TYPOLOGY AND SPATIAL PATTERNS OF WAREHOUSING IN CAPE TOWN, SOUTH AFRICA

by

FRANCIS GARATSA

Thesis submitted in fulfilment of the requirements for the degree

Master of Urban and Regional Planning

in the Faculty of Informatics and Design

at the Cape Peninsula University of Technology

Supervisor: Prof Masilonyane Mokhele

District Six
February 2024

DECLARATION

I, Francis Garatsa, declare that the contents of this thesis represent my own unaided work, and that the dissertation/thesis has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.

28 February 2024

Signed **Date**

ABSTRACT

As a result of globalisation and e-commerce, the freight flows have dramatically increased in metropolitan areas, contributing significantly to changes in the spatial location of logistics facilities generally and warehouses specifically. Warehouses are pertinent for spatial planning because they are land-intensive and big generators of freight traffic. There is however sparse literature on the spatial patterns of different warehousing types. The understanding of warehouse types would enable policymakers and planners to differentiate warehousing facilities and their locational needs since warehousing facilities vary in terms of size, resulting in some facilities consuming large parcels of urban land. The aim of the study was to analyse the spatial patterns of warehousing types and draw implications for spatial planning. The study answered the following research questions: What factors influence the spatial pattern of warehousing typologies? and How are the different typologies of warehousing facilities spatially distributed in the City of Cape Town municipality? The study adopted a case study approach, focusing on the City of Cape Town as defined by the administrative municipal boundary, and further classified into ten districts. The study used the building size/ footprint criterion to classify warehouses. Hinging on the descriptive quantitative approach, the geospatial data on the spatial distribution of warehousing was obtained from AfriGIS. Footprint analysis was then used to analyse the building size of warehouse facilities across the City of Cape Town. The study found that the majority of the warehouses in the City of Cape Town were x-small, followed by small, medium and large warehouses, while xx-small, x-large and mega warehouses accounted for the same number. Table Bay District accommodated the largest number of warehouses, with diverse typologies, while the Southern District accommodated the least number. Warehouses were located close to the main traffic corridors, the railway line, the airport and seaport. In terms of zoning, the study found that the highest concentration of warehouses in the general industrial zones. The study recommends that the municipality consider planning for different typologies of warehouses.

Keywords: City of Cape Town, warehouse, spatial pattern, typology, logistics, warehousing, facilities, distribution centre

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my supervisor Professor Masilonyane Mokhele, for your patience, support, guidance, and encouragement during the writing process of this thesis.

With all due respect, I would like to extend my profound gratitude to my family: my mother, Ms. P Makape; my brothers, specifically Frady, Welly, Basil, and my sister Clotty for your unwavering support and encouragement.

I would like to thank all staff members in the department of Urban and Regional Planning at the Cape Peninsula University of Technology for their support and critiques during the research colloquium presentations.

Special thanks to Brian Fisher-Holloway for assisting me with GIS mapping, and Mzingisi for his support.

Lastly, I would like to thank Mr. Machakaire for his encouragement and engaging in robust discussions during the writing process of this thesis.

LIST OF ABBREVIATIONS AND ACRONYMS

AG	Agricultural
B2B	Business to Business
B2C	Business to Consumer
BSB	Backward Snowballing
C2C	Consumer to Consumer
CoCT	City of Cape Town
CTIA	Cape Town International Airport
CTCT	Cape Town Container Terminal
DC	Distribution Centre
EDC	European Distribution Centre
FSB	Forward Snowballing
FC	Fulfilment Centre
GB	General Business
GDP	Gross Domestic Product
GGH	Greater Golden Horseshoe Area
GI	General Industrial
GIS	Geographic Information System
GR1	General Residential 1
GR2	General Residential 2
GTA	Greater Toronto Area
IT	Information Technology
KDE	Kernel Density Estimation
LB	Local Business zone
LU	Local Use
MU	Mixed Use
NDC	National Distribution Centre
NEG	New Economic Geography
NGI	National Geographic Information
SCM	Supply Chain Management
SDF	Spatial Development Framework
QIZ	Quasi-Industrial Zone
RDC	Regional Distribution Centre
TR	Transport Zones
UK	United Kingdom
USA	United States of America
VAL	Value-Added Logistics

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION 10

1.1 BACKGROUND AND OVERVIEW 10

1.2 RESEARCH PROBLEM 18

1.3 RESEARCH AIM, QUESTIONS AND OBJECTIVES 19

1.3.1 RESEARCH AIM 19

1.3.2 RESEARCH QUESTIONS 19

1.3.3 RESEARCH OBJECTIVES 20

1.4 RESEARCH DESIGN AND SUMMARY OF THE METHODS 20

1.4.1 RESEARCH DESIGN 20

1.4.2 SUMMARY OF THE METHODS 22

1.5 CONTRIBUTION AND LIMITATION OF THE STUDY 22

1.5.1 CONTRIBUTION 22

1.5.2 LIMITATIONS 23

1. 6 ORGANISATION OF THE THESIS 24

CHAPTER 2: LITERATURE REVIEW 25

2.1 METHODS EMPLOYED TO FIND THE LITERATURE 25

2.2 OVERVIEW OF THE TYPOLOGIES OF WAREHOUSES 26

2.2.1 DISTRIBUTION CENTRES 27

2.2.2 SPECIALISED DISTRIBUTION CENTRES /FULFILMENT CENTRES 32

2.2.3 CROSS-DOCK FACILITY 34

2.2.4 SPECIALISED WAREHOUSING 36

2.3 OVERVIEW OF THE SPATIAL PATTERNS OF WAREHOUSING TYPOLOGIES. 39

2.3.1 CLUSTERING AND CONCENTRATION OF WAREHOUSE TYPOLOGIES 39

2.3.2 THE DISPERSION AND POLARISATION OF WAREHOUSE TYPOLOGIES 45

2.4 FACTORS THAT INFLUENCE THE SPATIAL PATTERN OF WAREHOUSE TYPOLOGIES 50

2.4.1 AGGLOMERATION EFFECTS 51
2.4.2 ACCESSIBILITY 52
2.4.3 LAND PRICE 57
2.4.4 ZONING 59
2.4.5 ZONING AND LAND VALUES 61
2.4.6 POLICY AND WAREHOUSE LOCATION 62
2.4.7 MARKET ACCESSIBILITY 66
2.4.8 POPULATION DENSITY 67
2.4.9 LABOUR COSTS 68
2.5 SYNTHESIS OF THE LITERATURE 70
2.6 SUMMARY 72
CHAPTER 3: THEORETICAL FRAMEWORK 73
3.1 OVERVIEW OF THEORIES UESD IN LOGISTICS AND WAREHOUSING 73
3.1.1 LOCATION THEORIES/ GEOGRAPHY THEORY 74
3.1.2 NEW ECONOMIC GEOGRAPHY 81
3.2 APPLICATION OF THEORIES FROM OTHER DISCIPLINES IN LOGISTICS RESEARCH 84
3.2.1 TRANSACTION COST ECONOMIC 86
3.2.2 RESOURCE-BASED THEORY 87
3.2.3 RESOURCE DEPENDENCY THEORY 88
3.3 MODELS RELATED TO LOGISTICS FACILITIES AND WAREHOUSE LOCATION .. 89
3.3.1. GRAVITY CENTRE MODEL 89
3.3.2 HOOVER MODEL 91
3.4 SYNTHESIS OF THE THEORIES 92
3.5 SUMMARY 93
CHAPTER 4 RESEARCH METHODOLOGY AND METHOD 94
4.1 RESEARCH SETTING 94
4.1.1 CASE STUDY APPROACH 94

4.1.2 LEVEL AND UNITS OF ANALYSIS 97

4.2 RESEARCH METHODS 98

4.2.1 DATA SOURCES 98

4.2.2 DATA ANALYSIS 99

4.3 ETHICAL CONSIDERATIONS 100

4.4 SUMMARY 101

5.1 SPATIAL DISTRIBUTION OF WAREHOUSING TYPOLOGIES IN CAPE TOWN 102

5.1.1 TABLE BAY DISTRICT 105

5.1.2 TYGERBERG DISTRICT 107

5.1.3 SOUTHERN DISTRICT 109

5.1.4 NORTHERN DISTRICT 111

5.1.5 MITCHELLS PLAIN/ KHAYELITSHA DISTRICT 113

5.1.6 HELDERBERG DISTRICT 115

5.1.7 BLAAUWBERG DISTRICT 117

5.1.8 CAPE FLATS DISTRICT 119

5.2 SPATIAL PATTERN OF WAREHOUSING RELATIVE TO FACTORS 121

5.2.1 ROAD AND ROAD INTERSECTION/JUNCTION PROXIMITY 121

5.2.2 RAILWAY PROXIMITY 122

5.2.3 AIRPORT PROXIMITY 124

5.2.4 PORT PROXIMITY 125

5.2.6 ZONING 125

CHAPTER 6: SYNTHESIS OF THE FINDINGS AND CONTRIBUTION TO PRACTICE 133

6.1 SYNTHESIS OF THE FINDINGS 133

6.2 CONTRIBUTION 139

6.2.1 CONTRIBUTION TO PRACTICE 139

6.3 CONCLUSIONS 140

6.3.1 RESEARCH AIM 140

6.3.2 RESEARCH QUESTIONS AND OBJECTIVES 141

6.4 POTENTIAL AREAS FOR FURTHER RESEARCH 141

REFERENCES 143

CHAPTER 1: INTRODUCTION

The introductory chapter is structured into six sections. Section 1.1 provides the background to the study and defines the key concepts, which include logistics, supply chains, and warehousing. Section 1.2 discusses the research problem that the study intended to address. The research aim, questions, and objectives are presented in Section 1.3. Section 1.4 describes the research design and summarises the research methods used to address the research problem, aim, questions and objectives. Section 1.5 discusses the contribution and limitations of the study. Section 1.6 presents the organisation of the thesis.

1.1 BACKGROUND AND OVERVIEW

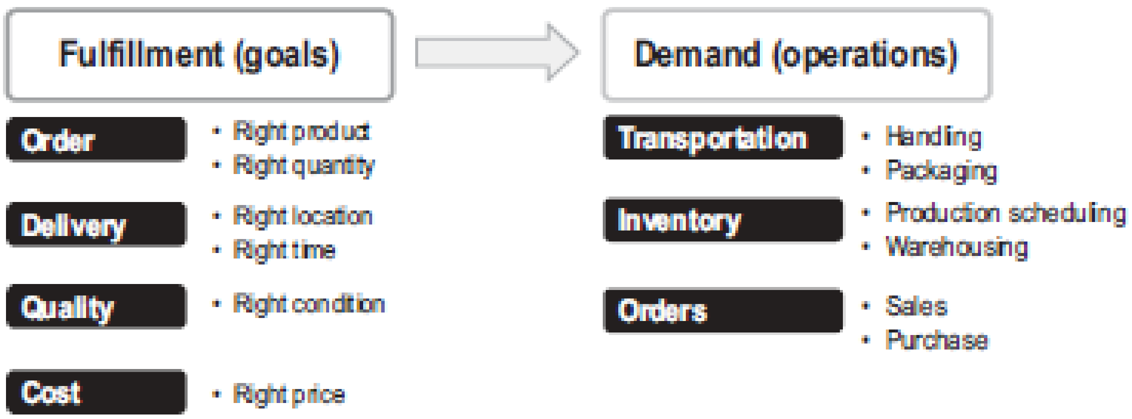
There have been major changes in the spatial organisation of economic activities in metropolitan areas largely as a result of globalisation (Hesse, 2016; Kang, 2020b). MacKinnon and Cumbers (2019:4) define globalisation as ‘‘the increased connections and linkages between people, firms and markets located in different places, manifested in flows of goods, services, money, information, and people across national and continental borders’’.

As a result of globalisation, the volume of freight flows in metropolitan areas increased dramatically and contributed significantly to changes in the spatial location of logistics facilities (He et al., 2018). The changes are exacerbated by the restructuring in the global economy, the rise in e-commerce, and the changes in consumer and business preferences due to advancement in transport technology with the advent of containerisation, and changes from supply-push to demand pull production that focuses on just-in-time deliveries resulted in an increased volume of global freight flows (Cidell, 2011; Hesse & Rodrigue, 2004; Rodrigue, 2020, Kang, 2020b).

Logistics refers to the physical flow of goods from the areas of production to the final destination areas (He et al., 2018). The contemporary trends indicate that logistics activities are on the constant rise in metropolitan areas, with urban areas experiencing a continual increase in the flow of goods and information. Hesse (2016:5) notes that ‘‘logistics consider a wide set of activities dedicated to the transformation and circulation of goods, such as the material supply of production, the core distribution and transport function, wholesale, and retail and the provision of households with consumer goods as well as the related information flows’’. Furthermore, logistics entails the flow of goods and information from one point to another, as such basic functions, namely transportation, storage, handling, distribution process, and information process are all combined (He et al., 2018). As illustrated in Figure I.1, Rodrigue (2020a) argue that logistics performs the following operations to ensure efficient distribution of goods in the supply chains: transportation operations, which includes the handling and packaging of order; inventory operations, which imply the production scheduling and warehousing of products and orders operations that include the sale and purchase of goods in the distribution systems.

Hesse and Rodrigue (2004) and Hesse (2016) argue that logistics performs two major functions, namely physical distribution and material management. Physical distribution relates to the activities involved in the storage and transportation of goods within supply chains (Onstein et al., 2022). It is argued that physical distribution refers to activities that are involved in the movement and handling of goods along the supply chains such as transportation services, transshipment and warehousing services, namely consignment, storage, and inventory management, whereas material management comprises the activities involved in the manufacturing of goods throughout the production process in the supply chains (Hesse and Rodrigue, 2004). Figure 1.1 illustrates that logistics comprises a set of goals and operations in the flow of goods and information from a place of origin to the final consumer. Therefore, logistics aims to fulfil four major functions in relation to order, delivery, quality, and cost fulfilment (Rodrigue, 2020a).

Figure 1.1: Logistics goals and operations



(Source: Rodrigue, 2020a:271)

As illustrated in Figure 1.1, order fulfilment relates to the transactions between the supplier and the customer and a product delivered in an agreed quantity whereas delivery fulfilment entails the distribution of products at the right time and location (Rodrigue, 2020a:271). Quality fulfilment entails the delivery of the product in the right condition by eliminating the possibilities of damage during the distribution process and cost fulfilment implies the final costs of the product and includes manufacturing and distribution costs (ibid.)

The concept of logistics has been constantly undergoing significant transformation, as such the operations and processes of logistics are constantly changing (Richnák,2022). The introduction of the Fourth Industrial Revolution, commonly known as Industry 4.0, which is characterised by an increasing reliance on virtual production systems with the Internet and automation playing a crucial role in the supply chains, resulted in the emergence of logistics 4.0 (Öztuna, 2022; Richnák, 2022). According to MacKinnon and Cumbers (2019), industry 4.0 emphasises the digital transformation of manufacturing and services necessitated by a cluster of interrelated technologies, namely cloud computing, artificial intelligence (AI), big data, the Internet of Things, 3D visualisation and automation. As a result of the changes in industry 4.0, logistics 4.0 is associated with the increased use of automated systems that work independently, thereby resulting in increased efficiency in logistics services such as storage, transportation, material handling, and information services (Öztuna, 2022). Logistics 4.0 is defined as ‘‘a new logistics system that is flexible, adaptable to market fluctuations, that lowers cost and supplies customer needs in the fastest and plentiful way’’ (Sekkeli & Zumurut, 2018: 13 cited in Öztuna, 2022). Therefore, the transformation in logistics is marked by the increased use of information technology and automation in the storage, handling, and distribution of goods.

It is argued that the concept of logistics evolved primarily from focusing on transportation and warehousing to supply chains (Rodrigue, 2020a). Some studies argue that logistics and supply chain management are different concepts although logistics activities are embedded in supply chain management (Anca, 2019; Felea & Albăstroiu, 2013). Regarding the ongoing debate, it is important to consider the definition of supply chains before delving into the concept of supply chain management. Berthold (2019:44) defines supply chains as ‘‘a set of organisations directly linked by one or more upstream and downstream flows of products, services, finances, or information from a source to a customer’’. İyigün et al. (2022) notes that a supply chain is a network of suppliers, manufacturers, warehouses, factories, distribution centres, retailers and customers throughout the purchase, conversion, production, and delivery of raw materials processes. Therefore, supply chain management plays a crucial role in integrating the stakeholders in the supply chain. According to Anca (2019:210), supply chain management encompasses a set of decisions and activities used to integrate suppliers, manufacturers, warehouses, transport providers, retailers, and final customers more efficiently to ensure that products are distributed effectively throughout the distribution process, in a short period of time, with lower costs to satisfy customers' needs. Maia and Cerra (2009) cited in Anca (2019), described logistics as part of supply chain management, which is directly linked to the material and information flows between companies that are part of the same supply chain. In this regard, logistics and supply chain are interconnected concepts, with supply chain management a much broader concept as compared to the concept of logistics.

The interrelatedness of logistics and supply chain led to the increased concentration of freight flows in urban areas, hence it is imperative to describe the concept of freight logistics. According to Havenga, Simpson and Goedhals-Gerber (2017), freight logistics is a part of supply chain management that specifically focuses on the transportation, warehousing, inventory holding and management of goods between the source and the final destination. Freight logistics primarily deals with the distribution of bulky goods along the supply chains and as such, it interacts with various components of logistics such as warehousing. Freight logistics evolved from supply chain management, as such logistics activities form the constituent parts of the supply chain management concept (Gattoma, 1990 cited in Hesse, 2016).

Against the backdrop of the transformation of logistics and supply chain management, the restructuring in the global economy, and the major boom in e-commerce activities, the use of Information and Communication Technology (ICT) in logistics has been on a constant rise (Hesse, 2016). Rodrigue (2020a) noted that logistics is directly linked to the changes that are brought about by the rise of e-commerce activities in metropolitan regions. E-commerce refers to the use of ICT in the handling and distribution of commercial activities (Szymanski, 2013 cited in Żuchowski, 2016; Hesse, 2016). The concept of e-commerce covers a wide range of commercial transactions and people in a society (Visser, Nemoto & Brown, 2014). Kovida et al. (2019) argue that the emergence of e-commerce plays an essential role in how firms conduct business, where the involvement of different players and the nature of the transactions involved in e-commerce can be classified into different transaction types, namely business to business (B2B), business to consumer (B2C) and consumer to consumer (C2C).

Business-to-business entails e-commerce transaction activities whereby businesses conduct commercial transactions with another business, and it involves large volumes of commercial transactions whereas business-to-consumer refers to transactions that take place between the business and its customers where business website provides an interface between the business and consumers (Aljifri, Pons & Collins, 2003). Consumer-to-consumer entails the transactions that take place between consumers, wherein a consumer after conducting a transaction with the business, performs transactions with other consumers (Aljifri, 2003). Hesse (2016) noted that B2C e-commerce logistics activities gained recognition in the early 1990s, with several customers becoming fully aware of the consumer goods home delivery options. Kovida et al., (2019) note that the current trends both in emerging and developed countries are that the B2C sector of e-commerce shows a substantial growth. Therefore, as a result of the growing e-commerce activities, there has been an increase in the volume of freight flows in metropolitan areas, which ultimately results in the increased demand for storage space.

The booming of e-commerce activities contributed immensely to the emerging new forms of logistics facilities since metropolitan regions are increasingly characterised by the growth of warehouse and distribution activities (Kovida et al., 2019; Rodrigue, 2020b). Kang (2020a) maintains that the growth of online shopping and the booming of e-commerce has a bearing on the warehousing and distribution industry. Mongelluzzo (2019), cited in Kang (2020c:10) argues that the growing trends in online shopping sales contributed significantly to the development of both large-scale and small distribution centres. Therefore, large logistics facilities, distribution centres and fulfilment centres, dominate the landscapes of different metropolitan areas (Rodrigue, 2020b). The growth in online retailing activities has been exacerbated by the COVID-19 pandemic, which resulted in the spike in B2C sales, thereby resulting in the increased growth in online shopping activities (Greenhalgh et al., 2021; Tutam 2022). Furthermore, it has been noted that changes in consumer preferences led to a decline in retail commercial footprint and impact the distribution and logistics sector marked by an increase in the demand for large warehouses (Greenhalgh et al., 2021; Rodrigue, 2020b).

Against the background of globalisation, the rise of e-commerce activities in metropolitan regions, and the recent trends in logistics and supply chain management, the geography of warehousing facilities in metropolitan regions changed dramatically, resulting in numerous large scale distribution centres located in peripheral areas (Bowen, 2008; Cidell, 2011; Kang 2020a). As such, there has been a surge in warehousing and distribution activities in metropolitan areas (Andreoli, Goodchild & Vitasek, 2010; Bowen, 2008; Woudsma & Jakubicek, 2020). In this respect, it is important to first consider the various definitions of the warehousing concept. A warehouse has been defined as a storage facility wherein products are handled in a four-stage cycle, namely receiving, order picking, storing, and shipping (Higginson & Bookbinder, 2005; Jones, 2022). Tutam (2022) notes that a warehouse is an important component of logistics, and it performs the following functions: receive, store, preserve, retrieve and deliver the products to different customers either on a daily or weekly basis. According to Bartholdi & Hackman (2005), warehouses are intermediate points in the supply chains where products pause thereby acting as a buffer by providing space that holds inventory back from the market. Ma (2019) maintains that warehouses are important components of the supply chain infrastructure, and they provide a competitive advantage owing to their strategic positions along the chains. In a retail context, warehouses are essentially used to consolidate and store a variety of products to reduce transportation costs and lead times (Kembro & Norrman, 2022).

Table 1.1: Definition of a warehouses

Author	**Definition of warehouse**
Higginson & Bookbinder, 2005; Jones, 2022	It is a storage facility wherein products are handled in a four-stage cycle, namely, receiving, order picking, storing, and shipping.
Tutam (2022	An important component of logistics, and it performs the following functions: receive, store, preserve, retrieve, and deliver the product to different customers either on a daily or weekly basis.
Bartholdi & Hackman (2005)	Intermediate points in the supply chains where products pause thereby acting as a buffer by providing space that holds inventory back from the market.
Ma (2019)	warehouses are important components of the supply chain infrastructure, and they provide a competitive advantage owing to their strategic positions along the chains.
Kembro & Norrman (2022)	warehouses are essentially used to consolidate and store a variety of products to reduce transportation costs and lead times.
City of Cape Town (2015:92)	‘‘a building used primarily for the storage of goods, except those that are offensive or dangerous, and includes property used for business of a predominantly wholesale nature, but does not include property used for business of a predominantly retail nature’’

Source: Author

Warehousing activities are constantly rising in the vicinity of the metropolitan areas and the hinterlands of seaports and airport facilities (Dablanc & Ross, 2012; Guiliano & Kang, 2020a; Woudsma & Jakubicek, 2020). As alluded to earlier, the key driving factors in the growth and demand for warehousing facilities are attributed to several factors, namely the rise in e-commerce activities which resulted in tremendous growth in online shopping, and the COVID-19 pandemic which dramatically changed consumer behaviour (Jones, 2022; Kang, 2020a). It can be argued that changes in consumer behaviour triggered by the surge in e-commerce activities, resulted in the demand for both large warehousing facilities and smaller warehousing units known as last-mile warehouses (Jones, 2022). However, as a result of the increased growth of varying warehousing facilities in metropolitan areas, there is an increased spatial shift in warehousing facilities of varying sizes occupying different locations.

The spatial shift in warehouse location is attributed to many factors such as changes in the traditional functions of warehousing from storage and inventory holding facilities to value-added centres, performing such functions as labelling, packaging, and barcoding (Bowen, 2008). However, such transformations witnessed a recent growth in super-sized structures performing warehousing functions (Andreoli, Goodchild & Vitasek, 2010). Therefore, to ensure the efficient distribution of goods in warehouses and distribution centres, there is an intense use of digital technology, including barcodes, laser scanners, and automation (automated storage and automated retrieval systems) (Berg & Zijm, 1999; Bowen, 2008).

Warehousing activities are constantly transforming, as such the evolution of warehouses went through different stages. In this respect, the digital transformation in warehousing activities is driven by the incorporation of industry 4.0 technologies in warehousing. According to Tutam (2022), as illustrated in Figure 1.2, the warehousing revolution can be explained in four stages. Firstly, warehousing 1.0 marked the first revolution in warehousing characterised by the incorporation of mechanical and powered systems in warehousing operations to increase productivity. Secondly, warehousing 2.0 was marked by a transition from mechanical systems to electro-mechano systems as a result of the advent of pallets, which made the loading, storage, handling, and unloading of goods fast and cheap in warehouses through the use of systems such as forklifts, cranes, and electric powered pulleys and conveyors.

Thirdly, warehousing 3.0 was characterised by the increased use of computers, the Internet, and automation systems in the handling of goods in warehousing facilities. In this regard, the increased use of automated vehicles in warehousing operations resulted in increased throughput and efficiency since human activities were reduced significantly. Lastly, warehousing 4.0 marked the fourth revolution in warehousing, where digital transformation in warehousing activities is characterised by the growth of automation and incorporation of information and communication technologies in warehousing operations (Tutam, 2022).

Figure 1.2: Warehousing revolution

(Source: Tutam 2022: 97)

Kang (2020b) argues that large, automated warehouses and distribution centres are increasingly constructed in the peripheral areas of metropolitan cities to facilitate the efficient, fast, and cheaper transportation of large volumes of freight in metropolitan areas. In this regard, it has been argued that warehousing transformed substantially from a conventional storeroom to a more integrated and automated system (Chen et al., 2020 in Kumar et al., 2021).

Bowen (2008:380) observed significant transformation in the functions of the traditional warehouse and contemporary distribution centres (DCs). It is argued that in traditional warehouses, inventory control was labour intensive, minimal use of technology such as automation and deliveries to warehouses was made via infrequent deliveries whereas DCs are characterised by efficient delivery of shipments on a scheduled time basis and intense use of IT (ibid.). Cidell (2011) argues that as a result of technological innovation, management and communication the geography of freight distribution has changed dramatically, as evidenced by the transformation from traditional warehousing operations to container shipping and distribution centres. Therefore, it has been argued that the reinvention of a warehouse is expressed with cross-docking activities which are characterised by the development of separate areas for arrivals and dispatch of freight within the DCs (Bowen, 2008; O’connor & Parsons, 2011). Warehousing functions and activities are constantly changing, and this has been evidenced by recent trends in the spatial shifts of warehouse location in the metropolitan areas in different countries in the global north and global south.

As discussed in Chapter Two, several studies investigated the spatial patterns of warehousing facilities in different metropolitan areas and the identified spatial patterns are influenced by a variety of factors (Bowen, 2008; Cidell, 2010; Jakubicek & Woudsma, 2011; Giuliano & Kang, 2018; Guerin et al., 2021; Heitz & Dablanc, 2015; Kang, 2020a, 2020b). To this end, several factors play an essential role in influencing the spatial patterns of warehousing facilities, with the contemporary trends in warehouse development characterised by a growing number of large warehouse facilities consuming large parcels of urban land within the metropolitan areas (Kang, 2020a). As mentioned earlier, the explanation for the observed pattern of warehousing development can be attributed to the growing influx of freight activities in the metropolitan areas. As such, warehousing and distribution evolved from the traditional functions of warehousing, hence it is important to examine the locational patterns of warehousing typologies. The spatial patterns of warehousing as evidenced by the sprouting of supersized warehouses become an issue of concern among spatial planners, geographers, and urban economists.

1.2 RESEARCH PROBLEM

As systematically outlined in Section 1.1, warehousing as a physical distribution component of logistics and an integral part of the supply chains provides physical linkage in the distribution of goods and services from suppliers to the final consumers (Hesse & Rodrigue, 2004; Bowen, 2008; Giuliano & Kang, 2018; Pretorius et al., 2021; Mokhele & Fisher-Holloway, 2022). Besides playing a pivotal role in the supply chains, the strategic location of warehouse facilities in metropolitan areas significantly reduces transportation costs and reduces externalities such as congestion (Aljohani & Thompson, 2016; Oliveira et al., 2018). Additionally, warehouses and logistics facilities are regarded as land-intensive uses, generators of freight traffic, contributes to loss of visual amenity (Cidell, 2011; Dablanc et al 2014; Jones, 2022; Mokhele & Fisher-Holloway, 2022; Yuan 2019).

As discussed in Chapter Two, the literature studied extensively the spatial patterns of warehousing and distribution centres in North America and Europe, wherein sprawling and polarisation patterns were identified (Bowen, 2008; Dablanc & Ross, 2012 Dubie et al. 2020;

Jaller, Pineda & Phong, 2017; McKinnon, 2009; Kang, 2022b; Strale, 2020; Woudsma & Jakubicek, 2020). Oliveira et al. (2022) and Guerin et al. (2021) analysed the locational factors behind the distribution of general warehousing facilities in Belo Horizonte and Saulo Paulo Metropolitan areas in Brazil without making explicit reference to different types of warehousing facilities. Various scholars focus much on the geography of a single type of warehousing, namely distribution centres (Ferrari, Parola & Morchio, 2006; Warffemius, 2007; Bowen, 2008; Dablanc & Ross, 2012; Onstein et al., 2015; Jaller et al., 2017; Onstein et al., 2021).

Against this backdrop, there is sparse literature on the spatial patterns of different warehousing types. It is largely because the existing limited studies on warehousing typologies focused much on North America and Europe. The previously mentioned studies employed the following criteria to classify different typologies of warehousing facilities: function, size of the facility, geographical location, market extent, and nature of the products (Vereecke et al., 2008; Rodrigue, 2020b; Onstein et al., 2021; Rodrigue, 2020b). In this regard, there is no clear-cut distinction between the warehousing types and logistics facilities since warehouses are components of logistics facilities. Therefore, to close the gap in warehousing typologies, the study draws from the logistics literature to develop the types of warehousing facilities in the City of Cape Town municipality, South Africa.

The understanding of warehouse types would enable policymakers and planners to differentiate warehousing facilities and their locational needs since warehousing facilities vary with regard to size, resulting in some facilities consuming large parcels of urban land (Mokhele & Fisher-Holloway, 2022). Lastly, the study extends the existing knowledge on the spatial patterns of warehousing types in the City of Cape Town municipality.

1.3 RESEARCH AIM, QUESTIONS AND OBJECTIVES

1.3.1 RESEARCH AIM

To address the research problem presented in Section 1.2, the aim of the study was to analyse the spatial patterns of warehousing types and draw implications for spatial planning.

1.3.2 RESEARCH QUESTIONS

To realise the overarching research aim, the study answered the following research questions:

1. What factors influence the spatial pattern of warehousing typologies?
2. How are the different typologies of warehousing facilities spatially distributed in the City of Cape Town municipality?

1.3.3 RESEARCH OBJECTIVES

The objectives of the study were to:

1. Analyse the factors that influence the spatial patterns of warehousing typologies in Cape Town
2. Analyse the spatial patterns of the different warehousing typologies in the City of Cape Town municipality.

1.4 RESEARCH DESIGN AND SUMMARY OF THE METHODS

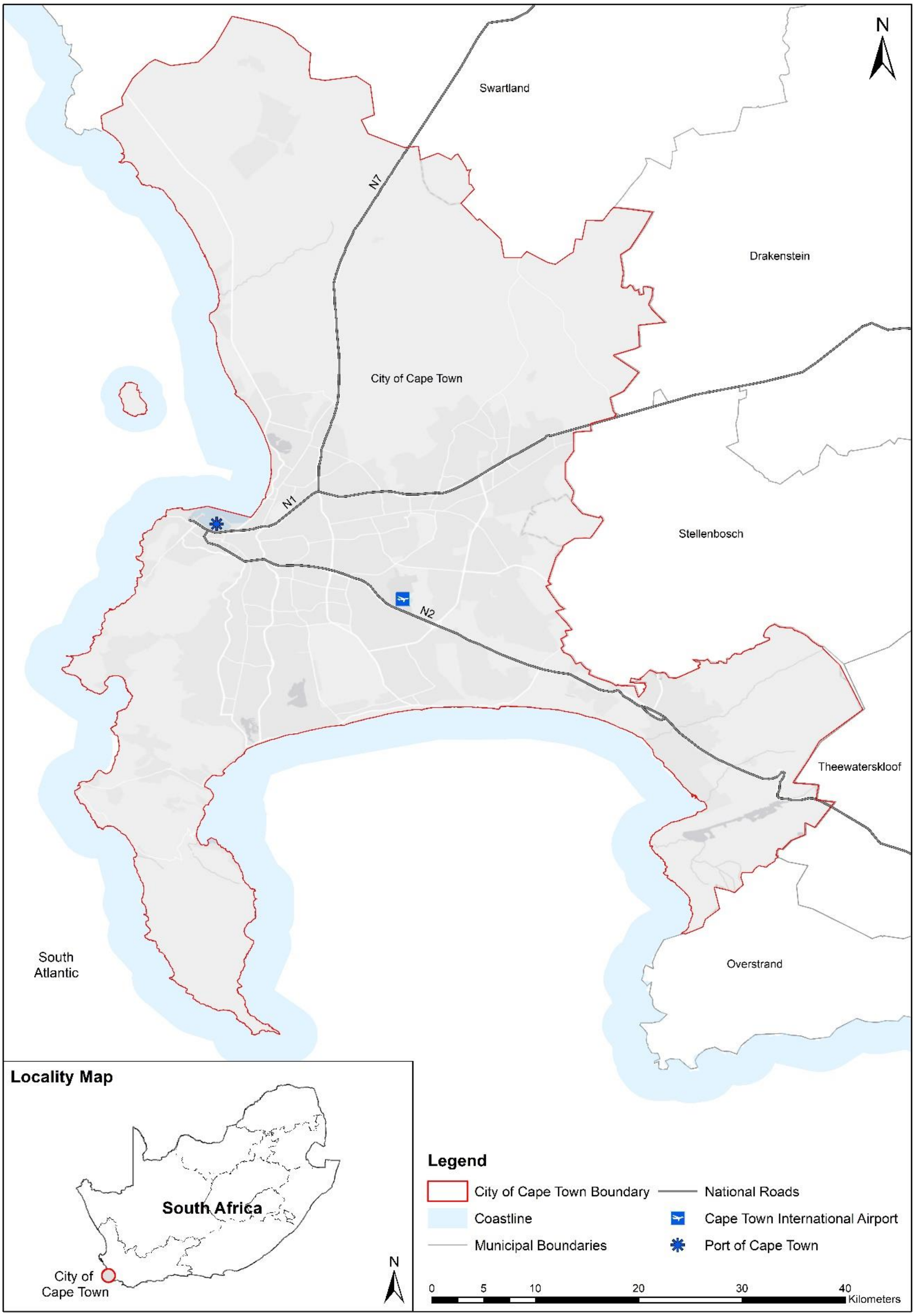
This section presents the research design and a summary of the research methods adopted in the study. A detailed discussion of the research and methods is in Chapter Four.

1.4.1 RESEARCH DESIGN

According to Kothari (2004:31) research design "constitutes the blueprint for the collection, measurement and analysis of data". The study is focused on quantitative data regarding the spatial patterns of warehouses in Cape Town. Quantitative research described as a research based on the measurement of quantity or amount and the approach is suitable to a phenomenon that can be expressed in terms of quantity (Kothari, 2004:3). As such, the study adopted a descriptive design, wherein descriptive design describes the characteristics of a particular individual or a group (Kothari, 2004:37). Following a descriptive research design approach, the study describes the characteristics of individual characteristics of warehouse typologies relative to factors that influence their location choice across the entire municipality.

The study adopted a case study approach, focusing on the City of Cape Town (CoCT) as defined by the administrative municipal boundary (Figure 1.3). Neuman (2014:42) argues that a case study investigates many features of a few cases, and this includes individuals, groups, organisations, movements, events, or geographic units. Following this definition, the case study approach enables the analysis of the spatial distribution of warehousing in the City of Cape Town municipality relative to the factors that influence the locational patterns of warehousing typologies generally.

Figure 1.3: Locality Map



1.4.2 SUMMARY OF THE METHODS

The study employed quantitative methods of data collection, analysis and presentation. As alluded to earlier, the study adopts a descriptive design wherein the study described the characteristics of warehouse typologies relative to factors that the location of warehousing and logistics facilities generally. The City of Cape Town municipal boundary defines the study area.

The quantitative data emanates from the Geographic Information System (GIS) data which focuses on the spatial distribution of warehousing facilities in the City of Cape Town, wherein spatial analysis in GIS using the footprint analysis method was used to analyse the building footprints of warehousing facilities to determine the size of warehousing facilities. Aerial photographs and Google Satellite images were used to analyse the shape and the form of warehousing facilities across the City of Cape Town.

1.5 CONTRIBUTION AND LIMITATION OF THE STUDY

This section presents the contribution and limitations of the thesis, and it discusses the contribution toward planning practice and extending the existing knowledge in warehousing and planning.

1.5.1 CONTRIBUTION

The study of the spatial patterns of warehousing types will contribute immensely towards the understanding of the spatial distribution of warehousing facilities as well as provide spatial planners with insights into the factors behind the spatial distribution of warehousing facilities in the City of Cape Town. The differentiation of various types of warehousing facilities will play a crucial role in informing spatial planners on making decisions about the different locational needs of warehousing facilities. This is largely because warehousing facilities are the major consumers of urban land. Therefore, from a land-use planning perspective, the understanding of different typologies of warehousing enables planners and policymakers to include freight-related policies during the preparation of land-use policies in order to address the economic, social, and environmental needs associated with logistics activities in the metropolitan areas (Raimbaut et al., 2018; Kin et al., 2023;). Additionally, regarding land-use policies, the study enables policymakers to gain insights regarding the placement of warehouses, as well as catering for logistics-related activities in spatial development frameworks, as well as the master plans that guide the future development of cities regarding different land uses, and economic activities. The study enables policymakers to effectively utilise zoning to combat negative externalities associated with logistics activities such as pollution, safety issues, and traffic congestion, by designating areas that explicitly house logistics-related activities (Raimbaut et al., 2018).

Moreover, regarding economic benefits associated with logistics facilities, the thesis will acquaint land-use planners and municipalities to recognise warehousing facilities as one of the major economic drivers, since contemporary urban economies are consumer-oriented economies that are characterised by the increasing growth of freight activities. As such warehouses are the potential sources of revenue and employment generation activities within the metropolitan areas (Andreoli et al., 2010; Jones, 2022). However, apart from contributing towards practice and policy point of view, the thesis contributes towards extending the knowledge in the field of logistics and warehousing studies, since there is limited literature on the spatial patterns of different types of warehousing facilities within the environs of metropolitan areas in the global south.

1.5.2 LIMITATIONS

The subsection presents limitations associated with the thesis, although the limitations are outweighed by the contribution of the thesis in planning practice and extending the existing knowledge on the spatial patterns of different typologies of warehousing facilities, as well as understanding their different locational needs. The study falls short of the following:

Firstly, the study draws much of the literature on the spatial patterns of warehouses from the Global North, such as North America and Europe, wherein given differences in geographical location as well as economic structure, some of the findings cannot be universally applicable to the Global South.

Secondly, the study relied on secondary sources of data to examine the spatial patterns of warehouse typologies in Cape Town, wherein findings from secondary sources of information may not adequately address the aim of the study. Additionally, GIS data is expensive, and some of the data is not readily available in the public domain. Despite the study obtaining much of the data on the city of Cape Town’s Open Data portal, some GIS data was not available to the public.

1. 6 ORGANISATION OF THE THESIS

CHAPTER ONE: The introductory chapter provided the background to the study and defines key concepts. The following key components are then discussed: the research problem, aim, questions and objectives. The chapter also presented the research design, a summary of research methods and the contribution and limitations of the study.

CHAPTER TWO: The chapter presents a literature review on warehousing typologies and the factors influencing the locational patterns of warehousing. The chapter also describes the different criteria used to differentiate the typologies of warehousing facilities.

CHAPTER THREE: The chapter discusses the theoretical lenses informing the analysis of the location of warehousing facilities. The theoretical framework draws on location theories, models and theories applied in logistics research. The theoretical lenses guide the analysis of the spatial distribution of different warehouse typologies.

CHAPTER FOUR: The chapter outlines the research methods employed to collect and analyse the data towards answering the research questions and fulfilling the aim of the study. The chapter also discussed the ethical matters that were considered during the research.

CHAPTER FIVE: The chapter presents the research findings on the locational patterns of warehousing typologies and discusses the patterns relative to the factors that influence the placement of warehousing generally.

CHAPTER SIX: The chapter concludes the thesis and provides recommendations for future research.

CHAPTER 2: LITERATURE REVIEW

The previous chapter presented the introduction and background to the thesis by outlining the research problem, aim, questions, and objectives. Chapter Two present the literature review on the spatial patterns of the typologies of warehousing facilities in various cities and regions across the globe. Section 2.1 discusses the methods employed to find the relevant literature. Section 2.2 presents an overview of warehousing typologies and the criteria used in their classification. Section 2.3 presents an overview of the locational patterns of warehousing typologies. Section 2.4 discusses the factors that influence the location of warehousing facilities. Section 2.5 synthesis of the literature review and the last section summarises the chapter.

2.1 METHODS EMPLOYED TO FIND THE LITERATURE

The study employed a systematic literature review method to identify the literature on warehousing. The method includes snowballing and database search. The Boolean query was also used in database search to find relevant literature. Systematic literature review entails a literature survey guided by defined research questions, search process, data extraction, and data presentation (Kitchenham et al., 2009). As such, it synthesises the relevant literature to answer a certain research question (Scells et al. 2020:1072).

Wohlin, (2014) defines snowballing as the process whereby the researcher uses the reference list or citation of the paper to find relevant sources (Wohlin, 2014). Badampudi et al. (2015) noted that the snowballing method can be classified into two broad categories, namely forward snowballing (FSB) and backward snowballing (BSB). Forward snowballing refers to the use of citations on the paper being examined to identify new papers and backward snowballing refers to the use of a reference list in a paper to search for additional information (Badampudi et al., 2015).

The study employed both backward and forward snowballing techniques for literature search. Snowballing technique was used in both internet database and the Cape Peninsula University of Technology library databases search. The databases used were the Cape Peninsula University of Technology (CPUT) library databases, SCOPUS, EBSCO host, Emerald, ProQuest, ScienceDirect / ELSEVIER, ResearchGate, and Google Scholar. The databases were used to identify the peer-reviewed journal articles on warehouse typologies and their spatial patterns. The study used the following keywords during the search process: ‘warehouse’, ‘distribution centre’, ‘spatial pattern’, and ‘locational pattern’. As a result, the title of the journal article, abstract, and conclusion were used to select the relevant literature sources.

Moreover, the Boolean query was employed to search for peer-reviewed journal articles within the CPUT library database. Specifically, the following Boolean operators were employed: ‘warehouse’ AND ‘spatial pattern’, AND ‘warehouse’ OR ‘distribution centre’. As pointed out by Karimi et al. (2010:3), the Boolean query partitions the search space by identifying the subset of documents in a collection based on query criteria. A query comprises a string of keywords interspersed/scattered with Boolean Operators (Karimi et al., 2010:3). The relevant papers were selected based on the following parameters: peer-reviewed articles published from January 2000 to August 2023, and articles published in the English language were included.

The articles obtained from the internet database search including CPUT library databases were included based on the article title, abstract, and conclusion. Following a careful assessment of article title, abstract and conclusion, journal articles which were not explicitly relevant to warehouse and spatial patterns were discarded. Therefore, 54 articles were included in this study.

2.2 OVERVIEW OF THE TYPOLOGIES OF WAREHOUSES

This section presents an overview of warehousing typologies as well as the different criteria used to categorise the typologies of warehousing facilities. According to Collins dictionary (2023), a typology is defined as a ‘‘*system of dividing things into different types, especially in science and social sciences*’’. The classification of warehousing facilities according to the general type plays a crucial role in understanding a variety of warehousing facilities in different metropolitan areas across the globe. It, therefore, provides insights into the different locational needs of warehousing facilities.

According to various studies that were conducted in Europe and North America, the following criteria were used to distinguish logistics facilities: size of the facility, functional activity, primary function, the geographic scope of the market, and the nature of the products (Rodrigue, 2020b; Onstein et al., 2021; Vereecke et al., 2008.; Schorung & Lecourt, 2021; da Costa Barros and Nascimento (2021) argue that a warehouse can be divided into several categories based on primary type, primary use, and size. It has been further noted that various typologies of warehouse facilities are directly linked to the type of activity, type of products, form of logistics, and product management (da Costa Barros & Nascimento, 2021). Notteboom and Rodrigue (2022) argue that specific warehousing facilities differ from one another depending on the distance to the customer and the level of specialisation of the product. The scholars developed a typology of warehousing facilities which include distribution centres, specialised distribution centres, bulk warehouses, and specialised warehouses. According to Notteboom & Rodrigue (2022) types of warehouses differ depending on the level of specialisation of a product. Therefore, several scholars on warehousing identified and studied various typologies of warehousing, including distribution centres, fulfilment centres, cross-dock centres, production warehouses, and contract warehouses (Berg & Zijm, 1999; Vereecke et al., 2008; Cidell, 2015; Da Costa Baross and Nascimento, 2021; Onstein et al., 2021). The following interrelated subsections present an overview of warehousing typologies.

2.2.1 DISTRIBUTION CENTRES

Scholars in warehousing and supply chains management use the term warehouse and distribution centres (hereinafter referred to as DC) interchangeably, as such in the end, the conception of the terms is highly treated as a matter of semantics (Bowersox, et al., 2013; Higginson & Bookbinder, 2013). Notteboom and Rodrigue (2022) argue that the term warehousing has a universal connotation since it can be used interchangeably with specific types of warehouses such as distribution centres and fulfilment centres. However, some scholars attempted to make a clear-cut distinction between the two terms (Lampert, Elram & Stock, 1996.)). Lampert, Elram and Stock (1996:265) assert that the term warehouse is more generic, and warehouses store a variety of products in four-stage cycles, i.e., receive, store, ship, and pick, whereas distribution centre holds minimum inventory in a two-stage cycle, namely receive and ship (Higginson & Bookbinder, 2005). Notteboom and Rodrigue (2022) offer a comprehensive distinction between warehouse and distribution centre, wherein distribution centre was conceived as a facility that performs a wide range of functions, namely consolidation, warehousing, packaging, decomposition, and light manufacturing activities such as assembly and packaging. A warehouse was described as a facility that is used to store goods in form of inventory for a relatively long period (ibid.). Cidell (2015) in the study of distribution centres as distributed places in Illinois, distinguish between the traditional warehouses and distribution centres, defines a distribution centre as a facility that offers a short-term dwelling place for goods that came in through containers awaiting distribution within few hours or days. However, in traditional warehouses goods are stored on shelves and retrieved when the need arises (ibid.).

da Costa Barros and Nascimento (2021) in their study of the implementation of robotic mobile fulfilment systems in warehouse systems in Brazil, described a DC as a warehouse facility that holds finished goods that are ready to be distributed locally or internationally. Higgins, Ferguson, and Kanarogloul (2012) described a DC as a single large warehouse or a cluster of large warehouses largely responsible for the rapid movement of goods. Onstein et al. (2019) noted that distribution centres are central elements in the distribution structures, as such, DC plays a variety of functions in the distribution of goods. The distribution centre was further described as a physical facility within a distribution structure responsible for the rapid movement of goods and performs various functions, namely goods receiving and goods shipping; warehousing/ transloading and cross-docking and value-added logistics (VAL) activities such as packing, labelling and production postponement of goods (Onstein et al., 2019).

da costa Barros and Nascimento (2021) noted that a DC is primarily used for the distribution of goods, although the facility shares the same functions of product distribution with the fulfilment centre. The major difference is that the facility is demand-driven and picking of goods at the facility is done on a larger scale through the use of pallets, case quantities, and a variety of order-picking methods through the use of automated systems and robots (da Costa Barros and Nascimento, 2021). To this end, a distribution centre is a facility that is specifically designed to facilitate the rapid movement of goods, as such, it performs limited storage functions since goods can be stored for days or weeks in the facility (Higginson & Bookbinder,2005; Higgins, Ferguson, & Kanaroglou, 2012). Higginson & Bookbinder (2005) assert that a DC performs the following roles in the supply chains, viz: break bulk/ consolidation centre; cross dock centre; transhipment facility; depot for returned goods (reverse logistics); product fulfilment facility, and assembly facility. Therefore, it is important to note that the distribution centre performs a wide range of functions in the supply chains to facilitate the distribution of goods to the customers. Table 2.1 presents a summary of the differences between warehouse and distribution centre based on their functions, since warehousing facilities are mainly concerned with the storage of goods inform of inventory, whereas distribution centres facilitate throughput distribution rather than storage (Notteboom and Rodrigue, 2022).

Table 2.1: Differences between warehouse and distribution centre

WAREHOUSE (STORAGE)	DISTRIBUTION CENTRE (THROUGHPUT)
• Supply driven (storage)	• Demand driven (throughput)
• Buffer related function (inventory holding)	• Fulfilling orders (processing and fulfilment)
• Inventory stored for weeks or months	• Inventory stored for days or weeks
• Cargo is owned by the supplier or producer	• Cargo is owned by customer or distributer
• Consolidation of cargo	• Consolidating, deconsolidating or sorting
• Limited added value outside storage	• Assembly, packaging and light manufacturing

(Source: Notteboom and Rodrigue, 2022)

Different scholars argue that the rise of e-commerce activities in metropolitan areas and the desire for economies of scale are the major factors responsible for the mushrooming of distribution centres in metropolitan areas (Onstein et al., 2021; Kang, 2020a). Some scholars in the domain of logistics and supply chains noted that distribution centres are classified into different categories based on different criteria such as the geographic scope of the market area, size of the facility, and functional operations among others (Vereecke et al., 2008; Onstein et al., 2021). Vereecke et al. (2008) in the study of the typology of distribution centres in Flanders found that DC is classified into various categories based on the geographic extent of the market served by the facility and functional activities carried out by the facility. In light of the geographic extent of the market area criteria, the following four sub-typologies of large-scale distribution centres were identified: national distribution centre, regional distribution centre, local distribution centre, and international distribution (De Ligt & Wever, 1998; Vereecke et al., 2008; Holzapfel et al., 2018). Holzapfel et al. (2018) in their study of assigning the products to different types of distribution centres in the retail logistics network found that different products are allocated to different types of distribution centres, namely central DC, regional DC and local DC due to the size of the storage capacity of the facility and the number of stores served. It is argued that central DC has large capacity as compared to regional DC; regional DC could supply a variety of stores within a specific area such as the whole province and the local DC could be dedicated to serving stores located in a specific area that could be single states or agglomerations (Holzapfel et al.,2018).

De ligt and Wever (1998:219) carried out a study on the locational patterns of the European Distribution centres (EDCs) and found that European distribution centres are classified into different types based on the size of the market area and the location of their production plants.

In this respect, the EDCs were further classified into different types, namely overseas distribution centres, which serve the regional distribution centre (RDC) and national distribution centre (NDC) by distributing products that are imported from overseas production plants. The EDCs are further classified into production-oriented EDC, mixed EDC, and spare parts EDC based on the primary functions performed by the facility (De ligt & Wever, 1998). Different scholars use the size of the facility as an important criterion to classify the different types of distribution centres, as such the size of distribution centres ranges from extra small (XXS) to extra-large (XXL) mega-sized structures which consume large expanse of urban land (Onstein, et al., 2021; Nerfs and Daamen,2022). It is argued that large distribution centres (XXL DC) in Europe are increasingly put on the planning agenda due to their growing spatial footprint and negative effects on the environment (Nefs & Daamen, 2022). Hesse (2004:164) assert that the average size of modern distribution centres is increasing in size as a result of economies of scale, where large distribution centres can reach a magnitude of 50 000m² or 75 000 m² and also, regional distribution centres exceed the threshold of 100 000m².

Onstein et al. (2021) in the study of the typologies of distribution centres in the Netherlands developed eight types of distribution centre based on the following criteria: geographical location, functional activity, and the size of the facility (surface area in m²). In this respect the functional criterion was further divided into different sub-sets, namely activity type (i.e., main activities performed at the facility, which includes warehousing, storage, and cross-dock; product type; product range and distribution speed of a product; network structure; market service area and service days. The size criterion (surface area in m²) includes eight categories of distribution centres which range from XXS to XXL sizes of the distribution centres (ibid.). Therefore, the following eight types of distribution centres were developed using the aforementioned criteria (i.e., functional and size criterion):

- Type 1: Parcel lockers and small pick-up points- The facility is used for the distribution of parcels to the customers, wherein it includes a self-service locker where customers pick and collect goods bought online. The facilities are XXS in size and usually cover a surface that ranges from 1m²-200m².
- Type 2: City hub distribution centre- This type of distribution centre performs the following functions, namely warehousing, storage, and consolidation of the returned goods. The facility is usually of the XS size and the surface area ranges from 201m² to 2000m², for

instance, urban consolidation centres are the perfect examples of city hub distribution centres (Onstein et al., 2021).

- Type 3: Parcel and postal sorting facilities perform the parcel and postal functions usually to facilitate the last-mile distribution of goods to the final customer as well as performing consolidation and warehousing functions. The facilities vary in size from S, M, L to XXL, occupying a surface area that ranges from 2001m² to 8 000m² (Onstein et al., 2021
- Type 4: Regional food wholesale and retail DC facilities – It is argued that most of the logistics facilities found in this category specialise in the regional distribution of goods to retailers and home delivery to customers. This type of DC performs other important functions such as consolidation, warehousing, cross-docking, and value-added logistics activities (VAL) (Onstein et al., 2021). The facility is operated by large wholesale and retailing companies and also, and the size of the facility ranges from XL to XXL with a surface area that ranges from 8 001m² to 15,000m².
- Type 5: National retail and e-commerce facility- The facilities are mainly used for storage, consolidation, warehousing, cross-docking, and value-added logistics activities (Onstein et., 2021:7). It is argued this type of DC facilitates national distribution to retail companies and customers. The size of the facilities ranges from M, L, and XL to XXL (15 001m² to 20 000m²) and performs important functions such as storage, warehousing, cross-docking, and value-added logistics. It is further noted that the facility distributes a wide range of products, and supplies a wider geographic area, thus ending up developing a mega distribution centre.
- Type 6: Manufacturer DC- It is maintained that the facility performs the aforementioned important functions, namely storage, warehousing, VAL, and national and international distribution. The facility is operated by manufacturers or logistics service providers (LSPs). The facility handles a wide range of products which could be either small or broad range of products. It is important to note that this type of facility serves a wider geographic market extent, as such its size ranges from L, XL to XXL with a surface area that ranges from 20001m² to 40.000m².
- Type 7: Bulk facilities – the facilities perform the storage and distribution functions of bulk goods on a broader geographic scale, usually at a regional scale. The bulk facilities are operated by manufacturers or wholesalers and oil depots are some of the perfect examples of these bulk facilities (Onstein et al., 2021). The facility's size ranges from M, L, and XL to XXL.

- Type 8: Global agricultural auctions- Apart from performing logistics functions, namely storage, consolidation, warehousing, VAL, and distribution the facility is used for handling and the distribution of agricultural products such as flowers and vegetables (Onstein et al., 2021). The size of the facility ranges from XL to XXL, covering a surface area that exceeds 40 000m².

2.2.2 SPECIALISED DISTRIBUTION CENTRES /FULFILMENT CENTRES

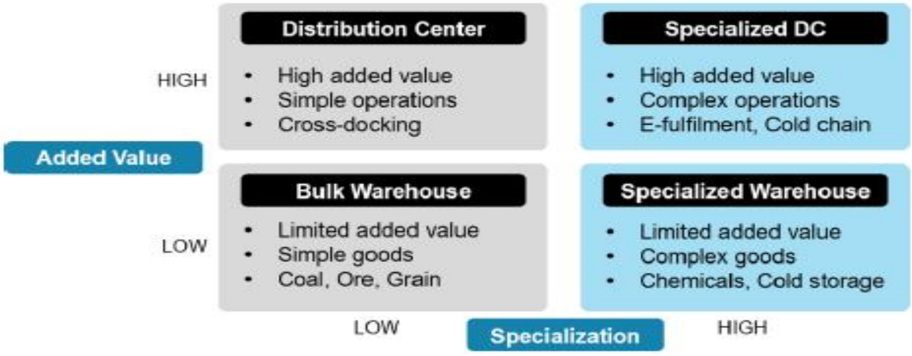
The literature acknowledges that the increased growth of e-commerce activities resulted in the widespread growth for customer fulfilment centers (Richards, 2014; Rodrigue, 2020b). The studies that describe e-commerce logistics facilities focuses on the geography of Amazon fulfilment warehouses in the United Kingdom, Japan, and the United States (De Silva et al., 2020; Rodrigue, 2020b; Schorung & Lecourt, 2021; Houde et al., 2017). It is therefore important to note that the abundant literature on warehousing often presents striking similarities between fulfilment centre and a distribution centre, wherein a fulfilment centre is described as a type of distribution centre that fulfils orders from the final consumers (Higginson & Bookbinder, 2005; Eriksson et al., 2019; Notteboom & Rodrigue, 2022). It can be noted that the difference between fulfilment centre and a distribution centre is very negligible since DC focuses on the demand for customers whereas fulfilment centre ensures that orders reach customers in a timely fashion wherein, orders are processed through online platforms and the facility has the capacity of processing both B2B and B2C goods (Notteboom & Rodrigue, 2022).

De Silva, Sano, and Hatoyama (2020) argue that there is a close resemblance between a fulfilment centre and a distribution centre since both facilities perform the storage function of products supplied through different suppliers in the supply chains. The literature acknowledges that there are different types of fulfilment centres, viz.: online fulfilment centre, e-fulfilment centre, and multichannel fulfilment centre (Fernie et al., 2010; Eriksson, et al., 2019; Rodrigue, 2020b; Newing et al., 2022). It is argued that the difference between the distribution centres and fulfilment centres lies in their respective methods of operations wherein, fulfilment centres are designed to handle high volumes of small, individual online orders (Fernie et al., 2010). Whereas distribution centres by the nature of their functional activity, have high turnover rates and fast throughput (Eriksson et al., 2019). De Silva et al. (2019) notes that the difference between the two facilities lies in the functional shift in the handling of products, wherein fulfilment centre handles small-sized parcels that are delivered to customers, whereas distribution centres specialise in the handling of bulky products that are distributed to the retailers. However, both facilities perform the distribution function of products to either retailers, wholesalers, or final consumers as they are the final points in the supply chains (Faber et al., 2018; da Costa Barros & Nascimento, 2021).

According to Jones (2022), fulfilment centres are a network of distribution centres. Houde et al. (2017:) defined fulfilment centres as ‘‘facilities where goods are stored, orders are packed, and packages are transferred to downstream facilities for sorting and final delivery’’. Rodrigue (2020b) in the study of the geography of e-commerce logistics facilities, in particular, the distribution network of Amazon and the footprint of freight digitalisation argues that e-commerce requires the development of distribution facilities such as e-fulfilment centre. An e-fulfilment centre was described as an extensive facility specifically designed to assemble individual online orders. The facility service large volumes of products distributed as parcels and is characterised by high throughput distribution, which in turn results in the increased use of automation (Rodrigue, 2020b. It is argued that fulfilment centres are undergoing full or partial automation through the use of robots thus enabling quicker retrieval of orders from storage and placing them into backs for parcel assembly (Rodrigue, 2020b; Schorung & Lecourt, 2021).

In this regard, the literature on warehouse and e-commerce facilities reports the use of different criteria in the classification of fulfilment centres, namely the primary function and activity roles of the facility (Rodrigue, 2020b; da Costa Barros & Nascimento, 2021). According to da Costa Barros and Nascimento (202), fulfilment centres formerly known as packing warehouses perform the primary function of distributing products to final consumers. It is argued that due to the growth of e-commerce activities, online retailers classify e-fulfilment centres into two major categories based on the range of items handled and the item size (Rodrigue, 2020a). Therefore, there are e-fulfilment centres that specialise in small sortable goods and normally small goods that can fit in a box, less than 10kg, and e-fulfilment centre for large sortable goods, usually specialising in products that weigh more than 25kg (Rodrigue, 2020b). Schorung and Lecourt (2021) in the study of the geography of Amazon warehousing, describe a pantry or fresh food fulfilment centre as a fulfilment warehouse that specialises in the distribution of perishable or fresh goods and cleaning products. Notteboom and Rodrigue (2022) classified fulfilment centre as a specialised distribution centre and developed a typology of warehousing facilities based on functional activities (i.e., added value and level of specialisation).

Figure 2.4: Typology of warehousing facilities



Source: Notteboom and Noteboom, 2022

2.2.3 CROSS-DOCK FACILITY

Cross dock facilities are important intermediary facilities that play an essential role in the fast and efficient distribution of goods in the distribution network. There is limited literature regarding cross-dock facilities as a typology of warehousing, wherein the majority of studies on cross-docking analyse vehicle routing and scheduling problems at cross-docking terminals by developing models for vehicle scheduling and routing, along with identifying optimal locations for cross-docking centers in the distribution network (Pereira, 2016.; Bartholdi & Gue, 2004; Boysen & Fliedner, 2010; Mousavi et al., 2019; Nasiri et al., 2019). Few studies on logistics and warehousing present cross-dock as a sub-component/function of other typologies of warehousing facilities such as the distribution centre (Notteboom and Rodrigue, 2022). In the study of Amazon e-commerce facilities and the spatial distribution of freight digitalisation, Rodrigue (2020b) developed a typology of cross-dock based on two factors of the role and function of the facility. In this respect, an inbound cross-dock facility was conceived as a large-sized facility located proximate to intermodal terminals, namely ports and rail yards, for easy de-stuffing and storage of inventory from imported containers. It is argued that the facility is configured with double-side cross docking, with bay doors on both sides, and mainly performs the primary role of receiving and transloading containers. Therefore, there are facilities that fully operate as stand-alone cross-dock facilities, while some facilities (distribution centre) incorporate cross-dock strategies in the distribution of goods.

The literature acknowledges cross dock as a warehouse strategy used in the distribution of goods in order to minimise logistics costs in warehousing and transportation as well as a facility/terminal that performs limited warehousing functions, namely storage and distribution of goods (Bartholdi & Gue, 2004; Van Belle et al., 2012; Boysen, Fleidner & Scholl, 2010; Gümüş & Bookbinder, 2004; Nasiri et al., 2019a). According to Barthold and Gue (2004), a cross-dock is understood as a logistics technique that performs two important functions of receiving and shipping, by eliminating the traditional functions of a warehouse such as packaging and storage. It is argued that the crossdocking strategy is widely used by retail firms, grocery and less than truck loads trucking firms to consolidate shipments for them to achieve transportation economies (Barthlod & Gue, 2004; Van Belle et al., 2012). According to the study by Jones (2022:530), cross-dock are described as a redistribution centre wherein goods are received from importers and manufactures.

However, some studies describe cross dock as a logistics technique that plays a fundamental role in the packaging and storage activities from the warehouse, by facilitating the transshipment process, wherein goods are unloaded from the inbound vehicles and loaded onto outbound vehicles (Nasiri et al., 2019). As such, the cross-dock strategy shortens the delivery time since goods are distributed from the supplier to the consumer in less than 24 hours. However, a cross-dock facility provides temporary storage of goods in staging areas near the dock doors for a short period, usually less than 24 hours (Van Belle et al., 2012). Cross-docking terminal is defined as a terminal where goods are stored for less than 24 hours, and upon arrival goods are from the inbound trucks are unloaded, sorted, and loaded onto outbound vehicles, as such the terminal is responsible for transhipment of truckloads (Boysen et al.,2008;Boysen & Fleidner, 2009; Van Belle, et al., 2012).Boysen and Fleidner (2009) further pointed out that cross-dock terminals enable the consolidation of various sizes of shipments scheduled for the same destination into a full truckload, thus presenting the major advantages of realising the economies of transportation. Richards (2014) asserts that cross-dock is widely recognised as the future of warehousing. Cross dock warehouse receives goods that are already labeled, and awaiting onward delivery, wherein goods are consolidated with other goods that are ready for dispatch (Richards, 2014). According to Richards (2014), cross-dock warehouses are usually used in outlying geographic areas to facilitate the efficient transfer of goods onto local and radial vehicles. Based on the study, cross-dock warehouses are ideal for the efficient transportation of perishable goods, namely fruits, vegetables, meat, and meat, since cross-dock warehouses facilitate same-day delivery of goods within the supply chains (ibid.).

Cross-dock facilities can serve the following goals in the distribution network: the consolidation of shipments, shorter delivery lead times, and reduced transportation costs (Van

Belle et al., 2012: 827). The literature highlights that cross-dock facilities come in various forms and shapes; however, the most common cross-dock are long, narrow, rectangular, I-shape, L, X, T, and U shapes are also used (Barthold and Gue, 2004; Van Belle et al., 2012). The previous scholars concur that the most common shapes used for cross-dock facilities are I, T, and L, although some of the aforementioned shapes not mentioned in this argument are also found in cross-dock. Therefore, it is important to note that a cross-dock facility has numerous loading docks or doors, wherein the loading and unloading of goods occurs. In the literature, there are different types of cross-dock facilities. Van Belle et al., (2012) found that a predominant distinction is made based on the number of touches and stages of products upon arrival at a cross-dock facility. In this respect the following types of cross-dock facilities are described: one-touch cross dock; two touch cross dock, and multiple-touch cross dock:

- One-touch cross-dock or pure cross-dock, wherein products are touched once during the process of receiving, unloading, and loading onto the outbound truck.
- Two-touch or single-stage cross-dock, wherein inbound products are received and staged on the dock up until when they are loaded onto an outbound truck.
- Multiple touches or two-stage cross dock, wherein inbound products are received, staged on the dock, and reconfigured for shipment onto an outbound truck (Van Belle et al., 2012).

There are also two important types of cross-dock facilities distinguished based on whether the freight is already assigned to a customer or not. These include pre-distribution cross-dock and post-distribution cross-dock facilities (Van Belle et al., 2012; Zhang et al., 2009).

2.2.4 SPECIALISED WAREHOUSING

In literature, few studies explicitly focus on the typology of warehousing facilities. Notteboom and Rodrigue (2022) in their study of port and distribution networks, developed a typology of warehousing facilities based on two important factors (functional activities**),** namely the stage within the supply chains (i.e., the distance to consumer) and the level of specialisation of the product. As illustrated in **Figure 2.4**, the study identified specialised warehouses as a typology of warehousing facilities that can be classified either as high or low depending on the level of specialisation of the product and added value (ibid.). Specialised warehouse is a facility that handles high-level specialised products, wherein the facility stores and distributes complex products (Notteboom and Rodrigue, 2022). Warehousing facilities found in this category include cold storage facilities and warehousing facilities that specialise in the distribution of pharmaceuticals, food, fresh produce, meat, dairy products, and a wide range of temperature-sensitive goods. However, some studies classify cold storage under the category of generalpurpose warehousing, wherein storage of goods is the primary use feature of the facility (Nascimento and Barros, 2021). The literature on cold chain logistics acknowledges that there has been a recent growth in cold chain warehouses (Dong et al., 2020; Li et al., 2020; Zhang & Hou, 2021). The majority of the existing studies on cold storage warehouses focus on the spatial patterns of cold storage warehouses and the general overview of cold chain logistics in Asia, specifically in China and India (Shravanthi & Mahendran, 2015; Zhao et al., 2018; et al., 2020; Li et al., 2020; Zhang & Hou, 2021)

Shravanthi & Mahendran (2015) conducted a comparative quantitative study to examine the spatial distribution of cold storage warehouses in different regions across India. According, to the study cold storage warehouses refers to temperature-controlled facility that serves various industries such as agriculture, horticulture, fisheries, aquaculture, dairy, and processed food (Shravanthi & Mahendran, 2015). Based on the findings of the aforementioned study, cold storage warehouse in India were classified into the following categories: potatoe cold storage warehouse; multipurpose cold storage warehouse; fruit and vegetables cold storage warehouse; meat and fish cold storage, meat and milk products cold storage warehouse. The previously mentioned cold storage warehouses were concentrated in different regions across India.

Furthermore, it is therefore, important to mention that the study acknowledges that cold storage warehouses play a crucial role in the supply chains by prolonging the freshness of products, preventing excess supply, alleviating transportation challenges during peak production times, and preserving the quality of goods (Shravanthi & Mahendran, 2015:54). According to Li et al. (2020**)** in the study of the spatial pattern evolution and the influencing factors of cold storage in China, asserts that cold storage plays a vital role as the important circulation nodes within the supply chains. Cold chain logistics is so broad, such that it is made up of different components, namely infrastructure facilities, and vehicles that are specifically designed to handle temperature-sensitive goods. In this regard, it is worth noting that cold storage warehouses are vital infrastructure for cold chain logistics (Li et al., 2021). Zhao et al. (2018) presents an overview of the status of cold chain logistics facilities in China, wherein the study suggested that cold storage warehouses are part of cold chains logistics, though the stud did not explicitly focus cold storage warehouses. Yahia (2009) in the study of the development of cold chain logistics in the developing world (DW) argue that in Africa, South Africa has advanced infrastructure for cold chains with a well-developed cold storage warehouse, advanced pre-cooling facility, and refrigerated port facilities.

Similarly, in the context of South Africa, few studies on cold chain logistics focused on the export of temperature sensitive goods such as fruits through the Port of Cape Town without specifically analysing cold storage as a typology of warehouse facilities. (Goedhals-Gerber et al., 2017; Goedhals-Gerber & Khumalo, 2020; Steynberg et al., 2022; Goedhals-Gerber et al., 2015). du Plessis et al. (2022) conducted a quantitative study to measure the intensity of carbon emission from the cold stores in South Africa. The study examines warehouse and transshipment points that handles two types of refrigerated goods, and the facilities are classified as fresh with temperature ranges from 4 to 7 degrees celsius and sensitive with temperature ranges from 0 to 2 degrees Celsius. According to the study, all warehouse and transshipment points that provide storage for fresh fruits were referred to as cold stores (du Plessis et al., 2022:3).

du Plessis et al., (2022:5) listed various functions performed by the cold stores in the supply chains. These functions include:

- Storage of goods for short periods usually less than 24 hours or extended durations lasting several days or months.
- Operates as a buffer in the fresh fruit supply chain to guarantee a continual supply of fruits to the markets.
- Establishing connections between different transportation modes, namely road, air, deep sea, and rail.
- Regulating temperatures of fruit to maintain the optimal storage temperatures.
- Enables the consolidation of fruit loads by producers to transport modes efficiently.
- Establishing a link during the transfer of fruits from one function unit of transport to another, such as transfer from pallets to refrigerated/reefer containers.

Against the afore-cited roles, du Plessis et al. (2022) classified cold storage facilities in South Africa as seasonal cold stores and large commercial stores. The former refers to the cold store facilities that are in operation for a few months per year during the harvest period (December to March) whereas the latter refers to the large cold stores that operate all year round (bid.). In addition, based on the 2020 data the study uncovered that a total of 360 000 pallets of fruit were moved through the large commercial cold stores.

Informed by the aforementioned findings, it is important to note that cold storage warehouses play a vital role in cold chain logistics, as they enable the preservation of perishable products such as fruits, vegetables, meat, fish, and dairy products. In conclusion, based on the findings from the literature it is of utmost importance, to maintain that there is sparse literature on typologies of warehouses, since the available studies generalise warehousing facilities. Therefore, Rodrigue and Notteboom in the study of port-centric logistics, acknowledge cold storage warehouses as part of specialised warehousing facilities.

Table 2.1: Summary of Typologies of warehousing facilities

AUTHOR	YEAR	FOCUS OF THE STUDY	TYPOLOGY	CRITERIA
V**ereecke et al.**	2008	Analyse the possibility and opportunity of Flanders to attract Distribution Centres (DC).	European distribution centre (EDC)	Geographic scope of the market
da Costa Barros & Nascimento	2021	Propose a unified and accessible concept of warehousing systems in the development of Robotic Mobile fulfilment systems in Brazil.	Distribution centre and Fulfilment centre	Primary function Size of the products
Onstein et al.	2021	Investigate the size and functional attributes of DC in the Netherlands and propose a typology of DC.	DC	Geographical location, size and functional activity
Rodrigue	2020b	Developed a typology of e-commerce logistics facilities of Amazon distribution network in the United States of America.	Fufilment Centre, Inbound cross dock	Primary function
Schorung M & Lecourt T	2021	Analysed the spatial logic of Amazon warehouse using the multiscale and temporal approach to the Amazon logistics system in the United States (US).	FC, DC, Inbound Cross dock center, Pantry FC, Delivery station	Functional activity, size, type of products
Berg & Zijm	1999	Present the models and decision support systems for the planning and control of warehousing management systems in the Netherlands.	Contract warehouse, production warehouse and distribution warehouse	

Source: Author

2.3 OVERVIEW OF THE SPATIAL PATTERNS OF WAREHOUSING TYPOLOGIES.

This section describes the geographical distribution of warehousing typologies across the globe. The literature discusses the locational pattern, namely the concentration, dispersion, and polarisation of warehouse typologies in different metropolitan areas. Additionally, different analysis methods that were used to analyse the spatial distribution of warehousing facilities are discussed.

2.3.1 CLUSTERING AND CONCENTRATION OF WAREHOUSE TYPOLOGIES

The literature on logistics activities examines the spatial patterns of warehouses and distribution centres in metropolitan areas in various countries, for instance in France (Masson and Petiot, (2015); the United States (Bowen, 2008; Cidell, 2010; Cidell, 2011; Dablanc & Ross, 2012; Dubie et al., 2020; Jaller et al., 2017; Kang, 2020a; Kang, 2020b); the United Kingdom (Allen et al., 2012; McKinnon, 2009); Belgium (Strale, 2020); Brazil (de Oliveira et al., 2022a; Guerin et al., 2021); the Netherlands (Warffemius, 2007; Warffemius & klaasen, 2008.

Various studies on warehousing facilities establish the concentration of warehousing facilities around major intermodal facilities such as airports and seaports (De light & Wever, 1998; Ferrari et al., 2006; Jaller et al., 2017; MacKinnon, 2009) and close to major highway intersection and motorways (Bowen, 2008; Dablanc & Ross, 2012; Tchang, 2016). Furthermore, there is a considerable number of studies that focus on the concentration of warehouse and distribution centres in metropolitan areas as a result of agglomeration economies (Warffermius, et al., 2010; Masson & Petiot, 2015).

Based on European experience, a considerable number of studies examined the spatial clustering of distribution centres around Amsterdam Airport Schiphol in the Netherlands (see Warffemius, 2007; Warffemius et al., 2010). The findings reveal that Schiphol Airport represents the concentration of European distribution centres (EDC) wherein, which emerged as a cluster of distribution centres largely because of agglomeration effects rather than air transport services provided by the airport (Warffemius, & Klaasen, 2008). Hesse (2004) found a high concentration of warehouse and distribution centres located in Berlin Brandenburg area due to the presence of integrated Freight Centres which offer multimodal transport access.

Several studies employed different spatial analysis methods and techniques to examine the spatial patterns of distribution centres (Bowen, 2008; Cidell, 2010; Dablanc & Ross, 2012; Strale, 2020; Tchang, 2016). Dablanc and Ross (2012) established a high concentration of large distribution centres in Henry County, and this could be explained by the presence of high-quality accessibility offered by Interstate 75. The study identified a mega distribution centre with a building footprint exceeding 500 000ft² in Piedmont Atlantic Megaregion. Tchang (2016:2836) focuses on the influence of proximity to highways in determining the rents of Distribution Centres in the Netherlands using a straight-line distance to the nearest highway in meters and found that most of DC are located 3000m from the nearest highway. Strale (2020:5) analysed the sprawl of logistics facilities in the Brussels metropolitan region and found that municipalities situated proximate to the airport and Brussels-Antwerp Axle as attractive node for warehousing, parcel facilities and trucking. Additionally, several DCs for supermarkets were located in the aforementioned municipalities due to low land prices and good accessibility.

McKinnon (2009) investigated the changing demands for land for the logistics sector, in particular classifying the logistics-related land use, changing trends in warehousing, and analysing the geography of DCs, logistics terminals, and warehouses in the United Kingdom uncovered the clustering of DC in areas designated as distribution parks. The study found the largest concentration made up of over 25 DCs in Magna Park near Lutterworth as well as the clustering of distribution centers around the decommissioned airfield in the West Midlands. Masson and Petiot (2015:4) noted that the concentration of logistics activities in particular areas is due to the centralisation process which leads to the construction of fewer but larger warehouses. It is, therefore, important to note that the desire to minimise stocks and consolidation of flows, subsequently resulted in the reduction in the number of warehouse facilities. The seminal work of Fernie and McKinnon (1991) examines the impacts of changes in the physical distribution of retail products in regional distribution centres in Scotland and found a clustered pattern of DC along motorway access, namely M1, M6, and M8 with a pronounced clustering in and around conurbations of Greater London, West Yorkshire, and Greater Manchester. It has been noted that the trend towards centralised distribution by retailers led to the construction of regional distribution centres which serves local and regional markets, which results in the concentration of inventory in one large facility (Fernie & Mckinnon, 1991).

Furthermore, studies on port-centric logistics establish the increased spatial concentration of distribution centres around ports (ESCAP, 2002; Ferrai, Parola & Morchio, 2006; MacKnnon &Woolford, 2011; Notteboom ad Rodrigue, 2022). The contemporary trends in the spatial clustering of DCs around ports have been studied by different researchers who found the clustering patterns of DCs in areas designated as logistics parks in or near seaports (Notteboom & Rodrigue, 2022). It is argued that there is an increasingly high number of large warehouses near container terminals in a container-oriented logistics park in and around the seaports (Notteboom & Rodrigue, 2022). In the same vein, it is worth noting that the port authorities (Municipal Port Management) at Rotterdam port in the Netherlands encouraged the formation of Distripark, wherein distribution centres were located near the cargo terminal to reduce transport costs and the time required to move products (ESCAP, 2002).

There is a growing body of literature on the geography of e-commerce logistics facilities in different metropolitan areas around the globe (Houde et al., 2017; De Silva et al., 2020; Kovida et al., 2019; Rodrigue, 2020b; Schorung & Lecourt, 2021; Yang et al., 2022). In this respect, Kovida et al. (2019) explicitly focus on the geographical patterns of fulfilment centres of four e-commerce logistics firms in the Tokyo metropolitan region, Japan. The study revealed that three fulfilment centres of the four major e-commerce logistics firms, namely Amazon, Rakuten Super Logistics, and Zozotown were located in the central part of Tokyo (De et al., 2020). It can be noted that the study further revealed a high concentration of fulfilment centres (FC) found in Ichikawa City. Additionally, a high concentration of Rakuten's fulfilment centres were found on the eastern side of Tokyo, compared to Amazon's facilities which were spatially distributed across the core region of Tokyo. De Silva et al. (2020) conducted a similar study, focusing on the correlation between urban form and the spatial configuration of Amazon fulfilment facilities in the UK and Japan. The findings of the study reveal that in Japan, logistics facilities are highly concentrated around Tokyo and Osaka metropolitan regions. Whereas, in the UK the study found that FCs were located on average within 8 km from a Motorway interchange and mean distance of 20 km from a domestic airport (De Silva et al., 2020:153).

Another strand of literature focuses on the spatial distribution of e-commerce logistics facilities, focusing on the North American context (Rodrigue, 2020b; Schorung & Lecourt, 2021; Houde et al., 2017). Rodrigue (2020b) in the study of Amazon distribution networks and the growth of the footprint of freight digitalisation in the US, establishes the emergence of fulfilment clusters in two metropolitan regions, Los Angeles and New York. The study uncovered a large fulfilment cluster in Los Angeles which is made up of the agglomerations of large inbound cross-dock facilities, 15 fulfilment centres in the Inland Empire, and a cluster of last-mile specifically serviced by small delivery stations in San Bernadino, Riverside, and Ontario respectively (Rodrigue, 2020b:12). Houde et al. (2017) established the increased growth of fulfilment clusters in the US from 1999 to 2018. The study found an increased concentration of new fulfilment facilities proximate to old ones wherein the study employed a clustering algorithm method to define the group of co-located fulfilment centres or clusters (Houde et al., 2017:10). To this end, it can be noted that the study established an Amazon fulfilment cluster in Harrington, PA, which is grouped into a cluster located at a centroid of six facilities.

Another important strand of literature on cold chain logistics reports on the spatial layout/distribution of cold storage facilities in China. Li et al. (2020), used the kernel density estimation, to analyse the spatial distribution of cold storage facilities in China between 2008 and 2018. The study establishes two trends in the spatial distribution of cold storage facilities, namely stability, and imbalance. To this end, based on the aforementioned observations, the spatial distribution of cold storage facilities was grouped into types of clusters, i.e., those clusters that show a certain level of stability were classified as ‘‘High-High clusters’’ and those clusters that reflect a certain level of imbalance was classified as ‘‘Low-Low clusters’’. The High-High cluster area is composed of cold storage facilities that were concentrated in the Bohai Rim region which includes Beijing, Tianjin, Hebei, Shandong and the Low-Low cluster areas that show a relatively low nuclear density of cold storage facilities were located in Southern China (i.e., Anhui, Jiangxi, Hubei, Hunan, Guangxi, Sichuan, Chongqing, and Guizhou) (Li et al., 2020).

Complementing the afore-cited study, (Zhang & Hou, 2022)analysed the temporal and spatial evolution of cold chain facilities in BJE City in China between 2010 and 2019. The study found dual spatial trends in the distribution of cold chain logistics facilities, namely agglomeration and suburbanisation characteristics of cold storage facilities. Based on the KDE, the study found that cold chains and cold warehouses were concentrated in the urban area of BJE city, thereby resulting in agglomeration characteristics (Zhang and Hou, 2022: 440**).** On the other end, the standard deviation ellipse method establishes a suburban pattern, wherein cold chain logistics facilities diffuse from the center to the periphery in a circular shape.

In addition to the abovementioned study, a few studies from India examine the spatial distribution of cold storage facilities. Shravanthi & Mahendran (2015) carried out a comparative study to examine the spatial distribution of cold storage warehouses in different regions across India. The study presents a clustering pattern of cold storage warehouses, wherein a high concentration of cold storage facilities was prevalent in the northern region, followed by the western, eastern, and southern regions. In addition, the study classifies the concentration of cold storage in different regions based on the commodity stored. The study revealed that, the northern region had the highest concentration of potato cold storage comprises of 67.27%, as well as a high concentration of multipurpose cold storage, followed by the Eastern region which comprised 19.68% (Shravanthi & Mahendran (2015). According to the study, the aforementioned regions attracted the highest concentration of potato cold storage owing to the highest potatoes production and consumption, particularly in Uttar Pradesh, West Bengal, and Bihar.

The literature reports on a considerable number of studies that focus on the spatial distribution of general warehousing facilities, without referring to or distinguishing the various typologies of warehouses (Button & Kurkan, 2001; Guerin et al., 2021; Mokhele & Fisher-Holloway, 2022; Oliveira et al., 2022b). A more recent study by Guerin et al. (2021) investigated the geographical distribution of warehousing facilities in the Saulo Paulo Metropolitan Region in Brazil. Based on centrographic analysis, barycentre, and Moran 1, the study found clusters of warehousing facilities in Osasco, Santana de Parnaiba, and Jandira due to the accessibility offered by Guarulhos International Airport. In the same vein, a study by Oliveira et al. (2022) in Belo Horizonte, Brazil found the highest concentration of warehousing facilities close to major intersections. The kernel density estimation method established a high concentration of warehouse facilities close to the major intersection of a Ring Road, which is a major access road connecting Belo Horizonte and Saulo Paulo, Re de Janeiro, and Brasilia.

Some studies focus on the spatial distribution of general warehouse and logistics facilities in France. For instance, Heitz and Dablanc (2015) analysed the spatial distribution of logistics facilities in the Paris mega-region (Ille de France) employing Centro graphic analysis, barycentre, and gravity centre analysis methods. The findings demonstrate that warehousing facilities were clustered around central Paris and a high concentration of warehouses at the fringe of Paris close to Roissy CDG airport and Orly Rungis in the southern suburb of Paris was observed. Also, a further concentration of logistics facilities around warehouse logistics clusters in the Northern part of Paris was prevalent due to its strategic location which provides access to the Antwerp/Rotterdam and Eastern Europe logistics route (Dablanc & Heitz, 2015).

Zhang et al. (2017) conducted a spatial analysis of the distribution of commodity delivery warehouses in 25 cities of the Yangtze River Delta region in China and established the concentration of commodity delivery warehouses in four cities, namely Shangai, Ningbo, Suzhou, and Wuxi. The findings further mention the high concentration of commodity delivery warehouses located in the economic zones along the Yangtze River and the Gulf coast of Hangzhou Bay region. A study focusing on warehouse facilities in the US by and Button & Kulkarni (2001) examined the potential of Geographic Information Systems in describing and analysing the clustering effects of warehousing and trucking/courier terminal facilities in the Detroit and Washington Baltimore area using the near neighbour analysis method. It is important to note that basically, the study focuses on general warehouse facilities and trucking terminals and found a much more concentrated pattern of warehousing in a very small area in the Baltimore area. In this regard, it can be noted that the clustering of warehouses was much more concentrated in the urban core areas of Baltimore.

Apart from the literature that focuses more on the spatial distribution of warehousing facilities in the global North, few studies in the global South investigate the spatial distribution of warehousing facilities, particularly in South Africa. Fisher-Holloway and Mokhele (2023) employed the geographical information system analysis, wherein optimised hotspot cluster analysis and kernel density analysis to examine the geographical patterns of warehouses in Cape Town, South Africa. The study established a high clustering of warehouse facilities in Cape Town municipality as compared to the other municipalities in the region. The findings of the study further revealed that warehousing facilities were located in the vicinity of major transport routes, Cape Town International Airport, the Port of Cape Town, and some industrial areas. The study focused on the spatial distribution of warehousing facilities without explicitly referring to the various typologies of warehousing facilities.

2.3.2 THE DISPERSION AND POLARISATION OF WAREHOUSE TYPOLOGIES

Several studies examine the spatial distribution of logistics facilities in different metropolitan areas and the overlapping theme among the scholars is 'logistics sprawl' (Cidell, 2010; Dablanc & Rakotonarivo, 2010; Dablanc & Ross, 2012; Dubie et al., 2020; de Oliveira et al., 2018; Jaller et al., 2017; Strale, 2020; Kang, 2020a; Oliveira, Dablanc & Schorung, 2022). Logistics sprawl has been described as the relocation of logistics facilities from the inner urban areas to suburban and ex-urban areas (Dablanc & Rakotonarivo, 2010; Dablanc & Ross, 2012; Dubie et al., 2020). Cidell (2010) employed two spatial analysis methods, Gini Indices, and regression analysis to examine the spatial distribution of warehouses and freight activities in fifty metropolitan areas in the US for two decades between 1986 and 2005. The study establishes an increased growth in inland distribution centres and the growing popularity of distribution and freight activities in suburban locations as opposed to traditional locations (city centres and port areas) (Cidell, 2010). Notably, the regression analysis uncovered the increased growth in the number of distribution centres in Midwest, Pacific Northwest, and Piedmont region in the US. Few studies based on Brazil investigated the phenomenon of logistics sprawl for warehousing facilities in the Belo Horizonte Metropolitan area from 1995 to 2015 (Oliveira et al., 2018). Oliveira et al. (2018:6) established an insignificant rate of logistics sprawl Belo Horizonte Metropolitan area over 20 years. The study found that in the year 1995 the standard mean distance of the warehouses to the mean centre was 17.5km, whereas, in 2015, the mean distance to the centre was 19km. This implies that the overall distance of sprawl increased by 1.2km. In addition to the afore-cited findings, the study further established a significant change in the location of warehouse facilities wherein in 1995, warehouse facilities were distributed in the east-west direction as compared to 2015 where warehouse location changed from southeast to the northeast direction (Oliveira et al., 2018:7). However, the study focused on analysing the logistics sprawl of the general warehousing facilities in Belo Horizonte Metropolitan area., without explaining the factors that drive logistics sprawl within the region.

Furthermore, Dablanc and Ross (2012) examined the spatial patterns of mega logistics centres in the Piedmont Atlantic Megaregion that include Birmingham, Atlanta, Raleigh Durham, and Charlotte in the US between 1998 and 2008. The study uncovered two complementary spatial patterns, logistics sprawl and polarisation (i.e., the concentration of logistics activities in specific zones). The previous study by Cidell (2010) established the dual warehouse structure, where both concentration and dispersion of warehousing facilities took place in different locations across the fifty metropolitan areas in the US. Dablanc and Ross (2012:435) employed the centrographic analysis which relates to the spatial analysis of geographical data using descriptive spatial statistics and the findings uncovered that distribution centres are largely responsible for logistics sprawl. Interestingly, the findings of the study also present evidence of logistics polarisation at the Piedmont Atlanta Megaregion, wherein there was an increase in the number of warehouse facilities in areas that are proximate to the Atlanta metropolitan area. Lastly, the study acknowledges general warehousing sprawl in Fulton County with a 28% increase in the number of warehouses and distribution centres during the decade 1998-2008.

Onstein et al. (2015) analysed the spatial patterns of distribution centres in the Netherlands, focusing on sprawl and polarisation patterns of distribution centres. The study reveals a dual pattern of distribution centres wherein both sprawl and polarisation occur in certain parts of the country. Polarised patterns of distribution centres were found in the peripheral regions from the Randstad wherein distribution centres proliferated in Noord-Limburg, especially in the logistics hotspot Venlo or Venray which is close to the German border. In addition, the finding draws that, the polarisation of distribution centres in these peripheral regions can be explained by relatively low land prices of 40 Euro/m² compared to other provinces such as Rotterdam where land is expensive.

More recent studies on the spatial patterns of warehousing facilities study the concentration and dispersion of warehousing facilities. Kang (2020a) examined the geographical distribution of warehouses in Los Angeles, CA, Combined Statistical Areas by analysing the underlying locational factors responsible for the dispersion of warehouses from inner urban areas to the peripheral areas. Regarding the spatial distribution of warehouses in Los Angeles, the study found the clustering of large-scale distribution centres in a small area of urban outskirts (Kang 2020a:9). Another, important study by Kang (2020b) compares the rate of decentralisation/ dispersion of warehousing facilities in 48 cities across the US between 2003 and 2013. The study found that high land prices, push logistics intensive businesses such as large warehouses from the central location to the peripheral areas and the rate of dispersal was even more in large metropolitan areas as compared to the small ones. Additionally, large warehouse shifted from their locations to peripheral areas in Los Angeles, Chicago, and Washington DC (Kang, 2020b).

Additionally, Jaller et al. (2017) analysed the geographic distribution of warehouses and distribution centres in five counties in Southern California (SCAG region) between 1998 and 2007. The study establishes a sprawling pattern of warehouse and logistics facilities wherein, the dual effects of sprawl and polarisation patterns of logistics facilities were observed. To this end, a high concentration of warehouse and distribution centres were found around the port of Los Angeles and Port of Long Beach, and this could be attributed to the accessibility offered by ports.

A few studies explicitly focus on the sprawling patterns of other typologies of warehousing facilities such as cross-dock terminals (Dablanc & Rakotanarivo, 2010; Robichet & Nierat, 2021). Dablanc and Rakotonarivo (2010) investigated the impacts of the increased growth of cross-dock terminals in the Paris region (the “Ile-de-France”). The study uncovered the spatial shift in the location of 90 cross-dock terminals in the Paris region between the period 1974 and 2008, wherein terminals (cross-dock facilities) were increasingly located in the greater metropolitan area which constitutes the outer suburbs of the Ille De France region. Based on the centrographic analysis method, the study further uncovers that the cross-dock terminals serving the parcel and express companies shifted from their location at an average distance of

6 miles from the centre of Paris during the period 1974 and 2008 (Dablanc and Rakotonarivo, 2010). The study also focuses on the negative impacts presented by the CO2 emissions from trucking activities. However, Robichet and Nierat (2021) conducted a study focusing on the spatial organisation of cross-dock terminals for parcel service companies in Paris. The study examined the relevance of locating five terminals of DB Schenker which is the second-largest parcel and distribution company located on the outskirts of Paris. The study found that cross-dock terminals are spatially organised in a polycentric manner, where each terminal serviced its territory around Paris. Additionally, the study further acknowledges that due to pick-ups and delivery activities at the terminals, the terminals are located outside Paris (Robichet & Nierat, 2021).

Contrary to the aforementioned discussion a recent study by Huang et al. (2023) employed several spatial analysis techniques (i.e., kernel density analysis, spatial autocorrelation analysis, and correlation coefficient analysis) to examine how warehouse supermarkets evolved regarding their spatial characteristics in Liaoning province in China. Warehouse supermarkets refer to a type of grocery store within the supermarket industry wherein the shopping environment is mostly located in a warehouse and goods are sold in bulk and at discounted prices (Huang et al., 2023). The study discovered an uneven spatial distribution pattern and areas of high nuclear density of warehouse supermarkets distributed along the Shenyang-Dalian line (Huang et al., 2023:1). Therefore, there is a limited number of studies that explicitly address the spatial patterns of different typologies of warehouses, since several existing studies examine the spatial distribution of patterns of general warehousing facilities.

Furthermore, several studies analysed the dispersion and polarisation patterns of general warehousing facilities without referring to the typologies of warehouses (Allen et al., 2012; Dubie et al.,2020; Woudsma et al., 2016). Dubie et al. (2020) examined logistics sprawl in Chicago and Phoenix wherein a kernel density estimation revealed the highest concentration of warehouse facilities in Central Cook, Southern Cook, North-east Dupage, and Will County in the United States of America. A study by Allen et al. (2012) found an increased growth of warehousing facilities in the peripheral areas across 14 UK cities. The study found a high density of warehousing facilities in West Midlands, South Yorkshire, Keynes, and York and this is attributed to good accessibility offered by motorways.

Woudsma, Jakubicek, and Dablanc (2016) carried out a study in Canada, focusing on logistics sprawl in the Greater Toronto Area (GTA), which comprises Toronto and satellite areas, and the Greater Golden Horseshoe Area (GGH), which comprises the Greenbelt and other satellite areas located outside of the Greenbelt. The study compared the spatial deconcentration of logistics firms and other businesses between 2002 and 2012. Additionally, the study found that the average distance to centre for warehousing in GTA increased by 7,5%, whereas the average distance to centre for warehousing in GGH increased by 32,1% (Woudsma, Jakubicek & Dablanc, 2016). In this regard, the study concludes that the GTA experienced negligible sprawl of warehouses as compared to the GGH, which experienced a significant rate of warehousing sprawl, and this could be attributed to the greenbelt which attracted warehousing facilities at the boundary of GTA. However, the study did not explicitly specify the type of the warehouses that sprawled more as compared to others, rather the study focused on the sprawling patterns of warehouses within GTA and GGH.

Table 2: A summary of the literature on the spatial distribution of warehousing typologies

AUTHOR	YEAR	CONTEXT	MAIN FINDINGS
Allen et al.	2012	UK	Growth of warehouse facilities in the peripheral areas across 14 UK cities.
De ligt & Wever,	1998	Netherlands	Concentration of European distribution centres around port of Rotterdam
Dablanc and Heitz,	2015	France	Cluster of warehouses around the Antwerp/Rotterdam and Eastern Europe logistics route
Dablanc and Rakotonarivo	2010	Paris	Dispersion patterns of cross-dock facilities at an average distance of 6 miles from the centre of Paris.
Cidell	2010	US	Suburban location of distribution centres in Midwest, Pacific Northwest, and Piedmont
Dablanc and Ross	2012	US	High concentration of large DC in Henry County due to accessibility offered by Interstate 75 Polarisation of warehouse and distribution centres in Piedmont Atlantic Megaregion
Dubie et al.	2020	Chicago and Phoenix	Focuses on the sprawl of logistics facilities from 1998-2013& 1998-2015
Ferrari et al.	2006	Southern Europe	Concentration of EDC around Southern European ports
Fisher-Holloway and Mokhele	2023	South Africa	High clustering of warehouse facilities in Cape Town municipality. Warehouses located in the vicinity of major transport routes, Cape Town International Airport and Port of Cape Town.
Guerin et al.	2021	Brazil	Clusters of warehouse facilities in Osasco, Santana de Parnaiba, Jandira due to accessibility offered by Guarulhos International airport
Hesse	2004	Germany	High concentration of warehouse and distribution centres located in Berlin Brandenburg
Heitz and Dablanc	2015	France	Concentration of warehouse close to Roissy CDG airport and Orly Rungis in Southern Paris.

Tchang	2016	Netherlands	High concentration of DC near highways
Strale	2020	Belgium	Concentration of warehouse and DC around the Brussels-Antwerp Axle logistics node and seaport
McKinnon	2009	UK	Clustering of DC in Magna Park near Lutterworth and around disused military airfield in West Midlands
Fernie and McKinnon	1991	UK	Clustered pattern of DC along motorway access e.g., M1, M6
Notteboom & Rodrigue	2022	Netherlands	Large warehouses located in close proximity to container terminals
Onstein	2015	Netherlands	Dual pattern of logistics sprawl and polarisation of distribution centres in peripheral regions in Noord-Limburg.
Oliveira et al	2018	Brazil	Insignificant rate of logistics sprawl for a 20-year period (1995-2015)
Oliveira et al	2022	Brazil	Concentration of warehouse facilities close to major intersection
Kang	2020a	Los Angeles	Clustering of large distribution centre in Inland Empire, Ontario, San Bernadino
Kang	2020b	US	Dispersion of warehouse from the CBD to peripheral areas in Los Angeles, Chicago, and Washington DC etc.
Kovida et al.	2019	Tokyo Japan	High concentration of fulfilment centres was located on the eastern side of Tokyo.
Kurkan	2014	US	Concentrated pattern of warehousing in the urban core areas of Baltimore.
De Silva et al.	2020	Japan and UK	Fulfilment centres were concentrated around 40-50km radius of Tokyo-centralised urban form of Japan. In UK Amazon fulfilment centres were concentrated in the corridor between North-West London to Manchester.
Rodrigue	2020b	US	Fulfilment clusters in two metropolitan regions, i.e., Los Angeles and New York
Li et al.	2020	China	Clusters and polarisation of cold storage warehouses in Southern China.
Zhang and Hou	2022	China	Agglomerations of cold storage warehouses in BJE city.
Zhang et al.	2017	China	Concentration of commodity delivery warehouses located in the economic zones along the Yangtze River
Robichet and Nierat	2021	France	Cross-dock facilities are spatially organised in a polycentric manner
Woudsma et al.	2016	Canada	Insignificant rate sprawl of warehousing facilities in Greater Toronto Area
Warffemius et al.	2010	Netherlands	Amsterdam Airport Schiphol emerged as a cluster of EDCS because of agglomeration effects
Huang et al	2023	China	Ueven spatial pattern of warehouse supermarkets, high nucler density along henyang-Dalian line

Source: Author

2.4 FACTORS THAT INFLUENCE THE SPATIAL PATTERN OF WAREHOUSE TYPOLOGIES

This section presents an overview of the factors that influence the locational patterns of warehousing typologies. The analysed factors include agglomeration effect; accessibility to air, road, rail, and maritime; spatial planning policy; market accessibility, land prices, population density, and labour costs.

2.4.1 AGGLOMERATION EFFECTS

Various studies investigate the role of agglomeration economies in the location of logistics and warehousing facilities in different metropolitan areas around the globe (Masson & Pettiot, 2014; Hylton & Ross, 2018; Van Den Heuvel et al., 2012). However, few studies in the literature explicitly investigate the influence of agglomeration economies in the locational patterns of warehouse typologies (Warffemius, 2007; Warfffemius et al., 2008).

According to Parr (2002:718) agglomeration economies are described "as cost savings to the firm which result from the concentration of production at a given location, either on the part of the individual firm or by firms in general". Warffemius et al. (2010) notes that the interaction of interaction of firms located within the same space is essentially characterised by externalities, namely linkages, knowledge spillover, shared local markets, and shared common infrastructure (Warffemius et al, 2010). In this regard, agglomeration economies relate to the benefits that accrue to firms and individuals as a result of being located in close proximity to each other. These benefits can include knowledge spillovers and access to a skilled labour pool among others.

Agglomeration economies are broadly divided into two components: localisation economies and urbanisation economies (Hylton & Ross, 2018; Masson & Petiot, 2015; van den Heuvel, et al., 2012). Localisation economies emanate from the presence of firms that belong to the same industry within the same geographic space (Masson & Petiot, 2015). It is, therefore, argued that these types of agglomeration are referred to as intersectoral agglomerations, wherein firms benefit from being located close to one another. As such, co-located firms enjoy benefits such as sharing of infrastructure and public goods, access to a specialised pool of labour, and access to larger markets (Masson & Petiot, 2015). While urbanisation economies are described as benefits/ economies external to the firm to which it belongs. It occurs where there is a concentration of firms from different sectors in the same location and the intersectoral benefits include technology transfer (ibid.).

Warffemius et al. (2010) found that agglomeration effects, including accessibility to air transport and proximity to major highways, played a leading role in the spatial clustering of

EDCs around Amsterdam Schiphol Airport. Also, the results indicated that 40% of the EDCs concentrated around Amsterdam-Schiphol Airport are essentially non-airport dependent, though the airport posed important factors such as location endowments, the findings suggest that a high concentration of EDCs around the airport is attributed to the presence of agglomeration economies.

A more recent study by Zhang and Hou (2022) focusing on the spatial-temporal agglomeration effects in the distribution of cold chains in BJE city in China for a period between 2010 and 2019, found no evidence of agglomeration of cold storage facilities in BJE city in 2010, followed by a gradual formation of the agglomeration area of cold storage facilities close to the junction of the southwest CY District and DC district of the BJE city. Between the period 2014 and 2016, the study established a single-center agglomeration around the CY region. Additionally, during the period 2017 to 2018, it is reported that the agglomeration of cold storage facilities expanded to other areas, and lastly, in 2019, the southwest region of CY District became the largest concentration of cold chain logistics facilities in BJE city. In this regard, it has been concluded that agglomeration areas of cold chain logistics facilities in BJE city evolved from a single center to a multi-centre wherein cold storage facilities were spatially distributed to different locations within the urban area. It is, therefore, important to note that agglomeration effects play a crucial role in the spatial distribution of logistics facilities since the findings suggest that cold storage facilities in BJE city were increasingly attracted to suburbanised areas.

2.4.2 ACCESSIBILITY

The sub-section discusses the role played by different facets of accessibility in the location of warehouse and logistics facilities. The nuance of accessibility entails proximity to airports, ports, highways/intersections, and railways. Several researchers have extensively studied the role played by accessibility in the geographical location of various warehousing typologies. The previous studies on the location factors of warehousing facilities argue that accessibility considers the ability to reach the warehouse by considering the present infrastructure and the available transport modes (Hilmola & Lorentz, 2011; de Oliveira et al., 2022). It is, therefore, important to note that several studies widely acknowledge accessibility as the dominant factor that plays a crucial role in the spatial distribution of warehouse facilities. Oliveira et al. (2018) in the study of logistics sprawl in Belo Horizonte Metropolitan area, among other factors analysed the locations of a warehouses relative to transport infrastructure (i.e., road and rail).

Utilising buffer analysis, the study measured the Euclidean distance of warehouses in relation to road and rail infrastructure. The study established a positive correlation between warehouse location and road infrastructure wherein the study found a slight increase in the number of warehouses located proximate to road infrastructure, for instance the study argues that in 1995, 91% of the warehouse facilities were situated within 2 km buffer from the road axis, while in 2015 the percentage of warehouses located within the 2 km buffer from the road axis increased to 93% (Oliveira et al., 2018:8).

In a similar study by Oliveira et al. (2022) focusing on factors that influence the location of warehouse facilities in Belo Horizonte Metropolitan area, among other factors, the study found that accessibility and land cost plays a huge role in the spatial distribution of warehouse facilities. The study used descriptive statistics methods in the ranking of warehousing influencing factors based on decision-makers' views. In addition, the study established a positive correlation between accessibility for delivering trucks and accessibility of freight vehicles for loading (Oliveira et al., 2022). It is worth noting that the aforementioned studies focus mainly on analysing the locational choice of general warehouse facilities rather than focusing on different typologies of warehouses.

Focusing on the USA, Bowen (2008) explored the four dimensions of accessibility, namely highway, maritime, air, and rail in the distribution of warehouses and distribution centres across the US. The findings uncovered a proliferation of large warehouse facilities in peripheral areas due to good accessibility offered by both air and highway proximity. To this end, air and highway accessibility emerged as the leading factors responsible for the increasing dispersion of warehouses and distribution in the suburban and exurban areas across the US since accessibility to both air and highway significantly reduces logistics costs. Similarly, focusing on the Netherlands, Tchang (2016) investigated the influence of highway proximity on the spatial distribution of DCs and the findings indicated a high concentration of DCs close to highway infrastructure. Moreover, most logistics companies were willing to pay high rents in areas with good highway accessibility (ibid). Also, Hesse (2004) uncovered a high concentration of DC along multi-modal transport infrastructure in the Berlin Brandenburg area.

Additionally, regarding highway accessibility, there is a significant number of studies that investigated the importance of accessibility to motorway junctions in the spatial distribution of warehousing (Durmuş & Turk, 2014a; Greenhalgh et al., 2021; Li et al., 2020; Huang et al., 2023; Oliveira et al., 2018; Pretorius et al., 2021). Durmus and Turk (2014) investigated the factors that affect warehouse location at an intra-urban level, focusing on Istanbul metropolitan area, and found that the location of the warehouse is sensitive to all transport nodes. Among other factors, the study found that transport accessibility plays a crucial role in the location of warehousing facilities. The study found that Istanbul is connected by two major axes, the TEM (E80) and E5 (D500) highways, which are primary drivers for warehouse facility concentration. The study concludes that location-specific factors play a crucial role in warehouse location, as such warehouse location follows certain economic rationality.

Greenhalgh et al. (2021) analysed the spatial distribution of large distribution warehouses in England and Wales and established the emergence of new warehouses located in areas with high level multi modal connectivity. The study uncovered a new pattern in the location of the large distribution warehouse, wherein the warehouses shifted their location from the previously known cluster of Golden Triangle of large distribution warehouses in the Midlands to Golden Pointer. Also, the study further acknowledges the emergence of the large distribution warehouse in Golden Dumbbell in Northern England. It is therefore important to note that, the study found large distribution warehouses concentrated in Midlands, due to the existence of motorway corridors. For instance, a large distribution warehouse extends further southeast along the MI corridor towards London. The study also established the growth of large distribution warehouses in the Golden Dumbbell area in Northern England along the M1, and A1 at Peterborough and London, and Bristol (Greenhalg et al., 2021:407). Li et al. (2020) analysed the spatial distribution patterns of cold storage facilities in the Bohai Rim region in China and found that areas with high road density plays a vital role in the location of cold storage facilities by improving the convenience of the transportation of fresh food products. Additionally, Huang et al. (2023) in the study of spatial temporary evolution and the factors influencing the location of warehouse supermarkets in Liaoning province in China, found a correlation between traffic location conditions and warehouses supermarkets. According to the study, warehouse supermarkets rely on the effectiveness of logistics and transportation (ibid.). It is, therefore, important to note that based on the above, the study uncovered in Liaoning province, most warehouse supermarkets were located in close proximity to highway intersections. The study present Dalian Aiyite warehouse supermarket located close to Shen Hai Expressway in Liaoning province as a specific example (Huang et al.,2023:13). In light of the previously discussed literature, (Pretorius et al., 2021) focusing on Southern African context, analysed the location of warehouse facilities relative to accessibility. Regarding the local context in relation to warehouse location, the study asserts that warehouse facilities must be easily accessible either from local or regional road networks without adversely affecting the local traffic, as such resulting in significantly lowering transport costs as well as serving a huge threshold market (Pretorius et al., 2021:77).

Furthermore, regarding air accessibility, several scholars examined the importance of air accessibility in the spatial distribution of warehouse typologies (Gingerich & Maoh, 2019; Heitz, Dablanc, et al., 2017; Durmuş & Turk, 2014b; Kang, 2020b; Mokhele, 2022; McKinnon, 2009). McKinnon (2009) found a huge concentration of DCs around Fredly, a disused military airfield in West Midlands. Focusing on airfreight-related literature Mokhele (2022) examines the effects of airport propinquity/proximity relative to the location of logistics facilities. Among other findings, the study discovered airport accessibility plays an essential role in providing airfreight services to warehouse facilities. Additionally, Mokhele (2022:8) argues that 72% of the literature reports on the concentration of logistics facilities, such as airfreight facilities inclined to warehouse. A recent study by Mokhele, and Mokhele (2023), focusing on the location of logistics facilities relative to the Cape Town International Airport (CTIA), found that the airport does not directly influence the location of logistics facilities. The study found a paltry number of logistics facilities do not locate directly close to the airport, rather logistics facilities were located in the 20km radius of the airport. In addition, the study also found that among sixteen logistics facilities that rely on CTIA, four warehouses rely on the airport for airfreight, that is receiving and shipping of freight through the airport (Mokhele & Mokhele, 2023:16).

Furthermore, a study by Durmus, and Turk (2014) focusing on Europe identified several factors influencing the placement of warehouses at the intra-urban scale. Among other factors, the study identified a relatively limited number of warehouse facilities near Ataturk Airport in Turkey, and this was primarily attributed to the high land prices in the airport's vicinity. Heitz et al. (2017) further cement the aforementioned argument wherein a high concentration of logistics facilities was observed around Amsterdam-Schiphol Airport largely because of its excellent air accessibility. Focusing on Toronto, Gingerich, and Maoh (2019) uncovered that both access to Pearson International Airport and highway infrastructure play a pivotal role in the location of warehouse facilities in Toronto, where it is argued that warehouses located in the vicinity of the airport benefit from the goods transported by air. As a result, the study uncovered a large concentration of warehouse facilities within the 7 km buffer of the Pearson

International Airport as compared to the other warehouses in Toronto Gingerich and Maoh (2019: 105). Kang(2020b) explores the outward migration of warehouse facilities from the core urban areas to the peripheral areas in Los Angeles, CA, using the discrete choice model wherein the study uncovered the burgeoning of large warehouse facilities in the peripheral areas due to airport and intermodal terminal access. To this end, it is interesting to note that most of the aforementioned studies focus on the spatial patterns of warehousing facilities in general without pointing to other typologies of the warehousing facilities.

A significant number of scholars focus on the role played by port accessibility in the spatial distribution of logistics facilities, and in this regard, several warehouse clusters were observed around ports in different countries around the globe. Heitz et al. (2017) found that maritime accessibility offered by Port Rotterdam plays a fundamental role in the concentration of warehouse facilities in Randstad. A similar study on the spatial distribution of EDC in the Netherlands demonstrates that the country has a higher density of EDC as compared to other European countries, due to the existence of Port Rotterdam-the largest seaport in Europe serving both Asian and European markets (Ferrari et al., 2006).Heitz et al. (2020) focused on the decentralisation pattern of logistics activities in Gothenburg, a southern port in Sweden uncovered the clustering of warehouse facilities around the port of Gothenburg due to the provision of affordable warehouse facilities within the port and its surroundings. In light of the previous studies, Kang (2020a), employed a multinominal logit model to determine the locational choice determinants of warehouse facilities in Los Angeles, and found that local market travel time and seaport access play a pivotal role as two locational choices for warehouses that were built between 1981 and 2016. Focusing on the literature that explicitly discusses the trends on the geographical patterns of logistics facilities in the Global south, specifically, South Africa, there has been few studies that focuses on spatial distribution of logistics facilities in Cape Town (Fisher-Holloway &Mokhele, 2023). According to the afore-cited study that examined the geographical patterns of warehousing facilities in the Cape Functional region, which include the city of Cape Town municipality, Stellenbosch municipality, and Drankestein municipality, established the concentration of warehouse facilities in the vicinity of the Port of Cape Town, industrial nodes, and proximate to national roads (i.e. N1 and N2). However, the study did not explicitly focus on different types of warehouse facilities.

Furthermore, a number of studies demonstrate the role played by the rail infrastructure in the location of warehouse facilities (Bowen, 2008; Olivera et al. 2018; Gingerich and Maoh, 2019; Pretorius et al., 2021). Oliveira et al. (2018:8) analysed the spatial dispersion of warehouse facilities in Belo Horizonte from 1995 to 2015 and found a positive correlation between warehouse location and rail infrastructure. In this regard, the findings from the buffer analysis indicate that in the year 1995, 100% of the warehouses were situated within the 5 km buffer from the rail infrastructure, compared to the findings of the year 2015, where 93% of warehouses were located within 5 km buffer from the railway infrastructure. As discussed by the afore-cited findings, the incline of warehouse facilities along rail infrastructure implies a significant role played by rail in lowering transport costs. However, a different study by Gingerich and Maoh (2019) hinged on developing a location choice model to determine warehouse location factors in Toronto and Ontario, corroborated the findings from the previously mentioned study. According to the study, based on the primary data on the warehouse location choice model obtained from InfoCanada in 2015, a noticeable number of warehouses situated close to railway yards was identified. Moreover, there is a considerable number of studies uncover an insignificant role played by rail infrastructure in the location of warehouses (Bowen, 2008; Jakubiciek and Woudsma, 2011). Bowen (2008) among all measures of accessibility, namely air accessibility, road accessibility, and maritime accessibility, the findings reviewed that rail accessibility played an insignificant role in the location of warehouse facilities. in regards, to the South African context, Pretorious et al. (2021:77) posit that railway accessibility is an important factor worth considering when looking at the factors that affect warehouse location at a local scale, though to a limited extent in South Africa because of the dilapidated rail infrastructure. However, it is further noted that, based on the National Infrastructure Plan, there are measures in place regarding the upgrading of both local, national and cross border railway line in order to cater for the growing demand for heavy freight transport (Pretorius et al., 2021:77).

2.4.3 LAND PRICE

Land costs are among the most influential factors that affect the distribution of warehouse and logistics facilities. The evidence from the literature suggests that the existing studies on logistics and warehousing conducted extensive research on factors that influence the location choice of logistics facilities (Verhetsel et al., 2015; He et al., 2018b; Yang et al., 2022b; Li et al., 2020). The findings from the existing studies suggest that there is a correlation between the land price and land size that influences the location choice of warehouse facilities. The size of warehouses, therefore, tends to increase as land prices decrease, and vice versa, which in turn affects the spatial distribution of warehouses. Against this backdrop, several studies argue that the suburban location of distribution centres and warehouses in the peripheral areas is attributed to the availability of cheap land as compared to the city centres (Cidell, 2011; Jakubicek & Woudsma, 2011; Woudsma & Jakubicek, 2020). According to a study by Jakubicek and Woudsma (2011), the findings of the study reviewed that high land costs among other factors contribute substantially to the sprawling pattern of logistics facilities in the Greater Toronto Area (GTA), Canada. A similar study by Woudsma et al. (2016) established that the decentralised pattern of warehouses in GTA is attributed to the high commercial rents levied on logistics facilities. A recent study by Yang et al. (2022b) argues that due to the limited land availability in urban core areas, logistics facilities moved from the core areas to the peripheral areas where there are large parcels of cheap urban land. The study further concluded that the increased demand for huge parcels of land at a low-cost price per unit area is the major force in the distribution of logistics facilities in Shanghai.

The literature acknowledges that land rent plays an important role in the location choice of logistics facilities. An empirical study by Verhetsel et al. (2015) focusing on the location choice of logistics facilities in Flanders argues that land rent plays the most influential role in the location choice of logistics facilities followed by accessibility to ports, motorway junctions, and location in the business park. The study further noted that despite the Flanders region having high land rent, it provides an attractive location for logistics facilities largely because of its large urban density. As such, most logistics companies are willing to pay high rents as a result of the attractiveness and good accessibility of Flanders.

Drawing on the finding from the aforementioned studies, it can be noted that there is a limited number of studies that focuses on the influence of land prices on the location of warehouse typologies since the majority of the studies examined the influence of land prices in the location choice of general logistics facilities. However, a recent study based on the Chinese context by Li et al. (2020) explored the influence of land prices in the spatial distribution of cold storage facilities. In this regard, the study brought to the fore an interesting dilemma wherein cold storage facilities were increasingly attracted to areas with high land prices. The study found the concentration of distribution centres in developed areas, wherein land prices were relatively high and the cold storage firms enjoys preferential policies.

2.4.4 ZONING

Land-use regulations such as zoning play an influential role in the spatial distribution of warehousing facilities in urban areas. Zoning has been described as a form of regulatory tool for development control (Bäing & Webb, 2020). Zoning regulates the following aspects of the built form such as: function, (the use), shape/building height (how tall), and the bulk (density) (Bäing & Webb, 2020). Regarding zoning, it is with noting that the literature highlights different studies across the globe that examines the correlation between zoning regulation and the placement of logistics facilities in different metropolitan areas across the globe (Aljohani & Thompson, 2016; He et al., 2018; Sakai et al., 2020; Sivitanidou, 1996; Yang et al., 2022; Nefs & Daamen, 2022**).** Sakai et al. (2020) argue that among other factors zoning and traditional clusters plays a significant role in the location of new logistics facilities, and it is used as a tool to control the sprawling logistics activities in the Paris region. Additionally, the study established that the introduction of economic activity zones and logistics zones as areas designated to house logistics-related facilities and manufacturing firms near major road transport nodes play an essential role in combating the haphazard development of warehouses and other logistics facilities on undesignated urban land (Sakai et al., 2020).

Similarly, in a previously related study, Sakai et al. (2016) developed location choice models and tested the impacts of zoning on the spatial distribution and transportation efficiency of urban logistics facilities in the Tokyo metropolitan area. The scholars carried out different simulations to evaluate the impacts of zoning scenarios. Based on the empirical results of the study, it is argued that most of the logistics facilities are located in areas designated as Quasi-Industrial Zone (QIZ), and well residential and commercial zones. It is important to note that the findings of the study revealed that smaller logistics facilities were in various zoning categories, whereas zoning regulations were more influential on the location of large logistics facilities. In light of the previously mentioned study, existing studies on multi criteria decision making on warehouse location employed the choquet integral model and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) to examine a diverse range of factors that influence warehouse selection process (Demirel et al., 2010; Ocampo et al., 2020). Based on the Choquet Integral, Demirel et al. (2010) classify zoning and construction plans as macro-environmental factors that must be considered during the warehouse location selection process. (Demirel et al., 2010: 3949). In a similar study by Ocampo et al. (2020) based on the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), wherein among other, zoning and construction plan criterion determines warehouse location decision. Moreover, based on the study zoning and construction plans looks at the different development plans, its implementation as well as the arrangements by the local administrative authorities to consider alternative location, regarding the location choice of warehouse facilities.

Contrarily, a recent study by Rai et al. (2022) focuses on proximity logistics (i.e., the development of logistics facilities in dense, mixed-use, and proximity to logistics facilities), argues that zoning regulations play a crucial role in the location of logistics facilities in urban areas. The study found that the New York City Department of City Planning (NYCDCP) passed a resolution that divided the city into the following three important zones, namely residential, commercial, and manufacturing. As a result of the zoning categories, the study found that warehouses are permitted as of right in areas that are zoned manufacturing (M1, M2, and M3) and in only one type of commercial zone commonly known as C8 9 (Rai et al., 2022:47). However, zoning regulations permit the development of warehousing facilities in the aforementioned zones, the main problem lies on the fact that the zoning ordinances of New York City do not exactly specify a specific type of warehouses to be located in a certain zone.

A seminal study by Sivitanidou (1996) investigated key factors driving the location of warehouse and distribution facilities in Los Angeles California, and established that restrictive land-use regulation tools such as zoning influence the locational choice of W&D facilities. Aljohani & Thompson (2016) in their study of the impacts of logistics sprawl in urban areas, argue that land use control through zoning influences the relocation of logistics facilities from inner core urban areas to peripheral areas. Yuan (2019) examines the locational choice of warehouse facilities in Los Angeles, California. The study found that land-use policies comprised of different elements, namely land availability, land parcel size, industrial connection, and industrial zoning played a pivotal role in the location choice of warehouses in Los Angeles, California (Yuan, 2019: 533). The study found that warehousing facilities are permitted in different zones, namely industrial zones, commercial manufacturing zones, limited manufacturing zones, freeway overlay zones, limited industrial zones, general industrial zones, light industrial zones, and community industrial zones. The zones permit the development of warehouses either as a permitted use, automatically permitted use, principal permitted use, or use subject to a conditional permit (Yuan, 2019: 534). However, it is important to note that because of zoning regulations, it becomes difficult to differentiate warehouses from industrial uses (Yuan, 2019:533).

2.4.5 ZONING AND LAND VALUES

A number of studies examined the correlation between zoning regulations and land prices in different areas across the globe (Pollakowski & Watchter 1990; Asabere, and Huffman (1991; Grooves and Halland (2002 Grimes & Liang, 2009; Vyn (2012). Vyn (2012) examines the effects of strict zoning regulations such as greenbelt and the price of land in the vicinity of the greenbelt in Ontario, Canada. The study uncovered that, as a result of the leapfrog effect, the farmland values near the Greenbelt increased value. Grimes and Liang (2009) examine the effects restrictive zoning regulations on land prices around the polycentric and coastal cities in Auckland. The study developed a model of all Auckland land values over a twelve-year period and found a significant zoning boundary effect on land prices (Grimes & Liang, 2009). Additionally, the study also found that land inside the metropolitan urban limit (MUL) is valued ten times more as compared to the land outside the boundary.

However, it is important to note that several studies examine the effects of zoning on residential property values. Pollakowski and Watchter (1990) conducted a study to examine the effects of land use regulations constraints such as zoning on housing property values. The study established that land use regulations raise housing and developed prices within a locality in Montgomery, Washington DC (Pollakowski & Watchter 1990). In addition, the scholars also found that land-use restrictions in adjacent areas significantly increases land prices (Pollakowski & Watchter 1990). Grooves and Halland (2002) conducted an empirical study on the effects of municipal zoning on land prices among the homeowners in Harris County, Texas. The study uncovered that zoning ordinances results in the redistribution of wealth between the existing homeowners. In addition, the study concludes that the zoning ordinances significantly led to the rise in the value of residential properties by protecting residential property from the negative externalities emanating from the neighbouring commercial properties (Grooves and Halland, 2002). As a result, the study found that properties used for residential purposes have high values as compared to properties that have high market potential. An empirical study by McDonald and McMillen (1998) found that the land use zoning system implemented by the city of Chicago in the 1920s did not have any significant contribution to the increase in land values. Contrarily, Asabere, and Huffman (1991) analysed the effects of zoning regulations on Industrial land prices in Philadelphia. The study employed a hedonic framework, wherein the findings of the study reviewed that lots zoned for industrial uses attracted a 58% price discount.

2.4.6 POLICY AND WAREHOUSE LOCATION

Several studies examine the influence of government policy in the location of logistics facilities and most them focuses on a wide range of policies that affect the location choice of logistics facilities such as employment creation/job-related policies, environmental regulation (pollution, noise, traffic congestion), incentive /tax exemption (sales tax incentives) (Raimbault et al., 2018; Yuan, 2019; Jones, 2022c; Demirel et al., 2010; Pretorius et al., 2021; Fisher-Holloway & Mokhele, 2022). Raimbault et al. (2018) argues that planning for logistics facilities is done at different scales, namely local scale widely referred to as urban logistics, and regional scale. As such, planning for logistics at the aforementioned scales is a public policy strategy that takes into account the social, economic, and environmental issues associated with logistics facilities (Raimbault et al., 2018:2).

Against this backdrop, Yuan (2019) examined the institutional factors that influence the location choice of warehouses in the Los Angeles region. The study analysed the implications of land-use regulation, environmental regulation, job-related policy, and financial incentives. Regarding the environmental regulation policy, the study examined the effects of warehouse facilities relative to the environment, wherein it is argued that warehousing facilities are the major generators of negative externalities such as traffic congestion and air pollution. Additionally, based on the views of planners from different municipalities in the Los Angeles region, the study found that planners from the city of Pico Rivera suggested introducing a truck restriction zone. In this regard, the aforementioned zone reduces the negative effects of warehouse-related truck movement (Yuan, 2019:540). Relatedly, Jones (2022:) found that at the local level, authorities expressed resentment on warehouse development based on environmental concerns, wherein it is argued that authorities perceive warehouses to be associated with a wide array of negative externalities such as noise pollution during the delivery and dispatch of goods, loss of visual amenity and pavement characteristics, loss of wildlife and habitats and destruction of green belt. In addition, the study further proffers the following solution to mitigate negative externalities associated with new warehouse development, namely planting of new trees and shrubs to provide screening to the lower level of buildings during the construction phase, and inorder to protect species and habitats the study advocate for extensive tree replacement (Ibid.). Considering the negative environmental effects associated with warehouse and logistics facilities, Aljohani and Thompson (2016) cited in (Kin et al., 2023) argued that based on a policy perspective, authorities placed stringent policies in order to prevent logistics facilities development as a result of negative externalities associated with logistics such as nuisance, safety issues and well as perceived limited economic benefits associated with warehousing.

Demirel et al. (2010) argue that warehouse location factors are influenced by a multiplicity of factors, and these could be quantitative and qualitative factors. In regard, to other criteria that are used to determine the location choice of warehouse facilities, government policy was broadly classified as macro-environmental factors. To this end, it is argued that government policy varies from one region to another, wherein the policies of the government entail a variety of factors, namely incentives, and tax exemptions among others (Demirel et al., 2010). Similarly, Yuan (2019) posits that financial incentives play a fundamental role in the location choice of warehouses. Drawing from the findings of the study, a comparison in tax rates between two cities namely Carson City and Compton City shows a positive relationship between tax rates and warehouse location. As a result, the findings from the afore-cited case study show that locating warehouse in Carson would be beneficial to the developers, largely because Carson has a lower sales tax, as well as utility user tax as compared to Compton (Yuan, 2019; 536). Pretorius et al. (2021) focus on the spatial perspectives of warehouse development in Southern Africa, particularly countries in the Southern Development Community (SADC), among other regional factors that influence the location of warehouse facilities, government decision plays a fundamental role in influencing the location choice of warehouse facilities. Therefore, government decisions include tax and incentives, wherein it is argued that incentives such as tax breaks for locating in a particular area may reduce, service delivery costs. In this regard, tax incentives play a fundamental role in providing attractive locations that have the potential to lure certain businesses to invest in a particular location (Pretorius et al.,2021:3).

Regarding job-related policies concerning warehousing, different studies assert that city planners and local authorities have mixed opinions, with some city planners expressing resentment whilst other local authorities were in favour of warehouse development as a source of employment creation (Jones, 2022; Yuan, 2019). According to Yuan (2019: 535) drawing from the opinions from the different views from the planners' view from the Inland Empire state cities, where planners expressed enthusiasm about warehouse-related jobs. It is therefore argued that planners expressed interest in support of warehousing development on the basis that warehouse facilities have the potential to attract a high calibre of skilled workers, resulting in high salaries. A recent study by Jones (2022), examined warehouse development policies at both national and local scales. Regarding local planning policies, the study found that despite an insignificant reference to a warehouse, local planning policies in the UK are in favour of warehouse development on the basis that warehouse facilities support economic growth as major employment generators, as such economic benefits derived from the warehouse are at the fore. In addition, it is argued that, despite making limited reference to the warehouse, national planning policies, such as the National Policy Planning Framework regarding Wales and Scotland ensure that local planning takes due cognisance of warehouse development by ensuring that economic growth is not stifled by inadequate land for warehousing (Jones, 2022). In support of the afore-cited study, (Andreoli et al., 2010) focusing on the Atlantic mega region argues that warehouses are major employment generators. The study uncovered that between 1998-2005, employment in the mega distribution. The findings show that between 1998-2005, employment in the mega distribution centres has an annual growth of 22.23% with a number of warehouse workers of about 595,325 in 2006 as compared to 119,493 people employed in a warehouse in 1998.

Moreover, national planning policies play a crucial role in the development of warehouse facilities in metropolitan regions noted that among other local factors that influence the location of warehouses, the spatial development framework policy (SDF) as a medium-term spatial planning framework has a bearing on future land-use development and areas prioritised for future development. To this end, SDFs significantly affect the placement of land-use activities that are related to warehousing. Mokhele and Fisher-Holloway (2022) carried out a study focusing on the inclusion of warehouses in the spatial plans in the Cape Functional region. Based on content analysis of the SDFs, the study found that the spatial planning frameworks did not explicitly make reference to warehouse and distribution activities. Similarly, Jones (2022), found that at the national level, despite the importance of warehouses in the UK, the National Planning Framework Policy makes little reference to warehousing.

On the contrary, some studies have shown that logistics facilities have been increasingly given attention as a policy agenda regarding logistics policies inclined towards, zero-emission, climate change, and mixed-use development, among others (Raimbault et al., 2018; Kin et al., 2023). Kin et al. (2023) focusing on the integration of logistics activities in planning by comparing two cities, namely Paris and Rotterdam noted that both in Paris and Rotterdam, authorities are striving to come up with urban logistics-related policies on the planning agenda. For instance, the study uncovered that in the City of Paris, regarding the climate action plans, the city proposes to extend zero-emission zones outside Paris, aimed at phasing out all dieselpowered mobility by 2024. Additionally, with regards to sustainability, the city introduced urban land use policies such as the introduction of logistics hotels which promote mixed land use developments, such as retail, office, housing, and entertainment close to logistics activities, inorder to combat sprawl (Kin et al., 2023:8). Regarding the city of Rotterdam, the study uncovered similar policy initiatives same as introduced in the city of Paris, wherein it is argued that urban logistics was given priority on Dutch climate policy agenda (Kin et al., 2023). In the context of Rotterdam, regarding climate action policies and urban logistics land uses, the city proposes zero-emission zones to be introduced at a national scale aimed at reducing carbon dioxide (CO_2) emissions due to the introduction of electric vehicles. However, it is further noted that electric vehicles are the chief source of public nuisance and safety issues in Rotterdam. Moreover, the findings of the study further maintain that, as a result of the urban structure of the city of Rotterdam, wherein the city is surrounded by green belt, the city strives to develop policies for logistics facilities that enable consolidation (Kin et al., 2023:11). In this regard, it is worth noting that consolidation centers limit the number of freight traffic passing through the city, resulting in the reduced negative externalities such as traffic congestion, noise pollution and safety concerns.

Similarly, in support of the afore-cited discussion, an earlier study by Raimbault et al. (2018) examined urban planning policies for logistics facilities in Paris and Atlanta and found that urban logistics issues are increasingly prioritised on urban planning agenda at the local, regional, and national level. Regarding, freight-related policies at the national level, the study noted that in 1996, two national acts mandated French metropolitan areas, such as the Paris region (ille de France), to consider the transportation of goods and deliveries when drawing up urban transport plans (known as PDU). According to the study at the regional level, the master plan for the Ile-de-France region (SDRIF) which is a long-term plan guiding future development, regarding different land uses, such as residential, economic activities, and infrastructure development, introduced the zones known as the Freight Villages (FV) which exclusively designated for logistics development. More importantly, the master plan identifies sites that should be set aside for intermodal facilities development, such as rail and ports for future use (Raimbault et al., 2018:6). To this end, it is argued that FV played a pivotal role, as environmental issues are concerned by limiting negative externalities associated with logistics facilities as well as combating logistics sprawl (ibid.).

Moreover, in the context of Atlanta, Raimbault et al. (2018) found that freight-related policies played a pivotal role in combating negative externalities associated with freight transport, wherein the study argues the city of Atlanta addressed the freight logistics-related issues at a regional level, wherein the metropolitan region introduced land use and community impact issues during the preparation of its regional freight plan and strategy as early as in the 2000s (Raimbault et al., 2018:4). It is, therefore, important to argue that as a result of the increased demand for logistic related activities in metropolitan areas, logistics related policies have become a priority in urban planning policies ranging from economic issues, social issue, as well as environmental issues.

2.4.7 MARKET ACCESSIBILITY

Different studies investigated the locational determinants of warehouse and logistics facilities relative to market accessibility and it has been observed that access to both local and regional markets play an influential role in the locational patterns of warehouse facilities. Andreoli et al. (2010) investigated the role of both micro and macroeconomic forces in the distribution of mega DC in the US and uncovered that accessibility to regional markets led to the proliferation of Mega DC in the US since the facilities had a capacity of holding large inventory within the same location. Also, Sivitanidou, (1996) and Kang, (2020b) in their separate studies on the locational factors behind the distribution of warehouses in the US, mentioned market accessibility as an important factor in the location of warehouse facilities.

Demirel et al. (2010) employed the Choquet integral model determine the warehouse location choice factors. Therefore, among other factors, the study discusses the market as a factor that should be taken into consideration. In this regard, the study described the market as the criterion that establishes the distance between the warehouse location to the suppliers, customers, and producers (Demirel et al.,2010:3948). In addition, the study asserts that the market criterion entails the supply duration as well as the ability to respond to an order. Moreover, it is therefore argued that market proximity entails the distance between warehouse location and customer needs. In the same vein, the study argues that proximity to suppliers and producers also entails the distance between the warehouse location and the suppliers and consumers respectively (ibid.). Therefore, it is worth noting that market proximity plays a fundamental role in either shortening or increasing the time taken by a warehouse to fulfil an order, as such some warehouses that explicitly deal with customer fulfilment (e-commerce warehouses) are located close to the customers.

2.4.8 POPULATION DENSITY

The existing literature acknowledges that population density plays a significant role in the location of logistics facilities around the globe (Li et al., 2020; Sakai et al., 2020; Yang et al., 2022; Yuan, 2018; Huang et al., 2023). Li et al. (2020) in examining spatial patterns and the influencing factors behind spatial distribution of cold storage in China, found that among other factors population density has a positive significant influence in the location of cold storage. Yang et al. (2022) examined the factors that influence the location choice of the general logistics facilities in Shanghai using a series of regression models found that among other factors population density plays a crucial role in the location of express-delivery logistics facility (EDLF). Additionally, the study revealed a shift in the location of logistics facilities to the areas with low population density which resulted in the decline of the quality of logistics services in urban centres. A more recent study by Huang et al. (2023) found that population quantity and density play an important role in the location choice of supermarket warehouses in Liaoning Province in China. The study revealed a positive correlation between supermarket warehouses and population density in Dalian and Shenyang, largely because large warehouse supermarkets rely on high population densities as well as the density of the residential areas (Huang et al., 2023).

Focusing on the American context, Yuan (2018) explored the location choice of the warehouse in low-income and medium-minority neighborhoods in Los Angeles. The findings of the study revealed that warehouse facilities were disproportionately distributed in both low-income and medium-income minority groups with a substantial number of warehouse facilities located in medium-income minority neighbourhoods. As such, the study further noted that warehouse distribution is highly related to the percentage of the minority population (Yuan, 2021:290). Similarly, Kang (2020a) employed the multinominal logit model to determine warehouse location choice factors in Los Angeles, found that population density have a negative correlation with the location choice of large warehouse facilities. However, the study also found that employment density influences the location of warehouse facilities, although employment density declined over time (Kang, 2020a; 9). Moreover, Yuan (2018) focusing on the environmental effects presented by the location of warehouse facilities in economically disadvantaged areas in California found a disproportionate distribution of warehouses in economically disadvantaged areas, Thus resulting in the disproportionately spatial distribution of warehouses in economically disadvantaged areas, as such economically underprivileged people bear the burden of negative externalities associated with warehouse development such as air pollution and traffic congestion (ibid.).

Oliveira et al. (2021) established a positive correlation between population density and warehouse location in Belo Horizonte, Brazil. Based on spatial bivariate autocorrelation analysis, the findings revealed a High-High cluster in Contagem and L-H cluster in Ibirité indicate a spatial autocorrelation between warehouse and population density in aforementioned areas (Oliveira et al.,2021:9). Additionally, the study asserts that as a result of high population density in Belo Horizonte, warehousing land for new warehouse facilities is scarce and the land cost is high.

2.4.9 LABOUR COSTS

Existing studies recognise the importance of labour in the location of logistics activities in different metropolitan areas across the globe (Demirel et al., 2010; Jakubicek & Woudsma, 2011; Sivitanidou, 1996, Li et al., 2020). The study by Jakubicek and Woudsma (2011) revealed the availability of a skilled labour force as a push factor that plays an influential role in the location of logistics facilities and the availability of the unskilled labour force as a retaining factor that plays a role in the location of logistics facilities. Sivitanidou (1996) noted that the blue-collar labour force plays a significant role in shaping the pricing patterns of warehouse and distribution facilities. However, Demirel et al. (2010) argue that different labour characteristics should be considered when selecting the location for warehouse facilities wherein the skilled labour force and availability of labour force are key important determinants for warehouse location. Kang (2020a) based on a multinomial logit model evaluated the locational trends of warehouses from 1951 -2016 in Greater Los Angeles and found a positive correlation between the availability of labour force and warehouse location, wherein the study argues that labour force has been a stable factor over time. Thus, areas with plenty of labour force offers attractive locations for warehouse location in Los Angeles.

Furthermore, Aljohani, and Thompson (2016), citing Van den Heuvel et al. (2013) argue that the sprawling of large logistics facilities in suburban areas is attributed to the availability of large labour pools in suburban areas, as some warehouse facilities are easily attracted to areas which offers high source of cheap labour. A previously mentioned study by Li et al. (2020) confirms that cold storage facilities located in densely populated areas significantly reduce the cost of labour search.

A recent study by Ontein et al. (2019:252) argues that labour costs play an influential role in the location of distribution centre wherein distribution centres are increasingly attracted in peripheral areas as a result of the availability of low labour costs which ultimately results in lowering warehousing costs. However, it has been argued that as a result of the rising trends in mechanisation and automation, there has been a significant decline in the demand for medium and low-skilled labour force in logistics facilities (Yang et al., 2022). Contrarily, Yuan, (2018) argues that the introduction of automated systems substantially reduces the labour costs in warehouse and distribution centres. In this regard, it is therefore argued that labour costs, play a fundamental role in the spatial distribution of warehouse facilities, since different areas depending on the level of economic growth presents different characteristics regarding labour costs, as well as the availability of labour force.

Table 3: A summary of the literature on the factors that influence the spatial patterns of warehousing typologies.

AUTHOR	YEAR	CONTEXT	MAIN FINDINGS
Aljohani & Thompson	2016	USA	Zoning
Andreoli et al.	2010	USA	Accessibility to regional markets
Bowen	2008	USA	Air and highway accessibility
Dablanc, Ogilvie and Goodchild	2014	GTA, Canada	High commercial rents
Demirel et al	2010	Europe	Quality and availability of labour force
Durmus and Turk	2014	Turkey	Highway, port, and air accessibility
Gingerich and Maoh	2019	Toronto	Access to Pearson Airport Highway accessibility, zoning
Greenhalgh et al.	2021	England and Wiles	Access to motorway highway
He et al.	2018	Europe	Land use planning policy
Hesse	2004	Germany	Land price, multimodal transport accessibility
Heitz et al.	2017	Paris and Randstad	Air and maritime accessibility, Land use policy
Heitz et al	2020	Gothenburg	Access to port, favourable consumer market,
Huang et al	2023	China	Population quantity and density
Jakibicek and Woudsma	2012	Greater Toronto Area	Land prices, highway proximity, access to customers
Jones	2022	UK	Land use planning policy
Kang	2020a	Los Angeles, CA	Market access, labour access, proximity to air, intermodal terminal access
Li et al.	2020	China	Population density
Nerfs and Daamen	2022	Netherlands	Land prices, planning policy
Mokhele	**2022**	Globally	Airport proximity
McKinnon	2009	UK	Access to air i.e., Fredley a disused military airfield
Oliveira et al.	2018	Brazil	Population density, infrastructure (i.e. road, rail)
Oliveira et al.	2021	Bazil	Population density, land cost and vehicle fleet
Onstein et al.	2015	Netherlands	Motorway access

Onstein et al.	2019	Netherlands	Labour, land costs, air, port, and highway accessibility
Li et al	2020	China	Access to high road density
Sakai et al.	2025	Tokyo	Zoning
Sakai et al.	2020	Paris	Zoning regulations, population density, access to autoroute
Sivitanidou R	1996	Los Angeles, CA	Market accessibility, labour, and zoning
Tchang G	2016	Netherlands	Highway accessibility
Verhetsel et al.	2015	Flanders	Land price, access to seaport, motorway, and business park
Waffemius	2007	Amsterdam Airport Schiphol	Agglomeration effects
Waffemius and Klasssen	2008	Netherlands	Airport accessibility- partial role Agglomeration effects
Warffemius et al.	2010	Amsterdam-Schiphol Airport	Economies of agglomeration Lock in logistics, location endowment
Woudsma and Jakubicek	2020	Canada	Land prices, local development policy, and transport linkage
Jakubicek and Woudsma	2011	Canada	Proximity to road, rail, port; low land costs, access to suppliers, access to labour
Jones	2022	UK	Planning policy
Warffemius, van den Hoorn & Klaassen,	2010	Netherlands	Agglomeration effects and highway accessibility
Yang et al.	2022	Shanghai, China	Market demand, land prices, traffic accessibility, land use policy; population density
Yuan	2018	Los Angeles	Population density
Yuan	2019	Los Angeles, Greater regionj	Institutional factors (land use policy, job related policy; financial incentive; environmental regulations)
Zhang and Hou	2022	China	Agglomeration effects

Source: Author

2.5 SYNTHESIS OF THE LITERATURE

The literature reviewed in this chapter outlines various typologies of warehousing facilities, the criteria used in their classification, the spatial patterns, and the key factors that influence the placement of warehousing typologies in both the Global North and Global South. The current section synthesises the literature and highlights the limitations and gaps.

There is sparse literature on warehouse typologies, as a result, the majority of the literature on warehouse typologies was drawn from the logistics literature and literature on warehousing management (da Costa Barros & Nascimento, 2021; Vreecke et al., 2008; De ligt & Wever, 1998; Onstein et al., 202; Rodrigue, 2020b; Notteboom & Rodrigue, 2022). The literature reviewed highlights that a few studies employed a size criterion to categorise/classify the typologies of warehouse facilities based on the surface area occupied by the building (area in m²) (Onstein et al., 2021; De ligt &Wever, 1998). Additionally, few studies categorise warehouse typologies based on attributes such as the functions of the building, geographic market extent, and level of specialisation (Noteboom and Rodrigu, 2022; Vereecke et al., 2098).

With regard to the spatial patterns of warehouse typologies, the majority of the studies focus on analysing the locational patterns of general warehousing facilities, and a few typologies such as distribution centres, and cross dock warehouses based on the global north experience (Allen et al.,2012; Dablanc & Heitz, 2015; Dablanc& Ross, 2010; Jaller et al., 2017; Kang, 2020b; Onstein et al., 2015; Strale, 2020). The literature found that the majority of the studies uncovered logistics sprawl as the dominant spatial pattern that is experienced by major cities in the global north. Contrarily, the limited literature focuses on the spatial pattern of warehouses in the global south, specifically Brazil (Oliveira et al., 2018; Oliveira et al.,2022), South African context (Fisher-Holloway& Mokhele, 2023) uncovered clusters of general warehouse facilities in proximity to major transport routes, airports and highway intersections. In this regard, it is worth commenting that the findings from the literature that focuses on spatial patterns based on the global north experience are not universally applicable to the economies in the third world, due to differences in context.

Furthermore, there is a limited number of studies that analyse the locational patterns of cold storage warehouses, and the few studies that exists are based on the Asian experience, specifically China (Li et al.,2020; Zhao et al., 2018; Zhang & Hou, 2022). Whereas few studies focusing on South African context did not explicitly focus on spatial pattern of warehouses, rather the studies conducted quantitative study to measure the intensity of carbon emission from the cold stores (Goedhals-Gerber et al., n.d., 2015; Goedhals-Gerber & Khumalo, 2020; Steynberg et al., 2022).

Regarding the factors that influence the location of warehouses, the majority of studies focus on the global north found that accessibility to road, rail, port and airport plays a crucial role in the location of warehouse facilities. Also, based on the studies focusing on global south experiences, accessibility to road, air and rail emerged as the dominant factors that influences the location choice of warehouse. However, focusing on South Africa few studies found that logistics facilities are attracted in the vicinity of Cape Town International Airport, not necessarily because of airport accessibility but due to other factors (Mokhele,2022). Also, it is important to note that the literature on factors that influence the location of warehouses in North America and Europe rely on secondary sources. As such the findings of literature from the

Global North may not explicitly address the location choice of warehouse and logistics facilities (in South Africa. Recently, few studies on the geographical patterns of warehouse and logistics facilities in the global south focuses on the factors that influence the general location of warehouse facilities without making explicit reference to nuanced typologies of warehouses (Fisher-Holloway & Mokhele, 2023). Moreover, the results from the literature review found that there is sparse literature that explicitly focus on the relationship between zoning and land values, which in turn have a bearing on the spatial distribution of logistics facilities, explicitly address the effect of zoning and land values in relation to the residential properties (Pollakowski & Watchter, 1990; Grooves & Halland, 2002).

2.6 SUMMARY

The chapter examined the different typologies of warehousing facilities as well as the criteria used in their classification across the globe. In regard, to the criteria that were used in the classification of warehousing facilities, the literature acknowledges a wide range of criteria and among them, the size criterion emerged as one of the most important criteria used to distinguish different types of warehousing facilities, since warehouse facilities vary according to the size depending on the nature of activities carried out in the warehouses. The chapter discussed the following typologies of warehouses: distribution centre; fulfilment centre as part of specialised distribution centres; cross-dock facility, and specialised warehouses that are made up of cold storage warehousing facilities. As such, the typologies of warehouse discussed performs the storage and distribution functions of goods and services. As discussed, the findings of the literature review established the different spatial patterns of logistics and warehouses typologies. The patterns include, dispersed, concentration, clustered and polarised. It is important to note that the chapter also discussed the factors that influence the spatial patterns of warehouse facilities around the globe, both in Global North and Global South. The next chapter discusses the theoretical framework to guide the analysis in the subsequent phases of the thesis.

CHAPTER 3: THEORETICAL FRAMEWORK

The previous chapter presented the literature on warehousing typologies, their spatial patterns, and the factors influencing the spatial distribution of warehousing facilities. The current chapter discusses the theories that can be used to analyse the spatial patterns and locational factors influencing the spatial patterns of warehousing facilities. The adoption of a theoretical framework in the analysis of the spatial distribution of warehousing facilities is premised on the argument that a theory is an analytical lens that can be used to conceptualise a particular phenomenon (Mokhele & Geyer, 2021). The chapter is structured as follows: Section 3.1 presents an overview of theories applied in logistics and warehousing. Section 3.2 discusses the application of other theories in logistics; 3.3 presents models related to logistics facilities and warehouse location; Section 3.4 synthesises the chapter; and Section 5 summarises the chapter.

3.1 OVERVIEW OF THEORIES UESD IN LOGISTICS AND WAREHOUSING

There is considerable literature that focuses on the spatial economic analysis of logistics and warehouse facilities globally. It is therefore important to note that before introducing various theories that were applied in logistics research, it is of vital importance to first consider how the term "theory" is conceived by different scholars. Liu& McKinnon (2016:973) citing Amundson (1998) described a theory as ''the statement of the nature of the relationship between concepts''. In light of the importance of theory in research, it is argued that theory is paramount in academic research as it enables the discipline to mature (Deffee et al., 2010). Karatas-Cetin and Denktas-Sakar (2013:129) citing Wacker (1998), noted that a theory consists of the following four basic criteria namely ''conceptual definition, domain limitations, relationship building, and predictions''. Mokhele and Geyer (2021) are of the view that theory provides an analytical lens that can be used to conceptualise a particular phenomenon. (Liu & McKinnon, 2019) noted that theory describes, explains, and represents an observed phenomenon.

The literature acknowledges that the majority of studies in logistics and supply chain applied theories that are borrowed from other disciplines to logistics research, namely strategic management, microeconomics, marketing, and sociology among others (Defee et al., 2010; Liu & McKinnon, 2016 Fisher-Holloway & Mokhele, 2022). However, the literature reports that a few studies applied theories of geography in logistics and supply chain studies (Fisher-Holloway & Mokhele, 2022). It is, therefore, important to note that geographic theories, particularly location theories play a pivotal role in explaining the spatial distribution of economic activities within a given space. The literature acknowledges that few studies applied human geography theories in logistics research (Dai & Yang, 2013a; Mokhele & Geyer, 2021b; Fisher-Holloway & Mokhele, 2022; Huang et al., 2023). Dai and Yang (2013) applied the growth pole theory in the study of logistics park development in China wherein the theory states that a logistics park acts as a growth pole for cities or regions with the ability to attract other logistics-related facilities within the same space. According to the study, a logistics park's potential for growth is attributed to the interplay of three economic forces, namely the dominance effect, multiplier effect, and polarisation diffusion effect (Dai and Yang, 2013). Huang et al. (2017) applied the Hotelling model of spatial competition to analyse the factors that contributed to the formation of a logistics park in China, by comparing the different siting behaviour of logistics enterprises. According to (Mokhele & Geyer, 2021) the Hotelling model involves two competitive sellers, selling the same product and competing for the same customers since the market is uniform along the line and the location cost is assumed to be zero. Informed by different viewpoints from the afore-cited literature, it is, therefore, important to note that the subsequent sections present an overview of the of theories that were applied in logistics and supply chain research.

3.1.1 LOCATION THEORIES/ GEOGRAPHY THEORY

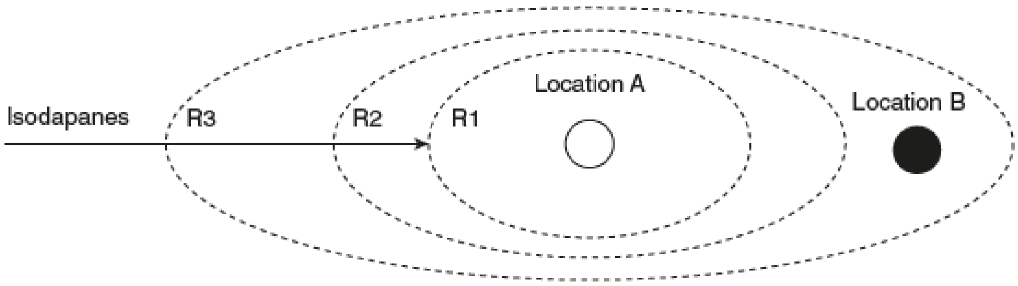
Drawing on the classical location theories, specifically Von Thunen's agricultural land use model, Weber's theory of firm location, cluster theory, Hoovers model, and Hotelling's model of spatial competition, it can be noted that location theories explain the spatial distribution of economic activities within a given space (Aoyama et al.,2011). According to Cappello (2011:3) location theory enables the identification of factors that influence the location of individual activities, reasons for the allocation of land among different producers, and the division of the spatial market among producers. The findings from the literature revealed that classical location theories acknowledge the role of agglomeration economies, transport costs, and labour costs in the spatial location of a firm (Aoyama et al.,2011). Therefore, location theories are paramount in explaining the role of accessibility, land costs, transport costs, labour costs, and agglomeration economies in the spatial distribution of logistics facilities such as warehouses.
Several studies hail Weber (1929) as the father of the generalised industrial location theory (Mokhele & Geyer, 2021; Aoyama et al., 2011). Mokhele and Geyer (2021) posit that theory is used to explain the spatial distribution of industries within space. Based on the findings from the literature reviewed, it is reported that few studies explicitly applied Weber's theory of

industrial location in warehousing and logistics research. Kudláčková and Chocholáč (2017) applied Weber's model in the study of warehouse location problems. It has been noted that according to Webers' industrial location theory, the firms will be attracted to locations where they benefit from minimising transport costs (Pillay & Geyer, 2016). Pretorius et al. (2021) in the study of the spatial development perspective of warehousing in Southern African Development Community countries (SADC) applied the lenses of the least cost approach of Weber's industrial location theory and found that South Africa has the largest concentration of warehouses as compared to the other countries in the region and this is attributed to well-developed infrastructure and easy of doing business.

According to the least-cost approach model of Weber's theory of industrial location, firms will be attracted to a location that offers the cheapest location for production, wherein labour costs and transport costs are low (Aoyama et al., 2011; Pretorius et al., 2021). Pretorius et al. (2021) applied Weber's industrial location theory in determining the location factors that influence the location of the warehouse and the supply chain they support based on regional spatial context. According to the study, the least-cost approach model of Weber's theory is premised on three main location factors, vis. transport costs, labour costs, and agglomeration economies (Pretorius et al., 2021).

Firstly, transport cost plays a vital role in the location of industrial activities. Kudlackova and Chocholac (2017) indicate that Weber's theory puts more emphasis on the need to minimise transport costs as one of the driving forces for industrial location. Transport cost relates to costs incurred in terms of the distance covered to obtain raw materials used in the industry and the costs incurred when delivering the product to the market (Pretorius et al., 2021). Additionally, the model states that the industries will be located at a location where they benefit from low transport costs (Pillay & Geyer, 2016; Pretorius et al., 2021). It is, therefore, important to note that by applying the theoretical lenses of the model, transport costs can be used to explain why some warehousing facilities that rely on transportation may choose to locate near major transportation hubs such as airports, ports, major transport corridors and highway interchange. Secondly, the theory recognises the cost of labour as a key determinant in the location of industries since labour is found to be concentrated within certain locations and its cost varies. It is therefore pointed out that, there is a least-cost transport location and least-cost labour location in a region (Pretorius et al., 2021: 64). As shown in Figure 3.1, it is argued that the industry is willing to shift from location A only if the transport cost incurred due to increased distance is lower than money served because of lower labour costs in location B (ibid.). Considering labour cost, the theory can be used to explain the reason why some warehousing facilities chose to locate in areas with low labour costs. Figure 3 illustrates the relationship between location A (transport) and location B (labour) the least-cost transport and the Isodapanes indicate how the unit cost of transport increases as the firm shifts from location A (ibid.)

Figure: 3.1 Relationship between least cost transport and least cost labour



Source: Pretorius et al., 2021: 64 adapted from Weber 1929

Lastly, several studies report that Weber's location theory acknowledges the influence of agglomeration economies in the location of firms and the formation of industrial clusters (Aoyama et al., 2011.; Masson & Petiot, 2015; Pretorius, 2021; Warffemius et al., 2010) According to Aoyama et al. (2011), Weber's model recognises the influence of both agglomeration economies and deagglomeration economies. As discussed in Chapter Two, agglomeration economies relate to the cost benefits obtained when firms are located close to each other, namely the use of common infrastructure and services, access to a specialised labour pool, and access to auxiliary benefits (accounting and financial benefits) (Aoyama et al., 2011; Pretorius et al., 2021; Rodrigue, 2020a). Masson and Petiot (2015) argue that agglomeration economies are classified into two broad categories, namely localisation and urbanisation economies. As a result of localisation economies, firms enjoy the benefits of being co-located to firms that belong to the same industry and the benefits entail access to specialised labour and sharing of the same infrastructures services (Masson & Petiot, 2015). Therefore, it is important to note that Weber's theoretical concepts provide the lenses upon which localisation factors such as labour and infrastructure can be used to explain the locational patterns of warehousing and other logistics facilities. The literature reports that agglomeration factors are attributed to the locational patterns of warehouse facilities in different spatial contexts across the globe. As such agglomeration factors can be used to explain the clustering of warehousing facilities in geographic space. Masson and Petiot (2015) examined the role of agglomeration economies on locational patterns of warehousing facilities in Paris.Warffemius (2007) examined the spatial clustering of distribution centres in the vicinity of Amsterdam Airport Schiphol through the lenses of agglomerations economies. To this end, Weber's theory of industrial location provides a good explanation for warehousing clustering patterns that stem from the factors of agglomeration as well as dispersed spatial patterns of warehousing facilities that emanate from the agglomeration diseconomies namely, traffic congestion and high rents (Aoyama et al., 2015).

Theoretical lenses from the bid rent theory could be used to explain the spatial distribution of economic activities in metropolitan areas. The literature reviewed found that different scholars applied the bid rent theory in examining the general location of economic activities within urban areas and specifically in determining the location of retail activities as well as establishing the relationship between airports and urban land-use activities (Narvaez, Penn & Griffiths, 2013; Larsson & Öner, 2014; Li et al., 2017; Gao et al., 2020). The literature acknowledges that the notion of economic rent or locational rent was first applied by Von Thunen (1826) in the agricultural land use model wherein economic rent refers to the highest rent a farmer is willing to pay for a parcel of land (Aoyama et al., 2011). In this regard, according to the bid rent, the distance to the market determines the nature and intensity of crops produced on a certain piece of land wherein perishable crops that yield high revenue and require high transportation costs are produced close to the market (Aoyama et al., 2015). Drawing on Von Thunen’s bid rent curve, Alonso (1964) expanded the bid rent theory by applying it to explain the spatial distribution of economic activities such as retail and commercial activities in urban areas. Alonso’s bid rent theory provides a framework that explains how land users compete for the land that is close to the Central Business District (CBD) and as distance increases from the CBD, the rent starts to decline (Berjranand et al., 2015; Lim & Park, 2020). Therefore, firms compete for locations that have access to market and labour opportunities (Kang, 2020a).

Narvaez et al. (2013:5) applied the lenses of Bid Rent theory in investigating the spatial configuration of economic activities in the city of Cardiff. According to the study, the concept of bid rent relates to the amount one is willing to pay to get a more central location but is willing to pay for a location that is far away from the central location at a lower rent or price (Narvaez et al., 2013:5).

In light of the afore-cited study Bejrananda et al. (2015) hold that Alonso's bid rent theory explains the location of economic activities in urban areas based on profit maximisation wherein economic activities that pay the highest rents occupy the central location in urban areas. It is, therefore, important to note that accessibility, distance, and rent are the basic tenets of the bid rent theory wherein economic activities that are willing to pay the highest rents are the ones that occupy the central locations. To this end, the theory could be applied in analysing the spatial patterns of logistics facilities such as warehousing facilities.

Li et al. (2017) in the study of spatial differentiation mechanisms of logistics nodes and logistics enterprises in Beijing, including bid rent theory found that transportation, rent, and assets were the major factors responsible for differentiation in type and function of logistics nodes and logistics enterprises. Additionally, in light of airport-centric logistics studies, Berjranand, et al., (2015) applied the lenses of Alonso's bid rent theory to determine the spatial patterns of the economic rent of Suvanabhumi International Airport development area in Thailand and found that the bid rent gradients of the six types of land-use activities declined due to the Asian Financial Crisis in 1997. Informed by Alonso's theory of bid rent, (Gingerich & Maoh, 2019) in studying the impacts of airport proximity on the location of warehousing facilities and truck trips in Toronto, found that warehouse facilities were increasingly attracted to locations that are further away from the CBD where land is cheaper. The findings of the study further noted a positive correlation between the distance of warehouse location and the CBD in the Toronto Census Metropolitan area, wherein warehousing facilities were increasingly located further away from the CBD along the periphery of Toronto urban core (Gingerich and Maoh, 2019: 102). Based on the aforementioned study, it is worth noting that bid rent theory provides a plausible explanation for the sprawling patterns of warehousing facilities in metropolitan regions.

Furthermore, based on the models of spatial competition, some studies applied the Hotelling model of spatial competition in logistics research (Crotti & Maggi, 2017; et al., 2017; Niu et al., 2019) Huang et al., 2023; Niu et al., 2019)). According to the seminal paper by Osborne & Pitchik (1987), the Hotelling model of spatial competition presents an illustration wherein two firms first simultaneously choose the locations in a line segment and simultaneously choose the prices. The model is premised on the following assumptions: customers are distributed uniformly across the line segment, both firms produce a homogenous product and lastly, firms choose a location and a price in the line segment (Osborne & Pitchik, 1987); Huang et al., 2017). Huang et al. (2017) applied the Hotelling framework in the study of the formation of logistics parks in China by comparing the different sitting behaviours of the logistics enterprises in different locations. According to the study, the Hotelling model demonstrated that two firms will move to the middle of the street to expand their market share when the market cannot be fully covered. As such, logistics park develops as a result of logistics enterprises' decision to cooperate rather than compete, thus resulting in the selection of an optimal point in a logistics park. Click or tap here to enter text. Logistics enterprises would gather to form a logistics park such that there would be a coordinated development of regional logistics systems (Huang et al., 2017).

In addition, Crottie and Maggi (2017) applied the duopolistic Hotelling approach, and the findings suggested that market-based measures and subsidies play an essential role in influencing the demand for public-private urban distributions centres (UDCs). UDC are logistics facilities that are located close to the city centre wherein goods from different logistics service providers are consolidated and distributed to different customers in urban areas using eco-friendly vehicles (Crottie & Maggi, 2017: 2). Drawing on Hotelling framework, the study found that customers (retailers) were in the city centre and customers varied in terms of delivery times (ibid.). The study further found that logistics service providers admitted costs and benefits as a result of the introduction of UDC-based delivery services as well as incurring extra delivery costs due to the UDC which was not strategically located outside the urban areas.

Several studies applied the principles of cluster theory in logistics and supply chain research (Bozarth et al., 2007; Patti, 2006; Liao et al., 2011; Chhetri et al., 2014; Chung, 2016; Wang et al., 2022). Porter and Porter (1998) described clusters as the geographical concentration of related firms within a specific area. Clusters are characterised by linkages and complementarities across industrial and institutional boundaries (Porter & Porter, 1998). Bozarth, Blackhurst, and Handfield (2007) applied the framework of industrial cluster theory in the context of supply chain management decisions wherein the study focuses on the development of the New England Cotton Textile Industry. Industry clusters are defined as the ‘‘geographic concentrations of interconnected companies and institutions in a particular field’’ (Bozarth et al., 2007: 154). It has been argued that the intellectual antecedents of cluster theory draw from Alfred Marshall (1890), wherein the Marshallian theory of externalities examines the various causes of industry localisation by establishing the role of externalities which were widely referred to as agglomeration effects (Hafeez et al., 2016; Porter & Porter, 1998). Hafeez et al. (2016), citing Porter (1990) argue that as a result of the co-location of suppliers, producers, and customers in a cluster, results in benefits such as transport benefits and proximity to a pool of skilled labour. It is further noted that several benefits arise as a result of firms operating in a cluster, namely cooperation, and competition, better access to specialised employees and suppliers, increased productivity, better access to public institutions, and access to specialised information as a result of knowledge spill over, etc. (Bozarth et al.,2007; Patti, 2006).

It is, therefore, imperative to note that there are a significant number of studies that apply the lenses of cluster theory in Supply Chain research (DeWitt et al., 2006; Hafeez et al., 2016; Patti, 2006; Liao et al., 2011). De Witt, et al. (2006) applied Porter's cluster theory using the case study of the Amish Furniture Industry in Ohio to establish the linkage between Porter’s cluster theory and supply chain management on a firm's competitiveness and performance. Informed by the Cluster theory, the study establishes the positive impacts of operating in an integrated supply chain within a geographically concentrated cluster. Similarly, Patti (2006) employed Porter’s economic cluster theory in supply chain studies wherein the study illustrates the benefits experienced by building a relationship with co-located local suppliers and customers. Based on a case study of a US petrochemical firm that used to outsource raw materials from a firm that was 200 miles away, significantly reduced both operational and transport costs when it started to outsource raw materials from a local firm located a few miles across the street. It is argued that the firm reduced its costs by $280,000 per annum as well as reduced its lead time from seven to ten days (Patti, 2006). Liao et al., (2011) examined the global supply chain adaptation of ABC automotive firms in the Chinese market based on the principles of contingency and Porter's economic cluster theory. It is therefore important to note that drawing on the framework of Porter’s economic cluster theory, the study examines the supply chain adaptations of a Japanese automotive firm (ABC) entry into the Chines automotive industry. The study found that to circumvent the Chines government's restriction and regulations on the policy that restrict reliance on international suppliers, the company established relations with local suppliers.

Chung (2016) examined the logistics cluster competitiveness in China by comparing it to other Asian main countries, Japan, Singapore, Hong Kong, Korea, and Malaysia based on the theoretical perspective of Porter's diamond model. In the context of China, Porter's diamond model explains the industrial competitiveness of logistics clusters at the national level. Four broad attributes were used to explain the countries' industrial competitiveness, and these include factor conditions (FC) related to the supply of labour force or infrastructure; demand conditions (DC) related and supporting logistics industries (RSLI) and firm structure, strategy, and rivalry (FSSR) (Chung,2016). However, when the logistics cluster competitiveness of China was compared to other Asian countries, it was found that Singapore had a high cluster competitiveness score of (7.93), China with a score of 5.40, and Malaysia the least with a score of 3.46 among others. It was further concluded that a country with a high score indicates that the country has an absolute advantage in logistics cluster indices (ibid.). It is important to note that the literature established a significant number of studies that focuses on logistics clustering. For instance, Rivera et al. (2016) investigate the benefits of logistics clustering and establish that logistics clustering provides the following benefits: value-added services, facilitates job growth at different levels within the cluster, and promotes career mobility of the workforce within a cluster. Chhetri et al., (2014) examined the economic activities and spatial logistics employment clusters in Australia and found that the logistics sector accounted for 3.57 percent of the total employment in Australia wherein Western and Southern corridors of Melbourne indicate the highest spatial clustering of logistics employment. However, besides theories described above, studies revealed that new economic geography play a significant role in explaining the spatial distribution of economic activities. The following paragraph discusses the new economic geography models.

3.1.2 NEW ECONOMIC GEOGRAPHY

The literature acknowledges Paul Krugman as the pioneer of the new economic geography (NEG), a branch of economics that seeks to explain the spatial economic activities within a geographical space (Krugman, 1991: 1998; Fujita, 2010). Krugman (1998) pointed out that the NEG deviates from the traditional theory mainly because of the adoption of the modelling tricks such as iceberg, evolution, the computer, and Dixit-Stiglitz model of monopolistic competition in explaining the spatial distribution of economic activities. Mokhele and Geyer (2021:28) posit that new economic geography theory draws from classical location theory, regional science, and growth pole theory wherein the theory explains the emergence of core-periphery structure at different scales, namely international, regional, or local scales based on scale as a level of analysis. Fujita (2010) asserts that the NEG emphasises the interaction of the three approaches, namely increasing returns, transport costs, and the movement of production factors based on modelling approaches. Kang (2020a) emphasises that the interactions between agglomeration economies and transport costs are at the centre of NEG models, wherein similar firms tend to agglomerate to decrease costs by resource sharing and knowledge spillover (Kang, 2020a:2).

Ducruet et al. (2010) applied the lenses of NEG in examining the inter-port relationships, concurs with Krugman (1991) wherein the study argues that NEG approach differs from the traditional economic geography largely because of employing the modelling approach in the explaining the changing spatial structures within a geographic space. However, previous studies argue that the preceding theories before the introduction of the NEG were merely descriptive, rather than providing explanations regarding the factors that are responsible for the spatial configuration of economic activities (Warffemius, 2007). According to a study by Humpl (2011:79) new economic geography theory occupies the second position among the neoclassical agglomeration theories wherein the theory investigates agglomeration activities at both meso and macro levels.

Venables (2005) posits that the NEG places much emphasis on the role of clustering forces in generating an uneven distribution of economic activities. Scholars suggests new economic geography seeks to explain the uneven distribution of human activities across the space which results in the formation of a variety of large agglomerations, dispersion, and regional integration (Ducruet al.,2010; Lafourcade & Thisse ,2008). Regarding agglomeration, it is argued that NEG theory explains the formation of agglomerations by analysing the interrelatedness between the two forces namely, centripetal, and centrifugal forces. Parr (2002) asserts that agglomeration as a concept is at the fore of monopolistic competition models in NEG which explains the spatial distribution of activities. Drawing from the new economic geography analytical framework, it is worth noting that a considerable number of studies applied the lenses of new economic geography in analysing logistics activities in metropolitan areas.

Warffemius et al. (2010), drawing on NEG models, the study developed a conceptual model explaining the clustering of European Distribution Centres around round Amsterdam Schiphol Airport and found that agglomeration economies influence the location choice of EDC around the airport rather than airport proximity. Yuanyuan and Bingliang's (2017) study on logistics agglomeration and its impacts in China, drawing from the theoretical lenses from the NEG in exploring how the spillover effect and scale economies of logistics agglomeration impact the development of logistics industry in China. As such, the following factors of new economic geography play a positive role in the growth of the logistics industry in China:

Firstly, logistics agglomeration promotes the specialisation of labour in the manufacturing sector. Henceforth, it reduces the production costs of the manufacturing sector in the logistics industry. Given that agglomeration promotes the specialisation of labour, thus showing the usefulness of the NEG in logistics studies. Fujita and Krugman (2004) indicated that the model is made up of the two sectors, agriculture, and manufacturing, and the two types of labour, farmers, and workers. Also, the model presents the interplay of two forces, centripetal and centrifugal forces, as such, centripetal forces are related to the agglomeration through the market, and the mobility of workers contributes to the agglomeration of manufacturing activities (Fujita & Krugman, 2004).

Secondly, logistics agglomeration attracts the concentration of manufacturing firms in one area. In this regard, the logistics industry linkages are created. Yuanyuan and Bingliang (2017) note that the concentration of manufacturers in one area has a bearing on the market demand of scale for logistics services. Logistics agglomeration promotes technical and knowledge spillover among firms. This is largely attributed to the benefits which are derived by firms as a result of co-locating within the same space.

In addition, the economies of scale effect which is derived from the agglomeration of logistics are attributed to playing an essential role in the growth of the logistics industry in China. As such, the industrial agglomeration can effectively realize scale economies according to New Economic Geographies (Yuanyaun & Bingliang, 2017). It is further argued that the scale economies effect derived from logistics agglomeration can be estimated by the product of scale of the logistics industry and the logistics demand derived from the manufacturing industry (Yuanyuan & Bingliang, 2017). On the same note, Humpl (2011) further agrees that New Economic Geography plays an essential role in the creation of agglomerations and networks in logistics, whereby agglomerations usually appear in connection with major transport nodes.

3.2 APPLICATION OF THEORIES FROM OTHER DISCIPLINES IN LOGISTICS RESEARCH

The studies on logistics and supply management widely recognise the application of theories from other disciplines in logistics research and these predominant theories were borrowed from strategic management; marketing, microeconomics, organisational studies, and management (Defee et al., 2010; Fisher-Holloway & Mokhele, 2022; Karatas-Cetin & Denktas-Sakar, 2013; Liu & McKinnon, 2016; Swanson et al., 2017). In light of the afore-cited studies, the literature findings revealed that Liu and McKinnon (2016) examine the frequency of use for theories that were borrowed from other disciplines in on the Chines logistics and supply chain management research. In a similar study, Defee et al. (2010) compiled an inventory of theories that were borrowed from other disciplines in logistics and Supply Chain Management research. Karatas-Cetin and Denktas-Sakar (2013) found that theories of competition namely, resource-based view, transaction cost economies, and systems theories are frequently applied by researchers in logistics research. According to Defee et al. (2010), of all the theories identified through content analysis, the transaction cost economies theory represents 10% of the identified theoretical incidents. Table 3.1 illustrates the theoretical incidents of theories that were applied in logistics and supply chain management based on the content analysis of the 683 scholarly articles on logistics research by Defee et al. (2010).

Table 3.1: Incidents of theories applied in logistics research.

Theory	**% of theoretical incidents**	**Cumulative % of theoretical incidents**
TCE	10.4	10.4
RBV	8.6	19.0
Porter's framework	3.0	22.0
Contingency theory	2.5	24.5
Bullwhip effect	2.3	29.2
Agency theory	1.9	31.2
Social exchange theory	1.9	33.1
Game theory	1.8	34.9
Core competency	1.6	36.4
General systems theory	1.6	38.8
Social network theory	1.6	39.6

General inventory theory	1.4	41.0
Communication theory	1.2	43.7
Market orientation	1.2	44.9
Organizational learning	1.2	46.1
Risk management	1.2	47.4
Alliance	1.1	48.4
Disconfirmation theory	1.1	49.5
Institutional theory	1.1	50.5
Organizational theory	1.1	51.6
Political economy	1.1	52.6
Supply chain	1.1	53.7
Total cost	1.1	54.8

(Source: Defee et l. 2010)

According to Liu and McKinnon (2016), based on a comprehensive literature review of 116 research articles on theories used in LSCM between 2004 and 2014, found management and organisational behaviour as the two fertile sources for theories that were applied in Chine's supply chain management research. By comparing the aforesaid disciplines, the study pointed out that the discipline of strategic management focuses on how firms achieve and sustain competitive advantage, while the discipline of organisational behaviour mainly focuses on the interface between human behaviour and the operations of a business (ibid). As reviewed by Defee et al. (2010), a similar study by Liu and McKinnon (2015) found that resource-based view (RBV) and transaction cost economics (TCE) theories accounted for 15.3% and 12.7% of the reviewed papers, as such the aforesaid theories marked the highest frequently used theories in the context of Chines supply chain management research. A recent study by Swanson et al. (2017) conducted a comprehensive literature review on theories borrowed from other disciplines in logistics and supply chain management research. The study identified several scholarly articles that employed theories from different disciplines namely, management, economics, sociology, psychology, mathematics, political science, systems, marketing, computer science, communication, philosophy, and accounting. Among all the disciplines, it is argued that theories from management (i.e., RBV; agency theory; stakeholder theory) dominate the logistics and supply chain management research and they account for 34% of the total theoretical research in logistics and supply chain management research

(LSCM). In regard to the discipline of management, the study noted that resource-based view (RBV) accounted for 18% of the total theoretical research in LSCM. According to the study, the discipline of economics emerged as the second borrowed discipline wherein theories such as transaction cost economies (TCE) and organisation theories were borrowed and applied in logistics research. Evidence from the literature suggests that TCE is the second most economic theory used in logistics and supply chain management research (Swanson et al., 2017). More importantly, a recent study by Fisher-Holloway and Mokhele (2022) concurs with the argument that TCE comes second after RBV as the predominant theories applied in logistics and supply chain research.

Against the backdrop of the afore-cited literature, the chapter draws insights from transaction cost economics, resource-based theory, and resource dependency theory. As discussed in the literature, it can be noted that the aforementioned theories were borrowed from the following disciplines namely, management and economics (Defee et al., 2010; Fisher-Holloway & Mokhele, 2022; Karatas-Cetin & Denktas-Sakar, 2013; Swanson et al., 2017). It is, therefore, important to note that the following subsections discuss the application of transaction cost economics, resource-based view, and resource dependency theories in logistics and supply chain management research.

3.2.1 TRANSACTION COST ECONOMIC

The literature findings reviewed that a significant number of researchers applied the lenses of transaction cost economics theory (TCE) in logistics and supply chain, for instance, (Zacharia et al., 2011) examined the changing roles of third-party logistics (3PL) as orchestrators in the supply chains to achieve the competitive advantage based on three different theoretical constructs/ foundations, namely transaction cost economics, resource-based view, and network theory. It is argued that transaction cost economics was first introduced by Coarse in 1937 and later extended by Williamson and the theory states that a firm's decision is based on minimising both production and transaction costs (Liu & McKinnon, 2015; Zacharia et al., 2011).

Recent literature on logistics outsourcing, the literature found a considerable number of studies that applied the lenses of transaction cost economics in examining the activities of third-party logistics providers (3PL) (Marchet et al., 2018; Rahman et al., 2019; Maditati et al., 2023). According to Rahman et al. (2019:260), transaction cost economics provides a framework that can be used to analyse logistics outsourcing decisions based on the idea that a firm organises its inter-organisational activities to reduce production and transaction costs, thus resulting in a more competitive 3PL). Zacharia et al. (2011) noted that non-core activities are outsourced to 3PL providers who play a critical role as orchestrators in providing logistics services. Additionally, Rintala et al. (2021:260) argue that the rational for deciding when a function should be kept in-house within the supply chains is based on two approaches namely transaction cost economies and core competency approach. Ketokivi & Mahoney 2020)) applied the TCE as a theory of supply chain efficiency based on the empirical study of an automobile assembly wherein the scholars analysed the supply chain efficiency based on the following three theoretical lenses of TCE namely, competency, power, and efficiency.

However, despite the increased recognition of TCE theory in supply chain and logistics research, Rintala et al. (2021) argue that the traditional use of TCE theory in explaining the outsourcing activities in logistics needs to be revisited, on the basis that there are assets-specific to a firm that are not supposed to be outsourced to outsiders. According to Mclvor, (2009) in Rintala et al., (2021) a firm may experience threats of opportunism from external service providers. Therefore, based on the afore-cited studies, it can be argued that logistics literature research, employed theoretical lenses from other disciplines to explain some of the complex logistics and supply chain processes. Olavarrieta & Ellinger (1996) citing Stock (1996) argues that theories from other fields help to elevate the discipline's level of theoretical development.

3.2.2 RESOURCE-BASED THEORY

Several studies in the literature report on the utilisation/ of resource-based theory in logistics research (Olavarrieta & Ellinger, 1997; Zacharia et al., 2011; Kalaitzi et al., 2018; Rahman et al., 2019). According to resource-based theory, a firm is viewed as a bundle of resources that gives it a competitive advantage (Zacharia et al., 2011:41). Competitive advantage stems from firms' possession of inimitable resources, innovation among others, thus enabling a firm to be competitive in the marketplace (ibid.). The literature highlights that the resource-based theory has its historical origins in the works of Wernerfelt (1984); Rumel (1987) and Barney (1991) (Olavarrieta & Ellinger, 1996; Rahman et al., 2019; Zacharia et al., 2011). According to the theory, resources can be both tangible and intangible (Olavarrieta & Ellinger, 1997). Zacharia et al. (2011) noted that tangible resources include equipment, plants, location, and intangible resources comprised of expertise and knowledge among others.

In this regard, Zacharia et al. (2011) applied the lenses of RBT to examine the role of third-party providers in logistics outsourcing processes. It is argued that RBT theory enables a firm to have access to a wider range of resources (Zacharia et al., 2011). Olavarieta and Ellenger (1997) demonstrated that logistics distinctive capability is a key source of sustainable competitive advantage for 3PL providers. Rahman et al. (2019) among other theories, applied the RBT theoretical lenses in examining the challenges faced by multinational third-party logistics operating in China. Informed by the theoretical lenses including RBT, the study found that multinational third-party logistics are faced with several challenges that include government regulations, price pressure, and transportation costs among others (Rahman et al., 2019). Drawing from the previously mentioned studies, theories from other disciplines play a crucial role in explaining some of the important concepts in logistics research. As such these studies support the notion that theory plays an important role in a discipline's maturity (Deffee et al., 2010).

3.2.3 RESOURCE DEPENDENCY THEORY

The RDT was employed in the logistics studies by Agyabeng-Mensah et al. (2020) in their study of green warehousing and logistics optimization in China and the findings revealed that the theory brings an understanding of the collaboration between local firms and their suppliers in a bid to reduce the negative externalities such emission of greenhouse gasses caused by the warehousing activities. In this regard, the theory suggests that logistics users should work with their supply chain members to facilitate resource sharing and ultimately improve its performance.

It has been argued that studies of inter-organizational relationships in the context of logistics outsourcing conducted in China revealed that logistics users develop high-quality outsourcing behaviour owing to the logistics performance which emanates from inter-organizational relationships (Chu & Wang, 2012). Therefore, this standpoint suggests that logistics users may develop logistics outsourcing relations to manage their dependency on 3PL. Thus, the theory forms the three important relationship factors namely trust, satisfaction, and commitment which are built upon the principles of competence, creditability, and benevolence (Chu & Wang 2012). Therefore, from the logistics outsourcing context, trust relates to the willingness of a client to depend on its logistics service providers based on the principles of competence, creditability, and benevolence (Chu & Wang, 2012).

Agyabeng-Mensa et al. (2020) mention that the resource dependency theory posits that firms do not have adequate resources to fully operate on their own. As such it is vital for firms to partner with other firms in the supply chain to obtain the required resources (Pfeffer and Salancik, 2003 cited in Agyabeng-Mensa et al., 2020). Firms may acquire resources such as expertise, knowledge, and technical know-how by establishing inter-organizational relations with other firms. Therefore, firms may become dependent on each other by establishing external relations. The resource dependency theory suggests the collaboration of firms in the supply chain to achieve high gains. These inter-organizational relationships can be established through partnerships and joint ventures, as such complementary assets can be created.

Also, the characterisation of a firm as an open system is another important feature of the resource dependency theory (Pfeffer and Salancik, 1978 cited in Chu and Wang, 2012). The theory suggests that developing a collaborative inter-organizational relationship is the only way to acquire resources as a way of reducing dependence and uncertainty. The RDT emphasized the need for interdependence among firms to obtain sufficient resource growth. Players in the logistics sector may be actively involved in managing outsourcing activities in a bid to reduce dependence.

3.3 MODELS RELATED TO LOGISTICS FACILITIES AND WAREHOUSE LOCATION

3.3.1. GRAVITY CENTRE MODEL

The gravity centre model proved to be efficient in the location of logistics facilities such as distribution centres (Huang et al., 2013). Vlckova et al., (2015) based on the study on the location of the new warehouse for the reverse flow of dangerous waste in the Czech Republic, the scholars use various examples of localisation models to find the optimum point to establish a new warehouse facility. Vlckova et al., (2015) further argue that the location model uses the gravity centre model to find an optimum location for warehouse facilities or distribution centres. Similarly, Liu et al., (2013) used the gravity centre model to find the optimum location of a distribution centre and through a comprehensive analysis, they came up with an optimal location at the centre in northern China. Vlckova et al., (2015) employed the gravity centre technique when selecting the optimal location for a reverse logistics warehouse facility. The Centre gravity centre model is described as a quantitative method used to find an optimal location of a new facility in a plane. It is further argued that the model is used to find the centre of gravity in the territorial location based on two factors namely, the customer's position and customer weight (Vlckova et al., 2015).

Firstly, the customer's position relates to finding the cheapest transport which will be directed from the newly established point. In this regard, the model seeks to minimize transport costs, because the model is used in decision making for the location of facilities that are characterized by high transport costs, in terms of transporting raw materials (Vlckova et al., 2015).

Secondly, customer's weights refer to the total quantity of raw material and products to be distributed from the warehouse facility to the customers. Also, the model is used to decide on how to transport goods within a certain period between customers and the newly established location.

Furthermore, the model uses the coordinates system, whereby the optimal point on the map is identified, and the method uses the system of Cartesian coordinates, as such the served area is assigned with a coordinate in the format of (xj, yj), (Vlckova et al.,2015. Therefore, the coordinates of the newly established location are calculated using the following mathematical formula,

$$x = \frac{\sum_{j=1}^{n} x_j w_j}{\sum_{j=1}^{n} w_j}, \quad y = \frac{\sum_{j=1}^{n} y_j w_j}{\sum_{j=1}^{n} w_j},$$

Source: Vlckova et al. (2018)

Where,

x, y are coordinates of the centre of gravity, i.e. the position of the new warehouse,

xj, yj are coordinates of the current facilities and their number is j = 1, 2,……n and

wj is the weight.

In this regard, it can be noted that the gravity centre model plays a part in finding the optimal location of new warehouse facilities in the geographical spaces.

It is argued that, although the method uses mathematical calculation in finding the optimum location of the warehouse facility, however, the model has its limitations. Jardas et al. (2020) argued that although it is easy to calculate, it does not take into account the other factors which contribute to the location of warehouse facilities such as labour costs, and the infrastructure system which facilitates the distribution of goods and inventory costs. In sum, it can be argued that the gravity centre model plays an important role when deciding where to locate warehouse facilities.

3.3.2 HOOVER MODEL

Hoover's theory explains warehouse locational choice being informed by the three location strategies namely, the market position, a product position, and an intermediate position (Wisner et al., 2014). Therefore, against these three location dimensions, firstly, market-positioned strategy plays an essential role in the location of warehousing facilities in geographic space. The market-positioned strategy relates to the warehouse location choice close to the customers, as such the locational proximity of the warehouse facility nearer to the customers seeks to maximize customer service levels and ensure high levels of distribution flexibility (Wisner et al., 2014). Divyendu (2019) pointed out that, market positioned warehouse strategy enhances large and cost-effective shipments from the manufacturer with lower costs. Therefore, the market-positioned strategy in warehouse locations enhances the minimization of transport costs.

Secondly, product or manufacturing positioned strategy is a force to reckon with when it comes to the locational choice of a warehouse. Wisner et al. (2014) highlight that the product positioned strategy refers to the location of a warehouse close to the source of supply, as such it enables the efficient distribution and collection of goods with minimum inbound transport costs incurred. The strategy can sometimes be referred to as the manufacturing positioned strategy, and it acts as a collection point for products needed to fill customer orders (Divyendu, 2019). In this regard, a manufacturing strategy is ideal in a situation where bulk goods are purchased from several sources of supply and an assortment of goods is ordered by different customers.

Lastly, the intermediately positioned strategy plays an essential role in the location of warehouse facilities. The intermediately positioned strategy refers to the location of warehouse facilities midpoint the sources of supply and customers and the strategy is ideal when distribution services are relatively high (Divyendu, 2019. This strategy helps in the consolidation of assortments coming from several manufacturing facilities to the warehouse.

Moreover, based on the aforementioned warehouse location strategies, it is worth mentioning that Hoover analyses the warehouse location analysis based on both costs and demand elements. As such, the analysis put more emphasis on cost minimization when determining the optimal location point for warehouse facilities. According to the recent literature on warehousing location, cost minimization, in terms of transport no longer plays a huge role in the locational choice of warehouse facilities since warehouse facilities are increasingly located close to major highways resulting in the sprawling of warehouse facilities in suburban areas (Bowen, 2008; Raimbult et al.,2018)

3.4 SYNTHESIS OF THE THEORIES

Drawing on theoretical insights from various theoretical frameworks plays a pivotal role in understanding complex concepts influencing the spatial distribution of economic activities. As such, transport costs, land costs, access to market, and agglomeration economies are the cross-cutting themes in most of the theories, namely Weber Industrial Location theory, Bid rent theory, Hotelling model of spatial competition, Gravity models, Hoover model, and New economic geography models (Aoyama et al., 2017; Fujita, 2010; Huang et a., 2017; Kudlackova & Chocholac, 2017; Pretorius et al., 2021; Warffemius et al., 2010: Wisner et al., 2014). To this end, the theoretical concepts from the aforementioned theories play a significant role in the understanding of the spatial agglomeration of logistics facilities, the location of warehouses close to transport routes, and generally, the factors that influence the spatial dispersion of economic activities, such as high land costs. Therefore, because of the interaction between agglomeration economies and transport costs, firms as rational economic actors, seeking to maximise profits choose an optimal location where it reduces transportation and labour costs. Additionally, due to externalities such as agglomeration forces, economic activities would cluster in a particular location, and benefit from access to shared infrastructure such as highways and freeways (Hafeez et al., 2016; Warffemius et al., 2010).

Furthermore, theories play a pivotal role in a discipline to maturity. As highlighted by Deffe et al. (2010), the application of theories from other disciplines plays a significant role in the development of the field of logistics. As such, TCE, RBT, and RDT provide theoretical lenses that can be used to understand the interaction of logistics actors among themselves. Therefore, the theories explain the logistics outsourcing activities among third-party logistics providers (Agyabeng-Mensa et al.,2020; Chu & Wang, 2012; Rintala et al.,2021; Zacharia et al., 2011).

3.5 SUMMARY

The chapter discussed various theories that can be used to analyse the spatial patterns of logistics facilities and theories that explain the outsourcing of logistics activities by third-party logistics providers (3PL). Drawing from different theoretical lenses, it can be noted that: economic theories help in explaining the interrelatedness of economic activities within the economic space and the driving forces that attract economic activities within an economic space. In addition, geographic theories and models used in logistics studies and warehouse helps in explaining the driving forces and factors which attracts the location of economic activities within a geographic space and is characterised by the interrelationships among various economic activities. It argued that almost every discipline is shaped and guided by the theory. As Deffee et al. (2010) argue a theory plays a pivotal role in a discipline to maturity. Therefore, for a better and clearer understanding of logistics and warehousing research both location models, economic models, and theories are of vital importance, largely because good research is embedded in theoretical research.

CHAPTER 4 RESEARCH METHODOLOGY AND METHOD

The preceding chapter presented a theoretical framework employed in the study to guide the analysis. The current chapter presents the research methodology and methods employed to collect and analyse data to address the research aim, objectives, and questions. The chapter is structured as follows: Section 4.1 presents an overview of the context in which the research was conducted, including the reasons for choosing the City of Cape Town municipality as a case study. Section 4.2 outlines the methods employed to collect and analyse data. Section 4.3 discusses the ethical aspects that were taken into consideration during the study. Section 4.4 summarises the chapter.

4.1 RESEARCH SETTING

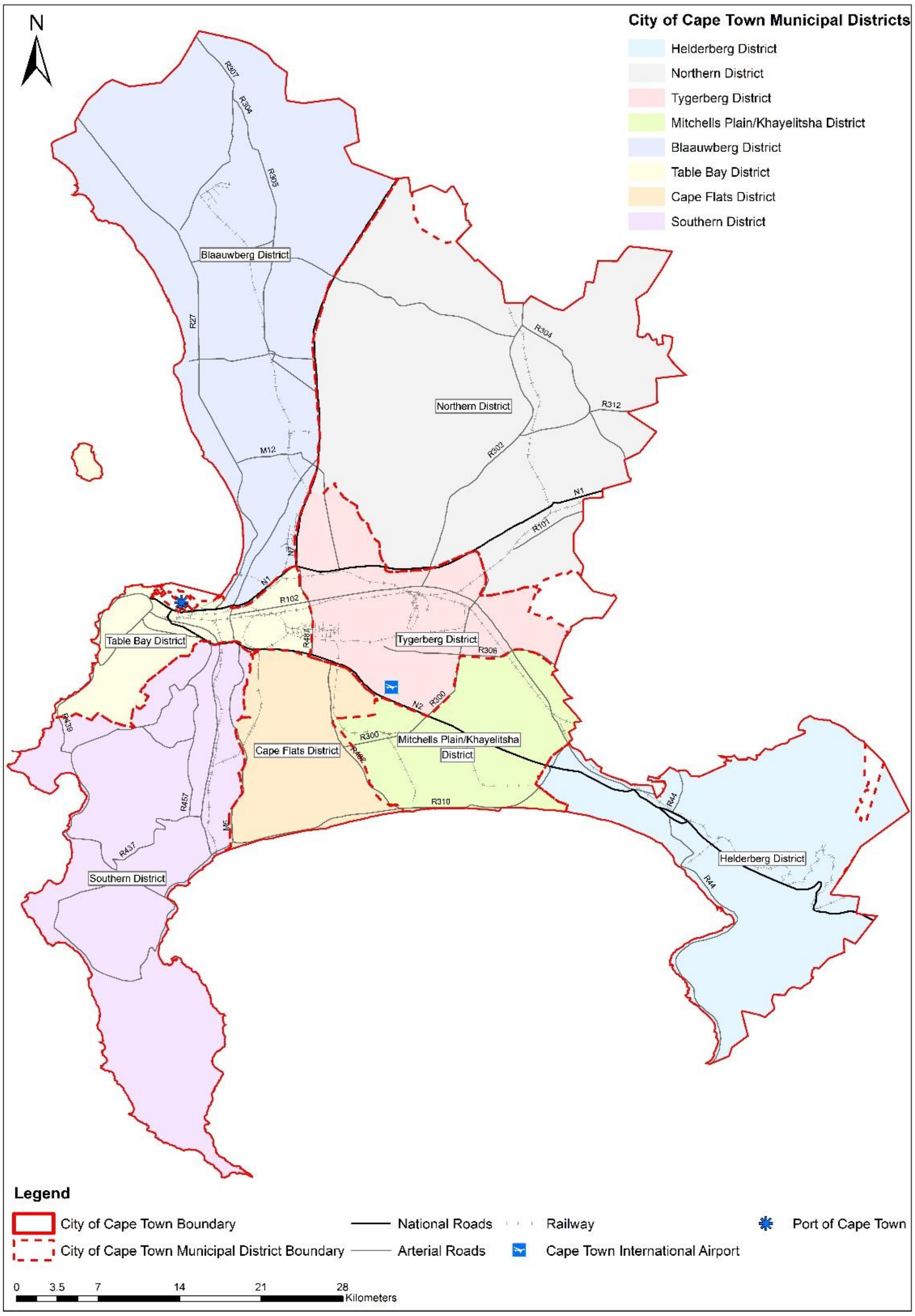
4.1.1 CASE STUDY APPROACH

The study was based on a case study approach. According to Yin (2018:45), a case study is "an empirical method that investigates a contemporary phenomenon (the "case") in depth and within its real-world context, especially when the boundaries between phenomenon and context may not be clearly evident". Kothari (2004:113) opined that a case study prioritises a thorough investigation of a limited number of events or circumstances and their interrelations. Additionally, Kothari (2004) argues that the case study approach aims to identify the factors behind the behaviour patterns of a specific as an integrated totality. According to Neuman (2014) a case study entails ''an in-depth examination of an extensive amount of information about very few units or cases for one period or across multiple periods. Additionally, Neuman (2014) suggested that case methods present the following advantages: enabling the identification of units as cases under study; enhancing the use of multiple methods of data collection; aiding in building a new theory-based on experience and establish the causal-effect relationships of intricate social processes. Meyer, (2001), citing Leonard-Barton, (1990) notes that a case study approach is the most appropriate when the study seeks to answer 'how' and 'why' research questions regarding a contemporary phenomenon.

The study employed a case study approach to analyse the spatial patterns of warehouse facilities across the City of Cape Town municipality relative to the general factors that influence the location of warehousing facilities.

The literature acknowledges two broad types of case study design, namely single and multiple case studies (Meyer, 2001; Yin, 2018). The choice of using one approach over the other depends on the nature of the research, its aims, and research objectives. In this regard, the study adopted a single case study design, focusing on the City of Cape Town municipality as defined by the administrative municipal boundary and further divided into eight districts (Figure 4.1).

Figure 4.1 City of Cape Town municipality



The reason for selecting the City of Cape Town municipality as a case study is based on the following reasons: Firstly, the City of Cape Town is the largest metropolitan municipality in the Western Cape province. As such the municipality is home to logistics firms that are actively involved in the storage and distribution of goods. Secondly, the City of Cape Town is the second-largest economic centre in South Africa after Johannesburg, with a GDP of R445 billion in 2017, which accounted for 9.8% of the national gross domestic product (GDP) in 2018 (CoCT, 2020). Thirdly, the City of Cape Town houses important freight terminal infrastructure such as the Port of Cape Town and Cape Town International Airport (CTIA), which play a vital role in freight distribution and logistics. According to Mokhele & Mokhele, 2023:7), the port of Cape Town is the second busiest port and CTIA the second busiest airfreight airport after OR Tambo Airport regarding the number of passengers and volume of cargo handled in South Africa. According to the City of Cape Town (2023), the CTIA plays an important role as a primary freight and logistics node that provides easy accessibility to the global commercial markets. Also, previous studies focusing on airport-centric developments suggested that CTIA presents an important concentration of diverse economic activities (Mokhele, 2016).

Several studies acknowledge the role played by the Port of Cape Town in logistics activities. For instance, studies on temperature breaks within the cold chain logistics, specifically focusing on the export of perishable fruit products such as blueberries, oranges, grapes, and plums among others acknowledge the influential role played by the Cape Town Container Terminal (CTCT) Goedhals-Gerber & Khumalo, 2020; Steynberg et al., 2022; Goedhals-Gerber et al., 2015; Goedhals-Gerber et al., 2017)). Goedhals-Gerber et al. (2017) examined the incidence and the time taken by the reefer containers to experience CTCT during the export of fruits. The study found that 70% of the total South African fruit export is exported to other parts of the world through the Cape Town Container Port. Additionally, the study suggested that as a result of the proximity of the Port of Cape Town to the fruit-producing areas, the CTCT accounts for the export of 70% of the summer fruits. Therefore, drawing on the findings of the study, it can be inferred that the Port of Cape Town plays an essential role in the cold chain logistics activities in Cape Town. However, a different study by Havenga et al. (2017) found that the Port of Cape Town handles private sector bulk which includes both liquid and dry bulk. Also, the study found that the Port of Cape Town plays an essential role in cold chain logistics wherein the Port of Cape Town handles fruit and refrigerated cargo among other freight goods such as edible, oils, and mixed cargo (Havenga et al., 2017).

The Port of Cape Town is therefore one of the major commercial and freight gateways that connects the city with the broader freight corridors on the western side of the country (City of Cape Town (2023:42). The freight corridors that connect the city include: the north/ south N1, which connects the city with Gauteng, the east/west N2 which connects the city with Port Elizabeth, and the north/south N3 which connects the city' west coast and Namibia, facilitate the transportation of freight goods as well as provide an attractive location for warehouse facilities (Havenga et al., 2017b; Fisher-Holloway & Mokhele, 2023). In this regard, the freight corridors play a pivotal in facilitating logistics activities.

4.1.2 LEVEL AND UNITS OF ANALYSIS

This section presents the level and units of analysis that informed the research. (Neuman, 2014) posits that social reality exists at different levels, which range from micro to macro levels. It is argued that in the social world, the units of analysis could be individual people, groups, organisations, countries, institutions, etc. (Neuman,2014.:68). The level of analysis comprises the City of Cape Town municipality, which is divided into eight districts, whereas the unit of analysis included warehousing firms located in the following districts: Helderberg, Northern, Southern, Table Bay, Tygerberg, Cape Flats, and Khayelitsha/ Mitchells Plain and Blauuwberg districts (Figure 4.1) .

The study focused on the districts because warehousing facilities are unevenly distributed across the City of Cape Town, wherein some districts are heavily clustered with warehousing facilities, whereas in some districts, warehousing facilities are dispersed. More importantly, it is argued that district plans play a pivotal role in guiding the policy formulation and implementation regarding spatial growth activities at a district level (City of Cape Town, 2023). To this end, districts enable policymakers to examine the extent to which spatial planning policy affects the spatial patterns of warehousing facilities. It is, therefore, important to note that informed by the recent study by Fisher-Holloway and Mokhele (2022), focused on the inclusion of warehouses and distribution in the spatial plans in the Cape Function region, the analysis of the district provides insights into how the locational needs of different types of warehouses were addressed since warehouse facilities consume large parcels of urban land.

4.2 RESEARCH METHODS

Building on the research design presented in Chapter One, this section discusses the research methods employed in the study to collect and analyse the data on the spatial patterns of warehousing facilities relative to factors that influence the location of warehousing generally. The data sources and data collection methods used in the study are illustrated on the Table 4.1, and discussed in the subsequent sub-sections.

Table 4.1 Data collection and analysis methods

RESEARCH QUESTIONS	DATA REQUIRED	DATA SOURCE	DATA ANALYSIS METHODS
What factors influence the spatial pattern of warehousing typologies?	Factors that influence the spatial distribution of warehousing typologies	Scholarly literature	Literature review
How are the different typologies of warehousing facilities spatially distributed in the City of Cape Town municipality?	Locational patterns of warehousing typologies	GIS data on warehousing firms from AfriGIS Aerial photography on Google Street view/map	Spatial analysis in ArcGIS Footprint analysis

4.2.1 DATA SOURCES

The geospatial data on the spatial distribution of warehousing was obtained from AfriGIS. Following the cleaning process, the data comprised 396 vector points of warehousing facilities located in different areas across the city of Cape Town municipality.

The raster shapefile containing the topographical maps that categorised the City of Cape Town into eight grid blocks was obtained from the National Geographic Information (NGI) under the Department of Agriculture Land and Rural Development. The latest topographical maps obtained from the NGI were dated 2010. The maps were used to identify the spatial distribution of warehouse typologies across the city.

Furthermore, the following vector shapefiles were obtained from the City of Cape Town's Open Data Portal: municipal boundary shapefile, roads and rail shapefiles, municipal district shapefile, and zoning shapefile. The latest data on zoning was also obtained from the City of Cape Town Map Viewer, which provided the zoning of the areas that accommodated warehousing facilities.

4.2.2 DATA ANALYSIS

Following Mokhele (2017), footprint analysis was used to analyse the building size of warehouse facilities. The QGIS desktop version 3.30.1 and ArcGIS 10.3.1 were used during the footprint analysis. Following secondary vector point data on the warehousing shapefile, the "Add Polygon" command in QGIS was used to trace the building footprints on each warehousing guided by the roof shape of the building. Google Street View and Google Satellite Hybrid were used to verify whether the identified building was indeed a warehouse. Google satellite provides the company's name, for example, some of the facilities were clearly labelled either as "warehouse" or "distribution" centre. Google Street View played a pivotal in identifying large buildings that resembled the characteristics of warehouse facilities.

Against this backdrop, the process of digitising 396 warehousing facilities was done systematically, wherein the process started with areas that had few concentrations of warehouse facilities. The city of Cape Town municipality is divided into the following grid blocks, namely Grid Block 3318CB; Grid Block 3318DA; Grid Block 3318CD; Grid Block 3318DC; Grid Block 3318DB; Grid Block 3318DD; Grid Block 3418AD_DB; Grid Block 3418BA; 3418BB. For instance, the warehouse facilities located in grid block 3318CB (Atlantis Industria) were digitised first.

The process was then followed by tracing warehouse building footprints in grid blocks with a slightly higher density of warehousing facilities. Lastly, tracing the building footprints of warehousing facilities in areas that have a high density of warehousing facilities for instance, the grid block 3318DC, which comprises areas such as the Epping Industrial, Parow Industrial, Maitland, Stikland Industrial, Brackenfell, and Kraifontein Indus
trial.

Informed by the literature (i.e., Onstein, 2021), the traced footprints were used to classify the sizes of the warehouses as shown in Table 4.2.

Table 4.2: Classification of warehouses based on size

Warehouse type	Building footprint size
XX-small warehouses	1-200m²
X-small warehouses	201-2000m²
Small warehouses	2001- 8000m²
Medium Warehouses:	8001-15000m²
X-large warehouses	20001-40000m²
Mega warehouses:	40001m² +

4.3 ETHICAL CONSIDERATIONS

The research was guided by the following important ethical matters: confidentiality, obtaining approval from the research committee, and honesty with professional colleagues as highlighted by Leedy & Ormrod (2015).

Firstly, it is important to note that the geospatial data on the spatial distribution of warehousing firms located in the City of Cape Town municipality was obtained from AfriGIS. Consequently, the data was handled with confidentiality, including not disclosing company names, since the information was not available to the public. Neuman (2014) describes confidentiality as a way of keeping data secret from the public.

Secondly, ethics approval was obtained from the Ethics Committee at Cape Peninsula University of Technology, Faculty of Informatics and Design, before the study was conducted. According to Creswell (2014), researchers should submit their research proposals to the institutional review board such as the ethics research committee at the university, for assessment of potential risks to the research participants. Lai et al. (2006) pointed out that the ethics committee plays a pivotal role in preventing unethical research practices by researchers. Additionally, it is noted that the ethics committee provides checks and balances by correcting ethical weaknesses in the research protocols (Lai et al., 2006:114). To this end, the University's Ethics Research Committee acts as a regulatory board to ensure that the research fully complied with the university's ethics standards.

Lastly, as the study was based on secondary data sources, the study took into account the need to uphold the standards of professional behaviour as suggested by (Creswell, 2014; Neuman, 2014; Leedy & Omrod, 2015). In this regard, the researcher cited all sources of work used to avoid plagiarism, which is regarded as scientific misconduct (Neuman, 2014). Creswell (2014) argues that researchers should acknowledge the sources of work. It is, therefore, important to note that since the study relied on secondary data sources, the study acknowledged all the sources of work used in the research process.

4.4 SUMMARY

The chapter discussed the methods employed to address the aim and objectives of the study. The study adopted a single case study design where the City of Cape Town municipality was adopted as the case study. The chapter outlined the level of analysis which includes the City of Cape Town, categorised into districts, and the units of analysis, which included warehousing firms located in different districts across the city. The chapter highlighted that the data was obtained from secondary sources, which included policy documents, journal articles, books, and previous thesis. Also, the chapter highlighted the methods used in the collection of secondary geospatial data as well as the methods of analysis. In this regard, the chapter highlighted that the study employed the footprint analysis method to analyse the building footprints of warehouse firms since the literature acknowledges that warehouse facilities differ from one another depending on size (area in m^2). Lastly, the chapter discussed the ethical considerations employed by the study. The next chapter presents the findings of the analyses conducted.

CHAPTER 5 FINDINGS

The previous chapter discussed the research methods used to collect and analyse the data. The current chapter presents the findings on the spatial distribution of warehousing typologies in the City of Cape Town municipality relative to the driving factors behind the locational patterns of warehouses generally. The chapter is divided into three main sections. Section 5.1 presents the findings on the spatial distribution of warehousing typologies in the City of Cape Town. Section 5.2 presents the spatial patterns of warehouses relative to factors and Section 5.3 summarises the Chapter.

5.1 SPATIAL DISTRIBUTION OF WAREHOUSING TYPOLOGIES IN CAPE TOWN

This section presents the findings on the spatial distribution of warehousing in the City of Cape Town. The study found that warehouses in the City of Cape Town are classified into various categories based on the size of the facility (extent in square meters). The warehouses are classified into seven categories based on size and these include xx-small warehouses (1-200m^2); x-small warehouses (201-2000m^2); small warehouses (2001-8000m^2); medium warehouses (8001-15000); large warehouses (15001-20000m^2); x-large warehouses (20001-40000m^2), and mega warehouses (+40001m^2). The spatial distribution of warehouses in the City of Cape Town is displayed in Figure 5.1.

Figure 5.1 Distribution of warehouses at a municipal scale

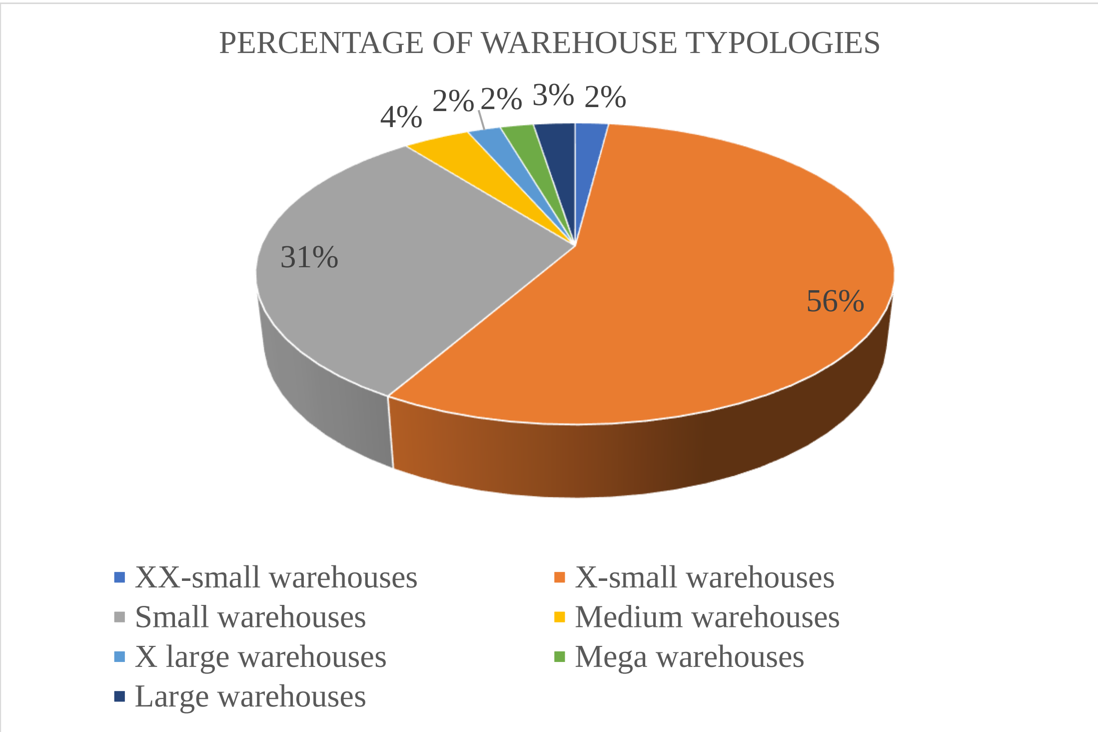
As shown in Table 5.1 and Figure 5.2, the majority of warehouses in the City of Cape Town are x-small, followed by small, medium and large warehouses, while xx-small, x large and mega warehouses account for the same number.

Table 5.1 Warehouse typologies and frequency

WAREHOUSE TYPES	SIZE	COUNT
XX-small warehouses	1-200m²	8
X-small warehouses	201-2000m²	223
Small warehouses	2001- 8000m²	123
Medium warehouses	8001-15000m²	16
Large warehouses	15001-20000m²	10
X-large warehouses	20001-40000m²	8
Mega warehouses	40 001 m² +	8

Source: Author

Figure 5.2 Percentage of warehouse typologies

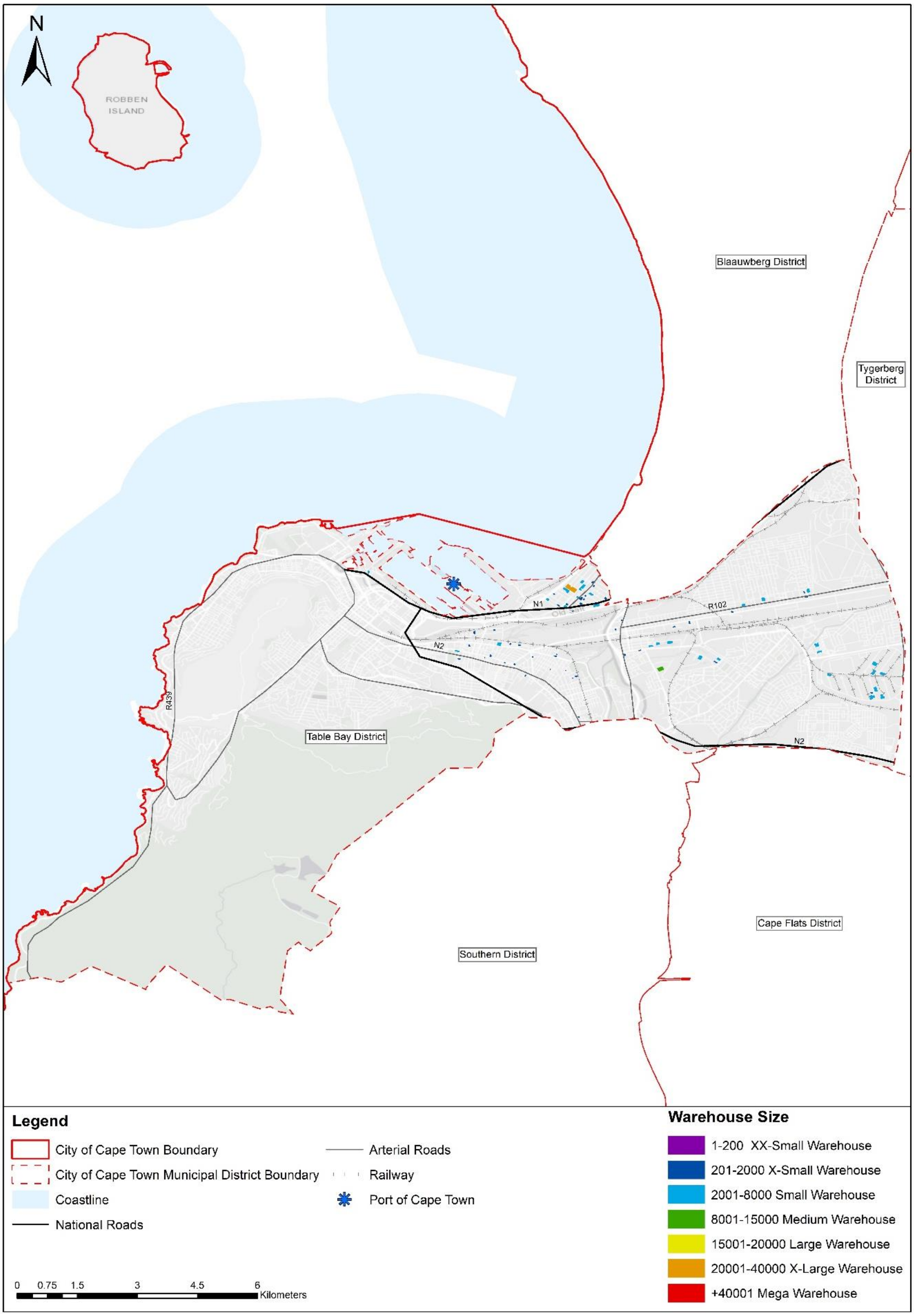


The next sub-sections present the findings of the warehouse typologies for each district in the City of Cape Town municipality.

5.1.1 TABLE BAY DISTRICT

The findings of the study presented in Figure 5.3 revealed that Table Bay district contains five typologies of warehouses. These typologies include xx-small warehouses (1-200m²); x-small warehouses (201-200m²); small warehouses (2001-8000m²); medium warehouse (8001-15000m²), x-large warehouse (20001-4000m²). The study found three xx-small warehouses in the Table Bay district. X-small warehouses are the dominant typology of warehouses found in the Table Bay district. X-small warehouses constitute a total number of forty-two, and most of the x-small warehouses are concentrated around the Port of Cape Town. Furthermore, the study found a total number of twenty-eight small warehouses in the Table Bay district. Small warehouses are the second dominant typology of warehouses found in this district. The district contains one medium warehouse and one large warehouse. The aforementioned typologies of warehouses constitute the lowest number of warehouses found in the Table Bay district. It is, therefore, important to note that there are no large warehouses and mega warehouses present in the district.

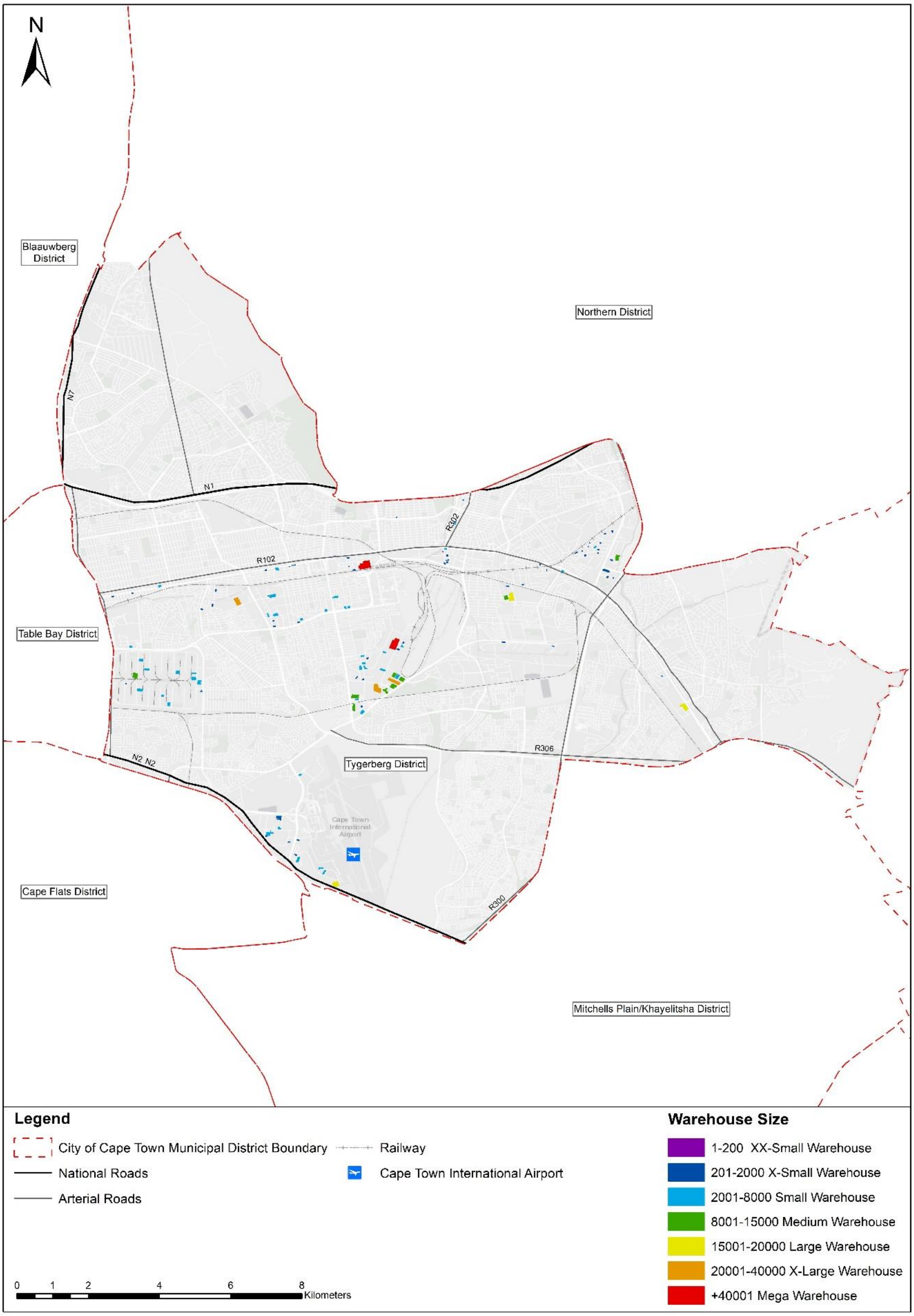
Figure 5.3 Warehouse typologies in the Table Bay District



5.1.2 TYGERBERG DISTRICT

As illustrated in Figure 5.4, Tygerberg district has the highest concentration of warehouses as compared to other districts. The study findings revealed all seven typologies of warehouses in the Tygerberg district. The study found one xx-small warehouse. Therefore, xx-small warehouses have the lowest number of warehouses as compared to other typologies. Whereas the study found sixty-four x-small warehouses in the Tygerberg district. It is, therefore, important to note that x-small warehouses show a high concentration as compared to other warehouses. In addition, the study found fifty-nine small warehouses in the Tygerberg district. The spatial concentration of small warehouses across the district depicts that small warehouses are the second dominant typologies of warehouses found in the district. Based on the findings of the study, there are nine medium warehouses, three large warehouses, three x-large warehouses, and two mega warehouses across the entire district.

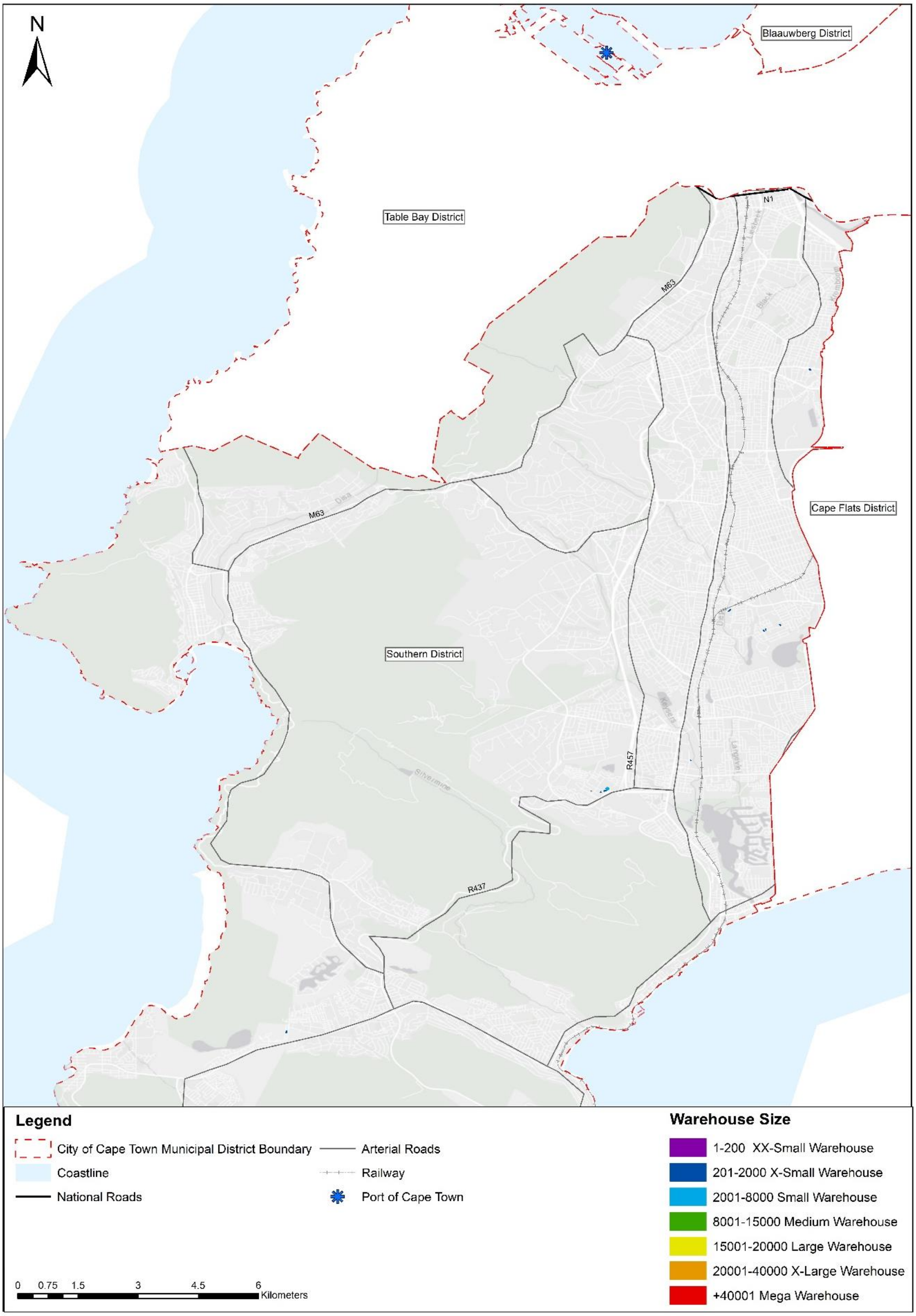
Figure 5.4 Warehouse typologies in the Tygerberg District



5.1.3 SOUTHERN DISTRICT

As shown in Figure 5.5, the Southern District accommodates the least number of warehouses compared to other districts. The study found one xx-small warehouse, twelve x-small warehouses, and one small warehouse in the Southern District. Based on the findings of the study, the district has a high concentration of x-small warehouses as compared to other typologies of warehouses.

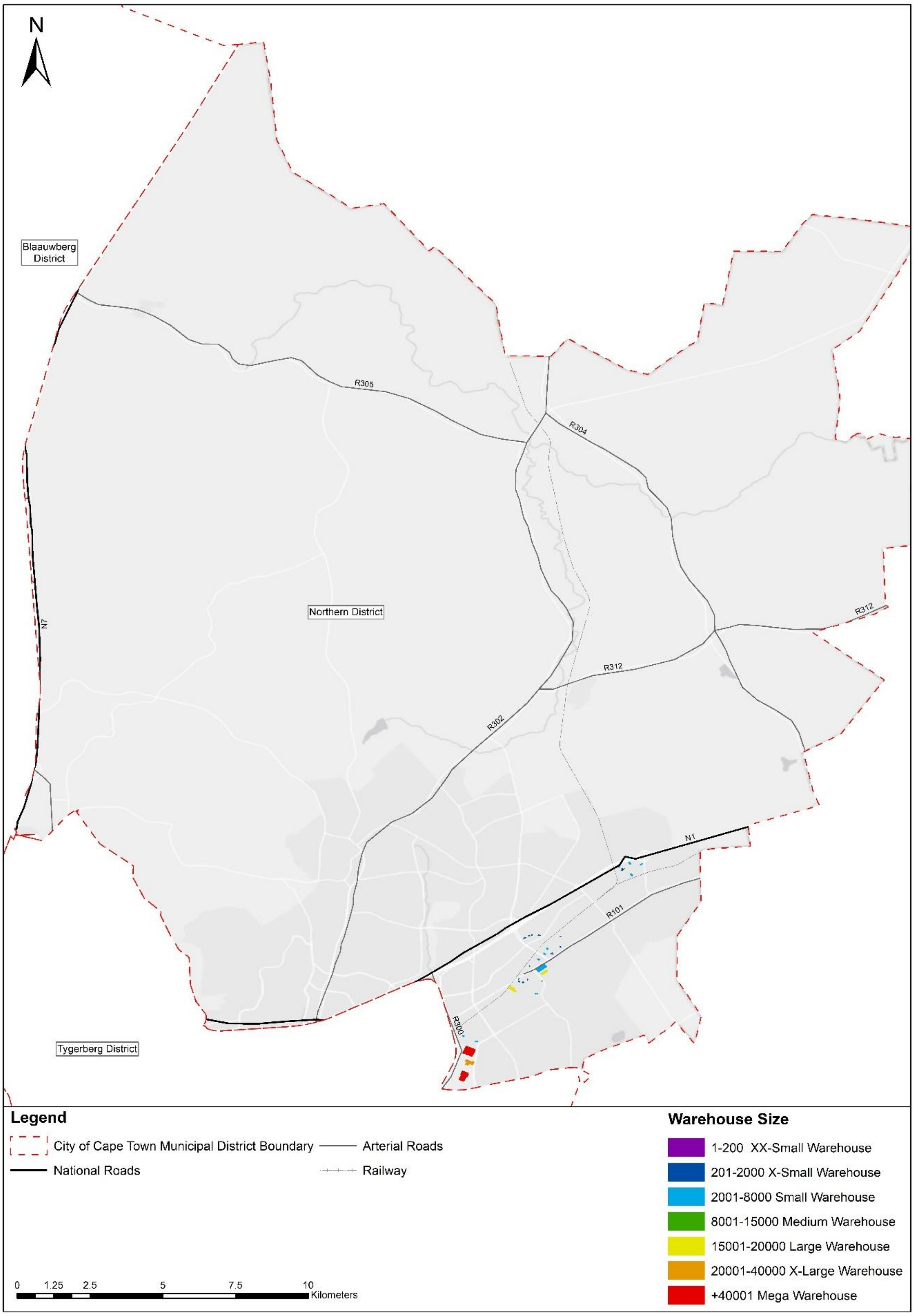
Figure 5.5 Warehouse typologies in the Southern District



5.1.4 NORTHERN DISTRICT

The findings of the study revealed that the Northern district is dominated by four typologies of warehouses, which include x-small warehouses, small warehouses, large warehouses, and mega warehouses. The study found a total number of eighteen x-small warehouses, eleven small warehouses, two large warehouses, and three mega warehouses. Therefore, based on the findings of the study, the district has the highest concentration of x-small warehouses, and small warehouses are the second dominant typology of warehouses found in the district as compared to others. Whereas large warehouses have the lowest number of warehouse typologies found in the district. Additionally, the findings revealed no evidence of xx-small warehouses, medium warehouses, and mega warehouses in the district.

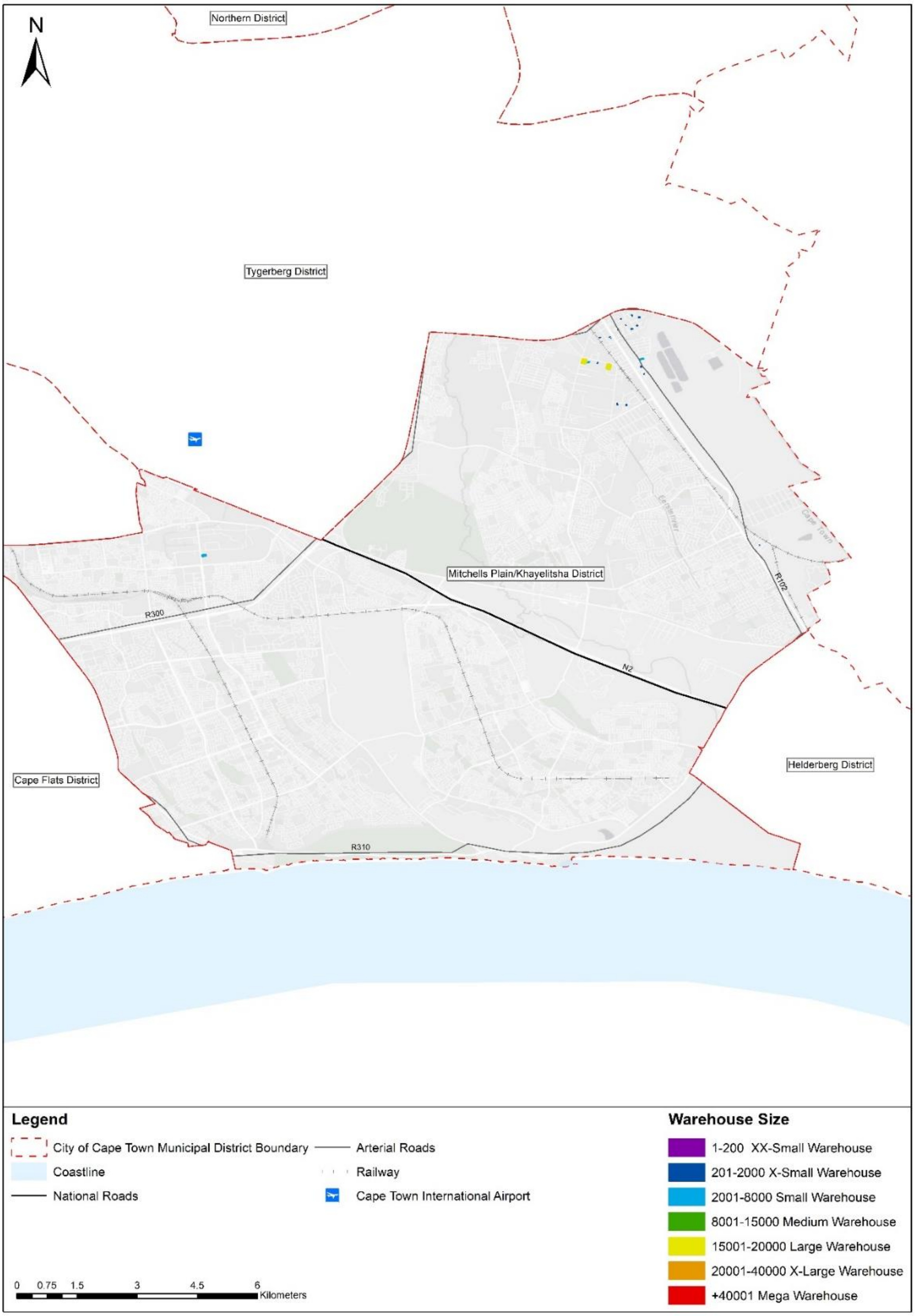
Figure 5.6 Warehouse typologies in the Northern District



5.1.5 MITCHELLS PLAIN/ KHAYELITSHA DISTRICT

As shown in Figure 5.7, the study revealed that there are three dominant typologies of warehouses in the Khayelitsha/ Mitchells Plain district, namely x-small warehouses, small warehouses, and large warehouses. The study found sixteen x-small warehouses in the district. To this end, x-small warehouses have the highest concentration warehouses as compared to other warehouse typologies. Additionally, the study found three small warehouses in the district and two large warehouses. The findings revealed no evidence of xx-small warehouses; medium warehouses, x-large, and mega warehouses in the Khayelitsha/ Mitchells Plain district.

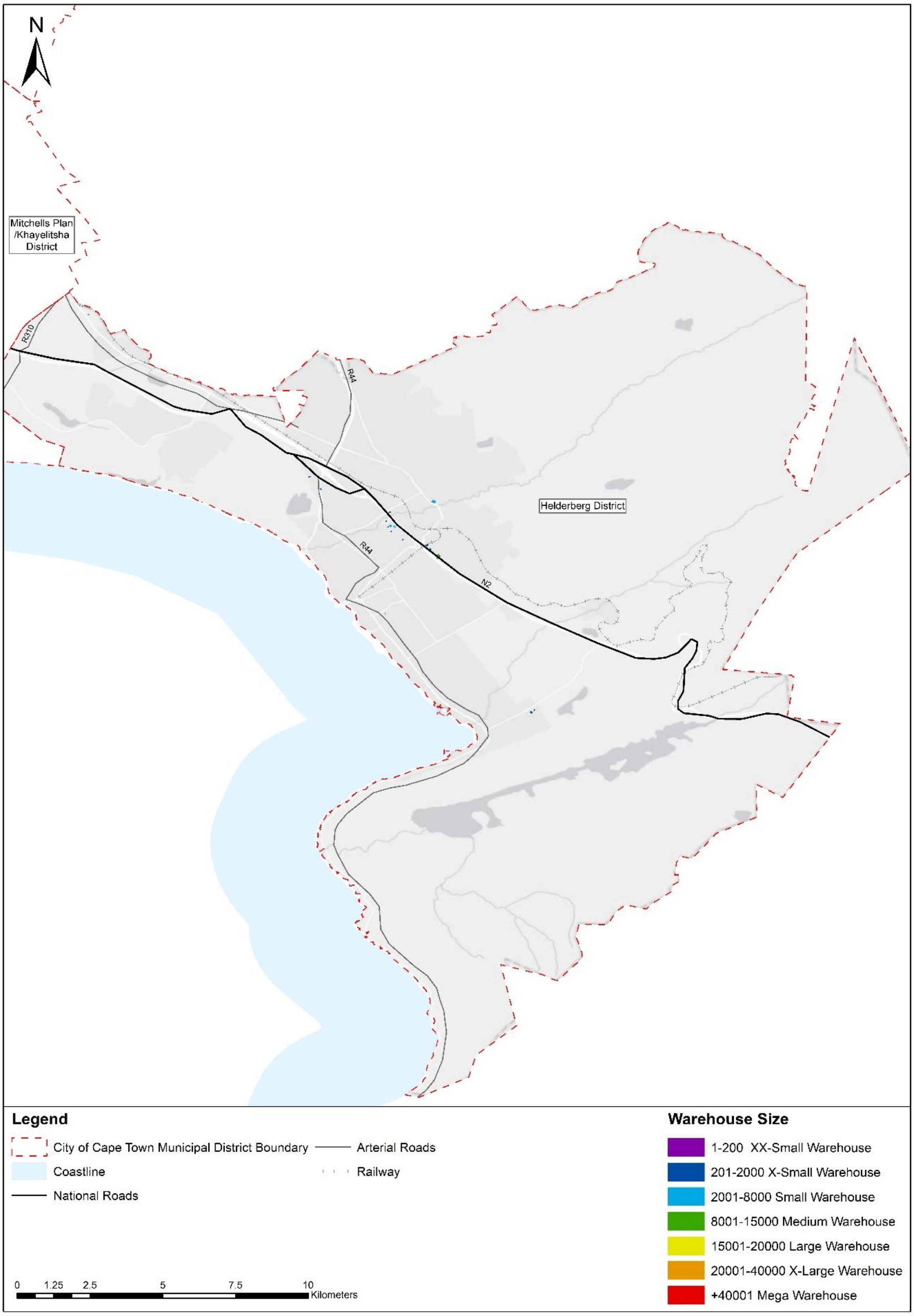
Figure 5.7 Warehouse typologies in the Mitchells Plain/ Khayelitsha District



5.1.6 HELDERBERG DISTRICT

The study found three dominant typologies of warehouses in the Helderberg district, wherein x-small warehouses constitute the dominant typology of warehouses as compared to other warehouses (Figure 5.8). There are nineteen x-small warehouses in the district, three small warehouses, and one medium warehouse. Medium warehouses constitute the lowest number of warehouses found in the district. Additionally, the study did not find evidence of xx-small, large, x-large, and mega warehouses in the district.

Figure 5.8 Warehouse typologies in the Helderberg District



5.1.7 BLAAUWBERG DISTRICT

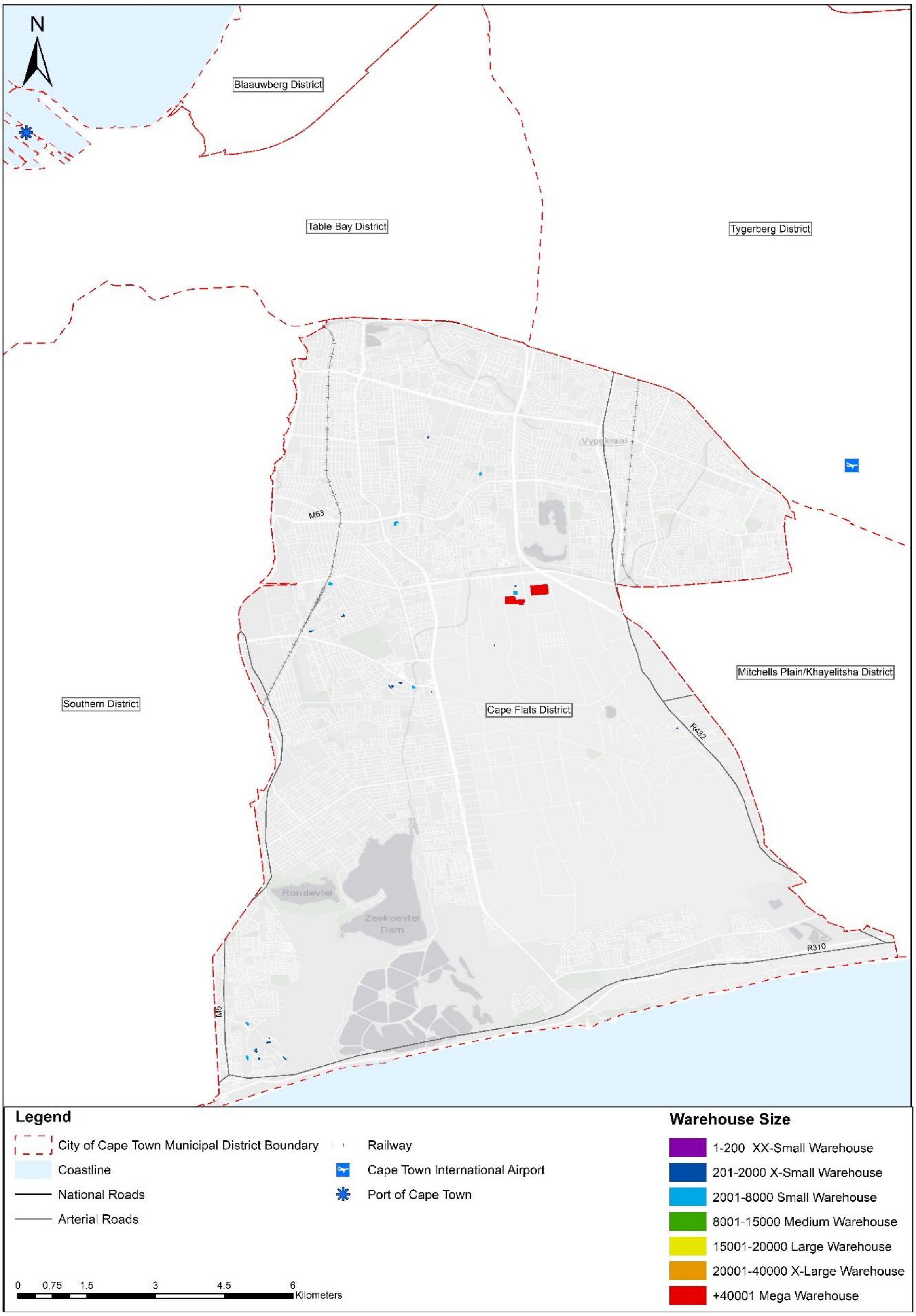
The study found all seven typologies of warehouses in the Blaauwberg district. The study found two xx-small warehouses in the district. X-small warehouses are the dominant typology of warehouses found in the district, with thirty-seven warehouses. Small warehouses are the second dominant type of warehouse found in the Blaauwberg district. The study revealed a total number of twenty-two small warehouses in the district. Additionally, the study found three large warehouses in the district. Moreover, the study found one mega warehouse in the Blaauwberg district. In this regard, mega warehouses have the lowest representation among other warehouses found in the district.

Figure 5.9 Warehouse typologies in the Blaauwberg District

5.1.8 CAPE FLATS DISTRICT

The study revealed that the Cape Flats district contains four dominant typologies of warehouses, which include xx-small warehouses, x-small warehouses, small warehouses, and mega warehouses. As illustrated by the study in Figure 5.10, there is one xx-small warehouse, fifteen x-small warehouses, seven small warehouses, and two mega warehouses in the Cape Flats district. Based on the findings of the study, x-small warehouses constitute the majority of warehouse typologies found in the Cape Flats district. Whereas xx-small warehouses are the few warehouses found in the district. Additionally, based on the findings of the study, there is no evidence of the following typologies of warehouses: medium, large, and x-large warehouses in the Cape Flats district.

Figure 5.10 Warehouse typologies in the Cape Flats District



5.2 SPATIAL PATTERN OF WAREHOUSING RELATIVE TO FACTORS

5.2.1 ROAD AND ROAD INTERSECTION/ JUNCTION PROXIMITY

The study analysed the spatial patterns of warehouse typologies relative to road infrastructure across the City of Cape Town municipality. It was found that warehousing facilities are located close to the major traffic corridors, including the N7 and N2, and a large concentration of warehouses are located between N2 and R102 (Voortreker Road). Regarding warehouse location relative to highway intersection, the study established a high concentration of warehouses in Montague Gardens, at the intersection of the N7 and N1 and the intersection of the N1 and N2. The study further analysed the spatial patterns of individual typologies of warehouses relative to the road infrastructure.

The findings revealed a high concentration of x-small warehouses creating a linear pattern along R102 road, and high clusters close to N7 in Montague Gardens Industrial and Killarney Gardens. It is, therefore, surmised that X-small warehouses are clustered in the aforementioned industrial precincts because of the easy accessibility offered by the N7 freeway. In addition, the study further uncovered the concentrations of X-small warehouses in Stikland Industrial and Brackenfell. Based on these findings it can be noted that X-small warehousing typologies are attracted to major transport routes. For instance, the Stikland Industrial area is located close to the junction of R300 and R101 (Voortreker Road).

Small warehouses resemble similar patterns with the X-small warehouses, wherein a high concentration of small warehouses was found close to the intersection of the N7 and N1. Notably, a high concentration of the aforementioned typology is found in different areas bounded by the R102 road and N2 freeway. Medium warehouses, large warehouses, and x-large warehouses are also located close to the N1 and N7 intersection. In addition, mega warehouses are geographically dispersed along major transport corridors, namely along R102 (Voortreker road), R300 and M7.

Regarding, proximity to highway junctions, the findings are supported by the literature findings in Chapter Two. Different studies uncovered the concentration of warehouses close to highway junctions in the United Kingdom (Greenhalgh, et al., 2021), and Brazil (Oliveira et al., 2022). Oliveira et al. (2022:215) established high density of warehouses across Belo Horizonte, wherein among other areas a high concentration of warehouses was found close to the intersection of the Ring Road and it is further noted that the majority of the warehouses in Belo Horizonte were located in 5 km range from the Ring Road. To this end, it can be inferred that the proximity to highway intersections augments freight transportation since warehouse facilities are major generators of freight traffic.

5.2.2 RAILWAY PROXIMITY

Considering railway proximity, the findings of the study revealed that a significant number of warehouse facilities are concentrated on the railway line across the City of Cape Town. X-small warehouses; small warehouses; medium warehouses; X-large warehouses and mega warehouses are situated close to the railway line in the following industrial precincts: Killarney Gardens, Montague Gardens, Epping Industrial, Parrow Industrial, Paarden Eiland, Stikland, Blackheath, and Brackenfell Industrial.

Furthermore, the findings depict interesting patterns, wherein the concentrated and dispersed patterns of warehouse typologies are not uniform across the entire City of Cape Town. Small warehouses (2001-8000m²) form a cluster around the railway line in Montague Gardens and Paarden Eiland. However, linear patterns are depicted at Epping Industrial, wherein the railway line in the aforementioned industrial precinct forms a fishbone pattern accessing almost individual warehouse facilities. In this regard, small warehouses clearly show a linear pattern along the railway trunk which forms a fishbone pattern. Additionally, small warehouses also form a linear pattern along the railway line passes through Brackenfell and connecting the city with the Cape Winelands.

Besides the spatial patterns depicted by small warehouses, the findings of the study revealed high concentration of x-small warehouses (201-2000m²) close to the railway line in Killarney Gardens, Montague Gardens, Woodstock, Paarden Eiland, Stikaland, Brackenfell, and Blackheath Industrial. X-small warehouses also show a linear pattern along the railway line in Somerset West, Maitland, Goodwood and Parow. Furthermore, a few large warehouses are in Parow Industrial, Paarden Eiland, Montague Gardens, and Stikland Industrial. As such the aforementioned warehouse typology shows a dispersed pattern as compared to city hubs that are concentrated in different locations across the City of Cape Town. Medium warehouses (8001-15000) form a cluster along the railway line in Montague Gardens, where the Industrial precinct is well connected by a railway line. In the same vein, a few dispersed and linear patterns of medium warehouses are found in the following areas, namely Parow Industrial, Stikland Industrial, and Ndabeni Industrial. Moreover, x-large warehouses (20001-40000m²) and mega warehouses (40000 m²+) depict a dispersed and linear pattern along the railway line in the Montague Gardens, Stikland Industrial, and Parrow Industrial. In this regard, the findings demonstrate that the aforementioned industrial precincts are well connected by the railway line which necessitates the bulky transportation of goods. As such, proximity to railway infrastructure lowers transport costs since the railway enables the bulky transportation of goods. The findings of the study are corroborated by the findings of the literature review in Chapter Two, wherein several studies examined the location of warehouse facilities relative to the railway line (Bowen, 2008; Gingerich and Maoh, 2019; Oliveira et al., 2018; Jakubicek &Woudsma, 2019). For example, Oliveira et al. (2018) investigated the trends in the location patterns of warehouse facilities in Belo Horizonte for twenty years, from 1995 to 2015. The study found that 100% of warehouse facilities were located in a 5km buffer from the railway line and there was a slight decrease in 2015, where 83% of the warehouse facilities were still located within the 5 km buffer from the railway line (Oliveira et al., 2018:8). Therefore, it appears that, though the study was based on Latin American context, the spatial patterns of warehousing facilities in Cape Town have similar resemblance to the locational patterns of warehousing facilities in Belo Horizonte. Also, Gingerich and Maoh (2019) found the concentration of warehouse facilities close to railway yards in Toronto.

The study findings revealed that, among all other factors that influence the location of warehouse facilities, to a lesser extent proximity to railway, and infrastructure attracted warehouses (Gingerich & Maoh, 2019). However, based on the findings of the study, it appears that in the City of Cape Town, proximity to railway infrastructure has a bearing on the location patterns of warehouses, for instance in Epping and Montague Gardens Industrial where warehouse facilities are accessed by railway line. In regard to railway inclination, one can surmise that railway infrastructure plays a pivotal role in the location of warehouse facilities around the City of Cape Town, as it facilitates the bulk transfer of freight goods.

Additionally, as supported by classical location theory literature discussed in Chapter Three, Weber's theory of firm location argues that argues that firms will be attracted to the locations where transport costs between resources suppliers and consumer markets are minimised (Kang, 2020a; Pillay and Geyer (2016).

5.2.3 AIRPORT PROXIMITY

The study shows a few concentrations of warehouse facilities around Cape Town International Airport. There are only two dominant typologies of warehouses located around the airport. These warehouse typologies include x-small warehouses (201-2000m^2) and small warehouses (2001-8000m^2). These typologies are located in Boquinar Industrial area (Airport Industrial 2) and Airport City. As demonstrated by the literature review chapter, a wide range of studies analysed the role of air accessibility in the location of logistics-related facilities such as warehouses. Bowen (2008) established a weaker correlation between large warehouse and airport proximity in 2005. It is further argued that due to high cost of land near the airport, large warehouses, which consume huge parcels of land are repelled away to areas where land is cheaper. Heitz et al. (2019) found a large concentration of logistics facilities around Amsterdam Airport Schipol; Gingerich, and Maoh (2019) found that proximity to Pearson International Airport in Canada attracted the location of warehouses. McKinnon (2009:295) discussing warehouse space in the UK, found that distribution centres clustered near disused airfields at Bitteswell. Therefore, this implies that warehouse facilities could be located in close proximity to the airport for easy accessibility and transportation of airfreight goods.

Apart from the studies that focuses on airfreight logistics and warehouse facilities in the global north, Mokhele and Mokhele (2023), found that a relatively small number of logistics facilities rely on the airport for airfreight services, wherein logistics facilities were located within a 20km Euclidean radius of the airport. In addition, the findings of the study uncovered that among the sixteen logistics facilities depending on CTIA, four were warehouse facilities that use the airport for airfreight services. Drawing from the findings of the afore-cited study, warehouse facilities were located in different industrial nodes that are found in a 20km radius of the airport in industrial nodes such as Epping, Parow, and Phillipi among others presumably rely on CTIA for airfreight services.

Regarding the above-mentioned study, the literature acknowledges that not all logistics facilities, specifically distribution centre are located close to the airport as a result of air accessibility, but rather are attracted to such location due to the good accessibility provided by highways, lock-in logistics factors which emanates from the agglomeration effects rather than air accessibility provided by the Amsterdam Schiphol Airport (Warffemius et al., 2010). To this end, it can be concluded that partly, proximity to CTIA plays a vital role in determining the location of x-small warehouses and small warehouses in the City of Cape Town.

5.2.4 PORT PROXIMITY

Considering port proximity, the study uncovered two dominant warehouse typologies located near the Port of Cape Town. The findings revealed a concentration of x-small warehouses (201-2000m²) and small warehouses (2001-8000m²) in Paarden Eiland, Maitland, Salt River, and Woodstock. Additionally, the study established a few x-large warehouses (20001-40000m²) located in the Paarden Eiland industrial node. Based on the findings of the study, the industrial nodes around the Port of Cape Town offer an attractive location for the previously mentioned two dominant warehouse typologies. Besides being close to the port, warehouse facilities located around the port could be attracted due to the industrial node that is close to the intersection of major traffic corridors such as the national roads N1 and N2, and proximate to the intermodal railway, which facilitates the transshipment of cargo from the port.

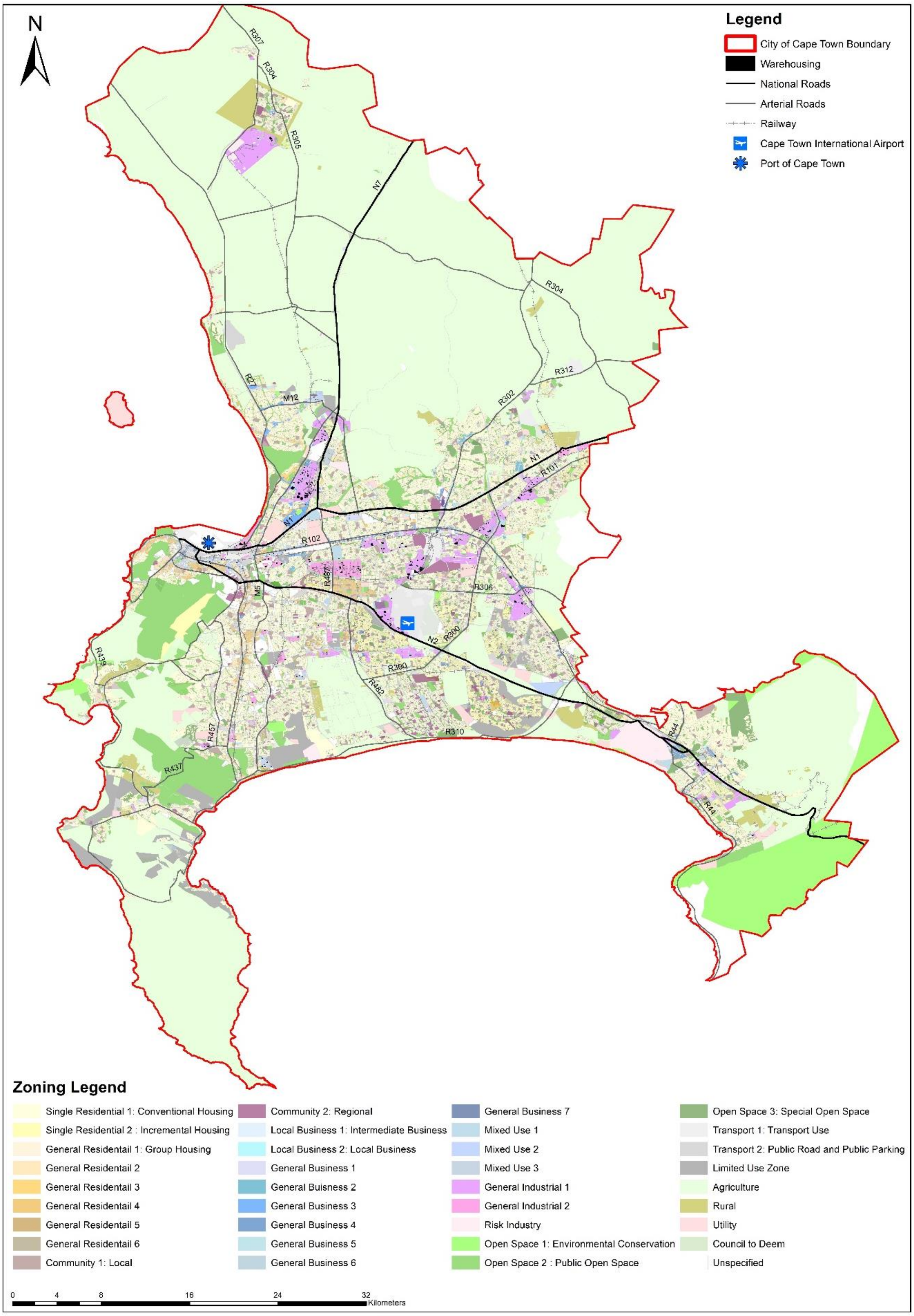
Drawing from the literature in Chapter Two, several studies were conducted in the past to examine the locational determinants of warehouse facilities, in countries such as the United States of America (Kang 2020a;2020b); Canada (Gingerich & Maoh, 2019); South Africa (Fisher-Holloway & Mokhele, 2023). According to the study by Kang (2020a), focusing on warehouse locational determinants in Los Angeles, found that among other factors, warehouse facilities built in the 1980s were greatly influenced by port/ intermodal terminal proximity. In addition, the study examined the location of the warehouse based on the Euclidean distance from the central business district of Los Angeles, wherein warehouses were concentrated in a 20mile band in areas adjacent to the port complex (i.e., Downtown LA-Norwalk-West Covina) (Kang 2020: 5). Similarly, when focusing on the spatial distribution of warehouse facilities in Cape Town municipality, a recent study by Fisher-Holloway and Mokhele, (2023) among other factors established the concentration of warehouse facilities in the vicinity of the Port of Cape Town. However, the study falls short as it did not establish the nuanced details of warehouse facilities that are located in the vicinity of the Port of Cape Town.

5.2.6 ZONING

As discussed in Chapter Two, zoning has been identified as one of the major factors that influence the spatial pattern of warehouses across the globe. Figure 5.11 illustrates the spatial distribution of warehouse facilities across the City of Cape Town. As shown on the map, warehouse typologies are distributed in different zones that include General Industrial 1 (GI1); General Industrial 2 (GI2); General Business 2 (GB2), General Business 3 (GB3); General business 4(GB4); General Business 5 (GB5); General Residential 1(GR1); General Residential

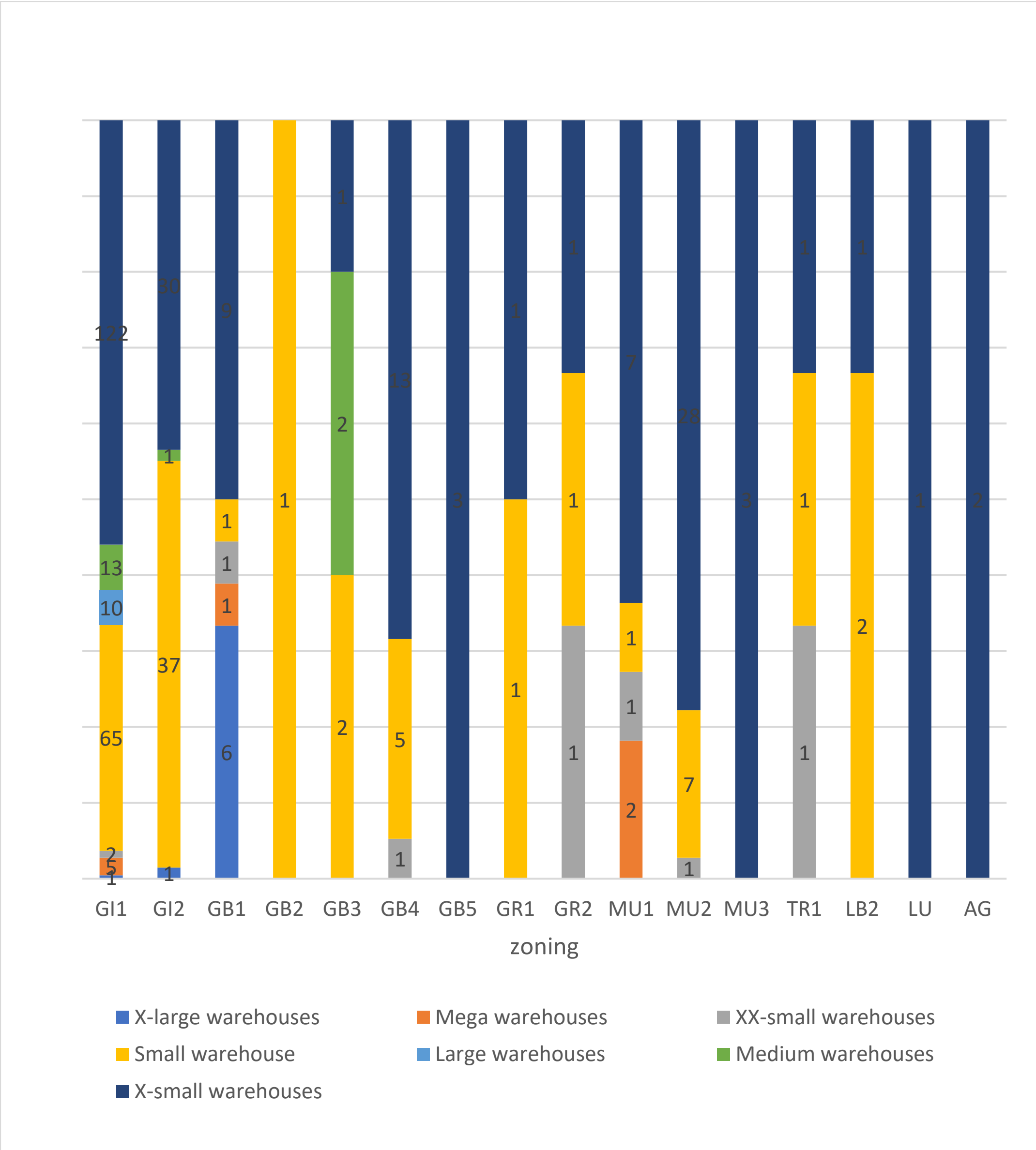
2 (GR2); Mixed Use 1(MU1); Mixed Use 2 (MU2); Mixed Use 3 (MU3); Transport Zone 1 (TR1); Local Business 2 (LB2); Limited Use (LU) and Agricultural (AG).

Figure 5.11 Spatial distribution of warehouses relative to zoning



As shown in Figure 5.12, the highest concentration of warehouses is found in the industrial zones that include GI1 and GI2. In addition, the polarised patterns of warehouse typologies are discerned in the General Industrial nodes as compared to other zones across the city. General business zones, namely GB2; GB3; GB4; and GB5 also show a high concentration of warehouses facilities in the City of Cape Town. The study presents few concentrations of warehouse facilities in the following zones: mixed use zones, namely MU1 and MU3 zones. Dispersed patterns of warehouses are depicted in the following zones, namely GR1; GR2; TR1; LU and AG zones across the city.

Figure 5.12 Distribution of warehousing typologies relative to zoning



The findings of the study revealed that x-small warehouses (201-2000m²) are the dominant typology of warehouses found in different zones across the entire city. The zones include GI1, GI1, GB1, GB3, GB4, GB5, GR1, GR2, MU1, MU2, MU3, LU and AG. The findings further present small warehouses (2001-8000m²) as the second dominant typology of warehousing facilities in the City of Cape Town. The warehouses are found in the following zones: GI1, GI2, GB1, GB2, GB3, GB4, GR1, GR2, MU1, MU2, TR1 and LB2.

One hundred and twenty-two x-small warehouses constitute 55% of the total warehouses located in the GI1 zone. Small warehouses are the second dominant typology of warehousing facilities found in areas that are zoned GI1 across the city. There are sixty-five small warehouses, which constitute a total of 29% of all warehouse typologies that are located within the GI1 zone. Also, thirteen medium warehouses constitute 5% of the total number of warehouse typologies that are spatially distributed in areas that are zoned GI1 across the City of Cape Town. Additionally, ten large warehouses are in areas that are zoned GI1, wherein the aforementioned typology of warehouses constitutes 4% of the total warehousing typologies that are located within the GI1 zone. In the same zone, there are five mega warehouses constituting 2%, two xx-small warehouses and one large warehouse.

In light of the spatial distribution of warehousing typologies in the General Industrial 2, the findings of the study revealed thirteen x-small warehouses that are spatially located in different locations across the city. The findings show that x-small warehouses constitute about 42% of the total warehouses found in different areas that are zoned GI2 across the entire City of Cape Town. The findings further present thirty-seven small warehouses that are located in areas zoned GI2 across the city. It is, therefore, important to note that small warehouses constitute 2% of the total warehousing typologies found in GI2 across the city. The study found one x-small warehouse and one small warehouse in GR1 zone. In this regard, it can be noted that the aforesaid typologies of warehousing constitute the same percentage of the total number of warehouse typologies that are spatially distributed within the GI2 zone.

Furthermore, different typologies of warehousing typologies are located in areas that are zoned General Business. The findings of the study revealed five different typologies of warehousing facilities that are in GB1 zone, wherein, nine x-small warehouses constitute 47% of the total warehouses found in GB1 zone. Six x-large warehouses constitute 31% of warehousing typologies located within the GB1 zone. The findings further present one mega warehouse, one small warehouse and one xx-small warehouse constitute the same percentage in the GB1 zone across the entire city.

The findings from the study further present one small warehouse in GB2 zone. The findings of the study show that small warehouse constitute 100% of the total warehousing typologies found in the GB2 zone across the entire city.

GB3 zone constitute three different warehouses typologies, namely small warehouses, medium warehouses, and x-small warehouse. The study found two small warehouses, constitute 40%, two medium warehouses, constitute 40% and one x-small warehouse which constitute 20% of the total warehouses found in this zone across the entire city.

The GB4 zone comprises three different typologies of warehousing facilities and these include xx-small warehouses, x-mall warehouses, and small warehouses. Among the typologies of warehousing facilities, thirteen x-small warehouses are the largest number of warehousing typologies found in GB4. It is important to mention that x-small warehouses constitute 68% of warehousing typologies found in the GB4 zone across the city. Five small warehouses constitute 26% of warehouses found in the GB4 zone across the City of Cape Town. One xx-small warehouse constitutes 5% of warehouses found in GB4 zone across the city.

The study found three x-small warehouses in GB5 zone across the entire City of Cape Town. X-small warehouses constitute 100% of the warehousing typologies found in GB5 zone. It is, therefore, important to note that the Cape Town municipal Bylaw 2015 permits the development of warehousing facilities in areas zoned General Business across the entire city as a consent use. However, the Bylaw does not specify the typology of warehousing facilities that are permitted within the GB5 zone.

The GR1 zone houses two different typologies of warehousing facilities, namely one small warehouse and one x-small warehouse. Both typologies of warehousing constitute 50% of the total warehouses found in GR1 across the entire municipality. GR2, house three typologies of warehousing namely one xx-small warehouse, one small warehouse and one x-small warehouse. As presented in Figure 5.4, each typology constitutes 33% of the total number of warehousing typologies found in the GR2 zone across the entire city.

The findings further present four different typologies of warehouses in MU1 zone, namely xx-small warehouses, x-small warehouses and mega warehouses across the entire City of Cape Town. Within the MU1 zone, seven x-small warehouses constitute 63%; two mega warehouses with a total of 18% of the total warehouses found in the MU1 zone. Also, one small warehouse and xx-small warehouse constitute 9% in MU1 zone across the city. In addition, the study found three warehouse typologies in MU2 zone across the entire City of Cape Town. The study findings show one xx-small warehouse, constitute 2.7%; seven small warehouses constitute 19%, and twenty-eight small warehouses constituting 77.7% of the total warehouses located in the MU2 zone across the entire city. Additionally, the study found, three x-small warehouses zoned MU3 across the entire City of Cape Town. It is worth noting that x-small warehouses constitute 100% of the total warehouses found in the MU3 zone. It is, therefore, important to mention that, across all three categories of Mixed-use zones, x-small warehouses emerged as a dominant typology of warehouses found across all three zones.

Furthermore, three different typologies of warehouses are found in TR1 zone. These warehouses include one xx-small warehouse, one x-small warehouse, and one small warehouse. It is therefore important to mention that each of the typologies constitutes 33% of the total number of warehouses typologies found in the TR1 zone across the City of Cape Town. It is important to mention that the City of Cape Town Bylaw 2015, permits the development of warehouses in areas that are zoned TR1 zones.

The findings further review two major typologies of warehouses found in the LB2 zone across the city. The warehouses include two small warehouses and one x-small warehouse. Small warehouses constitute 66% of the total warehouses found in LB2 zone across the entire city. X-small warehouses found in local LB2 zone constitute 33% of the total warehouses found in the LB2 in the City of Cape Town.

Only one x-small warehouse is found in the LU zone and the warehouses constitute 100% of warehouse typologies found LU across the entire city. Lastly, the study established one x-small warehouse in AG zone across the city. The warehouse constitutes 100% of warehouse typologies found in the City of Cape Town.

Informed by the literature review in Chapter Two, different studies examined the influence of zoning regulations in the locational choice of warehouse facilities. For instance, in Section

2.4.4 of Chapter Two, Yuan (2019:534) analysed the implications of different planning practices in the location choice of warehouses in Los Angeles and established that warehousing facilities are permitted in different zones, namely, industrial zones; commercial manufacturing zones; limited manufacturing zones; freeway overlay zones; limited industrial zones, and general industrial zones among others. In addition, according to a study by Rai et al. (2022) on proximity logistics, the study notes that zoning regulations in New York City provide for the development of warehousing facilities as a 'use right' in areas that are zoned manufacturing (M1.M2 and M3) and in commercial areas classified as C8 zone. To this end, the findings on the spatial distribution of warehouses in the City of Cape Town relative to zoning indicates that zoning plays a crucial role in influencing the spatial patterns of warehouses.

5.3 SUMMARY

The chapter presented the findings of the study regarding the spatial distribution of warehouse typologies across different municipal districts in the City of Cape Town. The chapter also discussed the locational patterns of warehousing typologies relative to the factors that influence the placement of warehousing facilities generally. The study established high concentration and dispersion as the dominant locational patterns of warehouse typologies in the City of Cape Town. The study established two dominant typologies of warehouse facilities namely, x-small warehouses (201-2000m²); small warehouses (2001-8000m²). The observed typologies of warehouse facilities are concentrated in the industrial nodes located in the vicinity of Port of Cape Town, CTIA, and freeway intersections such as N1 and N7, N1 and N2. Also, the study established a positive correlation between railway proximity and warehouse typologies. Regarding railway proximity, small warehouses (2001-8000m²) are highly saturated close to the railway infrastructure.

In addition, the study uncovered that warehouse facilities such as medium warehouses (80001-15000m²); large warehouses (15001-20000m²); x-large warehouses (20001-40000m²) and Global agricultural DC (40000m²+) are dispersed in different locations. The aforementioned typologies are dispersed along major traffic routes, industrial nodes located in the vicinity of the Port of Cape Town as well as the railway infrastructure. Moreover, the study found a positive correlation between warehouse and zoning wherein the majority of the warehouses located in the following five zones, namely General Industrial, Mixed Use, General Business, Agricultural and Transport Zones,

CHAPTER 6: SYNTHESIS OF THE FINDINGS AND CONTRIBUTION TO PRACTICE

The previous chapter presented the findings on the spatial patterns of warehousing typologies in the City of Cape Town municipality relative to the factors that influence the location of warehousing generally. The current chapter synthesises the findings and concludes the thesis. The chapter is structured into four interrelated sections. Section 6.1 synthesises the research findings. Section 6.2 presents the contribution of the study to planning practice. Section 6.3 highlights the extent to which the study answered the research questions and addressed the objectives and aim. Section 6.4 highlights the limitations of the study and recommends areas that require further research.

6.1 SYNTHESIS OF THE FINDINGS

The findings from the previous chapter identified several typologies of warehousing facilities. Informed by the literature presented in Chapter Two (Onstein et al., 2021), the warehousing typologies are classified according to the size of an individual building measured in square meters (m^2). Therefore, identified typologies include xx-small warehouses (1-200m^2), x-small warehouses (201-2000 m^2), small warehouses (2001-8000m^2), medium warehouses (8001-15000m^2), large warehouses (15001-20000m^2), x-large warehouses (20001-40000m^2) and mega warehouses (+40000m^2). Chapter Five discerned the following locational patterns of warehouse typologies in the City of Cape Town: concentrated, polarised dispersed and linear. The geographic patterns vary from one district to another in the municipality. The patterns of the smallest (xx-small) warehouses showed dispersed patterns in the following areas: Blauuwberg District (specifically in Killarney Gardens), Table Bay District (specifically in Paarden Eiland, Salt River), and Tygerberg District (specifically in Belville). The xx-small warehouses in the City of Cape Town are located proximate to the road infrastructure, which include national roads and regional roads (i.e., the N1, N7; R102, etc.) and railway infrastructure. The foregoing findings are supported by the literature presented in Chapter Two, wherein several studies established the spatial patterns of warehouse facilities, among others, near the road infrastructure, ports and rail (Aljohani & Thompson, 2016; Bowen, 2008; Gingerich & Maoh, 2019, Jakubicek &Woudsma, 2011; Oliveira et al., 2018).

Regarding zoning, the study found dispersed patterns of xx-small warehouses in the following zones around the City of Cape Town municipality: GI1, GB1, GB4, GR2, MU1, MU2 and TR2. According to the City of Cape Town (2015), warehouses are generally permitted either as primary use in TR1 zones or consent use in GB zones. However, the findings suggest that xx-small warehouses are located in different zones in the municipality.

Both x-large warehouses (20001-40000m²) and mega warehouses (+40 001m²) present a similar geographic pattern to that of xx-small warehouses. X-large warehouses and mega warehouses are dispersed in different locations across the City of Cape Town municipality. The geographic patterns of the largest warehouse facilities vary from one district to another. The study found a few dispersed patterns of x-large warehouses and mega warehouses in Blauuwberg District, and in the Montague Gardens Industrial node. The largest warehouses found in Montague Gardens are located close to the intersection of the N1 and N7 freeways, and the warehouses are also located near the railway infrastructure. Despite road and rail proximity, zoning plays a significant role in the spatial distribution of the largest warehouses, wherein x-large warehouses are found in the GB1 zone, while mega warehouses are found in the G11 zone. The Table Bay District, specifically Paarden Eiland, houses fewer x-large warehouses compared to other districts, and the warehouse is zoned GR2. The warehouse is located close to the railway line that accesses the Port of Cape Town, and R27 road. Interestingly, the Paarden Eiland Industrial is located close to the N1 and M5 interchange. Therefore, the findings of the study are reinforced by the literature review in Chapter Two. For instance, Tchang (2016: 2835) found that on average, distribution centres are located two kilometers from the highway in the Netherlands. It can, therefore, be argued that accessibility to road infrastructure among other factors plays an important role in the location of warehouses.

In light of the above, the findings of the study revealed that Tygerberg District constitute most of the x-large warehouses as compared to other districts. Both x-large and mega warehouses are found in Parow and Epping Industrial. X-large warehouses located in Parrow are in the GB1 zone, and GI1 zone in Epping Industrial, as compared to mega warehouses which are zoned GI1. Parrow Industrial is accessed through an extensive network of rail infrastructure and the M10 road. Also, the study established dispersed x-large and mega warehouses in the Northern District, specifically in Stikland and Brackenfell Industrial nodes. Regarding zoning, the study found that x-large warehouses located in Stikland Industrial are zoned GB1, while mega warehouses are zoned MU1 and GB1 in Brackenfell Industrial. The warehouses are located close to the R300 and the railway line that passes through Stikland Industrial connecting the city with Paarl. In Brackenfell, the mega warehouse is located close to R101 road. Lastly, the Cape Flats district, specifically in Sheffield Park in Phillip, houses a few mega-warehouses. The warehouses are in the GI1 zone and located close to the M7 and M9 roads. Moreover, the study found dispersed patterns of large warehouses (15001-2000m^2 in different districts of the municipality. Large warehouses are in the Blauuwberg, Northern, Tygerberg, and Mitchells Plain/ Khayelitsha districts. In Blauuwberg, the study found a few large warehouses in Montague Gardens. It can be argued that the large warehouses are attracted to Montague Gardens due to its proximity to the intersection of the two freight corridors, the N1 and N7 national roads. Large warehouses are in the GI1 zone. Large warehouses located in Tygerberg District are situated close to a railway line in Belville, whereas, in Kuils River, large warehouses are located close to the R102 road and close to the N2 in Boquinar Industrial. The warehouses are zoned GI1 in both industrial nodes. The Mitchells Plain/ Khayelitsha district, specifically in Blackheath Industrial shows a few large warehouses and they are located close to the railway line and the R102 road and are within the GI1 zone. Therefore, regarding zoning, large warehouses are found in areas zoned GI1 across the municipality.

In contrary to the findings synthesised above, the literature presented in Chapter Two found that large warehouses were spatially dispersed because of high land prices and prefered a suburban location where land is cheap and readily available (Cidell, 2011; Jakubicek & Woudsma, 2011; Woudsma& Jakubicek, 2020). However, regarding the spatial distribution of warehouse typologies in the City of Cape Town, the study did not analyse the correlation between land price and the location of both x-large and mega warehouses because real estate data is not available in the public domain. As highlighted by Greenhalgh et al. (2021) and Jakubicek and Woudsma (2011), the study found that accessibility to the road infrastructure plays a significant role in the location of warehouses. Additionally, the study's findings are further reinforced by Strale (2020:5) wherein the study found that the Brussels-Antwerp axle node is an attractive location for supermarket distribution centres due to good accessibility and low land prices. Regarding zoning, the findings of the study imply that in the City of Cape Town, the zoning scheme permits the development of both x-large warehouses and mega warehouses in MU1, GI1, and GB1. Also, important to note that the literature findings suggest that zoning plays an influential role in the location of warehouse facilities, though the study solely focused on the location of logistics facilities in dense urban environments (Rai et al., 2021).

Furthermore, the study established a dual pattern which includes concentration and dispersion of the following typologies of warehouses: x-small warehouses (201-2000m²), small warehouses (2001-8000m²), and medium warehouses (8001-15000m²) across the municipality. The concentration of x-small warehouses, small warehouses, and medium warehouses is discerned in industrial nodes situated in Blauuwberg District, specifically in Montague Gardens and Killarney Gardens. In Montague Gardens, x-small warehouses, small warehouses, and medium warehouses are located close to the railway line and the intersection of N7 and N1 roads. The previously mentioned warehouses are found in GI1, and GB3 zones in Montague Gardens, while in Killarney Gardens, both x-small and small warehouses are in GI1. The previously discussed findings concur with the literature findings, wherein De Silva et al. (2019: 957) focusing on the geographical patterns of fulfilment centres, argue that online retailers were attracted to locations close to expressways among other factors.

The study established a high concentration of x-small warehouses and small warehouses in the Table Bay district, specifically in Paarden Eiland Industrial, Salt River, and Ndabeni. X-small and small warehouses are the dominant typologies of warehouses found in Paarden Eiland. As discussed earlier, Paarden Eiland is in the vicinity of the Port of Cape Town and the location of x-small and small warehouses in Parden Eiland can be explained by a variety of factors, namely proximity to the Port of Cape Town, proximity to the N1 and M5 interchange, and railway infrastructure. Both x-small warehouse and small warehouse facilities in Paarden Eiland Industrial are in GI2 and TR1 zones respectively. In addition, a high concentration of warehouses located in Salt River are situated close to the railway infrastructure and R102 road. The facilities are found in MU2 and MU3 zones.

However, the study established several dispersed patterns of x-small and small warehouses in the following areas: Maitland, Ndabeni along R102 road, and Goodwood along R102. Both areas are accessed by an extensive network of railway line that passes through the industrial nodes. Both x-small and small warehouse facilities are found in GI2 and MU2 zones. The observed spatial patterns of x-small warehouses in the City of Cape Town municipality yielded similar results to those of empirical studies presented in Chapter Two, where Heitz et al. (2017) investigating logistics sprawl, argue that historically storage facilities were smaller in size and were attracted to industrial areas, and rail terminals among others.

The study found several concentrations/polarised and dispersed patterns in Tygerberg District as compared to other districts across the entire municipality. The polarisation of x-small, small warehouses, and medium warehouses are discerned in different industrial nodes, namely Parrow Industria, Epping Industria, Stikland Industria, and Boquinar Industria. The study found a high concentration of x-small, small, and medium warehouses in Parrow Industria. The warehouses are located close to the railway infrastructure, and M10 road. To this end, the findings of the study depict that proximity to both road and rail infrastructure plays a pivotal role in the location of warehouse facilities. The warehouses found in the previously mentioned industrial node are zoned in the GI1 zone.

In light of the above, the findings of the study revealed a high concentration of two typologies, x-small warehouses and small warehouses in the Boquinar Industrial node located in the vicinity of Cape Town International Airport (CTIA). It can, therefore, be argued that accessibility to the airport plays an influential role in the location of the warehouses. However, apart from being close to the airport, Boquinar Industrial is located close to N2, which is one of the major freight corridors that passes through the airport. It can be argued that transport corridors play a pivotal role in lowering logistics costs related to the transportation of freight goods. Thus, such locations offer attractive locations for warehousing facilities. In addition, zoning plays an important role in the location of warehouses in Boquinar Industrial, as such the study found that both x-small and small warehouses are zoned GI1. Drawing from the literature review in Chapter Two, regarding the CTIA, a few existing studies focus on airport-centric logistics (Mokhele, 2022; Mokhele & Mokhele, 2023. A recent study by Mokhele and Mokhele (2023) states that logistics facilities are located within a 20km radius of the CTIA. However, the concentration of warehousing facilities in the vicinity of CTIA could be attributed to other factors such as agglomeration economies and accessibility offered by the N2 road. Therefore, findings from the literature presented in Section 2.3.1 of Chapter Two, found that a large concentration of European Distribution Centres (EDC) around Amsterdam Airport Schiphol was attributed to agglomeration effects and road accessibility rather than proximity to the airport (Warffemius, 2007).

Polarised patterns of both x-small and small warehouses are discerned in the Epping Industrial node. The warehouses located in this industrial zone formed a fishbone pattern along the railway line. Therefore, it can be inferred that railway infrastructure enhances the bulk transportation of goods. Besides, the rail infrastructure, warehouses are zoned both GI1 and

GI2. The findings of the study are reinforced by the findings from the literature, wherein earlier studies presented in Chapter Two found that proximity to rail and zoning have a bearing in influencing the locational patterns of warehouse facilities (Gingerich & Maoh, 2019; Oliveira et al., 2018).

The Northern District, specifically Stikland Industrial and Brackenfell Industrial also presents another concentration of both x-small and small warehouses. The two industrial nodes are well connected to R300 and R101 arterial roads and the railway line. As such both road and rail play an important role in the transportation of freight goods. In both industrial nodes, warehouse facilities are in GR1 zones. To this end, the factors highlighted earlier suggest that both industrial locations offer attractive locations for the establishment of warehousing facilities. However, the literature highlights that apart from road accessibility, the concentration of warehouses could be influenced by market proximity (Sivintandou, 1996; Demirel et al., 2010; Kang 2020, Onstein et al., 2015). Demirel et al. (2010) pointed out that market accessibility includes the time taken to deliver a product to the customer. Onstein et al. (2015) argue that proximity to customers plays a crucial role in the location of distribution centres because of the increase in demand for Just-In-Time deliveries.

Moreover, the study found a dual pattern of x-small, small, and medium warehouses in Mitchells Plain/Khayelitsha District along the N2 road. The warehouses are close to both road and railway infrastructure. It is, therefore, important to note that most of the warehouse facilities are zoned GI1 whilst a small number of warehouses are found in GB4 zones. This implies that the district offers an attractive location for warehouse facilities because of the accessibility offered by both road and rail infrastructure. It should, therefore, be noted that the findings of the study are supported by literature findings presented in Chapter Two, wherein Cidell (2010) established both the concentration and dispersion of distribution centres. Additionally, Onstein et al. (2016:12) established a similar pattern in the Netherlands, where polarised patterns of logistics facilities were discerned within regions resulting in the formation of clusters.

Moreover, the findings of the study found very few dispersed patterns of x-small and small warehouses in Cape Flats and Sothern districts respectively. In the Cape Flats district, dispersed patterns are discerned along R310 road, and areas located between M5 and M7 road and close to the railway line. The concentrated pattern is discerned in Capricorn Business and Technology

Park. Concerning zoning, the typologies are located in the following zones, GI, G2, and MU2 respectively. It can be noted that MU2 is prevalent in Capricorn Business and Technology Park where there is a high concentration of both x-small and small warehouses as compared to other parts of the district.

The Southern District constitutes very few dispersed patterns of x-small and small warehouses as compared to other districts across the entire municipality. The dispersed patterns of x-small warehouses are depicted along M42 road. Apart from road proximity, a few dispersed patterns of warehouses are found to be located close to the rail infrastructure. Also, zoning has a bearing on the spatial distribution of warehouse facilities in the district, and the warehouse facilities are found in the GI2 zone. Against this backdrop, the literature findings support the findings on the spatial patterns of warehouses in Cape Town, largely because the studies established both concentration and dispersion of warehouse facilities in different locations across the globe (Kang, 2020a, Jakubicek & Woudsma, 2012).

6.2 CONTRIBUTION

This subsection discusses the contribution of the study towards planning practice as previously alluded to in Section I.5 in Chapter One. The contribution of the study towards warehousing planning is informed by the findings of the study on the spatial distribution of warehouse typologies in the City of Cape Town and the literature findings presented in Chapter Two.

6.2.1 CONTRIBUTION TO PRACTICE

Apart from extending the existing knowledge on spatial patterns of warehouse facilities, as noted earlier in Section 6.1, the study contributes towards practice, whereby planning efforts can be directed toward planning for warehouse facilities across the City of Cape Town municipality. The study discovered the concentration and dispersion of diverse warehouse typologies in different municipal districts, specifically in industrial nodes as well as business parks across the municipality with some industrial nodes dominated by single or few typologies of warehouse facilities. The study found that the spatial pattern of warehousing typologies is related to several factors, which include the proximity to road, rail, port, airport and zoning. Against this backdrop, the study contributes to practice in the following:

- **Planning for different typologies of warehouses at the municipal level**: There should be a clear understanding that warehouse typologies such as xx-small warehouses; x-small warehouses; small warehouses; medium warehouses, large warehouses; x-large warehouses, and mega warehouses have different locational needs across the municipality. As a result of variations in sizes of warehouse facilities, some facilities need large expanses of land and therefore prefer locations with large erven/plots where land is inexpensive. While the smallest warehouse facilities such as xx-small warehouses (1-200m²) prefer locations with high urban density.

The study contributes towards better-informed zoning regarding the placement of warehouse facilities across the municipality. Therefore, zoning can be used as a tool to evaluate the locational needs of warehouse typologies. Additionally, the zoning scheme can be revised to accommodate a variety of warehouse facilities in certain zones.

- **Evaluate economic policies that promote the growth and expansion of economic activities:** The study contributes to economic policies aimed at promoting the growth and expansion of industrial zones and business parks to attract a diverse of economic activities. The concentration of economic activities within industrial nodes combats the negative effects associated with the dispersed patterns of large warehouse facilities, such as the increased consumption of urban land.

  There is need to promote economic activities that generate employment opportunities and revenue inform of tax which contributes toward the overall economic growth across the municipality.

  Economic policies should be directed towards promoting the clustering of economic activities in industrial nodes located in the vicinity of intermodal facilities such as Port of Cape Town and Cape Town International Airport.

  There is a need a need to consider policies that promote the growth of a wide range of economic activities along the major corridors in the City of Cape Town.

6.3 CONCLUSIONS

6.3.1 RESEARCH AIM

The overarching aim of the study was to analyse the spatial patterns of warehouse typologies and draw implications for planning. In this regard, the study will contribute towards planning for warehouse facilities across the City of Cape Town municipality. The contribution of the study towards practice is presented in Section 6.2.1, demonstrating that the aim of the study has been achieved.

6.3.2 RESEARCH QUESTIONS AND OBJECTIVES

The research questions and objectives were set towards achieving the aim of the study highlighted in Section 6.3.1 above. Therefore, for ease of reference, indication is provided below of the main sections where research questions and objectives were addressed in the thesis.

- The first research question was, "What factors influence the spatial pattern of warehousing typologies?". The research question was thoroughly addressed in Chapter Two, Section 2.4.

- The second research question was, "How are the different typologies of warehousing facilities spatially distributed in the City of Cape Town municipality?" The research question was thoroughly addressed in Section 5.1 of Chapter Five.

6.4 POTENTIAL AREAS FOR FURTHER RESEARCH

Building upon the findings of the study, discussed earlier in Section 6.1 and the literature review findings presented in Chapter Two, this subsection discusses several areas warranting further research.

1) The research relied on secondary data to analyse the spatial patterns of warehousing typologies. Further research is required to collect primary data concerning the factors that influence the spatial patterns of warehouse typologies in the City of Cape Town municipality.
2) Further investigations are required to determine the interrelatedness of warehouse typologies located around the Port of Cape Town and port activities. The study found a high concentration of both large and small warehouses in industrial nodes in the vicinity of Port of Cape Town.
3) The study recommends further research be conducted on the role played by railway accessibility in the location of medium-sized warehouse facilities. Thus, ascertaining whether railway infrastructure has a direct influence on the location of warehouse typologies across the City of Cape Town municipality.

4) Further investigations are required to examine factors that attract x-large warehouses and mega warehouses in different zones, for example MU1 zones. Additionally, further investigation is required to examine the reason why some warehouse typologies are located in zones that do not directly permit warehousing development as provided for in the Bylaw.
5) Empirical research needs to be conducted on studies that examine the interrelatedness between land value and the location of warehousing typologies for instance to examine the extent to which land values/land prices influence the dispersion of warehouse typologies.

REFERENCES

Agyabeng-Mensah, Y., Ahenkorah, E., Afum, E., Dacosta, E. & Tian, Z. 2020. Green warehousing, logistics optimization, social values, and ethics and economic performance: the role of supply chain sustainability. *International Journal of Logistics Management*, 31(3): 549–574.

Aljifri, H.A., Pons, A. & Collins, D. 2003. Global e-commerce: A framework for understanding and overcoming the trust barrier. *Information Management and Computer Security,* 11(2–3): 130–138.

Aljohani, K. & Thompson, R.G. 2016. Impacts of logistics sprawl on the urban environment and logistics: Taxonomy and review of literature. *Journal of Transport Geography*, 57: 255–263.

Allen, J., Browne, M. & Cherrett, T. 2012. Investigating relationships between road freight transport, facility location, logistics management, and urban form. *Journal of Transport Geography*, 24: 45–57.

Anca, V. 2019. Logistics and Supply Chain Management: An Overview. *Studies in Business and Economics*, 14(2): 209–215.

Andreoli, D., Goodchild, A. & Vitasek, K. 2010. The rise of mega distribution centers and the impact on logistical uncertainty. *Transportation Letters*, 2(2): 75–88.

Aoyama, Yuko, Hanson, Susan, Murphy & James T. Key Concepts in Economic Geography.

Asabere, P.K. & Huffman, F.E. 1991. Zoning and industrial land values: the case of Philadelphia. *Real Estate Economics*, 19(2):154-160.

Badampudi, D., Wohlin, C. & Petersen, K. 2015. Experiences from using snowballing and database searches in systematic literature studies. In ACM International Conference Proceeding Series. Association for Computing Machinery.

Bäing, S. & Webb, B. 2020. Planning Through Zoning: a literature review. The Royal Town Planning Institute.

Bartholdi, J.J. & Gue, K.R. 2004. The best shape for a cross-dock. *Transportation Science*, 38(2): 235–244.

Bartholdi, J.J. and Hackman, S.T., 2008. Warehouse & Distribution Science: Release 0.89 (p. 13). Atlanta: Supply Chain and Logistics Institute.

Bejrananda, C., Lee, Y. & Khamkaew, T. 2015. The Spatial Pattern of Economic Rents of an Airport Development Area: Lessons Learned from the Suvarnabhumi International Airport, Thailand. In Proceedings of International Academic Conferences (No. 2604285). International Institute of Social and Economic Sciences. In International Institute of Social and Economic Sciences (IISES).

Berthold, K.R., 2019. Supply Chain Management: A Descriptive Conception. *International Journal for Empirical Education and Research*, 3(19):43-65.

Berg, J.P.V. Den & Zijm, W.H.M. 1999. Models for warehouse management: Classification and examples. *International Journal of Production Economics*, 59(1): 519–528.

Bowen, J.T. 2008. Moving places: the geography of warehousing in the US. *Journal of Transport Geography*, 16(6): 379–387.

Bowersox, D.J., Closs, D.J., Cooper, M.B. and Bowersox, J.C., 2020. Supply chain logistics management. McGraw-Hill.

Boysen, N. & Fliedner, M. 2010. Cross dock scheduling: Classification, literature review and research agenda. *Omega*, 38(6): 413–422.

Boysen, N., Fliedner, M. & Scholl, A. 2010. Scheduling inbound and outbound trucks at cross-docking terminals. *OR Spectrum*, 32(1): 135–161.

Bozarth, C., Blackhurst, J. & Handfield, R.B. 2007. Following the thread: Industry cluster theory, the New England Cotton textiles industry, and implications for future supply chain research. *Production and Operations Management*, 16(1): 154–157.

Buldeo Rai, H., Kang, S., Sakai, T., Tejada, C., Yuan, Q., Conway, A. & Dablanc, L. 2022. 'Proximity logistics': Characterizing the development of logistics facilities in dense, mixed-use urban areas around the world. *Transportation Research Part A: Policy and Practice*, 166: 41–61.

Button, K.J. & Kulkarni, Rajendra. 2001. Spatial and Distance Statistics of the Trucking and Warehousing Industries using GIS Tools. https://www.researchgate.net/publication/23730299.

Cappello, R. 2011. Location, regional growth, and local development theories. Location, Regional Growth, and Local Development Theories. Regional Growth and Local Development Theories: 1–25.

Chhetri, P., Butcher, T. & Corbitt, B. 2014. Characterising spatial logistics employment clusters. *International Journal of Physical Distribution and Logistics Management*, 44(3): 221–241.

Chu, Z. & Wang, Q. 2012. Drivers of Relationship Quality in Logistics Outsourcing in China. *Journal of Supply Chain Management*, 48(3): 78–96.

Chung, T.W. 2016. A Study on Logistics Cluster Competitiveness among Asia Main Countries using the Porter's Diamond Model. *Asian Journal of Shipping and Logistics*, 32(4): 257–264.

Cidell, J. 2010. Concentration and decentralization: The new geography of freight distribution in US metropolitan areas. *Journal of Transport Geography*, 18(3): 363–371.

Cidell, J. 2011. Distribution Centers among the Rooftops: The Global Logistics Network Meets the Suburban Spatial Imaginary. *International Journal of Urban and Regional Research*, 35(4): 832–851.

City of Cape Town. 2020. Profile and Analysis District Development Model. Available at https://www.cogta.gov.za/ddm/wp-content/uploads/2020/11/City-of-CT-September-2020.pdf

City of Cape Town. 2023. Municipal Spatial Development Framework. Available on https://resource.capetown.gov.za/documentcentre/Documents/City%20strategies%2C%20plans

City of Cape Town. 2015. Municipal Planning By-Law Amended 2019, Available at http://sfb.org.za/images/public_participation/Draft%20City%20of%20Cape%20Town%20Municpal%20Planning%20Amendment%20Bylaw.pdf

Collins Dictionary. 2023 https://www.collinsdictionary.com/dictionary/english/typology

Creswell, J.W. 2014. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Fourth Edition. Sage.

Crotti, D. & Maggi, E. 2017. Urban Distribution Centres and Competition Among Logistics Providers: A Hotelling Approach. *SSRN Electronic Journal*.

da Costa Barros, Í.R. & Nascimento, T.P. 2021. Robotic Mobile Fulfillment Systems: A survey on recent developments and research opportunities. *Robotics and Autonomous Systems*, 137.

Dablanc, L. & Ross, C. 2012. Atlanta: A mega logistics center in the Piedmont Atlantic Megaregion (PAM). *Journal of Transport Geography*, 24: 432–442.

Dai, Q. & Yang, J. 2013. Input-output Analysis on the Contribution of Logistics Park Construction to Regional Economic Development. *Procedia - Social and Behavioral Sciences*, 96: 599–608.

De Ligt, T. & Wever, E. 1998. European distribution centres: location patterns. *Tijdschrift voor Economische en Sociale Geografie*, 89(2): 217–223.

Defee, C.C., Williams, B., Randall, W.S. & Thomas, R. 2010. An inventory of theory in logistics and SCM research. *International Journal of Logistics Management*, 21(3): 404–489.

De Silva, C.K., Sano, K. & Hatoyama, K. 2020. Exploring the relationship between urban form and spatial organisation of Amazon fulfilment facilities in the United Kingdom and Japan. *Transportation Research Procedia*, 149–156.

Demirel, T., Demirel, N.Ç. & Kahraman, C. 2010. Multi-criteria warehouse location selection using Choquet integral. *Expert Systems with Applications*, 37(5): 3943–3952.

DeWitt, T., Giunipero, L.C. & Melton, H.L. 2006. Clusters and supply chain management: The Amish experience. *International Journal of Physical Distribution and Logistics Management*, 36(4): 289–308.

Divyendu, S.R., 2019. Analysis and study of warehouse management systems. *International Research Journal of Engineering and Technology (IRJET)*, 6(10): 56-72.

Dong, Y., Xu, M. & Miller, S.A. 2020. Overview of cold chain development in China and methods of studying its environmental impacts. *Environmental Research Communications*, 2(12).

Douglas M. Lambert, J.R.S. and L.M.E. 1996. LIMPERT, Elram &stock Fundamentals of logistics management Warehousing pdf.

Dubie, M., Kuo, K.C., Giron-Valderrama, G. & Goodchild, A. 2020. An evaluation of logistics sprawl in Chicago and Phoenix. *Journal of Transport Geography*, 88.

Ducruet, C., Notteboom, T.E. and De Langen, P.W. 2016. Revisiting inter-port relationships under the New Economic Geography research framework. In Ports in Proximity (pp. 11-27). Routledge.

du Plessis, M.J., van Eeden, J. & Goedhals-Gerber, L.L. 2022. The Carbon Footprint of Fruit Storage: A Case Study of the Energy and Emission Intensity of Cold Stores. *Sustainability*, 14(13).

Durmuş, A. & Turk, S.S. 2014. Factors Influencing Location Selection of Warehouses at the Intra-Urban Level: Istanbul Case. *European Planning Studies*, 22(2): 268–292.

Eriksson, E., Norrman, A. & Kembro, J. 2019. Contextual adaptation of omni-channel grocery retailers' online fulfilment centres. *International Journal of Retail and Distribution Management*, 47(12): 1232–1250.

ESCAP, U., 2002. Commercial development of regional ports as logistics centres. Available at https://www.unescap.org/sites/default/files/pub_2194_fulltext.pdf

Faber, N., De Koster, R.B.M. & Smidts, A. 2018. Survival of the fittest: the impact of fit between warehouse management structure and warehouse context on warehouse performance. *International Journal of Production Research*, 56(1–2): 120–139.

Felea, M. & Albăstroiu, I. (n.d.). Defining the concept of supply chain management and its relevance to romanian academics and practitioners.

Fernie, J. & Mckinnon, A. 1991. The Impact of Changes in Retail Distribution on a Peripheral Region: The Case of Scotland. *International Journal of Retail and Distribution Management*, 19(7): 25–32.

Fernie, J., Sparks, L. & McKinnon, A.C. 2010. Retail logistics in the UK: Past, present and future. *International Journal of Retail and Distribution Management*, 38(11): 894–914.

Ferrari, C., Parola, F. & Morchio, E. 2006. Southern European ports and the spatial distribution of EDCs. *Maritime Economics and Logistics*, 8(1): 60–81.

Fujita, M. & Krugman, P. 2004. The new economic geography: Past, present and the future. *Papers in Regional Science,* 83(1).

Fujita, M. 2010. The evolution of spatial economics: From Thünen to the new economic geography. *Japanese Economic Review*, 61(1): 1–32.

Fisher-Holloway, B. & Mokhele, M. 2022. The deployment of theory in logistics research: A systematic literature review. *Journal of Transport and Supply Chain Management*, 16.

Fisher-Holloway, B. & Mokhele, M. 2023. Geographical patterns of warehousing facilities in the Cape functional region, South Africa. *Regional Science Policy and Practice,* 15(6): 1317-1338

Gao, J., Wu, Z., Chen, J. & Chen, W. 2020. Beyond the bid-rent: Two tales of land use transition in contemporary China. *Growth and Change*, 51(3): 1336–1356.

Gingerich, K. & Maoh, H. 2019. The role of airport proximity on warehouse location and associated truck trips: Evidence from Toronto, Ontario. *Journal of Transport Geography,* 74: 97–109.

Giuliano, G. & Kang, S. 2018. Spatial dynamics of the logistics industry: Evidence from California. *Journal of Transport Geography*, 66: 248–258.

Goedhals-Gerber, L.L. & Khumalo, G. 2020. Identifying temperature breaks in the export cold chain of navel oranges: A Western Cape case. Food Control, 110.

Goedhals-Gerber, L.L., Haasbroek, L., Freiboth, H. & Van Dyk, F.E. 2015. An analysis of the influence of logistics activities on the export cold chain of temperature-sensitive fruit through the Port of Cape Town. *Journal of Transport and Supply Chain Management*, 9(1).

Goedhals-Gerber, L.L., Stander, C. & Van Dyk, F.E. 2017. Maintaining cold chain integrity: Temperature breaks within fruit reefer containers in the Cape Town Container Terminal. *Southern African Business Review*, 21: 362–384.

Greenhalgh, P., King, H.M., Muldoon-smith, K. & Ellis, J. 2021. The new distribution: Spatio-temporal analysis of large distribution warehouse premises in England and Wales. *Urban Planning*, 6(3): 399–414.

Grimes, A. and Liang, Y. 2009. Spatial determinants of land prices: Does Auckland's metropolitan urban limit have an effect? *Applied Spatial Analysis and Policy,* (2): 23-45.

Guerin, L., Vieira, J.G.V., de Oliveira, R.L.M., de Oliveira, L.K., de Miranda Vieira, H.E. & Dablanc, L. 2021. The geography of warehouses in the São Paulo Metropolitan Region and contributing factors to this spatial distribution. *Journal of Transport Geography*, 91.

Gümüş, M. & Bookbinder, J.H. 2004. Cross-docking and its implications in location-distribution systems. *Journal of Business Logistics*, 25(2): 199–228.

Hafeez, K., Foroudi, P., Dinnie, K., Nguyen, B. & Parahoo, S.K. 2016. The role of place branding and image in the development of sectoral clusters: The case of Dubai. *Journal of Brand Management*, 23(4): 383–402.

Havenga, J., Simpson, Z. & Goedhals-Gerber, L. 2017. International trade logistics costs in South Africa: Informing the port reform agenda. *Research in Transportation Business and Management*, 22: 263–275.

He, M., Shen, J., Wu, X. & Luo, J. 2018a. Logistics space: A literature review from the sustainability perspective. *Sustainability*, 10(8).

Heitz, A. & Dablanc, L. 2015. Logistics spatial patterns in Paris rise of Paris basin as logistics megaregion. *Transportation Research Record*, 2477.

Heitz, A., Dablanc, L. & Tavasszy, L.A. 2017. Logistics sprawl in monocentric and polycentric metropolitan areas: The cases of Paris, France, and the Randstad, the Netherlands. *Region*, 4(1): 93–107.

Heitz, A., Dablanc, L., Olsson, J., Sanchez-Diaz, I. & Woxenius, J. 2020. Spatial patterns of logistics facilities in Gothenburg, Sweden. *Journal of Transport Geography*, 88.

Hesse, M. & Rodrigue, J.P. 2004a. The transport geography of logistics and freight distribution. *Journal of Transport Geography*, 12(3): 171–184.

Hesse, M. 2016. The city as a terminal: The urban context of logistics and freight transport. Routledge. Ashgate.

Hesse, M., 2004. Land for logistics: locational dynamics, real estate markets and political regulation of regional distribution complexes. *Tijdschrift voor economische en sociale geografie*, 95(2), 162-173.

Higgins, C., Ferguson, M. & Kanaroglou, P. 2012. Varieties of logistics centers. *Transportation Research Record*, (2288): 9–18.

Higginson, J.K. & Bookbinder, J.H. 2005. Distribution centres in supply chain operations. In Logistics systems: Design and optimization (pp. 67-91). Boston, MA: Springer US.

Holzapfel, A., Kuhn, H. & Sternbeck, M.G. 2018. Product allocation to different types of distribution center in retail logistics networks. *European Journal of Operational Research*, 264(3): 948–966.

Houde, J.-F., Newberry, P., Seim, K., Asker, J., Collard-Wexler, A., Grieco, P., Kim, J.-H., Larsen, B., Lee, R., Molinari, F., Murry, C., Piolatto, A., Reimers, I. & Zheng, F. 2017. NBER working paper series nexus tax laws and economies of density in e-commerce: a study of amazon's fulfillment center network Nexus Tax Laws and Economies of Density in E-Commerce: A Study of Amazon's Fulfillment Center Network. http://www.nber.org/papers/w23361.

Huang, H., Li, D., Han, Z., Zhang, H., Wang, H. & Duan, Y. 2023. Analysis of Spatial-Temporal Evolution Pattern and Its Influencing Factors of Warehouse Supermarkets in Liaoning Province. *ISPRS International Journal of Geo-Information*, 12(3).

Huang, S.Z., Tsai, H.T. & Cheng, W.L. 2017. Analyzing coordinated development of logistics parks in China by hotelling model. *Journal of Interdisciplinary Mathematics*, 20(3): 837–849.

Humpl, D., 2011. Logistics a freight movement against the Background of New Economic Geography. *International Supply Chain Management and Collaboration Practices*, (4):77

Hylton, P.J. and Ross, C.L., 2018. Agglomeration economies' influence on logistics clusters' growth and competitiveness. *Regional studies*, 52(3):350-361.

İyigün, İ., Faruk, Ö. & Editors, G. 2022. *Logistics 4.0 and Future of Supply Chains*. Springer. https://link.springer.com/bookseries/13615.

Jakubicek, P. & Woudsma, C. 2011. Proximity, land, labor and planning? Logistics industry perspectives on facility location. *Transportation Letters*, 3(3): 161–173.

Jaller, M., Pineda, L. & Phong, D. 2017. Spatial analysis of warehouses and distribution centers in Southern California. *Transportation Research Record*, 2610(1): 44–53.

Jardas, M., Krljan, T., Perić Hadžić, A. and Grubišić, N.,2020. Distribution center logistics optimization model–City of Rijeka case study. Pomorstvo, 34(1):185-194.

Jones, P. 2022. Warehouse development and town planning policies in the UK. *Property Management*, 40(4): 527–540.

Kalaitzi, D., Matopoulos, A., Bourlakis, M. & Tate, W. 2018. Supply chain strategies in an era of natural resource scarcity. International Journal of Operations and Production Management, 38(3): 784–809.

Kang, S. 2020a. Warehouse location choice: A case study in Los Angeles, CA. *Journal of Transport Geography*, 88.

Kang, S. 2020b. Why do warehouses decentralize more in certain metropolitan areas? *Journal of Transport Geography*, 88.

Kang, S. 2020c. Relative logistics sprawl: Measuring changes in the relative distribution from warehouses to logistics businesses and the general population. *Journal of Transport Geography*, 83.

Karatas-Cetin, C. & Denktas-Sakar, G. 2013. Logistics research beyond 2000: Theory, method and relevance. *Asian Journal of Shipping and Logistics*, 29(2): 125–144.

Kembro, J. & Norrman, A. 2022. The transformation from manual to smart warehousing: an exploratory study with Swedish retailers. *International Journal of Logistics Management*, 33(5): 107–135.

Ketokivi, M. & Mahoney, J.T. 2020. Transaction Cost Economics as a Theory of Supply Chain Efficiency. *Production and Operations Management*, 29(4): 1011–1031.

Kin, B., Buldeo Rai, H., Dablanc, L. & Quak, H. 2023. Integrating logistics into urban planning: best practices from Paris and Rotterdam. *European Planning Studies*.

Kitchenham, B., Pearl Brereton, O., Budgen, D., Turner, M., Bailey, J. & Linkman, S. 2009. Systematic literature reviews in software engineering - A systematic literature review. *Information and Software Technology*, 51(1): 7–15.

Kopperschmidt de Oliveira, I., Gonçalves Ferreira de Araújo, G. & De Oliveira, L.K. 2021. Analysis of characteristics of the cities on the warehouse location: the case of Belo Horizonte metropolitan region. *TRANSPORTES*, 29(3): 1–15.

Kothari, C.R. 2004. Research methodology. Revised Second Edition. New Age.

Kovida, C., Silva, D.E., Sano, K., Hatoyama, K. & Thanh, L. 2019. Geographical Dimension of E-commerce Logistics Facilities in Tokyo Metropolitan Region, Japan.

Krugman, P., 1991. Increasing returns and economic geography. *Journal of political economy*, 99(3), pp.483-499.

Krugman, P., 1998. What's new about the new economic geography? *Oxford Review of Economic Policy*, 14(2), pp.7-17.

Kudláčková, N. & Chocholáč, J. 2017. Warehouse location problem in context of delivery time shortening. In MATEC Web of Conferences. EDP Sciences.

Kumar, S., Narkhede, B.E. & Jain, K. 2021. Revisiting the warehouse research through an evolutionary lens: a review from 1990 to 2019. *International Journal of Production Research*, 59(11): 3470–3492.

Lai, R., Elliott, D. & Ouellette-Kuntz, H. 2006. Attitudes of Research Ethics Committee Members Toward Individuals with Intellectual Disabilities: The Need for More Research. *Journal of Policy and Practice in Intellectual Disabilities*, 3(2): 114–118.

Larsson, J.P. & Öner, Ö. 2014. Location and co-location in retail: A probabilistic approach using geo-coded data for metropolitan retail markets. *Annals of Regional Science*, 52(2): 385–408.

Leedy, P.D. & Ormrod, J.E. 2015. *Practical research: planning and design*. Eleventh Edition. Pearson.

Li, G., Jin, F., Chen, Y., Jiao, J. & Liu, S. 2017. Location characteristics and differentiation mechanism of logistics nodes and logistics enterprises based on points of interest (POI): A case study of Beijing. *Journal of Geographical Sciences*, 27(7): 879–896.

Li, J., Xu, H., Liu, W., Wang, D. & Zhou, S. 2020. Spatial Pattern Evolution and Influencing Factors of Cold Storage in China. *Chinese Geographical Science*, 30(3): 505–515.

Liao, K., Marsillac, E., Johnson, E. & Liao, Y. 2011. Global supply chain adaptations to improve financial performance Supply base establishment and logistics integration. *Journal of Manufacturing Technology Management*, 22(2): 204–222.

Lim, H. & Park, M. 2020. Modeling the spatial dimensions of warehouse rent determinants: A case study of Seoul metropolitan area, South Korea. *Sustainability*, 12(1).

Liu, S.J., Wang, Z., Miao, R., Xu, J. and Huang, H., 2013. Research of location selection of distribution center for service based on gravity method. *Applied Mechanics and Materials*, (433): 2419-2423.

Liu, X. & McKinnon, A.C. 2016. Theory development in China-based supply chain management research: A literature review. *International Journal of Logistics Management*, 27(3): 972–1001.

Liu, X. & McKinnon, A.C. 2019. Practical relevance of theory-driven supply chain management research: Evidence from China. *International Journal of Logistics Management*, 30(1): 76–95.

MacKinnon, D. & Cumbers, A. 2019. *An introduction to Economic Geography: Globalisation, Uneven Development and Place*. Third Edition. Routledge.

Maditati, D.R., Kummer, S., Munim, Z.H. & Schramm, H.J. 2023. Comparing outsourcing-outlook of manufacturing firms and logistics service providers in India and DACH countries. *Journal of Global Operations and Strategic Sourcing*, 16(1): 24–46.

Marchet, G., Melacini, M., Perotti, S. & Sassi, C. 2018. Types of logistics outsourcing and related impact on the 3PL buying process: empirical evidence.

Masson, S. & Petiot, R. Spatial dynamics in warehousing activities and agglomeration economies: lessons from the French Case Spatial dynamics in warehousing activities and agglomeration economies: lessons. The Contributions of DEA to Airports Efficiency Analysis (A Meta-Analysis) View project Efficiency Assessment of French Logistics Services Providers Based on Data Envelopment Analysis View project. https://www.researchgate.net/publication/303825055.

McKinnon, A. 2009. The present and future land requirements of logistical activities. *Land Use Policy*, 26: S293–S301.

Meyer, C.B. 2001. A Case in Case Study Methodology. *Field Methods*, 13(4): 329–352.

Mokhele, M. 2016. Spatial economic attributes of airport-centric developments in Cape Town and Johannesburg. PhD thesis. Stellenbosch: Stellenbosch University.

Mokhele, M. 2017. Spatial economic evolution of the airport-centric developments of Cape Town and OR Tambo international airports in South Africa. *Town and Regional Planning*, (70): 26-36.

Mokhele, M. 2022. The geography of logistics facilities relative to airports: Taxonomy of literature and research agenda. *Journal of Transport and Supply Chain Management*, 16(0), a770.

Mokhele, M. & Fisher-Holloway, B. 2022. Inclusion of warehousing and distribution in the Cape functional region's spatial plans. *Town and Regional Planning*, (80): 66-76.

Mokhele, M. & Geyer, H.S. 2021. A theoretical foundation for investigating the spatial economic attributes of airport-centric developments. *Bulletin of Geography. Socio-economic Series*, 54(54): 21–31.

Mokhele, M. & Mokhele, T. 2023. Characterization of airfreight-related logistics firms in the City of Cape Town, South Africa. *Logistics*, 7(3): 38.

Mousavi, S.M., Antuchevičienė, J., Zavadskas, E.K., Vahdani, B. & Hashemi, H. 2019. A new decision model for cross-docking center location in logistics networks under interval-valued intuitionistic fuzzy uncertainty. *Transport*, 34(1): 30–40.

Narvaez, L., Penn, A. & Griffiths, S. 2013. Spatial Configuration and Bid Rent Theory: How urban space shapes the urban economy. https://www.researchgate.net/publication/315718155.

Nasiri, M.M., Aliakbarnia Omran, M. & Jolai, F. 2019. Scheduling Post-Distribution Cross-Dock under Demand Uncertainty. *Int. J. Nonlinear Anal. Appl,* 10: 53–65. https://dx.doi.org/10.22075/IJNAA.2019.4396.

Nefs, M. & Daamen, T. 2022. Behind the Big Box: understanding the planning-development dialectic of large distribution centres in Europe. *European Planning Studies*.

Neuman, W.L. (William L. 2014. Social research methods: qualitative and quantitative approaches. Seventh Editition. Pearson Education Limited.

Newing, A., Hood, N., Videira, F. & Lewis, J. 2022. 'Sorry we do not deliver to your area': geographical inequalities in online groceries provision. *International Review of Retail, Distribution and Consumer Research*, 32(1): 80–99.

Niu, B., Wang, J., Lee, C.K.M. & Chen, L. 2019. "Product + logistics" bundling sale and co-delivery in cross-border e-commerce. *Electronic Commerce Research*, 19(4): 915–941.

Notteboom, T. & Rodrigue, J.P. 2022. Ports and Distribution Networks. In port economics, management and policy. Edited by T. Notteboom, A. Pallis & J.P. Rodrigue.London: Routledge.57-66.

O'connor, K. & Parsons, H. 2011. The Impact of Logistics Activity on Cities. In 5th State of Australian Cities National Conference, 29 November–2 December 2011, Melbourne, Australia. http://www.portsaustralia.com.au/tradestats/.

Ocampo, L., Genimelo, G.J., Lariosa, J., Guinitaran, R., Borromeo, P.J., Aparente, M.E., Capin, T. & Bongo, M. 2020. Warehouse location selection with TOPSIS group decision-making under different expert priority allocations. *Engineering Management in Production and Services*, 12(4): 22–39.

Olavarrieta, S. and Ellinger, A.E., 1997. Resource-based theory and strategic logistics research. *International Journal of Physical Distribution & Logistics Management,* 27(9/10), pp.559-587.

Oliveira, L., Santos, O., Oliveira, R. & Nóbrega, R. 2018. Is the Location of Warehouses Changing in the Belo Horizonte Metropolitan Area (Brazil)? A Logistics Sprawl Analysis in a Latin American Context. *Urban Science*, 2(2): 43.

Oliveira, L.K. de, Lopes, G.P., Oliveira, R.L.M. de, Bracarense, L. dos S.F.P. & Pitombo, C.S. 2022. An investigation of contributing factors for warehouse location and the relationship between local attributes and explanatory variables of Warehouse Freight Trip Generation Model. *Transportation Research Part A: Policy and Practice*, 162: 206–219.

Oliveira, R.L.M. de, Dablanc, L. & Schorung, M. 2022. Changes in warehouse spatial patterns and rental prices: Are they related? Exploring the case of US metropolitan areas. *Journal of Transport Geography*, 104.

Onstein, A.T.C., Bharadwaj, I., Tavasszy, L.A., van Damme, D.A. & el Makhloufi, A. 2021. From XXS to XXL: Towards a typology of distribution centre facilities. *Journal of Transport Geography*, 94.

Onstein, A.T.C., Tavasszy, L.A. & van Damme, D.A. 2019. Factors determining distribution structure decisions in logistics: a literature review and research agenda. *Transport Reviews*, 39(2): 243–260.

Onstein, A.T.C., Tavasszy, L.A., Rezaei, J., van Damme, D.A. & Heitz, A. 2022. A sectoral perspective on distribution structure design. International Journal of Logistics *Research and Applications*, 25(6): 1011–1039.

Onstein, A.T.C., Van Damme, D.A., Tavasszy, L.A., Onstein, S., Onstein, A.T.C. & Van Damme, D.A. 2015. Distribution structure and distribution centre location decision-making–A review. https://www.researchgate.net/publication/317167331.

Osborne, M.J. and Pitchik, C., 1987. Equilibrium in Hotelling's model of spatial competition. Econometrica: *Journal of the Econometric Society*, 911-922.

Öztuna, B. 2022. Logistics 4.0 and Technologic Applications. In İyigün, İ., Faruk, Ö. (eds.) Logistics 4.0 and Future of Supply Chains. https://link.springer.com/bookseries/13615.

Parr, J.B. 2002. Agglomeration economies: Ambiguities and confusions. *Environment and Planning A*, 34(4): 717–731.

Patti, A.L. 2006. Economic clusters and the supply chain: A case study. *Supply Chain Management*, 11(3): 266–270.

Pereira, M.S. Restructuring of Logistics Processes: Case Study of Cross-Docking Operations at Warehouse AZ1 of Grupo Luís Simões.

Pillay, X. & Geyer, H.S. 2016. Business clustering along the M1-N3-N1 corridor between Johannesburg and Pretoria, South Africa. *South African Journal of Geomatics*, 5(3): 340.

Pollakowski, H.O. and Wachter, S.M., 1990. The effects of land-use constraints on housing prices. *Land Economics*, 66(3):315-324.

Porter, M.E. & Porter, M.P. 1998. Location, Clusters, and the 'New' Microeconomics of Competition. https://www.jstor.org/stable/23487685.

Pretorius, O.R., van Aswegen, M., Huston G.D. & Drewes J.E. 2021. Spatial perspectives on warehouse development. In W. H. E. Priya Ramgovind, ed. In Ramgovind, P. and Engelbrecht, W. Business warehouse and Inventory Management. Van Schaik Publishers. Cape Town: Van Schaik Publishers, 2021: 55–94.

Rahman, S., Ahsan, K., Yang, L. & Odgers, J. 2019. An Investigation into critical challenges for multinational third-party logistics providers operating in China. *Journal of Business Research*, 103: 607–619.

Raimbault, N., Heitz, A. & Dablanc, L. 2018. Urban planning policies for logistics facilities. A comparison between US metropolitan areas and the Paris region", Browne M., Behrends S., Woxenius J., Giuliano G. Holguín-Veras J. (eds.), In Urban Logistics. london: Kogan Page: 82–108. https://www.koganpage.com/product/urban-logistics-9780749478711.

Richnák, P. 2022. Current Trend of Industry 4.0 in Logistics and Transformation of Logistics Processes Using Digital Technologies: An Empirical Study in the Slovak Republic. *Logistics*, 6(4).

Rintala, O., Solakivi, T., Laari, S., Töyli, J. & Ojala, L. 2021. Drivers of logistics outsourcing: examining transaction costs, core competences and planned behavior. *International Journal of Physical Distribution and Logistics Management*, 51(3): 259–280.

Rivera, L., Gligor, D. & Sheffi, Y. 2016. The benefits of logistics clustering. *International Journal of Physical Distribution and Logistics Management*, 46(3): 242–268.

Robichet, A. & Nierat, P. 2021. Consequences of logistics sprawl: Order or chaos? - the case of a parcel service company in Paris metropolitan area. *Journal of Transport Geography*, 90.

Rodrigue, J.P., 2020a. *The geography of transport systems*. Routledge.

Rodrigue, J.P. 2020b. The distribution network of Amazon and the footprint of freight digitalization. *Journal of Transport Geography*, 88.

Sakai, T., Kawamura, K. & Hydo, T. 2016. Location Choice Models of Urban Logistics Facilities and the Impact of Zoning on their Spatial Distribution and Efficiency.

Sakai, T., Beziat, A. & Heitz, A. 2020. Location factors for logistics facilities: Location choice modeling considering activity categories. *Journal of Transport Geography*, (85): 102710.

Scells, H., Zuccon, G., Koopman, B. and Clark, J., 2020, April. Automatic boolean query formulation for systematic review literature search. In Proceedings of the web conference 2020, (1071-1081).

Schorung, M. & Lecourt, T. Analysis of the spatial logics of Amazon warehouses following a multiscalar and temporal approach. For a geography of Amazon's logistics system in the United States. https://halshs.archives-ouvertes.fr/halshs-03489397.

Shravanthi, A.R. & Mahendran, K. 2015. Cold storage warehouse units in India-a region-wise comparative study. International Journal of Agricultural Science and Research (IJASR), 5(5), pp.53-62. www.tjprc.org.

Sivitanidou, R. 1996a. Warehouse and distribution facilities and community attributes: an empirical study.

Snyder, H. 2019. Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, 104: 333–339.

Steynberg, P., Goedhals-Gerber, L.L. & van Dyk, E. 2022. An Analysis of the Impact of Logistics Processes on the Temperature Profile of the Beginning Stages of a Blueberry Supply Chain. *Horticulturae*, 8(12).

Strale, M. 2020. Logistics sprawl in the Brussels metropolitan area: Toward a socio-geographic typology. *Journal of Transport Geography*, 88.

Swanson, D., Goel, L., Francisco, K. & Stock, J. 2017. Applying theories from other disciplines to logistics and supply chain management: A systematic literature review. *Transportation Journal*, 56(3): 299–356.

Tchang, G. 2016. The impact of highway proximity on distribution centres' rents. *Urban Studies*, 53(13): 2834–2848.

Tutam, M. 2022. Warehousing 4.0 in Logistics 4.0. In İyigün, İ., Faruk, Ö. (eds.) Logistics 4.0 and Future of Supply Chainshttps://link.springer.com/bookseries/13615.

Van Belle, J., Valckenaers, P. & Cattrysse, D. 2012. Cross-docking: State of the art. *Omega*, 40(6): 827–846.

Van Den Heuvel, F.P., De Langen, P.W., Van Donselaar, K.H. & Fransoo, J.C. 2012. Spatial concentration and location dynamics in logistics : the case of a Dutch province Citation for published version (APA): Heuvel, van den Spatial concentration and location dynamics in logistics: the case of a Dutch province Spatial concentration and location dynamics in logistics: the case of a Dutch province. www.tue.nl/taverne.

Venables, A.J., 2005. Geographical economics: notes on Africa. *Journal of Development Perspectives*, 1(1), pp.63-84.

Vereecke, A., Desmet, D. & Boute, R. 2008. A typology of distribution centres in Flanders. In Proceedings of the 28th Vlaams Wetenschappelijk Economisch Congress on Globalization of the value chain: the regional impact (161-173) {November 2008}.

Verhetsel, A., Kessels, R., Goos, P., Zijlstra, T., Blomme, N. & Cant, J. 2015. Location of logistics companies: A stated preference study to disentangle the impact of accessibility. *Journal of Transport Geography*, 42: 110–121.

Visser, J., Nemoto, T. & Browne, M. 2014. Home Delivery and the Impacts on Urban Freight Transport: A Review. *Procedia - Social and Behavioral Sciences*, 125: 15–27.

Vlckova, V., Munzarova, S. and Sebrankova, E., 2015. Decision on location of a new warehouse for the reverse logistics company. In SGEM 2015: 2nd International Multidisciplinary Scientific Conference on Social Sciences and Arts, 683-692.

Vyn, R.J., 2012. Examining for evidence of the leapfrog effect in the context of strict agricultural zoning. *Land Economics*, 88(3):457-477.

Wang, P., Chen, X. & Zhang, X. 2022. Research on Location of Logistics Distribution Center Based on K-Means Clustering Algorithm. Security and Communication Networks, 2022.

Warffemius, P., 2007. Modeling the clustering of distribution centers around Amsterdam Airport Schiphol: Location endowments, economies of agglomeration, locked-in logistics and policy implications.

Warffemius, P.M.J. & Klaassen, H. 2008. The dynamic spatial impact of Amsterdam Airport Schiphol. https://www.researchgate.net/publication/254915903.

Warffemius, P., Van Der Hoorn, T. & Klaassen, H. 2010. The importance of agglomeration effects for distribution centres around Amsterdam Airport Schiphol. Journal of Airport Management.

Wisner, J.D., Tan, K.C. and Leong, G.K., 2014. Principles of supply chain management: A balanced approach. Cengage Learning.

Wohlin, C. 2014. Guidelines for snowballing in systematic literature studies and a replication in software engineering. In ACM International Conference Proceeding Series. Association for Computing Machinery.

Woudsma, C., Jakubicek, P. & Dablanc, L. 2016. Logistics Sprawl in North America: Methodological Issues and a Case Study in Toronto. *Transportation Research Procedia*, 474–488.

Yahia, E.M. 2009. April. Cold chain development and challenges in the developing world. In VI International Postharvest Symposium 877 (pp. 127-132).

Yang, Z., Chen, X., Pan, R. & Yuan, Q. 2022. Exploring location factors of logistics facilities from a spatiotemporal perspective: A case study from Shanghai. *Journal of Transport Geography*, 100.

Yin, R.K. 2018. *Case Study Research and Applications*. Sixth Edition. California: Sage Publications.

Yuan, Q. 2018. Environmental Justice in Warehousing Location: State of the Art. *Journal of Planning Literature*, 33(3): 287–298.

Yuan, Q. 2019. Planning Matters: Institutional Perspectives on Warehousing Development and Mitigating Its Negative Impacts. *Journal of the American Planning Association*, 85(4): 525–543.

Yuanyuan, C. & Bingliang, S. 2017. Logistics Agglomeration and Its Impacts in China. *Transportation Research Procedia*. Elsevier B.V.: 3875–3885.

Zacharia, Z.G., Sanders, N.R. & Nix, N.W. 2011. The emerging role of the third-party logistics provider (3PL) as an orchestrator. *Journal of Business Logistics*, 32(1): 40–54.

Zhang, H.-L., Sun, P. & Ma, L.-L. 2017. Analysis on Spatial Distribution of Commodity Delivery Warehouses in Yangtze River Delta.

Zhang, Q. & Hou, H. 2022. January. Analysis on Spatial-Temporal Distribution Evolution Characteristics of Regional Cold Chain Logistics Facilities: A Case Study of BJE. In LISS 2021: Proceedings of the 11th International Conference on Logistics, Informatics and Service Sciences (pp. 431-441). Singapore: Springer Nature Singapore. In X. Shi, G. Bohács, Y. Ma, D. Gong, & X. Shang, eds. Lecture Notes in Operations Research. Singapore: Springer Nature Singapore. https://link.springer.com/10.1007/978-981-16-8656-6.

Żuchowski, W. 2016. The impact of e-commerce on warehouse operations. *LogForum*, 12(1): 5-101.

Cape Peninsula
University of Technology
creating futures

PO Box 1906, Bellville,7535 Symphony Way, Bellville, Cape Town, South Africa
+ 27 (0)21 959 6767 www.facebook.com/cput.ac.za info@cput.ac.za www.cput.ac.za

Office of the Research Ethics Committee
Faculty of Informatics and Design
Room 2.09
80 Roeland Street
Cape Town
Tel: 021-469 1012
Email: ndedem@cput.ac.za
Secretary: Mziyanda Ndede

23 August 2023

Mr Francis Garatsa
c/o Department of Town and Regional Planning
CPUT

Reference no: 222688289/2023/16

Project title: Typology and spatial patterns of warehousing in Cape Town, South Africa

Approval period: 23 August 2023 – 31 December 2024

This is to certify that the Faculty of Informatics and Design Research Ethics Committee of the Cape Peninsula University of Technology approved the methodology and ethics of Mr Francis Garatsa (222688289) for Master of Urban and Regional Planning.

Any amendments, extension or other modifications to the protocol must be submitted to the Research Ethics Committee for approval.

The Committee must be informed of any serious adverse event and/or termination of the study.

Dr Blessing Makwambeni
Chair: Research Ethics Committee
Faculty of Informatics and Design
Cape Peninsula University of Technology