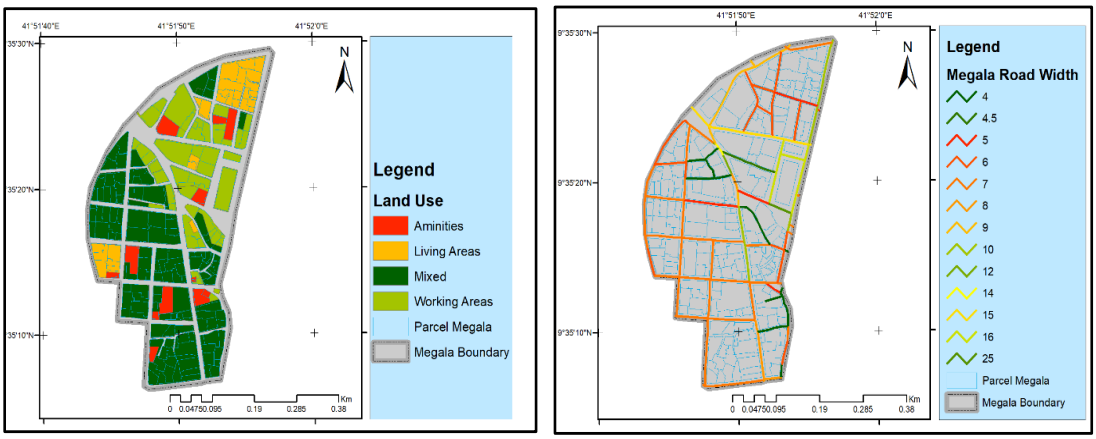

Figure 4-4: Land Use and Street width of *Megala* area

3. *Sabiyan* Area

The research conducted has revealed that the *Sabiyan* area's different uses are significantly related to road width, as illustrated in **Figure 4-5** and **Table 4-3**. The findings of the study suggest that there exists a medium-level negative relationship between residential use and street width at 0.01, and a positive but less significant association between amenity, working, and mixed uses. Additionally, the research indicates that there is an opposite statistically significant relationship between dwelling

use and other uses, with a medium level of significance at 0.01. However, the other uses do not exhibit any significant correlation with one another.

The results of this study have important implications for urban planners and policymakers. For instance, the negative relationship between residential use and road width suggests that areas with high-density residential use require wider roads to accommodate higher traffic flow. On the other hand, the positive association between amenity, working, and mixed uses indicates that narrower roads can suffice in areas with a mix of commercial and non-commercial activities. Moreover, the opposite association between dwelling use and other uses suggests that areas with more residential use may require different zoning regulations or land-use planning to ensure that traffic flow is not hampered.

Table 4-3: Correlation between land use and street width of *Sabiyan* area

	Street Width	Living	Amenity	Working Area	Mixed
Street Width	1.000				
Living	-.431**	1.000			
Amenity	.265**	-.578**	1.000		
Working	.239**	-.511**	-.097	1.000	
Mixed	.166*	-.476**	-.090	-.080	1.000

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

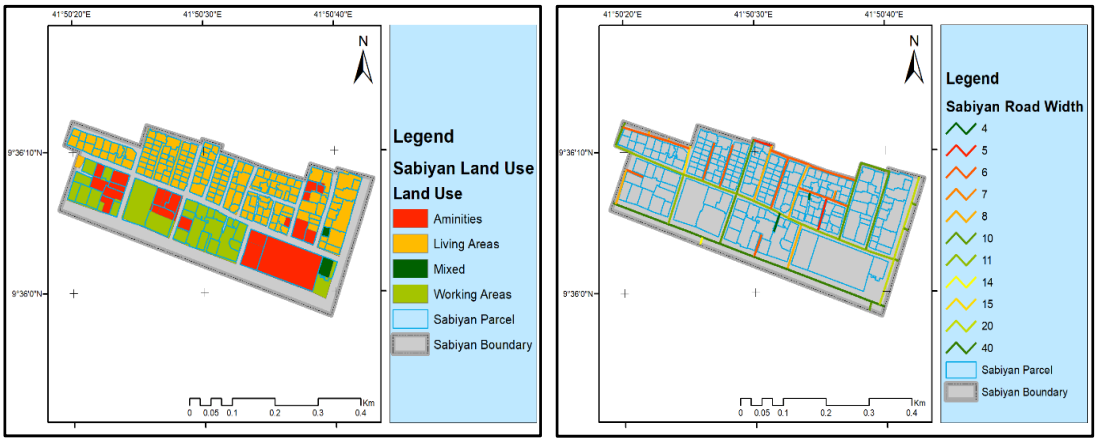

Figure 4-5: Land Use and Street width of *Sabiyan* area

4. *Legehare*

Based on the data presented in **Table 4-4**, this study reveals significant correlations between road access and the type of functional entities in a given area. **Figure 4-6** illustrates the land use and the street width situation of *Legehar*e area. The findings suggest that the width of road access has a significant positive correlation with mixed residential areas, indicating that wider streets are more likely to be located in neighborhoods with a diverse mix of residential properties.

Table 4-4: Correlation between land use and street width of *Legehar* area

	Street Width	Mixed	Living	Amenity	Working Area
Street Width	1.000				
Mixed	.204**	1.000			
Living	-.259**	-.832**	1.000		
Amenity	.083	-.041	-.300**	1.000	
Working Area	.120	-.053	-.390**	-.019	1.000

**. Correlation is significant at the 0.01 level (2-tailed).

In contrast, the study found that living areas are negatively correlated with other functional entities, such as amenity, mixed residence, and working areas. This implies that areas designated solely for living tend to be less integrated with other land uses,

which could have implications for transportation, social interaction, and access to services.

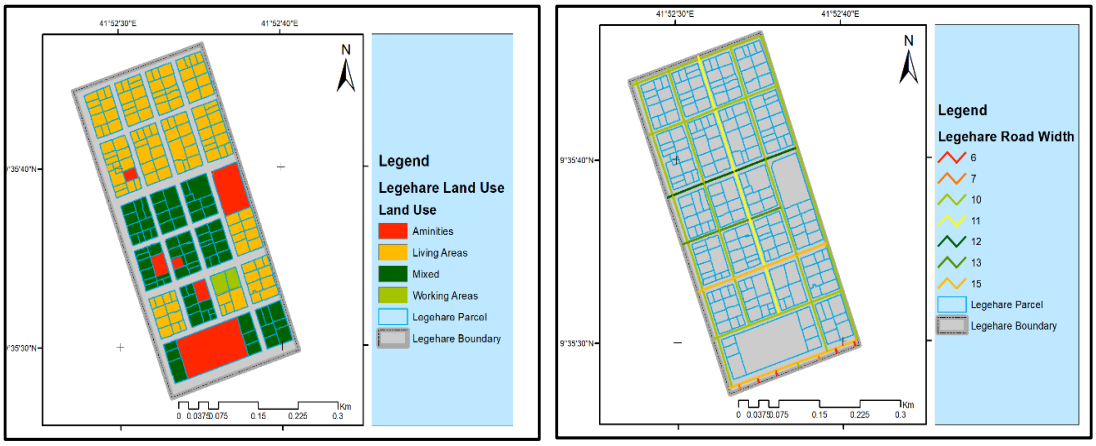

Figure 4-6: Land Use and Street width of *Legehare* area

Among the functional entities, mixed residence showed the strongest negative correlation with living areas, with a coefficient of -0.832. This means that neighborhoods with a higher proportion of mixed-use properties tend to have fewer areas that are exclusively designated for living. Similarly, working areas also exhibited a significant negative correlation with living areas, with a coefficient of -0.390, suggesting that residential areas may be less prevalent in neighborhoods with a higher concentration of commercial or industrial land use.

Interestingly, the study also found that the width of streets had a slightly positive correlation with mixed residential areas but a weak and unfavorable association with living areas. This indicates that wider streets may be more conducive to mixed residential land use patterns but may not be as desirable for areas designated solely for living. Overall, the findings suggest that there are complex relationships between road access, functional land use patterns, and the design of the built environment.

5. *Gende Gerada*

The *Gende Gerada* area's land use and road width, which is displayed in **Figure 4-7**, has been analyzed in **Table 4-5**, revealing several significant relationships. Firstly, there is a positive and significant relationship between access road width and amenity, with a p value of 0.01. Moreover, the access road width of plots also exhibits a medium level of significance in relation to living areas and mixed residence functions.

Interestingly, the relationship with living area is negative, indicating that wider access roads are associated with a decrease in residential living spaces. On the other hand, the relationship with mixed residence functions is positive, suggesting that wider access roads are linked to an increase in mixed-use developments.

Table 4-5: Correlation between land use and street width of *Gende Gerada* area

	Street Width	Amenity	Working Area	Living	Mixed
Street Width	1.000				
Amenity	.205**	1.000			
Working Area	.	.	.	.	.
Living	-.523**	-.374**	.	1.000	
Mixed	.469**	-.058	.	-.904**	1.000

**. Correlation is significant at the 0.01 level (2-tailed).

Another significant finding is that living areas have a negative and higher level of statistically significant relationship with mixed residential uses. This implies that residential living spaces are less likely to coexist with mixed-use developments, perhaps due to the increased noise and traffic generated by commercial activities. Furthermore, living areas have recorded a negative medium level relationship with amenity, indicating that areas with more residential living spaces may have less access to amenities.

Interestingly, working area use does not witness a statistically significant relationship with other uses in this study area. This suggests that there may be limited interaction between commercial activities and other land uses in *Gende Gerada*, perhaps due to zoning restrictions or the spatial layout of the area. Overall, these findings shed light on the complex relationships between land uses and access road width in the *Gende Gerada* area, highlighting the need for further research in this area.

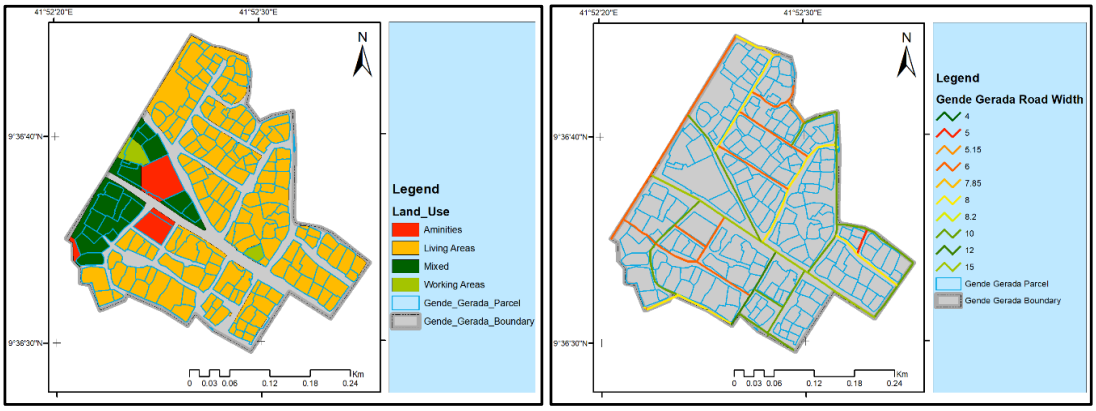

Figure 4-7: Land Use (left) and Street width (right) of *Gende Gerada* area

6. St. Mariam *Sefer*

Table 4-6 presents the findings of the St. Mariam *Sefer* study, which investigated the relationship between road access and land-use patterns in the area. The situation of land use and street width is displayed in **Figure 4-8.** The results indicate that there is a significant association between road access and mixed residential, living, and amenity areas, as evidenced by p-values of less than .01. This suggests that the availability of road access is an important factor in determining the distribution of these land uses in the study area.

Table 4-6: Correlation between land use and street width of St. Mariam *Sefer* area

	Street Width	Mixed	Living	Amenity	Working Area
Street Width	1.000				
Mixed	.433**	1.000			
Living	-.762**	-.699**	1.000		
Amenity	.467**	-.190	-.475**	1.000	
Working Area	.226*	-.095	-.237*	-.065	1.000

**. Correlation is significant at the 0.01 level (2-tailed)

*. Correlation is significant at the 0.05 level (2-tailed).

Furthermore, the study found a statistically significant correlation between street width and working areas, with a p-value of less than .05. This implies that the width of streets in the area has a notable impact on the distribution of working areas. Specifically, the

analysis revealed that living areas had the strongest correlation with street width, as indicated by a correlation coefficient of -0.762. This means that there is a strong negative relationship between living areas and street width, suggesting that narrower streets are more prevalent in areas with high residential density.

Amenity areas also displayed a statistically significant correlation with street width, with a correlation coefficient of 0.467. This indicates a positive relationship between amenity areas and street width, suggesting that wider streets are more common in areas with high levels of public amenities, such as parks, community centers, and other recreational facilities. Mixed-residence areas showed a weaker but still statistically significant correlation with street width, as evidenced by a correlation coefficient of 0.433. This implies that the width of streets is a moderately important factor in the distribution of mixed residential areas in the study area.

Finally, working areas exhibited the weakest correlation with street width, with a correlation coefficient of 0.226. This suggests that the availability of road access may be a more important factor in the distribution of working areas, rather than the width of streets. Overall, these findings provide valuable insights into the factors that shape land-use patterns in the St. Mariam *Sefer* study area, which can inform urban planning and development strategies in the region.

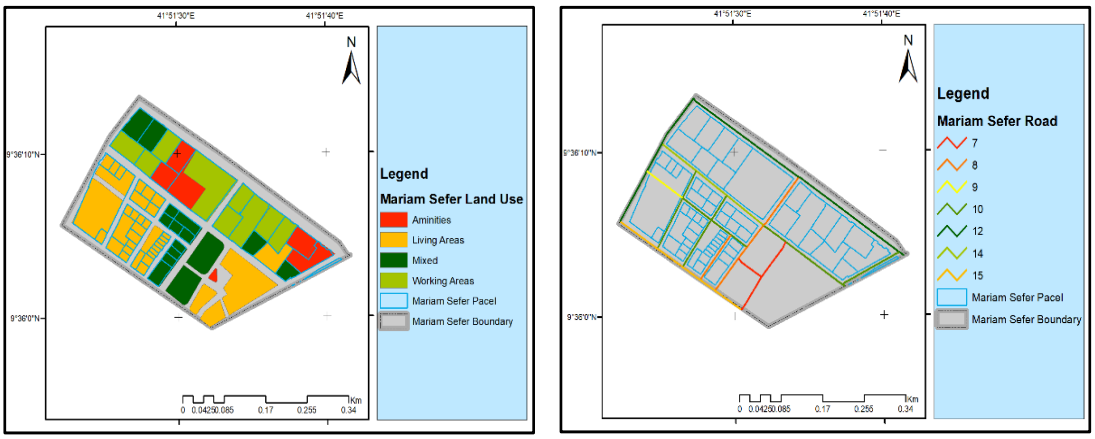

Figure 4-8: Land Use (left) and Street width (right) of St. Mariam *Sefer* area

It was also indicated that living areas do have a statistically significant but negative relationship with the areas covered by all the other functional entities: amenity, mixed-residence, and working. More specifically, the functional entity that has the highest but

negative correlation with the living area function is mixed residence, with a correlation coefficient of -0.699, followed by amenity areas with a correlation coefficient of -0.475, and then the working area with a correlation coefficient of -0.237.

Living areas, on the other hand, have a strong but negative relationship with their respective adjoining street widths, whereas amenities and mixed uses have a nearly moderate relationship. Working areas, however, have a small but positive relationship with street width. On the contrary, living areas have a strong but negative relationship with mixed residential areas, a nearly moderate but negative relationship with amenities, and a small but negative relationship with working areas.

The correlation results of street widths and land use functions of adjacent properties in various stages of the city's morphogenesis are presented in **Table 4-7**. In the first period of morphogenesis, there is no significant correlation between land use and street width except for mixed residential uses. However, in the spontaneously developed *Megala* segment, there is a significant correlation between land use and road width, except for mixed residential uses. It should be noted that there is a negative correlation between living area and street width.

During the secondary morphogenesis period of Dire Dawa, *Sabiyan* case area, the result has indicated that there is a significant relationship between street width and all of the four land uses. However, unlike the other land use types, the relationship of the street width and living area is negative and have a medium level of significance. The second case study site in this era is *Legehar*e where amenity and working areas do not have exhibited a significant relationship with street widths. On the other hand, there is a significant relationship between living areas and mixed residential uses where the former is negative.

The third morphogenesis period has indicated that there is a significant relationship in between the different land use categories and their attributed street widths in both of the formally planned and the spontaneously developed case areas. the exception here is that there is no recorded significant relationship in between working area functions and street widths. Similar to the previous cases, expect the case of *Kezira*, the living areas do have exhibited a negative relationship with street width in both St. Mariam *Sefer* and *Gende Gerada* case areas.

Table 4-7: Matrix of the correlation results of all the case areas

S/N	Case study	Correlation of streets width with different land uses								Remark	Period
		Amenity		Working Areas		Living Area		Mixed Residence			
		Correlation	Direction & Level	Correlation	Direction & Level	Correlation	Direction & Level	Correlation	Direction & Level		
	Kezira	No	-	No	-	No	-	Yes	Positive and Low	Planned	1st
	Megala	Yes	Positive and Low	Yes	Positive and Low	Yes	Negative and Medium	No	-	Spontaneously developed	1s,
	Sabiyan	Yes	Positive and Low	Yes	Positive and Low	Yes	Negative and Medium	Yes	Positive and Low	Planned	2nd
	Legehare	No	-	No	-	Yes	Negative and Low	Yes	Positive and Low	Planned	2nd
	Gende Gerada	Yes	Positive and Low	No	-	Yes	Negative and Medium	Yes	Positive and Medium	Spontaneously developed	3rd
	St. Mariam *Sefer*	Yes	Positive and Medium	Yes	Positive and Low	Yes	Negative and High	Yes	Positive and Low	Planned	3rd

Following the resolution of the correlation data, ordinal logistic regression (OLR) analysis is required to establish the predictive power of the independent variables over the dependent variables. This would allow the identification of a set of significant

factors from the various functional entities and built-up entities that could have an impact on road hierarchy.

Ordered logistic regression (OLR) should be used to assess the strength of relationship between the components. To that purpose, prior to doing ordered logistic regression (OLR) analysis, it is critical to confirm that the data is suitable for regression analysis, i.e., the underlying assumptions of regression analysis must be evaluated. As Creswell and Creswell (2017) point out, regression analysis is used when the data is normal and free of multicollinearity issues.

In terms of data normality and multicollinearity, tests of normality and multicollinearity are done. The Normal P-P Plot helps determine if the distribution is normal or non-normal. In this regard, (Pallant, 2010) claims that when the points in the Normal P-P Plot are in a pretty straight diagonal line from bottom left to top right, there are no notable deviations from normalcy. However, the results in the different case study areas have indicated that there is less normalcy in most of them. These situations could not allow to conduct an ordered logistic regression analysis.

4.5 Discussion

The correlation between street hierarchy and land use functions is a critical aspect of urban morphology, and it has been the subject of numerous studies in the field of urban planning and design. This discussion aims to illustrate the current state of research on the relationship between street hierarchy and land use functions along with the study result identified in this particular research.

There are various types of streets, each with its own shape and size, as well as distinct ways of interacting with the other streets assuming different urban purposes (Vítor Oliveira, 2016). The width of these streets which is very much related to the hierarchy of the respective streets is liable to create differences in the users' type and density. The width of the street could thus affect the significance of the abutting plot which is assumed in this study would in turn affect the land use type that the plot would serve. Similarly, in land use planning and strategic development, building morphotype clustering is a valuable strategy for establishing area types (Potapenko & Moor, 2020). In addition, the uniqueness of every area, which contributes to its importance, is

determined by the interplay of the essential components of urban form in their environment (Vítor Oliveira, 2016; Ünlü, 2019; J. W. Whitehand, 2001). Therefore, comprehending the urban form of parts of cities is worth due consideration in urban morphology research. This study sought to assess the relationship between the function of properties in an area with street width throughout the morphogenesis of the city of Dire Dawa. The assessment has also looked at the situation from the perspective of planning interventions. The result has been categorized into the four land use classes and described subsequently.

Urban land use policy could contribute to the proper allocation of land uses to their respective street hierarchies. Nevertheless, there is no codified and integrated land use policy in the country though there are some elements indicated in the constitution of the FDRE (FDRE, 1995) and urban land lease holding proclamation (FDRE, 2011). However, these two segments of policy did not sufficiently illustrate the situation and thus call for policy development. For instance, there is an old and widely disseminated theory regarding land use and street hierarchy at neighbourhood level developed by Clarence Perry (Perry, 1929). According to this theory, streets of higher hierarchies should serve through traffic, while adjacent properties should serve for retail functions, and streets of lower hierarchies should inhibit through traffic and be used for local functions. In addition, Shen and Karimi (2016) and Omer and Goldblatt (2016) have identified that different types of functions are connected to varied urban streets. In the practical situation, this notion has got prior significance in the allocation of streets and assignment of uses in urban planning while this may not materialize in the case of spontaneous developments.

The correlation between working area functions and street width in city morphogenesis lacks a definitive definition. Nevertheless, in *Sabiyan* and St. Mariam *Sefer*'s planned development sectors, a connection between these urban form components is noticeable. *Sabiyan* represents the intermediate developmental period, while St. Mariam *Sefer* is more recent. The evidence suggests that working area functions cluster in locations with higher hierarchical street widths. The reason is that working area functions to draw in a dense and diverse population that requires access via higher-level streets to accommodate greater traffic. The result aligns with the idea of Clarence Perry (Perry, 1929), Shen and Karimi (2016), and Omer and Goldblatt (2016). On the other hand, in

the case of spontaneous development, there is no clearly defined relationship between working area functions and street width. It has been seen in the case of *Megala* which is a spontaneously developed area in the early morphogenesis period while the recent morphogenesis case of *Gende Gerada* did not reflect a meaningful relationship. This suggests that planned developments can influence the allocation of working areas based on street width. Urban planning principles recommend allocating streets of better hierarchies to accommodate the traffic that working areas attract. Overall, while there may not be a universal relationship between working area functions and street width in cities, planned developments can play a role in shaping this relationship.

Streets that have a higher density and variety of land uses tend to be more connected to central streets (Berghauser Pont, Stavroulaki, Bobkova, et al., 2019). As a city develops and incorporates mixed functions, the relationship between street width and mixed land use strengthens over time. This approach to sustainable development and urban design promotes physical, social, and visual interactions that contribute to the vibrancy of cities (Grant, 2002; Hoppenbrouwer & Louw, 2005). While urban planners have traditionally segregated land uses due to potential negative externalities, mixed-use projects are now favored (Dempsey et al., 2010). Mixed-use development has become a major planning paradigm in various towns in recent decades. In the case of the study area, the city's form has reflected the correlation between mixed-use function and street width. However, there are certain areas within the city, such as the organic core of *Megala*, where mixed-use dominates regardless of street width. According to previous research in the study area, the site has a diverse mix of uses and is inhabited by various societies, earning it the informal nickname of the "colorful city" (Asfaw & Chernet, 2023). In these cases, a mix of uses can be found regardless of the street width. Overall, there is a significant reliance on street width for mixed land-use access.

Correspondingly, there is a correlation between living areas and street widths, albeit with an inverse relationship, unlike the previous paragraph. In urban planning, local streets are often allocated for private residential use, resulting in a common trend of wider streets in areas with mixed functions. However, the *Kezira* area, a formally planned core of the city with segregator planning principles, does not encourage mixity. Consequently, only major corridors in this area offer amenities and working areas, while the rest of the streets have a similar setting with few exceptions. This leads to

little correlation between living area functions and street width in this specific context. However, in general, there is a significant and increasing negative trend between living function and street width, regardless of the type of planning interventions that shape the city.

The presence of amenities in a city can generate a considerable amount of traffic and is typically associated with a well-organized street hierarchy. However, it has been observed that there is no clear pattern linking the width of a street with the use of amenity present in the city throughout its various stages of development. Despite this, recent urban developments in *Gende Gerada* and St. Mariam *Sefer* have revealed a strong correlation between the hierarchy of roads and the type of amenity available, independent of the planning methods utilized in shaping the city. This suggests that there has been an increased emphasis on allocating amenities based on their ability to attract traffic, with street width being a key factor in this allocation process.

During the focus group discussion, it was discovered that informal developers tend to follow the blocks designated for public amenities, but they frequently purchase land from the farming community on the outskirts to settle in other areas. Although this practice is not legal, it plays a crucial role in shaping the urban landscape of spontaneously developed regions. Additionally, in Dire Dawa, public or community associations typically oversee the development of amenities, further highlighting the connection between street width and amenity function. This demonstrates that the community is taking an active role in safeguarding spaces reserved for amenities in the city.

Overall, this suggests that urban planners should be mindful of the impact that amenities can have on traffic flow and consider the relationship between street width and amenity function when making decisions about city development.

4.6 Conclusion

The study aimed to assess the relationship between street width and land use type in different morphological periods of the city of Dire Dawa. A Pearson Product-Moment correlation analysis to assess the relationship between street width and land use in different areas of Dire Dawa, Ethiopia, during three morphological periods: early

(1902-1941), intermediate (1942-1991), and recent (1992-present). The study found that the relationship between street width and land use varied depending on the urban planning intervention type and the morphological period of the city.

The study found that street width has a positive relationship with mixed residential and amenity uses while living areas have a negative relationship with street width. The study also found that mixed residential and amenity uses have a medium-level opposing relationship. Furthermore, it was observed that living areas have a strong but negative relationship with mixed-use areas. Overall, the study reveals that the relationship between street width and land use type varies across different morphological periods of the city.

Although there are some similarities between planned and spontaneously developed areas, there are also significant differences. In formally planned areas, the lack of correlation between some land use classes and street width could be attributed to either problem with implementing the plan or issues with plan preparation. However, in the case of spontaneous developments, there are violations of land use functions, which result in neglect of the urban plan assigned for the area, except for public amenities and major roads, which exhibited minimal encroachment. In terms of common traits, both planned and spontaneously developed areas share the need for public amenities and roads. However, while formally planned areas have a more structured layout, spontaneous developments tend to be more disorganized, with irregularly sized plots and meandering streets. These differences can result in a lack of coherence in the urban fabric and impact the livability of the areas.

To address these challenges, urban planners need to develop strategies that accommodate the needs of both formal and informal developments. Such strategies could include improving the efficiency of planning processes, increasing real public participation in planning, and promoting alternative land-use patterns that better accommodate the needs of the community. By doing so, planners can help ensure that urban areas are livable, functional, and sustainable, regardless of their origin. The findings of this study may help urban planners and policymakers in making informed decisions related to land use and transportation planning.

The relationship between these two components is critical to understanding the form

and function of a city. As such, urban planners and policymakers must carefully consider the correlation between street hierarchy and land use functions when planning the development of a city. By doing so, they can help to ensure that the city is able to meet the needs of its residents and promote sustainable and equitable growth. In addition, land use policy is a crucial aspect of urban planning and urban morphology as it guides the allocation and use of land in urban areas. Without a well-developed land use policy, urban areas can experience problems such as a mismatch between land use and street width, urban sprawl, congestion, inefficient land use, and inadequate provision of infrastructure and services. Therefore, it is recommended that a comprehensive land use policy be developed for urban areas in the nation. The development of a well-designed land use policy is essential for effective urban planning and urban morphology. It ensures that land use is efficient, appropriate, and sustainable and that the needs of the community are met.

The presented study draws a conclusion with certain limitations and gaps that could be addressed by future researchers. Primarily, the research has concentrated on a sole city, examining only a restricted number of case areas within the city, which could restrict the applicability of the results. Thus, additional research is necessary to overcome the limitations and gaps in the current literature and to attain a more comprehensive comprehension of the correlation between street hierarchy and land use functions in cities of developing countries.

CHAPTER FIVE

5. SYNTHESIS OF FINDINGS AND GENERAL DISCUSSION

5.1 Introduction

Urban morphology, the study of the physical form and structure of cities, provides valuable insights into how cities evolve over time and the factors influencing their development. This comprehensive discussion focuses on the findings derived from comparative studies conducted in the city of Dire Dawa across different morphological eras. The comparative analysis encompasses various aspects, including street hierarchy, land use functions, urban form characteristics, and the role of planning interventions and community dynamics in shaping urban development.

The comparative study adopts a longitudinal perspective, examining three distinct morphological eras in Dire Dawa's urban development: the Early Morphogenesis Era (1902-1941), the Intermediate Morphological Era (1942-1991) which covers (Post-Italian Haile-Selassie Period: 1942-1974, and the Dergue Period: 1975-1991), and the Recent Morphological Era (since 1992). Each era represents a significant phase in the city's evolution, characterized by distinct planning approaches, socioeconomic dynamics, and urban forms.

Early Morphogenesis Era (1902-1941): The study compares two neighborhoods, *Kezira* and *Megala*, representing contrasting development patterns: formal planning versus organic growth. Through a detailed analysis of morphological characteristics such as street network density, floor space index, and open space ratio, significant differences in urban form emerge between the two neighborhoods. *Kezira*, with its formal planning and higher street network density, exhibits a more structured urban layout compared to the organic development of *Megala*. These findings highlight the influence of planning strategies on urban morphology during the early stages of Dire Dawa's development.

Intermediate Morphological Era (Post-Italian Haile-Selassie Period and Dergue Period): The comparative study focuses on *Legehar*e and *Sabiyan*, representing the post-Italian occupation and Dergue governance periods, respectively. Analyzing parameters such as floor space index, street network density, and open space ratio reveals distinct urban forms shaped by planning interventions and socioeconomic factors. *Legehar*e, influenced by formal planning, exhibits a more organized urban

layout with higher street network density, while *Sabiyan* reflects a mix of formal and organic development patterns. These findings underscore the interplay between planning strategies, governance regimes, and urban morphology during Dire Dawa's intermediate morphological era.

Recent Morphological Era (since 1992): The study examines the areas of St. Mariam *Sefer* and *Gende Gerada* to elucidate the urban transformation in the post-Dergue era. Findings indicate a shift towards compact and dense development, influenced by industrialization and infrastructure projects. St. Mariam *Sefer*, with its formally planned development, demonstrates higher density and a more structured urban form compared to the organic growth observed in *Gende Gerada*. The correlation between street width, land use functions, and planning interventions underscores the complex dynamics shaping urban morphology in the recent morphological era.

Across all morphological eras, the comparative study highlights the intricate relationship between planning interventions, socioeconomic dynamics, and urban form evolution. Planned developments tend to result in more structured urban layouts with higher density and better infrastructure, while organic growth areas exhibit a mix of land use functions and lower levels of formal planning. Community involvement, informal development practices, and historical legacies also play significant roles in shaping urban morphology.

The comparative study of urban morphology in Dire Dawa provides valuable insights into the dynamic interplay between planning interventions, socioeconomic dynamics, and urban form evolution across different morphological eras. By understanding the factors shaping urban development, policymakers and urban planners can formulate more effective strategies to promote sustainable and inclusive cities in the face of rapid urbanization and global challenges.

5.2 General Discussion

The general discussion delves into the multifaceted nature of Dire Dawa's urban form and its evolution over time. The city's unique duality challenges traditional morphological understandings, prompting a deeper exploration into its distinct characteristics. The focus then shifts towards Dire Dawa's journey toward achieving a sustainable urban form, emphasizing the integration of various urban planning

elements. Additionally, the evolving landscape is investigated by decoding the city's urban form through a historical planning lens and its relationship with density dynamics. Lastly, the intricate interplay between street hierarchy, land use, and urban form is examined, highlighting their interconnected roles in shaping Dire Dawa's urban fabric.

5.2.1 Dire Dawa's Path Towards Sustainable Urban Form: An Integrated Exploration

The exploration of Dire Dawa's sustainable urban form (SUF) journey is guided by three foundational theories: Compact City Theory, New Urbanism, and Mixed Land Use.

Compact City Theory, as advanced by (Calthorpe, 1993, 2011), emphasizes resource efficiency and density management. In Dire Dawa, this theory encourages the evaluation of density, use-mix patterns, and resource efficiency. Through spatial distribution analysis of residential, commercial, and other land uses, it is aimed to recommend future developments that advocate for a compact, sustainable urban form (SUF). Such development, characterized by densification and mixed-use strategies, can reduce car dependency, optimize resource use, and decrease environmental impact.

New Urbanism, championed by Peter Katz (1994) and Kevin Lynch (1960), underscores the creation of human-scale, livable neighborhoods. In Dire Dawa, this perspective invites an examination of open space accessibility, street pedestrianization, and neighborhood use diversity. This analysis will illuminate the city's capacity to cultivate sustainable living by correlating built environment features with social interactions, mobility, and quality of life.

Mixed Land Use, influenced by Jane Jacobs (1961), accentuates the integration of diverse land uses within neighborhoods, fostering a vibrant urban fabric. This approach imagines lively markets amidst residential areas, parks interwoven with shops, and bustling public spaces. Such development promotes community cohesion, serves a diverse population, and encourages sustainable transportation by placing essential amenities within walking or cycling distance.

By amalgamating these theoretical perspectives, one can construct a comprehensive framework for dissecting Dire Dawa's spatial transformation, assessing its present

sustainability, and charting a pathway for a more sustainable and livable future. The examination of Dire Dawa's landscape integrates the principles of Mixed Land Use, requiring a nuanced approach.

Early morphogenesis Period (1902 - 1941): *Kezira* and *Megala*, as historic urban cores, exhibit distinct development trajectories. *Kezira*'s formality in planning favored land-use segregation and strict zoning laws, contrasting with *Megala*'s organic, mixed-use character. This period underscores the tension between formal planning and traditional mixed-use urban development.

Intermediate Morphogenesis (1941 - 1991): *Legehar* and *Sabiyan*, representing this era, demonstrate a predominance of segregated land uses due to planned development interventions. The location of these areas also influences the intensity of mixed-land use, highlighting the role of spatial positioning in shaping urban form (UF).

Recent Morphological Era (since 1992): St. Mariam *Sefer,* a formally planned area, contrasts with *Gende Gerada*'s organic development. Formal planning in St. Mariam *Sefer* limited the blending of multiple land uses, while *Gende Gerada* exhibited more mixed-land use patterns. The intensity of mixed-land use in this era is influenced by both location and planning interventions.

The plot level analysis indicated that there is a clear disconnect emerges between early formal planning and sustainable urban form principles. This implies that in is important to promoting mixed-use development, shifting away from stringent zoning and embracing principles of compact development and New Urbanism. The research underscores the significance of mixed-use development, compact city principles, and New Urbanism for achieving sustainability in Dire Dawa.

Embracing mixed-use development, compact city principles, and New Urbanism is essential for fostering sustainable urban environments at plot level. Compact city planning is rooted in the belief that dense and concentrated cities support sustainable development by reducing pressure on city outskirts and enhancing transportation efficiency (Stebek, 2013). This approach aligns with the principles of sustainable urban form (SUF), emphasizing the need for mixed-use development and compact city design to achieve sustainability goals.

Studies have shown that compact development policies, building pro-environment awareness, and leveraging information technologies, are essential for sustainable urban resilience (Dehghani et al., 2022). These policies play a vital role in enhancing urban sustainability and resilience, crucial aspects for cities like Dire Dawa.

Choguill (2008) emphasizes the pivotal role of neighborhoods as the fundamental building blocks of sustainable cities. This perspective is further reinforced by Rice (2010), who underscores the significance of walkable mixed-use neighborhoods in urban sustainability. Our analysis reveals distinct patterns at the neighborhood level across different morphological periods in Dire Dawa.

Early Morphological Period: During this phase, *Kezira* and *Megala*, serving as the city's ancient core, manifest high levels of mixed-land use at the neighborhood level. These areas effectively accommodate a diverse range of city functions within their boundaries, reflecting a vibrant and integrated urban fabric that supports sustainable living.

Intermediate Era: In contrast, the intensity of mixed-land use at the neighborhood level shows a decline during the intermediate morphological period. This decline is notably influenced by the planned development interventions in *Legehar* and *Sabiyan*. These areas, characterized by segregated land uses, indicate a departure from the integrated and mixed-use urban form observed in the city's early period.

Recent Transformation Era: In the more recent morphological era, the contrast in neighborhood development is evident. St. Mariam *Sefer*, benefiting from formal planning and its proximity to the city center, demonstrates a more balanced and integrated use mix. In comparison, *Gende Gerada*, characterized by its organic and peripheral development, exhibits a less cohesive and mixed-use urban fabric. This highlights the influence of planning strategies and location on the intensity and quality of mixed-land use at the neighborhood level.

The neighborhood-level analysis therefore underscores the evolving nature of mixed-land use in Dire Dawa across different morphological periods. While the early period reflects a high level of integration and mixed-use, the intermediate era shows a decline influenced by planned development, and the recent transformation era reveals the positive impact of formal planning and central location on achieving a balanced and sustainable use mix.

Open Space Ratios: Declining Trends Across Morphological Eras

There has been exhibited a general decline in open space ratios across the different urban morphogenesis periods of Dire Dawa. This has been maily due to an suggests an increasing built-up area. This trend, while possibly driven by urban expansion, requires careful consideration to maintain a balanced open space ratio across neighborhoods.

A crucial aspect of Dire Dawa's urban transformation is the trend in open space ratios across morphological eras. A general decline in open space ratios across periods indicates an increasing built-up area. While this trend is fueled by urban expansion, like the case of Dire Daw, it raises concerns regarding the availability and accessibility of public and green spaces.

Maintaining a balanced open space ratio in urban areas is crucial for various aspects of city life. The trend in open space ratios across different morphological eras reflects the evolution of urban landscapes. A decline in open space ratios indicates increasing urbanization and built-up areas, which can impact the availability and accessibility of public and green spaces, essential for the livability and well-being of city residents and its sustainable urban form (Jović et al., 2021).

Studies have shown that urban open spaces contribute to various aspects of urban society, including social, physical, cultural, and environmental benefits (Timalsina, 2021). However, the design and maintenance of these spaces are also crucial, as issues like vandalism can affect their functionality and appeal (Othman El Sayed, 2019). As a result, understanding and monitoring the trends in open space ratios across different urban morphological eras are essential for sustainable urban development. Balancing built-up areas with open spaces is critical for creating livable cities that promote environmental sustainability and the overall well-being of their residents.

Our examination of Dire Dawa's morphogenesis, integrating theoretical perspectives and historical analyses, provides valuable insights into its path towards sustainable urban form. It highlights the importance of promoting mixed-use development, compact city principles, and New Urbanism. Balancing plot-level and neighborhood-level mixed-land use, achieving responsive open space ratios, and integrating concepts from organic development and formal planning are essential for fostering sustainable urban development in Dire Dawa and similar contexts globally.

5.2.2 Dire Dawa's Evolving Landscape: Decoding Urban Form Through the Lens of Historical Planning and Density

Planned Spaces, Organic Growth: Unveiling the Densities of Dire Dawa

Exploring Dire Dawa's intricate urban fabric requires a journey through its historical evolution. This analysis delves into the city's growth, investigating how diverse planning philosophies and shifting governance eras have influenced its morphological development. It was commenced with the Early Morphogenesis Era (1902-1941), where *Kezira* and *Megala* epitomize contrasting methodologies – one characterized by planned order and the other by organic growth. The narrative then transitions to the Intermediate Era (1942-1991), spotlighting *Legehar*e and *Sabiyan* as embodiments of the impact of evolving political regimes on urban planning approaches. Lastly, it was possible scrutinize the developments post-1992, juxtaposing the formally planned St. Mariam *Sefer* with the spontaneously evolving *Gende Gerada*. Through this historical exploration, one unravel the intricate relationship between past legacies, planning paradigms, and developmental trajectories that have crafted Dire Dawa's distinctive urban tapestry.

The Early Morphogenesis Era (1902-1941)

The early development of Dire Dawa presents a fascinating case study in contrasting urban planning philosophies. *Kezira* and *Megala*, the city's core districts, stand as testaments to these contrasting approaches. *Kezira*, with its formal planning, embodies a structured and intentional design. This is evident in its higher Floor Space Index (FSI), allowing for taller buildings, a lower street network density indicating more spacious layouts, and a clear emphasis on open space provision (Song et al., 2020). This approach prioritizes order, potentially aiming for efficiency and a modern aesthetic.

In stark contrast, *Megala* exemplifies organic development. Characterized by a lower FSI, a higher street network density with a more intricate web of streets, and a focus on street density over dedicated open spaces, *Megala* reflects a more spontaneous and traditional urban form (Song et al., 2020). This approach resonates with the layout of traditional Arab Islamic cities, prioritizing walkability and potentially fostering a stronger sense of community within its denser layout.

Despite their contrasting appearances, delving deeper reveals that both *Kezira* and *Megala* were shaped by underlying needs and considerations.

Kezira's focus on open spaces aligns perfectly with contemporary research on urban green spaces. Studies highlight the crucial role of parks and green areas in providing vital ecosystem services like air and water purification, mitigating urban heat island effects, and promoting overall environmental health (Song et al., 2020).

Megala's emphasis on street network density resonates with discussions on flood management. Research by Schuch et al. (2017) explores the relationship between flood control, land-use planning, and green spaces. While *Megala* may lack dedicated open spaces, its denser street network could potentially aid in drainage during heavy rainfall.

The contrasting approaches of *Kezira* and *Megala* further echo a wider debate within urban planning discourse. Literature on urban green space provision often grapples with the challenges and limitations of implementing different planning strategies (Maryanti et al., 2017). Striking a balance between imposing formal planning mechanisms and allowing for some degree of organic urban development remains a complex issue.

In conclusion, the case of *Kezira* and *Megala* offers valuable insights into the dichotomy between formal planning and organic growth during Dire Dawa's Early Morphogenesis Era. By examining these contrasting approaches through the lens of contemporary research on urban green spaces, ecosystem services, and pandemic-responsive planning, one gain a deeper understanding of the diverse factors shaping urban form and design. The lessons learned from this historical analysis can inform future planning decisions in Dire Dawa and other cities grappling with balancing planned development with the inherent dynamism of urban growth.

Planned Development in *Legehar*e and *Sabiyan* (1942-1991)

The Intermediate Morphogenesis Era (1942-1991) of Dire Dawa presents a period marked by distinct urban planning approaches in *Legehar*e and *Sabiyan*. *Legehar*e, representing the Haile Selassie Era, exhibits characteristics of a more densely planned area. This is evident in its higher Floor Space Index (FSI), indicating a higher allowance for building heights, a denser street network facilitating greater connectivity,

and a higher Ground Space Index (GSI) suggesting more built-up area compared to *Sabiyan*.

Sabiyan, developed during the Dergue Period, reflects a different planning strategy. Here, one can see a mix of low-rise and mid-rise structures with a lower FSI and street network density. This suggests a potentially less intensive and more spread-out development pattern compared to *Legehar*e.

Despite these variations, both *Legehar*e and *Sabiyan* are predominantly characterized by low-rise buildings. This dominance of formal planning methodologies limits the opportunity to directly compare them with organic development patterns observed in earlier eras of Dire Dawa. While the two areas showcase the influence of distinct political regimes on urban planning, a more nuanced analysis of building heights reveals a lack of significant variation.

Further research delving into the specific planning documents and policies implemented during the Haile Selassie Era and the Dergue Period could provide deeper insights into the rationale behind the observed planning differences in *Legehar*e and *Sabiyan*. Understanding the priorities and considerations that shaped these development strategies would enrich our understanding of Dire Dawa's urban evolution.

In conclusion, the Intermediate Morphogenesis Era in Dire Dawa showcases the influence of changing political regimes on urban planning approaches. While *Legehar*e exhibits a denser development pattern, and *Sabiyan* reflects a more spread-out layout, both areas are dominated by low-rise buildings. Further investigation into the planning documents and policies of this era would offer valuable insights into the decision-making processes that shaped these distinct urban landscapes.

Unveiling the Complexities of Dire Dawa's Urban Transformation

This comparative analysis of Dire Dawa's urban morphology offers valuable insights into the intricate relationship between historical, social, and economic factors shaping urban development. Since 1992, the city's landscape has undergone significant transformations, with distinct characteristics emerging in areas like St. Mariam *Sefer* and *Gende Gerada*.

St. Mariam *Sefer*, a formally planned area situated near the city center, embodies a denser and more structured approach to development. This is evident in its higher Floor Space Index (FSI) allowing for taller buildings, a denser street network facilitating greater connectivity, and a higher Green Space Index (GSI) indicating a more intentional incorporation of parks and green areas (Rusche et al., 2019).

Gende Gerada, in contrast, exemplifies organic development on the city's periphery. Characterized by a lower FSI with predominantly lower-rise structures, it reflects a more spontaneous growth pattern. However, *Gende Gerada* exhibits a higher Open Space Ratio (OSR) suggesting a larger portion of undeveloped land compared to St. Mariam *Sefer*. This comparison underscores the influence of historical evolution and planning practices on urban form. St. Mariam *Sefer*'s formal planning reflects the priorities of a centralized governance structure, while *Gende Gerada*'s organic growth hints at a potentially less regulated development process.

The observed variations across these areas highlight the impact of governance eras on urban morphology (Rusche et al., 2019). Dire Dawa's urban form has demonstrably evolved across different eras, reflecting the changing priorities and approaches of its governing bodies.

This analysis extends beyond simply documenting morphological changes. It emphasizes the importance of historical context and planning practices in shaping urban morphology. The trend towards compact and dense development observed in St. Mariam *Sefer* aligns with contemporary discussions on sustainable urban growth, where efficient use of space and resource conservation are paramount.

Looking beyond Dire Dawa, existing urban planning theories can provide a broader framework for understanding these dynamics. Studies on planning practices in Chinese cities, for example, offer valuable insights into the interplay between formal and organic development observed in St. Mariam *Sefer* and *Gende Gerada*, respectively.

Furthermore, research on sustainable urban logistics and urban climate change adaptation can inform future development strategies in Dire Dawa. The observed shift towards compact and dense urban forms aligns with these sustainability principles, highlighting the potential for Dire Dawa to create a more efficient and resilient urban environment.

In conclusion, Dire Dawa's urban morphological changes showcase a complex interplay between historical evolution, planning practices, and development patterns. Examining these changes through the lens of urban planning theories and sustainable development practices provides a deeper understanding of the city's urban form evolution. This analysis underscores the importance of context-specific planning approaches in shaping sustainable urban environments for the future of Dire Dawa and similar developing cities.

5.2.3 The Interplay Between Street Hierarchy, Land Use, and Urban Form

Streets are not merely passageways; they play a critical role in shaping the very fabric of a city. Their hierarchy, defined by size and function, significantly influences land use and ultimately, the overall urban form. Clarence Perry's seminal theory from 1929 laid the groundwork for understanding this relationship. He proposed that major streets handle through traffic, with adjacent properties ideal for retail functions, while smaller streets serve local access and support residential areas. This concept finds further support in studies by Shen and Karimi (2016) and Omer and Goldblatt (2016).

The current research in Dire Dawa delves deeper, specifically assessing the correlation between street width (an indicator of hierarchy) and land use functions across the city's development. This analysis encompasses both planned and organic development sectors, allowing for a more nuanced understanding. In planned areas like *Sabiyan* and St. Mariam *Sefer*, wider, higher-hierarchy streets are indeed associated with working areas. This confirms the influence of planned development on land use allocation based on street width and urban planning principles.

To fully grasp the relationship between street hierarchy and land use functions, a broader theoretical framework is necessary. Works by Han et al. (2020) offer valuable insights into classifying streets based on hierarchy and network features, respectively. Additionally, research by Wang et al. (2018) and Yin et al. (2022) explores the link between street centrality (a measure of a street's connection to other areas) and land use intensity (concentration of activity). These studies shed light on how different types of streets and their characteristics influence the types and intensity of urban land uses that flourish nearby.

The interplay between street design, land use, and urban functions is further emphasized in studies by Serok et al. (2019) and Kickert et al. (2020). They delve into the relationship between street configuration (layout and design) and the presence of retail stores. Their research highlights the importance of street layout in shaping economic activities within cities.

Understanding these dynamics is crucial for urban planners and policymakers. By considering the intricate relationship between streets, land use, and urban form, they can create functional and sustainable urban environments that cater to the diverse needs of residents and businesses alike.

Unplanned Patterns: Navigating the Complexity of Organic Development

In contrast to planned areas, the relationship between street width and land use functions in spontaneously developed areas like *Megala* and *Gende Gerada* is less clear-cut. This is a reflection of the absence of a pre-defined land use allocation strategy. Organic development often exhibits a dominance of mixed-use functions regardless of street width, as seen in *Megala*'s diverse mix of commercial and residential uses. This lack of a direct correlation between street width and land use highlights the inherent complexity of urban development processes, particularly the influence of organic growth on land use patterns.

To gain a deeper understanding of these unplanned environments, one can explore an analogy from the field of neuroscience. Spontaneous development areas might undergo a process of internal organization that shapes land use functions over time. Just as spontaneous neuronal activity contributes to the formation of mature neural networks, organic urban growth may lead to the emergence of distinct land use patterns and street hierarchies through a series of unplanned interactions and activities.

This analogy extends further. The use of biomarkers in brain research to assess brain recovery Cassidy and Cramer (2017) suggests a potential parallel for urban studies. The development of urban "biomarkers" could offer valuable insights into the evolution of land use functions in spontaneously developed areas. These markers could function similarly to neural biomarkers, helping us evaluate the progression and transformation of land use patterns within unplanned urban settings. The spontaneous interactions and

activities within these areas likely contribute to the establishment of unique land use functions and the creation of their own, often informal, street hierarchies.

In conclusion, by drawing parallels to the fascinating world of neuroscience, one can gain valuable insights into the complexities of unplanned development. Spontaneous neuronal activity, the use of biomarkers in brain research, and the wiring of sensory circuits offer a fresh perspective on how organic processes can shape both neural networks and urban landscapes. Understanding these dynamics is crucial for effectively managing and planning for the future of spontaneously developed areas within our cities.

Streets as Architects of Urban Life: The Interplay Between Design and Dynamics

The relationship between street characteristics and the lifeblood of a city – its urban dynamics – is far from simple. Street width emerges as a critical player, influencing not only access to a mix of land uses but also the overall vibrancy of a space. In Dire Dawa, for instance, the observed correlation between wider streets and a greater presence of mixed-use functions Wangbao (2022) highlights the power of street design to shape land use patterns. This aligns with the broader understanding that street width can significantly impact the vitality and functionality of urban spaces (Guo et al., 2021).

However, the story goes beyond just width. The inverse relationship between areas dedicated to living and street width, particularly in planned communities like *Kezira*, reveals another layer of complexity (Wangbao, 2022). This finding points to how street hierarchy, or the classification of streets based on size and function, can influence the distribution of land uses within a city. This resonates with the concept that street design can affect the allocation of amenities and living spaces, ultimately shaping the very fabric of an urban area (Nyunt et al., 2015).

Moving forward, developments like *Gende Gerada* and St. Mariam *Sefer* showcase a promising trend. The strong correlation observed between amenities allocation and street hierarchy suggests that recent urban planning efforts are integrating these principles to enhance accessibility and distribution of amenities within neighborhoods (Nyunt et al., 2015). This underscores the importance of considering street design as a key factor in urban development projects, with the potential to optimize the provision of amenities and services to residents.

These findings resonate with established urban planning theories that emphasize the role of street connectivity, land use mix, and density in shaping the form and function of a city (Bonaccorsi et al., 2020). Concepts like walkability, mixed land use, and street connectivity are recognized as key elements influencing the livability and vibrancy of urban areas (Park et al., 2016). The broader literature supports the idea that a well-designed street network, characterized by strong connectivity and a mix of uses, can promote physical activity, enhance street life, and contribute to a more sustainable and healthier urban environment (Bonaccorsi et al., 2020; Park et al., 2016).

In conclusion, this analysis underscores the intricate interplay between street hierarchy, land use functions, and urban dynamics. Street design, encompassing factors like width, connectivity, and the mix of uses it facilitates, plays a crucial role in shaping the functionality, accessibility, and vibrancy of urban spaces. Ultimately, well-designed streets can significantly impact the quality of life for residents and contribute to a more positive overall urban experience.

CHAPTER SIX

6. OVERALL CONCLUSIONS AND RECOMMENDATION FOR URBAN PLANNING AND FUTURE RESEARCH

6.1 General Conclusion

This research journey through Dire Dawa's urban form reveals a city characterized by its rich duality and complexity, where traditional morphologies and modern planning interventions blend to shape its unique urban fabric.

The discovery of Dire Dawa reveals a fascinating duality in its urban form. Megala embodies a vibrant, organic mix of uses, reflecting a spontaneous development (SD) process. In contrast, Kezira showcases a more rigid, planned character, influenced by Western infrastructure models. These stark differences – functional, spatial, and architectural – highlight the profound impact of planning strategies on a city's development.

It's interesting to note that both neighborhoods deviate from the traditional Ethiopian urban form seen in the north and central regions. While Kezira initially shared similarities with these areas, featuring a palace and church on higher ground, its development took a more planned turn. Megala, on the other hand, lacked these traditional elements and instead grew organically with a diverse mix of uses. Despite their distinct origins, both Megala and Kezira have developed their own unique character, enriching the urban fabric of Dire Dawa.

Dire Dawa's Path to Sustainable development explores the city's fascinating journey towards a more sustainable urban form (SUF). The analysis utilizes the principles of Compact City Theory, New Urbanism, and Mixed Land Use as frameworks to examine Dire Dawa's development. Historically, the city has grappled with the tension between formal, planned development and the more traditional, organic growth characterized by mixed-use spaces. While the early stages of Dire Dawa's existence showcased this struggle, recent morphological changes signal a significant shift. The city is increasingly embracing the principles of compact development, fostering walkable neighborhoods with a mix of residential, commercial, and green spaces. This aligns with the goals of New Urbanism, promoting a more livable and environmentally friendly urban environment.

However, a crucial observation has emerged from this analysis. Across different stages of Dire Dawa's development, a concerning decline in open space ratios has been identified. This highlights the critical need for balanced urban development strategies. By acknowledging the strengths of both spontaneous and formal development approaches, Dire Dawa can craft a future that prioritizes environmental health and the overall livability of the city. This balanced approach can ensure the preservation of green spaces while fostering a vibrant, mixed-use urban fabric that aligns with the principles of sustainability.

Dire Dawa's urban landscape is a fascinating tapestry woven from history, planning decisions, and population density. By examining contrasting areas like Kezira and Megala, it was possible to gain valuable insights into the impact of different planning philosophies and historical influences. Kezira, with its planned spaces, reflects a more formal approach, while Megala's organic growth embodies a traditional, mixed-use character. These contrasting morphologies reveal the city's evolving development story.

Recent shifts in Dire Dawa, particularly in neighborhoods like St. Mariam Sefer and Gende Gerada, showcase a move towards compact and dense urban forms. This trend aligns with contemporary discussions on sustainable urban growth. Compact cities promote efficient use of land, encouraging walkability, mixed-use development, and reduced reliance on private vehicles. By embracing these principles, Dire Dawa has the potential to create a more efficient, resilient, and ultimately, sustainable urban environment.

"The Interplay Between Street Hierarchy, Land Use, and Urban Form" explores the crucial role streets play in shaping the character of Dire Dawa. Examining planned areas like Sabiyan and St. Mariam Sefer reveals a clear correlation between street width and land-use functions. Wide avenues serve as major arteries, facilitating commercial activity, while narrower streets provide access to residential areas. This intentional design creates a legible and functional urban fabric.

However, the complexity of organically developed areas like Megala and Gende Gerada presents a different story. Here, the relationship between street design, land use, and urban dynamics is more nuanced. Narrow, winding streets might appear inefficient at first glance. Yet, they can foster a vibrant street life, encouraging pedestrian activity

and fostering a sense of community. These organic street patterns can also contribute to a more human-scaled and walkable environment.

This interplay between planned and organic development highlights the need for a comprehensive understanding of how street design interacts with land use and urban dynamics. Dire Dawa can benefit from strategies that leverage the strengths of both approaches. Planned areas could incorporate elements that promote pedestrian interaction, while organic areas might require targeted interventions to improve accessibility without sacrificing their unique character. By creating a diverse streetscape that caters to both vehicular flow and pedestrian activity, Dire Dawa can create a more vibrant and livable urban environment.

In conclusion, Dire Dawa's urban form is a product of its rich history, diverse planning philosophies, and evolving development strategies. By recognizing the city's distinct morphological traits and understanding the complex interplay between planning interventions, historical influences, and urban dynamics, urban planners and policymakers can strive to create vibrant, inclusive, and resilient cities in Ethiopia and beyond. This study's findings provide valuable insights for future urban development strategies in Dire Dawa and similar regional cities, contributing to their long-term sustainability and resilience.

6.2 Recommendations for Urban Planning and Future Research

The findings underscore the importance of holistic urban planning approaches that consider historical context, community dynamics, and socioeconomic factors. Future research should explore the long-term impacts of planning interventions on urban form evolution and the role of community participation in sustainable urban development. By integrating interdisciplinary perspectives and adopting a longitudinal approach, urban planners can effectively address the complex challenges of urbanization and promote inclusive, resilient, and vibrant cities.

6.2.1 Recommendations

Based on the findings and discussions presented, several recommendations can be made to inform urban planning practices and decision-making processes:

- Flexibility in Planning Approaches - While planned developments play a significant role in shaping urban form and land use allocation, planners should also recognize the importance of flexibility in accommodating organic developments. Embracing mixed-use dominance in certain areas, particularly in spontaneously developed regions, can foster vibrant and diverse urban environments.
- Preservation of Public Amenities: Safeguarding spaces reserved for amenities is critical for maintaining the quality of urban life and promoting social cohesion. Urban planners should prioritize the preservation and enhancement of public amenities, working closely with community stakeholders to identify needs and allocate resources effectively.
- Consideration of Traffic Flow and Accessibility: When making decisions about city development, planners should carefully consider the relationship between street width, land use functions, and traffic flow. Designing streets and urban spaces that prioritize pedestrian accessibility, efficient transportation networks, and vibrant public realms can enhance overall urban livability.
- Integration of Street Hierarchy in Urban Planning: Urban planners should integrate considerations of street hierarchy into their planning processes to optimize land use allocation, traffic flow, and spatial organization within cities. This may involve adopting principles such as Clarence Perry's theory of street hierarchy to guide the allocation of different land use functions along streets of varying widths.
- Longitudinal Studies: Conduct longitudinal studies to track the evolution of urban morphology over time, capturing changes in land use patterns, street hierarchies, and planning interventions across different eras.
- Comparative Analysis: Expand comparative analyses to include additional case studies from similar secondary tier cities in Ethiopia, enabling broader insights into urban development dynamics and regional variations.
- Interdisciplinary Approaches: Foster interdisciplinary collaboration between urban planners, architects, sociologists, historians, and geographers to gain comprehensive perspectives on the socio-cultural, economic, and political factors shaping urban morphology.

- Mixed-Use Zoning: Promote mixed-use zoning policies to create vibrant, walkable neighborhoods that integrate residential, commercial, and recreational spaces, fostering social interaction and economic vitality.
- Heritage Preservation: The study could promote conservation of cultural heritages.
- Capacity Building: Invest in capacity building initiatives to empower local stakeholders, government officials, and urban practitioners with the knowledge, skills, and resources needed to effectively manage and plan for sustainable urban development in Dire Dawa.

By implementing these recommendations, stakeholders can contribute to the creation of resilient, livable, and equitable urban environments in Dire Dawa, fostering economic prosperity, social cohesion, and environmental sustainability for current and future generations.

6.2.2 Recommendation for Further Studies

Dire Dawa, a city nestled in the eastern highlands of Ethiopia, encapsulates a rich tapestry of history, culture, and urban morphology. As urbanization accelerates and globalization reshapes its landscape, Dire Dawa stands at a pivotal crossroads, grappling with the complexities of heritage preservation, community participation, social dynamics, and informal urbanization. In the pursuit of sustainable development and inclusive growth, researchers and practitioners alike are increasingly turning their attention to understanding the intricate interplay between these multifaceted dimensions of urban life. This introductory paragraph sets the stage for exploring four key research avenues that offer valuable insights into the urban morphogenesis of Dire Dawa and the challenges and opportunities it presents. From unraveling the nexus between heritage preservation and morphological identity to investigating the social dynamics shaping urban form, each research theme contributes to a deeper understanding of Dire Dawa's urban evolution and offers pragmatic solutions for shaping its future trajectory. Through interdisciplinary inquiry and community engagement, these research endeavors aim to inform policy interventions, urban planning strategies, and grassroots initiatives that foster sustainable, resilient, and inclusive urban development in Dire Dawa and beyond.

A. Heritage Preservation and Morphological Identity:

Dire Dawa boasts a rich tapestry of heritage assets, ranging from Ottoman-style architecture to diverse cultural traditions. Investigating the nexus between heritage preservation and morphological identity entails understanding how these tangible and intangible elements contribute to the city's unique character and historical narrative. By delving into the significance of iconic landmarks like the Kafira Market and the Railway Station, researchers can unravel the layers of meaning embedded in Dire Dawa's urban fabric.

This study could employ a multidisciplinary approach, drawing insights from urban planning, architecture, anthropology, and cultural studies to comprehensively examine the complex relationship between heritage preservation and morphological identity. Through archival research, field surveys, and stakeholder interviews, scholars can document the evolution of key heritage sites, map their spatial distribution, and assess their socio-cultural significance. Furthermore, exploring innovative conservation techniques such as adaptive reuse, heritage tourism, and community-based heritage management strategies can offer pragmatic solutions for safeguarding Dire Dawa's cultural heritage while fostering sustainable development.

B. Community Participation and Cultural Heritage:

Community participation lies at the heart of effective cultural heritage management, especially in a diverse and dynamic city like Dire Dawa. Engaging local residents, indigenous groups, and heritage stakeholders in decision-making processes empowers them to take ownership of their heritage assets and contribute to their preservation for future generations.

Building upon existing research on participatory approaches to heritage conservation, further studies in Dire Dawa could delve deeper into the socio-political dynamics that shape community engagement initiatives. By examining case studies of successful community-led conservation projects and analyzing the factors that facilitate or hinder participatory processes, researchers can identify best practices and lessons learned for fostering inclusive heritage governance models. Moreover, exploring the role of digital technologies, social media platforms, and online crowdsourcing tools in democratizing heritage management can open new avenues for collaboration and knowledge sharing among diverse stakeholders.

C. Social Dynamics and Urban Form (UF):

The urban form of Dire Dawa reflects the intricate interplay between social dynamics, cultural identities, and historical processes. Understanding how social factors shape the spatial organization of neighborhoods, public spaces, and land uses is crucial for addressing urban inequalities, promoting social cohesion, and creating inclusive urban environments.

This research avenue offers an opportunity to conduct ethnographic studies, social network analysis, and spatial mapping exercises to elucidate the social dimensions of urban morphology in Dire Dawa. By examining how factors such as ethnicity, religion, class, and migration patterns influence the distribution of amenities, access to resources, and patterns of social interaction, scholars can gain insights into the lived experiences of diverse communities and inform more equitable urban planning strategies. Additionally, exploring the role of cultural practices, informal economies, and grassroots movements in shaping urban form can provide valuable insights into the adaptive capacities of marginalized populations and the resilience of informal settlements in the face of rapid urbanization.

D. Informal Settlements and Urbanization:

The rapid growth of informal settlements poses significant challenges and opportunities for urban development in Dire Dawa. Understanding the dynamics of informal urbanization, its impact on urban morphology, and its implications for housing, infrastructure, and service delivery is essential for promoting inclusive and sustainable urbanization.

This research theme necessitates a comprehensive analysis of the drivers, processes, and outcomes of informal settlement growth in Dire Dawa. By employing spatial analysis techniques, remote sensing technologies, and participatory mapping exercises, researchers can quantify the extent of informal urbanization, identify hotspots of vulnerability, and assess the socio-economic dynamics at play. Furthermore, exploring policy interventions, planning strategies, and community-based initiatives aimed at improving living conditions, upgrading infrastructure, and regularizing land tenure in informal settlements can offer practical solutions for addressing the complex challenges of urban informality while harnessing its potential for inclusive urban development.

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APPENDIX

For each research theme, specific data collection instruments tailored to the nature of the inquiry and the target stakeholders would be essential. Here are potential data collection instruments for each of the recommended research avenues:

Approaches Used for the Data Collection

Morphological Era Determination and Identification of each of the morphological period data:

- ✓ **Archival research**: Examination of historical documents, maps, photographs, and records to trace the evolution of Dire Dawa's built environment, cultural landmarks, and urban form.
- ✓ **Surveys and interviews**: Conducting surveys and semi-structured interviews with residents, community leaders, heritage experts, and government officials to gather perspectives on the historical land uses, cultural practices, and traditional urban patterns.
- ✓ **Visual documentation:** Photographic documentation of each of the morphological periods, cultural landmarks, and traditional neighbourhoods to create visual archives and record changes over time.
- ✓ **Geographic Information Systems (GIS) mapping:** Spatial analysis to map heritage sites, conservation areas, and urban morphological features, facilitating spatial planning and management.

Community Participation and Cultural Heritage:

- ✓ **Participatory mapping**: Engaging local communities and stakeholders in mapping the previous morphological periods land uses, building heights and building uses, and community assets using participatory GIS techniques.
- ✓ **Focus group discussions**: Facilitating group discussions with community members, indigenous groups, and heritage stakeholders to identify building height, building uses, building forms, plot structure, street situation.

- ✓ **Ethnographic fieldwork**: Immersive fieldwork to document oral histories, traditional knowledge systems, and cultural practices, illuminating the earlier morphological characters of each of the case areas.

Data Collection Instruments

Here's a detailed outline of the data collection instruments for each aspect of the Dire Dawa's Morphogenesis research:

1. **Archival Data collection:** To trace the historical evolution of Dire Dawa's built environment, cultural landmarks, and urban form through examination of historical documents, maps, photographs, and records.
   - **A.** Identify and access archives, libraries, and historical societies housing relevant documents, maps, and photographs related to Dire Dawa's history.
   - **B.** Systematically review and analyse historical documents, maps, photographs, and records to identify key events, developments, and changes in the city's morphology and cultural heritage.
   - **C.** Transcribe relevant information from primary sources, including historical narratives, land records, urban plans, and architectural drawings, to create a comprehensive dataset for analysis.
2. **Visual Documentation data collection and organization:** To create visual archives and record changes over time in heritage buildings, cultural landmarks, and traditional neighborhoods in Dire Dawa.
   - ✓ Photography: Capture high-quality photographs of heritage buildings, cultural landmarks, and urban streetscapes using digital cameras or smartphones.
   - ✓ Documentation protocol: Develop a standardized protocol for documenting visual data, including details such as location, date, and angle of each photograph.
   - ✓ Image cataloging: Organize and catalog photographs into a visual database or archive, annotating each image with relevant metadata to facilitate future analysis and interpretation.

3. **Geographic Information Systems (GIS) Mapping:** To spatially analyze and map heritage sites, conservation areas, and urban morphological features in Dire Dawa for spatial planning and management.
    - ✓ Obtain spatial data sources, including satellite imagery, cadastral maps, and urban plans, from government agencies, research institutions, or open data repositories.
    - ✓ Utilize ArcGIS software platform is used to process and analyze spatial data, including georeferencing historical maps, digitizing heritage sites, and conducting spatial analysis.
    - ✓ Generate thematic maps illustrating the distribution of urban morphological features, providing valuable insights for the study.

Here's a detailed outline of the data collection instruments for Community Participation and Cultural Heritage research:

Participatory Mapping: To engage local communities and stakeholders.

Focus Group Discussions: To facilitate group discussions with community members, indigenous groups, and heritage stakeholders in mapping historic land uses, building uses, building structure, and building height if there are differences from the existing one.

Data Collection Methods:

- ✓ Planning and organizing focus group discussions with diverse groups of participants, ensuring representation from different age groups, genders, and cultural backgrounds.
- ✓ Develop a semi-structured discussion guide with open-ended questions to explore participants' perceptions, experiences, and aspirations related to cultural heritage and community participation.

- ✓ Conduct focus group discussions in a neutral and conducive environment, guiding the conversation while allowing for spontaneous interactions and exchanges among participants.
- ✓ Audio record focus group discussions with participants' consent, supplemented by detailed notes and observations to capture key insights and themes.

Observational Studies: Conduct systematic observations of urban spaces, street life, and social interactions to understand how social dynamics manifest in the built environment.

- ✓ Develop a structured observation protocol outlining key variables, behaviours, and events to be recorded during field observations.
- ✓ Identify the required case study areas' urban spaces, neighborhoods, and thoroughfares in Dire Dawa for observation, considering factors such as diversity of land uses.
- ✓ Conduct on-site observations of the case areas using methods such as field notes, photographs, and video recordings to document pedestrian traffic, social gatherings, informal activities, and spatial configurations.

Plot/Building Level Data Collection Format

Introduction:

Welcome to the data collection sheet for the research project conducted by Mr. Samuel Asfaw under the supervision of Dr. Ing. Zegeye Chernet from Addis Ababa University focusing on the urban morphology of Dire Dawa. Your participation in this data collection effort is crucial in contributing to our understanding of the city's built environment, land use patterns, and urban form. By systematically documenting plot-level land use data, building characteristics, and building height information, we aim to gain insights into the dynamic nature of urban development in Dire Dawa.

Thank you for your participation and valuable contribution to advancing our understanding of urban morphology in Dire Dawa. If you have any questions or require assistance during the data collection process, please feel free to reach out to the research team. Your input is greatly appreciated, and we look forward to your collaboration in this important research endeavor.

A data collection sheet tailored for plot-level land use data collection, building height, and building-level land use data collection for each of the project areas in Dire Dawa based on the data collection index:

Plot/Building-Level Land Use Data Collection for each of the plots

Case Study Site: _____

Data Collection Date: _____

1. **Block ID _____**

S/N	Plot ID	Building ID	Building Footprint (m^2)	Number of Floors	Building Use Per Floor	Land Use*	Remark
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							

- Fill the land use if there is no building on the plot

Instruction: Fill the Block ID, Plot ID and Building ID based on the data collection index map

Fill in the land use selecting from the following choice.

Land/Building Use Type - *based on Van den Hoek, 2008*

A. Amenity
B. Living,
C. Working and
D. A Mix of them

This data collection sheet provides a structured format for capturing plot-level land use information, building-level land use details, and building height data for each case study sites in Dire Dawa.

Plot-Level Access Street Data Collection for each of the plots

Case Study Site: _____

Data Collection Date: _____

S/N	Block ID	Plot ID	Building ID	Number of Access Streets	Width of each of the access streets	Surface Material of each access street

Interview Guide:

1. Introduction

- ✓ Welcome and thank the participant for their time.
- ✓ The purpose of the interview is to gather insights on the urban morphology of Dire Dawa. Your participation in this data collection effort is crucial in contributing to our understanding of the city's-built environment, land use patterns, and urban form of Dire Dawa.
- ✓ Participants in this research study are assured that all information shared during interviews and focus group discussions will be treated with the utmost confidentiality. Your privacy and anonymity are paramount, and your personal details will not be disclosed in any reports, publications, or presentations. The purpose of this data collection is for academic research conducted by Mr. _____ from Addis Ababa University (EiABC), aiming to gain insights into various aspects of urban morphogenesis in Dire Dawa. Your participation is vital in contributing to the understanding of these phenomena.

2. Background Information

- ✓ Could you please explain your role and experience in Dire Dawa?
- ✓ Your familiarity with the city's urban development and morphological changes over time.

3. Perceptions of Urban Morphology

- ✓ What are your observations regarding the evolution of Dire Dawa's urban form and built environment?

- ✓ How do you perceive the relationship between urban morphology and the city's cultural identity?
- ✓ What factors do you believe have influenced the morphological transformation of Dire Dawa?

4. Heritage Preservation and Cultural Identity
    - What is your opinion on the importance of heritage preservation in shaping the identity of Dire Dawa?
    - How do you think historic buildings, cultural landmarks, and traditional urban patterns contribute to the city's sense of place and collective memory?
    - What challenges do you foresee in integrating heritage conservation into urban planning and development processes?
5. Community Participation and Cultural Heritage
    - How do you envision engaging local communities and stakeholders in cultural heritage management in Dire Dawa?
    - What role do you think participatory approaches can play in identifying and preserving culturally significant sites and intangible heritage practices?
    - How can collaboration between government agencies, non-profit organizations, academia, and grassroots initiatives support community-led heritage conservation efforts?
6. Conclusion
    - Thank the participant for their valuable insights.
    - Offer the opportunity for any additional comments or suggestions.

- Provide contact information for further inquiries or follow-up.

Focus Group Discussion (FGD) Guide:

1. Introduction
    - Welcome all participants and thank them for their participation.
    - Explain the purpose of the focus group discussion: to explore perspectives on [specific topic] related to the urban morphology of Dire Dawa.
    - Establish ground rules for respectful and constructive dialogue.
2. Icebreaker Question
    - To break the ice and encourage participation: What are your initial thoughts or impressions on the urban development of Dire Dawa?
3. Understanding Urban Morphology
    - How would you describe the current urban form and layout of Dire Dawa?
    - What historical factors do you believe have influenced the city's morphological evolution?
    - In your opinion, what are the key features that define the urban character of Dire Dawa?
4. Heritage Preservation and Cultural Identity
    - How important do you think it is to preserve heritage buildings, cultural landmarks, and traditional urban patterns in Dire Dawa?
    - Can you share any personal experiences or anecdotes related to significant heritage sites or cultural practices in the city?

- What challenges do you foresee in balancing heritage preservation with the need for urban development and growth?

5. Community Participation and Cultural Heritage

    - How can local communities and indigenous groups be actively involved in cultural heritage management and conservation efforts?
    - What strategies or initiatives do you think would promote community-driven heritage conservation projects in Dire Dawa?
    - How can diverse stakeholders collaborate to ensure inclusive decision-making and representation in heritage preservation processes?

6. Wrap-up

    - Summarize key points discussed during the focus group.
    - Invite participants to share any final thoughts, reflections, or recommendations.
    - Thank everyone for their valuable contributions and participation.
    - Provide information on how they can stay engaged or follow up on the research findings.

Focus group discussion guide to assist the mapped data for better understanding and confirmation.

Introduction: Welcome and thank you for participating in this focus group discussion. The purpose of this session is to categorize the morphological periods of Dire Dawa and identify the land uses and building situations from older times, specifically focusing on periods preceding the recent morphological era. Your insights and experiences are invaluable in helping us understand the historical development of the town and its urban form. Please feel free to share your perspectives openly and contribute to the discussion.

1. Introduction and Warm-up Questions:

   a. Could you please introduce yourself briefly?

   b. What is your connection to Dire Dawa, and how long have you been living or working here?

   c. How would you describe the overall character and development of Dire Dawa over time?

2. Identification of Historical Land Uses:

   a. Let's focus on the periods preceding the recent morphological era. What were the predominant land uses during these older times (Case area specific)?

   b. Can you recall any specific types of buildings or structures that were commonly found in this case study site during these periods other than the one indicated in the map?

   c. How were the land uses and building situations organized within each of the case study sites during these older times? Were there any distinct patterns or layouts?

3. Comparing Past and Present:

   a. Reflecting on the historical land uses and building situations you mentioned, how do they compare to the current urban landscape of Dire Dawa?

   b. Have there been any notable changes or transformations in land use patterns and building types over time?

   c. In your opinion, what factors have influenced these changes, and how have they shaped the town's morphological evolution?

4. Conclusion and Final Thoughts:

a. Is there anything else you would like to add regarding the identification of historical land uses in each of the case study sites?

b. Any final reflections or insights you'd like to share before we conclude the discussion?

Thank you once again for your participation and valuable contributions to this discussion. Your input will greatly enhance our understanding of Dire Dawa's urban morphogenesis and development.