UNIVERSITY OF HULL

Holistic Environmental Performance and Sustainability in Global Logistics Hubs: An Exploratory Multiple Case Study

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Dedication

To my dear mother, Nora,

There are no words that can fully capture the depth of gratitude and love that I feel for you. Your unwavering support, encouragement, and guidance have been a constant source of strength and inspiration throughout my life, but especially during my PhD journey. Your faith in me, even when I doubted myself, and your unconditional love have given me the confidence to pursue my dreams and aspirations.

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Publications and Conferences

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Abstract

In recent years, the emergence of global logistics hubs (GLHs) has been on the rise, with these hubs playing a critical role in facilitating the smooth flow of global trade through their strategic location and functions that support global supply chains. Furthermore, GLHs provide benefits to the regions hosting them through the attraction of foreign investment, enhancement of education, and creation of job opportunities. However, there are limited research studies on GLHs suggesting a gap in the current knowledge on the concept, which requires further exploration. Additionally, the accumulation of the functions and activities of existing and emerging GLHs is resulting in extensive environmental impact. The environmental performance and sustainability of GLHs is a topic that requires further exploration, particularly in light of the climate emergency, which is an urgent and pressing issue that requires immediate action (IPCC, 2022). The transportation and logistics sector, of which GLHs are heavily dependent on, is a significant contributor to greenhouse gas emissions and other environmental impacts. Therefore, it is imperative that GLHs are developed and operated in a sustainable and responsible manner given the global concentration of operations and activities in a specific location. This research aims to address this need by exploring the concept of GLHs and their environmental performance and sustainability. Adopting an inductive qualitative research approach and a multiple case study research method, this study focuses on four diverse GLH case studies: Rotterdam, Antwerp, Liverpool, and Suez Canal Economic Zone (SCZone) GLHs. The aim of the research is to establish a comprehensive understanding of GLHs, their environmental performance, and sustainability for academic and industrial applications for emerging and fully developed GLHs. The research contributes to the gap in knowledge by providing an up-to-date and clear definition of GLHs, their primary stakeholders and their operations, and a multi-stage development model. Additionally, a holistic conceptual environmental performance measurement framework for GLHs encompassing their primary stakeholders is developed. The research also highlights the level of connection between stakeholders in GLHs, the governance structure, and environmental sustainability responsibility in GLHs. Furthermore, this study explores the factors that drive or impede environmental performance and sustainability in GLHs, and provides an illustration of these factors using a fishbone diagram.

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Chapter 1 Introduction

1.1 Research Background

Globalization and global supply chains and logistics have brought the world closer together by facilitating trade between countries (Waters, 2013; Ritzer, 2015), and it resulted in the emergence of the concept of global logistics hubs (GLHs). Additionally, COVID-19 pandemic has ushered in a novel era, one in which the business landscape is characterized by increased digitalization and globalization (Popescu et al., 2021). As a result, the significance of logistics as a sector has been amplified on a global scale, as it plays a vital role in facilitating the movement of goods, services, and information from the point of origin to the point of consumption.

The term "Global Logistics Hub" (GLH) is often used haphazardly in literature, with varying degrees of specificity. This lack of consistency in usage contributes to confusion and ambiguity surrounding the term. Furthermore, there is a lack of a clear up-to-date definition and identification of the operations and activities associated with GLHs, which further exacerbates the ambiguity surrounding this concept. This is despite of the fast evolution and development of GLHs around the world. This ambiguity in terminology and definition can create challenges for researchers and practitioners alike, as it makes it difficult to compare and contrast different GLHs and to develop a comprehensive understanding of the concept for the emerging GLHs to refer to. Additionally, this ambiguity can also impede the ability of policymakers and regulators to effectively govern and manage GLHs, as it makes it difficult to identify and address key issues and challenges. Therefore, this research aims to provide a clear up-to-date definition of GLHs, identify their primary stakeholders along with their operations, role, and activities, and shine a light on the governance models adopted in GLHs within highly privatized industry and more publicly driven contexts ranging, taking into consideration GLHs from their initial stages of development to fully developed and functioning.

GLHs play a critical role in global trade and commerce, but their operations have significant environmental impacts due to the agglomeration of global operations in one location. Despite their importance, there is a gap in the literature on the holistic environmental impact and environmental performance measurement of GLHs. The few previous studies that have based their research on GLHs from a holistic view have mainly focused on economic considerations, neglecting to address the various aspects of organizational responsibility or the environmental sustainability of GLHs. Additionally, the literature contains research on the environmental impact and performance of different constituents of GLHs in a standalone manner. They lack connection of the various parts of a GLH to study the holistic view of the integration between them and its effect overall from an environmental lens.

Global logistics and transportation industry is responsible for 25-30% of total greenhouse gas emissions, which harms the environment and human health (Shoaib, 2022). Given the need for immediate action in response to the global climate emergency (IPCC, 2022), the lack of research on the environmental performance of GLHs is particularly concerning. Therefore, this research aims to explore GLHs environmental performance and sustainability and provide a holistic environmental performance measurement framework for GLHs. The framework will consider all primary stakeholders and constituents. Additionally, the framework will include appropriate environmental performance indicators to guide sustainable operations in GLHs in developed and developing host countries.

The development of such a framework will enhance our understanding of the environmental impacts of GLHs and provide a basis for the implementation of sustainable practices within these hubs.

1.2 Research Context

This research is going to consider the heterogeneous characteristics of GLHs, which has been largely overlooked in prior research. The heterogeneity of GLHs encompasses factors such as market served, economic development of the host country, and port ownership in the GLH. The focus of this research will be on public, public-private partnership (PPP), and private port ownership in GLHs, operating in developed and developing countries, and catering to the European market and the MENA region market, and in different development stages ranging from initial stages of development to fully developed and competitively functioning GLHs.

1.3 Research Gap

Despite the critical role of GLHs in global trade and their significant environmental impacts, there is a lack of consistency in the terminology and definitions used, as well as a gap in the literature on the holistic environmental externalities and environmental performance measurement of GLHs. The few previous academic research studies that have based their research on GLHs from a holistic view have mainly focused on economic considerations, neglecting to address the various aspects of organisational responsibility or the environmental sustainability of GLHs. The literature contains research on the environmental impact and performance of different constituents in a standalone manner, but not considering the overall impact of the holistic operations of the primary stakeholders in GLHs.

There is a need for a clear understanding of the term, its constituents, and its operations along with its governance model, as well as exploring the holistic environmental externalities and to develop environmental performance measurement frameworks for GLHs to guide sustainable operations in developed and developing host countries. This research aims to address these gaps by fulfilling the research objectives and research objectives presented in the next subsections.

1.4 Research Objectives

RO1: Explore GLHs in depth to better understand and clarify the term by providing an up-to-date definition, identify the primary stakeholders and their operations for future academic and industrial applications.

RO2: Explore the extent of integration of the primary stakeholders in GLHs, understand the governance structure models adopted in GLHs, and clarify the accountability and responsibility of GLHs as a whole regarding environmental sustainability.

RO3: Develop a holistic conceptual environmental measurement framework adapted for the agglomerated and connected functions of GLHs that aids the need for immediate action regarding GHG emissions and other environmental externalities associated with global concentration of activities in one location.

RO4: Help emerging and existing GLHs develop sustainably and alleviate their environmental impact by identifying the drivers and barriers encountered by primary stakeholders of GLHs to assist them and the governments of the hosting countries in their path towards sustainable development.

1.5 Research Questions

This research addresses the research gaps and objectives by investigating the following key research questions:

RQ1: What is a GLH? Who are its primary stakeholders?

RQ2: How are the primary stakeholders connected in a GLH? Who is responsible for the environmental sustainability of GLH?

RQ3: How do GLH operations impact the environment? How is the impact measured?

RQ4: What are the drivers of and barriers to environmental sustainability in a GLH?

1.6 Thesis Structure

This thesis is comprised of seven chapters. **Chapter 1** provides an introduction to this research, research background, context, gap, overall thesis structure, research objectives, and research questions. Following the introduction chapter, **Chapter 2** reviews the literature on GLHs in two stages, focusing first on the concept evolution, better understanding of the term, and critically reviewing the academic and grey literature on GLHs. The second stage is a review of the literature on their environmental performance and sustainability. The literature review identified the research gaps, established the research problem, proposed a conceptual framework to guide the research, and presented the research questions to address these gaps.

Chapter 3 discusses the research methodology used in this research, including the philosophical stance and research paradigm. Additionally, stakeholder theory was discussed as the theoretical lens adopted to guide this research through the empirical stage. This chapter also explains the chosen research approach, design, methods of data collection and analysis strategy. It also provides a justification for using multiple case studies and the appropriate methods was argued in light of other alternatives. It introduces the four case studies and their heterogenous characteristics. The case selection process and sampling technique are also highlighted. Additionally, this chapter describes the analysis approach and use of NVivo, and the pilot interviews conducted to prepare for the empirical research.

Chapter 4 presents the within-case analysis of the four GLHs cases. It presents the key empirical findings and detailed analysis for each case. It presents the extracted themes and analyses the findings relevant to the research questions for each case. Patterns and variations within each case were highlighted through three global themes and thirteen organizing themes. The analysis process is also supported by employing a simple frequency count to capture the magnitude of these themes. These themes helped answer the research questions and were supported by excerpts from the data. The contributions of the participants in each case, through their experiences and opinions, have helped shape these themes.

Chapter 5 presents the cross-case analysis of the findings across the four case studies to identify common patterns and differences considering their heterogeneous characteristics. The analysis serves as a foundation for developing theory in the next chapter, which is linked back to the individual cases to ensure a logical chain of evidence. This chapter also included a summary of major findings derived from both within-case and cross-case analyses in relation to each research question.

Chapter 6 provides a comprehensive examination of the key empirical findings from the research in relation to relevant literature. The findings from the within-case and cross-case analyses for each of the four research questions are compared and contrasted with existing literature. It evaluates the extent to which the empirical findings align with, refute, or expand existing theories on GLHs and determine if any new theories or concepts arise from the research. This chapter serves as a basis for determining the implications of the findings for both theory and practice, as well as for future research. Additionally, this research contributes to the understanding of GLHs and their impact on environmental sustainability. It provides an up-to-date and clear definition of GLHs, a multi-stage development framework for GLH, and a holistic environmental performance measurement framework.

The final chapter of this thesis is **Chapter 7**, it concludes the research, provides a summary of the key contributions, highlights the implications for practitioners and academics, and discuss the limitations and directions for future research.

Chapter 2 Literature Review

2.1 Introduction

This chapter will review the literature on Global Logistics Hubs (GLHs) and their environmental performance and sustainability. The literature review will be conducted in two stages. The first stage will focus on establishing an understanding of the concept and definition of GLHs, while the second stage will review the literature pertaining to the environmental performance and sustainability of GLHs. The chapter will conclude by presenting the research questions that will address any gaps identified in the extant scholarly literature.

The chapter is structured as follows: Section 2.2 focuses on the concept evolution and scholarly literature review of GLHs, including the emergence of GLHs, port generations and port clusters, as well as the identification of stakeholders. Section 2.3 reviews the literature on environmental performance and sustainability aspects of GLHs, encompassing environmental sustainability in supply chains and logistics, environmental performance measurement, and the drivers and barriers of environmental sustainability. This comprehensive review sets the foundation for the Section 2.4 that identifies research gap and formulate the research questions.

2.2 Global Logistics Hubs (GLHs): Concept Evolution and Literature Review

2.2.1 Background - Globalization Impact on Supply Chain and Logistics Management

According to Gourdin (2006) and Grant (2012), logistics coordinates and manages the flow of information and material through the supply chain to satisfy its main objective, which is customer satisfaction. Globalization and growth in international trade have driven the constant evolution of supply chain and logistics management over the years (Mangan et al., 2016). With this evolution comes different challenges in customer satisfaction and a change in the relationship between supply chain and logistics. Supply chains are constantly faced with the challenge of providing high levels of customer service while keeping costs low (Sheffi, 2005). Globalization has helped to address this challenge by allowing manufacturers to spread their processes across different countries, in order to improve their products and services. By moving some or all of their operations offshore, manufacturers could benefit from lower costs, higher quality, more economical, and more competitive products. Additionally, one of the biggest drivers of globalization is cost reduction and accessing cheaper labour, which has resulted in the fragmentation of business operations in different countries across the world (Maggi & Mariotti, 2012). Additionally, Fwa (2016) notes that despite the severe global economic crisis of the last decade, global trade has continued to grow due to the reduction of regulatory trade barriers between countries, which facilitates the trade process and improves the competitive advantage of supply chains.

The management of supply chain operations globally has brought numerous benefits, but it has also presented challenges in terms of product availability due to increased distance and longer lead times from customers. Despite these challenges, businesses need to locate different sectors of the supply chain in different countries to take advantage of reduced costs and economies of scale (Fernandes & Rodrigues, 2011). Therefore, effective management and planning of global transportation and longer lead times are crucial, and this is where international logistics management plays a vital role. The importance of international logistics has significantly increased due to globalization and the expansion of material exchange worldwide (Lee & Yang, 2003). The decentralization of supply chains has further emphasized the significance of logistics management activities that buffer the gaps and complexity of operations like never before.

Fernandes and Rodrigues (2011) argue that in order to optimize the trade-off between supply chain cost efficiency and responsiveness, products should ideally be completed and finalized in locations geographically close to the end customer. This concept has fuelled the emergence of GLHs, which serve to mitigate the risks and problems associated with global supply chains. A GLH is a strategic location that "integrates logistics, trade, industry, distribution and living functions, facilitates logistics services and value-added services through linkage between various destinations, playing a major role in national economic development" (Brito & Botter, 2012:250). They provide a smooth flow of products through specific locations, enabling value-adding operations geographically closer to customers (Chhetri et al., 2014). This approach enhances customer satisfaction, leverages economies of scale, and decrease the risks inherent in having production operations located far away from customers.

The emergence of GLHs has been facilitated by the evolution of international logistics activities. These activities have evolved to be carried out by independent providers and intermediaries, such as third-party (3PL) and fourth-party (4PL) logistics providers, to manage the complex operations of global logistics for different supply chains (Skender et al., 2016). Figure 2.1 illustrates the various logistics activities and processes involved in supply chains. Through the successful implementation of these activities, effective global supply chain management can be achieved.

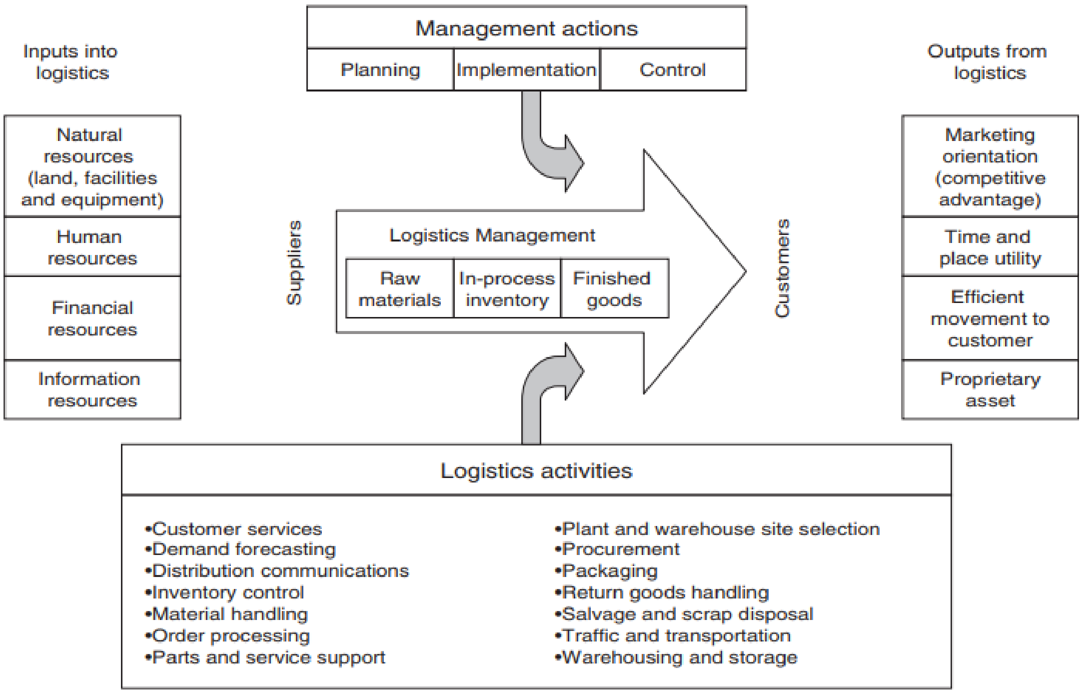


Figure 2.1 Components of logistics management (Grant et al., 2006:4)

Logistics activities are responsible for planning and implementing the flow of goods, services, and information efficiently and effectively whether forward or reverse in the supply chain between the point of origin to the point of consumption and helps supply chains by providing added-value services which holistically benefits the supply chains in reducing cost, time, waste while maximizing quality, customer satisfaction, profit. While global logistics provides the opportunity for businesses to become global by facilitating these activities on a global level (Waters & Waters, 2003).

2.2.1.1 Maritime Port-Based Global Logistics Hubs

Despite the existence of very few definitions for GLHs in the literature, a degree of ambiguity remains as the definitions provided do not convey a clear consistent meaning. Table 2.1 provides different variations of proposed definitions for GLHs in the academic literature.

Table 2.1 GLH Proposed Definitions

Reference	Proposed Definition
Hsu (2006:13)	*"A seaport/airport, which is an area made up of infra- and superstructures capable of receiving ships/aircrafts and other modes of transport, handling international trade cargo from ships/aircrafts to the seaport/airport and vice versa and capable of providing value-added logistics functions. Therefore, a global logistics hub is a four-modal node where water, road, railroad, and air modes exist. The cargo transported include local, gateway, and hub traffic; numerous logistics functions may perform in it, such as warehousing, re-consolidation, re-configuration, distribution, and other value-added activities."*
Lindohlm and Behrends (2012)	*A global logistics hub is a point of connection to many destinations, which in turn enhances the agglomeration of cargo, taking advantage of economies of scale.*
Brito and Botter (2012:250)	*"Integrates logistics, trade, industry, distribution and living functions, facilitates logistics services and value-added services through linkage between various destinations, playing a major role in national economic development"*
Yang and Chen (2016:181)	*"A port in a strategic geographical location at the intersection of major trunk and feeder systems, and which provides integrated value-added logistics services in addition to conventional import, export, and transit cargo operations"*
Essaadi et al. (2019:1)	*"Global Logistic Hub (GLH) is the point of entry into a specific continental region by linking national suppliers or producers to overseas markets and vice-versa."*

Based on these definitions, a composite definition for GLHs can be formulated as follows:

> *A GLH is a seaport/airport or a strategic geographical location that serves as a point of connection to many destinations, facilitating the integration of logistics, trade, industry, distribution, and living functions. It is comprised of infra- and superstructures capable of receiving and handling international trade cargo from various modes of transport, including water, road, railroad, and air. GLHs play a major role in national economic development by providing integrated value-added logistics services, such as warehousing, distribution, re-consolidation, and other value-added activities. It serves as a point of entry into a specific continental region, linking national suppliers or producers to overseas markets and vice-versa, while taking advantage of economies of scale through agglomeration of cargo.*

A composite definition serves as a starting point for understanding GLHs, even though it may encompass multiple ideas. However, despite the available definitions and the existing literature on GLHs, there remains a degree of ambiguity. Different terms are used to refer to GLHs, with some studies referring to them as maritime ports (Hsu, 2006; Nam & Song, 2011; Yang & Chen, 2016), while others describe them as locations, logistics centres, airports, or cities (Sheffi, 2005; Hsu, 2006; Nam and Song, 2011; Notteboom et al., 2017). These varied terms are associated with differences in functions, boundaries, operations, and characteristics, adding to the equivocality rather than providing clarity to the term GLH. Therefore, it is essential to further explore and understand the nuances and differences in the definitions of GLHs in order to establish a comprehensive understanding of their role in global supply chain management.

Globalization has led to transforming seaports and airports into crucial nodes of global supply chain operations and international logistics. Many airports have evolved from mere runway facilities to integrated operations with businesses and extended services. The development of larger, long-range, and faster aircraft has also enabled them to serve as vital connections for freight transportation, as seen in the case of Memphis airport, which is considered a global logistics hub for FedEx (Sheffi, 2012). On the other hand, the increased movement of freight in seaports and the emphasis on economies of scale have led shipping lines to acquire larger vessels to meet market demand, improve their competitive advantage, and attract powerful shippers (Wackett, 2017). However, not all seaports are equipped to handle large vessels, leading to the division of ports into hub and feeder ports based on location and facilities. Additionally, many seaports and cities are investing in their infrastructure in hopes of becoming hubs for their region, as they can drive economic growth and international trade, resulting in new plans and developments for emerging logistics hubs around the world (Fernandes & Rodrigues, 2011; Anderson, 2017; Notteboom et al., 2017; Sundarakani, 2017).

While maritime port and airport-based GLHs share similarities as transportation nodes and centres for global logistics operations, there are fundamental differences between them. This is due to the differences in the types and quantities of products they handle, as well as the unique governance, management, and sustainable development concerns associated with each. Maritime transportation is considered the "*backbone of globalization*" (UNCTAD, 2015), which if considered as a GLH, translates to seaport-based GLH handling a much larger volume of global trade than airport-based GLH. According to an UNCTAD report (2017), maritime transport is responsible for handling 80 percent of global trade's volume and 70 percent of global trade's value. The cargo types in seaborne trade include crude oil, petroleum products, gas, iron ore, coal, grain, steel products, bauxite, nickel ore, cement, petroleum coke, sugar, and containers (UNCTAD, 2017). In contrast, air cargo transport accounts only for "*35% of world trade by value*", and includes perishable, time-sensitive, and valuable cargo (IATA, 2022). Each of these types of cargo has distinct logistics-related requirements, environmental impacts, risks, location requirements, and handling requirements that cannot be directly compared to the types of cargo handled in seaport-based GLH. Therefore, it would be challenging to consider airports and seaports in one research context, despite some definitions referring to GLHs being either of these entities. Consequently, this research will focus exclusively on GLHs that are based on seaports or are seaports, with the aim of clarifying this boundary. Subsequently, the term 'GLH' in the following sections will refer specifically to GLHs that are relevant to seaport-based GLHs. Based on this, the next section is going to critically review the academic literature on GLHs.

The concept of global logistics hubs (GLHs) is thoroughly reviewed in the following sections, drawing from both academic and grey literature. Through a critical examination of the existing literature, the historical development of the term GLH, its emergence, and potential differences with other related terms are explored in depth, as well as identifying its potential stakeholders.

2.2.2 GLHs Scholarly Literature Review

2.2.2.1 GLH Critical Literature Review

A literature review was conducted utilizing Scopus and Web of Science databases in order to review the scholarly literature and academic research conducted on GLHs. The search terms in Table 2.2 were used to identify relevant literature on GLHs.

Table 2.2 GLHs Literature Review Keywords Search

Keywords	**Scopus**	**WOS**
"global logistic* hub*"	13	7
"logistic* hub* port*"	1	1
"container* hub* port*"	21	14
"maritime hub*" OR "maritime logistic* hub*"	13	6
"sea hub*"	4	1

By reviewing these articles, removing duplicates, and identifying the relevant articles to the field, the pertinent research articles were found to be studied under different themes, dividing the articles' objectives into 10 broad categories. Table 2.3 provides a list of the themes. Additionally, based on these search terms, Table 2.3 shows that academic research on GLHs indicates that the research period is mainly between 1997 and 2022, with 2017 having the highest number of publications on GLHs.

Table 2.3 GLHs Literature Themes

Themes	Articles [No. of Citations]	Total
Cost Optimization	(Fossey, 1997 [16]; Xie et al., 2005 [4]; Hsu & Hsieh, 2007 [193])	3
Engineering	(Chae & Jeong, 1998 [1]; Soon, 2017 [0])	2
Port Development	(Mei & Baoguo, 1998 [4])	1
Berth Allocation Models	(Imai et al., 2003 [439]; Qiu & Jin, 2014 [1]; Zeng et al., 2016 [0]; Zeng et al., 2017 [23])	4
Hub Port Competition	(Veldman & Backmann, 2003 [259]; Veldman et al., 2005 [48]; Lee, 2007 [15]; Wang & Cui, 2007 [2]; Khalid, 2009 [5]; Lee et al., 2009 [82]; Ng et al., 2010 [7]; Nam & Song, 2011 [100]; Asgari et al., 2013 [135]; Xiao & Liu, 2017 [10]; Havenga et al., 2017 [44])	11
Location Models	(Baird, 2006 [237]; Notteboom, 2011 [91]; Zabihi et al., 2016 [10]; Essaadi et al., 2019 [13])	4
Port Supply Chain integration	(Trappey et al., 2008 [16])	1
Port Policy	(Lee & Flynn, 2011 [75])	1
Port Vulnerability and resilience	(Su et al., 2016 [14])	1
Potential Global Logistics Hubs	(Brito & Botter, 2012 [16]; Esqueda, 2012 [1]; Yang & Chen, 2016 [119]; Anderson, 2017 [6]; Bennett, 2017 [2]; Sundarakani, 2017 [10]; Hammad et al., 2021 [0]; Rustamova, 2022 [0])	8

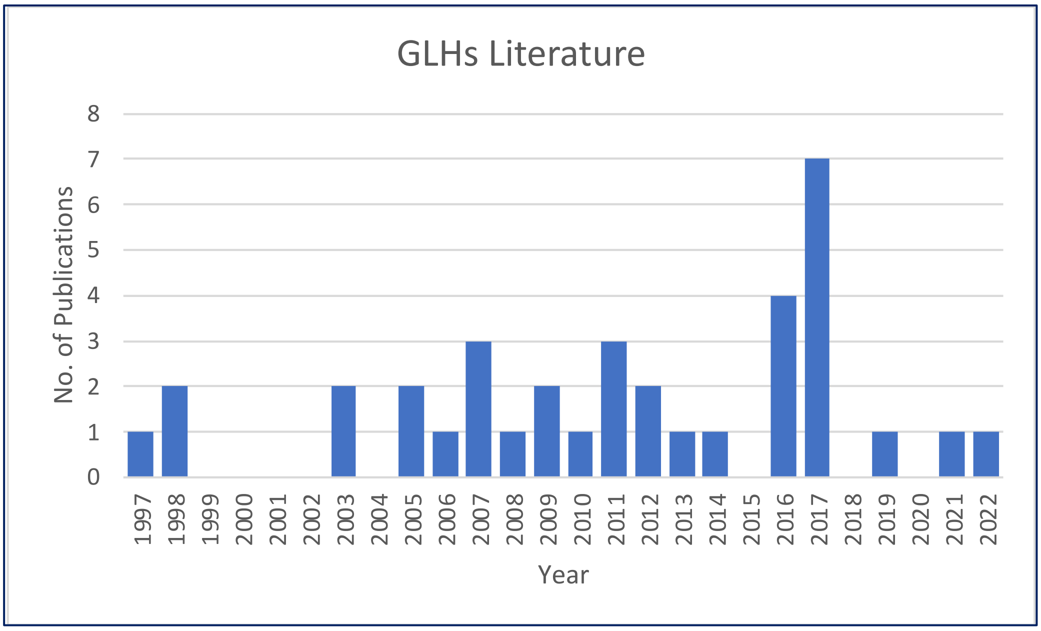


Figure 2.2 Number of Publications on GLHs

The number of articles resulting from each keyword search in Table 2.2 shows that academic literature on GLHs and similar terms is scarce, only 36 articles between 1997 and 2022 were published in the academic literature on GLHs and similar. Furthermore, after removing duplicates, there were only 11 articles specifically using the term 'global logistics hubs' published from 2007 to 2021, with three of them published in 2017. Moreover, the research output has decreased in the past five years compared to the publications in 2017. Despite recent declines in academic research activity and the limited research on GLHs, GLHs remain important in shaping the global supply chain landscape as outsourcing, trade, and transportation evolve. This is perceptible in the rising trend of various locations across the globe actively striving to establish themselves as GLHs (Anderson, 2017; Sundarakani, 2017; CIPS, 2019). These locations are motivated by the perceived benefits of GLHs, such as enhancing their competitiveness in the global logistics and supply chain industry, attracting investment, creating employment opportunities, and fostering economic growth. As the field evolves and new challenges and opportunities arise, there is a need for fresh perspectives and innovative research to tackle these issues.

By reviewing the articles in Table 2.3, it shows that early articles studied Asian ports, mainly in China, till 2003. They mainly focused on cost optimization models and engineering in regard to transhipment ports. Most likely until the project of developing the port of Rotterdam to improve its competition and container throughput was being considered (Veldman & Backmann, 2003). Most of the themes are focused on container hub ports. By reviewing these articles, container hub ports meant, ports with simple transhipment activity of containers. These articles focused on the development, location selection, resilience, and berth allocation in these ports, which rules out using the term ‘container hub port’ instead of ‘global logistics hub’ in the literature. Furthermore, the majority of articles are on hub port competition. How to increase the competitive advantage of ports by being hub ports (Lee et al., 2009); competition and cooperation between container hub ports in the same region (Xiao & Liu, 2017), however, port competition is mainly the purpose of developing port clusters. Port clusters encourage cooperation between ports and provide incentives to not compete; and container hub ports market share (Veldman et al., 2005). However, these studies did not study the concept and did not help in clarifying the ambiguity of the term. They did not illustrate what activities under the GLHs that would make it competitive, and they did not specify a certain governance setting that would help these ports develop into hub ports. Furthermore, Lee and Flynn (2011) studied port policy in container hub ports. However, their study was viewing the port policies in Asia and Europe for pricing the port’s services to increase competitiveness and not how GLHs are managed or what policies and legislation they follow. They were also contained in the boundaries of container ports. The second most researched theme is the potentiality, benefits, feasibility or impact of ports, cities, countries, or regions developing into a GLH, for instance, in Panama (Brito & Botter, 2012), Taiwan, Korea and Japan (Yang & Chen, 2016), the Caribbean (Anderson, 2017; Bennett, 2017), Dubai (Sundarakani, 2017), and Azerbaijan (Rustamova, 2022). This theme is the closest to treat the concept as a standalone term and not combine it with others. The studies of Brito and Botter (2012) and Yang and Chen (2016) identified relevant criteria for developing a region into a GLH. Sundarakani (2017) study views a GLH clearly and studies the case of transforming Dubai into a GLH, discussing the potentials and the benefits of Dubai. These studies managed to pin down the relevance of the criteria to GLHs and the benefits and potentiality of developing GLHs. However, they failed to incorporate a framework that clarifies the concept and its operations or its governance structure. Additionally, their studies did not consider other locations where these criteria might be relevant, their studies mainly focused on a certain region. They did not consider economic development, governmental burdens, sustainability, or stakeholders' perspectives. Furthermore, Anderson (2017) and Bennett (2017) viewed the GLH in a clear form, however their studies' objectives were focused on how a GLH development in the region would benefit the agritourism and its sustainability (Anderson, 2017) and the effect of security on tourism and logistics (Bennett,2017). Furthermore, Hammad et al. (2021) researched the potential benefits of establishing a GLH for energy and provided a conceptual framework for establishing and operating a GLH. However, its focus was energy supply chain, and did not consider other applications to the term. This indicate that the concept and definition of a GLH in the literature are being used more clearly, and more encompassing of other constituents of GLHs in recent years. Even though these studies are encouraging the development of GLHs, they did not provide a holistic framework of operations, identify the stakeholders involved in a GLH, or governance structure of GLHs. GLHs have several benefits on the economy, tourism, education, employment, and many other aspects therefore countries and regions are encouraging their emergence as GLHs as seen in the 'Potential Global Logistics Hub' theme in Table 2.3. Despite the growing interest and development of GLHs in the real world, the academic literature on GLHs is still falling behind. Therefore, there is a need for more comprehensive and in-depth academic research to fill the gaps in the knowledge to guide emerging GLHs through their development and help them develop in a more efficient and sustainable manner.

2.2.2.2 Global Logistics Hubs Framework and Structure

Based on the understanding established from the reviews above, this section attempts to clarify a theoretical framework for GLHs. Notteboom et al. (2017) addressed the lack of conceptualization perceived around logistics hubs and its variants by proposing a framework including different terminologies used to describe logistics hubs. While it is not a framework that is for GLHs, it can still guide the process of developing a conceptual framework for GLHs. They classified them according to their infrastructure and distinguishing components into three categories: (Storage and warehousing - Cargo trans-loading and rapid transit - Value-added service and soft/light manufacturing). Even though they tried to take a holistic view on logistics hubs, their study did not incorporate transportation or multimodal connections, which in any logistics hub are important. Another attempt was by Sheffi (2012), who listed examples of logistics hubs in his book. He described consolidation centres associated with transportation infrastructure facilities and highlighted different types of logistics hubs through them. He specified that a logistics hub is considered a hub because of the purpose it serves. Table 2.4 lists logistics hub ports examples used in his book.

Table 2.4 Logistics Hub Port Examples (Adapted from Sheffi, 2012)

Logistics Hub Ports	
Ports	**Purpose**
Dubai	A gateway to an increased export/import market every year
Shanghai & Tianjin; or Los Angeles & Long Beach (LA/LB)	Entry/departure points of cargo into/out of their countries
Rotterdam	A mode changing node that involves logistics operations and value-added services
Singapore (transhipment hub)	Consolidation/deconsolidation hub between ocean going vessels focused on transhipment
Panama	Taking advantage of the increased traffic due to the expansion plan of the canal and developing the area with logistics operations and value-added services

According to Sheffi (2012), Singapore is focusing mainly on being a transhipment hub, acting as a centre for consolidation and deconsolidation between ocean going vessels. Singapore is considered Asia's main transhipment hub (Gordon et al., 2005). It acts as an intermediate destination to which the cargo can be decoupled and re-consolidated to different destinations. The Port of Singapore is one of the world's busiest ports and was titled the number one busiest port until 2005 in shipping tonnage, and now it is ranked as the second busiest after Shanghai port (Mangan et al., 2008; Wackett, 2017). Additionally, the port of Singapore handles cargo locally, from and to neighbouring countries, as well as internationally, positioning the port as a transhipment hub (Lam, 2016). Additionally, according to Fernandes and Rodrigues (2011), Dubai Port is following the footsteps of Singapore. However, Majdalani et al. (2006) believe that

Dubai is integrating its multimodal infrastructure to become a GLH and not just a centre for transhipment. This highlights a differentiating feature between a GLH and a transhipment hub, which is the multimodal infrastructure. Dubai was following Singapore to be a transhipment hub, however, it is becoming the centre of developmental plans for its region due to its strategic geographical location, its potential, and the relaxed governmental burdens on logistics compared to others in the same region (Sheffi, 2012, Sundarakani, 2017).

On the other hand, the expansion of the Panama Canal and the increased traffic is motivating Panama to take advantage of its position and the high traffic to develop into a GLH by improving its logistics infrastructure and multimodal connections (Brito & Botter, 2012). The expansion of the Panama Canal is an endeavour to accommodate the ultra large vessels transported through oceans with great cargo capacities (CanagaRetna, 2013). Panama is striving to develop into a GLH to serve the Americas. However, according to Munoz and Rivera (2010), developing Panama has taken into account Singapore and Dubai logistics hubs as successful cases. Since Singapore and Dubai are transhipment hubs currently, it seems that Panama has a long way ahead to develop into a GLH due to a lack in the infrastructure.

Furthermore, Sheffi (2012) described Rotterdam as a mode changing node. The port of Rotterdam being the largest European seaport allows it to accommodate larger vessels and act as a centre for Europe's freight transportation by taking advantage of its strong and abundant multimodal connections (Peng, 2013). It is a very important transition point, for freight transport, regarding connecting Europe with the rest of the world. Peng (2013) explained that the huge ships coming from Asia could only be handled by Port of Rotterdam, it can then transfer the containers into smaller ships to be transported to different ports across Europe.

Additionally, Shanghai and Tianjin or Los Angeles and Long Beach are considered gateways to each of their countries due to their combined traffic and facilities, so they are taking advantage of this by being logistics hub ports for their regions. According to Sheffi (2012,) Tianjin and Shanghai ports or Los Angeles and Long Beach ports are gateways for freight to and from the entire United States or China. Sun and He (2008) point out that Tianjin port is the core hub port for the Northern China area because of its prominent logistics distinction and development environment, while Shanghai is ranked the busiest port in the world (Wang et al., 2017). Both ports support each other's operations and serve as entry and departure points to China. On the other hand, the Ports of Los Angeles and Long Beach together formulate the biggest shipping composite in the United States with regards to cargo volume as well as container traffic, combining their facilities to excel their services (Giuliano & Brien, 2007). Hayuth and Fleming (1994) stated that the ports of Los Angeles, with its excellent multimodal connection, and Long

Beach form a mega-port complex serving the entire United States. Moreover, sixty percent of the cargo arriving to or leaving from the United States is transported through this composite facility (Giuliano & Brien, 2007). This classification and description by Sheffi (2012) show the heterogeneity of the logistics hub concept. Whether a port, city, or region; is a gateway, has high traffic, capacity, facilities, logistics infrastructure, multimodal connections, or a strategic geographical location, it is a logistics hub due to serving its purpose.

Furthermore, Yang and Chen (2016) defined the determinants of GLHs ports' competitiveness (Table 2.5), which could be presenting some of the potential characteristics of GLHs.

Table 2.5 Determinants of Global Logistics Hub Ports (Adapted from Yang & Chen, 2016)

Dimension	**Assessment Criteria**
Political-economic environment	Stability of political climate
	Economic scale of market
Operating environment	Volume of transshipment cargo
	Deregulation of international trade and foreign currency exchange systems
	Efficiency of local government administration
	Convenience of customs clearance procedures
	Efficiency of port and logistics operations
Cost environment	Integration of customs and port logistics information
	Cost of labour
	Cost of land
Infrastructure facilities environment	Harbour and stevedoring costs
	Transport and distribution costs
	Effectiveness of port logistics facilities
	Infrastructure facilities environment
	Adequacy of the port hinterland for logistics functions
	Efficiency of intermodal transport network
Preferential incentive environment	Sailing frequency and diversification of shipping routes
	Soundness of investment system and incentive measures
	Exemption from or reduction of corporate and local taxes
	Exemption from and reduction of custom duties and value-added tax for cargo

According to Yang and Chen (2016), for a GLH port to be competitive, it is important that it has political and economic stability, cheaper costs, provide the infrastructure of facilitates to ensure transportation and distribution, as well as the effectiveness of port logistics facilities.

Additionally, they refer to the maritime traffic, frequency, and diversity of routes. They also highlight the importance of tax and custom exemptions. Furthermore, the governmental burdens on logistics operations in the region or the city hosting the GLH is an important determinant of the applicability of the concept and its operation. Political perspective and governmental burdens are some of the criteria that Brito and Botter (2012) took into consideration when choosing the assessment criteria for developing a GLH in Panama, as shown in Table 2.6. According to their study, these criteria were based on a literature review, professional opinions from experts in the field, and logistics hub stakeholders.

Table 2.6 GLH Development Main Assessment Criteria (Brito & Botter, 2012:258)

Category 1	**Category 2**	**#**
Physical and technical infrastructure	Intermodal network development (Efficiency of modal integration)	[1]
	General GLH accessibility	[2]
	Adequacy infrastructure facilities	[3]
	Hinterland size, development, and potential	[4]
Costs environment	Freight and transhipment costs	[5]
	Land availability and cost	[6]
	Cost of labour force (training, education, R&D)	[7]
	Industrialisation cost (fabrication and processing)	[8]
Political/administrative perspective	Political stability	[9]
	International trade soundness	[10]
	Administrative efficiency	[11]
	Customs regulation	[12]
	Business tradition and potential	[13]
	Taxes/Subsidy to business Activities	[14]
	Soundness of investment system	[15]
Geographical location	Proximity to import/export areas	[16]
	Vorland development (attractiveness to main commercial routes)	[17]
	Global strategic location	[18]

Brito and Botter (2012) explain that these assessment criteria would identify the country's logistics potential for a GLH development. Most of the assessment criteria are similar to that of Yang and Chen (2016). However, they have added the political/administrative perspective, which dives deeper into the governmental policies and burdens that might face the logistics operations when developing a GLH. Political and administrative perspective is a significant criterion, because if taxes to business activities are high and the area is not politically stable then it will be very hard to attract businesses or make a case of smooth logistical operations. It will be unappealing for foreign investments as well. Areas with no flexibility in the customs and no administrative efficiency risk that businesses will not consider the location for distribution operations due to time constraints and risking losing the cargo in the process. Therefore, the political and governmental accommodation of the operations of the GLH is very important to its potential to develop.

As discussed earlier, GLHs are multifaceted and often accompanied by conflicting views in the literature. In order to gain a better understanding of the concept and categorize the various perspectives, the next section will review the literature on the evolution of ports, port clusters, and port-centric logistics. This review will be used to compare and contrast these concepts with the current understanding of GLHs in the literature, with the goal of identifying any differences or distinctions among them in the literature.

2.2.3 Ports, Port Clusters, and the Emergence of GLHs

2.2.3.1 Port Generations, Evolution of Logistics, and Port-Centric Logistics

A simple definition of a port can be taken from Stopford (2009:81), who defines a port as "*a geographical area where ships are bought alongside land to load and discharge cargo – usually a sheltered deep-water area such as a bay or river mouth*". However, this idea of a port might have been applicable before the 1960s (UNCTAD, 1992), but it does not capture the complexity of how a port is viewed in recent literature and in the modern world. The definition of a port varies between this simple idea and a more comprehensive perspective. For example, Ibrahimi (2017) provides a more complex definition of a port:

> *A commercial port is a territorial, operational, and institutional cluster of interrelated social-economic resources, activities and legitimate actors engaged in appropriate agreements (in) directly related to the transfer of goods and people between land and sea vehicles, serving as a node for the foreign trade and tourism, for the industry, logistics and supply chains, and for the global transport system ever more intermodal in its hinterland and foreland.*

However, this definition seems to combine several ideas together. Ports have been evolving since the 1960s to keep up with market demands and trade advancements. Several studies have addressed this evolution and the most popular categorization of this evolution is done by the United Nations Conference on Trade and Development (UNCTAD, 1999). The report proposes four generations of ports starting from the 1960s to 2000s and then a fifth-generation evolution was coined by Flynn et al. (2010) from 2010's onwards. Even though this evolution might suggest that all ports have evolved to the fifth generation, this is not the case since there still exist all generation types of ports nowadays depending on their location and market needs (Kaliszewski, 2018. For detailed tables illustrating these generational differences, please refer to Appendix 16.

The UNCTAD report (1999) explained the adaptation and changes that ports had to incorporate to adapt to the evolution of the world around them. Notteboom (2011) categorizes the differences of the UNCTAD model into external environment, functional organization, spatial organization, and port organization strategy. These differences are highlighted in a chronological order: ports before the 1960s where trade was simple, exchange of services or products between individuals or companies; to ports after the 1990s being influenced by globalization and global supply chains spreading their operations internationally. The evolution emphasizes that first-generation ports are responsible for transhipment, loading and unloading of cargo, and storage (acting as a warehouse) and these are the kinds of ports that existed before 1960s. They are isolated entities, handling break-bulk cargo and port authorities are mainly responsible for nautical services. Their location is determined by the presence of market and the availability of labour. Second-generation ports have a better connection with their trade and transport partners, offer a range of functions acting as a commercial centre with a wider scope of activities rather than just loading and unloading (Beresford et al., 2004). They were fuelled by industrialization after 1960s. Additionally, combining services led to expanding the outline of the port's range, and relationships between the port and port users became closer. However, there is no integration between activities within the port in this generation. As from the third-generation port onwards, the term hub was used to describe ports in the literature (UNCTAD, 1992; Alderton & Saieva, 2013). However, describing the third-generation port as a 'hub' is because the distribution services of the port go beyond the port boundary (Wan et al., 2014).

The evolution of third-generation ports occurred after the 1980s, influenced by containerization and intermodal transport. They are considered a hub, a distribution centre, or a transhipment centre, and a logistics platform in the international trade network. Modern equipment and information technology are used to deliver the port's services, and various integrated added-value (port-oriented) activities related to ship service or cargo are included in the port's function (Beresford et al., 2004). This generation of ports has an integration of activities within the port organization and a united port community. The term "added-value" that distinguishes the port generations after 1980s "*signifies value newly added or created in the productive process of an enterprise … added value can take different forms such as cargo consolidation and deconsolidation, providing up-to-date information on the inventory and cargo movements; stuffing/unstuffing containers, crating, palletization, shrink-wrapping, labelling, weighing, repacking etc*." (UNCTAD, 1992:19). In third-generation ports, the area around them is integrated and used as terminals and distriparks to aggregate all added-value activities at one large site.

As for the fourth-generation ports, Alderton and Saieva (2013) explain that their evolution is the result of globalization since it required physically separate ports and port communities to connect and form a network through linking common operators and the integration of logistics. This resulted in ports being the centre of international trade and economic activities and an important element in global supply chains (UNCTAD, 1999; Chhetri et al., 2014; Wan et al., 2014). They offer a wider range of sophisticated logistics and value-added services than third-generation ports. They are central nodes and important connections to the transhipment of containers in the global transportation flow as a result of transport operators' integration in the global logistics chain horizontally and vertically (Zhang & Lam, 2013; Wan et al., 2014). Fourth generation ports can be considered as the ports on which global logistics hubs are based since they are global ports, connecting several ports and facilitating the formulation of hub-and-feeder networks between ports in the same region.

Fourth-generation ports operate from an internal profit viewpoint, and it does not consider the ports' stakeholders. Therefore, Flynn and Lee (2010) coined a fifth-generation port concept that operate from a 'customer-centric community-focused' viewpoint to focus on the port's users' multi-faceted business requirements along with the community's requirements, while taking into consideration port competition and government regulations and policies (Lee & Lam, 2016). So, it is a generation of ports that takes into consideration all stakeholder interests, which requires a great deal of integration. The fifth-generation port is classified under the same 8 categories that the UNCTAD (1999) used for fourth-generation ports: service quality, information technology, community environmental impact, port cluster, maritime cluster, logistics hub, inland, and waterside, to facilitate the comparison between them. Flynn et al. (2011) also proposed a new classification for ports development, shown in Figure 2.3. This classification framework shows the adaptation and improvement of ports along the 'port ladder' and presents the effect of responding to new customers' requirements and change in shipping and ports environment.

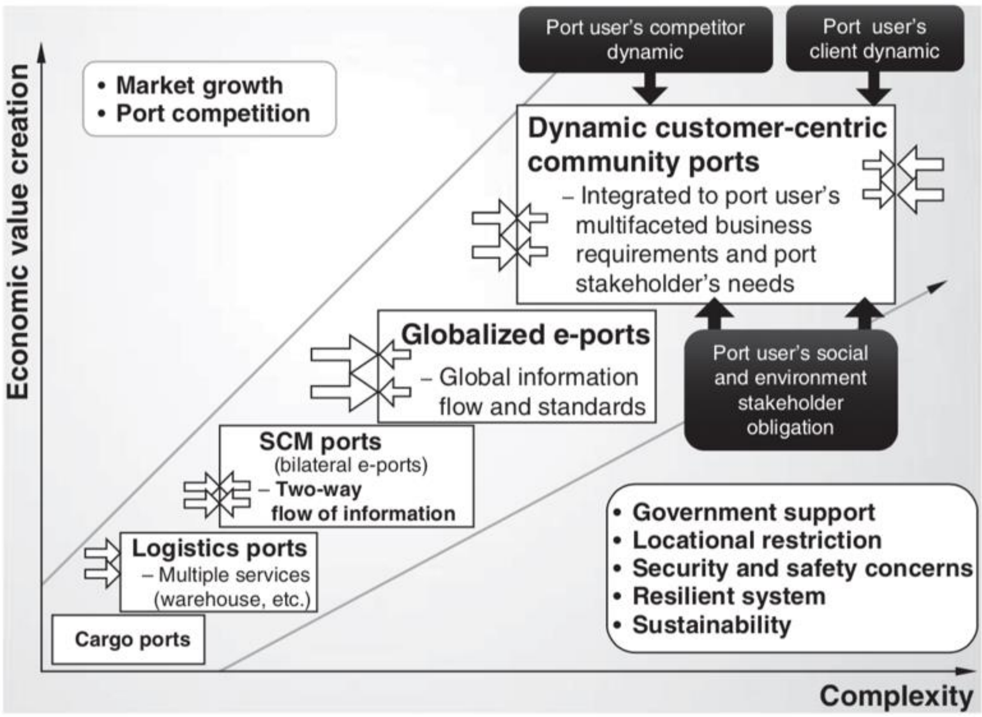


Figure 2.3 Evolution Path to the Fifth Generation as "Dynamic Customer-Centric Community Ports" (Flynn et al., 2011; modified by Lee, 2015)

Flynn et al. (2011) explain that as the ports rise on the 'port ladder' the complexity of services and level of integration increases. The five development stages: cargo ports, logistics ports, supply chain management ports, globalized e-ports and dynamic customer-centric community ports show the ports growing complexity along the port ladder and the integration of port's stakeholders is a requirement to develop into a fifth-generation port in order to satisfy its customers and increase the loyalty of its customers, which is the goal of leading ports (Lee & Lam, 2015). Additionally, Lee and Lam (2016) provide a more detailed differentiation between the fourth and the fifth-generation ports, as presented in Appendix 16. The main differentiating point between them is integrating port's users, stakeholders, and community in the aims and goals of their performance. For instance, in the service quality and IT comparisons the aim in the fourth-generation port is to get the job done and to make profit. However, in the fifth-generation port the aim is to integrate customer satisfaction in the service quality, provide a one stop service for its users, and improve security and provide environmental data through IT. Fifth-generation port performance is evaluated financially as well as through customer satisfaction. Therefore, fifth-generation ports might be more suitable to be associated with GLH's operations and system to have the capability to involve the different stakeholders in a GLH. Unlike fourth-generation ports that function around profit, fifth-generation ports function from a customer satisfaction point of view and stakeholders' involvement. They operate around the network of their users and stakeholders. This can be reflected in their connectivity in the GLH system. Furthermore, in regards to the environmental impact comparison, fourth-generation ports are operating from a regulatory compliance viewpoint, but fifth-generation ports are actively engaging ports' stakeholders and community in their environmental planning and operating. This is done through a rewarding green system with their users. In accordance with this research, the environmental impact and environmental management are aligned with the focus of this research. It is important to understand how the ports manage their environmental impact and what position do they have within the environmental sustainability of a GLH. Even though fourth-generation ports are environmentally aware of their impact, and they comply with environmental regulations, this does not imply that they have a strong environmental management system. This could result in a weak environmental management system within the port and for the stakeholders, users, and the community of the system of a GLH (Dasgupta et al., 2000). On the other hand, fifth-generation ports are proactive in their environmental strategies and initiatives. They encourage their users through rewarding green systems and involving their stakeholders in the environmental planning. In a GLH, this could help with the overall environmental management, since a fifth-generation port will be connected to the other activities and operations taking place under the umbrella of a GLH.

Furthermore, the evolution of ports does not stop at the fifth-generation ports, recent studies have been proposing a sixth-generation evolution (Kaliszewski, 2018; Lee et al., 2018). It is worth noting that there is not a widely accepted or standardized definition of a sixth-generation port in academic literature, as the concept is still evolving and being debated among experts (Karaś, 2022). The emergence of the sixth-generation port concept in the literature highlights the ongoing evolution and adaptation of ports to the changing global trade and transportation landscape. A key feature of 6th generation ports is the advancement of integration of smart technologies and digitalization to improve efficiency, sustainability, and customer service (Kaliszewski, 2018; Lee et al., 2018; González-Cancelas et al., 2021). This includes the use of digital platforms to connect and coordinate various port stakeholders, as a response to the high digital transformation seen in the world currently. This is also reflected in the adoption of digitalization in the maritime transport sector due to cost benefits and improving the interconnectedness of the whole supply chain (Karamperidis et al., 2021). The fifth and the sixth-generation ports are focusing on integrating themselves with the communities they serve by being more customer-focused and utilizing technology and digitalization to improve their operations. The changes in these generations are not necessarily about the functions of the port itself, but rather about how the port interacts with and serves its community.

The evolution of ports can also be closely linked to the evolution of logistics. According to Coyle et al. (2003, cited in Nam & Song, 2011) logistics has not always been seen or defined this way, it has evolved through three stages. The first stage between 1960s and 1970s was seen as a simple physical movement of cargo, where retailers distributed their cargo locally or regionally by developing their own distribution structure. The second stage was between late 1980s and 1990s, they viewed logistics as materials management, physical distribution, and applying information technology. While the third stage is from the year 2000 onwards, incorporating the value-added logistics activities and helping businesses improve their competitive advantage.

Furthermore, Kent and Flint (1997) identified six eras of logistics thought evolution: farm to market, segmented functions, integrated functions, customer focus, logistics as a differentiator, and behaviour and boundary spanning, as shown in Figure 2.4. Each era is characterized by distinct features and influenced by various factors, showcasing the dynamic nature of logistics evolution.

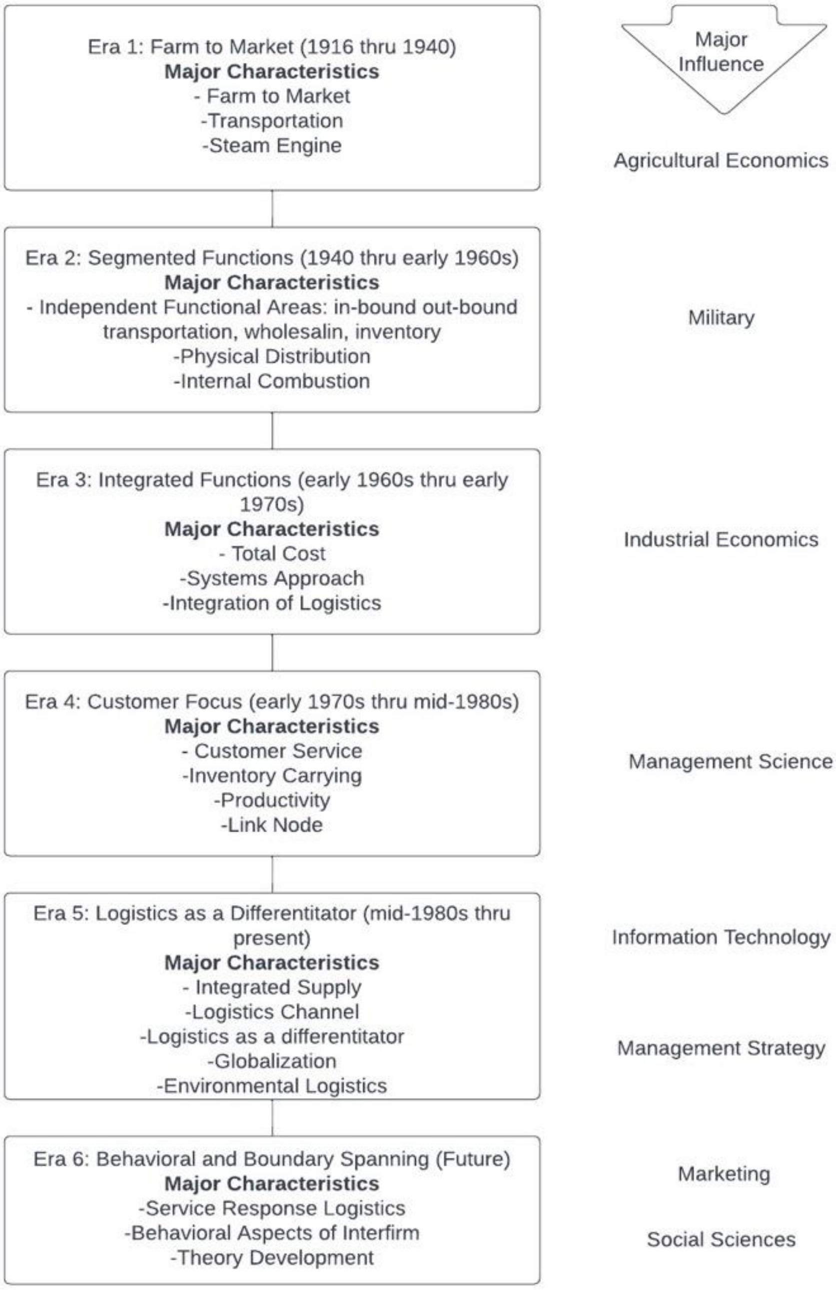


Figure 2.4 Chronological Model of the Evolution of Logistics Thought (Kent & Flint, 1997:22)

The functions span from segregated and siloed functions to the more recent eras where there is more integration due to globalization and information technology, and the forecasted 6th era of having more customer-centric logistics functions and integrated supply chains (Szymańska et al., 2017). The evolution and integration of logistics activities within ports have contributed to the diversity of perspectives on ports and the emergence of 'Port-Centric Logistics'. Mangan et al. (2008:36) define it as “the provision of distribution and other value-adding logistics services at a port”. In response to the increasing complexity and globalization of supply chains, ports have evolved from simple berth allocation to multifaceted centres that offer a wide range of services and activities to improve the competitive advantage of the entire supply chain. This transformation has been driven by the need for increased efficiency and effectiveness in supply chain management, as well as changing dynamics in the ports sector, such as heightened competition between ports, evolving ownership structures, and the growing influence of shipping lines (Mangan et al., 2008).

Port-centric logistics focuses on viewing the port not only as a transportation node, but also as a centre that provides opportunities for storage, warehousing, and value-added logistics. The strategic goal of port-centric logistics is to reduce transportation distances and associated costs by locating distribution centres at or near the port, thereby minimizing the distance travelled in distribution and transportation activities within a specific supply chain based on their strategy and supply and deman patterns (Mangan et al., 2008). An alternative perspective on port-centric logistics can be framed in terms of port-based versus inland-based logistics, as proposed by Monios and Wilmsmeier (2012) in the context of primary and secondary legs of supply chains. They argue that the adoption of a centralized or decentralized distribution centre strategy by the supply chain determine whether port-centric logistics would be suitable for a supply chain.

While port-centric logistics and GLHs might seem to have a similar idea of having centralized logistics, their purpose, scale, and function are different. Port-centric logistics is a supply chain-focused approach that can be applied to any port with available space, whereas GLHs are typically large-scale logistics hubs strategically located with advanced infrastructure and services to support complex global supply chains by using multimodal connections, and not necessarily just port locations. From the current theoretical understanding of GLHs, they are often planned and developed with significant investments in infrastructure, technology, and resources to cater to a wide range of logistics activities for international trade cargo with global origins and destinations, with sophisticated systems for coordination and management, playing a major role in national economic development (*Table* 5.1*,* Figure 5.1*, and Table* 5.2 *evidence this later with clarity in frequency tables*). In contrast, port-centric logistics may rely more on existing port infrastructure and services to cater for local customers and local demand, without the same level of specialized resources and capabilities that GLHs may offer.

Another concept that could contribute to the clarification of the GLH concept is port clusters. Port clusters and logistics hubs are seen as part of the differentiating features of recent port generations (Lee & Lam, 2016). However, it is not clear whether they are connected to or part of the port. The next sub-section is going to discuss port clusters to shed light on differentiating factors.

2.2.3.2 Port and Maritime Clusters

A cluster is the concentration of a group of similar firms or businesses in the same industry around a geographical location, linked vertically or horizontally to complement or compete against each other (Porter, 1990). It is a population of associations and public or private organizations not an entity (De Langen, 2002). Clustering is a central concept used to analyse the competitiveness of firms or nations (Porter, 1998). Moreover, Chhetri et al. (2014) explains that there are two ways to view clusters, one relates them to supplier-customer convenient location links to enhance horizontal integration, and the other relates them to cooperation and alliance between firms to enhance performance. In the application of Porter's (1998) cluster theory to maritime and port clusters the differentiation is in the boundaries of each one of them. Maritime clusters are bigger than port clusters, they include a wider range of firms and industries related to shipping, fisheries, ports, dredging, inland shipping, R & D, relevant manufacturing, off-shore oil drilling, marine sports, financial services, relevant manufacturing or any maritime related industry (De Langen, 2002; Roh, 2007; Shinohara, 2010). There is not a set or a fixed type of industries required to be in a maritime cluster. It is different in each one depending on the circumstances and particular development of the cluster. For instance, Maritime London cluster developed around maritime law, insurance and finance; Maritime Forum of Norway is developed around aquaculture, fishing and ship gear and service; and Dutch Maritime Cluster is developed around shipbuilding, port services, inland shipping, dredging, and trade associations (Roh, 2007). The Dutch Maritime Cluster is a leading example of maritime clusters and taken as an example in different studies, highlighting the economic prosperity and political and environmental value resulting from this clustering (Shinohara, 2010). Figure 2.5 illustrates the boundaries of the Dutch maritime Cluster, where it contains several Dutch ports including Port of Amsterdam, Port of Rotterdam, a shipping cluster, a shipbuilding cluster, a marine equipment supplies cluster, an offshore cluster, an inland shipping cluster, a dredging cluster, a port cluster, a maritime services cluster, a fishing cluster, the Royal Netherlands Navy cluster, and a yacht building industry cluster, which illustrates how diverse a maritime cluster could be. According to Roh (2007), there are several configurations of the port range, maritime cluster, port cluster, and port. This ranges from ports including port clusters, or vice versa, the port clusters include several ports and other maritime activities clusters. This depends on the case, which makes it difficult to set a specific boundary to a port cluster.

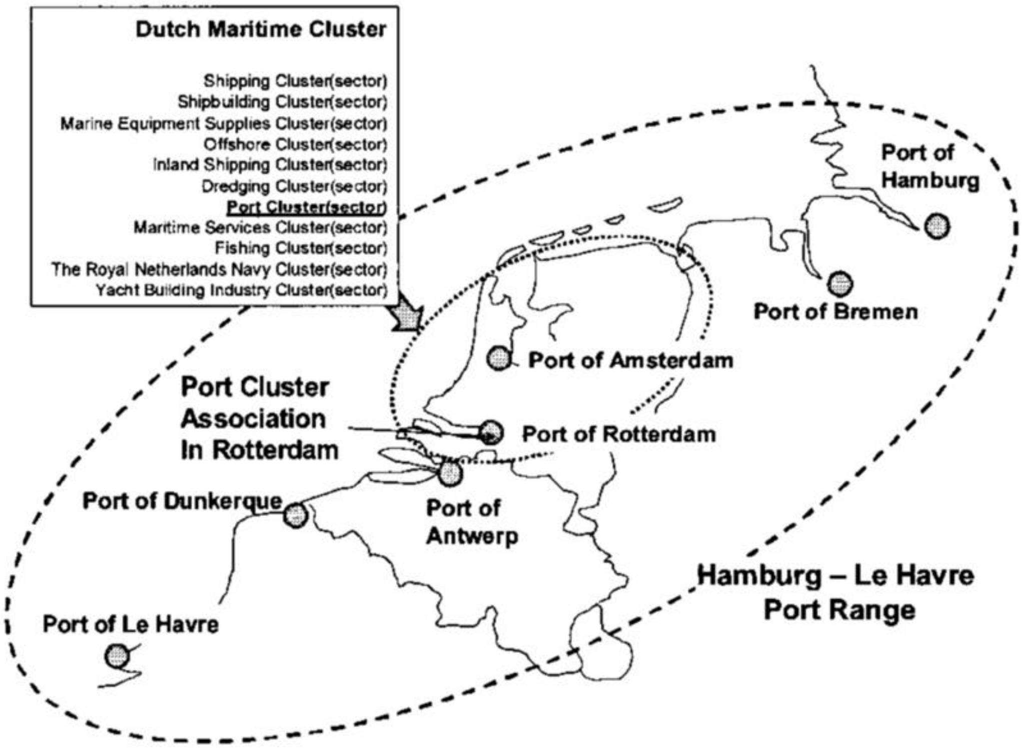


Figure 2.5 Hamburg - Le Havre Port Range: Illustrating Maritime Cluster, Port Cluster, and Ports (Roh, 2007:63)

The development of port clusters in the maritime industry is believed to have occurred due to the intensified competition happening between ports that is adversely affecting the regional economies because of the duplication of resources and "*trade cannibalism"* (Lam et al., 2013:33). Therefore, by forming port clusters, the regional economy is promoted, the ports' resources are developed, and it gives the incentive for ports to cooperate rather than compete (Zhaoliang et al., 2009; Lam et al., 2013). According to Roh (2007) the term "*port cluster"* was first used in 2001 by Haezendonck (2001:136) defining it as "*a set of independent firms engaged in port related activities, located within the same port region and possibly with similar strategies leading to competitive advantage and characterized by a joint competitive position vis-à-vis the environment external to the cluster*". A port cluster system is formed when two or more ports have the same hinterland, however, the borders of a port cluster is not well defined and vague in practice (De Langen & Haezendonck, 2012). Table 2.7 lists the activities that are generally considered to be available in a port cluster.

Table 2.7 Port Cluster Activities (De Langen & Haezondonck, 2012:641)

Cluster component	**Activities**
Cargo handling	Loading, unloading and transhipment activities
Transport	Pilotage Port engineering Shipping services Inland shipping services Salvage services Shipbrokers Rail transport Pipeline transport Trucking services
Logistics	Transport intermediaries (forwarders and ship agents) Warehousing and storage Logistics consultancy services
Manufacturing	Oil refining Flour milling Cokes manufacturing Basic chemical manufacturing Other chemical manufacturing Production of iron and steel Shipbuilding and repair Specialized suppliers to port industries
Trade	Trade intermediaries in oil, fuel, and chemical products Trade intermediaries in metals, ores, and food Fuel, grain, metals, and mineral oil wholesalers

Table 2.7 shows that a port cluster includes manufacturing and trade activities in addition to the port, transportation, cargo handling, and logistics activities. However, it is difficult to confidently set the activities found in a port cluster due to the variation of boundaries explained by Roh (2007) between port clusters and ports. On the other hand, a leading port is seen as an entity that possesses the necessary service quality to meet the satisfaction of customers and the interests of the port community (Lee & Lam, 2016). This includes the consideration of information technology, environmental impact, and the benefit of the port's stakeholders. Logistics within a port is considered a component of the broader maritime logistics chain, facilitating intermodal transport is not directly under the functions of the port. The synergy between the port, port clusters, and maritime clusters, as well as incentives and strategies for developing inland connections with the port, and policies for the development of maritime ports,

all demonstrate that the port is a complex system of interconnected activities, facilities, and connections.

Therefore, a port along with its services and global transport discussed within the port generations can be included within the boundaries a of port cluster. A port cluster represents the geographical proximity of multiple ports, with the aim of avoiding the duplication of resources and fostering complementary service offerings rather than competition. Therefore, the purpose of port clusters is to serve cooperation, horizontal integration, benefiting from locating manufacturing firms and trade activities in the same geographical location, benefiting from the supplier-customer linkages, alliance, and interdependencies between firms (Chhetri et al., 2014). This distinction highlights the purpose of and the nature of activities carried out in a port cluster, which may overlap with those carried out in a port. However, each entity serves a distinct purpose in its existence.

2.2.3.3 A Review of the Term 'GLH' in Academic and Grey Literture Publications through Summon Database

Scholarly articles lack a unified usage of the term, with various definitions and frameworks proposed by different researchers (Nam & Song, 2011; Sheffi, 2012; Yang & Chen, 2016; Notteboom et al., 2017). Despite attempts to define and use the concept as a foundation for studies, the terminology continues to be heterogeneously used by practitioners and academics alike (Nam & Song, 2011). Nam and Song (2011) note that the concept of a hub originated in the late 1970s in the US, primarily within the passenger airline industry. The concept of "hub and spoke airports" referred to a network pattern where large shipments were consolidated at the hub and redistributed to spokes. This idea of a hub and spoke network is considered an essential component of the GLH concept.

In this section a systematic search was conducted using Summon database to investigate the usage and emergence of the term "global logistics hub" in the academic and grey literature. Summon is a digital database accessible through the university's account. It encompasses a wide range of scholarly articles, newspaper articles, e-books, and other electronic resources, providing a comprehensive source of information for expanding the background knowledge about the term. This database was used to discover the term's earliest use and to review the contexts and meanings of the term in different settings, and through different sources. The search yielded 173 results. The earliest use of the term according to this search was in a newspaper publication, Electronic News (1997), an article describing Shanghai as a GLH for mainland China. This aligns with the first relevant publication on 'Hub Ports' in the academic literature in 1997 by Fossey (1997), where the term was used to denote a global distribution centre for a certain product. However, according to the literature review conducted in section

2.2, the earliest recorded usage of the term "global logistics hub" (GLH) in academic literature dates back to 2007 in a study by Lee (2007). Additionally, Biederman (2000) described Singapore as a developing GLH because of the clustering of many logistics companies in Singapore, all major shipping lines calling there, its strategic location, well-educated and trained workforce, and simplified customs procedures. This was the aim of the initiative 'Logistics Enhancement and Applications Programme' (LEAP) to turn Singapore into a GLH which resulted in the convenience for companies to outsource their logistics operations, whether it is freight transportation, materials management, or integrated and value-added logistics services (Chang, 2004). However, Singapore in other studies is described as a transhipment hub (Cullinane et al., 2006; Lam, 2016), which refers to "*cargo transfer from one transport conveyance (any mode) to another*" (Fleming, 2000:164). Consequently, this points out that the term was first used in a broad and ambiguous context compared to more recent publications (Hsu, 2006; Yang and Chen's, 2016) that specifically refer to GLHs as maritime ports in strategic locations. Over the years, various studies, articles, and industrial reports referred to the term to describe different ports, regions, or cities that were attempting to develop into or have the potential to develop into GLHs. Table 2.8 presents pertinent publications identified through Summon database, during the period 2000-2022 excluding publications on airports.

Table 2.8 Diversity of GLH Term Usage in Publications between 2000-2022

City/Port/Region	Description	Publications
Port of Singapore	Transhipment Hub port	(Gordon et al., 2005; Hayes, 2006)
Kansas City	Logistics Park	(Bierderman, 2005)
Port of Antwerp	Global Logistics Hub	(Baron, 2005)
Port of Houston	Distribution Hub	(Bierderman, 2006; Bierderman, 2008)
Dubai	Transhipment Hub	(Gallagher, 2007; Sundarakani, 2017)
Port of Miami	Logistics Hub port for the Americas	(Burnson, 2015)
Busan, Tokyo & Kaohsiung	Global logistics hub port for Northeast Asia	(Yang & Chen, 2016)
Caribbean region *(Jamaica, Dominican Republic, Antigua, Barbados) - Port of Oakland – Jamaica – Panama – Mexico - Suez Canal Region -* ***Persian Gulf Region*** *(Kuwait – UAE – Saudi Arabia)* ***North Africa*** *(Egypt)* ***North America*** *(New Jersey)* ***Asia*** *(Azerbaijan)*	Potential Global Logistics Hub (City, Country, or Region)	(Hoffman, 2006; Proto, 2009; Gonzalez, 2014; Country Forecast, 2014; Zbar, 2015; Burnson, 2016; Ajagunna et al., 2017; Bennett, 2017; Poo, 2017; Perry, 2019 Arab Finance Brokerage Company, 2022; Rustamova, 2022)
Dallas – Infineon Technologies Asia Pacific - BMW RDC	Defining Global Logistics Hub as global distribution centres for a certain company or product	(Hoffman, 2007; Lee et al.,2009; India IT, 2015; Germany Automotive, 2016)

The terminology used to describe Global Logistics Hubs (GLHs) in various publications is diverse, with each publication assigning a different meaning to the term, as shown in Table 2.8. While the general notion is that GLHs function as hubs, Table 2.8 demonstrates that the definition varies according to the purpose attributed to it in each publication, revealing a lack of consensus or standardization in its usage. For example, Singapore has been considered an early example of a GLH, but Sheffi (2012) characterizes it as a transhipment hub. Additionally, Fernandes and Rodrigues (2011) describe Dubai as a transhipment hub striving to become a GLH for the entire Gulf region due to its strategic location. Furthermore, Logistics Park Kansas City (2017) defines a GLH as a logistics park used for distribution and warehousing operations, while other publications identify a GLH as a port, such as the Port of Houston, as a distribution hub (Bierderman, 2006), and the Port of Miami as a logistics hub port (Burnson, 2015). Furthermore, according to a CBRE report (2015), emerging and fully developed GLHs include cities such as Liverpool/Manchester region, Rotterdam, and Antwerp. This indicates a more complex meaning to the term GLH and suggests the need for a more refined framework for understanding GLHs.

Since many countries and regions want to reap the benefits of being a GLH, they started using the term to describe themselves even though the concept is used precariously. This inconsistent usage of the term is further highlighted in Table 2.3, where several publications in the 'Potential Global Logistics Hub' theme category refer to the economic prosperity, improvement of tourism, accessing new markets, and development of trade, which are not typically associated with logistics and distribution centres. Table 2.3 and Table 2.8 reveal the wide-ranging application of the term "GLH" in different publications, encompassing ports, regions, cities, countries, and logistics distribution centres. This variation contributes to the lack of consensus in defining GLHs. However, the majority of publications primarily associate GLHs with seaports or specific locations such as cities, countries, or regions.

The literature on the topic of GLHs has been diverse and inconsistent, making it challenging to establish a clear and unified definition or framework for the concept. Nonetheless, several key components have been identified in previous studies that can serve as the foundation for establishing a preliminary framework and concept for a GLH. Specifically, with regards to the current research, this framework will aid in clarifying and operationalizing the concept of GLHs for the purpose of conducting this research. Based on the current theoretical understanding of the concept, Figure 2.6 illustrates the positional relationship between ports and port clusters, with GLHs temporarily added to this framework.

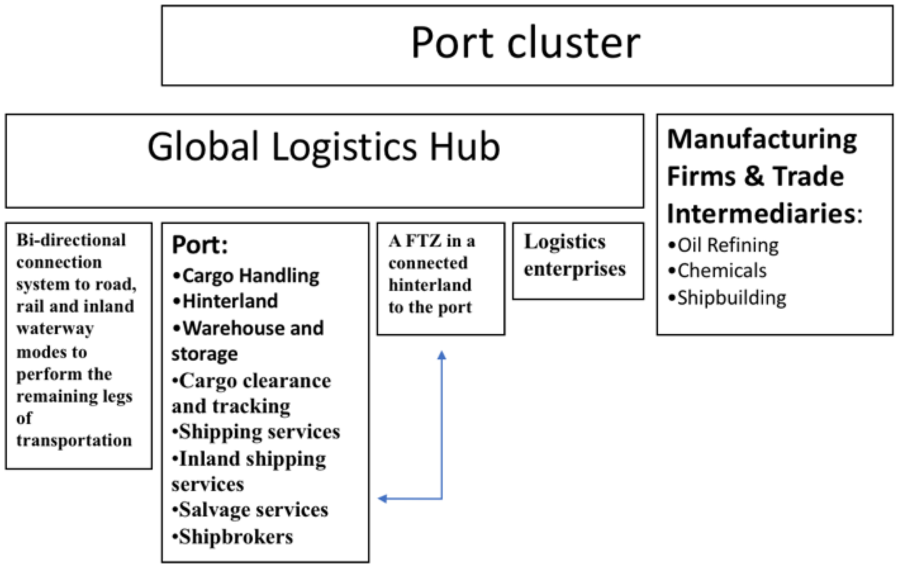


Figure 2.6 Preliminary Conceptual Framework illustrating the Boundaries of Port Clusters, GLHs, and Ports (Source: Author based on: Roh, 2007; Song & Panayides, 2008; Britto & Botter, 2012; De Langen & Haezondonck, 2012; Yang & Chen, 2016)

This framework suggests that a port is included in the constituents of both a GLH and a port cluster. A port cluster could include a port with all its services, along with manufacturing firms and trade intermediaries in the same geographical location to enhance regional economy and benefit from complementing each other's business. A GLH includes a fourth or fifth generation port (according to the operation of the port whether its customer-centric or profit oriented), along with a connected hinterland including a free trade zone (FTZ), and it has multimodal connections to implement one of the main purposes of a GLH, which is distributing to feeder/spoke locations.

After establishing a preliminary conceptual framework for GLHs, the next section will explore the potential stakeholders involved in the operations of GLHs, based on this understanding of the concept. By exploring the stakeholders, the research aims to identify who may be involved in the GLH operations and can be considered as a constituent of the GLH. This will provide additional dimensions to the definition of the GLH framework and will facilitate the subsequent stage of the literature review, which will encompass a critical review of the literature pertaining to the environmental performance and sustainability of GLHs. By providing additional dimensions to the definition of the GLH framework, the research will be better positioned to critically evaluate the existing literature on the environmental performance and sustainability of GLHs.

2.2.4 Identification of Potential Stakeholders in GLHs

Alam (2013) stated that organizations' activities and operations affect many stakeholders directly and indirectly. Globalization has expanded the supply chain networks over the world, involving an extensive number of stakeholders and that resulted in intricate relationships between stakeholders (Cheng & Wang, 2016). Businesses and Industries always had the usual and obvious interest of their direct suppliers and customers in their operations. However, this circle of interest has been increasing to include different groups of stakeholders over the years, such as governments, NGOs, competitors, communities, and others (Escoubes, 1999). Stakeholders are defined as *"…those groups without whose support the organisation would cease to exist…"* (Reed, 1983:89). Even though the term stakeholder was first used in the management literature in the 1960s by the Stanford Research Institute (Freeman, 1984), but Freeman's book represents a landmark for stakeholder theory in strategic management publications (Donaldson & Preston, 1995). His stakeholder theory definition is the one mostly used in the literature. According to Freeman (1984:52), a stakeholder is "*any group or individual who can affect or is affected by the achievement of firm's objective*s". These definitions suggest that an organization does not only affect and is not solely affected by shareholders, but by many other stakeholders. Another relevant definition by Hill and Jones (1992:133) defines stakeholders as "*constituents who have a legitimate claim on the firm ... established through the existence of an exchange relationship*", and who supply "*the firm with critical resources (contributions) and in exchange each expects its interests to be satisfied (by inducements)".*

Additionally, building on Freeman's (1984) work, Mitchell et al. (1997) presented stakeholder typologies that classify stakeholders according to their importance determined by three key attributes: power, legitimacy, and urgency. A stakeholder could have one, two or all three of these attributes resulting in 7 types of stakeholders, Figure 2.7. These typologies can help in understanding the relative importance, power, and interest of different stakeholders, Figure 2.7.

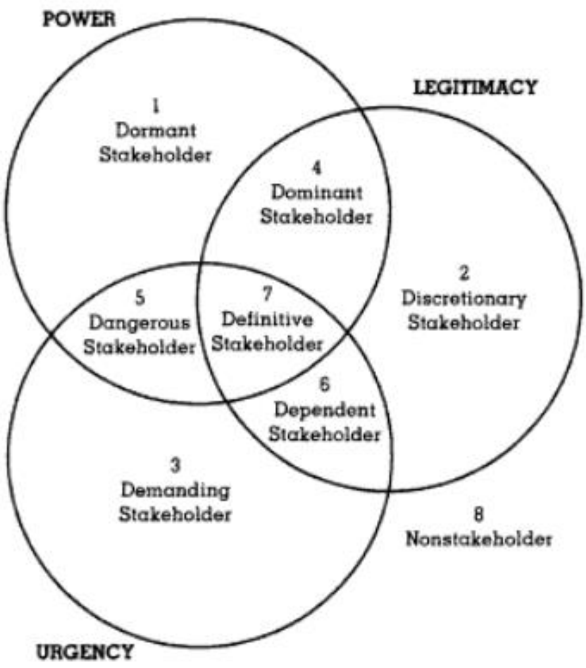


Figure 2.7 Stakeholder Typology: One, Two, or Three Attributes Present (Mitchell et al., 1997:874)

Table 2.9 Stakeholder Typologies (Mitchell et al., 1997; Perkins et al., 2022)

Stakeholder Typology	**Description**
Dormant Stakeholders	have low power, legitimacy, and urgency, and hence have the lowest level of salience.
Discretionary Stakeholders	have low power but high legitimacy and urgency and may be important for public relations purposes.
Demanding Stakeholders	have high urgency, but low power and legitimacy, and may be able to exert pressure through vocal or disruptive actions.
Dominant Stakeholders	have high power and legitimacy, but low urgency, and may not require immediate attention.
Dangerous Stakeholders	have high power and urgency, but low legitimacy, and may use coercive tactics to achieve their goals.
Dependent Stakeholders	have high legitimacy and urgency, but low power, and may need support from other stakeholders to exert influence.
Definitive Stakeholders	have high power, legitimacy, and urgency, and are considered the most salient stakeholders, requiring immediate attention and action.

The key stakeholders of an organization are usually identified by using stakeholder theory (Lavassani & Movahedi, 2010). According to Phillips et al. (2003), stakeholder theory is an organization management and business ethics theory. Stakeholder theory is the theoretical lens adopted to conduct this research, and it is discussed in more detail in Section 3.3.2.

In the context of globalized sustainable logistics and supply chain management, as well as ports and port clusters, stakeholders are considered significant participants since they influence the sustainability of organizations (De Langen, 2006; Samsuddin et al., 2021). This influence may vary in its power, but it still has a weight to be considered (De Langen, 2006). The purpose of sustainability according to its definition is focused on the interest of present and future generations, people, and stakeholders (Brundtland, 1987). In the context of GLHs, a few studies have mentioned some players and actors in their hubs, as listed in Table 2.10. However, there is a lack of studies that clearly identifies the primary stakeholders of a GLH. Additionally, the players and actors mentioned across the studies in Table 2.10 shows a lack of consistency, which could be attributed to them being different hubs.

Table 2.10 GLH Actors identified in the Literature.

Reference	**Hub**	**Actors and Players mentioned in the Study**
Lee (2007)	GLH	• Airports • Seaports • Supply Market • Manufacturing Market • Consumer Market
Lee et al. (2009)	Transhipment Hub	The demanders of logistics activities include: • Manufacturing firms • Wholesalers • Retailers that provide manufacturing, assembly, distribution, and retail services for products. The suppliers of logistics activities include: • Carriers • Forwarders • Container freight station (CFS) operators • Customs brokers • Other logistics integration companies that provide the transportation, storage, consolidation, assembly, inspection, labelling, packing, and documentation services.
Hammad et al. (2021)	Global Logistics Energy Hub	• Governments and regulators • Investors and financiers • International companies • Pipeline owners & operators • International bodies and organisations

Additionally, through the literature review on GLH, there was a gap of studies on the specific operations and activities that take place in a GLH, and their management or governance systems. Evidently because of the scarcity of studies on GLHs in general and the ambiguity of its description in specific. So far, GLHs are perceived as complex agglomeration of activities in a geographical location that require different actors to achieve its purpose. To achieve synchronization between the different actors, it is essential to have a management or a governance structure to ensure smooth management of the relationships between them. In order for this to be achieved, primary stakeholders should be identified in order to form a structure and manage their relationships. There is a lack of research discussing the governance structure in GLHs. However, there is a study that explains the governance structure in regional logistics hubs by Bolumole et al. (2015). Regional Logistics Hubs are defined by non-traditional boundaries and with capabilities that acknowledge the value-added synergies derived from regional resources, including "geographic proximity and access to high-quality transportation infrastructure, proximity to markets, stable government policies, and availability of skilled labour and supporting educational infrastructure" (Bolumole et al., 2015:183). In contrast, a GLH is not only focused on one region but aim to facilitate efficient and seamless movement of goods across different regions and countries, capitalizing on global resources. GLH are typically located at major transportation nodes and ports, and they serve as critical links in global supply chains. While both regional and global logistics hubs aim to enhance logistics and freight operations as well as economic development, they differ in scope and scale. Bolumole et al. (2015) propose that governance structures in regional logistics hubs can adopt a relational model, emphasizing cooperation and coordination between organizations, rather than a strict hierarchy. This model involves sharing of resources, knowledge, and decision-making power among the organizations involved in the logistics hub. In contrast, another model is a hierarchical model. It is characterized by a clear chain of command and centralized decision-making process, with one organization having power to make decisions and allocate resources, and other organizations following its direction. This could be an indication of the governance models adopted in GLHs as well.

The primary stakeholders involved in a GLH can also be enhanced through a compilation of the stakeholders identified in separate studies that are pertinent to the concept. The stakeholders involved in global logistics and supply chains are identified in the literature as: the network planner, carriers, hub port operators, and intermodal operators (Meng & Wang, 2011); government agencies, investors, policy makers, infrastructure providers, hub operators, hub users, and the community (Alam, 2013); terminal operators, steamship lines, and customers (Giuliano & Brien, 2007); Shareholders, employees, organizations in the supply chain, society, and natural environment (Carter & Rogers, 2008). Other stakeholders can be identified through supply chains and logistics stakeholders’ relevance to GLHs. For instance, in regard to ports’ stakeholders, De Langen (2004) explained that ports’ activities are not just limited to shipping services but also to cargo-handling activities, transport activities, logistics activities, specific production activities and specific trading activities are strongly inter-related and under the port's authority. Port authority is another stakeholder that is overlapping in all of them. "*A port authority can be defined as the entity, which whether or not in conjunction with other activities, has as its objective under national law or regulation, the administration and management of the port infrastructures, and the co-ordination and control of the activities of the different operators present in the port*" (Verhoeven, 2010:251). On a national and international levels, governments with their legislation and institutional policies can be considered stakeholders (Heaezondonck, 2001), since governmental burdens and laws are determinants of the suitability of GLHs development (Brito & Botter, 2012; Yang & Chen, 2016). Additionally, port companies or port operators could be considered GLHs' stakeholders since they are responsible for operating the ports, handling cargo, and ensure that the services required are provided in a quality assured system (Heaezondonck, 2001). Manufacturing firms involved with the operations of GLHs could be considered stakeholders as well because they get affected by the hubs' business and operations. Port users could be considered as stakeholders whether these are shipping companies, rail companies, customers, supply chains, freight forwarders, or third-party logistics companies.

Based on this compilation, it appears that there are numerous potential primary stakeholders for GLHs. However, it is important to note that without conducting further research, it is difficult to confidently set a framework of the primary stakeholders of GLHs with certainty. This constitutes one of the gaps in knowledge that this research aims to address.

According to recent reports and studies, emerging markets and potential regions are on the rise to developing into GLHs. Regions and cities with ports in strategic locations currently tend to improve their multimodal transport connectivity, enhance their logistics service infrastructure, and encourage the cooperation between different actors in the logistics chain to emerge as a GLH, hoping to attract foreign investments (Fernandes and Rodrigues, 2011). Several examples of emerging GLHs can be seen in the literature. Egypt's Suez Canal Economic Zone developing into a GLH (Boulos, 2016), Jamaica developing into a GLH initiative and its legal implications (Aiken, 2014), digging the Nicaragua Canal and the position of Panama logistics hub (Yip & Wong, 2015). This is due to the benefits that GLHs have towards trade, economies, communities, and prosperity of the countries hosting it. The availability of great logistics and transportation infrastructure in GLHs attracts foreign investments (Fernandes & Rodrigues, 2011), and benefit the hosting countries economy.

Literature on GLHs, as scarce as it is, it is mainly economic driven and not addressing the different parts of organizational responsibility or the environmental sustainability of GLHs. It is important to explore the environmental impact and sustainability GLH operations, since the agglomeration of global operations in the same geographical location, instead of its normal distribution around the world, affects the region hosting the GLH the most with an environmental impact that should be dispersed worldwide. Therefore, to understand their environmental impact and sustainable development of GLHs, the next sections will discuss the environmental sustainability, why sustainable development is a pressing issue, and the environmental sustainability and environmental performance measurement in logistics, supply chains and critically review the literature on environmental sustainability in GLHs.

2.3 Environmental Performance and Sustainability in GLHs

Sustainable development is a multi-faceted concept that encompasses a wide range of cultural, societal, organizational, and other elements. As a result, it can be challenging to arrive at a universally accepted definition of the term (O'Riordan, 2014). However, in recent years, sustainable development has evolved from being a trendy buzzword in the 1990s to a globally recognized and adopted plan, with 17 specific goals that have been agreed upon by 193 countries in 2015. Furthermore, the '2030 Agenda for Sustainable Development' and the Paris Climate Change Agreement have added a legally binding component to the concept of environmental sustainability (UN, 2023). The ongoing climate crisis, along with the declaration of climate emergencies worldwide, highlights the pressing need for sustainable development in light of the critical environmental issues that humanity currently faces as a result of our actions.

Since the Rio Summit of 1992, there has been a growing interest and awareness of sustainability among scholars, societies, governments, and non-governmental organizations (NGOs). Despite the fact that sustainable development may lack operationalization in certain areas (Roman, 2017), there are a growing number of initiatives around the world that are increasing awareness and spurring researchers and academics to help operationalize it and incorporate it into the economic system. One of the most widely cited definitions of sustainable development can be found in the Brundtland Report (1987:8), which defines it as "*the development that meets the needs of the present without compromising the ability of future generations to meet their own needs*". However, this definition has been criticized by some authors as being overly general, and alternative, more specific definitions have been proposed (Sneddon et al., 2006). The concept of sustainable development has since evolved to include three pillars, also known as the triple bottom line of sustainability, namely environmental, social, and economic. Elkington

(1998) first introduced the concept of the "triple bottom line" of sustainability, which refers to the integration of environmental, social, and economic considerations in decision-making. This framework emphasizes the need to balance the interests of stakeholders affected by the organization's activities, including environmental impacts such as pollution, resource use, and ecological imbalances, with the organization's social responsibilities towards the community, and its economic obligations.

Environmental sustainability has gained huge attention over recent years due to declaring a climate emergency. Climate change is a pressing issue that requires immediate action from governments and businesses in order to prevent future catastrophe (Ghadge et al., 2020). Greenhouse gas emissions need to be halved by 2030 in order to align with the critical goals set to avoid climate catastrophe (IPCC, 2022).

2.3.1 Environmental Sustainability in Supply Chain and Logistics

Sustainable organizations can encompass a wide spectrum of sustainable development practices, ranging from the minimal consideration of future requirements in the formation of strategies, to the most advanced form, characterized by "*social and ecological embeddedness*" in the management’s nature of the organization (Roman, 2017). A famous study by Carter and Rogers (2008) introduced the concept of sustainability within the field of supply chain management and developed a theoretical framework that encompasses the integration of the triple bottom line with supply chain management, as shown in Figure 2.8. This framework builds upon and integrates the siloed approach that was commonly found in logistics and supply chain literature when discussing topics related to environmental and social issues, and instead introduced an integrated framework of economic, environmental, and social pillars. The authors suggest that this framework serves as a valuable tool to illustrate the potential benefits of implementing sustainability, including enhanced reputation, reduced costs, and proactive shaping of future regulation, despite the challenges that supply chains may face.

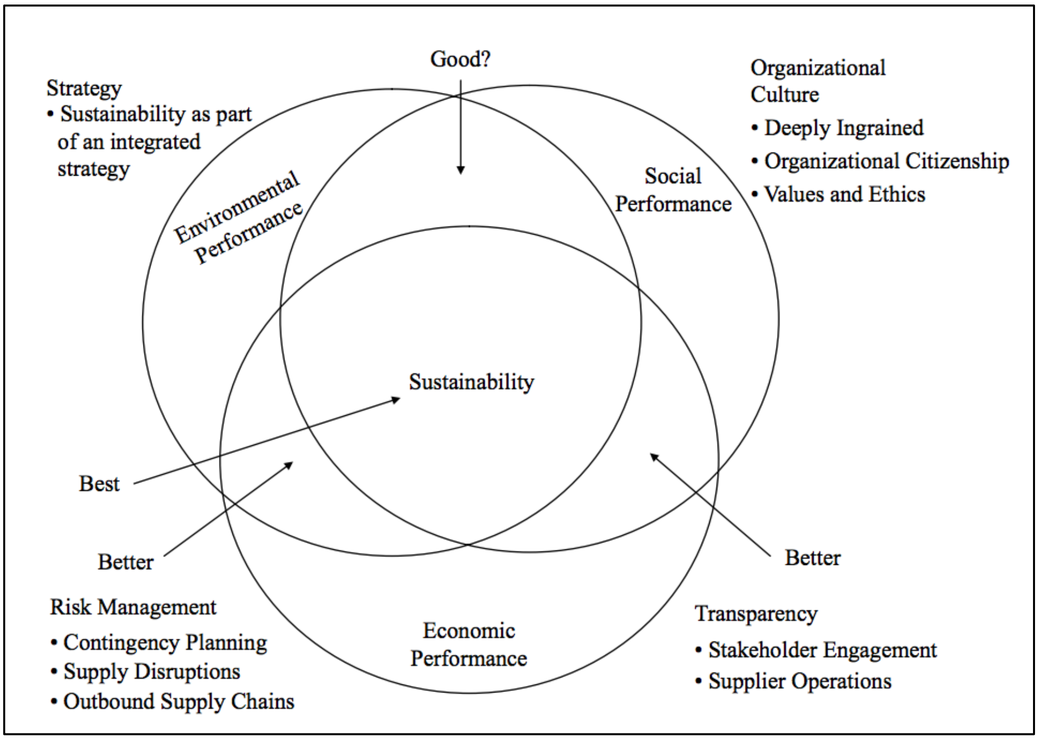


Figure 2.8 Sustainable Supply Chain Management Framework (Carter & Rogers, 2008:369)

Furthermore, it is important to note that sustainable organizations within supply chains could be private and public organisations. However, there is a distinction in the responsibilities and restrictions they face regarding sustainability. Sustainable organisations operating within the public sector are faced with a unique set of responsibilities and constraints, distinct from those in the private sector. Organizations in the private sector are primarily focused on achieving financial gains while also addressing social and environmental externalities, and satisfying the interests of stakeholders (Roman, 2017). In contrast, sustainable organizations operating within the non-profit and public sectors are also required to maintain fiduciary responsibilities and navigate the limitations of available public resources, Figure 2.9 (Roman, 2017). This necessitates a more nuanced and complex balancing act for organizations in the non-profit and public sectors when it comes to sustainable development.

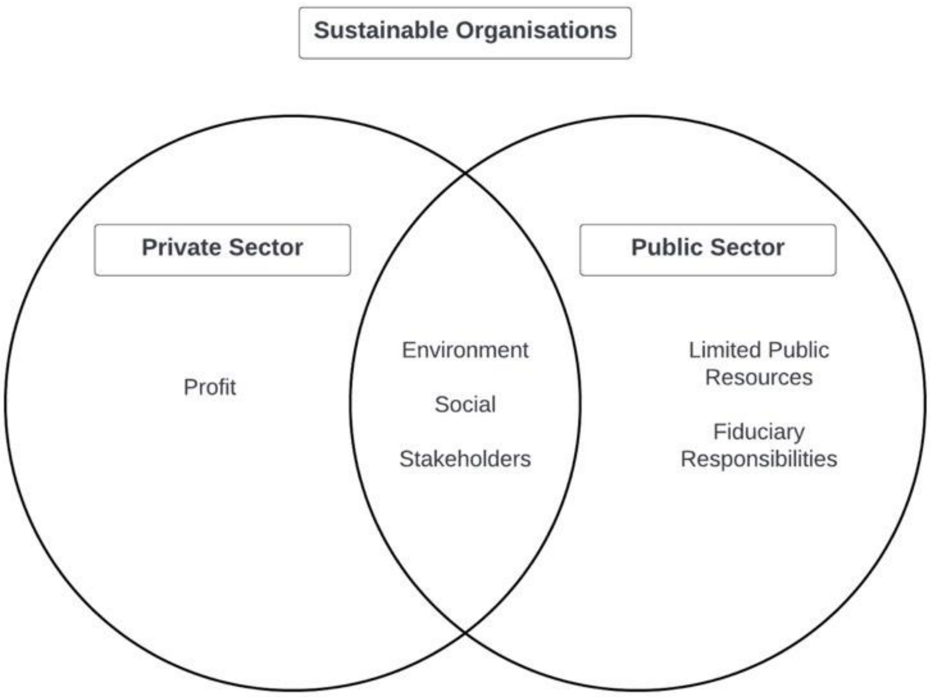


Figure 2.9 Private Vs Public Sustainability (Adapted from: Roman, 2017)

Recent research in the field of supply chain sustainability has demonstrated a growing inclination towards incorporating a broader range of and more detailed considerations. For instance, the model proposed by Geissdoerfer et al. (2018) introduces a comparison between circular business models and traditional linear business models, as shown in Figure 2.10. This model effectively sheds light on the environmental sustainability aspect of the business in a more specific manner, with a particular focus on natural resource depletion, emissions, and waste management. Such an approach provides a level of granularity that allows for a more practical application of environmental sustainability within the supply chain and logistics field.

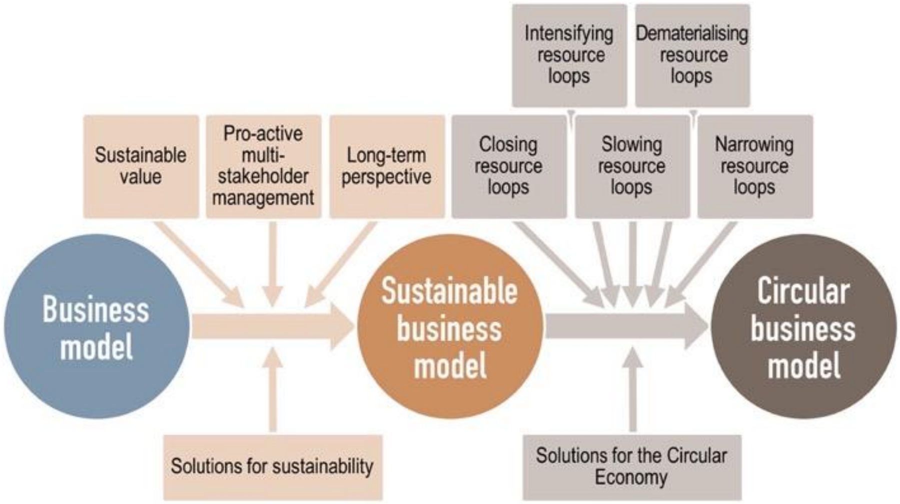


Figure 2.10 Comparison of traditional, sustainable, and circular business models (Geissdoerfer et al., 2018:714)

In logistics research, it has been acknowledged that there has been a growing awareness of sustainability in the logistics sector in recent years (Macharis et al., 2014). Macharis et al. (2014) introduced the concept of the 4 A's of sustainable logistics: Awareness, Avoidance, Act and Shift, and Anticipation of new technologies. This framework emphasizes the importance of increasing awareness among stakeholders, measuring the sustainability of an organization, and understanding its impacts on people, planet, and profit. The second aspect, avoidance, focuses on reducing the strain of the organization on the triple bottom line, and eliminating or substituting activities that are not sustainable. The third aspect, acting and shifting, highlights the importance of taking action to address sustainability challenges, and shifting towards alternative solutions that promote sustainable development. The fourth aspect, anticipation of new technologies, emphasizes the importance of investing in new technologies that are more environmentally friendly or socially acceptable. This framework aids in guiding the logistics field into the pathway that is required to achieve the goals set to decarbonize the industry. As the COP 26 in the UK, COP 27 in Egypt, and the latest IPCC (2022) report emphasized the importance and the need for immediate action. It is important to for the sustainable development integration, awareness, and action to be achieved collectively, rather than just a specific department or unit in the supply chain. The entire entity and its connections should operate in a sustainable manner holistically to be considered truly sustainable, and not overlook certain environmental impacts or harmful social practices of individual partners (Dao et al., 2011).

However, according to Wolf and Seuring (2010), logistics service providers choices is not dependent on how sustainable they are, but it is based on economic reasons. Therefore, the lack of interest in whether the logistics service providers are environmentally sustainable or not does not drive the logistics service providers to develop sustainably. This shows that neglecting the holistic sustainability of the organizations will lead to parts of these organizations or their connections to not look after their externalities. On the other hand, this was highlighted by Elliott (2013), from another perspective. He introduced 10 tenets for sustainable management, listed in Table 2.11. He explained that sustainable development in the context of marine environments requires a holistic approach that considers the complex interdependence between human, political, and natural systems. This requires collaboration and long-term planning, as well as ongoing monitoring and evaluation to track progress and identify areas for improvement. Additionally, Iannone (2012) points out that logistics services are mostly offered by private companies, but they are controlled by governments in how they impact humans and the environment. Governments and legislation in different countries affect global logistics activities and operations. Therefore, all these aspects have to work in harmony together.

Table 2.11 The 10 Tenets for Sustainable Management (Elliott, 2013)

10 Tenets to be successful, sustainable management measures or responses to changes resulting from human activities
• Ecologically sustainable • Technologically feasible • Economically viable • Socially desirable/tolerable • Legally permissible • Administratively achievable • Politically expedient • Ethically defensible (morally correct) • Culturally inclusive • Effectively communicable

The operations in the fields of global logistics and supply chains are major sources of greenhouse gas emissions since they heavily depend on transportation. Greenhouse gas emissions percentages resulting from the consumption of fossil fuels in multimodal transportation are shown in Figure 2.11. In 2017, air transportation accounted for 3.8%, road transportation contributed 21%, and rail transportation contributed 1.6% of the EU's CO2 emissions (European Commission, 2022a). Additionally, despite being more energy efficient than other modes, maritime transportation contributed 2.9% of global greenhouse emissions in 2018 (European Commission, 2022b). In GLHs, these emissions are resulting from global amounts of cargo transportation, logistics, and shipping, all agglomerated and centralising in one location.

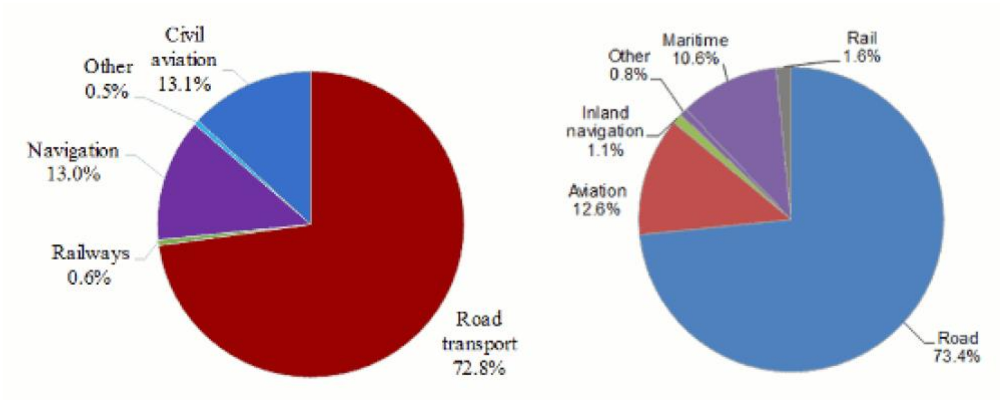


Figure 2.11 Greenhouse gas emissions from transport by mode in 2014 - Share of transport energy demand by mode in 2014 (%) (European Commission, 2022a)

While greenhouse gas emissions are a significant environmental issue, they are not the only factor to be considered in assessing an organization's environmental impact. The Department for Environment, Food and Rural Affairs (Defra, 2019) highlighted six environmental indicator categories: Greenhouse gas emissions, waste, materials and resource efficiency, biodiversity/ecosystem services, and emissions to air, land, and water. This is to help companies identify and manage the links between their environmental impact and financial performance. Some organizations adopt Environmental Management Systems (EMS) such as ISO 14001 and the European Commission's Eco-management & Audit Scheme (EMAS) to guide them in reducing their negative impact on the environment (Shaw, 2013).

Sustainable development is multi-dimensional and encompasses a wide range of aspects, for which a variety of methodologies have been developed to measure it (Harrison & Hester, 2004). According to Evangelista (2014), supply chains are increasingly pressured to adopt green operations and policies, which poses a major challenge for logistics management due to the outsourcing of logistics services to third-party providers, including the operations in a GLHs. This results in a critical issue as supply chains have limited control over their sustainability practices. Grant et al. (2017) also notes that it is difficult to apply the same environmental management system to every firm, as each firm has its own unique environmental impacts and structure. This applies to transportation as well, as sustainable transport is different in each mode and has its unique impacts and structure. This might also be reflected in GLHs depending on the diversity of operations and constituents operating within it.

The environmental impacts of transportation and logistics have become increasingly pressing as global trade continues to grow and distances travelled increase (Shoaib et al., 2022). This is further exacerbated by the development of GLHs and the agglomeration of global operations in one location. GLH operations could have an immense negative impact on the local community and societies, as well as the environmental issues that could be affecting the rest of the world due to this conglomerate of activities. According to Shoaib et al., (2022:2), "*the logistics and transportation industry produces 25-30% of total greenhouse gas emissions) damaging the environment and human health*". Despite this, there is a growing awareness and motivation among logistics providers of the need to operate in a more environmentally friendly manner and many are adapting their strategies accordingly (Zailani, Amran & Jumadi, 2011; Murthy & James, 2018). However, strategies and willingness alone do not align with the immediate action and urgency required to address the current climate emergency. Measuring environmental impact is crucial in order to effectively alleviate it. The famous quote of the Management expert Peter F. Drucker "*You cannot manage what you cannot measure*", highlights the importance of measuring environmental performance in order to manage and alleviate it.

2.3.2 Environmental Performance Measurement

ISO 14001 standard serves as a framework to assist in managing an effective environmental system (Epstein and Roy, 1998). However, it should be noted that "*ISO 14001 is a general environmental management system with no precise requirements concerning environmental objectives set*" (Weiß & Bentlage, 2006:28). On the other hand, this can be considered one of its advantages due to the wide application that it accommodates. Similarly, the Eco-Management and Audit Scheme (EMAS), according to Morrow and Rondinelli (2002), is an environmental management system that provides guidance, but is designed to bring about changes in environmental performance. Additionally, ISO 14031, an environmental performance evaluation tool, is "*an internal process and management tool designed to provide management with reliable and verifiable information on an ongoing basis to determine whether an organization's environmental performance is meeting the criteria set by the management of the organization*" (Jasch, 2000:79). ISO 14031 is not a certification and does not prescribe certain metrics to be utilized, but it serves as an informative guide to assist organizations in evaluating their environmental performance by providing a wide range of indicators (Morhardt et al., 2002; Shaw, 2013). According to ISO 14031:2013, environmental performance indicators are divided into three categories:

• Environmental Condition Indicators (ECI): environmental performance indicators that provide information about the local, regional, national, or global condition of the environment

• Management Performance Indicators (MPI): environmental performance indicator that provides information about the management activities to influence an organization's environmental performance

• Operational Performance Indicators (OPI): environmental performance indicator that provides information about the environmental performance of an organization's operational process

It is important for organizations to select appropriate indicators for their specific context and use them as a tool to evaluate and improve their environmental performance over time. Furthermore, Shaw (2013) reported that the most commonly used supply chain performance tool is the company's own reporting tool, followed by ISO 14001, and in third place is the Balanced Scorecard. This highlights the importance of tailoring the environmental measurement system to the specific activities of the organisation.

Additionally, Hervani et al. (2005) built upon the PDCA (Plan-Do-Check-Act) model that the ISO 14031 works through to integrate environmental performance measurement in supply chain management, as shown Figure 2.12. This is in an effort to address the challenges associated with measuring inter-organizational environmental performance, such as "*non-standardized data, poor technological integration, geographical and cultural differences, differences in organizational policy, lack of agreed-upon metrics, or poor understanding of the need for inter-organizational performance measurement*" (Hervani et al., 2005:330). This approach may be relevant in the context of GLHs, given the diverse range of activities that take place within a GLH and the potential for multiple stakeholders to impact each other's environmental sustainability interdependently and mutually as a result of the close proximity within a GLH.

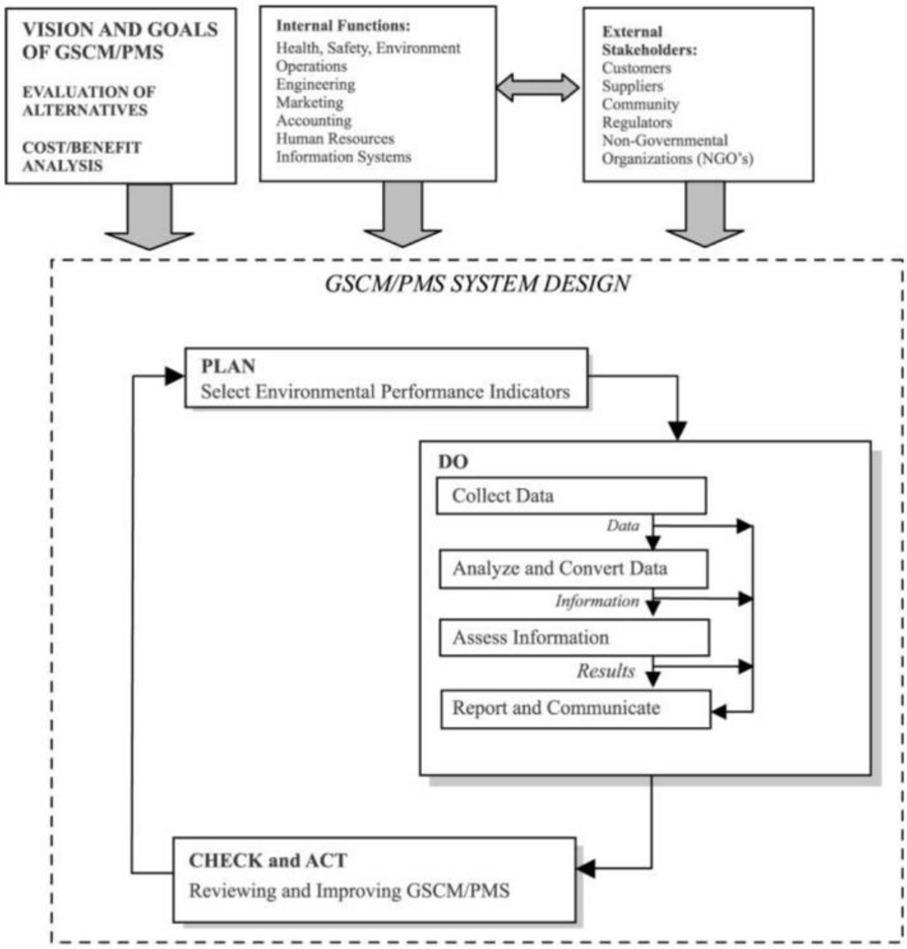


Figure 2.12 Green Supply Chain Performance Measurement System, PDCA ISO 14031 (Hervani et al., 2005:343)

Furthermore, Shaw (2013) identified 16 key green supply chain performance measurement variables, with the majority of them related to energy, efficiency, and transport areas, specifically, 4 of the variables were specific to transportation. Transportation is a significant sector within GLHs. It is not certainly clear what operations or constituents are in a GLH from the literature, however, it is clear that they connect different modes together, providing logistics services, and fostering high levels of integration between stakeholders in addition to transportation. It is essential to identify the overall environmental performance indicators of a GLH and how the different sectors influence each other with regards to their environmental impact. The following section will review literature on environmental performance indicators in GLH and some of the known stakeholders so far to understand how environmental sustainability is measured in a GLH. This is necessary as the literature found on GLH discussed in the previous sections lacked studies on the sustainable development or environmental performance of GLH.

2.3.3 Drivers and Barriers of Environmental Sustainability

In the existing literature, drivers for sustainable development is usually fear of losing competitive advantage or customers, market pressure, legislation, law enforcement or financial costs. According to Mann et al. (2010:53) sustainable development drivers are classified into five categories: "*The first two are external to business: 'legislation', 'environmental' drivers and the latter three are internal to the business, i.e., 'financial' drivers, "internal business process" drivers and the drivers related to the 'customer'*"'. On the other hand, barriers that prevent sustainable development adoption comprise of financial costs, operations' disruption risks, time constraints, 'lack of access to capital' and prioritizing other things over sustainable development (Lee, 2015).

On the other hand, according to Rondinelli and Berry (2000), the degradation of natural resources and environmental pollution resulting from business activities hurt the corporate image and receive negative reactions from stakeholders and this has repercussions on the competitive position of the business. Additionally, countries are now coming under the pressure of achieving net zero (IPCC, 2022), and as a result legislation is passed on from the government, which will impact and pressure business to reducing their carbon emissions.

Logistics activities and freight transport operations are connected with the supply chain and are necessary for the smooth flow of products to the customers. However, they might not always be frontline or apparent to the stakeholders. Hervani et al. (2005) point out that the complexity of the system and the numerous tiers involved in the supply chain is a barrier to performance measurement in supply chains. In the fields of logistics and supply chains, researchers have examined the negative environmental impacts, including carrier selection for hazardous materials transportation (Sharp et al. 1991); fuel efficiency for freight transportation (McKinnon et al., 1993); accident avoidance (Weener et al., 1992); energy utilisation efficiency and emissions reduction (Stock, 1978); environmental logistics management (Murphy et al., 1996); environmental supply chain management (Handfield et al., 2005). Therefore, as much as the externalities and negative impacts are concerned, logistics activities and freight transport operations have a significant negative impact on sustainable development. Regardless of the barriers, they should be addressed. Abbasi and Nilsson (2012) suggested that mindsets of people, organisations, and nations should change to incorporate this complexity for sustainable development to be natural and successful.

As for the logistics service providers there are several studies showing that the drivers and barriers mentioned above are not applicable in their case. A study by Wolf and Seuring (2010) about logistics service providers' selection criteria, and the results show that the decisions were made on traditional criteria without taking into consideration how sustainable or environmentally conscious the logistics service provider is. Another study by Large, Kramer and Hartman (2013) showed that the purchasing companies of the logistics services were very environmentally and socially considerate but that did not translate into their selection decision of the logistics service provider. Whereas Coliccia et al. (2013) found that one of the barriers in environmental sustainability measurement for logistics service providers was the lack of a standard measurement method. Additionally, according to Olcer and Ballini (2015), seaborne transportation industry's main drivers have been the environmental regulations by the International Maritime Organization (IMO) conventions and the European Union Directives along with the economic impact of fuel costs. Furthermore Shaw et al. (2021) identified 18 drivers and 17 barriers for environmental supply chain performance, as shown in Table 2.12. They also highlight that the government and legislation are a main driver for environmental performance in supply chains.

Table 2.12 Drivers and Barriers for Environmental Supply Chain Performance (Shaw et al., 2021:6,8)

Drivers	Barriers
1. Desire to reduce cost	1. Cost
2. Improving operational efficiency	2. The complexity of the supply chain
3. Government regulation /legislation	3. Obtaining data
4. Reducing energy consumption	4. Too many disparate governing bodies & regulations
5. A genuine care for the environment	5. Lack of reporting/measurement tools
6. The CEO /Board of Directors	6. Lack of time
7. Employee involvement	7. Different sectors have different challenges
8. Re-using, recycling materials and packaging	8. Knowing who should measure in the supply chain
9. Collaboration with customers	9. Lack of demand/requirement for measurement
10. Pressure from customers	10. Knowing what to measure in the supply chain
11. ISO 14001 certification	11. Suppliers unwilling to exchange data
12. Product brand	12. Lack of employee training and commitment
13. Public pressure	13. Lack of legitimacy/'Greenwashing
14. Collaboration with suppliers	14. The scope of the supply chain
15. Carbon emissions reduction	15. The recession/austerity measures
16. Pressure from competitors	16. Employee values and attitudes
17. Suppliers	17. Trust in the supply chain
18. Pressure from retailers	

Furthermore, according to Dinwoodie et al. (2012) the cost of environmental specialist or international environmental management tools is too high for some ports to obtain, which is considered a barrier of environmental sustainability in ports. Kotowska (2016) pointed out that one of the strategic tools or drivers of sustainability applied by European ports is 'strict requirements for safety and emissions level' in regard to using road transportation and prioritizing alternative modes of transport that are more socially and environmentally friendly. Additionally, the author explained that financial incentives for port users who are more environmentally conscious is another aspect that is considered by port authorities to encourage sustainability. According to Verhoeven (2009) the European Union has been imposing environmental legislation on European ports to face the ecological and societal challenges. Additionally, Walker et al. (2008) explain that the small companies face financial difficulties when trying to comply with the environmental sustainability of the rest of the stakeholders in the supply chain.

Evangelista (2014) concluded that sustainability concerns have not yet been included in the service buying decision-making process. But that does not mean that this should not change, and sustainable development has to be among the selection criteria for the service as well. Furthermore, Ellram and Monique (2017) conducted a systematic review of the environmentally sustainable freight transportation and found that the most popular focus in the literature is on environmentally sustainable activities and outcomes, followed by drivers and barriers of sustainability. They classified the drivers into five categories: legal/ regulatory, External (which included stakeholders, market, and customers among others), technological advances, environmental, strategic/ organizational; as for the barriers, they classify them into five categories: External collaboration (i.e., lack of collaboration), financial/cost, strategic/organizational, metrics, and systemic (global supply chain complexity). What can be drawn from this study is that in the logistics industry, sustainability could be more of a qualifier for purchasing customers rather than a decision-making criterion.

The extant literature on the drivers and barriers of environmental performance and sustainability in the transport, logistics, and supply chain industry was reviewed and are listed in Table 2.13 and Table 2.14.

Table 2.13 Transport, Logistics, and Supply Chain Environmental Performance and Sustainability Drivers

Drivers Identified in the Literature	
Drivers	**Literature Sources**
Reputation; public Image; corporate image	(Evangelista et al., 2010; Tay et al., 2015; Lozano et al., 2019)
Customers; customers pressure; customer satisfaction; customer requirements	(Evangelista et al., 2010; Giunipero et al., 2012; Björklund & Forslund, 2013b; Tay et al., 2015; Lozano et al., 2019; Williamsson et al., 2022)
Competitive advantage	(Walker et al., 2008; Giunipero et al., 2012)
Internal risk management, investments infrastructure	(Walker et al., 2008; Björklund & Forslund, 2013b; Tay et al., 2015; Williamsson et al., 2022)
Legislations; regulations; government	(Walker et al., 2008; Evangelista et al., 2010; Giunipero et al., 2012; Björklund & Forslund, 2013b; Tay et al., 2015; Serra & Fancello, 2020)
Increased awareness and knowledge	(Serra & Fancello, 2020)
Contracts	(Tay et al., 2015)
Employees	(Tay et al., 2015;)
Corporate policy; culture; top management commitment	(Walker et al., 2008; Giunipero et al., 2012; Björklund & Forslund, 2013b; Tay et al., 2015; Williamsson et al., 2022)
Competitors	(Tay et al., 2015; Giunipero et al., 2012; Serra & Fancello, 2020)
Resource capability; resource utilization	(Giunipero et al., 2012; Serra & Fancello, 2020)
Social Pressure	(Walker et al., 2008; Serra & Fancello, 2020)
Incentives; cost reduction	(Walker et al., 2008; Giunipero et al., 2012; Björklund & Forslund, 2013b; Williamsson et al., 2022)
Access to information	(Walker et al., 2008)
Responsibility	(Giunipero et al., 2012)

Table 2.14 Transport, Logistics, and Supply Chain Environmental Performance and Sustainability Barriers

Barriers Identified in the Literature	
Barriers	**Literature Sources**
Legislations; regulations; government; political	(Walker et al., 2008; Evangelista et al., 2010; Giunipero et al., 2012; Al Zaabi et al., 2013; Tay et al., 2015; Serra & Fancello, 2020; Williamsson et al., 2022)
Customers	(Evangelista et al., 2010; Tay et al., 2015)
Competitors	(Walker et al., 2008; Evangelista et al., 2010)
Resources;	(Tay et al., 2015)
Awareness; knowledge; training; education	(Giunipero et al., 2012; Al Zaabi et al., 2013; Tay et al., 2015)
Media; greenwash	(Tay et al., 2015)
Organization strategy; culture; top management support; misalignment of short- and long-term goals	(Abbasi & Nilsson, 2012; Giunipero et al., 2012; Al Zaabi et al., 2013; Tay et al., 2015)
Technology	(Tay et al., 2015; Serra & Fancello, 2020; Williamsson et al., 2022)
Financial; cost; high initial investment; economic uncertainty;	(Walker et al., 2008; Abbasi & Nilsson, 2012; Giunipero et al., 2012; Al Zaabi et al., 2013; Serra & Fancello, 2020; Williamsson et al., 2022)
Time requirements	(Serra & Fancello, 2020)
Risk; uncertainty	(Walker et al., 2008; Abbasi & Nilsson, 2012; Serra & Fancello, 2020)
Information transparency and availability	(Walker et al., 2008; Al Zaabi et al., 2013; Serra & Fancello, 2020)
Feasibility; operationalisation; inadequate facilities; complex	(Abbasi & Nilsson, 2012; Williamsson et al., 2022)
Cooperation and coordination among stakeholders; reluctance of suppliers to change; inertia; burden on suppliers	(Walker et al., 2008; Giunipero et al., 2012; Serra & Fancello, 2020; Williamsson et al., 2022)
Fragmentation of environmental criteria; lack of standards;	(Walker et al., 2008; Giunipero et al., 2012; Al Zaabi et al., 2013)
Complexity	(Abbasi & Nilsson, 2012)

Even though this shows there are several studies examining and highlighting the drivers and barriers of environmental performance and sustainability in the transport, logistics, and supply chain industry sustainability, the literature review on GLHs shows a lack of studies addressing the drivers and barriers of stakeholders in a GLH context. Evidently because of the scarcity of studies on GLHs in general and the ambiguity of its operational model in specific.

In the case of GLHs, their structure has various entities and a GLH is usually characterized by its strategic location, so there are limited alternatives to what each GLH offers. Additionally, GLHs seem to be quite complex since they combine multi-users and there are different sectors involved, which makes managing it in a sustainable manner even more complex. However, the 10 tenets frame by Elliott (2013) highlight principles for sustainable marine measures that can help as a steppingstone for drivers and barriers in GLHs.

Although sustainable development is the balance between the three pillars of sustainability, it is one of the aims of this research to explore the environmental sustainability, environmental impact, and indicators in GLHs. Therefore, the next section is going to critically review the scholarly literature on the environmental performance in GLHs and some the known constituents.

2.3.4 GLH Environmental Performance and Sustainability Critical Literature Review

The literature review on GLHs revealed the limited availability of scholarly literature pertaining to GLHs and the diversity of terminology employed by both academics and practitioners. Therefore, it was deemed appropriate to employ a variety of synonymous terms and potential components of GLHs in conjunction with the phrase "global logistics hub" when conducting the critical literature review on the environmental performance and sustainability in GLHs. As such, a thorough search of the background scholarly literature was reviewed between 1997 and 2022 to identify key articles which have discussed and empirically researched GLH environmental performance previously to identify gaps. To facilitate this process, a relevance tree technique, as outlined in Figure 2.13, was employed to subdivide the research topic for this section of the literature review, and generate appropriate keywords for the search strings, as listed in Table 2.15 (Saunders et al., 2011; Collis & Hussey, 2013). To identify relevant studies, the online databases Web of Science (WoS) and Scopus were searched using these keywords:

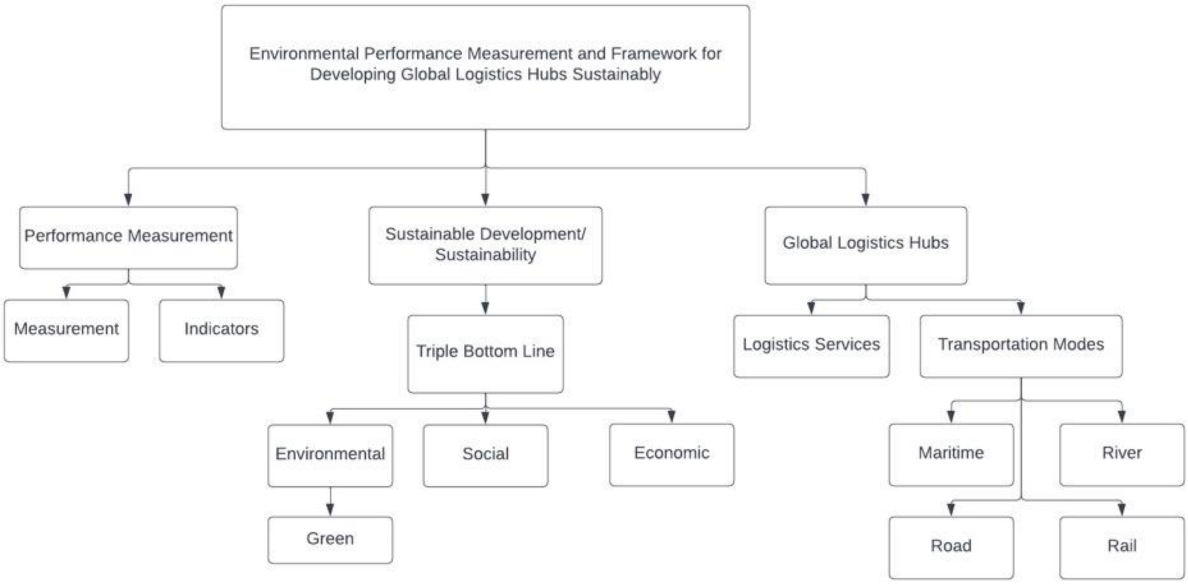


Figure 2.13 Keywords Relevance Tree

Table 2.15 Search String Results

Search strings used in WOK and Scopus databases		
Keywords	**Scopus**	**WOK**
("Sustainable Development" or Sustainability) and (Seaport* or "maritime Transport")	206	114
("Sustainable Development" or Sustainability) and (Logistic*) and (Cent* or Hub*)	510	409
("Sustainable Development" or Sustainability) and (Rail* or Road* or River* or "inland waterway*) and (Port* AND Transport*)	229	118
("Sustainable Development" or Sustainability) and (triple bottom) and (Transport* or Port*)	64	64
(Environment* or Green) and (Port* and Transport*) and (Sustain* and develop*)	535	442
(Econom*) and (Port* and Transport*) and (Sustain* and Develop*)	423	292
(Environment*) and (Logistic*) and (Sustain* and Develop*) and (Cent* or Hub*)	284	155
("Perform* Measure*" or "Perform* Indicator*") and (Transport*) and (Hub*)	18	5
("Perform* Measure*" or "Perform* Indicator*") and (Logistic*) and (Hub*)	12	9

The different combinations of keywords in the search strings were based on the different modes of transportation that could be considered as connections in a GLH, sustainable development, the triple bottom pillars, performance measurement and indicators used in GLH constituents, and logistics service centres. The search strings were used in order to review the scholarly literature on environmental performance measurement in GLHs. By using the same search strings in both databases, and reviewing titles and abstracts, relevant studies to this research proceeded to an in-depth review of the full text based on the research focus area and objectives.

Table 2.16 presents an overview of the studies that were considered relevant to the environmental performance in GLHs through the literature review process between 1997 and 2022. The table includes information on the author(s) of the study, the year of publication, the specific aspect of the GLH that the study pertains to, the purpose of the study, and the region that the study addresses.

Table 2.16 GLHs Environmental Performance Literature Review (1997 - 2022)

Author(s)	Year	Application	Objective	Location
Darbra et al.	2004	Seaport	Developed self-diagnosis method to evaluate the management's actions and procedures to handle the environmental impact of port operations	Europe
Peris-Mora et al.	2005	Seaport	Developed a system of sustainable environmental management indicators	Port of Valencia, Spain
Rohacs & Simongati	2007	Inland	Assessment of sustainability different transport modes promoting a modal shift to inland transport: Sustainable transport indicators	Europe
Kuhl and Zhou	2009	Logistics/transportation	Present a preliminary simulation toolkit that will integrate environmental and traditional aspects of performance	General
Dinwoodie et al.	2012	Seaport	Propose a business process framework to facilitate environmental management in small ports	Falmouth, UK
Acciaro et al.	2014	Seaport	Investigation on successful innovations improving environmental sustainability of seaports	Variety of regions
Lee and Wu	2014	Logistics - Multimodal transport	Measure the economic and environmental performance in logistics and supply chain management - examination of environmental impacts on financial performance	Australia
Lam & Notteboom	2014	Seaport	Investigate the port management tools	Leading ports in Asia and Europe
Puig et al.	2014	Seaport & Stakeholders	Identify, select, evaluate, and validate environmental performance indicators in port areas using ISO 14031	Europe
Kuznetsov et al.	2015	Seaport	Proposed a systematic method for small ports to manage their sustainability	Cornwall & Devon, UK
Shiau & Chuang	2015	Seaport	Using social construction of technology to identify indicators for port sustainability	Keelung Port, Taiwan

Table 2.16 (continued)

Author(s)	Year	Application	Objective	Location
Wang and Zhao	2016	Seaport	Builds a quantitative evaluation indicator system of seaport sustainable development	China
Klumpp	2017	Logistics - FFW	DEA index efficiency calculation of the triple bottom line aspect for logistics forwarders	Europe
To and Lee	2017	Logistics - Multimodal transport	Present a quantitative triple bottom line analysis of the logistics sector	Hong Kong
Ha e al.	2017	Seaport	Port performance indicators including sustainable growth	South Korea
Vaio et al.	2018	Seaports	Managerial KPIs for environmental sustainability and energy efficiency in the port industry	Italy
Hussain et al.	2019	Seaport	Evaluated sustainability and environmental performance at 18 major ports	Canada
Bajec et al.	2020	Logistics & Stakeholders	Proposed a framework to measure environmental and social performance in warehouses including local community impacts as stakeholders	Not specified
Gruetzmacher et al.	2020	Transport Sector	Assess the performance of the transport sector in relation to greenhouse gas emissions	Europe
(Rodrigues et al., 2021)	2021	Seaport	Benchmark to compare the performance of European seaports using environmental performance indicators from GRI	Portugal
Puig et al.	2022	Seaport & Inland Port	Assessed the environmental performance of European ports based on a representation of EcoPorts members.	Europe
De Souza et al.	2022	Logistics	Evaluating the performance of green logistics in the plastic sector.	Not Specified
Perotti et al.	2022	Logistics	Assessing the environmental impact of logistics facilities and proposes a structured model for quantifying greenhouse gas emissions.	Not Specified

There was a lack of studies addressing the environmental performance in GLHs as a whole, as was expected from the previous stage of the literature review. Most of the research as seen in Table 2.16 is dedicated to seaports. In the maritime transport, several authors based their research on the ISO 14001 environmental management system. For example, Darbra et al. (2004) designed a Self-Diagnosis Method for port use to review the environmental management performance and compare the results to the previous year. It is based on the ISO 14001 and acts as a facilitator step to be reach the standard certification. Lam and Notteboom (2014) analyses the different tools used in green port management and categorizes them into pricing, monitoring, and measuring; and states that ports like Antwerp, Rotterdam, and Singapore adopted the ISO 14001 standard for their environmental management. Puig et al. (2014) identified environmental performance indicators using the (EPE) ISO 14031. Other authors have designed their own measurement or framework, like Acciaro et al. (2014) proposes a framework that assess the different environmental innovations of ports through a ranking system of predefined green objectives. Kuznetsov et al. (2015) designed a Port Sustainability Management System (PSMS) for smaller ports to help appraise sustainability practices. Shiau & Chuang (2015) by using a Social Construction of Technology (SCOT) procedure, they manage to develop port sustainability indicators (PSIs) economic, environmental, and social. Dinwoodie et al. (2012) offers a generic tool, a systems framework, to assist smaller ports that the cost of environmental specialist or international environmental management tools is too high for, plan more sustainable maritime operations and focuses on business processes. Wang and Zhao (2016) built a quantitative evaluation indicator for sustainable development of seaports.

Additionally, several of the research on seaports' environmental performance and in the port industry focused on measuring and evaluating the environmental performance of seaports using a set of environmental indicators (Vaio et al., 2018; Hussain et al., 2019; Rodrigues et al., 2021 De Souza et al., 2022; Perotti et al., 2022; Puig et al., 2022). There is a lack of unity in developing the measures or indicators, and it is because of the diversity of the sizes and functions of maritime ports, the cost of the certification, and international environmental systems is high for some ports.

Furthermore, logistics and transport research also addressed the environmental performance from a stand-alone manner. Lee and Wu (2014) measured the economic and environmental performance of logistics and supply chain, considering different modes of transport, different equipment and the distance travelled. However, the environmental aspect is considering the emissions from the distance travelled. Klumpp (2017) used the DEA Malmquist index to calculate the efficiency of European logistics forwarders through the triple bottom line aspect and used greenhouse gas emissions as the environmental indicator. Although, this study is approaching the efficiency of forwarders from sustainability perspective, but it is shallow in the indicators used. Additionally, Gruetzmacher et al. (2020) also assessed the greenhouse gas emissions in the transport sector recommending a shift to rail and inland transport based on their findings.

Kuhl and Zhou (2009) presented their preliminary investigation of developing a simulation toolkit that considers the environmental performance of truck transportation and logistics along with the traditional aspects of logistics performance. However, they failed to acknowledge the different modes of transport. To and Lee (2017) calculated the land, sea, and air transport greenhouse gas emission for the environmental indicator, number of employments for the social indicator, and value added as the economic indicator. Even though this study quantifies the triple bottom line and considers multimodal transport, however, it only considers one performance indicator for each pillar, and it does not reveal the interrelation between the different modes or the other stakeholders in the GLH. Bajec et al. (2020) proposed a framework to measure the environmental and social performance in warehouses and considered the local community impact, which is one of the rare studies found to include other stakeholders within the environmental performance measurement.

Even though several constituents of GLHs were included in the literature review process, but the pertinent studies were mainly related to maritime ports and logistics service providers, with maritime ports having more interest from scholars. Additionally, the majority of studies did not consider any stakeholders within their framework or assessment.

In contrast, Peris-Mora et al. (2005) combined the ISO 14001 and EMAS to identify potential environmental impacts and risks. They are one of the few articles that considered the stakeholders in the environmental performance framework, which aids in including other constituents of the GLH under the same environmental performance measurement framework. Figure 2.14 presents the framework, including the operators, port activity distribution company, port authority, and public body or government. It is considering entities within and outside of the port. This is rarely seen in the literature possibly due to the complex system that this requires. The downside of this framework is that it is built only from a port's perspective and does not take into consideration the rest of the GLH stakeholders. Therefore, due to the deficiency of scholarly research that holistically address the environmental performance of GLHs, encompassing all primary stakeholders and constituents, there is a need to address this research gap. This research aims to develop a framework that encompasses environmental performance measurement and indicators that are appropriate for the operations and stakeholders of a GLH, in order to fill this gap.

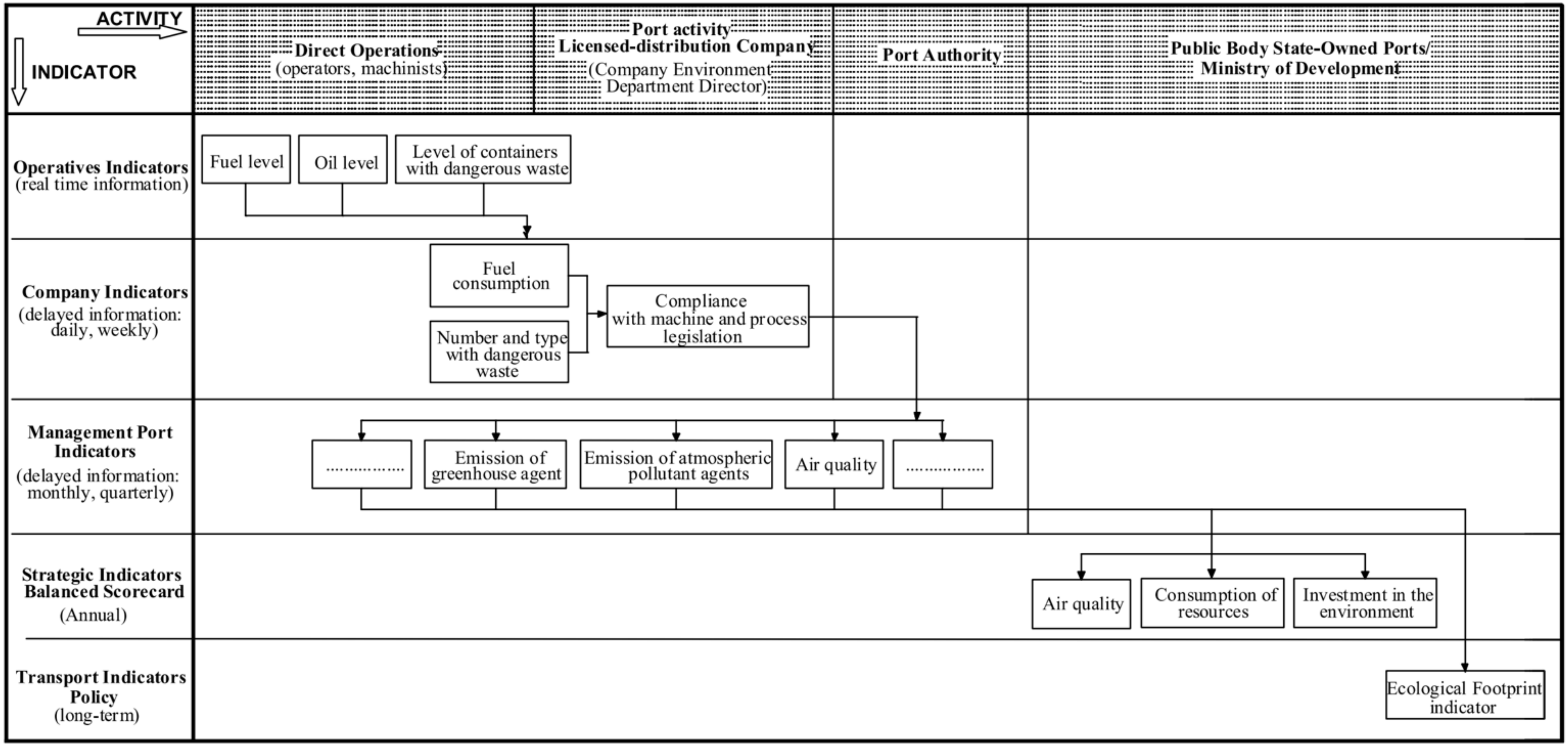


Figure 2.14 Port environment: management decision level (Peris-Mora et al., 2005:1652)

2.4 Literature Review Conclusion, Gaps, and Proposed Research Questions

2.4.1 Conclusion and Research Gap

GLHs are strategically located in key geographical areas dealing with global cargo. They serve as the hub in a hub-and-spoke network. Globalization and the agglomeration and clustering of global logistics activities and operations have played a significant role in the development and proliferation of GLHs. The term GLH is used in various publications with varying degrees of specificity, ranging from ports, regions, cities, countries, and logistics distribution centres. This lack of consistency in usage contributes to confusion and conflict surrounding the term. An analysis of the literature, as presented in Table 2.8, reveals that most publications refer to the term in the case of seaports, or locations such as cities, countries, or regions. Furthermore, there is a lack of up-to-date and clear definitions of the term, its operations and activities, and its stakeholders and constituents. This lack of definition could be particularly pronounced because of the fast-paced emergence and development of GLHs seen from 1997 and till present, both in developed and developing countries, with a few corresponding academic research on the topic. Additionally, the governance models and authorities responsible for overseeing and regulating GLHs are not well-defined in the literature, further exacerbating the confusion surrounding this topic.

Despite the growing body of literature that advocates for the development of GLHs, these studies have yet to provide a comprehensive framework for the operations of GLHs, nor have they effectively identified the stakeholders involved in their development or the governance structures that govern them. Despite this, GLHs are recognized to have a number of economic, social, and environmental benefits, including but not limited to, economic development, tourism, education, and employment. As a result, countries and regions are increasingly promoting their emergence as GLHs, as evidenced by the 'Potential Global Logistics Hub' theme in Table 2.5. Given this context, it is imperative to address the knowledge gaps in order to guide the development of emerging GLHs, and to help them develop more efficiently and effectively.

The literature on GLHs, while limited, tends to focus primarily on economic considerations and benefits, neglecting to address the various aspects of organizational responsibility or the environmental sustainability of GLHs. It is crucial to examine the environmental impact and sustainability of GLH operations, given that the concentration of global operations in a single geographical location, as opposed to their typical distribution around the world, disproportionately affects the host region. Failure to consider the environmental sustainability of GLHs may have long-term negative consequences on the host region and the global community. However, there is a gap in the empirical research and extant scholarly literature regarding the measurement of environmental performance in GLHs. Previous studies have tended to focus on individual constituents of a GLH, rather than considering the entire ecosystem holistically as shown in Table 2.16. Furthermore, there is a lack of studies that integrate the various components of a GLH to examine the overall impact from an environmental perspective. This lack of holistic understanding impairs the ability to effectively measure and improve the environmental performance of GLHs, highlighting the need for bridging the gap in this area of research.

Given the urgent need for action in response to the global climate emergency, the lack of research on the environmental performance of GLHs is particularly concerning. It is imperative that further research is conducted in this area in order to understand the impact of these hubs on the environment to aid the development of strategies to mitigate any negative effects. This research aims to develop a framework that encompasses environmental performance measurement and indicators that are appropriate for the operations and stakeholders of a GLH, in order to fill this gap.

2.4.2 Research Questions

To address the research gaps, the following questions will be investigated:

RQ1: What is a GLH? Who are its primary stakeholders?

RQ2: How are the primary stakeholders connected in a GLH? Who is responsible for the environmental sustainability of GLH?

RQ3: How do GLH operations impact the environment? How is the impact measured?

RQ4: What are the drivers of and barriers to environmental sustainability in a GLH?

2.5 Summary of literature Review

In this chapter, a thorough review of the extant literature pertaining to GLHs was conducted in two stages. The first stage focused on the concept and definition of GLHs, while the second stage reviewed literature pertaining to the environmental performance and sustainability of GLHs.

This literature review provided insight into the research gaps in the scholarly literature and served as a basis for identifying the research problem. Finally, the chapter presented the research questions that will be used to address the identified gaps in the extant scholarly literature.

In the next chapter, the research methodology will be discussed in detail to provide an understanding of how the research was designed and conducted.

Chapter 3 Research Methodology

3.1 Introduction

This chapter discusses the research methodology adopted in this research. It sheds light on the philosophical stances and research paradigm that the researcher followed, based on the nature of the investigation. In this chapter, the researcher identifies and selects the appropriate research approach, design, data collection methods, and analysis strategy.

The chapter is structured as follows: Section 3.2 discusses the research philosophy and paradigm, outlining the underlying assumptions and beliefs that shape the research approach. Section 3.3 introduces the research theoretical lens. Section 3.4 discusses the research methodology and strategy, providing the overall approach adopted to address the research questions. Section 3.5 focuses on the data collection methods employed in the study, discussing the sources of data and the techniques used to gather it. Section 3.6 highlights the data analysis strategy, explaining how the collected data is processed, organized, and interpreted to derive meaningful insights. Finally, Section 3.7 provides a comprehensive summary of the research methodology, summarizing the key aspects and setting the stage for the subsequent chapters.

The chapter will proceed with a discussion of the philosophical underpinning in the next section to explore philosophical stances and examine popular paradigms and methodologies adopted in logistics research. It also discusses the researcher's philosophical position and the research paradigm adopted in this research.

3.2 Research Philosophy and Paradigm

Research philosophy is a fundamental aspect of the research design. It is a system of beliefs that refers to the assumptions on how knowledge is built, developed, and analysed (Saunders et al., 2019). These assumptions shape how the research is conducted, how the data are collected, and how the findings are analysed and interpreted (Crotty, 1998). Philosophical positions relate to assumptions about the nature of social reality and how it should be examined (Bryman, 2016). It is important to establish philosophical assumptions and the researcher's position at the outset of any research because it feeds into how the research is carried out and how the research questions are answered. Burrell and Morgan (2017) suggest that all social researchers are influenced by their philosophical assumptions concerning the nature of the social world and are embedded in ontology and epistemology.

Ontology refers to shaping the researcher's assumptions about the nature of reality. The ontological standpoint determines whether reality exists outside of the social construct of the social actors, or whether it is reality because of the perception of the social actors (Sobh & Perry, 2006). Thus, ontology has two extreme positions on the continuum: realism and nominalism. In nominalism, researchers are constructionists who believe reality is created through the perception of the researcher and the participants (i.e., subjective). Therefore, they strive to design their research to capture the perception created by social actors (Collis & Hussey, 2021). In this research, the researcher is adopting the nominalism doctrine, which embraces constructionism. The constructionist ontological position regards organizations and cultures as entities brought to life by the perception and understanding of humans (Bell et al., 2022).

Epistemology, on the other hand, is the set of assumptions that guide the process of knowing (De Gialdino, 2009). It is a key stage in defining the trajectory of the research because it highlights how knowledge is generated, the relationship between the researcher and the topic that is being researched, and how the research should be conducted (Guba & Lincoln, 1994; Holden & Lynch, 2004; Bell et al., 2022). Epistemology is pre-set when ontology is decided. According to Guba and Lincoln (1994), having a certain ontological assumption will define and limit the epistemological position of the researcher. Therefore, epistemology also has two opposite sides positivism and interpretivism (Collis & Hussey, 2021). Positivism is linked to realism and interpretivism is linked to nominalism. In this regard, the epistemology of this research is interpretivism. It is based on obtaining knowledge by interpreting human actions and making meaning of the perception of social phenomena within a particular context (Collis & Hussey, 2021).

A research paradigm is a philosophical framework that offers the researcher an accepted framework of theories, methods, ways to interact with the data, and how results should be interpreted to understand social phenomena (Bryman, 1988; Saunders et al., 2019; Collis and Hussey, 2021). Burrell and Morgan (2017) illustrate this through three levels: the basic beliefs of the researcher as the philosophical level, how the researcher is going to conduct the research as the social level, and the methods and techniques as the technical level.

Further details about the research philosophy, paradigms, and different research approaches can be found in Appendix 9, which includes a detailed description of the paradigm spectrum (Burrell and Morgan, 2017), paradigms continuum (Cunliffe, 2011), and the impact of paradigmatic assumptions on shaping the research approach.

3.2.1.1 Logistics Research Paradigms

The logistics discipline has been dominated by positivistic research (Naslund, 2002; Sachan & Datta, 2005; Derwik & Hellström, 2017). According to Kovács and Spens (2005), inductive and abductive approaches in logistics research are rare, unlike the deductive approach. Furthermore, Mentzer and Kahn (1995) investigated the percentage of articles published in the Journal of Business Logistics (JBL) that adopted a positivistic paradigm. Their analysis revealed a dominance in research using surveys (as seen in Table 3.1), which suggests a dominance in quantitative research and a preference towards the deductive approach.

Table 3.1 Categories of Methods used in publications in JBL (Source: Mentzer & Kahn, 1995:242)

Category	% of Articles Published in JBL
Survey	54.3%
Simulation	14.9%
Interviews	13.8%
Archival Studies	9.6%
Math Modelling	4.3%
Case Studies	3.2%

Consequently, the logistics discipline has been criticized for its heavy dependence on quantitative research and its high tendency towards positivism. This tendency and the lack of diversification in the methodologies used caused research in this discipline to be considered as lacking rigour and lacking theory development that would otherwise enhance and move the discipline forward (Mentzer & Kahn, 1995; Naslund, 2002). Interpretive philosophy is often associated with qualitative methodology (Denzin & Lincoln, 2011). Additionally, adopting interpretive philosophy in logistics research will provide the richness and depth that quantitative research lacks (Naslund, 2002). The shift in the research questions to how and why in this discipline will lead researchers to explore through qualitative research (Sachan & Datta, 2005). Therefore, qualitative research is encouraged to help advance, enrich, and develop research in the logistics discipline.

3.2.2 Researcher's Philosophical Position and Research Paradigm Adopted

This section will justify the researcher’s philosophical position and the research paradigm adopted to conduct this study. The research paradigm will influence the whole research process: the research design, methodology, methods, and analysis techniques (Guba & Lincoln, 1994; Holden & Lynch, 2004; Collis & Hussey, 2021; Bell et al., 2022. Therefore, it is important to clarify and frame the paradigmatic assumptions adopted by the researcher to ensure clarity and precision in the research process.

The researcher is adopting a social constructionism ontological position, and as a result following an interpretive epistemology. The reason behind adopting these philosophical assumptions is because the research area is new. It requires a detailed, deep, and rich understanding of the phenomena to build knowledge and theories through exploring and interpreting the perception of professionals in the field (Bell et al., 2022). The research aims to build theory on GLHs and their environmental sustainability. These complex and massive concentrations of global logistics operations require a deep dive to holistically investigate them. This can be achieved by engaging with professionals involved with GLHs. This is possible by following an interpretive paradigm to understand the perceptions of the primary stakeholders and explore the meanings and interpretations of practitioners in this area (Shah & Corley, 2006). Consequently, contributing to developing an in-depth and rich understanding of GLHs and their environmental sustainability.

Furthermore, interpretive research acknowledges the influence of the researcher on the research. Therefore, the axiological position of the researcher must be acknowledged to highlight possible influence. Based on the paradigm adopted in this research, it is acknowledged that the interpretations are value-laden, and the researcher is involved in interpreting the perceptions of participants. This plays an important role in data analysis and the interpretation of findings under this research paradigm. Qualitative research acknowledges the role of the researcher in the data collection process and in how the data is analysed (Saunders et al., 2019). This is necessary for developing an in-depth and rich understanding of the phenomenon. In the context of this research, it is following a qualitative approach to investigating GLHs, which is a type of research approach that is currently encouraged in the logistics discipline.

Another factor affecting the research approach is the literature scarcity on the topic. The literature review chapter highlighted that there is a lack of sufficient academic literature on the environmental sustainability of GLHs, and there is a misperception found in the literature around the definition of GLHs. Therefore, following an inductive approach in this research will enable the researcher to investigate empirical reality in GLHs, deeply understand the topic, and build theoretical understanding on the topic. As a result of this research, the theoretical underpinning of this area will be enhanced. This in turn will enable future researchers to advance the knowledge on this topic by testing or building on these theories. Therefore, this inductive approach will provide a steppingstone for GLHs research. The next section is going to discuss the theoretical lens that is adopted as a guide for the research process, in order to provide a framework for this research.

3.3 Research Theoretical lens

"*The purpose of theory is to increase scientific understanding through a systematized structure capable of both explaining and predicting phenomena*" (Hunt, 1990:10). According to Touboulic and Walker (2015), the theoretical lens deeply affects the ontological position of the research which in turn affects the approach to dealing with the research problem and questions. Therefore, it is essential to define the theoretical lens prior to identifying the research methodology that the research is going to adopt. In order to define the theoretical lens, several pertinent organizational theories are examined and compared to find a suitable and fitting lens that would steer the research in the direction of the research objectives.

3.3.1 Theoretical Lenses in Logistics and Supply Chain Research

In the logistics and supply chain fields, it is argued that theories do not have a weight and the discipline is quite practical and has not yet developed its theoretical side (Mentzer et al., 2004). Additionally, Storey et al. (2006:758) mention that the discipline of supply chain and logistics is criticized for being "*atheoretical*". This is reiterated as well in Croom et al.'s (2000) study, where they found that supply chain management literature is mainly empirical-descriptive, as shown in Figure 3.1 and lacking "*a significant body of priori theory*".

	PRESCRIPTIVE	DESCRIPTIVE
THEORETICAL	6%	11%
EMPIRICAL	27%	56%

Figure 3.1 Framework for Classifying Literature according to the Methodology (Croom et al., 2000:75)

Even though the discipline has been considered deeply empirical and descriptive, a study by Defee et al. (2010), found that over half of the articles in four of the major logistics and supply chain journals used existing theory whether explicitly or implicitly between 2004 and 2010 (Defee et al., 2010). Additionally, there are several authors who are building theories for the discipline of logistics and supply chain (Chen and Paulraj, 2004; Giannakis and Croom, 2004; Mills et al., 2004). This indicates that the discipline is becoming theoretically more sophisticated, and the body of theory is being developed throughout recent years.

A theoretical lens is required to fit the purpose of the research and connect with the research areas. According to Defee et al. (2010), the theories used in the logistics and supply chain management literature is based in microeconomic theories and systems theories. However, it requires careful examination of the theory prior to adopting it in the research. It is important to ensure that the theoretical lens can combine the view of the research areas and be able to explore them without neglecting any of them. Both the transaction cost theory (TCT) and resource-based view theory (RBV) have their advantages in competitive advantage, costs, and financial aspects. However, this research is focusing on the environmental performance and sustainability in GLHs. Therefore, they will not assist the research in fulfilling its objectives.

According to Touboulic and Walker (2015), sustainable supply chain management studies that use theories have not developed their own theories, but they borrowed theories from other disciplines. The authors continue to debate that even though there are popular theories in sustainable supply chain management, authors tend to utilize them differently. Among the most popular theories in this research area are the stakeholder and institutional theories (Touboulic & Walker, 2015), Appendix 10. Furthermore, Amundson (1998) points out that the theoretical lens chosen for research should have a relationship, relevance, and explanatory power with the subject of the study.

Institutional theory is a relevant theoretical lens, it is defined by DiMaggio and Powell (1991:8) as:

> *Comprising a rejection of rational-actor models, an interest in institutions as independent variables, a tum towards cognitive and cultural explanations, and an interest in properties of supraindividual units of analysis that cannot be reduced to aggregations or direct consequences of individuals' attributes or motives.*

"*Institutions are comprised of regulative, normative, and cultural-cognitive elements that together with associated activities and resources provide stability and meaning to social life*" (Scott, 2008:46). Institutional theory explores the impact of regulations, rules, social, and political context on a firm's behaviour and organizational structure (DiMaggio & Powell, 1991). It is used to explore the compliance of an organization with external pressures (Rowley, 1997). Additionally, Greenwood and Hinings (1996) explain that institutional theory is a theory used to explain stability and similarities (Isomorphism) in organizations and not to explain change. DiMaggio and Powell (1983:147) explain isomorphism as "*a context in which individual efforts to deal rationally with uncertainty and constraints often lead, in aggregate, to homogeneity in structure, culture, and output*". There are three forces in institutional theory: normative, such as pressures from society and value; coercive, such as pressures from the government or regulatory bodies; and mimetic, such as pressures from competitors (Martínez-Ferrero & García-Sánchez, 2017).

It would be interesting to understand how GLHs react to external pressures whether due to stakeholder pressures or legislation and policies. However, the concept of GLH is not clear yet to be able to explore the research through institutional theoretical lens. Additionally, GLHs are heterogeneous and diverse as reflected in the literature. This is going to be considered in this research. Institutional theory will come into the focus of discussion, but it will not serve the research objectives if adopted as the research theoretical lens. This research is focusing on GLHs, their stakeholders and operations, as well as their holistic environmental performance and sustainability. Therefore, stakeholder theory can be considered more appropriate to explore GLHs through this lens.

3.3.2 Stakeholder Theory

Given the research focus, objectives, and questions, it would be more appropriate to adopt a stakeholder theoretical perspective. The research questions are primarily directed towards understanding the constituents of a GLH, the environmental impact and sustainability, and the responsibility of stakeholders in relation to the environmental sustainability of the GLH as a whole. In this context, the stakeholder theory is applied in the sense that it primarily addresses the environmental sustainability and its ultimate goal of benefiting present and future stakeholders. By conducting the research through a stakeholder theoretical lens, it will enable exploring the stakeholders in GLHs and how they operate in a holistic manner. Furthermore, this lens will also aid in revealing the relevant environmental sustainability concerns, and the drivers and barriers of environmental sustainability from the perspective of various stakeholders of GLHs.

Furthermore, according to Mainardes et al. (2011), stakeholder theory is relatively new in the management literature and business practice. However, it has stirred an academic debate over its ambiguity and vagueness. According to Gossy (2008), stakeholder theory is mainly used in the literature in two contexts, to define the stakeholders of an organization in pertinence to the management's consideration, and the second is to explore the pertinence of stakeholders' relationships and influence on the organization's decisions. This is aligned with this research's objectives.

However, Donaldson and Preston (1995) critique the wide range of theories and the ambiguity of the stakeholder concept as explained and used in the literature. Therefore, they proposed a taxonomy of the stakeholder concept to clarify and point out its differences. In contrast, Mainardes et al. (2011) look at this wide range of theories as an advantage of diversity in the points of view that can express the scope of a study. Donaldson and Preston (1995) classify the concept into three branches based on past literature: instrumental, descriptive/empirical, and normative, as shown in Figure 3.2. In their opinion, these three branches underlie any piece of stakeholder literature.

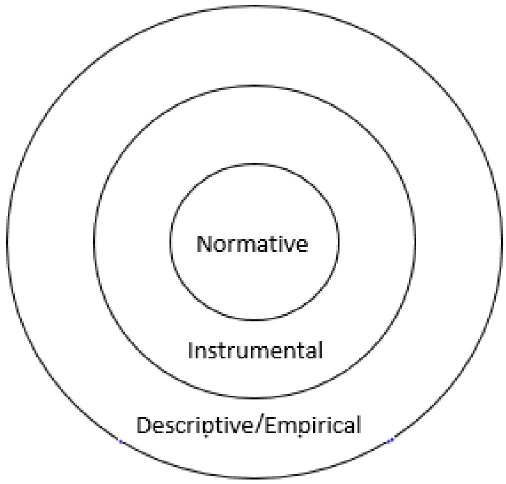


Figure 3.2 Three Aspects of Stakeholder Theory (Donaldson & Preston, 1995:74)

The three aspects of stakeholder theory are embedded in one another. Donaldson and Preston (1995) explain that the stakeholder theory can be used as a descriptive/empirical lens of a corporation's management to their stakeholders. This is applied in the actual situation of stakeholders within the corporation. It can also be used as an instrumental model to test the cause and effect of using stakeholder theory to achieve certain outcomes for the corporation in an (if… then) scenarios. Additionally, they explain that the fundamental core of stakeholder theory is its normative aspect, basing the moral foundations of a corporation around stakeholders, whether their interests are considered due to their legitimacy or their intrinsic value.

Furthermore, the descriptive/empirical aspect of stakeholder theory can be used to view the nature and the actual management of stakeholders within a corporation, or the way managers and board members of a corporation think about the management and the interests of the corporate's stakeholders (Donaldson & Preston, 1995). The instrumental aspect of the theory can be used to examine the links (or lack thereof) between stakeholder management and achieving corporate performance goals (Donaldson & Preston, 1995). While the normative aspect of stakeholder theory can be used to interpret the moral standpoint and obligations of a corporation towards its stakeholders (Donaldson & Preston, 1995). Although the three aspects are nested in one another, they reflect and can benefit different research purposes. Donaldson and Preston (1995:71) explain that the descriptive aspect of stakeholder theory is "*desirable in the exploration of new areas*" in order to explore the real-life situation. While both instrumental and normative analyses are prescriptive. With instrumental being hypothetical, it is used for its predictive nature. On the other hand, normative being concerned with "*moral or philosophical guidelines*", it is considered the core of stakeholder theory.

However, this classification is criticized for splitting the categories into three clear aspects, which in the literature is not really the case because it depends on the context being used (Freeman et al., 2010). Roberts and Mahoney (2004) propose a more recent differentiation concentrating on the level of analysis. Stakeholders can be divided into primary or key stakeholders and secondary stakeholders. According to Clarkson (1995:106), primary stakeholders are those "*without whose continuing participation the corporation cannot survive as going concern*" such as "*shareholders, investors, employees, customers, suppliers, the governments and communities*". Secondary stakeholders are "*those who influence or affect, or are influenced or affected by, the corporation, but they are not engaged in transactions with the corporation and are not essential for its survival*" (Clarkson, 1995:107). Brenner (1993) explains that the main goal of stakeholder theory is to look at the stakeholders influences in an organization. Given the agglomeration of several constituents in the concept of a GLH and the ambiguity surrounding the concept and its constituents. Stakeholder theory is considered an appropriate theoretical lens to adopt in this research to guide the research process.

Following the discussion on philosophical and theoretical considerations, the next section is going to discuss the research methodology. This is going to shed light on the research strategy and the methods used to conduct the research.

3.4 Research Methodology and Strategy

Collis and Hussey (2021) highlight different methodological approaches related to interpretivism such as: hermeneutics, ethnography, participative enquiry, action research, case studies, and grounded theory. The choice of suitable research methodologies and methods can be based on several factors. For instance, Ellram (1996) explain that the research questions inform the choice of methodological approaches and methods. Ellram (1996) and Yin (2014) provide guidance on the choice of methodology and method, as shown in Table 3.2 and Table 3.3.

Table 3.2 Classification of Research Methodologies According to Key Research Objectives and Questions (Source: Ellram, 1996:98)

Objective	Question	Examples of appropriate methodology
Exploration	How, why How often, how much, how many, who, what, where	Qualitative - Experiment - Case study - Participant Observation Quantitative - Survey -Secondary data analysis
Explanation	How, why	Qualitative - Experiment - Case study - Grounded theory - Participant Observation - Ethnography - Case survey
Description	Who, what, where How much, how many	Qualitative - Experiment - Case study - Grounded theory - Participant Observation - Ethnography - Case survey Quantitative - Survey - Longitudinal -Secondary data analysis
Prediction	Who, what, where Who, what, where, how much, how many	Qualitative - Experiment - Case study - Grounded theory - Participant Observation - Ethnography - Case survey Quantitative - Survey - Longitudinal -Secondary data analysis

Table 3.3 Conditions Under Which Each Method is Used (Source: Yin, 2014:65)

Method	Forms of Research Question	Requires Control of Behavioural Events?	Focuses on Contemporary Events?
Experiment	how, why	yes	yes
Survey	who, what, where, how many, how much	no	yes
Archival Analysis	who, what where, how many, how much	no	yes/no
History	how, why	no	no
Case Study	how, why	no	yes

According to Ellram (1996), the decision on the research methodology can be linked to the research approach, the nature of the research objective, and the type of research questions. Additionally, Yin (2014) explains that the research method can be decided based on other factors in addition to the research questions, such as the degree to which the researcher has control over events and whether the events are historical or contemporary. He also highlights that due to the overlapping of methods across research approaches, it is the researcher job to identify the methods with distinct advantages relevant to their research. Therefore, the researcher has to take these factors into consideration before deciding on a methodological approach and research method. According to Yin (2014), if the research questions are "what", one of two possibilities is to approach it through an exploratory study. Additionally, when the research is posing "how" or "why" questions, a case study can be considered for its rich and deep insight. Ridder (2017) highlights that some of the strengths of the case study approach are its exploratory function and the richness it can provide, which is required for inductive theory building. Gomm et al. (2000) compare the case study to experiment and survey approaches to explain when each should be used. More detailed information can be found in Appendix 12.

Case study methodology is known to be used for theory building research (Yin, 2014). A case study can be adopted when the researcher has no control over behaviours (or when behaviours cannot be manipulated) and when examining contemporary events. Additionally, a case study is considered a desirable methodology when there is little known about the phenomenon being studied because it provides a rich and in-depth insight (Ellram, 1996). Yin (2014) defines a case study as:

> *an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon (the "case") in*

> *depth and within its real-world context, especially when the boundaries between the phenomenon and context may not be clearly evident.*

"Case studies focus on holistic situations in real life settings, and tend to have a set boundaries of interest, such as an organisation, a particular industry, or a particular type of operation" (Ellram, 1996:97). In this research, the combination of "what", "who", and "how" research questions propose several appropriate methodologies. However, the contemporary nature of the phenomenon and the lack of requirement for the researcher to have control over events and behaviours puts the case study methodology in a favourable position against other methodologies. Additionally, little is known about the environmental sustainability of GLHs and there is a lack of clarity around the concept's definition and its boundaries in the literature, which also another factor that plays a role in prioritizing the choice of case study methodology over others. Furthermore, this methodology will help the purpose of the research to explore GLHs in depth and their environmental sustainability from a real-world context, since it is not possible dissect the phenomenon and study it in a controlled environment.

Based on these factors, the researcher carefully considered the case study methodology and its alignment with this research. The following sub-section is going to discuss in depth and justify the choice of a case study methodological approach for conducting this research and the case study selection criteria.

3.4.1 Case Study Strategy

"A case study is an empirical inquiry that investigates a contemporary phenomenon (the case) in depth and within its real-world context when the boundaries between phenomenon and context may not be clearly evident" (Yin, 2014:84). Case study research is a suitable method to study emergent concepts and develop new theory, and are useful when the definition of the constructs is surrounded by uncertainty (Mukherjee et al., 2000; Voss et al., 2002). There are three outstanding strengths of case study research (Voss et al., 2002:197):

- The phenomenon can be studied in its natural setting and meaningful, relevant theory generated from the understanding gained through observing actual practice.
- The case method allows the questions of why, what, and how, to be answered with a relatively full understanding of the nature and complexity of the complete phenomenon.
- The case method lends itself to early, exploratory investigations where the variables are still unknown and the phenomenon not at all understood.

Therefore, case studies are suitable for research that requires exploration and in-depth, rich, complex understanding of relationships and processes unique to a particular context. Case studies are known for exploration, theory building, theory testing and theory extension/refinement research (Voss et al., 2002; Yin, 2014). Additionally, case studies are flexible in the suitable data collection techniques that can be applied such as observations, documents, interviews, and photos etc. (Ellram, 1996). Therefore, case studies are considered a research methodology and not just a method (Yin, 2014). As a result, it has been used for different purposes and designed in different ways to cater for several research paradigms (Saunders et al., 2019). Thomas (2011) compiled different types of case studies discussed in the literature highlighting several factors affecting the choice and approach of case study, such as the number of cases, the depth and borderlines drawn around the case, time aspect, theoretical or atheoretical, and the purpose. Each case study type offers different insights and learnings about the case(s). However, considering these criteria, the decision to choose one type over the other will be based on the research purpose (Starman, 2013).

Focusing on the number of cases, case study research can involve single or multiple cases. The following section will provide an overview of the characteristics of both and a justification of the researcher's choice.

3.4.1.1 Rationale behind Choosing Multiple Case Studies

One of the main issues that face researchers adopting case study research is deciding whether a single or a multiple case study design is appropriate for the research. Rationales for choosing single case studies include testing significant theories, examining extreme or unusual cases, and longitudinal data for a case over time (Ellram, 1996;Yin, 2014). While the rationales for choosing multiple case studies include literal replication to predict similar results and theoretical replication to predict contrasting results for predictable explainable reasons (Ellram, 1996; Yin, 2014). Additionally, multiple case study research has its advantages, which makes it a strong approach to conducting research when compared with single case study approach. It provides a more compelling and robust study, augment the external validity, and help guard against observer bias (Voss et al., 2002). Ellram (1996) explains that multiple case study research is more suitable for replication and analytical generalization, and it allows for the "development of a rich theoretical framework". Both single and multiple case studies are strong and have benefits for their purpose, but each requires different goals.

Stake (1995) maintains that the collective/multiple case study helps in understanding the general phenomenon and the common characteristics and coordination between the individual cases, which takes the research a step closer to generalisation compared to other types. It is however important to mention that the purpose of studying multiple cases is not mainly to generalize the findings, as this is left to other research types. The foundation of using multiple or collective case study approach is to consider the variation and balance of cases to improve the opportunity of learning more about the phenomenon. In this research, the strengths of multiple case study research design is favoured due to the opportunity to compare and contrast different cases to provide more analytical generalizability than the single case design (Eisenhardt, 1989; Yin, 2014). Therefore, multiple case study approach is considered a good trade-off in this research based on the purpose of this research, time constrains of PhD research, availability of resources to the researcher, accessibility to the industry, the uniqueness of cases and heterogenous characteristics of GLHs, and the rich and in-depth investigation that this type of case study approach can provide to understand the phenomenon.

In case study research, case selection is considered an important aspect of the research design (Eisenhardt, 1989). Voss et al. (2002) and Yin (2014) maintain that resources of the researcher play a role in how many cases a researcher can include in their study. Yin (2014) prefers multiple case studies when possible, with at least two cases to provide an opportunity for replication. Eisenhardt (1989) argued that there is no ideal number of cases for a multiple case study research but favoured four to ten. Furthermore, Ellram (1996) sets six to ten cases as an appropriate number of cases to provide a sound study. Therefore, there is little consensus in the literature on the exact appropriate number of cases in a multiple case study research. However, Perry (1998) sets a reasonable range, where multiple case study numbers in a research can fall anywhere between a minimum of two to four cases and a maximum of twelve to fifteen cases. In the context of this research, four GLHs were selected to explore and gain rich and in-depth insights about the similarities and differences between these cases in light of the research questions. The next sub-section is going to discuss the rationale behind selecting the cases in this research and the sampling technique adopted within each case.

3.4.2 Case Study Selection

Case selection is regarded as an important and critical stage in case study research design. Eisenhardt (1989) explains that case study selection is an important aspect of building theory from case studies. She compares its importance to the concept of extracting a sample from a population in hypothesis testing research. Many decisions made at this stage depict the quality of the research design, where questions on the boundaries and the scope of the cases are answered. Yin (2014) explains that there is not a model or a catalogue for case study research design yet, as is the case in other research methods. However, he explains that the definition of the case (also referred to as unit of analysis) is dependent on the initial research questions. Collis & Hussey (2021) define the unit of analysis as "the kind of case to which the variables or phenomena under study and the research problem refer, and about which data is collected and analysed".

According to Eisenhardt (1989), case studies are selected based on theoretical reasons and not statistical reasons. Additionally, multiple case selection should follow a replication approach not a sampling approach, where the cases are selected to either satisfy a literal replication, theoretical replication, or a small number of cases are selected for each replication approach (Yin, 2014; Saunders et al., 2019). Yin (2014) maintains that a case can be anything from a person to an event or entity and he highlighted two steps to consider when selecting a case: defining the case and bounding the case. The bounding or characteristics of the case is what distinguishes the cases selected to be included in the study. It is the context of the case study.

In this research, a case is defined as a location that identifies as a GLH (Global Logistics Hub) in the EMEA region (Europe, the Middle East and Africa region). Based on the criteria mentioned below, this region was selected due to the diversity of GLH characteristics located in this region. Four cases were selected as the units of analysis for this research: Rotterdam, Antwerp, Liverpool, and Suez Canal Economic Zone (SCZone). These locations were identified as developed or emerging GLHs in literature sources and/or professional sources (Sheffi, 2012; Basnett, 2014; CBRE, 2015; Hafez & Madney 2020; Agility, 2022; SCZone, 2022). The case selection followed both literal and theoretical replication due to the similarities of some cases, such as in the cases of Rotterdam and Antwerp; and the contrasting characteristics of others, such as in the cases of Liverpool and SCZone. The selection criteria considered in the case selection process are the GLH location, the level of development of the GLH, the hosting country's economic development, the ownership of the main ports in the GLH, and the size of the GLH indicated by the cargo handled through the main port of the GLH. Table 3.4 summarizes the selection criteria of the GLHs.

Table 3.4 GLH Case Selection Criteria

GLH	Location	Level of GLH Development	Country's Economic Development	Ownership of the Main Port	Size - Cargo Handled through the Main Port	
Rotterdam GLH	Netherlands (Europe)	Developed	Developed	Public	Large	440 million tonnes
Antwerp GLH	Belgium (Europe)	Developed	Developed	Public	Large	235 million tonnes
Liverpool GLH	United Kingdom (Europe)	Developing	Developed	Private	Medium	34.3 million tonnes
SCZone GLH	Egypt (North Africa)	Under development	Developing	PPP (Public-Private Partnership)	Medium	20.5 million tonnes

These criteria are chosen to explore the concept of GLH and its sustainability under different circumstances and levels of development that might influence the understanding of the concept and could influence the environmental sustainability of the GLH. Selecting cases in both developed and developing countries will allow for a comparison of environmental sustainability of GLHs under different economic conditions, thereby highlighting the challenges and opportunities faced by GLHs in each context. Additionally, this will also highlight best practice as well as areas where more support and investment may be needed to improve the environmental sustainability of emerging GLHs and GLHs in developing countries. The GLH cases are described in more detail below to shed light on their profiles, characteristics, and sustainable development.

3.4.2.1 Rotterdam GLH

Rotterdam GLH is located in Rotterdam, the Netherlands. This GLHs has a competitive position and a unique location with connections via an extensive multimodal transport network to global origins and destinations (Port of Rotterdam, 2022). It has the largest maritime port in Europe and one of the biggest in the world (Daamen, 2020). The Port of Rotterdam handles all types of cargo, whether for transhipment or import and export, with a throughput of around 440 million tonnes: accounting for a market share in the Hamburg - Le Havre range of 36.6% in 2020 (Port of Rotterdam, 2020d). The port authority is publicly owned by the Dutch Government and the Municipality of Rotterdam, 30% and 70 % respectively (Port of Rotterdam, 2022d). The port authority lets the port sites to terminal operator, warehousing, logistics, industrial, and manufacturing companies (Port of Rotterdam, 2022d). The turnover for the port is approximately €750 million (Port of Rotterdam, 2022d). Furthermore, Rotterdam is a sustainability driven city, with collaborations between the government, the industry, and knowledge institutions to tackle environmental externalities and to progress Rotterdam's sustainability transition program (Ernst et al., 2016). Additionally, this GLH is home to the largest logistics and industrial hub in Europe, where it accommodates the largest renewable energy cluster, and they strive to be one of the world leaders with regards to energy and combating climate change through different projects such as energy transition, biobased and circular economy, carbon capture and storage, hydrogen and renewables and decarbonisation of transport (Port of Rotterdam, 2022c). The city is becoming Europe's most sophisticated energy hub (Carpenter & Lozano, 2020).

3.4.2.2 Antwerp GLH

Antwerp GLH is located in Flanders, Belgium (Dooms et al., 2013; CBRE, 2015). It has the second largest maritime port in Europe, Port of Antwerp (Karimpour et al., 2020). This GLH has a strategic, competitive position and unique location. Its port is the farthest port inland in Europe, which gives it a central location and connections to European hinterland (Port of Antwerp-Bruges, 2022a). It has very good connections via an extensive multimodal transport network to global origins and destinations (Ignaccolo et al., 2020). There is a world-class presence of logistics, freight forwarding, and industrial companies in proximity to the port (Port of Antwerp-Bruges, 2022b). The port authority lets the port sites to terminal operator, warehousing, logistics, freight forwarding, and industrial companies. Furthermore, the port handles all types of cargo, whether for transhipment or import and export, with a throughput of around 289 million tonnes in 2021 (Port of Antwerp-Bruges, 2022b). The port is publicly owned and operated by Port of Antwerp-Bruges authority, with City of Antwerp and City of Bruges as its shareholders (Port of Antwerp-Bruges, 2022b). This GLH has the second largest chemical cluster in the world integrated in the port (Esser et el., 2020). It is Europe’s largest integrated chemical cluster hosting the top 10 biggest chemical producers in the world (Port of Antwerp-Bruges, 2022c). Furthermore, Port of Antwerp's sustainability strategy is setting it to be the region's leader on sustainability through the collaboration among the port, logistics, maritime, and industries (Karimpour et al., 2020). Furthermore, according to the Environmental Implementation Review of Belgium (European Commission, 2019), there are significant sustainability transitions in Flanders through its 'Vision 2050' initiative.

3.4.2.3 Liverpool GLH

Liverpool GLH is spread over the two cities of Liverpool and Manchester, Northwest England (CBRE, 2015). This GLH's conglomeration of activities and companies includes Peel Ports Group, which is the company that owns and operates the Port of Liverpool and the Manchester Ship Canal (Peel Ports, 2022b). The Port of Liverpool is the fourth biggest port in the UK (UK Ports

Association, 2019). It provides maritime services as well as logistics and supply chain solutions. Additionally, it is expanding and developing one of the most efficient terminals in the world, 'Liverpool 2' (Peel Ports, 2022d). 'Liverpool 2' is a deep-water container terminal that allows the largest vessels to berth. This terminal increased the importance of this region, and it is one the reasons that Liverpool-Manchester area is considered an emerging GLH (CBRE, 2015). Additionally, after Brexit, Liverpool City Region was granted a Freeport status to facilitate import and export (Liverpool City Region, 2022). This GLH has a competitive position and a unique location with connections via multimodal transport to global origins and destinations (Peel Ports, 2022c). Furthermore, the Port of Liverpool handles all types of cargo for transhipment, import, and export; with a throughput of around 34.5 million tonnes in 2021 (Department for Transport, 2022; Peel Ports, 2022c). There is a very good presence of logistics, freight forwarding, and manufacturing companies in this GLH (Peel Ports, 2022d). Additionally, the Manchester Ship Canal offers a 'Green Highway' for more sustainable multimodal transport solutions (Peel Ports, 2022a). This sustainability thinking is also paired with the current development of the Liverpool-Manchester Hydrogen Energy and Carbon Capture Cluster (Elliott, 2020). Additionally, the Liverpool City Region is committed to have 'zero carbon emission' by 2040, through partnerships and collaboration with a diverse range of stakeholders (Liverpool City Region, 2022).

3.4.2.4 SCZone (Suez Canal Economic Zone) GLH

SCZone GLH is located in the Suez Canal economic zone within the vicinity of the Suez Canal banks in Egypt (SCZone, 2022). The Suez Canal route is considered one of the most important maritime routes in the world (Bayirhan & Gazioglu, 2021). Recently, the Suez Canal was expanded to increase the depth and width of the canal allowing bigger ships and more traffic to pass through as part of the development plan for the SCZone that launched in 2014 (Kenawy, 2016; Rusinov et al., 2021). Additionally, The SCZone currently has 6 maritime ports and 4 industrial clusters, however, the area is still under development, with more facilities, transport infrastructure, and logistics and industrial centres to be developed (Kenawy, 2016; Hafez & Madney 2020). This GLH is strategically located and connects Asia, the Middle East, North and East Africa, and Europe (Hafez & Madney 2020). Additionally, 12% of global maritime trade passes through the Suez Canal (SCZone, 2022). The SCZone is also characterized by free trade zones that serve the industrial clusters and trade agreements (Hafez & Madney 2020). The SCZone General Authority is a public independent authority. It is fully responsible for the development of the area and has full authority to oversee operations and facilitate business and partnerships (SCZone, 2022). The ports along the Suez Canal are in public-private partnership (PPP) with different operators to carry out the terminals' operations (SCZone, 2022). The main port for this area is the second largest port in Egypt - East Port Said Port, and it had a throughput of 20.5 million tonnes in 2017 (Maritime Transport Sector, 2017). There is a green logistics centre under development currently in this port (SCZone, 2022). Furthermore, sustainability is set at the heart of the SCZone development to be one of the leading green fuel production hubs in the world (Hafez & Madney, 2020; SCZone, 2022). In 2022, on the proceedings of the Climate Summit (COP27) that was hosted by Egypt, 9 contracts were signed for green fuel projects to be implemented in the SCZone (SCZone, 2022).

In addition to the case selection criteria and rationale discussed above, sub-units of analysis, such as persons, departments, levels, or layers can also be determined if the case study is embedded and not holistically studied (Saunders et al., 2019). In the context of this research, the case studies are embedded as the researcher is adopting a stakeholder theoretical lens, which helped in identifying several layers of stakeholders to dissect the GLHs further and study them in-depth. This will be discussed in more detail in the next section.

3.5 Data Collection

Data collection starts with identifying participants through an appropriate sampling procedure for each case study. Sampling approaches can be categorised into probability and non-probability sampling. Probability sampling follows random sampling strategies, while non-probability sampling follows convenience, quota, volunteer, or purposive sampling strategies (Sekaran & Bougie, 2016; Schreier, 2018; Saunders et al., 2019). Non-probability sampling approach can be used when the population may not be well defined (Etikan, 2016), which is the case in this research. The GLH as a concept has inconsistent definitions in the literature, and its stakeholders are not quite clear. Therefore, a non-probability sampling approach is considered more appropriate in this research to be able to identify the primary stakeholders through participants without forcing a specific framework for GLHs from the literature or previous knowledge of the researcher that might be inaccurate.

In non-probability sampling, researchers often combine several sampling strategies (Bell et al., 2022). In the context of this research, purposive and snowball sampling strategies were combined. Purposive sampling is an appropriate strategy to collect data for qualitative research as respondents are selected based on their ability to provide the knowledge and the information required to answer the research questions and provide in-depth insight on the research topic (Sekaran & Bougie, 2016). It is considered a suitable approach for this research since it requires identifying the most appropriate participants to answer the research questions due to the complexity of the concept of GLHs and its sustainability. The initial sampling of participants in each case study was purposive to provide the basis for a subsequent snowball approach (Bell et al., 2022). Snowball technique is a form of convenience sampling, and it is used to identify participants through other participants allowing the sample to grow as a snowball (Collis & Hussey, 2013; Saunders et al., 2019). An advantage of this technique is that participants who are included have experience of the phenomenon and can identify others with similar experience (Bell et al., 2022). Snowball sampling was used to facilitate identifying participants through other participants by making the initial contact with one type of stakeholder and asking them to identify other participants of experience on the topic in any of the stakeholder types they mention in their interview.

The sampling approaches used can be criticized for their low likelihood of being representative as is the case with any non-probability sampling technique (Saunders et al., 2019). However, they were considered suitable for this research because of their advantages, such as considering diversity and identifying participants when it is difficult to identify them. The sampling techniques used were therefore flexible and open to including the most appropriate participants to answer the research questions.

Combining these two sampling approaches allowed the researcher to identify different types and levels of stakeholders within each case during the data collection process, as shown in Figure 3.3. The heterogeneity of stakeholder types, their roles, and levels were clarified and enhanced by the participants as the research developed. For example, the outermost level of primary stakeholders (Figure 3.3) was not anticipated by the researcher in the initial stages of data collection. However, during the interviews, participants reiterated that they are considered as primary stakeholders and were identified as part of the snowball sampling process. Therefore, the data collection extended to participants in the outermost layer of stakeholders in all cases. Additionally, the industrial cluster companies were identified by participants as part of the primary stakeholders, and the snowball sampling technique identified a few industrial cluster company participants. However, the interviews were never conducted due to the companies backing out of the research. This is discussed in more detail in the limitations chapter.

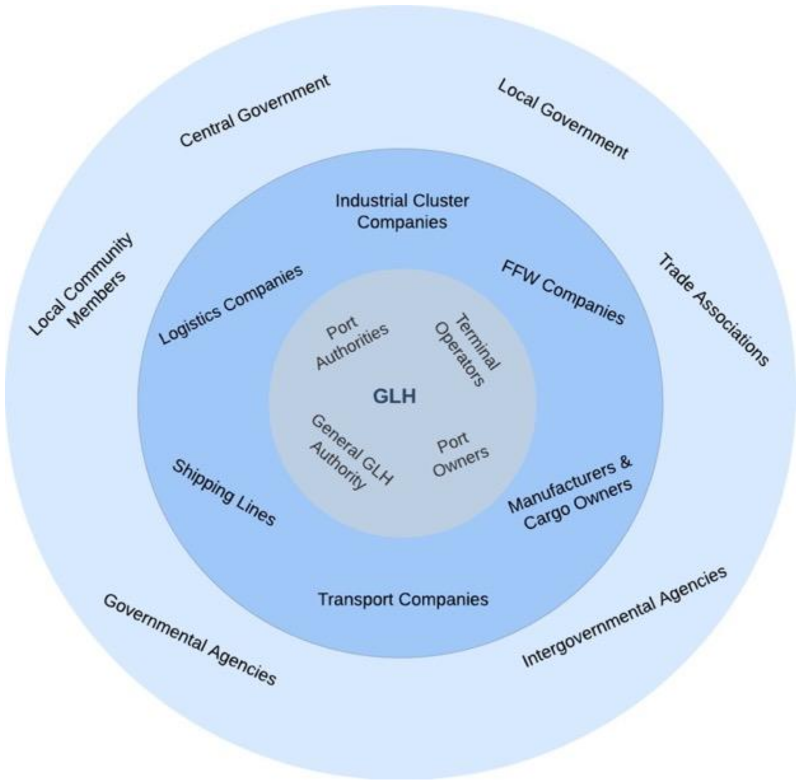


Figure 3.3 GLH Stakeholder Onion

The layers of stakeholders in Figure 3.3 demonstrate the level of involvement and role of stakeholders in GLHs. Starting from the innermost layer, this is the point where most GLH cargo passes through. It can be considered as a central point to the GLH. The stakeholders at this level are responsible for managing the operations of the port and managing the concessions and relationships of the GLH stakeholders. The second layer of stakeholders are the catalyst of business for the GLH such as the shipping lines, manufacturers and cargo owners, industrial cluster companies, and transport, freight forwarding and logistics companies. This level of stakeholders is crucial for lucrative, dynamic, and diverse operations. The third layer of stakeholders are key stakeholders. They include the local community members who are directly affected by the operations of the GLH; the central or local government authorities and agencies who monitor and oversee the operations and the infrastructural needs of the GLH; and the trade associations that play a facilitating role of relationships and communication among GLH stakeholders. The Results and Discussion chapters are going to provide more information and discussion on the stakeholder levels, connection and involvement, and role in GLHs.

3.5.1 Data Collection Methods

In this research, multi-method triangulation was used by collecting data through semi-structured interviews, documents, pictures, and observations to increase the research trustworthiness and reduce researcher and participants' bias. Data were primarily collected through interviews, which served as the main technique for data collection, and were supplemented with pictures, observations, and documents subsequent to the interviews. For the four case studies, data were collected from different types of stakeholders in the layers identified in Figure 3.3 using the sampling approaches mentioned above. Table 3.5 displays the stakeholder participants included from the different layers for each case.

Table 3.5 Stakeholder Participants in Case Studies

Stakeholders	Europe			North Africa	Pilot Study
	Rotterdam GLH	**Antwerp GLH**	**Liverpool GLH**	**SCZone GLH**	UK Port Authority
1st Level	Port Authority Terminal Operator & Logistics Service Provider	Port Authority I Port Authority II Terminal Operator & Logistics Service Provider	Port Owner & Operator & Logistics Service Provider	SCZone General Authority Port A Terminal Operator Port B Terminal Operator	
2nd Level	Multinational Logistics Company Freight Forwarding Company	Logistics Department in Multinational Manufacturer Company & Cargo owner	Global Retailer Logistics Department & Cargo Owner Road Haulage Company	Multinational Logistics Company Freight Forwarding Company A Freight Forwarding Company B Local Logistics Company A Local Logistics Company B Shipping Line Branch operating in MENA Region	
	Shipping Line Branch Operating in Europe				
3rd Level	Local Community Member Local Community Member Government Environment Agency	Local Community Member Trade Association	Local Community Member Trade Association Local Government	Local Community Member Local Community Member Central Government Intergovernmental Agency Rep	
No. of Interviews	7	6	6	13	
	1				

Total No. of Interviews	33 Interviews

Table 3.5 also shows the number of interviews conducted in each case. Interviews were one of the methods used to collect data from stakeholders. Interviews are considered a very important source of evidence in case study research (Yin, 2014). There are three types of interviews: structured, semi-structured, and unstructured interviews (Stuckey, 2013). Structured interviews are more suitable for positivistic approach, while unstructured and semi-structured interviews are suggested for the phenomenological approach (Collis & Hussey, 2013). Both semi-structured and unstructured interviews are considered 'non-standardized'. Matters, answers, and topics explored could change from one interview to the other within the topic guide (Collis & Hussey, 2013; Easterby-Smith et al., 2021). However, they help with exploring answers in more depth.

Interviews are considered a very important method to collect data for interpretivist research because they allow the researcher the opportunity to ask participants for elaborations or to have a chance to build on their answers (Saunders et al., 2019). Semi-structured interviews were preferred over unstructured interviews for this research because they allow for a degree of structure as well as flexibility (Easterby-Smith et al., 2021). As outlined in Table 3.6, semi-structured interviews combine the advantages of structure found in structured interviews, as well as the flexibility found in unstructured interviews.

Table 3.6 Advantages of Semi-Structured Interviews (Adapted from: Collis & Hussey, 2013)

Structure	Flexibility
• Clarifies the topics to be explored • Helps in controlling the timeframe for data collection • Facilitates comparisons in the analysis process	• Helps with in-depth exploration • Helps in obtaining further information • Allows asking more complex questions

Several researchers have recommended the development of an interview guide for semi-structured interviews to ensure a clear structure, flexibility, and to improve the research reliability (Yin, 2014; Saunders et al., 2019; Easterby-Smith et al., 2021). Data were collected through interviews first as the main method for data collection in this research and supplemented with pictures, observations, and documents after the interview where possible.

3.5.1.1 Interview Guide Development

The interview guide was designed to provide a structure and a clear guide to the interview. However, the structure and order of questions were subject to modifications during the interview (Kallio et al., 2016). This provided more flexibility and allowed the researcher to probe further questions and clarify on any points discussed by the participants which seemed relevant to the research and would offer new and interesting insights (Bell et al., 2022). The interview guide has a set of open-ended questions, probes and prompts to promote further discussion, and a suggested sequence for the questions (Saunders et al., 2019). The interview questions were formulated based on the information required to answer the research questions (Bell et al., 2022). Furthermore, the preliminary semi-structured interview questions were tested in pilot study interviews for their clarity, validity, and usefulness, and the interview guide was modified and refined accordingly. To test the interview guide and enhance its validity, the researcher conducted pilot interviews with ABP (Associated British Ports) port authority representatives in the UK and Port of Antwerp port authority representative. In the ABP interview, 2 managers from 2 departments of the port were interviewed together to get feedback on the interview questions and check the feasibility of analysis techniques. Based on the responses and feedback from the pilot study, the interview questions were refined before conducting the second pilot interview. In the second pilot interview, a port authority representative was interviewed to ensure the modifications to the interview guide were in the right direction before continuing with the main case studies interviews. The second pilot interview was included in the Antwerp GLH case and is considered in the analysis as no major modifications to the interview guide resulted from this interview.

The interview guide was then used in all cases and for all participants in this research. A copy of the interview guide is presented in 'Appendix 1'. Interview questions covered the following topics: exploring and understanding the concept of GLHs, GLHs environmental impact, stakeholders' environmental performance measurement, stakeholders' extent of connection, stakeholder environmental responsibility, and environmental sustainability drivers and barriers in GLHs. Additionally, probes and prompts were used to further explain an answer, provide examples, or clarify the interviewer's understanding of the participant's answer (Saunders et al., 2019). This helped in enhancing the quality of the interview, as well as reduce bias and inaccurate interpretations. Additionally, several scholars suggest following an interview sequence (Robson, 2002; Saunders et al., 2019; Easterby-Smith et al., 2021; Bell et al., 2022). Figure 3.4 displays the steps of the interview process.

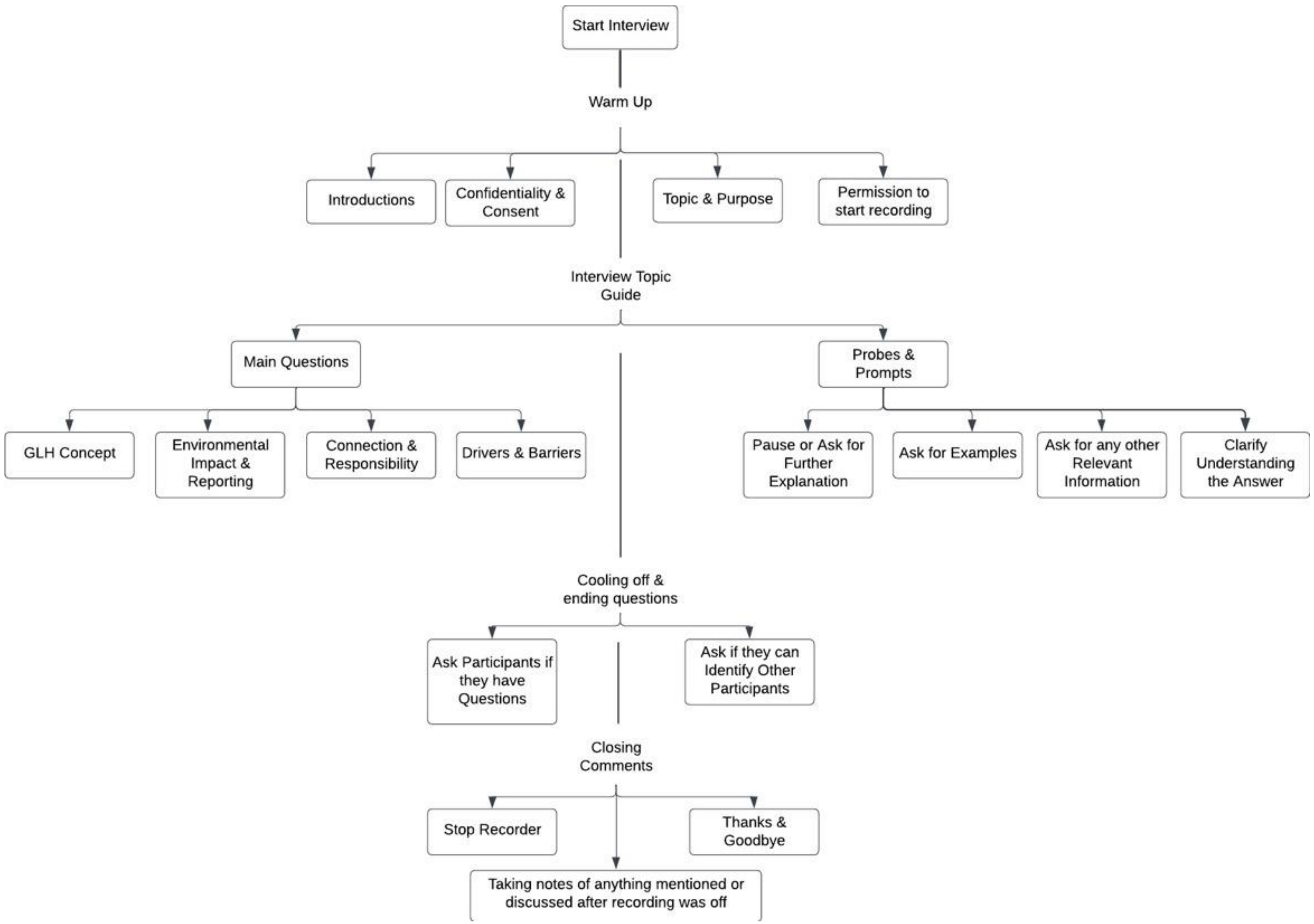


Figure 3.4 Interview Sequence (Adapted from: Robson, 2002)

An important part of the interview is after the interviewer has stopped recording. Bell et al. (2022) emphasize the importance of the discussion that takes place after the recorder is off and recommend taking notes after the interview has ended. Details regarding the ethical guidelines followed by the researcher can be found in 'Appendix 7'.

The semi-structured interview data was supported by collecting data through observations, photos, and documents. Visual data such as photos or observational evidence provide a complementary source of information to interviews and documents when there is small amount of data on a phenomenon or topic (Yin, 2014; Easterby-Smith et al., 2021). Therefore, using photos and observations can provide additional information to enhance noticing the context and help with triangulation. Additionally, as a form of secondary data, documents such as sustainability reports and annual reports were used to support data collected through other methods (Saunders et al., 2019). These sources of secondary data were very useful especially in answering RQ2. However, they were used carefully to avoid data bias since companies' public sources are known to likely idealise the company and present their best (Gillham, 2010).

3.5.2 Data Collection Process

Data collection took 12 months from July 2019 to July 2020 working with 4 case studies from 4 different countries, collecting data from several types of stakeholders, and the research being conducted during a global pandemic. The implications of Covid-19 Pandemic will be discussed further in the Limitations Chapter.

For this research, interviews were conducted with the types of stakeholders listed in Table 3.5. The interviews lasted between 30 minutes and an hour and a half with an average of 45 minutes for most interviews. A suggested duration of 30 to 45 minutes was indicated in the interview guide for participants. During all interviews, the researcher was balancing providing the interviewees with the freedom to talk without interruption when answering the questions, while following the interview guide and being mindful of the time used to answer all questions and follow-up questions within the timeframe of the interview (Easterby-Smith et al., 2021). Additionally, this strategy also helped when stakeholder types were added to the interviewing process who were not anticipated at the outset such as local community participants (Bell et al., 2022). The interviews conducted in this research were mostly conducted with one interviewee. However, in some interviews the interviewee was accompanied by another person that would be suggested by the main interviewee. This was to ensure that all interview questions can be answered (Collis & Hussey, 2013). This was especially the case for some stakeholder participants, where the environmental sustainability was shared between two positions or two departments.

Furthermore, the research was designed to conduct face-to-face interviews and facilitate observations, however, due to Covid-19 Pandemic it was not possible for all stakeholders and cases. Easterby-Smith et al. (2021) explain that the Covid-19 Pandemic made remote interviews the only option for many researchers. In the context of this study, the researcher started the data collection with face-to-face interviews; but due to lockdowns in 2020, the interviews were modified to tackle the issue and were completed over video calls with participants. The majority of participants conducted their interviews in English due to their proficiency in the language, while some Arabic speaking participants opted to conduct the interview in Arabic. The researcher's proficiency in Arabic allowed for smooth communication with Arabic-speaking participants, with no issues during data collection regarding differences in languages.

For data collected from documents, this was achieved from reports that were made available to the public on the companies' websites including sustainability, CSR, and annual reports. The researcher acquired a copy from documents during interviews or downloaded all relevant reports and information from company/organisation websites. They were then compiled in a file of documents for each stakeholder. These files were added to NVivo to be coded and analysed. Furthermore, photos were used in this research to gather more information about GLHs in terms of how they are structured, understand the proximity of stakeholders in a GLH, and gain more information about the context of each case. Photos were taken with participants' consent when they were taken on the company's premises. They were then added to NVivo to be coded and analysed for each of the three cases (Rotterdam, Liverpool and SCZone). Additionally, observations were used to check for participant bias and gain more information to complete the picture. Observations were written down after the researcher has concluded each interview or immediately after the field trip was over. The observations were then compiled in a file for each case and added to NVivo to be coded and analysed. Even though there was a small opportunity for photos and observations, adding these sources of data to the research helped in generating richer data, enriched the depth of understanding, and enhanced research rigour and transferability (Lincoln & Guba, 1985). However, observations and photos were only possible before Covid-19 pandemic. Due to restrictions and lockdowns, field trips were only possible in the cases of Rotterdam, Liverpool, and SCZone. For Antwerp case study a field trip was not possible due to the pandemic. Since interviews were the primary sources of data and most of them were possible to conduct online, it was still possible to include Antwerp as a case despite the limitations imposed by pandemic-related restrictions. There was sufficient data available from interviews and documents to proceed with the case study. Therefore, interviews and documents were still utilized as the sources of data collection for the Antwerp case, while observations and photos were not employed due to the restrictions.

Another important aspect of collecting data in qualitative research is deciding on the appropriate number of interviews and knowing when to stop collecting further data. The concept of 'saturation' (data or thematic saturation) is a widely used justification for sample size in qualitative research, and specifically in thematic analysis (Braun & Clarke, 2021). It is defined as "information redundancy or the point at which no new themes or codes emerge from data" (Braun & Clarke, 2021:201). Data saturation evolved from the concept of theoretical saturation used in grounded theory. Deciding that saturation has been achieved is critical, where no new information, themes, or insights are being introduced by adding more interviews; and noticing previously explored information start repeating (Bell et al., 2022). This decision should be taken carefully to ensure that the emerging themes are well understood and saturated (Braun & Clarke, 2021). Additionally, this will inform the number of interviews that the sample will settle on. Determining the appropriate sample size for the purpose of the research is important because if the sample size is too small it will be difficult to achieve saturation, while if it is too large it will be difficult to conduct a deep, case-oriented analysis (Bell et al., 2022). Therefore, the sample size decision cannot be precisely made in the beginning of a study that is using saturation. However, this can be supported by suggestions in the literature regarding the appropriate number of interviews required to achieve saturation. This provided more structure to the decision. Hagaman and Wutich (2017) suggest that around five interviews are required to identify a new occurrence of common themes. Therefore, five interviews were considered the threshold for each case to allow for occurrence of themes in each case. Additionally, as a rule of thumb, Warren (2002) suggested that for non-ethnographic qualitative studies, a minimum number of interviews should be between 20 to 30 interviews. Therefore, this research has considered data saturation to inform the researcher when to stop collecting further data, as well as the appropriate number of interviews suggested in the literature to inform the number of interviews for each case and for the overall study. This resulted in a total of 33 interviews across 4 case studies, with at least 6 interviews in each case.

3.5.2.1 Case Study Participants

The participants in each case were interviewed based on their abilities to answer the interview questions. If there was a specific department or position in the company or organisation dedicated to environmental sustainability, sustainable development, or corporate social responsibility, a participant from that department would be interviewed. Otherwise, the interview was conducted with a top management role or role with an overview of logistics, transportation, or shipping operations. A description of participants in each case is provided in Table 3.7, Table 3.8, Table 3.9, and Table 3.10. It can be noted in Table 3.10 that the number of participants in the SCZone GLH case were considerably more than the other cases. This is because the GLH is still under development, and some participants did not have answers to all questions. This extended the process to achieve data saturation for this case, and it resulted in including several more participants than the other cases.

The next section is going to discuss in depth the data analysis strategy adopted in this research.

Table 3.7 Rotterdam GLH Participants

Level of Stakeholder	Stakeholder Type	Participant Code	Participant Role	Participant/Organisation Description
1st Level	Port Authority	C1L1P1	Middle Management	Port of Rotterdam.
	Terminal Operator & LSP in Port of Rotterdam	C1L1P2 C1L1P3	Operational Management Middle Management (Two participants in one interview)	Privately owned company providing terminal, logistics, and freight forwarding operations.
2nd Level	Multinational Logistics Company - Rotterdam	C1L2P1	Middle Management	Multinational logistics company providing logistics services & freight forwarding through road, ocean, rail, and air transport modes. They have a global reach to over 200 countries.
	Freight Forwarding Company - Rotterdam	C1L2P2	Top Management	Freight forwarding company providing cargo shipping and transportation to/from global origins/ destinations.
	Shipping Line - Europe	CEL2P3	Middle Management (One participant interview for the three European case studies)	Multinational company providing ocean transportation, logistics, and supply chain services. It one of the biggest shipping companies in the world.
3rd Level	Local Community 1	C1L3P1	Local Community Member	35 highly educated Female living in Rotterdam.
	Local Community 2	C1L3P2	Local Community Member	33 highly educated Female living in Rotterdam.
	Environment Agency - Rotterdam	C1L3P3	Operations Level	Environment agency operating as part of the Dutch government responsible for conducting research and inspections.

Table 3.8 Antwerp GLH Participants

Level of Stakeholder	Stakeholder Type	Participant Code	Participant Role	Participant/Organisation Description
1st Level	Port Authority I	C2L1P1	Middle Management	Port of Antwerp.
	Port Authority II	C2L1P2	Commercial Representative (2nd Pilot Interview)	
	Terminal Operator & LSP in Port of Antwerp	C2L1P3	Middle Management	Privately owned company providing ocean and inland terminal operations, and logistics services. This company is operating in several countries, but its headquarters is in Antwerp.
2nd Level	Multinational Manufacturers' Logistics Department - Antwerp	C2L2P1	Middle Management	The manufacturer's logistics department is from a multinational company. They provide logistics services and distribution for their own products, but they don't own fleets or warehouses since they outsource them.
	Shipping Line - Europe	CEL2P3	Middle Management (One participant interview for the three European case studies)	Multinational company providing ocean transportation, logistics, and supply chain services. It one of the biggest shipping companies in the world.
3rd Level	Local Community 1	C2L3P1	Local Community Member	28 highly educated Male living in Antwerp.
	Trade Association - Antwerp	C2L3P2	Top Management	Global trade association involved with GLH stakeholders, and it is recognized as an NPO and NGO.

Table 3.9 Liverpool GLH Participants

Level of Stakeholder	Stakeholder Type	Participant Code	Participant Role	Participant/Organisation Description
1st Level	Port Owner & Operator	C3L1P1 C3L1P2 C3L1P3	Middle Management Middle Management Operations (Three participants in one interview)	Peel Ports - Port of Liverpool
2nd Level	Transport Service Provider - Liverpool	C3L2P1	Top Management	Road haulage company providing road transport services and warehousing in the UK and Europe using their own fleet of trucks.
	Global Retailer Logistics Department	C3L2P2	Middle Management	Global retailer company owns over 500 stores across Europe. The logistics department involved in this case is responsible for UK distribution and logistics services.
	Shipping Line - Europe	CEL2P3	Middle Management (One participant interview for the three European case studies)	Multinational company providing ocean transportation, logistics, and supply chain services. It one of the biggest shipping companies in the world.
3rd Level	Local Community 1	C3L3P1	Local Community Member	26 highly educated Male living in Liverpool
	City Region - Local Government	C3L3P2	Middle Management	Liverpool City Region Combined Authority is a local government institution for six local authorities that tackles issues such as transport, sustainability in the region and employment among other things.
	Trade Association	C3L3P3	Top Management	One of the largest trade associations in the UK. It is a representative of logistics, all modes transport members, and freight customers. It provides services to the members to help their efficiency and sustainability.

Table 3.10 SCZone GLH Participants

Level of Stakeholder	Stakeholder Type	Participant Code	Participant Role	Participant/Organisation Description
1st Level	Port Authority – Port A	C4L1P1	Top Management	Port Authority Port A and the connection between terminal operators and SCZone General Authority
	Terminal Owner & Operator - in Port A	C4L1P2 C4L1P3	Middle Management Middle Management (Two participants in one interview)	Multinational company co-owning and operating one of the terminals in the 6 ports in the SCZone. It is one of the big projects in SCZone.
	Terminal Owner & Operator - in Port B	C4L1P4	Operational Management	Multinational company co-owning and operating one of the terminals in the 6 ports in the SCZone. It is one of the big projects in SCZone.
2nd Level	Multinational Logistics Company	C4L2P1	Middle Management	Multinational logistics company providing logistics services & freight forwarding through road, ocean, rail, and air transport modes. They have a global reach to over 200 countries.
	Logistics Company	C4L2P3	Top Management	Logistics company providing value-added logistics services and multimodal transport solutions to their customers throughout Egypt and worldwide.
	Freight Forwarding Company	C4L2P4	Top Management	Logistics company providing value-added logistics services and multimodal transport solutions to their customers throughout Egypt and worldwide.
	Transport & Freight Forwarding Company -1	C4L2P2	Top Management	Freight forwarding company providing cargo shipping and transportation to/from global origins/ destinations.
	Transport & Freight Forwarding Company-2	C4L2P5	Top Management	Freight forwarding company providing maritime and air freight forwarding to/from global origins/destinations.
	Shipping Line (MENA region) - Egypt	CML2P6	Middle Management	Multinational company providing ocean transportation, logistics, and supply chain services. It one of the biggest shipping companies in the world.
3rd Level	Local Community 1	C4L3P1	Local Community Member	25 highly educated Male living near SCZone
	Local Community 2	C4L3P2	Local Community Member	26 highly educated Male living near SCZone
	Government	C4L3P3	High-level Government Official	Ministry of Transport - the government department responsible for the Egyptian transport network and the SCZone development. It acts as a higher authority over SCZone General Authority.
	Government & UN Agency	C4L3P4	Manager & Representative	Technical Manager at the Department of Maritime Transport & Representative of the sector at UN Agency

3.6 Data Analysis Strategy

According to Yin (2014) and Eisenhardt (1989), the analysis stage is important to building theory from case studies, however, it is also considered the most difficult stage of the research and the least codified. Nevertheless, it is extremely important to establish and maintain a chain of evidence to provide a logical flow from the research questions, through data analysis, and to how the conclusions were reached (Ellram, 1996). Therefore, this section explains the data analysis process in this research. This research followed a thematic analysis method to condense and display the qualitative data collected in this research. According to Braun & Clarke (2006:79), thematic analysis is "a method for identifying, analysing, and reporting patterns (themes) within data". It was employed to analyse textual data from interview transcripts, observations, documents, as well as visual data from photos. Thematic analysis was chosen as the data analysis strategy due to its ability to provide a comprehensive and in-depth understanding of qualitative data, allowing for the exploration and interpretation of themes and patterns that emerged from the data sources utilized in this research. It is a flexible and widely used technique in qualitative analysis as it is considered a foundational method (Clarke et al., 2015). However, since there is not a clear agreement on how to conduct it, it is vital to clearly document the coding process and the practice of the method in the research (Braun & Clarke, 2006). Furthermore, the frequency of coded data was extracted from NVivo and incorporated in the data analysis process to capture the magnitude of themes. This allowed for a comprehensive exploration of the data, providing deeper insights into the prevalence of specific themes. By incorporating this quantitative aspect, the research findings gained additional robustness, enhancing the overall rigor of the research findings.

Creswell and Poth (2016) describe that there are three general steps in data analysis for qualitative research: preparing and organising the data, reducing the data, and representing the data. Several researchers recommend that the data collection, data analysis (reduction and interpretation), and write-up of findings should be done concurrently or at least overlap to a certain extent (Eisenhardt, 1989; Glaser & Strauss, 2017; Creswell & Creswell, 2018). Furthermore, Miles et al. (2014) proposed an interactive model to explain the interaction between data collection and data analysis, as shown in Figure 3.5.

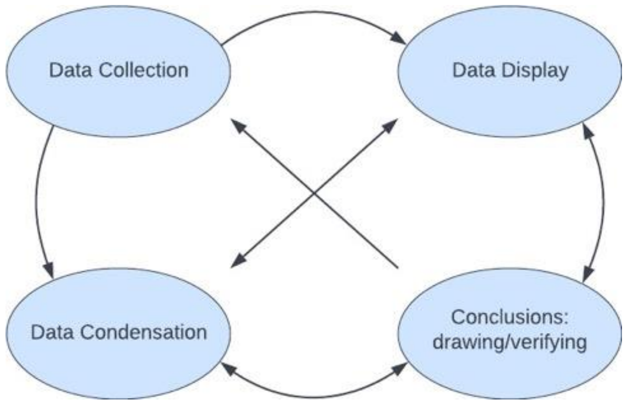


Figure 3.5 Data Analysis interactive Model (Source: Miles et al., 2014:33)

Additionally, Creswell and Poth (2016) explain the process of data analysis as a spiral of data analysis steps where each level builds on and advances the previous one, as shown in Figure 3.6. Therefore, this research followed these models throughout the data collection and analysis processes.

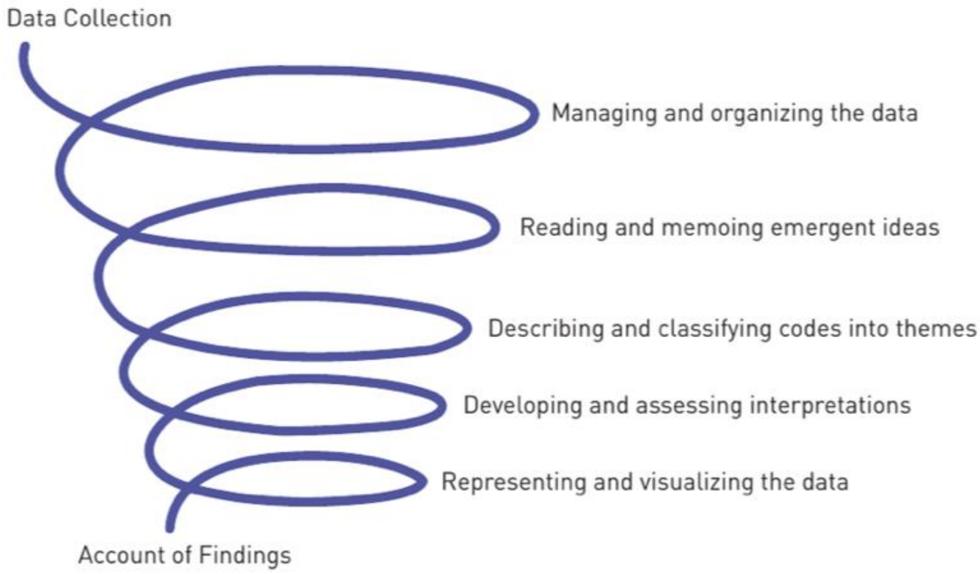


Figure 3.6 Data analysis spiral (Source: Creswell & Poth, 2016:151)

As part of preparing and organising the data, documentation of all data was carried out. Voss et al. (2002) suggested that a necessary initial step in data analysis should be documentation. Therefore, the first step after data collection in this research was a detailed write up and organisation of the data collected such as transcribing interview recordings, translating transcripts where required, tidying up field notes and background information, importing photos, downloading reports, and organising all files into labelled folders to facilitate data management (Voss et al., 2002; Creswell & Poth, 2016). Documentation was done as soon as any data was collected, and the process was applicable throughout the data collection process. Digitizing all data was necessary for the data analysis because the researcher used a qualitative data analysis software - NVivo. This process of documentation allows on-screen coding and exploration of patterns (Voss et al., 2002).

The next step in data analysis is data condensation. It starts with reading and recording emergent ideas, then coding and classifying the data into themes. Data condensation focuses the mass of qualitative data obtained by selecting, summarizing, abstracting, and organising it. It is the part of the analysis where the researcher makes an analytic decision to code chunks of data and choose category labels that best describe several chunks (Miles et al., 2014). "A code in qualitative inquiry is most often a word or short phrase that symbolically assigns a summative, salient, essence capturing, and/or evocative attribute for a portion of language-based or visual data" (Saldaña, 2021:3). Coding is an essential part of qualitative data analysis. Miles et al. (2014) explain that codes help link relevant information from multiple sources. Multiple sources and good documentation allow the chain of evidence to be established and enables the researcher to code interesting incidents into categories, and then comparing the categories to develop the properties and dimensions of theoretical concepts (Voss et al., 2002). Therefore, coding is regarded as a data condensing technique; where first the data is broken down, then relevant information is coded and categorised (Miles et al., 2014).

Coding is interpretive, iterative, and reflective (Braun & Clarke, 2006; Glaser & Strauss, 2017; Saldaña, 2021). For the purpose of this research, the coding iteration followed Strauss and Corbin's (1990) three steps coding scheme to structure the iteration process. This method was developed for grounded theory analysis, but it has gained popularity across other types of analysis for its usefulness, flexibility, and clarity (Voss et al., 2002). The researcher followed the three steps of coding: open coding, axial coding, and selective coding. The open coding is an initial examination coding where the researcher broke down all data collected for each case study and coded them by summarizing relevant segments of the data using descriptive and verbatim codes (Ellram, 1996; Miles et al., 2014; Saldaña, 2021). The axial coding is the second step where the codes developed in the initial coding were compared and contrasted to be re-grouped in new ways, linked, and cross-referenced to refine codes into categories and develop new overarching categories (Voss et al., 2002). Selective coding was the final step in the coding process to further distil, link, condense, and sort the categories into themes. Furthermore, in this research, the researcher started building a thematic network (Appendix 6) after the second coding step to display the data and develop global themes, which also helped in completing the third level of selective coding. A thematic network is a web-like map used as an organizing and a representational structure depicting the salient themes at each of the three levels of coding and illustrating the relationships between them (Attride-Stirling, 2001). The researcher used this technique to enable methodical systemization of data, and to facilitate the organisation and rich exploration of the underlying patterns (Attride-Stirling, 2001).

Data display is a systematic visual presentation of information to help the researcher draw valid conclusions (Voss et al., 2002). Miles et al. (2014) suggested using matrices, graphs, charts, networks, and other graphical formats to assemble organised information in an accessible and compact structure. This helps the researcher gain an overview of what is happening, process large amounts of data, and draw conclusions for each case as a stand-alone entity for within-case analysis and across cases for cross-case analysis (Voss et al., 2002). In this research, data display is constructed and used in both within case and cross-case analysis. The forms of data display used are matrices, word clouds, and thematic networks. Furthermore, data display facilitated the systematic search for within case and cross-case patterns as this is a key step in case research (Voss et al., 2002). It is an important stage because the researcher becomes intimately familiar with each case, where this process allows developing the unique patterns of each case before generalising patterns across cases (Eisenhardt, 1989). Searching for patterns within cases and across cases helped the researcher go beyond initial impressions of within case analysis and investigate the data through structured and diverse lenses to remove biases and enhance the probability of capturing novel findings. According to Eisenhardt (1989), cross-case searching tactics improves the likelihood of developing accurate and reliable theory that is a close fit with the data. The analysis tactic that the researcher followed in this study was selecting and looking at the categories and themes in data displays to identify patterns of similarities and differences within and across cases, taking into account the types of stakeholders in each case (Eisenhardt, 1989). This process was structured in this research according to Creswell and Poth's (2016) framework for multiple case study analysis, shown in Figure 3.7.

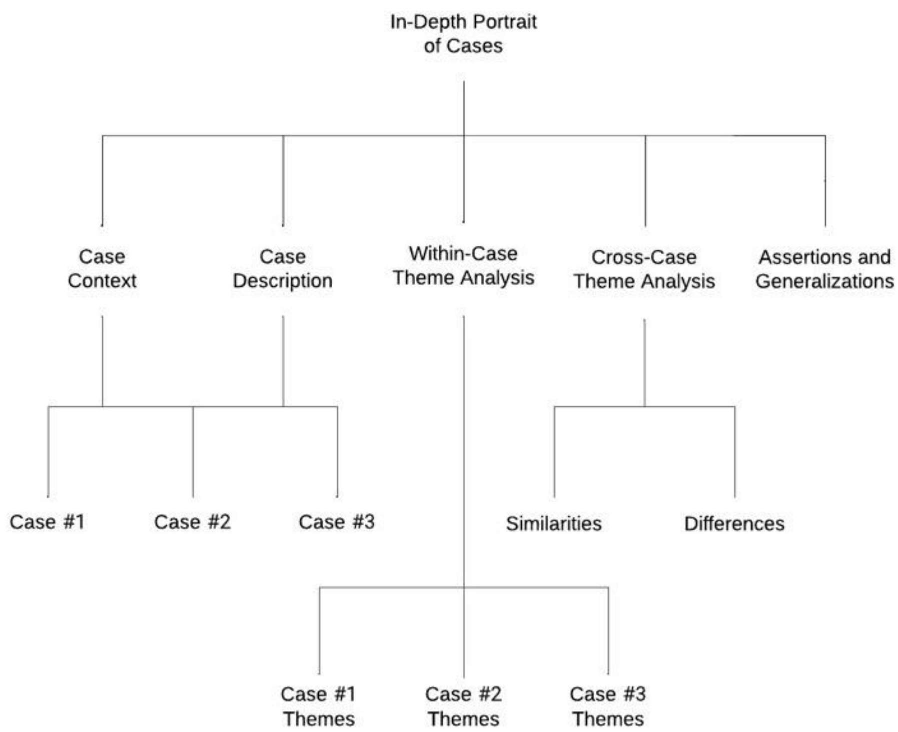


Figure 3.7 Multiple Case Study Coding Framework (Source: Creswell & Poth, 2016:218)

There are different frameworks for qualitative data analysis suggested by several researchers (Strauss & Corbin, 1990; Attride-Stirling, 2001; Miles et al., 2014; Yin, 2014; Creswell & Poth, 2016). However, the framework proposed by Creswell and Poth (2016) for multiple case study analysis was used in this research because it caters for multiple case study approach. It is considered appropriate to guide the researcher from within case analysis to cross-case analysis and through to interpretations and theory development. The framework breaks the multiple case analysis process into several stages, with tasks appropriate for each stage. The case context and description are presented for each case, and then the themes are explored and described with the help of the data displays and thematic networks for each case individually (Attride-Stirling, 2001). Following the within-case theme analysis, the themes are then compared to highlight the similarities and differences between cases for cross-case theme analysis. The results of this stage are then incorporated in the assertions and generalizations across all cases. This leads to the third analysis flow of drawing conclusions and verification (Miles et al., 2014). This process is considered the last step of the integration of concepts to facilitate the elevation of description or conceptual ordering to the level of theory, and integrate theory into a cohesive whole (Corbin, 2015). It is important to note that for the sake of clarity, the steps are explained as a linear process. However, it was rather iterative and overlapping. Screenshots of the coding process on NVivo are available in 'Appendix 2'.

To sum up the research process followed in this research, Figure 3.8 illustrates detailed steps of the data collection and analysis processes in this research.

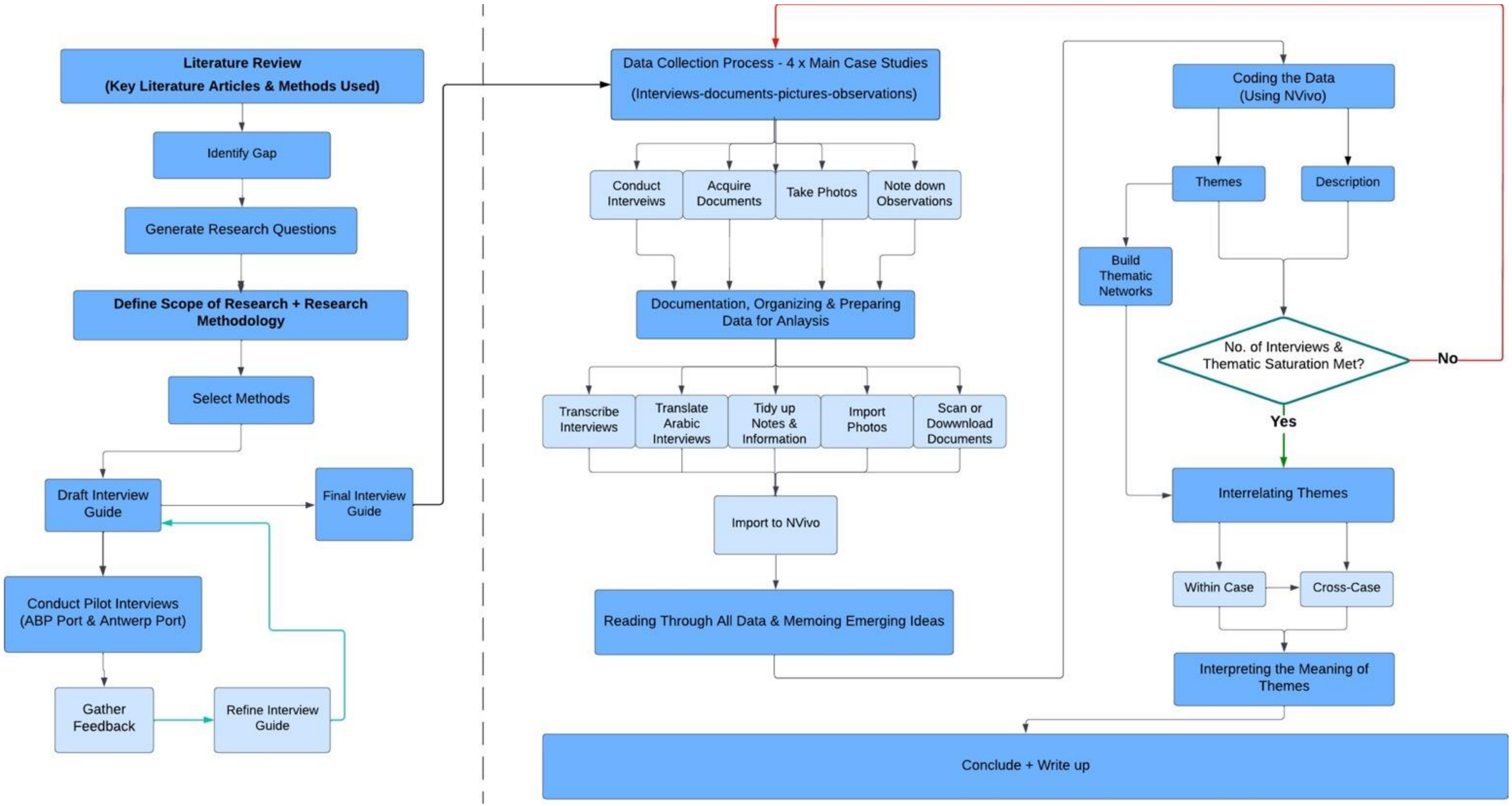


Figure 3.8 Research Process (Adapted from: Creswell & Creswell, 2018:194)

In qualitative research, according to Ellram (1996), reliability is showcasing consistency, availability, and transparency of the decisions made throughout the research process so that another researcher can follow them clearly. Additionally, validity is the accurate representation of things and the accuracy of reflecting the actual phenomenon in qualitative research (Morse, 2015). Furthermore, validity and reliability are considered intertwined in qualitative research; whereby the attainment of validity, reliability is achieved (Morse, 2015; Guba, 1981). In the context of this research, it is considered as having high internal validity and reliability, but less so external generalizability due to the inductive, exploratory, and qualitative nature of this research (Rafi-Ul-Shan & Grant, 2022). While true generalisability is not possible in qualitative research due to the nature of the research, transferability is adopted as an alternative measure (Easterby-Smith et al., 2021). According to Bell et al. (2022), the use of quality measures designed for quantitative research in qualitative research is seen as stifling. Using replication as a measure of reliability in qualitative research is destructive to its inductive nature (Morse, 2015). The approach to transferability can be distinguished in the intended practical contributions, which are primarily context-specific, and the theoretical contributions that stem from the broader analytical generalizability discussed (Rafi-Ul-Shan & Grant, 2022). In the context of this research, Lincoln and Guba (1985) and Halldórsson and Aastrup (2003) guidelines on research quality measures in qualitative research were followed to ensure research trustworthiness. These are credibility, transferability, dependability, and confirmability. Table 3.11 provides a summary of the quality measures and corresponding actions undertaken to address them in this research.

Table 3.11 Measures Taken to Ensure Research Rigour (Creswell and Miller, 2000; Halldórsson & Aastrup, 2003; Lietz & Zayas, 2010; Easterby-Smith et al., 2021; Rafi-Ul-Shan & Grant, 2022)

Measure	Purpose	Action Taken
Credibility	The degree of truthfulness of the study's interpretation representing the meanings of participants	• 'Member Checking' - interview transcripts were sent to participants for reviewing and approving to ensure that they reflected what they said. • The researcher ensured not to ask leading questions or questions that revealed the researcher point of view. • Methodological triangulation - using multiple sources and techniques to collect data such as semi-structured interviews, documents, pictures, and observations (wherever possible). This helped in increasing the research trustworthiness and reduce researcher and participant bias.
Transferability	Specifying the context in which research findings can be transferred	• Multiple case study research process. • A thick and rich description of the context for all GLH cases. • Theoretical sampling of four GLHs.
Dependability	Data collection and interpretation transparency and traceability	• Interview transcripts were kept in their original format, the translated transcripts, the proof-read and modified transcripts, and the initial NVivo analysis were saved. • All versions of the analysis phases were kept and numbered in multiple folders. Therefore, each stage and every record of the research is traceable and accessible.
Confirmability	Assurance of the integrity of the findings based on data	• Data were collected from informed professionals in the field who had the knowledge and experience to answer the research questions. • All versions of the analysis phases were kept and numbered in multiple folders to ensure conclusions and interpretations are traceable back to the source throughout the coding iteration.

3.6.1 Using a Computer Assisted Qualitative Data Analysis Software (NVivo)

This section discusses the extent of using NVivo in the data analysis process and the rationale behind using it. Firstly, manual coding is time consuming and laborious, therefore researchers prefer using a CAQDAS (Computer Assisted Qualitative Data Analysis Software) (Creswell & Creswell, 2018). NVivo software was used to organise, code, categorize, thematize, and analyse the data in this research. NVivo is a well-recognized CAQDAS that allows an improved data management, facilitates the analysis of a large mass of data using the features available for coding and developing data displays (Creswell & Creswell, 2018). Even though learning to use NVivo requires time and skill to use effectively, the researcher took the time to learn how to use it and trained using cases provided by the software and the pilot interviews before using it for the main case studies. The rationale behind using NVivo in this research is built on the advantages that this software provides (Creswell & Creswell, 2018):

- The capacity of locating all data relevant to one code or category across the data collected such as pictures, recordings, or text.
- It allows the researcher to run queries on interrelated codes to find links among codes and cases or carry out a comparison among different codes.
- Faster and more efficient coding process.
- It allows the researcher to quickly locate all passages and segments of texts coded under the same code.
- It is better for managing larger databases.

Therefore, the researcher used NVivo for most of the data condensation and data display of the analysis process except for developing the thematic networks. The networks were drawn manually by the researcher for each case study. Using NVivo enhanced the traceability, rigor, and transparency of the process while maintaining the actual context of the data. Screenshots of NVivo coding process are available in the 'Appendix 2'.

The next section discusses the pilot interviews conducted in this research before data collection commenced. The section sheds light on the lessons learned about the research design and interview procedures.

3.7 Pilot Interviews

A pilot case study can be used to refine the procedures of data collection as well as the content of the data collected (Yin, 2014). By conducting a pilot interview, the researcher can test and improve the validity of the interview guide and the reliability of the data collected (Saunders et al., 2019). Additionally, pilot interviews can be used for rehearsing the interview, ensuring everything is working efficiently, and refine data collection plans (Gillham, 2010; Yin, 2014). The selection of the pilot cases was based on access, convenience, and geographic proximity (Yin, 2014). Taking these factors into consideration and the benefits of conducting pilot studies, the researcher conducted two pilot interviews.

3.7.1 Pilot Interview Cases: Description

The first pilot interview was conducted with ABP Ports in the UK. The port is privately owned. It acts as a trade gateway to the area with multimodal connections (ABP, 2022). Additionally, the port has a focus on sustainability because of the Humber offshore wind cluster and the industries surrounding the port because of it (ABP, 2022). It was selected as one of the pilot cases because of the ports' characteristics, as well as its geographic proximity to the researcher and the university, and the convenience to access participants. Two managers responsible for the energy and the environment in the port were interviewed together. Furthermore, the second pilot interview was conducted with a participant from one of the main case studies - Antwerp GLH case study. The participant is a commercial representative of the port authority. The selection of this participant was based on the opportunity to establish a connection with the participant through the university.

The main purpose of conducting the pilot interviews was to ensure the questions are clear to the participants and can provide the answers for which they were designed (Saunders et al., 2019). Furthermore, the pilot interviews helped the researcher calculate the time taken to complete an interview based on the number and type of questions asked. Practising through the pilot interviews helped the researcher improve her interview skills, confidence in asking the questions, and getting ready for the field research. Several researchers emphasize the importance of conducting a pilot study to try out the questions to make sure that they are working as intended (Oppenheim, 1992; Saunders et al., 2019; Bell et al., 2022). Therefore, a list of questions and probes were developed prior to the first pilot interview. The researcher worked on the feedback received from the first pilot interview before conducting the second pilot study.

Conducting pilot interviews was extremely useful. The feedback that the researcher received from pilot interview participants helped in re-arranging, elaborating, or rewording questions as well as eliminating duplicates. This helped in making the interview questions clearer and more concise. Additionally, feedback suggested starting with general and easier questions for participants to answer and then proceed to more complex questions, which improved the flow and structure of the interview guide. Furthermore, pilot interviews also highlighted that there are questions that can be answered by anyone and others that were industry specific. Therefore, the researcher elaborated in the interview guide which questions are industry specific. This aided the overall interview experience and helped directing the questions to the appropriate participants, given that there were several types of stakeholders in this research. Furthermore, following the modification and amendments of the English version of the interview guide, the researcher translated the guide to Arabic for Arabic speaking participants in the SCZone case. Even though several of the participants spoke fluent English and conducted the interviews in English, it was important to properly translate and check the accuracy of the Arabic version of the interview guide for the participants who partook the interviews in Arabic. This helped in providing a relaxed atmosphere and made the participants more confident when answering the questions.

Additionally, the pilot interviews were used to practise coding and analyse the data on NVivo, which proved very useful. It helped in evaluating if the interview questions are designed to answer the research questions, as well as gauging the level of detail the participants provided in their answers for each question. This resulted in adding more probes and prompts to the interview guide to ensure that the questions are answers at a suitable level of depth and richness of information. Overall, the pilot interviews improved the quality of the interview guide, the process of conducting the interview, and the analysis approach using NVivo.

3.8 Research Methodology Summary

This chapter discussed the philosophical foundation and the methodological approach of this research. Additionally, this chapter discussed the research design adopted to collect data to answer the research questions. The justification of using multiple case studies and the appropriate methods was argued in light of other alternatives. Furthermore, it discussed the importance of quality and rigour in research and the steps considered to ensure qualitative research quality measures are applied. The analysis approach is also explained in addition to the extent of using NVivo in the analysis stages. Finally, pilot interviews were conducted to test and set the stage for the empirical part of the research. This is discussed in the next chapter presenting the within-case analysis of the four case studies.

Chapter 4 Within-Case Analysis

4.1 Introduction

This chapter will present the key results and in-depth analysis of findings for each case. As noted in Figure 3.7 in the previous chapter, the data analysis followed Creswell and Poth's (2016) framework. Therefore, this chapter will present the extracted themes and provide the analysis of findings relevant to the research questions for each individual case. A recognised benefit of within-case analysis is that it facilitates coping with the large volume of data associated with qualitative research (Eisenhardt, 1989). Additionally, it helps familiarise the researcher with each case as a stand-alone unit to identify patterns and understand each case within its context before generalising themes and identifying patterns across cases.

The chapter is going to discuss each organising theme and its encompassing basic themes for each case study, while supporting the themes with excerpts from the data. The thematic framework shown in Figure 4.1 presents 3 global themes and 13 organising themes extracted by the researcher from the data in relation to the 4 research questions.

Table 4.1 provides a brief description of each global and organising theme to create a basis for the presentation of the results and analysis. These themes are the result of data analysis and are not predetermined. They are provided in the beginning of this chapter to guide the presentation of findings. Furthermore, the relevant basic themes (codes) are presented and explained below in their respective organising themes subsections. The respondents in each case discussed the themes from their own experience and understanding as primary stakeholders of a GLH.

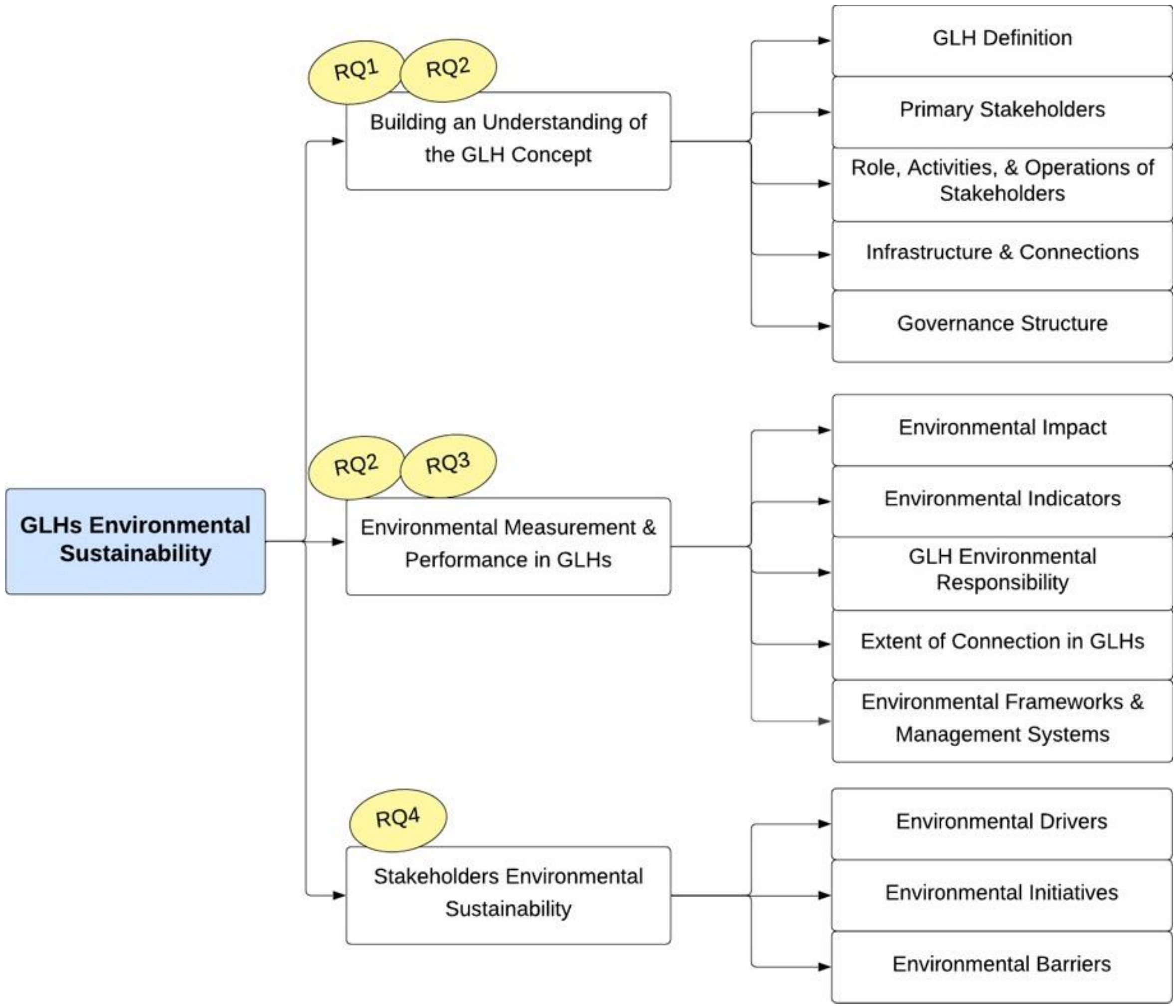


Figure 4.1 Thematic Framework

Table 4.1 Description of Global and Organising Themes

Building an Understanding of the GLH Concept	**Global**	This theme encompasses all organising themes that helped in understanding the concept of GLHs.
GLH Definition	Organising	This theme defines GLHs from the participants' perspective.
Primary Stakeholders	Organising	This theme highlights who are considered the primary stakeholders in a GLH.
Role & Activities of Stakeholders	Organising	This theme explains the role, services, activities, or operations of each of the primary stakeholders in a GLH.
Infrastructure & Connections	Organising	This theme describes the physical infrastructure and connections of a GLH that already exist, are being developed, or under consideration for further development to maintain or progress the GLH status.
Governance Structure	Organising	This theme explains the governance structure in GLHs, focusing on responsibilities and relationship dynamics between primary stakeholders.
Environmental Measurement & Performance in GLHs	**Global**	This theme encompasses all organising themes that depict environmental measurement and performance in GLHs.
Environmental Impact	Organising	This theme describes the impact of GLH operations on the environment.
Environmental Indicators	Organising	This theme outlines the environmental indicators used by GLH stakeholders to measure their environmental impact.
GLHs Environmental Responsibility	Organising	This theme explains who is/should be responsible for the environmental performance and sustainability of GLHs.
Extent of Connection in GLHs	Organising	This theme describes the stakeholders' extent of connection regarding the environmental performance and reporting in a GLH.
Environmental Frameworks & Management Systems	Organising	This theme lists the environmental frameworks and management systems used by stakeholders in a GLH.
Stakeholders Environmental Sustainability	**Global**	This theme encompasses all organising themes that explain the drivers and barriers of GLH stakeholders' environmental sustainability.
Environmental Drivers	Organising	This theme describes the stakeholders' environmental sustainability drivers.
Environmental Initiatives	Organising	This theme highlights the environmental initiatives introduced by GLH's stakeholders.
Environmental Barriers	Organising	This theme describes the stakeholders' barriers to environmental sustainability.

4.2 Case Study A: Rotterdam GLH

This section will present and describe the themes that emerged from the data collected in the Rotterdam GLH case study, and provide supporting excerpts from the participants to illustrate these themes. Participants codes and abbreviations used in the discussion and data display of this case study are presented in Table 4.2.

Table 4.2 Rotterdam Case Stakeholders Abbreviations & Participants Codes

Abbreviation	Description	Participants Codes
PA	Port Authority	C1L1P1
TO & LSP	Terminal Operator and Logistics Service Provider	C1L1P2 & C1L1P3
Log.	Multinational Logistics Company	C1L2P1
FFW	Freight Forwarding Company	C1L2P2
Ship.	Shipping Line	CEL2P3
LC I	Local Community	C1L3P1
LC II	Local Community	C1L3P2
Env. Ag.	Environment Agency	C1L3P3

4.2.1 Theme 1: Building an Understanding of the GLH Concept

This global theme has 5 organising themes that contribute to the understanding of the concept of GLH in the case of Rotterdam GLH.

4.2.1.1 GLH Definition

Participants in this case defined a GLH as a location that serves as a hub for logistics, freight, and maritime services, with the infrastructure and connectivity to handle and store all types of cargo for transhipment, import, and export in a specific region. The majority of participants in this case most commonly referred to 'multimodal transport' and 'logistics and marine services' when referring to the term as shown in Table 4.3. This highlights the importance of these areas in the functioning of a GLH in this case. Figure 4.2 shows the frequency of responses coded under each theme. It suggests that 'logistics and marine services', 'good accessibility and global connection', 'multimodal transport', 'major maritime port', and 'industrial cluster' are among the most crucial aspects of a GLH. These themes have the highest frequency of responses, emphasizing their importance in the participants' perception.

Participants emphasized that a GLH is designed to facilitate multimodal connections, enabling the movement of goods by various modes of transportation (Excerpts A1.1-1). Additionally, participants indicated that the logistics and marine services provided at this GLH encompass a wide range of diverse cargo handling, transhipment, and warehousing capacity to handle and store a significant volume of cargo (Excerpts A1.1-2, A1.1-3, A1.1-4). This is also supported by the presence of numerous logistics and freight companies in the area surrounding the port (Appendix 3).

Furthermore, strategic location, global connectivity, and good accessibility were discussed by some participants. Rotterdam is described as a GLH due to its geographical location, which makes it a gateway to the European market and allows for good accessibility. It is considered an important location for the coordination and distribution of goods on national and international levels. Other factors that can contribute to a location's suitability as a GLH include infrastructure, such as major maritime ports, airports, and road and rail networks, and the presence of a large consumer market (Excerpts A1.1-4, A1.1-5, A1.1-6, A1.1-7).

In addition to these features, Rotterdam is home to a diverse range of industries, including electricity companies and oil refineries. The presence of these industries further contributes to the GLH's role. However, the port authority distinguishes between the shipping operations at the port and the industrial cluster, highlighting the multifaceted nature of the GLH's role as both a hub for shipping traffic and a concentration of interconnected businesses and industries (Excerpt A1.1-8). It is essential that there is synergy between all logistics, maritime, and industrial activities in Rotterdam in order to fully capitalize on its potential as a global logistics hub (Excerpt A1.1-9). Table 4.4 presents excerpts from the data.

Table 4.3 Rotterdam Case NVivo Matrix - GLH Definition Codes Frequency (Source: NVivo 12)

GLH Definition Keywords	PA	TO & LSP	Log.	FFW	Ship.	Total
Good Accessibility & Global Connection	3			1	2	6
Economic engine & trade link				1		1
Infrastructure to accommodate & deliver	2				1	3
Logistics & Marine Services	5	1		1	1	8
All types of cargo	1					1
Import, export & transhipment	2	1		1		4
Safe transport		1		1		2
Storage capacity		1	1	1		3
Major Maritime Port	4				1	5
Multimodal Transport: Road, Rail, River, Air, Ocean, Short-sea shipping, & Pipelines	3	1	1		1	6
Port Cluster	1					1
Smart Hub	1		1			2
Strategic geographical location	2				1	3
Synergy between maritime, logistics & industrial activities	2					2
Industrial cluster	4	1				5

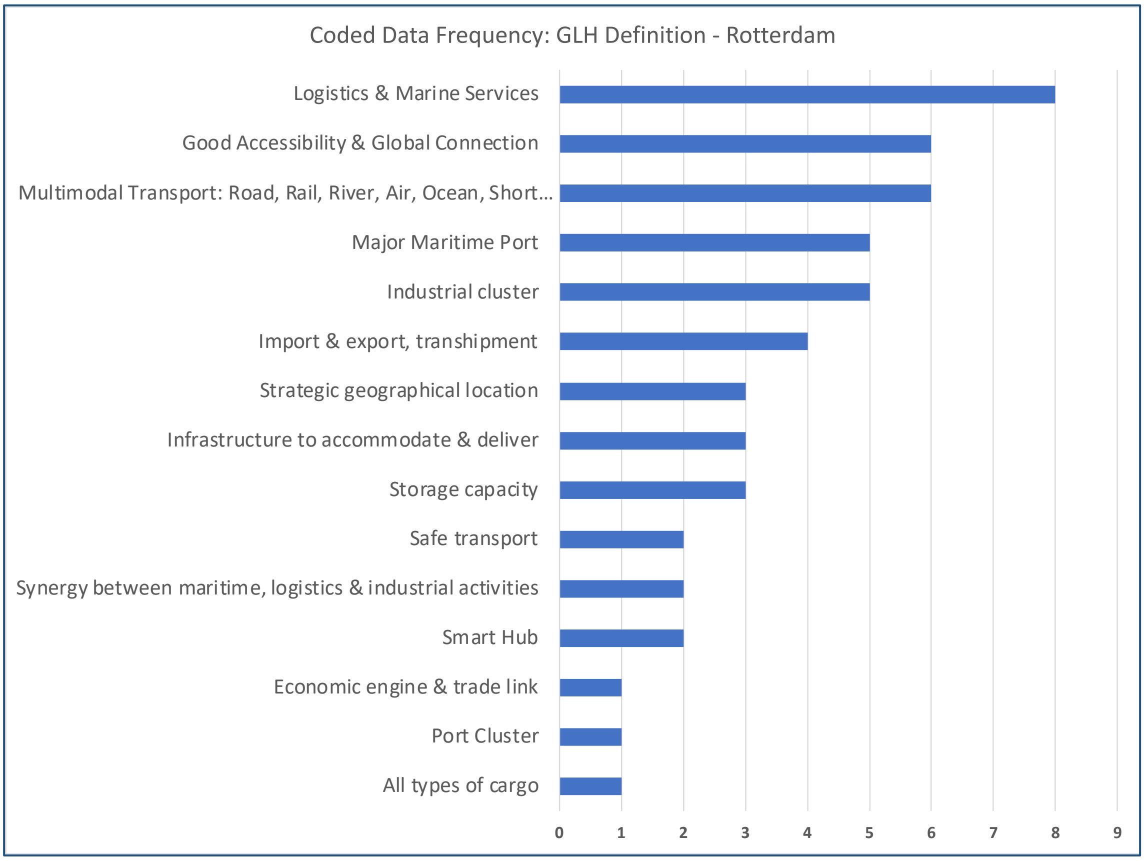


Figure 4.2 Coded Data Frequency: GLH Definition – Rotterdam (Source: NVivo 12)

Table 4.4 Rotterdam Excerpts Supporting: GLH Definition Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
A1.1-1	PA	*"The port brings together shipping, inland shipping, rail, road and pipeline modalities." (Port of Rotterdam, 2022a)*
A1.1-2	PA	*"...adequate space for development, natural hinterland connections and an increasing focus on social infrastructure. With a maximum water depth of 24 metres, it is the only one of the four largest ports in the Hamburg-Le Havre range with unlimited access for the vessels with the deepest draughts." (C1L1P1)*
A1.1-3	TO & LSP	*"Our main activity that we contribute to the chain is transhipment from ocean deep sea to barge inland waterway connections, and temporary storage..." (C1L1P2)*
A1.1-4	PA	*"Well, we're responsible for the public infrastructure. So, we build it, we maintain it, for instance dredging, very important for shipping traffic... We also take care of safe shipping traffic." (C1L1P1)*
A1.1-5	Ship.	*"Mainly it's a strategically geographic location that can serve specific markets" and the port authority defines it as" Our geographical location makes Rotterdam the gateway to the European market" (CEL2P3)*
A1.1-6	PA	*"Good accessibility is crucial for the port of Rotterdam" (C1L1P1)*
A1.1-7	FFW	*"...coordination and distribution of goods for national and international transit on a commercial basis by various operators" (C1L2P1)*
A1.1-8	PA	*"We have an industrial cluster, and we have global hub, and the global hub is about shipping traffic, the industrial cluster is about our industry for instance: the electricity companies, the oil refineries and many other kinds of Industries." (C1L1P1)*
A1.1-9	PA	*"When new activities are established the synergy with existing activities is often relevant. The broadening the port economy strengthens the economic power of the total." (C1L1P1)*

4.2.1.2 GLH Primary Stakeholders

Participants in this case most commonly referred to ‘cargo owners and shippers’, ‘government and local councils’, and ‘logistics and freight forwarder companies’ as primary stakeholders of this GLH as presented in Table 4.5. Additionally, industrial cluster companies and shipping lines were identified by the port authority as primary stakeholders, as they are integral partners in the port's vision (Excerpts A1.2-1, A1.2-3). It was also noted by the port authority that the local community and other ports in the country are considered primary stakeholders to the GLH (Excerpts A1.2-4, A1.2-7). Furthermore, rail and road transport and logistic companies were also identified by participants in this case (Excerpts A1.2-2, A1.2-5). Regulatory bodies, government, local authorities, and environmental authorities were all identified by all participants as primary stakeholders (Excerpt A1.2-6). Table 4.6 presents excerpts from the data.

Additionally, Figure 4.3 shows the frequency of responses coded under each theme. It suggests that 'cargo owners or shippers', 'government and local councils', 'logistics companies and freight forwarders', 'associations and interest groups', and 'shipping lines' are among the most frequently mentioned primary stakeholders of a GLH. These themes have the highest frequency of responses, emphasizing their importance in the participants' perception.

Table 4.5 Rotterdam Case NVivo Matrix - GLH Primary Stakeholders Codes Frequency (Source: NVivo 12)

GLH Primary Stakeholders	**PA**	**TO & LSP**	**Log.**	**FFW**	**Ship.**	**Total**
Airports					1	1
Associations & interest groups	4				1	5
Cargo owners or shippers	3	2	1	4	2	12
Employees	1				1	2
Government & local councils	5	2	1	1	2	11
Industrial cluster companies	2					2
Inland vessel sector	3					3
Local community	2	1		1		4
Logistics Companies & Freight forwarders	2	1	1	1	1	6
Investors					1	1
Port Authorities or owners-operators	2		1			3
Railway operators					1	1
Shipping lines	3				1	4
Terminal operators		1			1	2
Trucking companies	1		1		1	3

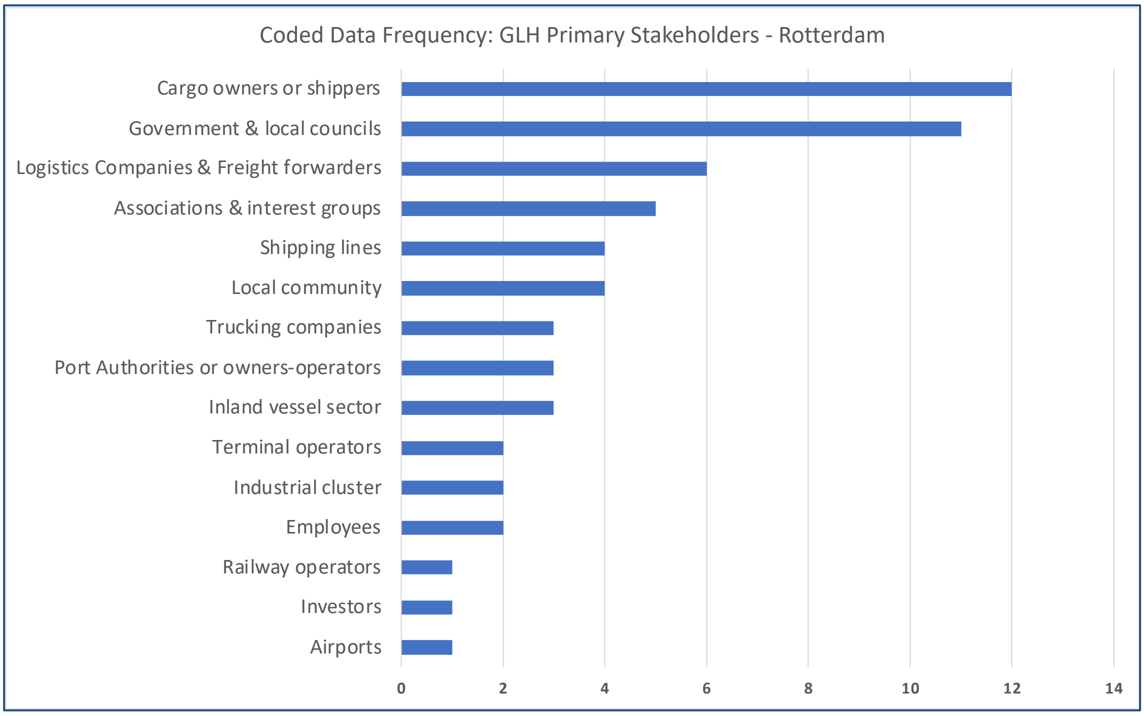


Figure 4.3 Coded Data Frequency: GLH Primary Stakeholders – Rotterdam (Source: NVivo 12)

Table 4.6 Rotterdam Excerpts Supporting: GLH Primary Stakeholders Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
A1.2-1	PA	*"[Industrial clusters and shipping lines] are also the partners in our port vision, and I guess they are the most important stakeholders" (C1L1P1)*
A1.2-2	PA	*"So, there are groups of cargo owners and there are groups of road trucks, and also groups of logistic companies. So that they are not mentioned separately. But they are in groups of customers and unions who work together" (C1L1P1)*
A1.2-3	PA	*"So also, oil refinery company or refineries... it's several kinds of Industries" (C1L1P1)*
A1.2-4	PA	*"Other ports in the Netherlands" (C1L1P1)*
A1.2-5	Ship.	*"You have the rail operators, the rail set-house" (CEL2P3)*
A1.2-6	Log.	*"It is always the regulatory country or the town management, which is part of the main stakeholders" (C1L2P1)*
A1.2-7	PA	*"But for instance, the residents in the environment are also stakeholders" (C1L1P1)*

4.2.1.3 Role, Activities, and Operations of GLH Primary Stakeholders

The role, activities, and operations of the stakeholders were identified by participants depending on the nature of the stakeholder's role or operations within the GLH, as listed in Table 4.7. The port authority role and operations are described by the participant as involving both public and private roles. The public roles involve investing in and building infrastructure, providing marine services such as monitoring and inspecting ships, dredging, and maintaining safe shipping traffic, and serving as the regulatory authority with the ability to impose fines on ships that do not comply with legislation. The private role involves managing property, renting port facilities, and acting as a landlord, with the goal of generating revenue that is reinvested in the port (Excerpts A1.3-1, A1.3-2).

On the other hand, the terminal operator and logistics service provider's services and activities overlap with those of some logistics and freight forwarding companies, as shown in Table 4.7. This overlap is evident among multiple stakeholders in this case such as the shipping line, logistics, freight forwarding, terminal operator companies. The terminal operator's primary operations include transhipment, cargo handling and storage, and the operation of their own warehouses. Additionally, the terminal operator offers logistics services such as packaging, repackaging, stuffing and stripping of containers, as well as customs clearance and compliance with legal regulations (Excerpts A1.3-3). Additionally, the shipping and ocean transport company is responsible mainly for transporting big volumes of cargo via ocean transport. This multinational shipping company's core activity is ocean-related services globally for massive amounts of cargo. However, it also provides a wide range of logistics services, and it is involved in other industries (Excerpt A1.3-4). This shows an overlap of operations between the types of stakeholders when companies are large enough to diversify their activities.

Furthermore, the government environmental agency is responsible for protecting the environment through the collection and analysis of data, monitoring for violations, reporting any infringements, and penalizing the responsible parties. This includes ensuring that all environmental requirements are being met (Excerpt A1.3-5). Additionally, local community members' role is working for the companies within the GLH, gaining benefits from the economic development of the region and improved employment, and receiving commodities as consumers. However, the local community also receives the adverse impacts of operating a GLH within their locality, including the adverse environmental impact (Excerpt A1.3-6). Table 4.8 presents excerpts from the data.

Table 4.7 Rotterdam Case Role, Activities, and Operations of GLH Primary Stakeholders

Stakeholder	Role, Activities & Operations	Stakeholder	Role, Activities & Operations
PA	-Public Role: Investing & Building Infrastructure & Port facilities Provide Marine Services and Maritime Traffic Regulatory Authority -Private Role: Landlord (managing & renting the port facilities)	Ship.	Ocean transport & related services Logistics Solutions Inland transport Warehousing Distribution Supply chain management Insurance
TO & LSP	Operate Terminal Transhipment Cargo Handling Warehousing Logistics Services Freight Forwarding Arranging Customs Clearance Ensuring Safety & Legal Regulations are met Packaging & repackaging Stuffing & stripping containers Weighing containers	Log. & FFW	Air freight Customs Distribution Door-to-Door Ocean Freight Outsourcing transportation and storage facilities Packing Rail freight Road freight Warehousing
Env. Ag.	Analysing data Checking for infringement Reporting and penalizing Protecting the environment	LC	Employees, Economic development of the region, stimulating work in the area, and receiving goods as consumers

Table 4.8 Rotterdam Excerpts Supporting: Role, Activities, and Operations of GLH Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
A1.3-1	PA	*"The public role is that we handle shipping traffic in a safe way. And in that role, we are a **public authority**. So, we can give fines to shipping traffic when they do not comply to legislations, when they are moving too fast, or when they do not comply to environmental legislations" (C1L1P1)*
A1.3-2	PA	*"The other people are working on the private part of our company and that's the part which makes money by investing in the port and by renting the port length to customers" (C1L1P1)*
A1.3-3	TO & LSP	*"We do all kinds of value-added activities as well. And those value-added activities are very diverse. From packaging, repackaging, stuffing and stripping of containers" C1L1P3*
A1.3-4	Ship.	*"Part of what we do is ocean, inland, warehousing, distribution, e-commerce, consolidation, like the end-to-end visibility aspect of the business. So, any kind of third-party logistics solutions as well. One of the products is supply chain management. So, just like we have ocean as a product we have customs as a product, we have warehousing, distribution, insurance etc" (CEL2P3)*
A1.3-5	Env. Ag.	*"To check if they are meeting all the requirements, and all the environmental requirements are in place" (C1L3P3)*
A1.3-6	LC	*"So, it is a bit of work provider for me because It's physical labour what they have to do. So, they will get complaints and then I see them I treat them because it's close, they live in Rotterdam mainly" (C1L3P1)*

4.2.1.4 GLH Physical Infrastructure and Connections

Despite Rotterdam having excellent infrastructure, the importance of continuous improvement of the infrastructure and connectivity of the GLH are emphasized in this case. The port authority's reports indicate that ongoing efforts are being made to improve and maintain the infrastructure within and around the port. For instance, in their annual report (Port of Rotterdam, 2020), the port authority mentions that they are working to improve accessibility to the port and the hinterland by developing public infrastructure and maintaining various forms of transportation infrastructure, including waterways, railways, roads, and pipelines, as well as customer-specific infrastructure.

The development of rail and road networks has also been a priority, with initiatives such as the installation of a railway bridge and the introduction of a container exchange route (CER) aimed at improving global accessibility and connection. The CER will utilize a dedicated road network and autonomous vehicles to efficiently transport containers within the port.

> *"The CER enables transportation of containers on the Maasvlakte. A dedicated road network connects all terminals, container depots, distribution centres and customs facilities on the Maasvlakte. Using this network, autonomous vehicles transport the containers to their destination, fast and efficiently, undisturbed by other traffic" (Port of Rotterdam, 2022b)*

> *"The 177-metre-long railway bridge over the Rozenburg lock was successfully installed on 4 April 2020. The railway bridge is an important part of the Theemsweg route, a new section of the harbour railway line measuring more than four kilometres" (Port of Rotterdam, 2020)*

On the other hand, the Ministry of Infrastructure and Water Management is responsible for the development of infrastructure beyond the port. The Dutch government provides funding for the maintenance of roads, waterways, and railroads, as well as for the improvement and development of the rail networks to European destinations through the 'European Year of Rail' project. Additionally, The Port of Rotterdam Authority is developing initiatives with partners to reduce CO2 emissions in logistics and industrial sectors and transition to carbon neutrality. This will be achieved by infrastructure investments such facilities for CO2 capture and storage and pipeline network for green hydrogen (Port of Rotterdam, 2022c).

4.2.1.5 GLH Governance Structure

The governance in this case is split between the port authority and the government. The participants in this case identified the port authority as the landlord. It is responsible for the public infrastructure to build it, maintain it, rent it and manage the concessions within the port. Therefore, the technical management of the infrastructure and the waterways is the port authority's responsibility. Additionally, the port authority has a regulatory role of being responsible for ensuring safe shipping traffic and ensuring legislation is followed. So, they act as an authority in issuing fines for those who do not comply with the legislation.

The Municipality of Rotterdam and the Dutch state are the owners of the port, and they are responsible for issuing the legislation for the port.

> *"The Dutch state has two roles they are shareholders, but they also make legislation" (C1L1P1)*

On the other hand, the port authority acts as an intermediary between the government and the companies and industries operating within the port, facilitating communication and collaboration on legislative matters. As mentioned by terminal operator respondent, the port authority can exert influence on the government to advocate for changes to legislation that align with the goals of the companies and industries in the port, such as environmental sustainability.

"They could influence the government for example to say: 'yes, we need the legislation because otherwise we cannot reach targets, we cannot make it environmentally friendlier' for example. They are actually the fine point because the government is busy with everything and every business and every industry". (C1L1P2)

However, as noted by the port authority respondent, the port authority does not have direct control over these companies and industries, particularly those with headquarters in other countries with separate legislative systems. Despite this, the port authority still attempts to influence these companies as they operate within the port and are considered customers.

"The companies in our area who are our customers, we do not have a direct influence on them. They make their own decisions and often their headquarters are in the United States or in Asia, but we try to influence them because they are in our port, and they are our customers" (C1L1P1)

4.2.2 Theme 2: Environmental Measurement and Performance in GLHs

This global theme has 5 organising themes that describe environmental measurement and performance related organizing themes in the case of Rotterdam GLH. The participants responses were complemented by reports, documents, and website data where possible to generate precise information for the environmental impact and the environmental indicators used by the primary stakeholders in this GLH.

4.2.2.1 GLH Stakeholders' Environmental Impact

The environmental impact of the GLH was explored through the primary stakeholders' impact. Table 4.9 presents the environmental impact of stakeholders in this GLH case and Figure 4.4 shows the frequency of responses coded under each theme. It suggests that 'consumption of natural resources', 'CO2 emissions', 'greenhouse gas emissions', 'waste' and 'nitrogen oxides' are among the most mentioned environmental impacts of a GLH. These themes have the highest frequency of responses, emphasizing their importance in the participants' perception.

Furthermore, in Table 4.10, the environmental impacts are listed in detail and linked to the contribution of each stakeholder. Greenhouse gas emissions was one of the common impact factors among all participants. This is due to the emphasis and awareness around climate change as it is a global problem and an impact that all stakeholders contribute to currently or in the case of the local community affected by it (Excerpt A2.1-1). This is also evident in the word frequency cloud in Figure 4.5, where 'air', 'pollution', 'CO2', and 'nitrogen' are shown to be the most frequently used words by participants when discussing the environmental impact.

Table 4.9 Rotterdam Case NVivo Matrix - GLH Environmental Impact Codes Frequency (Source: NVivo 12)

Environmental Impact	**PA**	**TO & LSP**	**Log.**	**FFW**	**Ship.**	**LC I**	**LC II**	**Total**
Biodiversity & ecosystem disturbance	1		2					3
Consumption of natural resources		6	6	1				13
Greenhouse Gas emissions		2	3			3	4	12
CO2 emissions	4	3	2	2	1			12
Nitrogen oxides	5		2	1				8
Particulate matter	3		3	1				7
Sulfur dioxide	2		2		1			5
Noise pollution	1	1	1					3
Odour pollution	2							2
Waste	1	3	5		1			10
Liquid waste	1				2	1	1	5

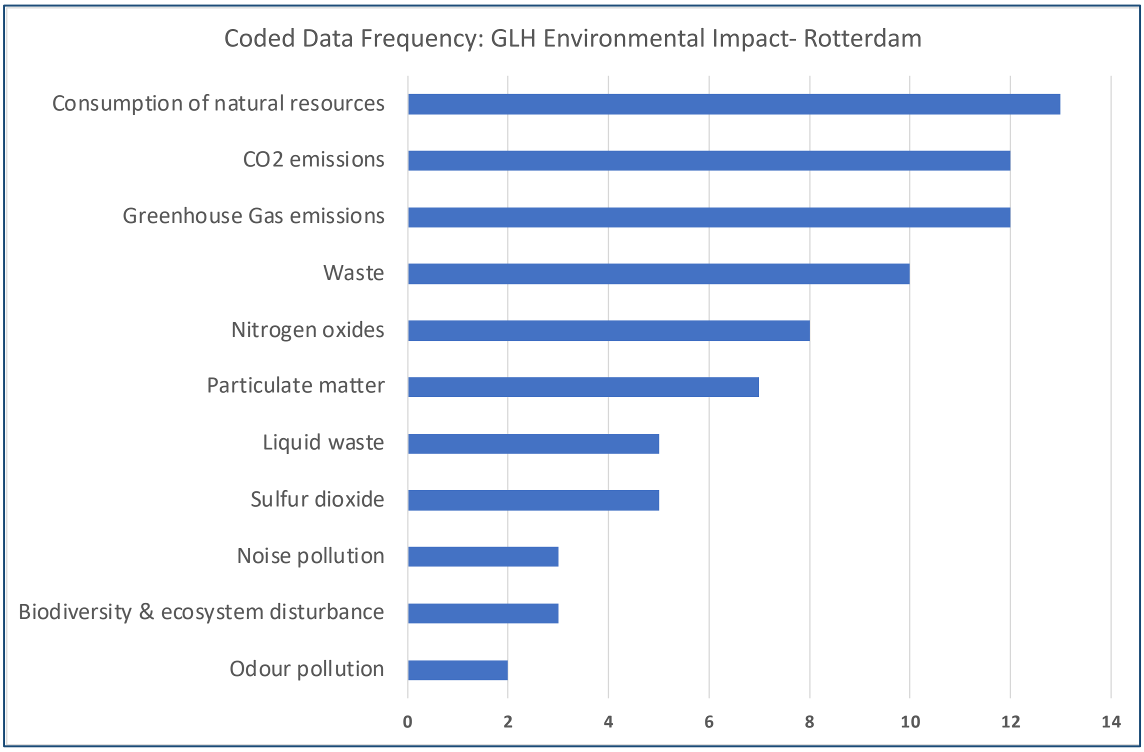


Figure 4.4 Coded Data Frequency: GLH Environmental Impact – Rotterdam (Source: NVivo 12)

Table 4.10 Rotterdam Case NVivo Matrix - GLH Environmental Impact - Description

Environmental Impact	**Description**	**PA**	**TO & LSP**	**Log.**	**FFW**	**Ship.**	**LC I**	**LC II**
Biodiversity and ecosystem disturbance	Biofuel usage and production's impact on biodiversity			√				
	Impact on biodiversity and nature	√						
	Ocean acidification & global warming			√				
Consumption of natural resources	Energy consumption - Electricity/Gas/Fuel		√	√	√			
	Water consumption			√				
Air Pollution	Reduced air quality						√	√
	Greenhouse Gas Emissions		√	√				
	-CO2	√	√	√	√	√		
	-NOx	√		√	√			
	-Particulate matter	√		√	√			
	- SOx	√		√		√		
Water Pollution	Reduced water quality						√	√
	Oil Spills					√		
	Water Ballast Mg.					√		
	Cooling water discharges	√						
Noise Pollution	Loud noise	√	√					

Table 4.10 (continued)

Odour Pollution	Strong & unpleasant smell	√						
Waste	Plastic		√	√				
	Wood/pallets		√	√				
	Food					√		
	Paper/cardboard		√	√				
	Metals		√					
	Contaminated dredging	√						

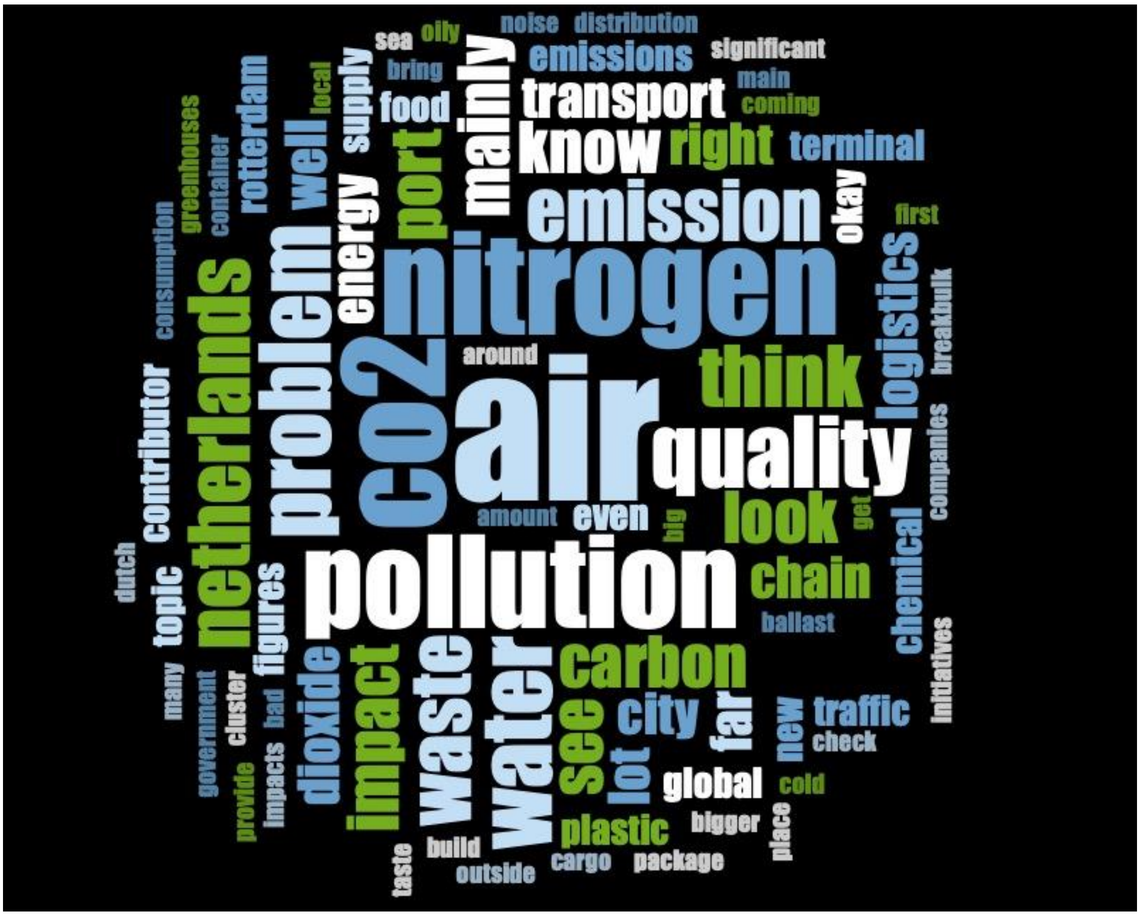


Figure 4.5 Rotterdam Case Environmental Impact NVivo Word Frequency (Source: NVivo 12)

Therefore, the environmental impact discussed by participants in this case is primarily focused on air pollution and climate change. On the other hand, some stakeholders also acknowledged that their impact may be perceived as relatively minimal compared to that of other stakeholders in the GLH. For instance, the terminal operator participant noted that they recognize the chemical cluster as a significant contributor to carbon emissions, while logistics is comparatively minor (Excerpt A2.1-2).

While greenhouse gas emissions are an important consideration, it is also important to address other environmental impacts with the same level of urgency to avoid negative consequences. For instance, the local community are affected by the environmental impact of the GLH, particularly in terms of reduced air and water quality (Excerpts A2.1-3, A2.1-4). Table 4.11 presents excerpts from the data.

Table 4.11 Rotterdam Excerpts Supporting: GLH Environmental Impact Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
A2.1-1	PA	*"I think the Paris agreement has led to awareness in the whole world and also in the Netherlands about the importance of trying to stop the growing emissions" (C1L1P1)*
A2.1-2	TO & LSP	*"They then obviously realize that the chemical cluster being active in the port is by far a bigger CO2 contributor than the logistics is. Logistics is, even when we ultimately have all our figures in place and we look at it, it is actually really small that we have, compared to other industries" (C1L1P2)*
A2.1-3	LC II	*"I really like to run and be outside and then sometimes I think, you know what I'm breathing right now. Is it even healthy for me to be running in the city?" (C1L3P2)*
A2.1-4	LC I	*"You really notice that the water is more polluted than in Utrecht. If you taste, It's like earthy oily water" (C1L3P1)*

4.2.2.2 GLH Stakeholders' Environmental Indicators

Participants provided the environmental indicators they used to measure their environmental impact (if there were any used). Table 4.12 lists the environmental impact, a detailed breakdown of the impact, and the environmental indicators used by participants to measure them. However, it can be seen in the table that for some environmental impact factors, the indicators used to measure them varied among the stakeholders such as greenhouse gases and fuel consumption. Additionally, Figure 4.6 shows the frequency of responses coded under each theme. It suggests that 'CO2 emissions in metric tonnes', 'electricity consumption in MWh', 'Sox in tonnes', 'NOx in tonnes', and 'waste in tons' are the most mentioned environmental indicators among the stakeholders of this GLH. These indicators have the highest frequency, emphasizing their widespread usage and recognition in the participants' perception.

Additionally, it is noted that certain indicators, including greenhouse gas concentrations, water acidity, emissions into water, and average percent of species biodiversity cannot be disaggregated to display the individual contributions or shares of each stakeholder. They are measured and fall under the port authority's responsibility in this case.

On the other hand, some indicators may not be suitable for the intended purpose such as the indicators used for noise and odour. However, they are still utilized as indicators. As noted by the port authority's participant, the number of complaints for noise pollution is indirect and may not accurately reflect improvements or deteriorations in noise pollution, but it is still an indicator that helps with tracking.

> *"Noise complaints is an indirect indicator so when complaints are declining, it doesn't say that it's really better and reverse. But It's an indicator" (C1L1P1)*

Additionally, stakeholders are using varying environmental management frameworks, which results in a fragmented and diverse set of indicators among stakeholders to measure the same environmental impact. For instance, some stakeholders reference the Global Reporting Initiative (GRI) standards in their measurements, while others employ the GHG Protocol and other measurement frameworks and systems. This diversity in measurement methods among stakeholders and within the same stakeholder type creates a variation in the indicators used and creates challenges in comparing and identifying best practices.

The terminal operator and logistics service provider participant:

> *"We calculate everything towards CO2 emissions and the CO2 footprint. That is basically because the GRI also takes this approach and it is a uniform standard, which makes it easy to compare different types of activities " (C1L1P2)*

It is evident that there are efforts towards measuring the environmental performance in this case. However, it is also clear that there is a discrepancy in the indicators used and the extent of participation of different types of stakeholders towards measuring their environmental performance.

Table 4.12 Rotterdam Case NVivo Matrix - GLH Environmental Indicators Codes Frequency (Source: NVivo 12)

Environmental Impact	Indicators	Measures	PA	TO & LSP	Log.	FFW	Ship.	Env. Ag.	Total
Air Emissions	CO2 Emission	metric tonnes	4	7	9		1		21
	CO2 Efficiency	Kg of Co2 per tonne.Km (tkm)			3				3
	CO2 Intensity	tons per fulltime employee (FTE)		1					1
		gram per square meter		1					1
	CO2 Reductions	metric tonnes	2						2
		% per square meter		3					3
	NOx concentrations	micrograms per cubic meter	3						3
	NOx emissions	Tonnes	3		1		1		5
	Particulate Matter concentrations	micrograms per cubic meter	3						3
	Particulate Matter emissions	Tonnes	3		1				4
	SOx concentrations	Micrograms per cubic meter	3						3
	SOx emissions	Tonnes	4		1		1		6
Biodiversity & Ecosystem	Biodiversity	average % of species compared with objective or lower limit	1						1
		number of incidents with impact on biodiversity		1				1	2
	Land Use	Number of hectares created compared with Regional Land Use Plan		2					2
Energy Consumption	Electricity consumption	Megawatt hour (MWh)	1	2	2	1	1		7
	Diesel, Gasoline, Compressed natural gas	Litres		1		1			2
	Energy (Efficiency)	Petajoule (PJ)					1		1
	Fuel consumption	Megawatt hour (MWh)			1				1
		Tonnes					1		1
		Kilometres per litre (Km/L)				1			1
	Consumption of Shore-based power	Megawatt per year	1						1

Table 4.12 (continued)

Environmental Impact	Indicators	Measures	PA	TO & LSP	Log.	FFW	Ship.	Env. Ag.	Total
Modal Split	Cargo transported by greener modes	Percent of modal split %	1	1					2
Sustainability capabilities	Ship visits with ESI discounts	number of ESI discounts	2						2
	Providing ships with LNG bunkering	number of LNG bunkering ships	2						2
	Shore-based power connections	Number of shore-based power connections	1						1
	Sustainable Energy Capacity	Megawatt electric (MWe)	2						2
	Share of renewable energy	Percent %	1		1				2
	Truck engine status (Euro Standard)	Percent %		1	1				2
		Number of vehicles			1				
	Vehicles with alternative drive system	Number of vehicles			1				1
	Employee vehicles with alternative drive system	Number of vehicles		1	1				2
Waste Pollution	Liquid Waste	Cubic meter	2						2
	Solid Waste (by type)	Metric tons		3			1		4
	Recycled waste	Tons		1					1
		Per item		1					1
Water Quality	Water pollution	number of oil/industrial incidents	3				1		4
	Water acidity	PH Levels	1					1	2
	Emissions into water	above or below normal percent %	1					1	2
Noise Pollution	Loud noise	Number of complaints	4						4
Odour Pollution	Strong & unpleasant smell	Number of odour related complaints	3						3
Water Consumption	Fresh Water Consumption	Cubic meters		1			1		2
		Million litres			1				1

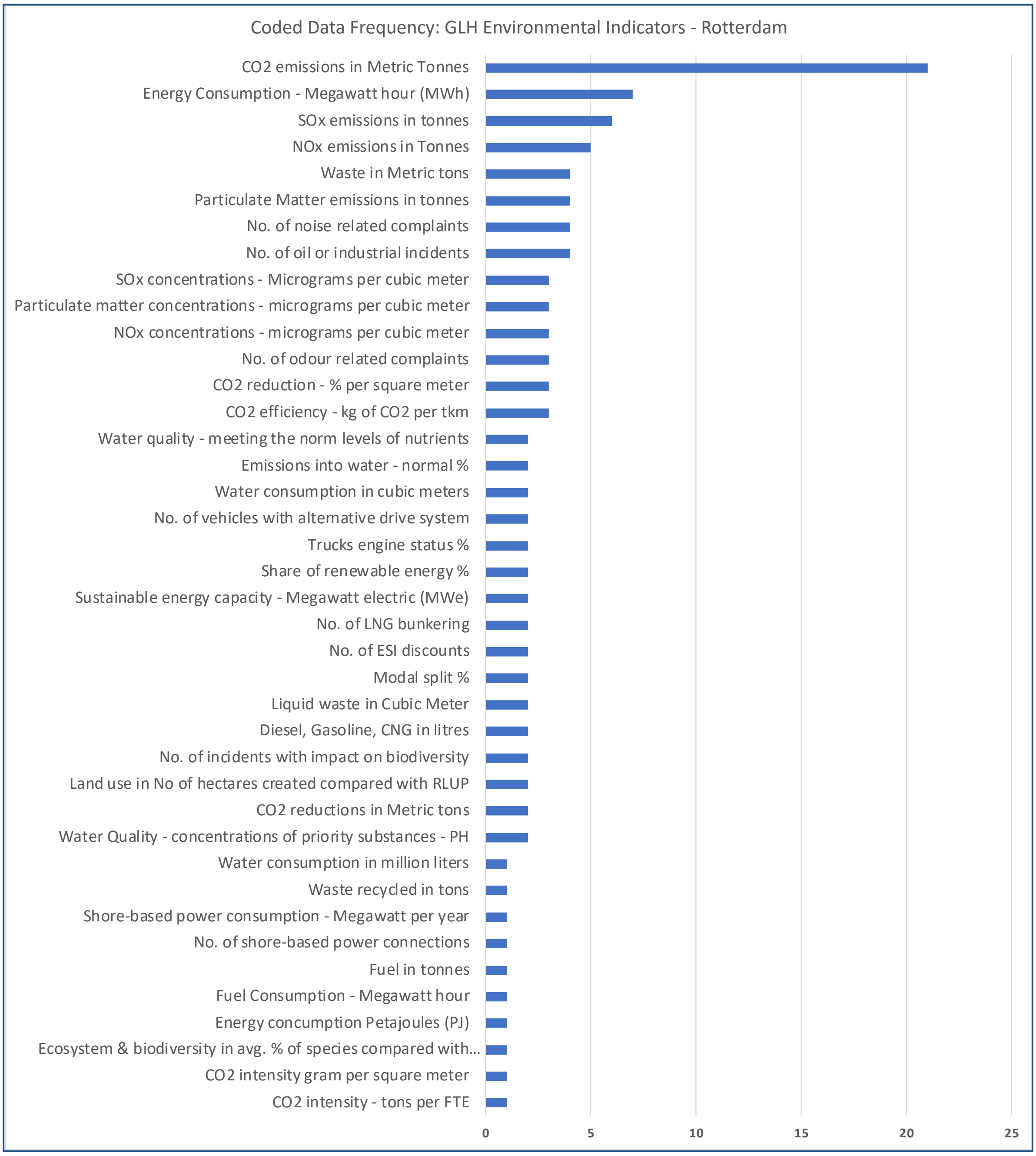


Figure 4.6 Coded Data Frequency: GLH Environmental Indicators – Rotterdam (Source: NVivo 12)

4.2.2.3 GLH Environmental Responsibility

Participants in this case suggested that the responsibility for ensuring the environmental sustainability of the GLH, collecting data from stakeholders, and measuring the holistic environmental impact of the GLH should lie either with the government, port authority, third party organisation, or voluntary stakeholder participation. Table 4.14 summarizes the reasons behind their choices.

Table 4.13 illustrates the responses according to each participant and Figure 4.7 shows the frequency of responses coded under each theme, suggesting that 'government' is the most frequently mentioned theme, followed by 'port authorities', 'third party', and ‘voluntary participation’. The frequency count of these responses emphasizes the importance attached to each theme in the participants' perception, with a higher frequency indicating a greater importance and common opinion among participants. Most participants believed that the government or local governing body should be responsible for measuring the holistic environmental performance of the GLH due to their regulatory power, neutral position, and economic capabilities (Excerpts A2.3-1, A2.3-2).

Additionally, several participants believed that the port authority should be responsible. As a government-owned entity with connections to both the public sector and the business community, it is well-suited to assume responsibility for the holistic environmental sustainability of the GLH. As the link between these two spheres, the port authority has the connections and resources necessary to effectively measure and address sustainability concerns across the GLH (Excerpts A2.3-3, A2.3-4). However, there may be a problem in this case that the port authority would be both a "poacher and gamekeeper" with respect to the polluter pays principle. The polluter pays principle states that those who cause pollution or damage to the environment should bear the costs of managing and mitigating it (Luppi et al., 2012). Therefore, the port authority may have a conflict of interest that could compromise the impartiality required for reporting the environmental performance of their customers.

Alternatively, the shipping company and the local community participants suggested the need for a third party, unbiased body to enforce regulations and measure environmental performance, with the ability to connect with stakeholders and maintain confidentiality and neutrality (Excerpts A2.3-5, A2.3-6). Another suggestion was to leave the responsibility for measuring environmental sustainability within the GLH to the individual stakeholders, without any overarching control. The port authority participant argued that *"everyone in the chain should take their responsibility"* and that they had observed instances in which some stakeholders wrongly believed that others should be responsible for measuring their sustainability. This approach would rely on voluntary participation and individual accountability from stakeholders, rather than a centralized authority (Excerpt A2.3-7). Table 4.15 presents excerpts from the data.

Table 4.13 Rotterdam Case NVivo Matrix - GLH Environmental Responsibility Codes Frequency (Source: NVivo 12)

GLH Environmental Responsibility	PA	TO & LSP	Log.	FFW	Ship.	LC	Env. Ag.	Total
3rd Party Responsibility for GLH Sus					1	2		3
Government Responsibility for GLH Sus			1	1	2	2	1	7
Port authority Responsibility for GLH Sus	4	3						7
Voluntary participation	1							1

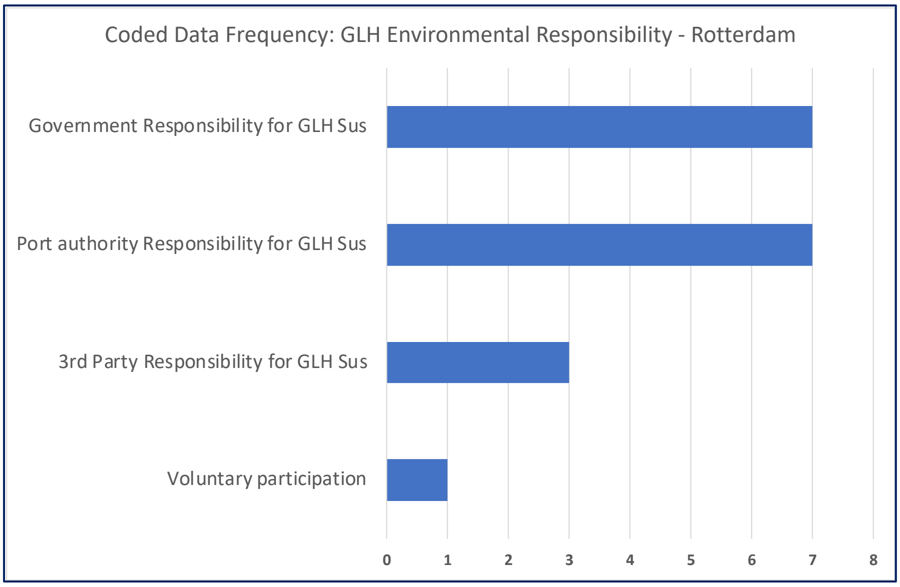


Figure 4.7 Coded Data Frequency: GLH Environmental Responsibility – Rotterdam (Source: NVivo 12)

Table 4.14 Rotterdam Case - GLH Environmental Responsibility Reasons

Responsibility	Reason
Government	Overarching regulatory power
Port Authority	Connection to stakeholders and capabilities of the port
Third Party	Unbiased position, confidentiality, and reliability
Voluntary participation	Everyone should be responsible for sustainability

Table 4.15 Rotterdam Excerpts Supporting: GLH Environmental Responsibility Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
A2.3-1	Log.	*"I would think that it should be the local regulation or the local government body for the town, I don't know how to say that. But that is more like the regulations I would say, not so much I think from an individual supplier" (C1L2P1)*
A2.3-2	Ship.	*"I would look at it that governments can take this because they do have the capabilities like financial and economic to enforce, and the regulatory" (CEL2P3)*
A2.3-3	TO & LSP	*"It takes a natural approach... I think the Port of Rotterdam should be. It is at the forefront to look at because they do have the size and the capabilities" (C1L1P3)*
A2.3-4	TO & LSP	*"They could influence the government... they are actually the fine point, because the government is busy with everything and every business and every industry" (C1L1P2)*
A2.3-5	Ship.	*"I think there should be a body or a party that is in between that could be able to set some regulations so that corporations would abide" (CEL2P3)*
A2.3-6	LC I	*"There would be another party involved that has no link to it at all. So, completely separate from all the stakeholders, and they should watch over all the measurements and like the consequences" (C1L3P1)*
A2.3-7	PA	*"I believe that in sustainability everyone in the chain should take his responsibility and what I see nowadays is that parts of the chain think that not another part of the chain should take his responsibility" (C1L1P1)*

4.2.2.4 Extent of connection among GLH Primary Stakeholders

All participants in this case maintained there is at least communication between the stakeholders of the GLH, as shown in Table 4.16. The extent of connection among the GLH primary stakeholders highlights their degree of communication, cooperation, collaboration, or integration. Additionally, Figure 4.8 shows the frequency of responses coded under each theme, suggesting that 'communication' is the most commonly mentioned theme. This indicates that it is the most prevalent form of connection among stakeholders in this GLH. This is followed by 'encouraging or influencing', 'very limited or non-existent', 'collaborating', 'reporting on behalf of', and 'mandating, forcing, and legislating'. The frequency count of these responses emphasizes the significance attached to each theme in the participants' perception, with a higher frequency indicating a greater importance and shared opinion among participants.

Stakeholders in this case have various levels of communication and engagement with each other. Some stakeholders engage in simple communication, while others engage and collaborate on environmental sustainability projects. An example of simple communication include the local community reporting to the local council any environmental issues. Another level of communication participants mentioned in this case was transparent and ethical dialogue with

GLH stakeholders through meetings and networking to share experiences, as described by the port authority and the terminal operator participants (Excerpt A2.4-1, A2.4-2).

The port authority also has a dedicated stakeholder management and engagement department for communicating with stakeholders. The relationship among stakeholders is seen as an interconnected ecosystem, with parties being dependent on each other (Excerpt A2.4-3). Additionally, according to the port authority participant, there are multiple dialogue platforms in Rotterdam GLH that bring together different stakeholder groups for various purposes including reporting environmental figures and monitoring agreements related to nature and emissions (Excerpt A2.4-4).

Furthermore, some participants indicated that their stakeholder relationships enable them to encourage more sustainable practices. For instance, the logistics company offers customers options with lower environmental impact, or they prioritize suppliers with strong environmental performance in their contracts in order to encourage sustainability. Another example is the shipping line has partnerships with manufacturers to transport containers on biofuel and with zero emissions (Excerpt A2.4-8). The port authority also stated that they attempt to encourage their stakeholders towards sustainability, though they do not have direct control over their decisions (Excerpt A2.4-5). On the other hand, the port authority can influence and shape regulations related to environmental sustainability (Excerpt A2.4-6).

Additionally, collaborating with primary stakeholders in this GLH is another form of connection that can exist between its stakeholders. This type of connection goes beyond mere communication and involves the integration of operations or companies in order to address environmental sustainability issues. For example, the port authority participant described a collaboration with primary stakeholders on the development of "*The port vision*", which outlines a strategic approach to sustainability that is applicable to all levels of the GLH. This collaboration is not limited to environmental concerns, but also includes economic and social considerations as part of a triple bottom line approach to sustainable growth (Excerpt A2.4-7).

Another form of connection is mandating and legislating through the government Environmental Agency, they have the authority to issue licenses of operation to stakeholders responsible for operations in the GLH, including requirements for environmental sustainability (Excerpt A2.4-9). On the other hand, While the port authority typically has a certain level of authority within their jurisdiction, it is important to note that this authority is limited to specific areas such as maintaining safe shipping traffic and issuing fines. In this case however, it appears that the port authority's powers do not extend to issuing fines related to environmental concerns (Excerpt A2.4-10).

Furthermore, the extent of connection among some stakeholders in the GLH is not complete, with some missing links or limited connections. For instance, the terminal operator participant stated that they do not know who their corporate social responsibility (CSR) counterparts are within other companies and ports. Additionally, local community respondents noted a lack of communication from the port, which suggests a lack of holistic approach when it comes to the GLH sustainability approach (Excerpts A2.4-11, A2.4-12).

Overall, there are connections established among this GLH stakeholders, and mostly stakeholders are communicating, encouraging, and influencing each other to improve environmental sustainability. However, this is not consistent throughout the GLH and not all on the same level. Some stakeholders have more influence, while others have limited communication and involvement with other stakeholders. However, it is evident that the preferred forms of connection in this GLH are communication and encouragement. Table 4.17 presents excerpts from the data.

Table 4.16 Rotterdam Case NVivo Matrix - Extent of Connection among GLH Primary Stakeholders Codes Frequency (Source: NVivo 12)

Extent of Connection	**PA**	**TO & LSP**	**Log.**	**FFW**	**Ship.**	**LC**	**Env. Ag.**	**Total**
Collaborating with stakeholders for a sus growth	4				1			5
Communicating with stakeholders reg. env sus	7	3	1	1	1	2	1	16
Encouraging or Influencing stakeholders towards a sustainable direction	7		2	1				10
Mandating, forcing and legislating sustainability							1	1
Reporting on behalf of the company & the companies (in) direct spheres			1	2				3
Very limited or Non-existent		3				3		6

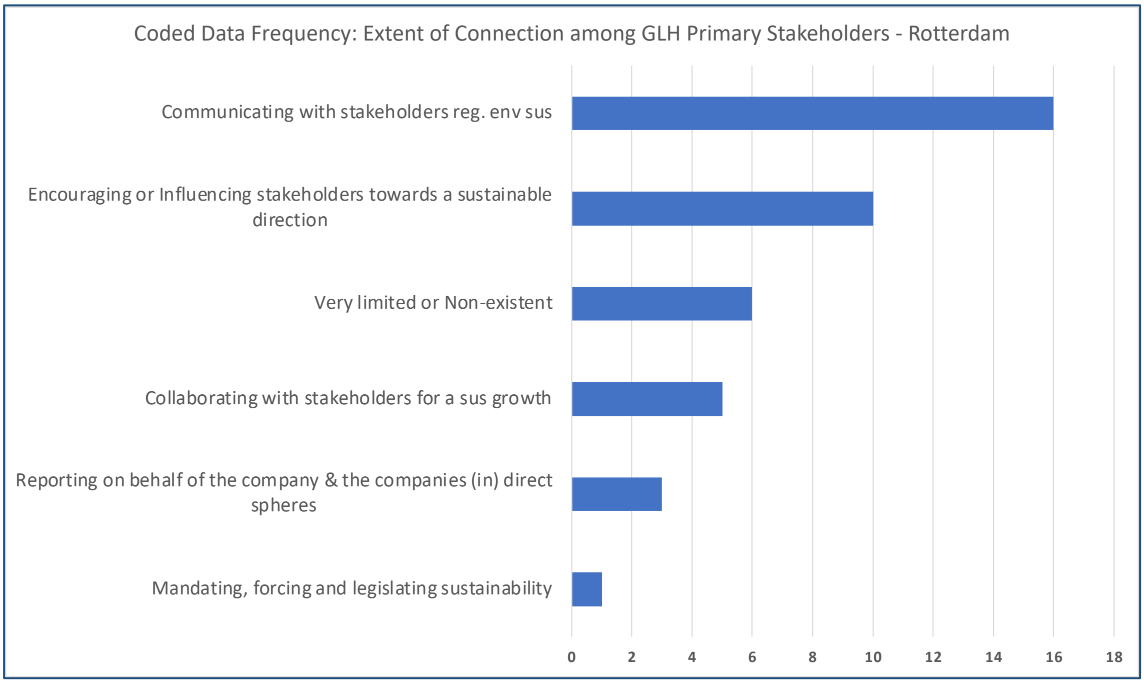


Figure 4.8 Coded Data Frequency: Extent of Connection among GLH Primary Stakeholders – Rotterdam (Source: NVivo 12)

Table 4.17 Rotterdam Excerpts Supporting: Extent of Connection among GLH Primary Stakeholders Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
A2.4-1	PA	*"I'm in a CSR network of Dutch companies. So many CSR managers come together and meet each other and share experiences... It's also out of the company. There are several networks in which stakeholders meet each other" (C1L1P1)*
A2.4-2	TO & LSP	*"We have quite some good connections with the Port of Rotterdam Authorities for, our own CSR report actually, we have some good interviews with C.H. who brought us into contact" (C1L1P2)*
A2.4-3	TO & LSP	*"There is very clearly an ecosystem where parties are dependent of each other" (C1L1P3)*
A2.4-4	PA	*"There are many platforms in which stakeholder groups organize themselves. Sometimes we have a leading role and sometimes we have a participating role" (C1L1P1)*
A2.4-5	PA	*"The companies in our area who are our customers, we do not have a direct influence on them. They make their own decisions... we cannot decide it for them. We can only stimulate it… But we try to influence them because they are in our port, and they are our customers" (C1L1P1)*
A2.4-6	PA	*"There will be a new sulphur cap for the sea shipping traffic and it's a decision of IMO, but we were one of the partners who claimed, and we shared our opinion about this topic" (C1L1P1)*
A2.4-7	PA	*"This document 'The port vision' is not only our vision, but it's a vision with our most important stakeholders... So, this is for example the strategic approach of sustainability in our company and that's what I said, these principles are useful for all the four levels I showed you" (C1L1P1)*

Table 4.17 (continued)

Excerpt No.	Participant	Excerpts from Interviews & Data
A2.4-8	Ship.	*"[name of global manufacturer] they have signed a contract with us, and they have agreed to pay around $400 more per container, and it's just a batch testing, only to have these containers transported on biofuel and with zero emissions" (CEL2P3)*
A2.4-9	Env. Ag.	*"When a company starts, they have to fill these plans and in them they have different points that say which kind of rules they have to meet... my job will be to go through these plans and analyse if they are meeting the points in those plans". (C1L3P3)*
A2.4-10	TO & LSP	*"Do you also request/demand from your customers, from the companies being active in the port, that they implement sustainability measures. Do they need to report to you their CO2 emissions? and basically the answer of the port was no, they don't do it yet" (C1L1P2)*
A2.4-11	TO & LSP	*"That already says enough that I don't know who my CSR counterparts are within the other companies and ports" (C1L1P3)*
A2.4-12	TO & LSP	*"There is no real integration when it comes to a sustainability approach for the port as a whole" (C1L1P3)*

4.2.2.5 GLH Stakeholders' Environmental Sustainability Frameworks and Management Systems

Table 4.18 lists the measurement frameworks, certificates, management systems, or platforms that any of the participants in this case are using for their environmental performance or sustainability. The ISO 14001 is the most commonly mentioned environmental management system among participant in this case. It is a widely applied framework, and it allows companies to implement their environmental policies and strategies through it. Additionally, there are 2 other frameworks that were common between a few of the participants such as the 17 Sustainable Development Goals (SDGs) and the GHG protocol.

On the other hand, it is evident from the table that there is a lack of consensus among stakeholders in regards to their approach to this issue, where this discrepancy may be influenced by the availability of several frameworks. As the logistics company participant explained:

> *"There are several frameworks in place to measure the efficiency and also the CO2 emissions thus far" (C1L2P1)*

It is important to consider the role that external factors play in shaping the focus and priorities of stakeholders in regards to environmental sustainability. Additionally, the level of environmental performance measurement and sustainability varies among stakeholders based on their capabilities and size. This discrepancy among stakeholders operating within the same industry and geographic location can make it challenging for companies to use benchmark frameworks or develop their own sustainability frameworks and reporting systems.

The terminal operator participant explained:

> *"We don't have the luxury of having a CSR officer or a sustainability manager in the company and that is again to do with the business" (C1L1P3)*

The shipping line participant shed light on their sustainability reporting based on the company's size:

> *"We have multiple areas that form a region and then the regions report to global in that sense. So, the setup is that we have global teams, and we have the local, area and regional teams" (CEL2P3)*

However, this still highlights the fragmentation in the approach to measuring environmental performance among the stakeholders of this GLH.

Table 4.18 Rotterdam Case NVivo Matrix - GLH Stakeholders' Environmental Frameworks and Management Systems Codes

Environmental Frameworks & Management Systems	**PA**	**TO & LSP**	**Log.**	**Ship.**	**Env. Ag.**
Sustainability Report - TBL			√	√	
17 SDGs	√			√	
Greenhouse Gas Protocol (GHG Protocol) (Scopes 1, 2 & 3)			√	√	
ISO9001 and ISO14001		√	√	√	√
CO2 performance Ladder and Envirometer					√
Carbon calculator			√		
Carbon Efficiency Index (CEX)			√		
GRI Sustainability Reporting Framework (Scopes 1 & 2)		√			
Foundation for Climate Friendly Procurement and Business (SKAO)		√			
OECD Guidelines for Multinational Enterprises (Benchmark)		√			
Environmental Impact Report (EIR)	√				
Portbase: Portbase manages the Port Community System (PCS) of the Dutch ports	√				

4.2.3 Theme 3: Environmental Sustainability of GLH Stakeholders

This global theme has 3 organising themes that discuss the drivers and barriers of GLH stakeholders' environmental sustainability in the case of Rotterdam GLH.

4.2.3.1 GLH Stakeholders' Environmental Sustainability Drivers

Table 4.19 lists the drivers according to the participants in this case and Figure 4.9 shows the frequency of responses coded under each theme for this GLH. The top five drivers are 'demand for sustainability', 'legislation', 'responsibility', 'being a leader in sustainability', and 'reputation/public image'. The frequency count of these responses emphasizes their importance and suggests a degree of prioritization within the participants' perception. However, it is crucial to note that the importance and ranking of these drivers vary among participants, as their individual perspectives and priorities differ. Further quantitative investigative research is also needed to validate the significance of each of these aspects and their ranking in terms of importance.

It is evident that the most common driver among stakeholders is the sense of 'responsibility' (Excerpts A3.1-1 and A3.1-2). Additionally, several participants also pointed to the increasing demand for sustainability as a motivator for investing in and offering sustainable solutions. The terminal operator respondent noted that customers often request alternative options and that being able to offer these options can provide a competitive advantage (Excerpt A3.1-3). Similarly, the shipping company respondent, CEL2P3, mentioned that customers often consider both cost and carbon footprint when making purchasing decisions (Excerpt A3.1-4).

Another common driver among participants is the increasing pressure from government and society to adopt more environmentally friendly practices. Governments around the world are enacting more stringent laws and regulations that require businesses to adopt sustainable practices and reduce their environmental impact (Excerpt A3.1-5, A3.1-6).

Finally, participants also suggest that they are recognizing the benefits of adopting sustainable practices, which are also driving their environmental sustainability, including cost savings, legislation, improved reputation, and increased competitiveness. As a result, an overarching driver is that sustainable solutions are considered a way to meet the demands of customers and stakeholders, while also improving the bottom line. Table 4.20 presents excerpts from the data.

Table 4.19 Rotterdam Case NVivo Matrix - GLH Stakeholders' Environmental Sustainability Drivers Codes Frequency (Source: NVivo 12)

Environmental Sustainability Drivers	PA	TO & LSP	Log.	FFW	Ship.	LC	Env Ag.	Total
Accountability for own operations	1							1
Being a leader in sustainability	3				3		1	7
Corporate Policy			1	1	2			4
Demand for Sustainability	3	4	2	1	4			14
Employees	1	1	3					5
Environmental sustainability is business sustainability	1		1					2
Gaining Competitive Advantage		1			1			2
Health and Wellbeing of humans and planet					1	1		2
Increased Awareness	3					2		5
Legislation	3	2	1		2			8
Long Term financial gains	1	1	1					3
Paris Climate Agreement	1		1		2		1	5
Pressures from Government and Society		1				1	1	3
Reputation/Public Image	3	1			1			5
Responsibility	1	1	1	1	2	1	1	8

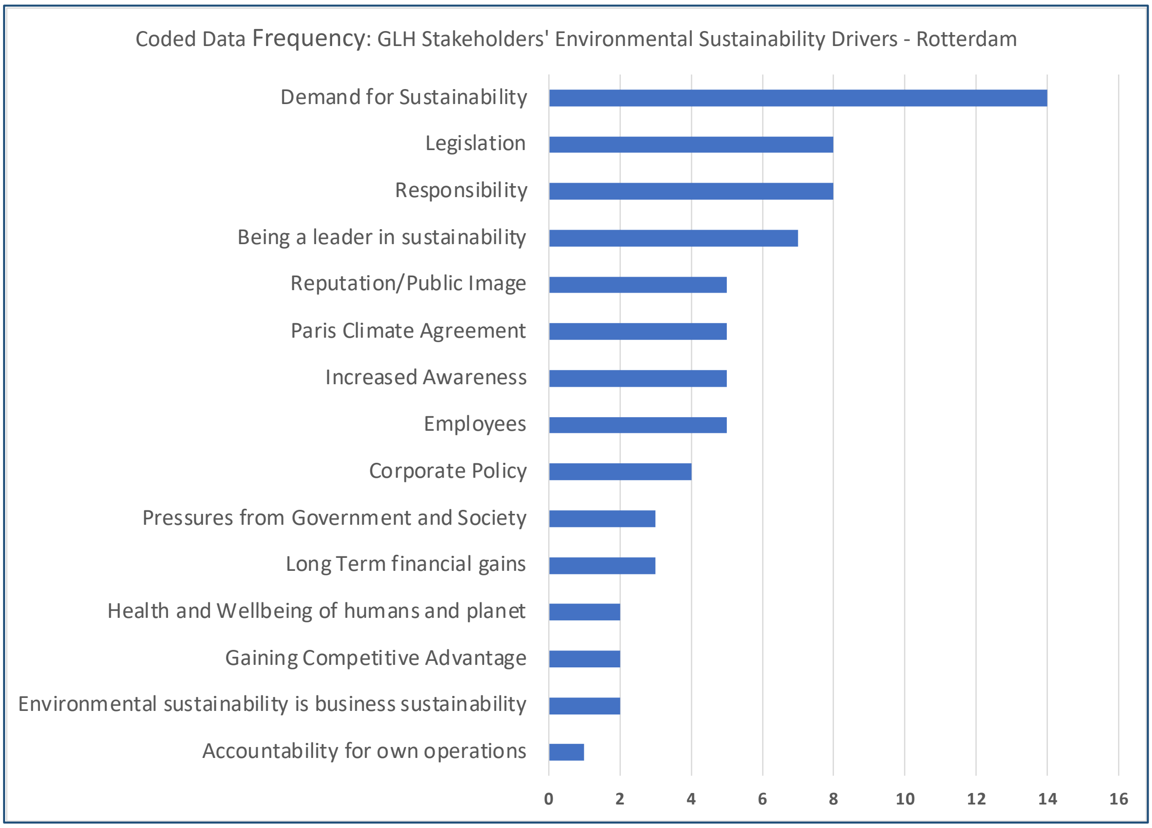


Figure 4.9 Coded Data Frequency: GLH Stakeholders' Environmental Sustainability Drivers – Rotterdam (Source: NVivo 12)

Table 4.20 Rotterdam Excerpts Supporting: GLH Stakeholders' Environmental Sustainability Drivers Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
A3.1-1	PA	*"We want to provide healthy and attractive living environment and we are dedicated to combating climate change" (C1L1P1)*
A3.1-2	FFW	*"Our vision is that this is essential for a better environment and world to live in" (C1L2P2)*
A3.1-3	TO & LSP	*"If you look at customers demanding alternative options, we do ask them and then it is always good to be able to offer those alternative options" (C1L1P2)*
A3.1-4	Ship.	*"When they go on tendering... they choose based on a combination of cost plus carbon footprint" (CEL2P3)*
A3.1-5	Ship.	*"… local and regional regulations that are set for example by the EU… they are imposing more rules and regulations around waste, emissions and environmental footprint…" (CEL2P3)*
A3.1-6	TO & LSP	*"It is probably the government institutions, like locally as well as nationally. For example, now before the 5th of December, we are pressured by the government institutions to report the kind of information or information about every business unit, like CO2 or electricity consumption. But mainly also what investments have you done in the past 5 years to be more environmentally friendly" (C1L1P2)*

4.2.3.2 GLH Stakeholders' Environmental Sustainability Initiatives

As can be seen from the list of initiatives in Table 4.21, the port authority and the multinational logistics company have a large number of initiatives compared to other stakeholders. This could be relevant to their size and capabilities, as well as the focus on tackling climate change by governments and businesses. There is a mix of initiatives to help on different environmental issues including greenhouse gas emissions, waste, and energy consumption. Participants in this case are not exclusively concentrating on one topic. However, there is a wide range of initiatives set to address greenhouse gas emissions and climate change. This is in line with the results of the word frequency cloud Figure 4.5 in the environmental impact theme, as it also highlighted an emphasis on greenhouse gas emissions and climate change in this case.

On the other hand, while some of these initiatives may be driven by a desire to align with societal expectations and values, it is important to note that they can also lead to operational efficiencies and cost savings such as Heat Alliance, energy efficient vehicles for employees, and green logistics network optimization.

Additionally, some participants in this case highlighted that the initiatives usually start from training. For example, the freight forwarding company participant explained:

> *"Our commitment to reduce CO2 emissions starts with training programmes to maintain and expand the environmental awareness among our teams. It continues with the implementation of renewable energy and the reduction of business trips, and waste disposal." (C1L2P2)*

Also, the logistics company participant mentioned:

> *"... there are also some more that we do for example this training programme this is a big investment for the company. And it is really getting people access" (C1L2P1)*

Table 4.21 Rotterdam Case - GLH Stakeholders' Environmental Sustainability Initiatives

Stakeholders	**Initiatives**
PA	Carbon Capture and storage studies and research
	Hydrogen cluster for alternative fuels
	ZES lease exchangeable battery containers (ZES-Packs) to inland shipping operators
	Shore-based power for seagoing vessels
	Encouraging an environmental modal split
	Green Gateway: developing and maintaining green land around the port
	LED for public lighting in the port
	ESI discounts
	E-noses
	Heat Alliance: residual heat repurposed
	Wind and solar power in the port
	Using alternative fuels for the ports' vessels and vehicles
	The World Ports Climate Action Program (WPCAP)
	Part of NEPTUNES Project (Noise Exploration Program To Understand Noise Emitted by Seagoing ships)
TO & LSP	Warehouse relocation with better energy efficiency
	Reduce speed in reach-stackers, terminal tractors & heavy forklift trucks
	LED lighting
	Controlled use of gas fired heaters
	Lease agreements with energy efficient vehicles for employee cars
	Increase the electric vehicle fleet
	Working with local community to recycle plastic and paper of their products

Table 4.20 (continued)

Stakeholders	Initiatives
FFW	Leveraging head-haul and backhaul capacity
	Environmental training programmes
Log.	Carbon calculator
	Green Logistics Network Optimization
	Electric, biofuels and LPG vehicles
	Green Training Programmes
	Planting trees
	Offsetting unavoidable emissions through climate protection projects
	Sustainable subcontractor management (carrier scorecards)
	Offering customers alternative modes of transport, reverse logistics, waste management, carbon reports and offsetting emissions
	Sustainable, reusable, and recyclable solutions for products and services offered
Ship.	Member of the Clean Cargo Initiative
	Ship Recycling
	UN Global Compact
	Collaboration with the Ocean Clean-up Project
Env. Ag.	Carbon Tax law
	Institutions and corporations have to report on their investments and efforts to being environmentally friendly

4.2.3.3 GLH Stakeholders' Environmental Sustainability Barriers

It is clear from Table 4.22 that the barriers are more than the drivers identified above. Through the responses collected in this case study, several barriers were identified, with several factors centring around the feasibility, reporting, and legislation (Excerpts A3.3-1, A3.3-2, A3.3-3). Figure 4.10 shows the frequency of responses coded under each theme for this GLH. The top five barriers in this case are ‘sustainability is not prioritized’, ‘the environmental impact is not yet integrated in the buying decision’, ‘losing competitive advantage’, ‘cost’, and ‘complicated process’. The frequency count of these responses emphasizes their importance and suggests a degree of prioritization within the participants' perception. However, it is crucial to note that the importance and ranking of these barriers vary among participants, as their individual perspectives and challenges differ. Further quantitative investigative research is also needed to validate the significance of each of these aspects and their ranking in terms of significance.

Additionally, financial factors were also discussed by participants in this case (Excerpt A3.3-3). These include the initial investment in new technologies, potential loss of profit, limited budget for sustainable investments, the cost of hiring personnel to manage and measure environmental sustainability, the higher price of sustainable options, and the potential for a loss of competitive advantage by setting higher prices to cover the cost of offering sustainable alternatives. Additionally, other factors that contribute to a business's success, such as convenience, service level, profit, and reliability, may be prioritized over sustainability.

Differences in the sustainability agenda between stakeholders can be a significant barrier to achieving sustainability goals. This is because different stakeholders may have conflicting priorities or motivations when it comes to sustainability. For example, a company may prioritize reducing its carbon emissions, while a customer may prioritize minimizing waste through reverse logistics services (Excepts A3.3-4, A3.3-5).

In contrast, by reviewing Table 4.19 and Table 4.22, it was interesting to find that there are both common and contrasting factors influencing the drivers and barriers to environmental sustainability. One common factor is the role of knowledge and awareness, with a lack of knowledge and awareness identified as a barrier, and an increased awareness identified as a driver. Additionally, legislation and regulations were identified as a driver, while the lack of such regulations was identified as a barrier. This could suggest that while there are efforts being made towards environmental sustainability, there may still be incomplete progress in this area. Table 4.23 presents excerpts from the data.

Table 4.22 Rotterdam Case NVivo Matrix - GLH Stakeholders' Environmental Sustainability Barriers Codes Frequency (Source: NVivo 12)

Environmental Sustainability Barriers	**PA**	**TO & LSP**	**Ship.**	**Log.**	**FFW**	**Env. Ag.**	**LC**	**Total**
Bureaucratic System		1						1
Complicated process (requires collective action & collaboration from several sectors)	3							3
Cost (ex. sustainable solutions are 'more' expensive; low budget for sustainability)	1	1	1				1	4
Different regulations in different regions (ex. Inconsistency of regulations; additional work)	1			1				2
Different sustainability agendas for different stakeholders			1		1			2
Green Washing							1	1
Lack of data to measure environmental performance		1						1
Lack of enforcing environmental sustainability regulations and legislations		1					1	2
Lack of feasibility or practicality of some sustainable technologies or solutions (ex, env. restrictions)		2						2
Lack of human resources		3						3
Lack of incentives		1						1
Lack of knowledge and awareness				1		1		2
Lack of transparency from global operations				2				2
Logistics industry environmental impact is seen as small compared to other sectors or services (chemical cluster)		1						1

Table 4.22 (continued)

Environmental Sustainability Barriers	**PA**	**TO & LSP**	**Ship.**	**Log.**	**FFW**	**Env. Ag.**	**LC**	**Total**
Losing competitive advantage (price or enforcing sus measures)	**1**	**2**	**1**					**4**
Some environmental indicators are not true representation of the impact	**1**							**1**
Sustainability is not prioritized (ex. it is not incorporated yet in metrics of a successful business, price is seen more important, effort & inconvenience, or developing economy faces social challenges)	**1**	**2**	**3**	**1**			**2**	**9**
Technology infancy and high cost may drop		**1**	**1**		**1**			**3**
The chain of responsibility is broken	**1**							**1**
The environmental impact is not yet integrated in the buying decision, the financial or economic system	**1**	**3**				**1**		**5**
The small scale of new sustainable technologies (ex. availability & access to environmental options)	**1**							**1**
There is an extent to environmental impact to operations that cannot be avoided		**1**	**1**					**2**
Unknown profitable extent of sustainable technologies investment	**1**							**1**

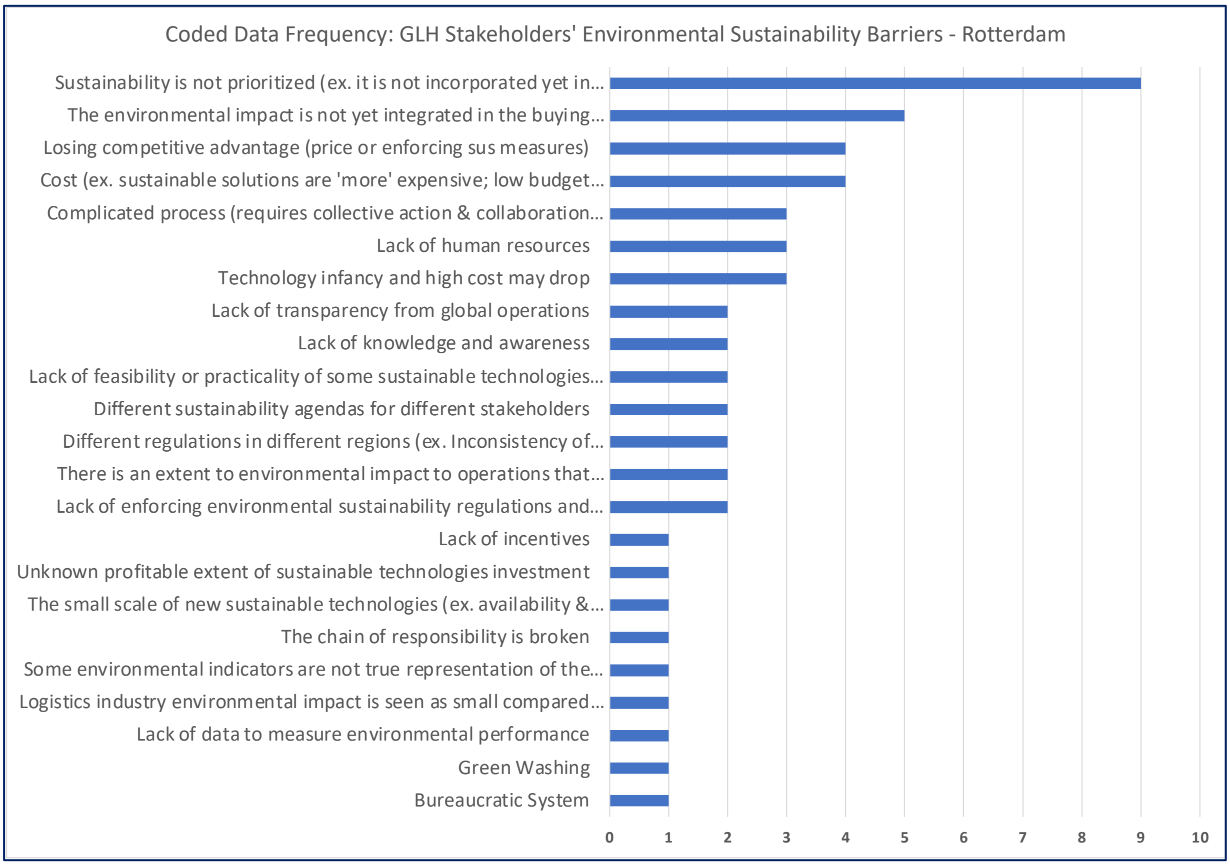


Figure 4.10 Coded Data Frequency: GLH Stakeholders' Environmental Sustainability Barriers – Rotterdam (Source: NVivo 12)

Table 4.23 Rotterdam Excerpts Supporting: GLH Stakeholders' Environmental Sustainability Barriers Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
A3.3-1	Log.	*"… but then of course it is the measures that are imposed to us from local regulations are different from that, that means additional work" (C1L2P1)*
A3.3-2	TO & LSP	*"… and legislations and if technologies are allowed to be put at certain places. There is still some open space in the port where we could put windmills, but on the other hand windmills close to crane operations are also not very useful. Talking about feasibility." (C1L1P2)*
A3.3-3	TO & LSP	*"Because they also realise that many companies active in the port do not even have the resources, the human resources, to take upon the whole burden of doing all the reporting work. It is quite in that sense a bit of bureaucracy that you need to do the reporting" (C1L1P2) – TO*
A3.3-4	FFW	*"Our customers and suppliers have unique sustainability goals. Some seek to use a lower carbon-emitting mode of transportation or utilize consolidation services to reduce number of shipments. Others leverage reverse logistics services, want to align LTL (less-than-truckload) freight with the best carrier to reduce waste, or use a network analysis to help minimize inventory and transportation miles" (C1L2P2)*
A3.3-5	Ship.	*"But at the end of the day, not all these stakeholders are looking at or they don't have the same sustainability agenda" (CEL2P3)*

4.3 Case Study B: Antwerp GLH

This section will present and describe the themes that emerged from the data collected in the Antwerp GLH case study, and provide supporting excerpts from the participants to illustrate these themes. Participants codes and abbreviations used in the discussion and data display of this case study are presented in Table 4.24.

Table 4.24 Antwerp Case Stakeholders Abbreviations & Participants Codes

Abbreviation	Description	Participants Codes
PA	Port Authority	C2L1P1 & C2L1P2
TO & LSP	Terminal Operator and Logistics Service Provider	C2L1P3
Log Dept.	Manufacturer's Logistics Department	C2L2P1
Assoc.	Trade Association	C2L3P2
Ship.	Shipping Company	CEL2P3
LC	Local Community	C2L3P1

4.3.1 Theme 1: Building an Understanding of the GLH Concept

This global theme has 5 organising themes that contribute to the understanding of the concept of GLH in the case of Antwerp GLH.

4.3.1.1 GLH Definition

Participants in this case defined a GLH as a strategic geographical location with good accessibility and global connection, in addition to providing logistics and marine services. C2L1P2 and C2L1P1 especially emphasized the importance of “marine access” and “connectivity”. It was also described as a location with multimodal transport and a major maritime port with infrastructure to accommodate the volume of global cargo. Figure 4.11 shows the frequency of responses coded under each theme. It suggests that ‘good accessibility and global connection’, ‘multimodal transport’, ‘logistics and marine services’, ‘industrial cluster’, and ‘strategic geographical location’ are among the most crucial aspects of a GLH. These themes have the highest frequency of responses, emphasizing their importance in the participants' perception.

Multimodal transportation was explicitly mentioned by several participants as shown in Table 4.26. Additionally, GLHs are developed in locations where industrial clusters can form as part of the GLH configuration (Excerpt: B1.1-9). Furthermore, the synergy between maritime, logistics, and industrial activities is very important to provide safe and smooth operations as per the port authority's data. In GLHs, the infrastructure allows handling all types of cargo for import, export, transhipment, as well as having a FTZ for the value added and manufacturing activities that allows for fast and smooth transportation of cargo. Additionally, a port cluster is one of the features that can be seen in this GLH. The Port of Antwerp and Port Zeebrugge joined forces in 2022 to complement each other's strengths (Antwerp-Bruges, 2022). However, the focus of several respondents was on transportation and connectivity more than any other characteristics in this GLH. Table 4.25 illustrates the codes used to describe the data defining GLHs according to the primary stakeholders, and Table 4.26 presents excerpts from the data.

Table 4.25 Antwerp Case NVivo Matrix - GLH Definition Codes Frequency (Source: NVivo 12)

GLH Definition Keywords	PA	TO & LSP	Log Dept.	Assoc.	Ship.	Total
Good Accessibility & Global Connection	7	1	1	1	2	12
Economic engine & trade link	1					1
Infrastructure to accommodate & deliver	3				1	4
Logistics & Marine Services	4		1	1	1	7
All types of cargo	2					2
Import, export & transhipment	1					1
Safe transport	1					1
Storage capacity	1					1
Tailored, excellent, flexible & smooth service	3					3
Major Maritime Port	1			1	1	3
Port Cluster	1					1
Multimodal Transport: Road, Rail, River, Air, Ocean, Short-sea shipping, & Pipelines	6			1	1	8
Smart Hub	1					1
Strategic geographical location	3				1	4
Synergy between maritime, logistics & industrial activities	2					2
Industrial cluster	3	1		1		5

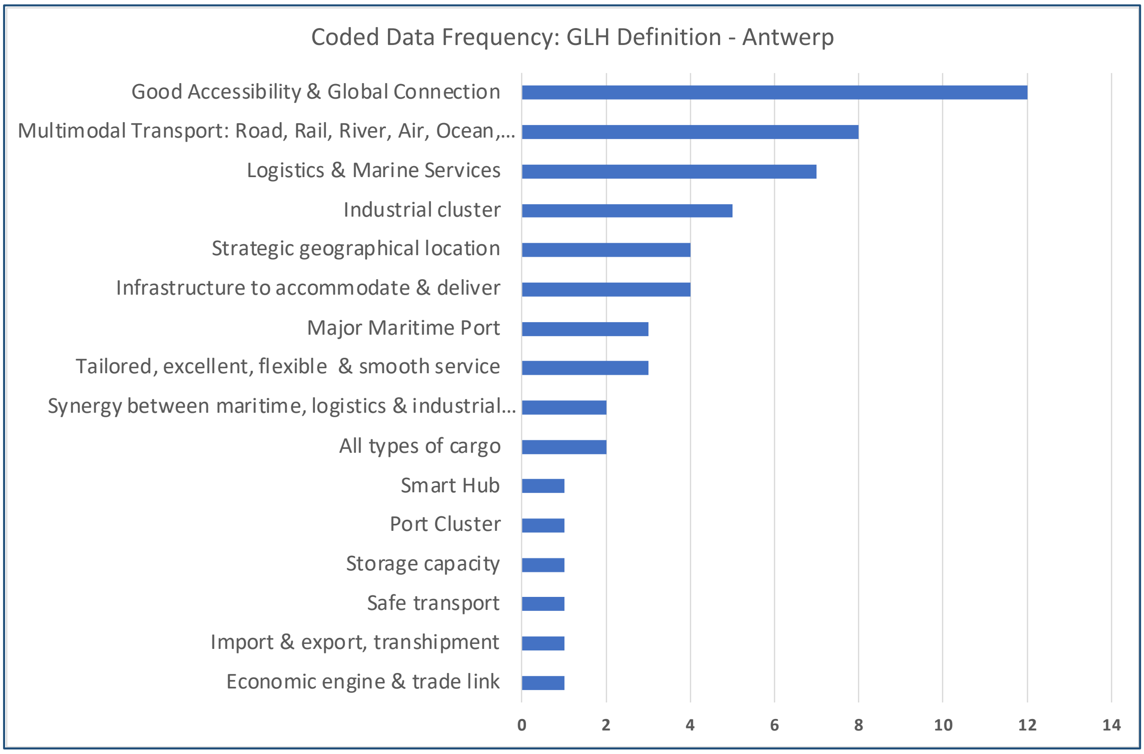


Figure 4.11 Coded Data Frequency: GLH Definition – Antwerp (Source: NVivo 12)

Table 4.26 Antwerp Excerpts Supporting: GLH Definition Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
B1.1-1	Log Dept.	*"...complicated logistics activities take place of loading, unloading, transportation, logistics processing, cross docking, storage and warehousing. So, typical freight related activities, but are also connected with transportation networks to be able to create that global perspective in terms of connectivity" (C2L2P1)*
B1.1-2	PA	*"...staff are employed in different things. Number 1 in the marine access, so they are providing the people on the lock gates, the people who are opening the lock gates, the people on the tugs, and the people who are doing the tying up of the ships" (C2L1P2)*
B1.1-3	Assoc.	*"I would say it's a place where different transport modes come together. So that automatically brings ports into sort of the first line of examples of a global logistics hub, because they are in most cases multimodal" (C2L3P2)*
B1.1-4	TO & LSP	*"...a place that you can send stuff to all over the world with different kinds of transport modes" (C2L1P3)*
B1.1-5	PA	*"So, if it is going to Holland, it might go on a barge. If it is going into France, it might go onto a train. If it's going into Belgium, it might go on a truck. If it's going to the UK, it will need loading onto a smaller ship and transhipping" (C2L1P2)*
B1.1-6	PA	*"I'd say first and foremost you have to have infrastructure. So, you for example have to be able to accommodate, deep, big depth, big ships...You need to have the port infrastructure for storage" (C2L1P2)*
B1.1-7	Assoc.	*"...and for it to be global, it would have to involve overseas transport so not just intra-regional transport, or aviation for that matter, but it's not purely intra-European or intra-US, then I would not consider it global" (C2L3P2)*
B1.1-8	PA	*"... you need the connectivity to then forward cargo to and from that global logistics hub" (C2L1P2)*
B1.1-9	PA	*"We also are in exception situation because we have besides logistics, we also have a lot of industrial activities. So, we have a huge cluster of maritime, logistics and industrial players and of course the industrial players create a lot of logistics activities because they need to have fleet stock and they also have to export the products they are making..." (C2L1P1)*
B1.1-10	PA	*"Main European centres of production & consumption nearby... This central location offers the fastest and cheapest connections with the European hinterland, as well as ecological advantages" (PA Report -(Sustainability, 2021))*

4.3.1.2 GLH Primary Stakeholders

Participants in this case identified GLH primary stakeholders as transportation, logistics, shipping, manufacturers, government, local community, institutions, and associations among others as presented in Table 4.27. Respondents identified industrial cluster companies as primary stakeholders because they provide an export stream of products. In addition to the logistics players that form the logistics foundation network of the GLH.

> *"of course, the industrial players create a lot of logistics activities because they need to have fleet stock and they also have to export products they are making so they are certainly an important stakeholder" (C1L1P1).*

Additionally, associations, interest groups, and local community were identified as primary stakeholders. However, employees in this case are only identified by the shipping company, but not any other stakeholder. In Table 4.27, the difference in identification of stakeholders by participants can be due to the perspective of the stakeholders. For example, the port authority identifies its concessionaires and users, while the terminal operator and the logistics department identify the port and the shipping line identify the terminal operator but not the port authority. So, the compilation of perspectives gives a more comprehensive picture of the GLH primary stakeholders.

Furthermore, Figure 4.12 shows the frequency of responses coded under each theme. It suggests that ‘government and local councils’, ‘logistics companies and freight forwarders’, ‘industrial cluster’, ‘port authorities’ and ‘cargo owners or shippers’ are among the most frequently mentioned primary stakeholders of a GLH. These themes have the highest frequency of responses, emphasizing their importance in the participants' perception.

Table 4.27 Antwerp Case NVivo Matrix - GLH Primary Stakeholders Codes Frequency (Source: NVivo 12)

GLH Primary Stakeholders	PA	TO & TSP	Log Dept.	Assoc.	Ship.	Total
Airports					1	1
Associations & interest groups	2				1	3
Cargo owners or shippers			1	1	2	4
Employees					1	1
Government & local councils	6			3	2	11
Industrial cluster companies	3	1		1		5
Inland vessel sector	1			2		3
Local community			1	1		2
Logistics Companies & Freight forwarders	1		1	3	1	6
Investors					1	1
Science & educational institutes	2					2
Port Authorities or owners-operators		1	1	2		4
Railway operators	1			1	1	3
Shipping lines	1			1	1	3
Terminal operators	1			1	1	3
Trucking companies	1			1	1	3

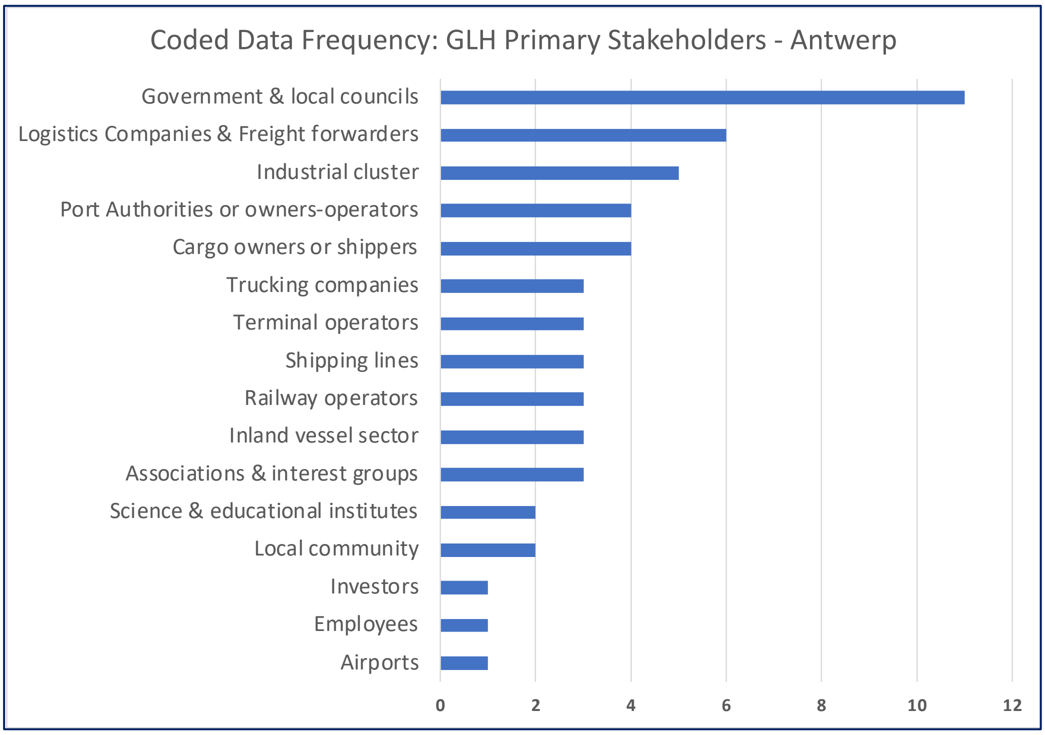


Figure 4.12 Coded Data Frequency: GLH Primary Stakeholders – Antwerp (Source: NVivo 12)

4.3.1.3 Role, Activities and Operations of GLH Primary Stakeholders

The role, activities, and operations of the stakeholders were identified by participants depending on the nature of the stakeholder's role or operations within the GLH, as listed in Table 4.28. The port authority operations are described by the port authority respondents. The port is publicly owned by the Government of Flanders where they oversee the port authority. The port authority does not provide operations or logistics services. The port has a landlord configuration of managing the port. It provides and maintains the infrastructure and connections to the port's hinterland and works on attracting and managing concession agreements. They look more at the overall picture, the infrastructure management, and the attraction of businesses (Excerpt: B1.3-1). Additionally, part of the responsibilities of the port authority is to provide marine services to facilitate the maritime operations and ensure safe shipping traffic. They are also responsible for overseeing from a regulatory point of view (Excerpt: B1.3-2).

The terminal operator and logistics service provider company is a multinational company that provides both types of services. The company deals with all types of cargo and specialized industries providing tailored solutions (Excerpt: B1.3-3). Additionally, the shipping and ocean transport company is responsible mainly for transporting big volumes of cargo via ocean transport. This multinational shipping company's core activity is ocean-related services globally for massive amounts of cargo. However, it also provides a wide range of logistics services, and it is involved in other industries (Excerpt: B1.3-4). This shows an overlap of operations between the types of stakeholders when companies are large enough to diversify their activities.

The multinational manufacturer's logistics department is responsible for the logistics processing of their own product and providing the distribution planning and execution. They are connecting their whole supply chain from overseas factories to the final consumer through their logistics chain. However, they outsource all transportation and storage facilities. Furthermore, the trade association represents stakeholders from the core of this industry around the world. The stakeholders represented by this association are primary stakeholders to the GLH such as port authorities, terminal operators, logistics companies, government departments, in addition to others. It is a network organisation offering support, advice, and exchange of best practice among the member stakeholders (Excerpt: B1.3-5).

On the other hand, local community members' role is working for the companies within the GLH, gaining benefits from the economic development of the region and improved employment, and receiving commodities as consumers. However, the local community also receives the adverse impacts of operating a GLH within their locality, including the adverse environmental impact. Table 4.29 presents excerpts from the data.

Table 4.28 Antwerp Case Role, Activities, and Operations of GLH Primary Stakeholders

<table>
<tr><th>Stakeholder</th><th>Role, Activities & Operations</th><th>Stakeholder</th><th>Role, Activities & Operations</th></tr>
<tr><td>PA</td><td>-Public Role:
Investing & Building Infrastructure & Port facilities
Provide Marine Services and Maritime Traffic
Regulatory Authority

-Private Role:
Landlord (managing & renting the port facilities)</td><td>Log Dept.</td><td>Warehousing
Cross-docking
Packaging
Transportation
Distribution planning & activities
Door-to-Door
Outsourcing transportation & storage facilities</td></tr>
<tr><td rowspan="2">TO & LSP</td><td rowspan="2">Operate terminal
Stevedoring services
Cargo Handling
Arranging Customs Clearance
Freight Forwarding & Distribution
Outsourcing transportation and storage facilities
Airfreight
Ocean Freight
Barge freight
Rail freight
Road freight
Warehousing
Packaging
Stuffing & stripping containers
Value-added services
Supply chain solutions</td><td>Ship.</td><td>Ocean transport & related services
Logistics Solutions
Inland transport
Warehousing
Distribution
Supply chain management
Insurance</td></tr>
<tr><td>Assoc.</td><td>Exchange of best practice
Representing a united voice of the member stakeholders
Coordinate with other organizations</td></tr>
<tr><td>LC</td><td>Employees, Economic development of the region, and receiving goods as consumers</td><td></td><td></td></tr>
</table>

Table 4.29 Antwerp Excerpts Supporting: Role, Activities, and Operations of GLH Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
B1.3-1	PA	*"We as a port authority do not have logistics operations ourselves so we just facilitate the activities on the port platform... we also try to optimize the modal shifts to the hinterland so to optimize the logistics activities" (C2L1P1)*
B1.3-2	PA	*"We set up requirements and legislations linked to certain activities on the terminals but that is limited" (C2L1P1)*
B1.3-3	TO & LSP	*"We are quite a large company, and we have all kinds of operations" (C2L1P3)*
B1.3-4	Ship.	*"Part of what we do is ocean, inland, warehousing, distribution, e-commerce, consolidation, like the end-to-end visibility aspect of the business. So, any kind of third-party logistics solutions as well. One of the products is supply chain management. So, just like we have ocean as a product we have customs as a product, we have warehousing, distribution, insurance etc" (CEL2P3)*
B1.3-5	Assoc.	*"Topics of interests are energy transition, digitalization and of course also anything that's to do with disruption, which is the pandemic crisis is one of the big examples of what happens globally and how it affects the industry" (C2L3P2)*
B1.3-6	PA	*"A lot of the people that work on the port are the community actually, so they have a vested interest" (C2L1P2)*

4.3.1.4 GLH Physical Infrastructure and Connections

The participants in this case explained how the multimodal connections, the infrastructure, global connections, and capacity are some of the features that make a location a GLH as they defined the term. It is therefore important for GLHs to maintain and develop these features to accommodate the changing factors affecting the market such as technology, increasing global trade, environmental sustainability, and the advancement of their competitors. Respondents in this case discussed some of the developmental projects to improve the infrastructure or connections. The port is developing extra container capacity to maintain its ability of handling the increasing number of containers going through the port.

> *"Without extra container capacity, the port risks losing its world-port status in the future. In order to maintain this competitive position, we are investing in more and better capacity" (Port of Antwerp-Bruges, 2022)*

The port authority explained that there is always space for renewal and innovation. On the other hand, rail connections to new regions in Central and Eastern Europe are being developed to facilitate a modal shift from road transport to rail transport. In addition to these developments, there are other projects related to the smart hub concept and digitalizing operations to cope with the changes happening in the market. The development projects of the infrastructure of the GLH and the connections are collaboration projects between the government, the port authority, other ports, rail operators and other stakeholders to maintain and improve the position of the GLH. For example, there are collaborations between Duisburg inland port, Port of Antwerp-Bruges, and the Flemish government to establish rail networks, pipelines, and hinterland connections between the two ports to strengthen the infrastructure and face the global challenges.

4.3.1.5 GLH Governance Structure

The governance in this case is split between the port authority and the government. The participants in this case identified the port authority as the landlord. It is responsible for the public infrastructure to build it, maintain it, rent it and managing the concessions within the port. Therefore, the technical management of the infrastructure and the waterways is the port authority's responsibility. Also, the port is publicly owned. So, the port authority has a regulatory role of being responsible for ensuring safe shipping traffic and ensuring legislation is followed. So, they act as an authority in issuing fines for those who do not comply with the legislation. They have an overview of the GLH as explained by the port authority and the trade association participants:

> *"…because we do that on 2 levels. We focus on the whole global logistics hub as well as on role of the port authority." (C2L1P1)*

> *"They would sort of look more at the overall picture, regulation, infrastructure." (C2L3P2)*

Additionally, companies operating within the GLH provide the services and operation of the GLH. They don't have governance authority over each other or over the port:

> *"The concessions and the private companies, they are the people that are providing the 24-hour working, the flexible discharging, the warehousing, the ability to take goods and packaging them." (C2L1P2)*

They are the port's customers since a high percentage of the port's revenues is generated from concessions and because of the activities happening around the port. For example, the industrial cluster companies are part of the GLH, and they are considered customers by the port. Therefore, the role of the port authority can be seen on two levels in the governance structure. Acting as a landlord on one level and a regulatory authority on another higher level.

On the other hand, the local government is responsible for the governance, collaboration projects, and enforcing legislation outside the borders of the port. The Flemish government is the owner of the port, and they also have their authority outside of the port. They support, facilitate, and manage the infrastructure requirements for the development of the GLH. Furthermore, the trade association is an NGO that helps and supports the stakeholders in the GLH. It represents and has members from all over the world. It facilitates communication and coordination between stakeholders and provides a platform for exchanging best practices. It also doesn't have governance authority over other stakeholders.

4.3.2 Theme 2: Environmental Measurement and Performance in GLHs

This global theme has 5 organising themes that describe environmental measurement and performance related organizing themes in the case of Antwerp GLH. The participants responses were complemented by reports, documents, and website data where possible to generate precise information for the environmental impact and the environmental indicators used by the primary stakeholders in this GLH.

4.3.2.1 GLH Stakeholders' Environmental Impact

The environmental impact of the GLH was explored through the primary stakeholders' impact. Table 4.30 presents the environmental impact and Figure 4.13 shows the frequency of responses coded under each theme. It suggests that 'waste', 'greenhouse gas emissions', 'liquid waste', 'noise', and 'particulate matter' are among the most mentioned environmental impacts of a GLH. These themes have the highest frequency of responses, emphasizing their importance in the participants' perception.

Furthermore, in Table 4.31, the environmental impacts are listed in detail and linked to the contribution of each stakeholder. Greenhouse gas emissions was one of the common impact factors among all participants. This is due to the emphasis and awareness around climate change as it is a global problem and an impact that all stakeholders contribute to currently or in the case of the local community affected by it.

The port authority explains:

> *"If we look at the global scale, then of course it comes to greenhouse gas emissions. So as Port of Antwerp, on the port complex level with all the industrial and petrochemical industry, we certainly have a significant impact on the emission of greenhouse gases." (C2L1P1)*

Table 4.30 Antwerp Case NVivo Matrix - GLH Environmental Impact Codes Frequency (Source: NVivo 12)

Environmental Impact	PA	TO & LSP	Log.	Assoc.	LC	Ship.	Total
Biodiversity & ecosystem disturbance	1		1	1			3
Consumption of natural resources	2	2	2				6
Greenhouse Gas emissions	4	3	2	1	4		14
CO2 emissions	1	1	1	1		1	5
Nitrogen oxides	4		1	1			6
Particulate matter	6			1			7
Sulfur dioxide	3			1		1	5
Land-use change					3		3
Light pollution	1						1
Noise pollution	4		1	2			7
Odour pollution	3				1		4
Sediment Pollution	3						3
Waste	15	3	2			1	21
Liquid waste	6					1	7

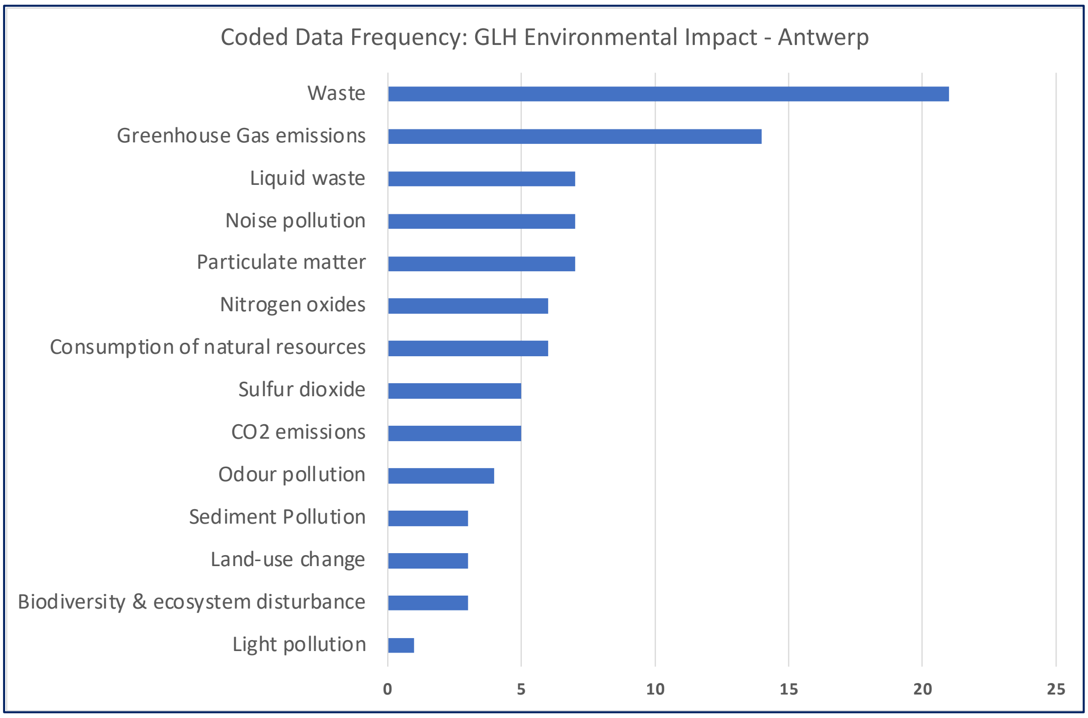


Figure 4.13 Coded Data Frequency: GLH Environmental Impact – Antwerp (Source: NVivo 12)

Table 4.31 Antwerp Case NVivo Matrix - GLH Environmental Impact Codes - Description

Environmental Impact	**Description**	**PA**	**TO**	**Log**	**Assoc.**	**LC**	**Ship.**
Biodiversity and ecosystem disturbance	Impact on biodiversity and ecosystem	√		√	√		
Consumption of natural resources	Energy consumption - Electricity/Gas/Fuel	√	√	√			
	Water consumption	√					
Air Pollution	Reduced air quality			√			
	Greenhouse Gas Emissions		√			√	
	-CO2	√	√	√	√		√
	- NOx	√		√	√		
	- Particulate matter	√			√		
	- SOx	√			√		√
Water Pollution	Oil Spills	√					√
	Water Ballast Mg.						√
	Emissions of metals and polyaromatic hydrocarbons	√					
Noise Pollution	Loud noise	√		√	√		
Odour Pollution	Strong & unpleasant smell	√				√	

Table 4.31 (continued)

Waste	Hard Plastic	√	√				
	Polystyrene foam	√					
	Wood/pallets	√	√				
	Food						√
	Metals	√	√				
	Industrial waste	√					
	Contaminated dredging	√					
	Ship's sewage & garbage	√					
	Cargo Residues	√					
	Paper/Cardboard		√	√			
	Batteries		√				
	Liquid, chemical, residual & sanitary water, oily waste	√	√				
	Litter, fly tipping, weeds, and damage to the street infrastructure	√					
Sediment Pollution	Soil contamination	√					
Land-use change	Green land displacement					√	
Light Pollution	Excessive artificial light	√					

On the other hand, Figure 4.14 shows a word cloud of the frequency of words used by participants in this case when talking about environmental impact. The emphasis of participants was on waste, water, and emissions with waste being the most frequently used word. Even though greenhouse gas emissions are an environmental impact that relates to all stakeholders, waste was also a focus in this case. As it is also evident from the number of impact factors relating to waste that was highlighted by the port authority in Table 4.31.

Furthermore, the local community also explains other environmental impacts that were not mentioned by other stakeholders such as "green land displacement":

> *"I think the port also takes away a lot of green space that the port authority tries to compensate us by installing a lot of smaller nature areas within the port zone." (C2L3P1)*

Figure 4.14 Antwerp Case Environmental Impact NVivo Word Frequency (Source: NVivo 12)

4.3.2.2 GLH Stakeholders' Environmental Indicators

Participants provided the environmental indicators they used to measure their environmental impact (if there were any used). Table 4.32 lists the environmental impact, a detailed breakdown of the impact, and the environmental indicators used by participants to measure them. However, it can be seen in the table that for some environmental impact factors, the indicators used to measure them varied among the stakeholders such as fuel consumption, water quality, and noise. Additionally, Figure 4.15 shows the frequency of responses coded under each theme. It suggests that 'electricity consumption in MWh', 'CO2 emissions in metric tonnes', 'water consumption in cubic meters', 'biodiversity in average % of species', and 'soil pollution in number of sites requiring clean-up' are the most mentioned environmental indicators among the stakeholders of this GLH. These indicators have the highest frequency, emphasizing their widespread usage and recognition in the participants' perception.

Table 4.32 shows that most of the indicators are used by the port authority. The port has taken the responsibility to report on all activities within the port area. Furthermore, the indicators are balanced between the impact factors with priorities given to electricity consumption and then to greenhouse gas emissions according to the frequency of responses. Additionally, the port authority acquires the data for the indicators from the government, supplier companies, or they measure it themselves. The port authority respondent explains:

> *"The soil quality is based on information which we receive from the Flemish government... they give us the collected or the joint data. The water management we do ourselves... the use of water is based on the data which we receive from the water companies." (C2L1P1)*

> *"Air quality data which we receive from the Flemish environment agency, so that is also standardized data… but we as port authority have financed monitoring station so if we see that there is a black spot where we do not have enough data, then we finance a monitoring station and hand it over to the Flemish environment agency, who is then actually doing the measurements." (C2L1P1)*

On the other hand, other stakeholders are not as transparent or comprehensive with their environmental impact and measurement as the port authority. For example, the terminal operator and logistics service provider company does not provide public reports that include environmental impacts or indicators. Additionally, their indicators are mainly used for financial purposes:

> *"We have an idea of how much fuel we use, but we monitor the amount of fuel mostly from a cost perspective than from an environmental perspective." (C2L2P1)*

Other stakeholders use different standards or frameworks to understand and measure their environmental impact, such as the GRI Framework or GHG Protocol. This suggests a lack of uniformity in the approaches used by GLH stakeholders to measure their environmental impact. It is evident that there is a clear discrepancy in the effort and participation of different types of stakeholders towards comprehending their impact and measuring their environmental performance.

Table 4.32 Antwerp Case NVivo Matrix - GLH Environmental Indicators Codes Frequency (Source: NVivo 12)

Environmental Impact	Indicators	Measures	PA	TO	Log	Ship	Total
Air Emissions	CO2 Emission	metric tonnes	8		3	1	12
	NOx concentrations	micrograms per cubic meter	2				2
	NOx emissions	Tonnes	6			1	7
	Particulate Matter concentrations	micrograms per cubic meter	5				5
	Particulate Matter emissions	Tonnes	7				7
	SOx concentrations	Micrograms per cubic meter	2				2
	SOx emissions	Tonnes	5			1	6
Biodiversity & Ecosystem	Biodiversity	average % of species compared with objective or lower limit	8				8
	Land Use	Number of hectares created compared with Regional Land Use Plan	5				5
Energy Consumption	Electricity consumption	Megawatt hour (MWh)	9	1	6	1	17
	Gas	Cubic Meter	1				1
	Diesel, Gasoline, Compressed natural gas	Litres	2	1			3
	Energy (Efficiency)	Petajoule (PJ)	2			1	3
	Fuel consumption	Megawatt hour			1	1	2
		Tonnes				1	1
Natural Material Consumption	Paper Consumption	Quantity printed & copied	1				1
Modal Split	Cargo transported by greener modes	Percent of modal split %	7				7
Sustainability capabilities	Ship visits with ESI discounts	number of ESI discounts	4				4

Table 4.32 (continued)

Environmental Impact	Indicators	Measures	PA	TO	Log	Ship	Total
Sustainability capabilities	Compliance of vessels with international maritime legislation	Number of ships complying with international maritime regulations	2				2
	Vessels with emission reducing technology	No. of ships with emission reducing technology	2				2
	Truck container pick-up & delivery	Percent % of trucks that manage to combine container delivery with pick-ups to avoid empty trips	1				1
	Sustainable Energy Capacity	Megawatt electric (MWe)	4				4
	Truck engine status (Euro Standard)	Percent %	2				2
	Employees Mobility Modal split for transport between home and work	Percent %	2				2
Waste Pollution	Liquid Waste	Cubic meter	5				5
	Solid Waste (by type)	Metric tons	1		4	1	6
	Recycled waste	Tons			1		1
Water Quality	Water pollution	number of oil/industrial incidents	3			1	4
	Water Nutrients	Meeting the norm levels of nutrients	6				6
	Chemical water quality	Number of priority substances that exceed or do not exceed the water quality norm.	3				3
	Emissions into water	above or below normal percent %	5				5
Soil Quality	Soil pollution	Number of sites requiring clean-up	7				7
Noise Pollution	Loud noise	Number of complaints	2				2
		Noise level in Decibels (L -den - dB(A))	5				5
Water Consumption	Fresh Water Consumption	Cubic meters	9		1	1	11

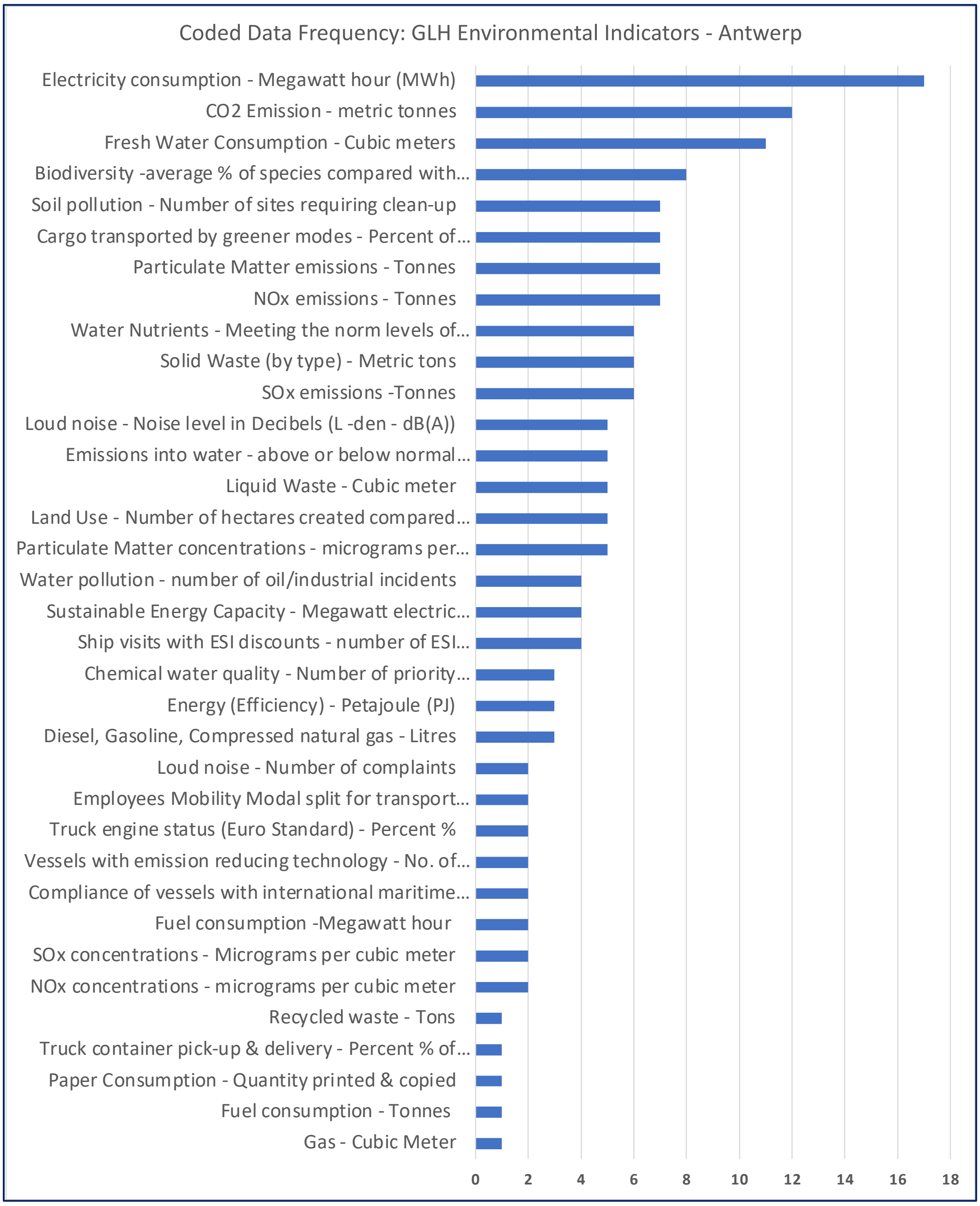


Figure 4.15 Coded Data Frequency: GLH Environmental Indicators – Antwerp (Source: NVivo 12)

4.3.2.3 GLH Environmental Responsibility

Participants in this case suggested that the responsibility for ensuring the environmental sustainability of the GLH, collecting data from stakeholders, and measuring the holistic environmental impact of the GLH should lie either with the government, port authority, third party organisation, voluntary stakeholder participation, or supranational legislators. Table 4.34 lists the reasons behind their choices.

Table 4.33 illustrates the responses according to each stakeholder and Figure 4.16 shows the frequency of responses coded under each theme, suggesting that 'government' is the most frequently mentioned theme, followed by 'port authorities', ‘supranational legislator’, ‘voluntary participation’, and 'third party'. The frequency count of these responses emphasizes the importance attached to each theme in the participants' perception, with a higher frequency indicating a greater importance and common opinion among participants. Most participants believed that the government or local governing body should be responsible for measuring the holistic environmental performance of the GLH due to their regulatory power, neutral position, and economic capabilities (Excerpts B2.3-1, B2.3-2).

Additionally, several participants believed that the link between the port authority and the rest of the stakeholders can facilitate communication regarding holistic environmental measurement. However, as the port authority noted, it requires *“open communication with the private companies” (C2L1P1)*. The port authority reports on emissions and environmental data for companies active on the port platform in its sustainability report, using their connection to the government and stakeholders to facilitate the collection of data and holistically reporting the environmental performance of the port complex. The port also has a facilitating role in promoting environmental sustainability, offering incentives and facilities to support stakeholders (Excerpt B2.3-5). However, there may be a problem in this case as well that the port authority would be both a "poacher and gamekeeper" with respect to the polluter pays principle. The polluter pays principle states that those who cause pollution or damage to the environment should bear the costs of managing and mitigating it (Luppi et al., 2012). Therefore, the port authority may have a conflict of interest that could compromise the impartiality required for reporting the environmental performance of their customers.

Furthermore, one respondent noted that some emissions are regulated by the European Union's Emissions Trading System, but global regulation through intergovernmental agencies like the IMO is difficult to enforce consistently across countries, leading to differences in the competitiveness and appeal of ports based on their locations and regulatory environments. Therefore, a supranational legislator such as the European Union's institutions can enforce regulations to measure the environmental performance of GLHs holistically without fear of affecting competitiveness among GLHs.

On the other hand, some participants suggested voluntary participation instead of centralizing control over holistic measurement. Voluntary participation allows individual stakeholders to measure and take responsibility for their actions without overarching control, addressing differences in operations and impacts among multiple stakeholders and geographical boundaries. Alternatively, the shipping company respondent suggested the need for a third party, unbiased body to enforce regulations and measure environmental performance, with the ability to connect with stakeholders and maintain confidentiality and neutrality. Table 4.35 presents excerpts from the data.

Table 4.33 Antwerp Case NVivo Matrix - GLH Environmental Responsibility Codes Frequency (Source: NVivo 12)

GLH Environmental Responsibility	PA	TO & LSP	Log Dept.	Assoc.	LC	Ship.	Total
3rd Party Responsibility for GLH Sus						1	1
Government Responsibility for GLH Sus	1	1		1	2	2	7
Port authority Responsibility for GLH Sus	2		1	1	1		5
Ports have a facilitating role when it comes to env sus strategies				1			1
Supranational legislators with more stringent criteria, like EU to be the no. one sustainable region in the world.	1			2			3
There is a different pattern in the world when you look at the level of legislation and the enforcement, that is in place.				1			1
Weaknesses of intergovernmental system when issuing legislation but not being able to enforce it on all countries				1			1
Voluntary participation			1		1		2

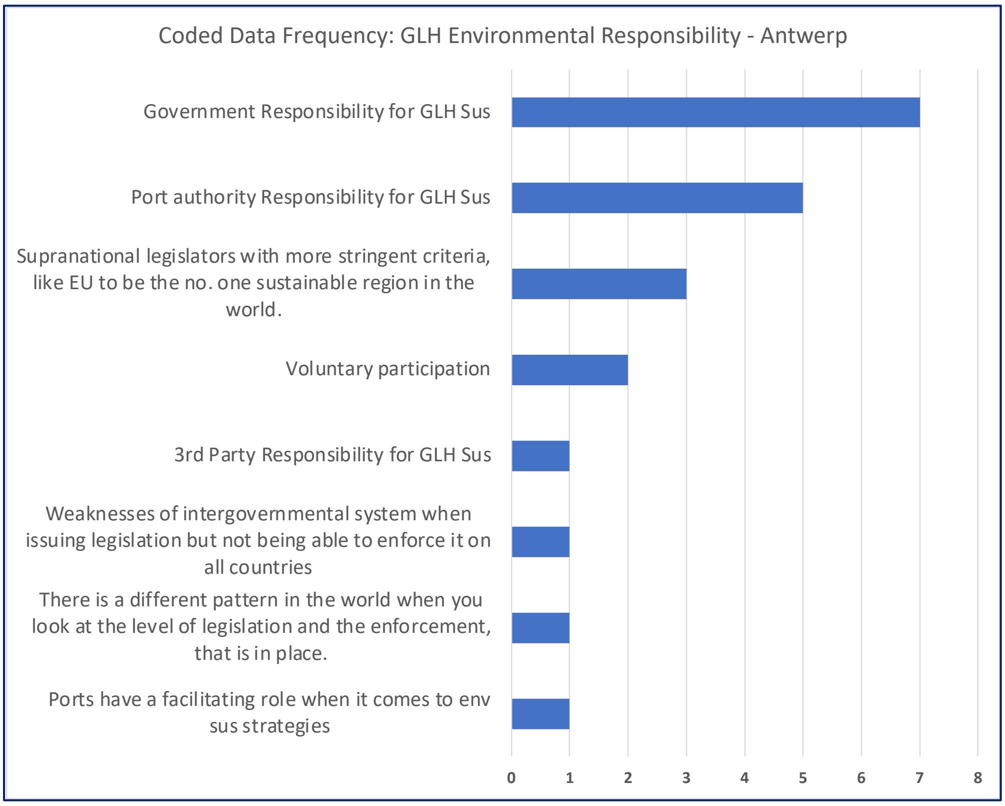


Figure 4.16 Coded Data Frequency: GLH Environmental Responsibility – Antwerp (Source: NVivo 12)

Table 4.34 Antwerp Case - GLH Environmental Responsibility Reasons

Responsibility	Reason
Government	Neutral position, overarching authority and regulatory power, & financial capabilities
Port Authority	Connection to stakeholders, landlord/owner responsibility, part of the government and capabilities of the port
Third Party	Unbiased position, confidentiality, and reliability
Voluntary Participation	Everyone should be responsible for sustainability and to overcome the multiple stakeholders and geographical issues
Supranational Legislators (EU)	Levels the field in competitiveness and appeal between GLHs

Table 4.35 Antwerp Excerpts Supporting: GLH Environmental Responsibility Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
B2.3-1	TO & LSP	*"I think it needs to be the government because normally they have to be neutral" (C2L1P3)*
B2.3-2	Assoc.	*"I think it would almost have to be a government agency to measure the impact and make sure that all stakeholders provide data and the information that is needed... because getting data is incredibly difficult and getting people to share data is terrible, especially in our industry" (C2L3P2)*
B2.3-3	PA	*"I think it should be the port authority. I think for the holistic environmental measurement, it should be the authority. But there should be a really open communication with the private companies" (C2L1P1)*
B2.3-4	Assoc.	*"I think to some extent the port authority could have that leverage in maritime hubs and they are often also close to the government... But I think you would need sort of that level of authority" (C2L3P2)*
B2.3-5	Assoc.	*"The role of ports is more facilitating. So that you have the possibility to deal if ships are using scrubbers for instance and you have facilities for wastewater, or that you can provide when ships are at berth that you provide shoreside electricity, provision of fuel, low sulphur fuel is another one. And ports can also provide incentives to ships that are doing actually better than what the international standard requires that you provide incentives to those ships by the reduction in port use or things like that" (C2L3P2)*
B2.3-6	Ship.	*"I think there should be a body or a party that is in between that could be able to set some regulations so that corporations would abide" (CEL2P3)*
B2.3-7	LC	*"Otherwise, it might be some platform that comes from the stakeholders themselves that is kind of a shared platform, like an initiative from the industry itself" (C2L3P1)*
B2.3-8	Log Dept.	*"let's say we take a different perspective. End-to-end supply chain. It might be the cargo-owner. So, the one who owns the supply chain... So again, it depends on the geographical context in my point of view" (C2L2P1)*
B2.3-9	Assoc.	*"I think the level of regulation will be more stringent certainly in European Union because you have an EU which is a supranational regulator very, sort of, wants to be the number one, sustainable region in the world... I mean with the low sulphur rule that is an obligation worldwide, but it's the enforcement, which is not in the hands of the UN. It's in the hands of the countries of the member states, that's the big difference between the European Union, which has its own institutions that can enforce the rules and the measures. There is the European Court of Justice as well so you can bring governments or, or parties to court, which is something the UN, or IMO doesn't have" (C2L3P2)*

4.3.2.4 Extent of connection among GLH Primary Stakeholders

Most participants in this case maintained there is at least communication between the stakeholders except for one participant as shown in Table 4.36. The extent of connection among the GLH primary stakeholders highlights their degree of communication, cooperation, collaboration, or integration. Additionally, Figure 4.17 shows the frequency of responses coded under each theme, suggesting that 'communication' is the most commonly mentioned theme. This indicates that it is the most prevalent form of connection among stakeholders in this GLH. This is followed by 'encouraging or influencing', 'collaborating', 'reporting on behalf of', 'very limited or non-existent', and 'mandating, forcing, and legislating'. The frequency count of these responses emphasizes the significance attached to each theme in the participants' perception, with a higher frequency indicating a greater importance and shared opinion among participants.

Several participants in this case regarded communication as an essential level of connection among the stakeholders. The port authority and the trade association facilitate communication with GLH primary stakeholders, including industry, logistics, NGOs, and government, to discuss environmental sustainability and other topics. Furthermore, the port is open to communication from the local community and carries out sustainable development surveys to engage with the local community. However, the community is not aware of all the communication coming from the port. Additionally, there are platforms for sharing knowledge and sustainability performance, such as a database and a platform created by the Port of Antwerp in collaboration with the city and another established by the trade association for communication and sharing best practices (Excerpts B2.4-1, B2.4-2). However, it is evident that communication among stakeholders is not consistently established throughout the GLH.

Participants in this case also referred to influence as a mean of connection. Stakeholders can influence each other's decisions towards environmental sustainability through various means, such as signing contracts with sustainability clauses, shaping industry regulations and legislation, and influencing legislators. The port authority may use contracts to bind users to certain sustainability standards, while smaller local councils and communities may have less influence on the operations and impact of the Port of Antwerp (Excerpts B2.4-4, B2.4-5). Additionally, participants explained that partnerships are also important for environmental sustainability, as they allow for a joint effort and the participation of various actors. For example, the shipping line has partnerships with manufacturers to transport containers on biofuel and with zero emissions, and the port has strong partnerships with various parties, including the city, trade associations, and private companies (Excerpts B2.4-7, B2.4-9).

Another form of connection is mandating and legislating. Port authority respondent explains that they are responsible for the regulating and mandating environmental sustainability of companies within the port borders (Excerpt B2.4-10). Another example is the city council and Flemish government set out environmental laws for businesses to follow, and they have the authority to issue licenses of operation to stakeholders in the GLH, including requirements for environmental sustainability.

On the other hand, the extent of connection among some stakeholders in the GLH is not complete, with some missing links or limited connections. The terminal operator stated that their connection with other stakeholders is "non-existent", and smaller local councils and villages around the port have less influence on events within the GLH.

Overall, there are connections established among GLH stakeholders, and mostly stakeholders are collaborating and integrating in this GLH to accurately measure their environmental performance and improve the environmental sustainability. However, this is not consistent throughout the GLH and not all on the same level. Some stakeholders have more influence, some stakeholders are investing in integrations and partnership, while others have limited communication and involvement with other stakeholders. Table 4.37 presents excerpts from the data.

Table 4.36 Antwerp Case NVivo Matrix - Extent of Connection among GLH Primary Stakeholders Codes Frequency (Source: NVivo 12)

Extent of Connection	PA	TO & LSP	Log Dept.	Assoc.	LC	Ship.	Total
Collaborating with stakeholders for a sus growth	5		1				6
Communicating with stakeholders reg. env sus	4		1	3	1	1	10
Encouraging or Influencing stakeholders towards a sustainable direction	3		1	2	1		7
Reporting holistically with stakeholders	5						5
Very limited or Non-existent		2			2		4
Mandating, forcing, and legislating sustainability	1						

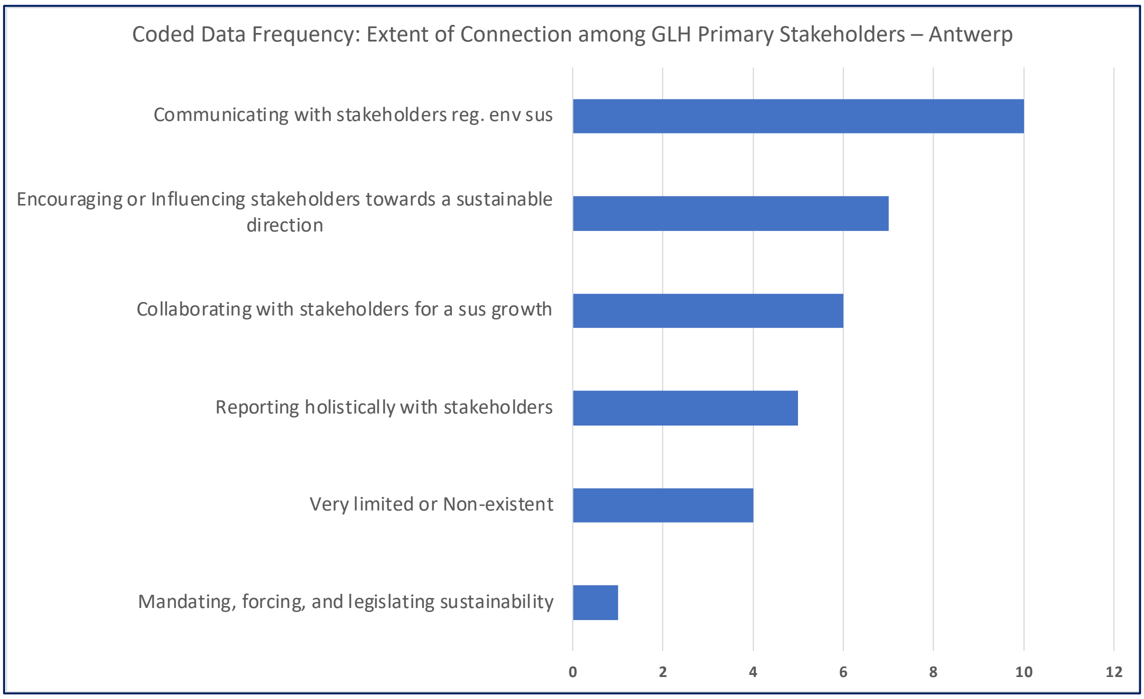


Figure 4.17 Coded Data Frequency: Extent of Connection among GLH Primary Stakeholders – Antwerp (Source: NVivo 12)

Table 4.37 Antwerp Excerpts Supporting: Extent of Connection among GLH Primary Stakeholders Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
B2.4-1	PA	*"We publish every two years and actually in the sustainability report we report on the port platform level, so we really try to give figures on the emissions of the port authority together with all other companies active on the port platform... and it is a joint effort, so we do it together with the companies, together with chamber of commerce the representative of the logistics sector active in the port" (C2L1P1)*
B2.4-2	Assoc.	*"I've created that roundtable about two years ago to sort of strengthen our voice in IMO when it comes to issues that affect our part of the industry" (C2L3P2)*
B2.4-3	PA	*"The port understands its impacts of its operations on the community and therefore there is a lot of effort that's put into managing that relationship in balance" (C2L1P2)*
B2.4-4	Log Dept.	*"We do have influencing channels because if we don't push our stakeholders to behave more sustainably, meaning that to be able to deliver different innovations to the market, to be more responsible in daily operations. We do have continuous influencing channels to ensure that we take responsibility for additional demand, additional operations and being able to cooperate with our partners to collectively and mutually pick the right decisions towards this direction" (C2L2P1)*
B2.4-5	Assoc.	*"The dominant stakeholder when you look at the regulatory front are the ship owners, the shipping companies and there are many trade associations that represent them... and they are very dominant when it comes to lobbying and influencing international regulators like IMO" (C2L3P2)*
B2.4-6	LC	*"They have their own city councils, of course. But I think they have much less influence on what is happening in the port" (C2L3P1)*

Table 4.37 (continued)

Excerpt No.	Participant	Excerpts from Interviews & Data
B2.4-7	PA	*"It is a joint effort, and then we as port authority for example when it comes to air quality, we try to bring the different actors together and try to set up a joint agenda. Also cooperated the Flemish government when it comes to this" (C2L1P1)*
B2.4-8	PA	*"I am sure that their environmental and sustainability groups and initiatives on the port perhaps driven by the port, but what it needs is the buy-in and the participation of the people actually out there carrying out the activities" (C2L1P2)*
B2.4-9	PA	*"We put a lot of focus into partnerships. We work very closely with our owners 'the city' and the city region, we work with trade associations and interest groups, with local and international authorities, science and educational institutes, we are happy to be here today, and with private companies as well... There is actually a very strong partnership relationship between the port and the concessions" (C2L1P2)*
B2.4-10	PA	*"If you are a port or you are a terminal handling dry bulks for example, you will have to have a license for managing dust emissions, so that is something that the local authority is setting as a requirement" (C2L1P2)*
B2.4-11	TO & LSP	*"No, I think it is more non-existent. Because I know I tried to find something of communication, and I cannot find anything actually. So, I think it's not really there" (C2L1P3)*
B2.4-12	Ship.	*"(name of global manufacturer) they have signed a contract with us, and they have agreed to pay around $400 more per container, and it's just a batch testing, only to have these containers transported on biofuel and with zero emissions" (CEL1P3)*

4.3.2.5 GLH Stakeholders' Environmental Sustainability Frameworks and Management Systems

Table 4.38 lists the measurement frameworks, certificates, management systems, or platforms that any of the participants in this case are using for their environmental performance or sustainability. There are two commonly mentioned frameworks among all participants, the 17 Sustainable Development Goals (SDGs) and the Triple Bottom Line (TBL) framework. These frameworks are flexible and can be applied to any setting, unlike the Environmental Ship Index (ESI) measurement framework for example, which is specifically designed for ships. The flexibility of the SDGs and TBL frameworks allows them to be applied to any setting.

On the other hand, it is evident from the table that the rest of the frameworks and management systems are mostly used by the port authority or the trade association. It also shows that there is a lack of consensus among stakeholders in regards to their approach to this issue. This discrepancy may be influenced by the distinct nature of the operations and activities undertaken by the stakeholders. As the manufacturer's logistics department participant explains that they "*outsource everything*". It is important to consider the role that these factors play in shaping the focus and priorities of stakeholders in regards to environmental sustainability. However, it still highlights the fragmentation in the approach to measuring environmental performance among the stakeholders of this GLH.

Table 4.38 Antwerp Case NVivo Matrix - GLH Stakeholders' Environmental Frameworks and Management Systems Codes

Environmental Frameworks & Management Systems	PA	Log Dept.	Assoc.	Ship.
Sustainability Report - TBL	√	√		√
Cleanliness Index	√			
EMMOSS shipping emissions model	√			
A dynamic sustainability website	√			
17 SDGs	√	√	√	√
Ports Sustainability report (all member ports)			√	
Ships and ports emission toolkits (GloMeep Project)			√	
NEPTUNES (Noise Exploration Program to Understand Noise Emitted by Seagoing ships)			√	
Environmental Ship Index (ESI)			√	
Online platform to provide members with knowledge and best practice			√	
Greenhouse Gas Protocol (GHG Protocol) (Scopes 1, 2 & 3)				√
ISO9001 and ISO14001				√

4.3.3 Theme 3: Environmental Sustainability of GLH Stakeholders

This global theme has 3 organising themes that discuss the drivers and barriers of GLH stakeholders' environmental sustainability in the case of Antwerp GLH.

4.3.3.1 GLH Stakeholders' Environmental Sustainability Drivers

Figure 4.18 shows the frequency of responses coded under each theme for this GLH. The top five drivers are 'demand for sustainability', 'responsibility', 'pressures from government and society', 'legislation', and 'reputation/public image'. The frequency count of these responses emphasizes their importance and suggests a degree of prioritization within the participants' perception. However, it is crucial to note that the importance and ranking of these drivers vary among participants, as their individual perspectives and priorities differ. Further quantitative investigative research is also needed to validate the significance of each of these aspects and their ranking in terms of importance.

It is evident from Table 4.39 that the main drivers for most participants in this case are the 'demand on sustainability', 'responsibility', and 'pressures from government and society'. There are several participants suggesting a growing demand for sustainability in business, which in turn drives sustainability. This can be caused by the increasing awareness among consumers and stakeholders about the environmental impact of various products and services in Europe. Therefore, it is reflected in the growing demand for sustainable solutions that minimize negative environmental impacts. Port authority respondent explains:

> *"So it might be that their environmental and sustainable policies are driving some of the things that are changing. So, if a new customer wants to come and build something on the port. They say: 'we need a facility that has solar array on it'. It is not an option it has to be on it." (C2L1P2)*

Another common driver among participants is the increasing pressure from government and society to adopt more environmentally friendly practices. Governments around the world are enacting more stringent laws and regulations that require businesses to adopt sustainable practices and standards to reduce their environmental impact. At the same time, there is a clear trend towards increased social pressure on businesses to be more environmentally responsible, as consumers and other stakeholders expect companies to act in a way that is consistent with their values and concerns about the environment. Port authority respondent highlights:

> *"I think society changed. The mindset in society is changing and that is something which takes place in the company, so it results in a lot of pressure from society on companies. It is a trend which you see everywhere." (C2L1P1)*

Furthermore, several participants referred to their sense of responsibility towards the environment and the society as a driver for their environmental sustainability. For example, the manufacturer's logistics department participant maintained that there is a strong sense of responsibility among companies to promote environmental sustainability:

> *"It is about the responsibility that we need to have a cleaner environment., clean water, and fresh air. It is a matter of also being in the company's DNA to be able to put forward this responsibility and to create more alive environments and thriving environments for people." (C2L2P1)*

Finally, participants also suggest that they are recognizing the benefits of adopting sustainable practices, which are also driving their environmental sustainability, including cost savings, legislation, improved reputation, and increased competitiveness. As a result, an overarching driver is that sustainable solutions are considered a way to meet the demands of customers and stakeholders, while also improving the bottom line.

Table 4.39 Antwerp Case NVivo Matrix - GLH Stakeholder’' Environmental Sustainability Drivers Codes Frequency (Source: NVivo 12)

Environmental Sustainability Drivers	**PA**	**TO**	**Log**	**Ship**	**Assoc.**	**LC**	**Total**
Avoiding Fines	1						1
Being a leader in sustainability				3	1		4
Contract binding environmental obligations	2	1					3
Corporate Policy	1			2			3
Demand for sustainability	1	2	1	4	1		9
Employees	3						3
Environmental sustainability is business sustainability	2				1		3
Gaining Competitive Advantage	1	1		1			3
Health and Wellbeing of humans and planet			1	1		1	3
Increased Awareness	1				1		2
Initiatives and incentives	1	1			1		3
Legislation	2			2	2		6
Long Term financial gains	1				1		2
Paris Climate Agreement	1			2			3
Pressures from Government and Society	3	1	1		1		6
Reputation-Public Image	3	1		1			5
Responsibility	2		3	2	1		8

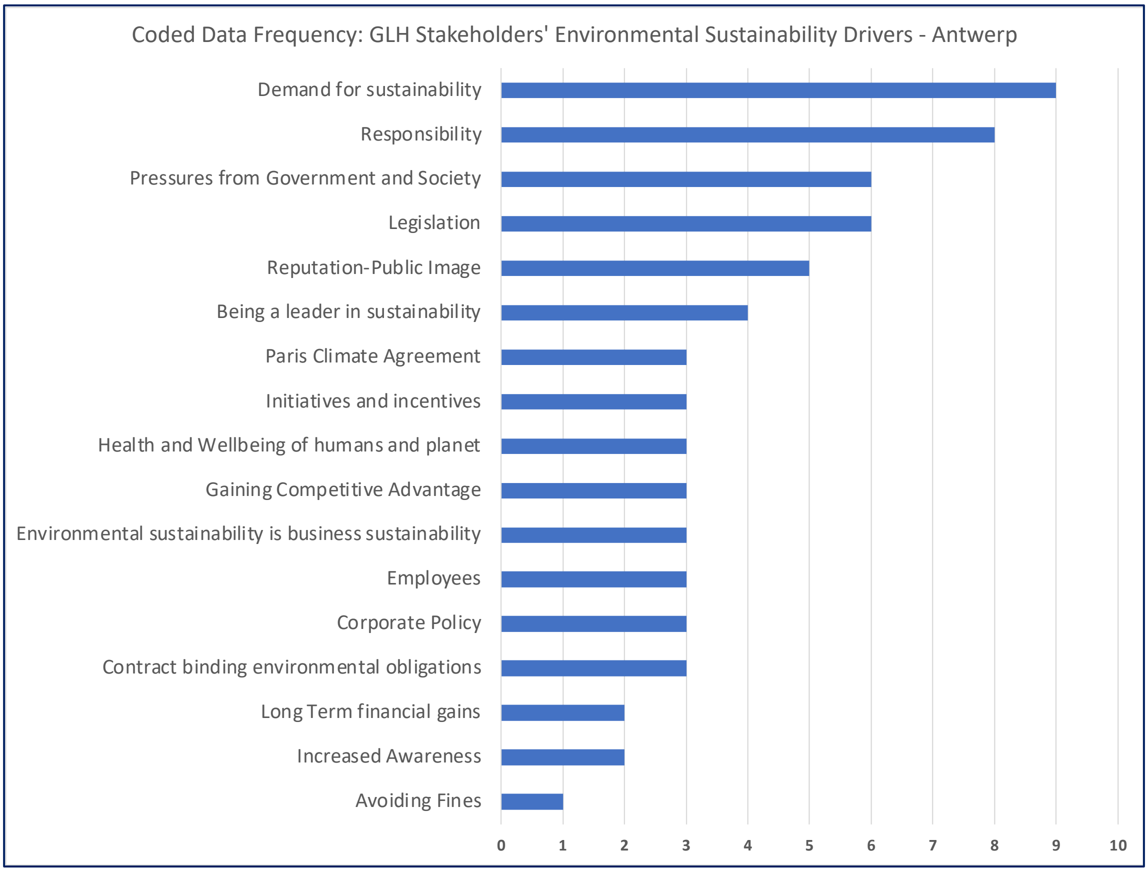


Figure 4.18 Coded Data Frequency: GLH Stakeholders' Environmental Sustainability Drivers – Antwerp (Source: NVivo 12)

4.3.3.2 GLH Stakeholders' Environmental Sustainability Initiatives

As can be seen from the list of initiatives in Table 4.40, the port authority has a large number of initiatives compared to other stakeholders. That is because they are setting a target to be Europe's most sustainable port, according to Port of Antwerp Sustainability report (Port of Antwerp, 2020). The port authority initiatives are also a mix of initiatives to help on different environmental issues. They are not concentrating on one topic. They had initiatives set up for greenhouse gas emissions, energy use, nature reserves, plastic and waste pollution, odour pollution and water quality.

On the other hand, participants in this GLH have an emphasis on waste initiatives such as Clean-up campaign, Zero-Waste program, Ship's Waste discounts, Plastic Catcher, Ship recycling, and reusing packages. This is in line with the results of the word frequency cloud Figure 4.1 in the environmental impact theme, as it also highlighted an emphasis on waste in this case.

Table 4.40 Antwerp Case - GLH Stakeholders' Environmental Sustainability Initiatives

Stakeholders	Initiatives
PA	Encouraging an environmental modal split
	Shore-based power for inland vessels and looking to extend it to seagoing vessels
	ESI discounts
	Energy Hub (Energy transition to alternative and renewable energies)
	Using alternative fuels for the ports' vessels and vehicles
	Water Quality: Dredging and sustainably processing the most polluted sludge in the docks
	Plastic Catcher: cleaning up waste, plastics, and litter from the waterways
	Operation Clean Sweep programme for Zero Pellet Loss: is a platform bringing together several stakeholders of the GLH to prevent loss of plastic pellets
	Clean-up campaign
	Nul-O-Plastic: is a nature vacuum cleaner for plastic
	iNoses
	Species Protection Programme
	Agriculture Innovation Fund
	Developing and maintaining nature reserves on the right and left banks of the river
	Handing in Ship's waste discounts
	Carbon Capture and Utilisation (CCU) studies and research
	Condor clean-up barge and bilge barge to remove solid and liquid waste from the water and shores
	Wind and solar arrays in the port
	Employees' environmental commuting
	The World Ports Climate Action Program (WPCAP)

Table 4.38 (continued)

Stakeholders	Initiatives
TO/LSP	Green energy production: solar and wind
	Zero Waste Programme: an initiative to avoid packaging through product flow in bulk
	Government Green Solution Truck Subsidies
Log/C.O.	Employees' environmental commuting
	Reusing packing and exploring alternative packaging solutions and designs to eliminate waste and reduces air shipped
	Eliminated Styrofoam cups
Assoc.	An initiative platform to provide members with knowledge and best practice
	A program to encourage voluntary cooperation between stakeholders to reduce GHG emissions
	Supporting the Getting to Zero Coalition
	Working closely with World Ports Climate Action Program (WPCAP)
Ship.	Member of the Clean Cargo Initiative
	Ship Recycling
	UN Global Compact
	Collaboration with the Ocean Clean-up Project

4.3.3.3 GLH Stakeholder’’ Environmental Sustainability Barriers

Figure 4.19 shows the frequency of responses coded under each theme for this GLH. The top five barriers in this case are ‘cost’, ‘sustainability is not prioritized’, ‘losing competitive advantage’, ‘lack of data to measure environmental performance’, and ‘the small scale of new sustainable technologies’. The frequency count of these responses emphasizes their importance and suggests a degree of prioritization within the participants’ perception. However, it is crucial to note that the importance and ranking of these barriers vary among participants, as their individual perspectives and challenges differ. Further quantitative investigative research is also needed to validate the significance of each of these aspects and their ranking in terms of significance.

It Is clear from Table 4.41 that the barriers are more than the drivers identified above. Through the responses collected in this case study, several barriers were identified, with a significant portion centring around financial considerations (Excerpt B3.3-4). These include the initial investment in new technologies, potential loss of profit, limited budget for sustainable investments, the cost of hiring personnel to manage and measure environmental sustainability, the higher price of sustainable options, and the potential for a loss of competitive advantage by setting higher prices to cover the cost of offering sustainable alternatives. Additionally, other factors that contribute to a business's success, such as convenience, service level, profit, and reliability, may be prioritized over sustainability (Excerpt B3.3-1).

Furthermore, the companies are hesitant to offer a product that has no guaranteed market or demand, and the customers cannot easily find sustainable products or services because they are not offered by companies. Therefore, this presents a dilemma for companies seeking to adopt more environmentally sustainable practices, as it is unclear whether the demand for sustainable products should be stimulated by the customer, or the supply of such solutions should be created by the industry (Excerpts B3.3-2, B3.3-3).

Additionally, the infancy of technology and the inflexibility of solutions are other barriers highlighted by respondents in this case. Therefore, the stagnant position or the high prices of some sustainable technologies or solutions are causing a barrier for stakeholders to move towards greener operations.

In contrast, by reviewing Table 4.39 and Table 4.41, it was interesting to find that there are both common and contrasting factors influencing the drivers and barriers to environmental sustainability. One common factor is the role of knowledge and awareness, with a lack of knowledge and awareness identified as a barrier, and an increased awareness identified as a driver. Additionally, legislation and regulations were identified as a driver, while the lack of such regulations was identified as a barrier. This could suggest that while there are efforts being made towards environmental sustainability, there may still be incomplete progress in this area (Excerpt B3.3-5). Table 4.42 presents excerpts from the data.

Table 4.41 Antwerp Case NVivo Matrix - GLH Stakeholders' Environmental Sustainability Barriers Codes Frequency (Source: NVivo 12)

Environmental Sustainability Barriers	PA	TO & LSP	Log Dept.	Ship	Assoc.	LC	Total
Complicated process (requires collective action & collaboration from several sectors)			1		1		2
Cost (ex. sustainable solutions are 'more' expensive; low budget for sustainability)	1	2	1	1	2	1	8
Different regulations in different regions (ex. Inconsistency of regulations; additional work)					1		1
Different sustainability agendas for different stakeholders			1	1			2
Difficulty in improving past the legislation requirements (difficulty convincing private companies to)	1	1					2
Difficulty in mapping the impact of activities	1						1
Lack of data to measure environmental performance	2				1		3
Lack of enforcing environmental sustainability regulations and legislations		1					1
Lack of feasibility or practicality of some sustainable technologies or solutions (ex, env. restrictions)	1						1
Lack of good measurement frameworks	1	2					3
Lack of human resources					1		1
Lack of knowledge and awareness			1				1
Logistics industry environmental impact is seen as small compared to other sectors or services (chemical cluster)			1				1
Long distance air pollution (NOx) travels negate local decrease in emissions	1						1
Losing competitive advantage (price or enforcing sus measures)		1	1	1	2		5
Some environmental indicators are not true representation of the impact			1				1
Sustainability is not prioritized (ex. it is not incorporated yet in metrics of a successful business, price is seen more important, effort & inconvenience, or developing economy faces social challenges)		1	1	3		1	6
Technology infancy and high cost may drop				1	1		2
The Inflexibility & amount of cargo required for more sustainable modes of transport (ex. Inland vs truck)	1	2					3
The small scale of new sustainable technologies (ex. availability & access to environmental options)	1		1			1	3
Unknown profitable extent of sustainable technologies investment			1		1		2

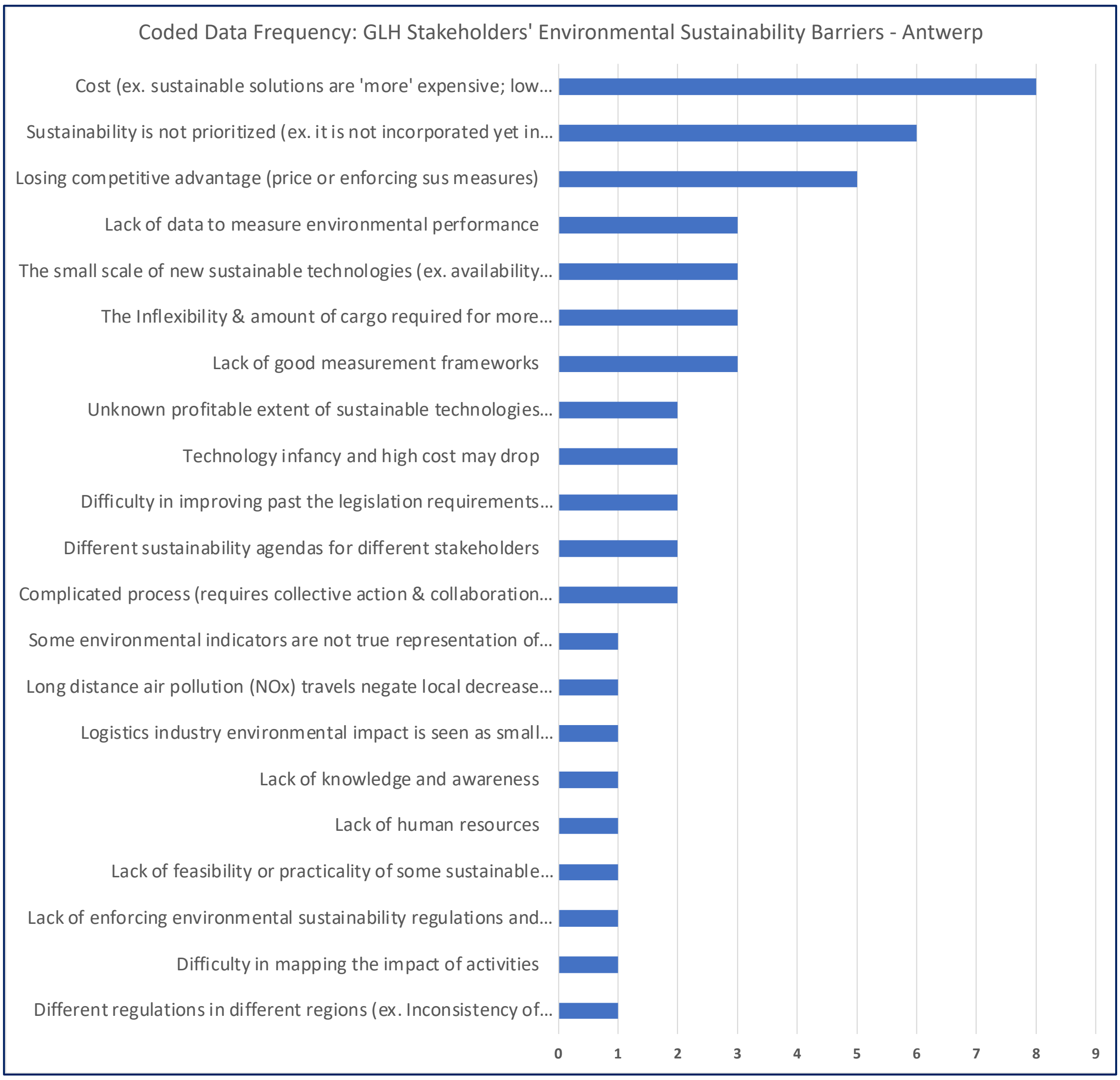


Figure 4.19 Coded Data Frequency: GLH Stakeholders’ Environmental Sustainability Barriers – Antwerp (Source: NVivo 12)

Table 4.42 Antwerp Excerpts Supporting: GLH Stakeholders' Environmental Sustainability Barriers Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
B3.3-1	TO & LSP	*"Money is a big factor. The greener options are more expensive, so you need higher investments. And on the other hand, prices go up and then the customers would rather go to someone else because it's cheaper offer so it's both ways. So that is why I say you need customers who want to transport in a green way because otherwise it is not possible." (C2L1P3)*
B3.3-2	LC	*"If we want to consume differently, we do not always have access to products which are more sustainable than others. So often, we as a consumer don't always have a choice. For example, there's a lot of plastic use in packaging we don't often have always a choice to not to go for this option." (C2L3P1)*
B3.3-3	Assoc.	*"So that's the eternal chicken and egg problem that we've had with alternative fuels and provision of bunkering in ports. So, I guess the investment is probably the highest barrier" (C2L3P2)*
B3.3-4	Ship.	*"... and then you go to your customer and say I need to add 40% on top of ocean freight because I want to be carbon neutral, zero. He will tell you 'Thank you, I will look for another carrier'. So, like this is the main challenge." (CEL2P3)*
B3.3-5	PA	*"The environmental quality criteria which is harder and which we think will become more stringent in the future but that is not at this moment... and we expect that they will become more stringent in the future, so the question is 'are you going to anticipate already now on it or are you going to wait until these criteria are changing?'." (C2L1P1)*

4.4 Case Study C: Liverpool GLH

This section will present and describe the themes that emerged from the data collected in the Liverpool GLH case study, and provide supporting excerpts from the participants to illustrate these themes. Participants codes and abbreviations used in the discussion and data display of this case study are presented in Table 4.43.

Table 4.43 Liverpool Case Stakeholders Abbreviations & Participants Codes

Abbreviation	Description	Participants Codes
PO	Port Owner and Operator	C3L1P1 & C3L1P2 & C3L1P3
TSP	Transport Service Provider	C3L2P1
Log Dept.	Global Retailer Logistics Department	C3L2P2
Ship.	Shipping Line	CEL2P3
LC	Local Community	C3L3P1
Gov.	Local Government	C3L3P2
Assoc.	Trade Association	C3L3P3

4.4.1 Theme 1: Building an Understanding of the GLH Concept

This global theme has 5 organising themes that contribute to the understanding of the concept of GLH in the case of Liverpool GLH.

4.4.1.1 GLH Definition

Some participants in this case were unsure about the definition, which signals that the concept can be confusing in the industry as well (Excerpts C1.1-1, C1.1-2). On the other hand, other participants defined it as a location where transportation modes intersect for international goods exchange, linking internal and external trade. The global retailer logistics department participant also explained that it is used to consolidate group collections from a wider supplier network and to maximise the shipments fill for onward shipment to destinations (Excerpts C1.1-3, C1.1-4).

Furthermore, there are three themes that are most common between participants' responses in this case. These are good accessibility and global connection, logistics and marine services, and multimodal transport, as shown in Table 4.44. This could be an indication of the importance of these features in this GLH. Additionally, Figure 4.20 shows the frequency of responses coded under each theme. It suggests that 'logistics and marine services', 'multimodal transport', 'good accessibility and global connection', 'major maritime port', and 'industrial cluster' are among the most crucial aspects of a GLH. These themes have the highest frequency of responses, emphasizing their importance in the participants' perception.

According to participants, a GLH is a strategic location with a setting that facilitates international trade, including a maritime port connected to global shipping routes. In this GLH, there is also inland connection to the Manchester Ship Canal, which allows for inland shipping as part of the modes transport connected to this GLH (Excerpt C1.1-6). The location also serves as a manufacturing and export base, while multimodal connections to the location facilitate the distribution of goods. Additionally, a Free-Trade Zone in a GLH attracts various industries, such as manufacturers, suppliers, energy sectors, exporters, and service providers, to set up an industrial cluster and take advantage of the strategic location, the setup of varied services and facilitates, and global trade route connections (Excerpts C1.1-4, C1.1-5). Table 4.45 presents excerpts from the data.

Table 4.44 Liverpool Case NVivo Matrix - GLH Definition Codes Frequency (Source: NVivo 12)

GLH Definition Keywords	PO	Log Dept.	TSP	Gov.	Assoc.	Ship.	Total
Good Accessibility & Global Connection	1	1		3	2	2	9
Economic engine & trade link				2	1		3
Infrastructure to accommodate & deliver			1			1	2
Logistics & Marine Services	14	1		2	2	1	20
All types of cargo	1						1
Import, export, transhipment & FTZ		1		1	1		3
Safe Transport		1			1		2
Tailored, excellent, flexible & smooth service	3						3
Major Maritime Port	1			4	1	1	7
Port Cluster				1			1
Multimodal Transport: Road, Rail, River, Air, Ocean, Short-sea shipping, & Pipelines	5	1	1	1		1	9
Strategic geographical location	2					1	3
Synergy between maritime, logistics & industrial activities			1	1			2
Industrial cluster			1	2	1		4

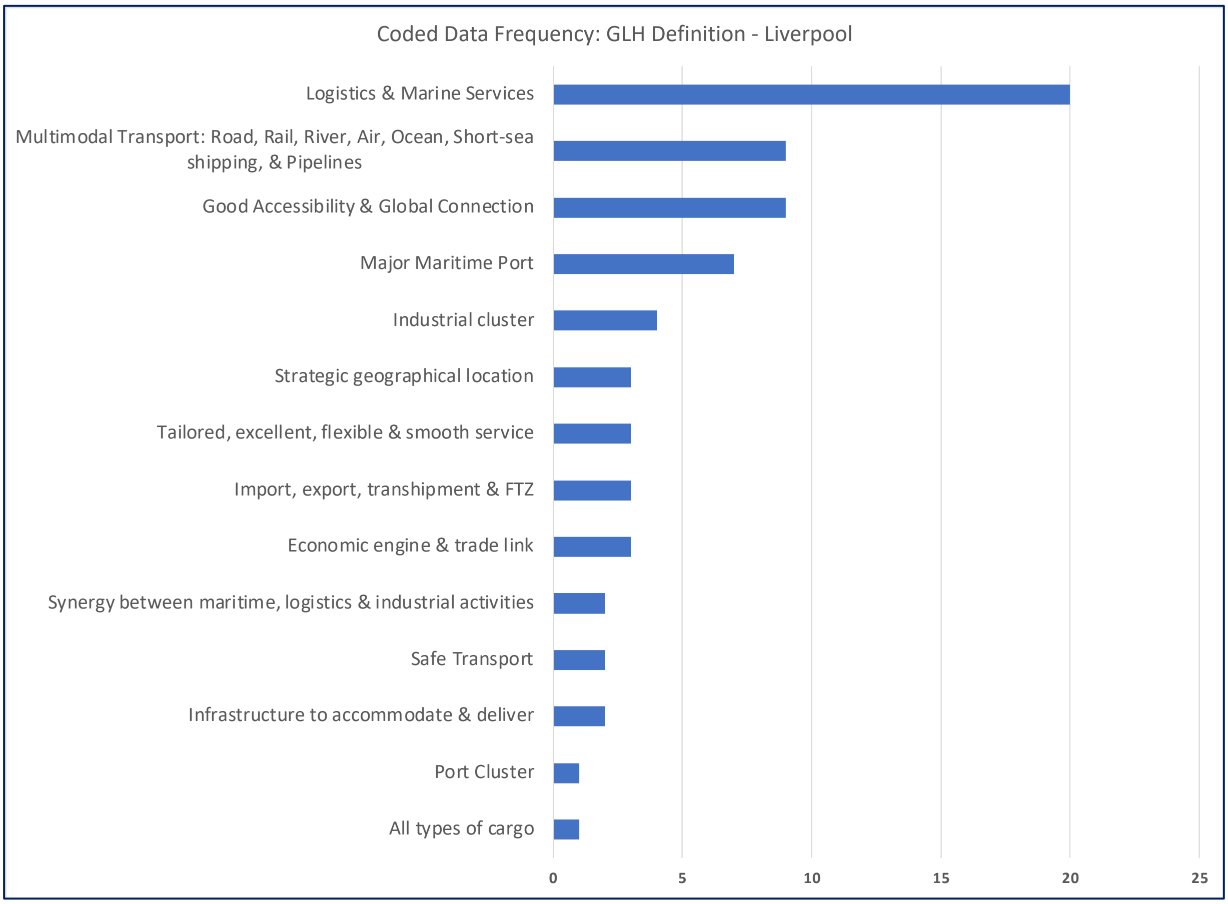


Figure 4.20 Coded Data Frequency: GLH Definition – Liverpool (Source: NVivo 12)

Table 4.45 Liverpool Excerpts Supporting: GLH Definition Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
C1.1-1	PO	*"There isn't really a definition of it. It was a term that certainly for me I hadn't really come across and I know what all the words mean, and I know what a logistics hub is, but I've not really seen them put together in that way... it's not a term that I'd certainly come across" (C3L1P1)*
C1.1-2	Assoc.	*"I think all I can say is that I think I've seen some major maritime ports or indeed places refer to themselves in that way" (C3L3P3)*
C1.1-3	Log Dept.	*"We actually use the terminology when we look to consolidate, group collections, deliveries, shipments from a wider supplier network. We consolidate such orders in the Hub for onward shipment to destination. We use it to maximise our shipment unit fill and also use the location as a base due to it being linked to Multimodal options, possibly a Free Trade Zone, consolidation and added value services. Good base for Global Trade" (C3L2P2)*
C1.1-4	Gov.	*"it's primarily a transport hub, and possibly airport, like Manchester Airport or Heathrow. And a maritime port, such as Port of Liverpool... where there's an intersection between the inland interface and inland, rail, or road connections to domestic consumer market... and manufacturing and export base within a country, and the outward-facing international air routes or international shipping routes. So, serving international trade globally. And this is an intersection between those two aspects, and then around that you got ports or airports tend to attract related industries... so food processing industry, low carbon industries, energy sectors, professional services to support the activity of a port, or manufacturing who wants to export through the port and move supply parts..." (C3L3P2)*
C1.1-5	Ship.	*"So, like you are connected and have easy access by sea but most importantly it's the land services. Land services, even the setup when you have like cold stores, the warehousing, you have air freight facilities for easy access, and then you could have the biggest reach" (CEL2P3)*
C1.1-6	PO	*"So, as well as the river, we also operate Manchester ship canal. So, then the waterway goes up to Manchester, so we can facilitate movement of goods by that route taking them off roads and rail" (C3L1P2)*

4.4.1.2 GLH Primary Stakeholders

Participants in this case identified GLH primary stakeholders as government and local authorities, port owners and operators, logistics and freight forwarding companies, shipping, manufacturers, local community, investors, cargo owners, and associations among others as presented in Table 4.46.

Respondents mentioned port authorities, port owners, and terminal operators as primary stakeholders. It should be noted that in this case, the terminal operators and the port owners are one and the same, as Peel Ports holds both roles in the Port of Liverpool and the Manchester Ship Canal. However, the reference was also to other ports in the area (Excerpt C1.2-1).

Additionally, airports were identified as a primary stakeholder. In this case the Peel Group also part-owns the Liverpool John Lennon Airport and there are plans to expand its operations to include cargo transport to complement the multimodal connections of this GLH (Excerpt C1.2-2). Despite the privatized nature of the industry in this case, it was common among all participants that the government and local authorities were considered as primary stakeholders. Additionally, associations and interest groups were identified by participants as primary stakeholders such as Mersey Maritime, Propeller Club Liverpool, and Chambers of Commerce.

Another common primary stakeholder in this case is the cargo owner and manufacturer. The reason behind is that they are considered the lifeblood of the GLH (Excerpts C1.2-13, C1.2-4). Furthermore, the logistics, freight forwarding and haulage companies in addition to the shipping lines for cargo movement, services and distribution are identified by several stakeholders. Table 4.46 shows a sense of cohesion in the perspectives of participants on primary stakeholders in this case. Table 4.47 presents excerpts from the data.

Furthermore, Figure 4.21 shows the frequency of responses coded under each theme. It suggests that ‘port authorities’, ‘cargo owners or shippers’, ‘government and local councils’, ‘shipping lines’, and ‘logistics companies and freight forwarders’ are among the most frequently mentioned primary stakeholders of a GLH. These themes have the highest frequency of responses, emphasizing their importance in the participants' perception.

Table 4.46 Liverpool Case NVivo Matrix - GLH Primary Stakeholders Codes Frequency (Source: NVivo 12)

GLH Primary Stakeholders	PO	Log Dept.	TSP	Gov.	Assoc.	Ship.	Total
Airports	1			1		1	3
Associations & interest groups				3		1	4
Cargo owners or shippers	3	1	2		1	2	9
Employees	1					1	2
Government & local councils	2	1	1	1	1	2	8
Industrial cluster companies				1			1
Inland vessel sector				3	1		4
Local community	1						1
Logistics Companies & Freight forwarders	1	1	1	1	2	1	7
Investors	1					1	2
Port Authorities or owners-operators	3	2		3	2		10
Railway operators				1	1	1	3
Shipping lines	2	1		1	2	1	7
Terminal operators				2	1	1	4
Trucking companies				1	1	1	3

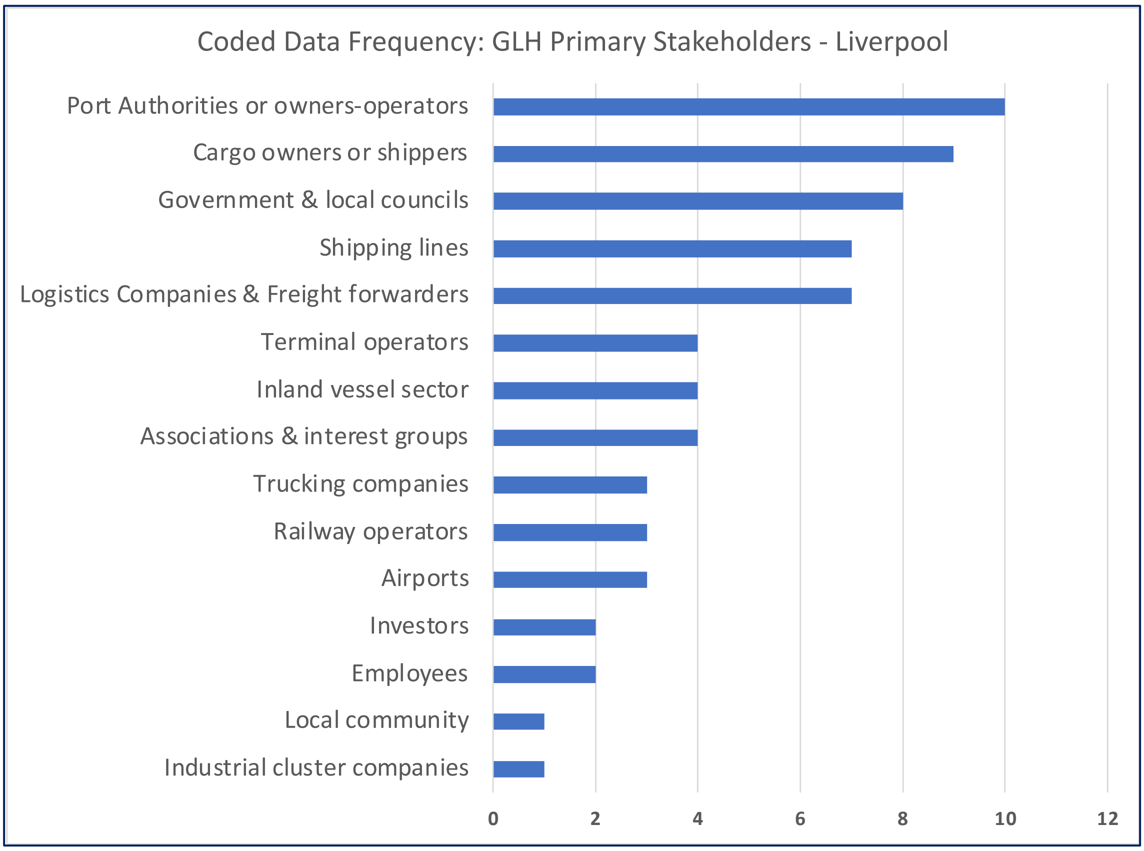


Figure 4.21 Coded Data Frequency: GLH Primary Stakeholders – Liverpool (Source: NVivo 12)

Table 4.47 Liverpool Excerpts Supporting: GLH Primary Stakeholders Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
C1.2-1	Gov.	*"...obviously out of a port, you've got the shipping lines mainly across to North America and towards the Panama Canal direction. And then you've the logistic operators, haulage companies doing the inward transport from the port to the wider market in the UK and rail operators, ship canal as inland flow as well. And you've other freight terminals around the city region. And the wider industry cluster of energy, manufacturing, processing industries which are supported by the port. And you've the local authorities" (C3L3P2)*
C1.2-2	Gov.	*"Liverpool John Lennon airport hasn't got much of a freight role currently, but it's got aspirations to expand into that area." (C3L3P2)*
C1.2-3	PO	*"...the shipper that's going from A to B, because without it you haven't got the logistics hub" (C3L1P1)*
C1.2-4	Log Dept.	*"What drives us is that obviously the consumer, the manufacturer, and the importer" (C3L2P2)*

4.4.1.3 Role, Activities, and Operations of GLH Primary Stakeholders

The role, activities, and operations of the stakeholders were identified depending on the nature of the stakeholder's role or operations within the GLH, as listed in Table 4.48. The port owner and operator respondents described their role and operations from private and public aspects because they have public roles as a statutory harbour authority and a licensing authority, even though they are a private company. Additionally, they own and operate the port as a private company providing services as terminal operators, distribution, logistics services and landlords in terms of managing and renting the port's facilities. It is clear that there is an overlap of role and operations in this case as shown in Table 4.48. This overlap can be seen between the port and the government and among the port, the shipping line, and the transport and logistics providers (Excerpts C1.3-1, C1.3-2).

Furthermore, the local government plays a crucial role in the operations of this GLH and other businesses and industries in the city region. They do this by setting policies and regulatory frameworks, developing industrial, infrastructural, and transportation plans, advocating for and raising awareness on certain issues with national governments, providing financial support to businesses to drive change and innovation, and linking innovation with demand on issues such as climate change. Additionally, the local government works to provide new infrastructure outside of the port to support urban logistics and distribution. All these activities help to create a holistic, collaborative approach to supporting the growth and success of the GLH (Excerpt C1.3-3). This could be the reason behind their prominence in the identification of primary stakeholders in the previous theme. Table 4.49 presents excerpts from the data.

Table 4.48 Liverpool Case Role, Activities, and Operations of GLH Primary Stakeholders

Stakeholder	Role, Activities & Operations
PO	-Public Role Operates as a statutory harbour authority Operates as a licencing authority Customs Cargo Inspection Regulatory Body and Local Authority -Private Role: Cargo Handling Warehousing Freight Forwarding Landlord (managing & renting the port facilities) Stevedoring Providing the port's infrastructure, facilities, and equipment Landowner Port operator Value-Added Services Container depot services Container Weighing Short sea shipping -conservancy -pilotage -berthing -facilities rental -marine services -shipping
Gov.	Regulatory Body and Local Authority Setting policies and regulatory frameworks for the city region Setting local industrial strategies and transport plans Lobbying and communicating with national governments Providing financial support to businesses to drive big changes and new directions Convening role to link innovation with real-life issues to stimulate demand Providing new infrastructure
Ship.	Ocean transport & related services Logistics Solutions Inland transport Warehousing Distribution Supply chain management Insurance
Assoc.	Lobbying Policy Campaigning Provide information, support, and advice on regulations and issues Representing a united voice of the member stakeholders Exchange of best practice Provide Training

Table 4.48 (continued)

Stakeholder	Role, Activities & Operations	Stakeholder	Role, Activities & Operations
TSP	Air Freight Ocean Freight Road Freight Outsourcing transportation and storage facilities Warehousing Distribution Commercial Vehicle Maintenance Cargo Handling Exports used Trucks and Transport Equipment	Log Dept.	Logistics Consolidation Operations Distribution planning and activities
		LC	Employees, Economic development of the region, and receiving goods as consumers

Table 4.49 Liverpool Excerpts Supporting: Role, Activities, and Operations of GLH Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
C1.3-1	PO	*"I think Liverpool has a very wide-ranging operational basis in that respect. And it's a mix of most activities... some we do ourselves and some same operations but done by a tenant" (C3L1P2)*
C1.3-2	TSP	*"Our main activity is transport by road, and it is primarily the UK but also Europe. We also do air freight and ocean freight" (C3L2P1)*
C1.3-3	Gov.	*"We provide a leadership role in terms of setting a policy and regulatory framework for the city region, which fits within the national framework set by central government... we also do local industrial strategy, transport plan to guide policies in terms of different parts of the economy... and we have an influence role... the corridor for rail is quite a big issue at the moment so we are lobbying and communicating with national governments to raise the priority level on that and raise awareness with them as to why it's needed and what to do for us... we also have a delivery role through our funding division we can deliver new infrastructure" (C3L3P2)*

4.4.1.4 GLH Physical Infrastructure and Connections

The participants in this case highlighted the importance of the transportation infrastructure and access to multimodal transport as part of their definition of this GLH. Participants also highlighted several plans for development and projects to accommodate the changing factors affecting the market such as technology, increasing global trade, environmental sustainability, and the advancement of their competitors.

The development of new infrastructure and connections in this case is a shared responsibility between the government and the private sector. Given that this GLH is still emerging and developing, the development and maintenance are concentrated on five key areas: port infrastructure, rail networks, inland waterway connections and facilities, biomass facility, and the establishment of new maritime trade flows. These focus areas are critical for the effective operation and growth of the GLH. By investing in these areas, the GLH will increase and improve the movement of cargo, facilitate international trade, improve environmental sustainability, and support the economic development of the region.

Some examples of the development projects and plans are the development of the Liverpool2 deep water container terminal in the Port of Liverpool (Excerpt C1.4-1). The rail networks improvement and development is another aspect of development to improve the operations of the GLH and decrease the amount of trucks on the roads from the port (Excerpts C1.4-2, C1.4-3). Inland connections development to ensure smooth operations and removing congestions off the road for the magnitude of the cargo of the GLH. Additionally, new maritime trade routes to stimulate and increase the cargo flow to Liverpool GLH (Excerpt C1.4-4). Table 4.50 presents excerpts from the data.

Table 4.50 Liverpool Excerpts Supporting: GLH Physical Infrastructure and Connections Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
C1.4-1	PO	*"In terms of Liverpool2 development, there was a lot of promotional stuff done about the cargo-200 initiative, which was about bringing the containers up north in the country, on the basis that they used to come into the southern ports and have to be hauled up to this area, and there's a lot of work calculating the saving in road miles and try bringing obviously the containers here, and then distributing them for the Manchester-Liverpool and further north market. It's meant to be a net environmental benefit from doing that is part of the key drivers in full, and ticking sustainability, and in the development books" (C3L1P1)*
C1.4-2	Gov.	*"...businesses tell us that they need a particular infrastructure connection improved. So, for Liverpool, Hull, and Newcastle, the TransPennine corridor for rail is quite a big issue at the moment. So, we are lobbying and communicating with national government to raise the priority level on that and raise awareness with them as to why it's needed and what to do for us" (C3L3P2)*
C1.4-3	PO	*"At Port of Liverpool we have a rail terminal, and we have plans to build more... We have just launched a rail container service" (Peel Ports, 2020c)*
C1.4-4	Gov.	*"We are the leading transatlantic gateway to the UK and 45% of the trade from North America goes to Liverpool. Subject to Brexit moving at some point, it could have a gradual advantage as things maybe orientate slightly more towards westward facing links. Towards North America - Panama Canal direction" (C3L3P2)*

4.4.1.5 GLH Governance Structure

The governance structure in this GLH adopts a decentralized structure. The setup of this GLH is different to the other cases because the public sector does not have the same direct involvement as seen in other cases. The City Region participant explains that the nature of the industry in the UK as compared to Europe is different because *"it is a very privatized industry" (Excerpt* C1.5-1*). T*he Port of Liverpool has a public authoritarian role assigned to them by the government, and a private profit-oriented role tending to the investors' interests and increasing profit, which also provides a decentralized authority and operations (Excerpt C1.5-2). *Additionally, the decentralization is also applied to the government. Liverpool City Region as a local authority in the region is devolved from the central government (Excerpt* C1.5-3*). Despite this decentralization, the governance structure is still subject to various regulations and legislation, including those issued by the United Nations, national, and local controls (Excerpt*

C1.5-5*).* Furthermore, the trade association also influences future regulations, as it works in collaboration with the government to shape and communicate new policies and regulations (Excerpt C1.5-4). In addition to this, the trade association supports and provides information and training to all types of GLH stakeholders such as ports, shipping lines, logistics and freight companies, etc. This includes communicating new regulations and facilitate training and the transition of businesses if required. Table 4.51 presents excerpts from the data.

Table 4.51 Liverpool Excerpts Supporting: GLH Governance Structure Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
C1.5-1	Gov.	*"...that's given us greater devolution than some other areas, which don't have a city region authority. That gives us greater funding opportunities and more devolved power" (C3L3P2)*
C1.5-2	PO	*"Peel Ports Group operates as a statutory harbour authority, licencing authority, port operator and a landowner in numerous locations around the UK and Ireland" (Peel Ports, 2020a)*
C1.5-3	Gov.	*"The UK is quite a different model to the continent of Europe because the public sector has much more direct involvement in ports, but in the UK, it's mainly done by private operators. This is a very private-sector maritime freight and logistics industry and they will do their corporate commercial things. The government and public sector tend to intervene where we need to change or influence and help collaboration or change. All mandated through regulations as required" (C3L3P2)*
C1.5-4	Assoc.	*"We draw a distinction between our campaigning and lobbying work where we're trying to influence and change future regulation and policy" (C3L3P3)*
C1.5-5	Assoc.	*"Shipping environmental emissions is regulated at the global level by the United Nations. So, there are now rules in place about the reduction of sulphur. It is like a pair of scissors. You have local controls here in the UK and across Europe about the emissions coming from the ships, trucks, and trains servicing the port business, and then you've got the other part of the system is the global regulations saying everybody must now use low sulphur fuel" (C3L3P3)*

4.4.2 Theme 2: Environmental Measurement and Performance in GLHs

This global theme has 5 organising themes that describe environmental measurement and performance related organizing themes in the case of Liverpool GLH. The participants responses were complemented by reports, documents, and website data where possible to generate precise data for the environmental impact and the environmental indicators used by the primary stakeholders in this GLH.

4.4.2.1 GLH Stakeholders' Environmental Impact

The environmental impact of the GLH was explored through the primary stakeholders’ impact. Table 4.52 lists the environmental impacts of GLH and Figure 4.22 shows the frequency of responses coded under each theme. It suggests that ‘greenhouse gas emissions’, ‘waste’, ‘noise’, ‘liquid waste’, and ‘particulate matter’ are among the most mentioned environmental impacts of a GLH. These themes have the highest frequency of responses, emphasizing their importance in the participants’ perception.

Table 4.53 presents the environmental impacts in detail linking them to the contribution of each stakeholder. Reduced air quality was one of the common impact factors among all stakeholders. This is due to the emphasis and awareness around climate change as it is a global problem and an impact that all stakeholders contribute to currently or in the case of the local community affected by it (Excerpt C2.1-1). This is also evident in the word frequency cloud in Figure 4.23, where ‘air’ is the most frequently used word by participants when discussing the environmental impact.

Furthermore, waste, water, and noise are mentioned frequently when participants were discussing their environmental impact, as shown in Figure 4.23. Waste was a particular concern for participants, however, the type of waste varied among participants. For example, the transport service provider had a focus on ensuring that as much waste as possible is recycled, with cardboard being their main source of waste (Excerpt C2.1-2). Food waste was also identified as a significant global issue by the shipping line, with traders sometimes overloading containers with more food than can be sold, resulting in waste and negative environmental impacts (Excerpt C2.1-4). Additionally, the shipping line respondent explained that water pollution is an environmental issue for their type of activities and operations, with the main causes being oil spills and the management of water ballast in the shipping industry (Excerpt C2.1-3). Noise is a focus in this case because of the proximity of the residential areas to the GLH. Houses are located two streets away parallel to the gates of the port and therefore noise from operations and activities in the locality is an issue for locals.

On the other hand, several participants mentioned the unavoidable impact of vehicle movements, which are necessary for the functioning of certain industries but also contribute to pollution (Excerpts C2.1-5, C2.1-6). An approach to mitigating this impact by the port, is to promote short-sea and other alternative modes of transportation, which can help to reduce the number of vehicle movements causing pollution. The government and council's approach to addressing pollution caused by these "*necessary evils*" was also mentioned, with the use of taxes and clean air zones being one approach. However, some participants expressed concern about the effectiveness of these measures in dealing with the problem (Excerpt C2.1-6). This highlights the importance of finding effective ways to mitigate the negative environmental impacts of vehicle movements, while also considering the practical realities of the industries that rely on them.

Furthermore, during the field trip to Liverpool GLH, the researcher observed various forms of environmental impact. These impacts included noise pollution, the proximity of residential areas to the port, industrial cluster, and hinterland; most waterfront locations being dedicated to GLH operations. Additionally, the researcher observed litter and fly tipping in the area, including various types of waste, such as tyres, oil and soil contamination, metal waste on land and in the sea, and wood pallets. The impact on biodiversity and the presence of dust and rust dust from the handling of scrap metals were noted. The researcher took pictures (Appendix 4) of the area around the port, industrial factories, transport companies, and Royal Docks, which demonstrate the wide-ranging and holistic nature of the environmental impact experienced in the area contributed to by a combination of operations and activities of various stakeholders in the region. It should also be noted that the port participants were very cautious about sharing any information regarding their environmental impact that could affect their image or their customers image negatively. Table 4.54 presents excerpts from the data.

Table 4.52 Liverpool Case NVivo Matrix - GLH Environmental Impact Codes Frequency (Source: NVivo 12)

Environmental Impact	**PO**	**Log Dept.**	**TSP**	**Gov.**	**Assoc.**	**LC**	**Ship.**	**Total**
Biodiversity & ecosystem disturbance					2			2
Consumption of natural resources	2		1					3
Greenhouse Gas emissions	1	1	3	2	4	1		12
CO2 emissions							1	1
Particulate matter		1		2	1			4
Sulfur dioxide							1	1
Land-use change					1			1
Noise pollution				1	1	5		7
Odour pollution						3		3
Sediment Pollution		1						1
Waste	2	1	5		1		1	10
Liquid waste	1	1	1				1	4

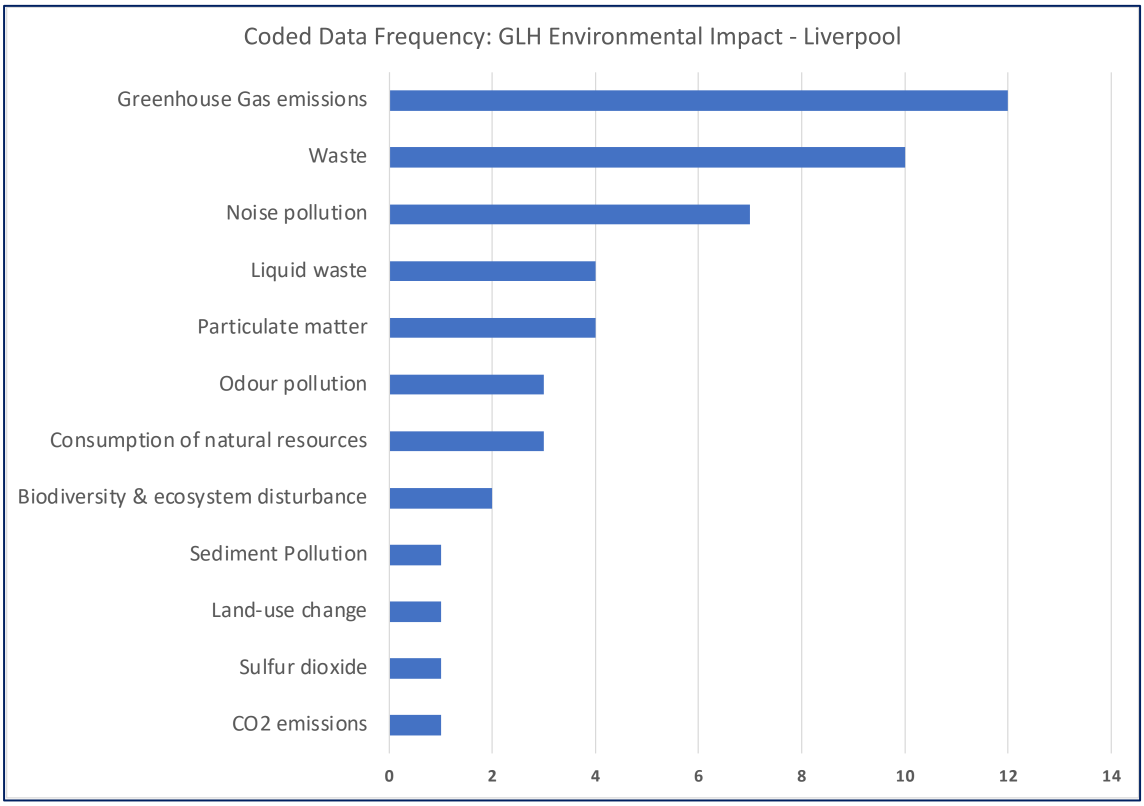


Figure 4.22 Coded Data Frequency: GLH Environmental Impact – Liverpool (Source: NVivo 12)

Table 4.53 Liverpool Case NVivo Matrix - GLH Environmental Impact Codes - Description

Environmental Impact	Description	PO	Log Dept.	TSP	Gov.	Assoc.	LC	Ship.
Biodiversity & ecosystem disturbance	Impact on biodiversity and ecosystem					√		
Consumption of natural resources	Energy consumption - Electricity/Gas/Fuel	√		√				
	Water consumption			√				
Air Pollution	Reduced air quality	√	√		√	√	√	√
	Greenhouse Gas emissions		√	√				
	CO2 emissions							√
	Particulate matter		√		√	√		
	Sulphur dioxide							√
Water Pollution	Oil Spills							√
	Water Ballast Mg.							√
	Emissions to water		√	√				
Noise pollution	Loud noise				√	√	√	
Odour Pollution	Strong & unpleasant smell						√	
Waste	Liquid Oil Waste			√				
	Liquid Waste	√	√	√				√
	Hazardous & Non-Hazardous waste			√				
	Contaminated dredging					√		
	Food							√
	Batteries			√				
	Tyres			√				
	Metal			√				
	Cardboard			√				
Sediment Pollution	Soil contamination		√					
Land-use change	Green land displacement					√		

Figure 4.23 Liverpool Case Environmental Impact NVivo Word Frequency (Source: NVivo 12)

Table 4.54 Liverpool Excerpts Supporting: GLH Environmental Impact Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
C2.1-1	Assoc.	*"We've seen over the last two or three years the issue of air quality become much much more prominent than it has been. I mean I've been working in this area for about 20 years, and air quality kind of comes and goes as an issue, and it's really come back. And cities and towns, in the UK and all over the world really, have been much more strong about wanting air quality to be addressed by the emitters of that" (C3L3P3)*
C2.1-2	Ship.	*"Every single waste product we produce is recycled… the main waste we have is cardboard in terms of packaging" (CEL2P3)*
C2.1-3	Ship.	*"You have water pollution in two aspects: oil spills and then the water ballast, water ballast management from an ocean perspective" (CEL2P3)*
C2.1-4	Ship.	*"Food waste is a huge global topic… I would say the main impact is because of the traders are just dumping. Like okay, let's just bring 50 containers of banana, but then, do you really know if you need these. Sometimes the cargo stays in the container and then they're not able to sell it in this sense" (CEL2P3)*
C2.1-5	PO	*"There are a large number of vehicle movements that you cannot get away from, it's the nature of it. However, by promoting short-sea and sorts we can aid in juicing those" (C3L1P2)*
C2.1-6	TSP	*"[trucks]… because they are a necessary evil, but they do pollute…" (C3L2P1)*
C2.1-6	TSP	*"But the government approach or the council approach seems to be to tax the HGV and now those HGVs have to go into those clean air zones so that isn't really an effective way of dealing with the problem" (C3L2P1)*

4.4.2.2 GLH Stakeholders' Environmental Indicators

Participants provided the environmental indicators they used to measure their environmental impact (if there were any used). Table 4.55 lists the environmental impact, a detailed breakdown of the impact, and the environmental indicators used by participants to measure them. However, it can be seen in the table that for some environmental impact factors, the indicators used to measure them varied among the stakeholders such as greenhouse gases. Additionally, Figure 4.24 shows the frequency of responses coded under each theme. It suggests that 'CO2 emissions in metric tonnes', 'diesel, gasoline, CNG in litres', 'electricity consumption in MWh', 'water consumption in cubic meters', and 'waste in tons' are the most mentioned environmental indicators among the stakeholders of this GLH. These indicators have the highest frequency, emphasizing their widespread usage and recognition in the participants' perception.

Regarding the indicators and documents in this case, it should be noted that some participants only utilized the indicators and reports for internal purposes and were unable to share them with the researcher. As a result, the tables that follow present only the indicators shared by the participants, rather than a comprehensive list of all KPIs employed by the stakeholders. For example, the port owner participants stated that they have a series of KPIs for management purposes, as well as data to assess consumption and usage, but they are only used for internal reporting.

> *“We have a series of KPIs that are used internally for managing these things and we have possibly good data on it, and we have a validator on almost all of those inputs so we can see what was used in the previous 24 hours and how well we consumed it" (C3L1P1)*

The environmental impact indicators mentioned by the participants in this case primarily focused on air pollution. Some participants provided information about the metrics they use to calculate these indicators, while others discussed the specific types of waste or pollutants they measure. This depended on the nature of most of their activities, whether air pollution or waste pollution heavy, or whether they provide their services to a wide range of companies (as in the case of the trade association). For example, trade association mentioned measuring the concentration of air pollutants at different times of the day and several alternative fuels uptake.

> *"The indicators are typically the amount of NOx, particulate matter, sulphur oxides in the air. What is the concentration of them in particular sides in different times of the day they are measured and that's typically used as an indicator. There's also a review about what's the exposure" (C3L3P3)*

Additionally, the trade association produces reports on the environmental impact of their members and provides information on how their members report their indicators. While the transport service provider mentioned recycling various types of waste, including oil, tires, and batteries.

> *"Waste can include anything from oil through to batteries. And every single item, every single waste product we produce is recycled. So, the oil, the tyres, the batteries, metal, every product that comes through our system gets recycled... the main waste we have is cardboard and that's recycled" (C3L2P1)*

Furthermore, some participants assess and report on the environmental impact upstream and downstream in their supply chain such as the global retailer, C3L2P2. They measure direct and indirect emissions using the GHG Protocol - Scopes 1 and 2.

It is therefore evident that there is a significant discrepancy in the measurement, reporting, and availability of environmental data among the participants in this case. While this may be due in part to the diverse nature of their operations and activities, the discrepancy is not limited to specific types of environmental impacts. For example, even greenhouse gas emissions, which are commonly measured and reported by multiple participants, are measured and reported in different ways. This suggests that other factors may also be contributing to the inconsistency in the indicators used and ways of measuring the environmental impact among the participants.

Table 4.55 Liverpool Case NVivo Matrix - GLH Environmental Indicators Codes Frequency (Source: NVivo 12)

Environmental Impact	Indicators	Measures	PO	Log Dept.	TSP	Gov.	Assoc.	Ship.	Total
		metric tonnes		4	1		1	1	7
	CO2 Emission	Kg of CO2 per Vehicle.Km (VKM)					1		1
		Average tonne of CO2 per member					1		1
	CO2 Efficiency	Kg of Co2 per tonne.Km (tkm)		3					3
	CO2 Reduction	metric tonnes		2					2
	NOx concentrations	micrograms per cubic meter					1		1
Air Emissions	NOx emissions	Tonnes			1		1	1	3
	Particulate Matter concentrations	micrograms per cubic meter					1		1
	Particulate Matter emissions	Tonnes			1		1		2
	SOx concentrations	Micrograms per cubic meter					1		1
	SOx emissions	Tonnes			1		1	1	3
	GHG Emission Reduction	metric tonnes of Co2e per million dollars of revenue		1					1
	GHG CO2 Equivalent	Tonnes of Co2e		1		1			2
	Electricity consumption	Megawatt hour (MWh)	2			1		1	4
	Diesel, Gasoline, Compressed natural gas	Litres	2		1		1		4
Energy Consumption	Energy (Efficiency)	Petajoule (PJ)						1	1
	Fuel consumption	Tonnes	1					1	2
	Fuel Efficiency	Miles per Gallon (mpg)			1				1

Table 4.55 (continued)

Environmental Impact	Indicators	Measures	PO	Log Dept.	TSP	Gov.	Assoc.	Ship.	Total
Sustainability capabilities	Truck engine status (Euro Standard)	Percent %			1		1		2
	Vehicle Utilisation/Fill	Percent % of trucks combining delivery with pick-ups			1				1
	Emission Reduction Measures	Percent % of operators using them					2		2
	Uptake of alternative fuels (CNG, LNG, Electricity, Biodiesel, LPG, Biomethane, Hydrogen)	Litres, litres/kg – kwh – litres – kg – kg					1		1
Waste Pollution	Liquid Waste	Cubic meter			2				2
	Solid Waste (by type)	Metric tons			1			1	2
	Recycled waste	Tons			3				3
Water Quality	Water pollution	number of oil/industrial incidents						1	1
Noise Pollution	Loud noise	Noise level in Decibels (L -den - dB(A))			1				1
Water Consumption	Fresh Water Consumption	Cubic meters	2					1	3

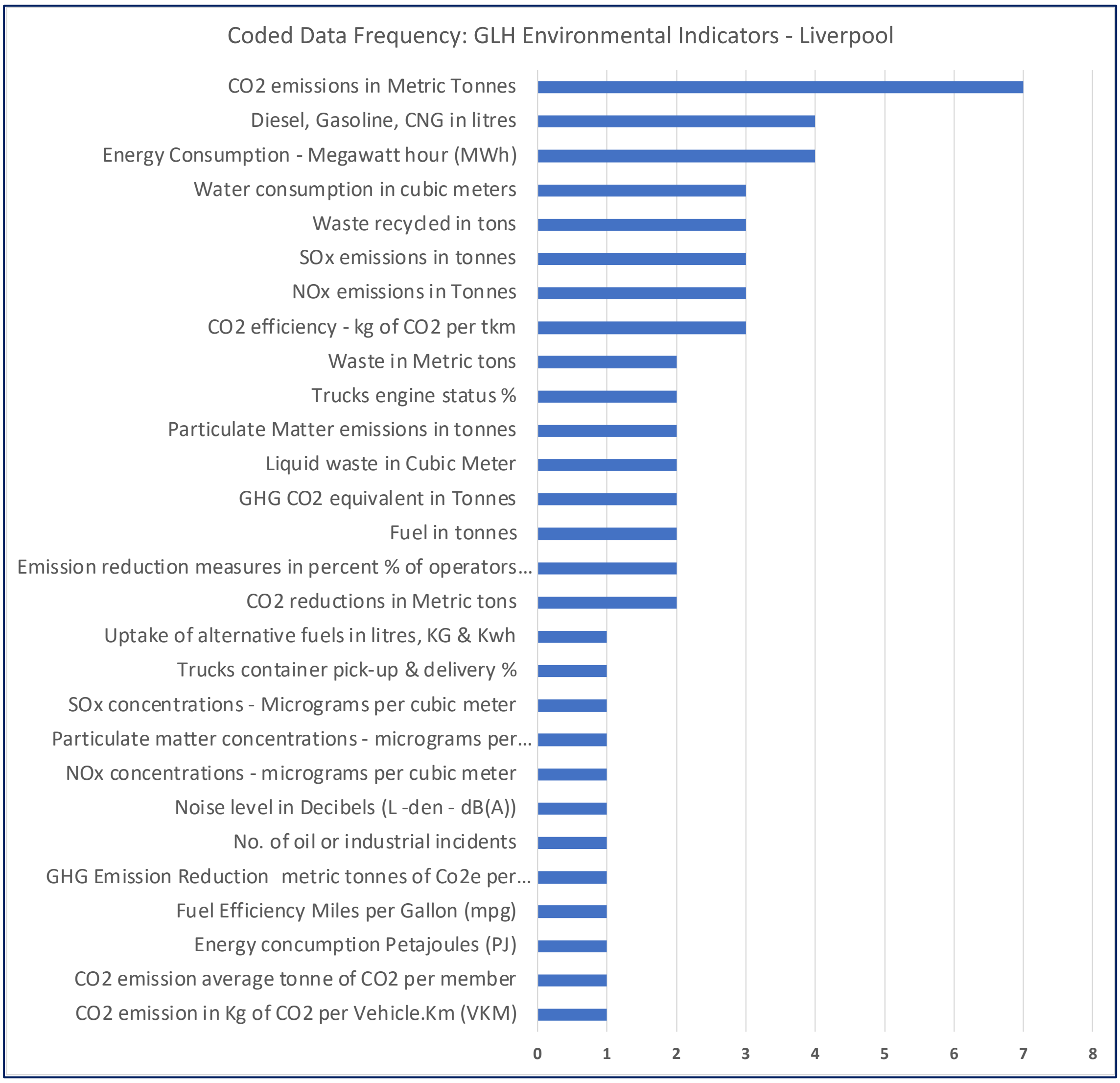


Figure 4.24 Coded Data Frequency: GLH Environmental Indicators – Liverpool (Source: NVivo 12)

4.4.2.3 GLH Environmental Responsibility

Participants in this case suggested that the responsibility for ensuring the environmental sustainability of the GLH, collecting data from stakeholders, and measuring the holistic environmental impact of the GLH should lie either with the government, third party organisation, voluntary stakeholder participation, or supranational legislators. Table 4.57 lists the reasons behind their choices.

Table 4.56 illustrates the responses according to each stakeholder and Figure 4.25 shows the frequency of responses coded under each theme, suggesting that 'government' is the most frequently mentioned theme, followed by ‘voluntary participation’, ‘supranational legislator’, and 'third party'. The frequency count of these responses emphasizes the importance attached to each theme in the participants' perception, with a higher frequency indicating a greater importance and common opinion among participants. The most common response among the participants was that the government or local governing body should be responsible for the environmental sustainability and measuring the holistic environmental performance of the GLH due to their overarching authority, regulatory power, neutral position, financial capabilities, and their connections to all stakeholders (Excerpt C2.3-1).

The government could face challenges in being responsible for the holistic measurement of the environmental impact of the GLH stakeholders, especially given the UK's highly privatized maritime and logistics industry (Excerpt C2.3-7). However, as the trade association participant explains that this needs to be addressed to have consistency throughout and remove any distortions or loss of business that might occur otherwise (Excerpt C2.3-2).

On the other hand, even though the port has an authority assigned to them from the government, they were not suggested by any of the participants. According to the port's participants, the port can only assist the government in promoting change and reaching smaller companies, as well as sharing information with stakeholders and helping to monitor, measure, and report on the environmental impact of primary stakeholders. As a private port, the competitive advantage is a major consideration. The port does not want to lose customers by imposing reporting regulations or restrictions on their business or their customers due to environmental concerns (Excerpt C2.3-3).

Furthermore, voluntary participation was a common suggestion among some participants in this case (Excerpts C2.3-4, C2.3-5, C2.3-6). Voluntary participation allows individual stakeholders to measure and take responsibility for their actions without risking losing business or competitive advantage. Table 4.58 presents excerpts from the data.

Table 4.56 Liverpool Case NVivo Matrix - GLH Environmental Responsibility Codes Frequency (Source: NVivo 12)

GLH Environmental Responsibility	PO	Log Dept.	TSP	Gov.	Assoc.	LC	Ship.	Total
3rd Party Responsibility for GLH Sus		1					1	2
Government Responsibility for GLH Sus	2			1	1	1	2	7
Supranational Responsibility for GLH Sus					2			2
Voluntary participation	1	1	1					3

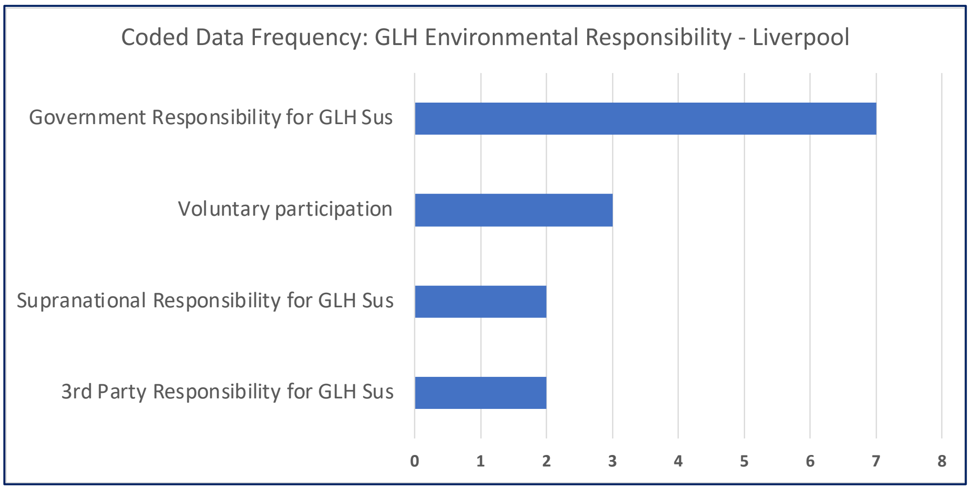


Figure 4.25 Coded Data Frequency: GLH Environmental Responsibility – Liverpool (Source: NVivo 12)

Table 4.57 Liverpool Case - GLH Environmental Responsibility Reasons

Responsibility	**Reason**
Government	Overarching authority and regulatory power - Neutral position - Financial Capabilities - Overview and connections to all stakeholders (consistency)
Third Party	Unbiased position
Voluntary participation	Everyone should be responsible for sustainability - To overcome competitive issues and the fear of losing customers
Supranational Responsibility	Decreases distortions

Table 4.58 Liverpool Excerpts Supporting: GLH Environmental Responsibility Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
C2.3-1	Gov.	*“The only way to get a complete overview of the whole ecosystem of a global logistics hub is to go to the highest level. And the neutral player, which unfortunately probably is the city region” (C3L3P2)*
C2.3-2	Assoc.	*"it's something that needs to be regulated at least a policy agreed at the national level. And that's something that we say all the time about all the air quality restrictions that are coming in the UK. We really need to have some consistency otherwise you might just get distortions or loss of business of some ports others gaining” (C3L3P3)*
C2.3-3	PO	*"There are some idealistic solutions that we as Port of Liverpool we certainly participate in and trying to help and influence, but there's definitely a limit to where we could get into success. It's the competition element, the impact to smaller stakeholders, which is where a government really has the power to play. Even as a port if we put restrictions on, realistically, they could move their business to a lot of other ports. So, again, unless that competition element is removed from it, it's difficult to put change across the port" (C3L1P2)*
C2.3-4	PO	*"We can seek to influence and share information, but it would be up to individual company stakeholders to decide if they want to participate" (C3L1P2)*
C2.3-5	TSP	*“It is a common responsibility I believe. So, the government needs to engage with the logistics companies and vice versa. We also need to engage with the consumer, and we need to engage with the manufacturer or the importer” (C3L2P1)*
C2.3-6	Log Dept.	*"All stakeholders should have input" (C3L2P2)*
C2.3-7	Gov.	*“But then getting the city region to get the buy-in of all the different private sector partners involved, could be a challenge. If you want an overview of how the entire ecosystem operates, the only place where you could have a chance of getting some information on that level is the public city-region level" (C3L3P2)*

4.4.2.4 Extent of connection among GLH Primary Stakeholders

Several participants in this case maintained there is at least communication between the stakeholders, as shown in Table 4.59. The extent of connection among the GLH primary stakeholders highlights their degree of communication, cooperation, collaboration, or integration. Additionally, Figure 4.26 shows the frequency of responses coded under each theme, suggesting that 'communication' is the most commonly mentioned theme. This indicates that it is the most prevalent form of connection among stakeholders in this GLH. This is followed by 'very limited or non-existent' suggesting that some participants frequently mentioned the limited level of connection among stakeholders. Additionally, ‘encouraging or influencing’, ‘collaborating’, and ‘mandating, forcing, and legislating’ were also notable themes. The frequency count of these responses emphasizes the significance attached to each theme in the participants' perception, with a higher frequency indicating a greater importance and shared opinion among participants.

The most common forms of connection indicated by participants in this case are communication and encouragement (Excerpts C2.4-1, C2.4-2, C2.4-3). For example, Mersey Maritime, a maritime cluster organization, facilitates meetings and communication between the port and businesses in the Liverpool GLH, allowing them to pool their voices and present a united front (Excerpt C2.4-1). However, these forums or meetings do not include the government or the local community as part of the communication or meetings. There is not a regular forum that involves all stakeholders on a regular basis (Excerpts C2.4-2, C2.4-4). On the other hand, the connection between the companies and the government can be facilitated by trade associations. For example, the trade association participant explained that they connect companies with the government by providing information and explanations on new regulations, and communicating their members' voices to the government to advocate for change (Excerpts C2.4-3). Furthermore, the local community communicate their concerns to the local council, and the transport service provider communicates their environmental policy to all persons and stakeholders working on behalf of the company or providing third-party logistics service. Therefore, according to participants, communication among some GLH stakeholders exists. However, other stakeholders highlighted that the connection is limited, difficult, or non-existent between them and other stakeholders in the GLH (Excerpts C2.4-4, C2.4-5, C2.4-6).

Additionally, collaboration and integration are considered limited by participants in this case (Excerpts C2.4-7). However, participants indicated that there are plans to improve it. Furthermore, the government participant states that they may connect with stakeholders through mandating and enforcing legislation (Excerpts C2.4-8). Table 4.60 presents excerpts from the data.

Table 4.59 Liverpool Case NVivo Matrix - Extent of Connection among GLH Primary Stakeholders Codes Frequency (Source: NVivo 12)

Extent of Connection	PO	Log Dept.	TSP	Gov.	Assoc.	LC	Ship.	Total
Collaboration				2			1	3
Communicating with stakeholders reg. env sus	3		1	3	3		1	11
Encouraging or Influencing stakeholders towards a sustainable direction	1			2	1			4
Mandating, forcing and legislating sustainability				1				1
Very limited or Non-existent		1	4			4		9

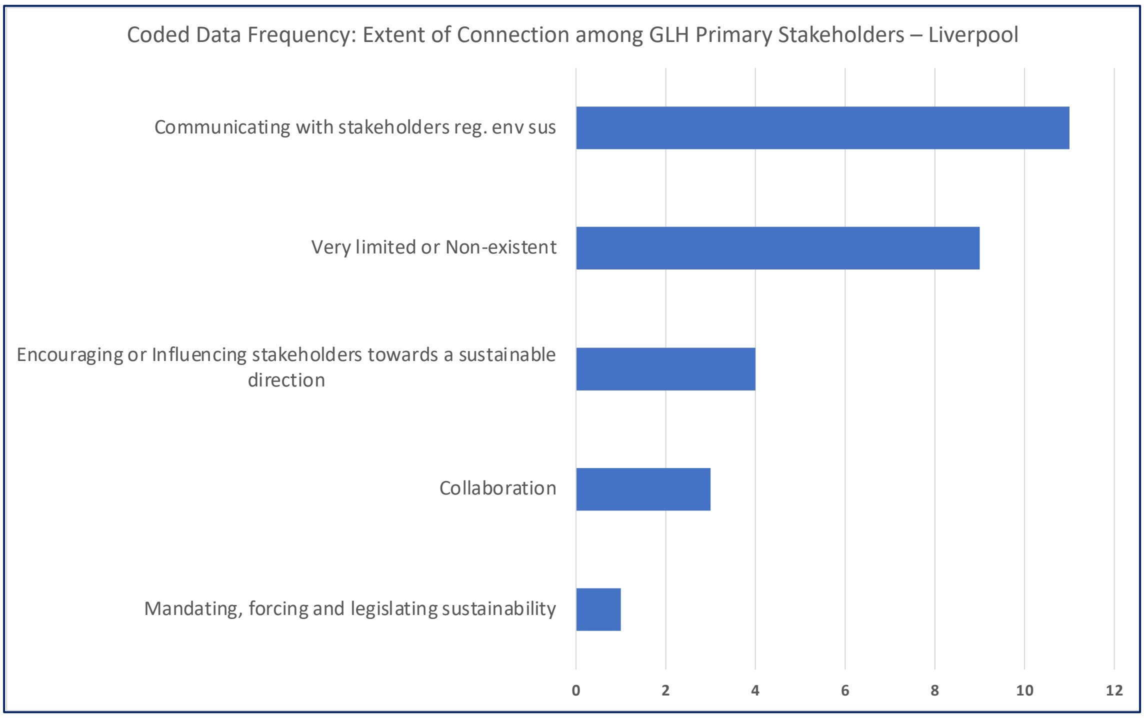


Figure 4.26 Coded Data Frequency: Extent of Connection among GLH Primary Stakeholders – Liverpool (Source: NVivo 12)

Table 4.60 Liverpool Excerpts Supporting: Extent of Connection among GLH Primary Stakeholders Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
C2.4-1	PO	*"I think part of its role is to try and help those small operators. They have meetings periodically and one of our directors sits on the board. And when it's about supporting small and maritime-based businesses in the Mersey to get opportunities or to become aware of sort of initiatives so that they can benefit from some of the bigger businesses... they do meet regularly and sort of engage with those smaller operators, and it gives them a bigger voice because it clusters them together and targets stuff to lots of people that have joined up to it". (C3L1P1)*
C2.4-2	Gov.	*"There is not a single communication mechanism with the entire set of organisations in the global logistics hub" (C3L3P2)*
C2.4-3	Assoc.	*"We have a meeting every quarter, where whenever there is an environmental regulation that is coming in that region that will be raised and members will be briefed on it. And asked for their opinion, and then based on what they say, our staff will go back and try to influence the regulation on their behalf or if it is something that's already been decided, an explanation of how they must comply with the regulations" (C3L3P3)*
C2.4-4	Gov.	*"There's a bit of a gap in terms of adequate engagement and awareness basic across all the different players because they may only see their bit" (C3L3P2)*
C2.4-5	Log Dept.	*"I would say very limited, but will start the journey this year specifically connecting with our freight managers, forwarders and shipping lines"* (*C3L2P2)*
C2.4-6	TSP	*"Not great, it could be a lot better... I don't think really that there is a level of involvement. It is very remote" (C3L2P1)*
C2.4-7	Gov.	*"A lot more of industry are sort of realising they do need to collaborate a bit more between different operators and partners and also with the universities and also with the public sector and they historically have done, because it's a bigger issue than one organisation can solve. It is a sort of a bit limited engagement, and it tends to be more on a project basis really, but we hope to increase collaboration and awareness of what all the different bits do over time" (C3L3P2)*
C2.4-8	Gov.	*"If that doesn't work, you may have to put in regulations to say no. So, with air quality, for example, we've tried to do it voluntarily through persuasion, but that doesn't really achieve the gains we would need. So, we're going to have to move towards mandating it through looking into clean air zone ideas"(C3L3P2)*

4.4.2.5 GLH Stakeholders' Environmental Sustainability Frameworks and Management Systems

Table 4.61 lists the measurement frameworks, certificates, management systems, or platforms that any of the participants in this case has shared for their environmental performance or sustainability. The ISO 14001 is the most commonly mentioned environmental management system among participant in this case. It is a widely applied framework, and it allows companies to implement their environmental policies and strategies through it. As the transport service provider participant explains *"The Policy is implemented through the company's Environmental Management System [ISO 14001]" (C3L2P1).*

Additionally, other environmental frameworks are also noted in this case whether company specific such as the Enviro 365 Framework used by the port, or the more generic frameworks such as the GHG Protocol used by the shipping line. Nevertheless, Table 4.61 shows that there is a lack of consensus among stakeholders in regards to their approach to their environmental sustainability. This discrepancy may be influenced by the varied voluntary reporting frameworks available. As the trade association participant notes *"there are many voluntary reporting schemes in place" (C3L3P3).* Additionally, the Therefore, it highlights the fragmentation in the approach to measuring environmental performance among the stakeholders of this GLH.

Table 4.61 Liverpool Case NVivo Matrix - GLH Stakeholders' Environmental Frameworks and Management Systems Codes

Environmental Frameworks & Management Systems	PO	Log Dept.	TSP	Assoc.	Ship.
Enviro 365 Framework	√				
Waste Mg. Hierarchy – Recycling		√	√		
Voluntary Reporting Schemes				√	
17 SDGs					√
Sustainability Report - TBL					√
Greenhouse Gas Protocol (GHG Protocol) (Scopes 1, 2 & 3)					√
ISO9001 and ISO14001	√		√		√
Carbon Trust Standard		√			

4.4.3 Theme 3: Environmental Sustainability of GLH Stakeholders

This global theme has 3 organising themes that discuss the drivers and barriers of GLH stakeholders' environmental sustainability in the case of Liverpool GLH.

4.4.3.1 GLH Stakeholders' Environmental Sustainability Drivers

Figure 4.27 shows the frequency of responses coded under each theme for this GLH. The top five drivers are 'legislation', 'pressures from government and society', 'demand for sustainability', 'responsibility', and 'reputation/public image'. The frequency count of these responses emphasizes their importance and suggests a degree of prioritization within the participants' perception. However, it is crucial to note that the importance and ranking of these drivers vary among participants, as their individual perspectives and priorities differ. Further quantitative investigative research is also needed to validate the significance of each of these aspects and their ranking in terms of importance.

It is evident from Table 4.62 that the main drivers for most participants in this case are 'responsibility', 'reputation and public image', 'legislation', 'health and wellbeing of humans and planet' (Excerpts C3.1-1, C3.1-2, C3.1-3). For some participants environmental sustainability is a key component of the corporate policies of certain stakeholders, such as the port and the shipping line company. This serves as a driving force for these organizations, as it aligns with their overall direction and goals. In particular, the shipping company aims to be a leader in environmental sustainability, viewing it as a responsibility of the company and its employees to uphold. According to the shipping line participant, the company does not seek to compare itself to other carriers, as it believes it is significantly ahead in terms of sustainability efforts.

Furthermore, the trend towards sustainability in business has led to an increased demand for sustainable practices in the global logistics and transportation industry. Therefore, both customer demand and the need to remain competitive are considered drivers for stakeholders to prioritize sustainability (Excerpt C3.1-4). On the other hand, some environmentally sustainable solutions can also lead to increased efficiency and financial savings. According to transport service provider participant sustainability is driven by productivity and utilization, which can also result in reduced environmental impacts. Therefore, drivers for adopting sustainable practices for some participants is the desire to reduce financial costs, but these practices also have the added benefit of decreasing the company's environmental impact (Excerpt C3.1-5).

Additionally, legislation and regulations aimed at controlling the environmental impact of global logistics and transportation stakeholders are considered important drivers by participants in this case (Excerpts C3.1-6, C3.1-7). The Paris Climate Change Agreement is another driver mentioned by participants in this case. This agreement encourages governments to support businesses in adopting and improving their environmental sustainability, as well as fostering innovation and technologies. The government participant notes that this can lead to the creation of new industries, such as the low carbon energy sector, and can also drive demand for infrastructure development (Excerpt C3.1-8). Furthermore, the increasing pressure from both government and society for businesses to address their environmental impact is considered as a driving force by participants (Excerpts C3.1-9, C3.1-10). Table 4.63 presents excerpts from the data.

Table 4.62 Liverpool Case NVivo Matrix - GLH Stakeholders' Environmental Sustainability Drivers Codes Frequency (Source: NVivo 12)

Environmental Sustainability Drivers	PO	Log Dept.	TSP	Gov.	Assoc.	LC	Ship.	Total
Being a leader in sustainability							3	3
Corporate Policy	1						2	3
Demand on sustainability					2		4	6
Efficiency of sustainable options			3					3
Gaining Competitive Advantage			1				1	2
Health and Wellbeing of humans and planet				1	1	1	1	4
Increased Awareness	1							1
Legislations			1	1	9		1	12
Opportunity to create sustainable industries				2				2
Paris Climate Agreement					1		2	3
Pressures from Government and Society	3		1	2				6
Reputation-Public Image	1	1	1				1	4
Responsibility	1	1				1	2	5
The success of sustainable solutions in other settings	1							1

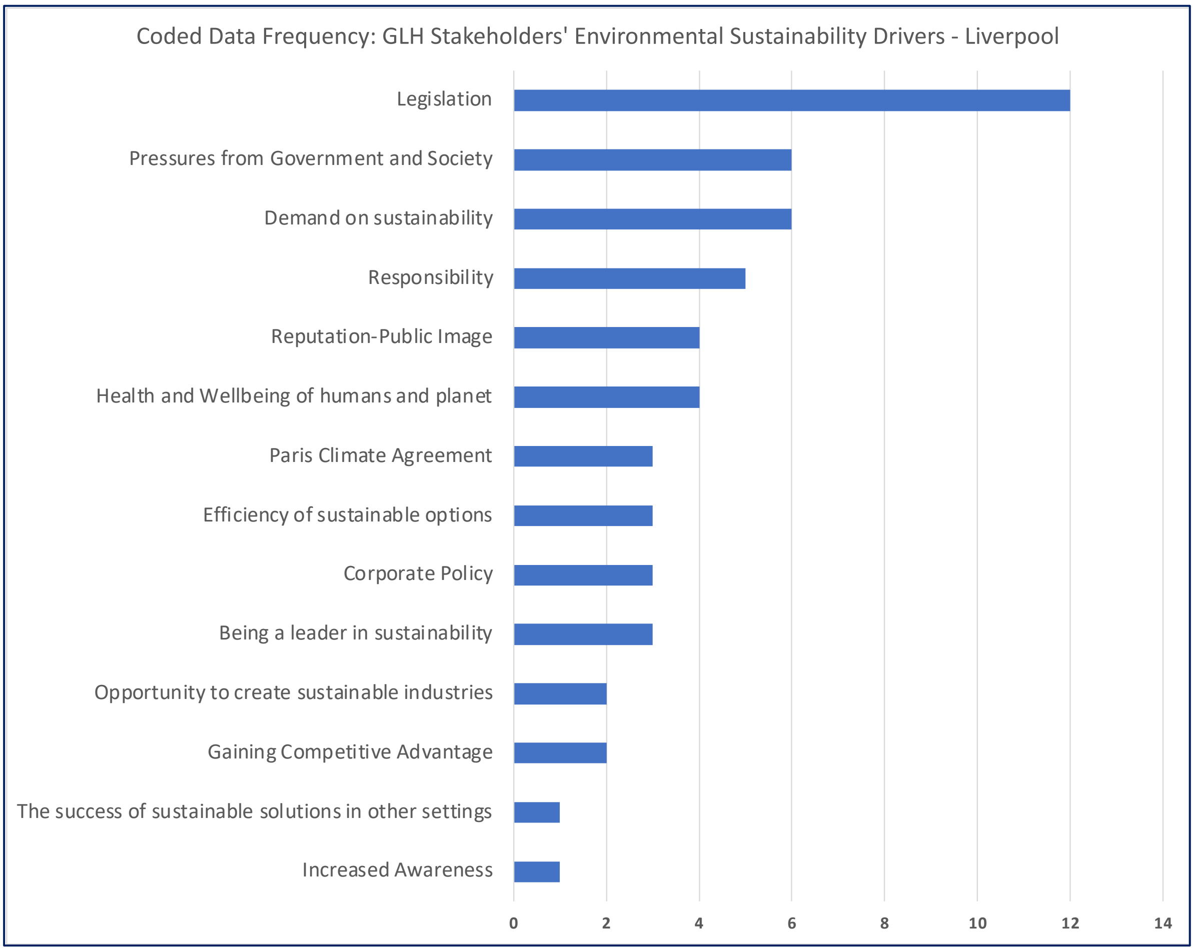


Figure 4.27 Coded Data Frequency: GLH Stakeholders' Environmental Sustainability Drivers – Liverpool (Source: NVivo 12)

Table 4.63 Liverpool Excerpts Supporting: GLH Stakeholders' Environmental Sustainability Drivers Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
C3.1-1	TSP	*"For us, it becomes more critical because it is a natural efficiency. So, to be polluting and to be non-sustainable, is not a good business practice. So, the reason we see it so critical is that it is good management. It is good everything. It is a good thing to do" (C3L2P1)*
C3.1-2	PO	*"... making sure that business operates in a responsible way, includes making sure that we're looking at environmental impacts and looking to manage and minimise them where possible" (C3L1P1)*
C3.1-3	LC	*"I think we all have our part to play... I just think that it's very easy to see, everyone's role is being that small and it will make a difference" (C3L3P1)*
C3.1-4	TSP	*"If we are operating non-efficient and highly polluting vehicles, we are not competitive" (C3L2P1)*
C3.1-5	TSP	*"That is effective for us and that is more about efficiency but then that, of course, is good for the environment ... environmental sustainability it is driven ultimately by good productivity and utilisation and as a by-products and as an outcome there are less environmental impacts so we don't want to use lots of fuel and we don't want to cause lots of pollution so therefore we want the most efficient and most modern equipment possible and that then leads to many efficiencies and ultimately we are driven by cost and profit" (C3L2P1)*
C3.1-6	Assoc.	*"One is the regulation side whether that's local, international, national, or European" (C3L3P3)*
C3.1-7	Gov.	*"With air quality, for example, we've tried to do it voluntarily through persuasion, but that doesn't really achieve the gains we would need. So that forces business and public in a certain direction, but also need the tools as a last resort if all your persuasion methods haven't worked" (C3L3P2)*
C3.1-8	Gov.	*"But there's the opportunity to create new industries such as low carbon energy sectors, booming quite significantly in Liverpool and also Hull and other places with offshore wind farms and the sort of new workboats and flows to and from to support that..." (C3L3P2)*
C3.1-9	PO	*"From all elements of society, there's a rising demand within society to be proven to be more environmentally responsible. And we need to be part of that" (C3L1P2)*
C3.1-10	Gov.	*"Quality, congestion impacts concern local communities often raise with the public sector, local councils and ourselves.... government obviously is very keen on environmental sustainability through air quality issues. So, the climate emergency mandating through all the national strategies, local government, and industry to work together, to decarbonize transport, reduce congestion, and improve air quality" (C3L3P2)*

4.4.3.2 GLH Stakeholders' Environmental Sustainability Initiatives

Participants in this case have implemented initiatives to reduce their environmental impact and promote sustainability, as demonstrated in Table 4.64. These initiatives include climate change, waste, technologies and innovation, and materials consumption initiatives. For example, the trade association runs training programs for their members dedicated to emission reduction and schemes for reporting emissions and energy saving schemes. *“[They] primarily exist to do policy campaigning, training, and compliance advice for members” (C3L3P3).*

In this case, there was not a specific domination of one type of initiatives. They had initiatives set up for greenhouse gas emissions, energy use, nature reserves, plastic, and waste pollution. However, the government’s focus was on climate change primarily. They declared climate emergency to influence decisions and regulations.

The government participant maintains:

> *"we've done a climate emergency declaration so it can influence and drive change through all sorts of policies and regulatory frameworks and influence delivery and infrastructure delivery projects for our funding channels" (C3L3P2)*

Table 4.64 Liverpool Case - GLH Stakeholders' Environmental Sustainability Initiatives

Stakeholders	Initiatives
PO	LED for public lighting in the port
	Urban logistics modal shift
	Environmentally friendly road resurfacing project
Retail	Incorporate a green clause in logistics agreements
	Testing new alternative fuel vehicles
	Ocean Clean-up Project
	Plastic Collective
	BRC Climate Action Roadmap
Gov	Climate Emergency Declaration
	Catalysing demand for new technologies and innovation
	Ban on sales of new diesel lorries in 2040
	Clean Air Zones (CAZ), Ultra-Low Emission Vehicle (ULEV) and Zero Emission Zones
Assoc	Logistics Emissions Reduction Scheme
	Energy Savings Opportunity Scheme (ESOS)
	Offering emission reduction training programs for members
Ship.	Member of the Clean Cargo Initiative
	Ship Recycling
	UN Global Compact
	Collaboration with the Ocean Clean-up Project

4.4.3.3 GLH Stakeholders' Environmental Sustainability Barriers

Figure 4.28 shows the frequency of responses coded under each theme for this GLH. The top five barriers in this case are ‘sustainability is not prioritized’, ‘cost’, ‘losing competitive advantage’, ‘technology infancy and high cost may drop’, and ‘complicated process’. The frequency count of these responses emphasizes their importance and suggests a degree of prioritization within the participants' perception. However, it is crucial to note that the importance and ranking of these barriers vary among participants, as their individual perspectives and challenges differ. Further quantitative investigative research is also needed to validate the significance of each of these aspects and their ranking in terms of significance.

It is clear from Table 4.65 that the barriers are more than the drivers identified above. Through the responses collected in this case study, several barriers were identified, with a significant portion centring around financial considerations. All participants in this case consider cost to be a barrier. They discussed the cost of changing operations, commercial viability, and return on investment (Excerpts C3.3-1, C3.3-2, C3.3-3, C3.3-4). Some companies in the same industry face higher costs for change than others. For example, the trade association respondent highlighted the difficulty in quickly changing the composition of shipping fleets, as they are in operation for long periods of time when compared to trucks or aeroplanes (Excerpt C3.3-5). Therefore, the direct cost of implementing environmentally sustainable practices is a significant barrier to adoption.

Furthermore, participants discussed a number of additional indirect financial considerations that impact their decisions around sustainability, including the higher cost of sustainable solutions, the prioritization of profit and other business success factors over environmental concerns, and the potential for losing competitive advantage (Excerpt C3.3-6). These issues are all linked to the fact that environmental impact is not adequately accounted for within the current financial and economic system. It is not yet consistently considered by companies and consumers as a crucial factor in decision-making (Excerpts C3.3-7, C3.3-8, C3.3-9, C3.3-10)

On the other hand, participants also identified non-financial barriers to implementing environmentally sustainable practices in this case. These barriers included a broken chain of responsibility and difficulty in stakeholder engagement due to the confidential nature of private industry in the UK and limited connections between stakeholders. The transport service provider respondent noted that the government is remote and happy to set targets for local councils to meet EU and minimum expectations (Excerpt C3.3-11), while the trade association respondent described the challenges of engaging stakeholders in the port industry due to the lack of control over solutions and the need to maintain confidentiality (Excerpt C3.3-12). This highlights another barrier participants discussed that is the different sustainability agendas for different stakeholders within the GLH. The government participant noted that the private sector orientation of the UK makes it challenging to bring everyone together and align their viewpoints while accounting for commercial sensitivities (Excerpt C3.3-13). The shipping company participant also emphasized that not all stakeholders have the same sustainability agenda (Excerpt C3.3-14). This diversity of agendas creates difficulties in achieving consensus and cooperation on sustainability, which in turn creates a barrier for being environmentally sustainable.

In contrast, by reviewing Table 4.62 and Table 4.65, it was interesting to find that there are both common and contrasting factors influencing the drivers and barriers to environmental sustainability. One common factor is the role of knowledge and awareness, with a lack of knowledge and awareness identified as a barrier, and an increased awareness identified as a driver. Additionally, demand for sustainability is identified as a driver, while lack of demand for new sustainable solutions and concerns about competitive advantage are identified as barriers. It is important to note that the drivers and barriers influencing environmental sustainability vary among different stakeholders and are subject to interpretation. The contrast between these drivers and barriers highlights a gap in understanding the details and explanations behind them. For instance, the demand for sustainability as a driver may refer to customers demanding sustainable solutions, while the lack of demand for sustainable solutions may be attributed to the high cost and uncertainty surrounding the success of new technologies. This illustrates the complex and multifaceted nature of the factors influencing environmental sustainability and calls for a deeper understanding of the specific drivers and barriers for each stakeholder type. Table 4.66 presents excerpts from the data.

Table 4.65 Liverpool Case NVivo Matrix - GLH Stakeholders' Environmental Sustainability Barriers Codes Frequency (Source: NVivo 12)

Environmental Sustainability Barriers	**PO**	**Log Dept.**	**TSP**	**Gov.**	**Assoc.**	**LC**	**Ship.**	**Total**
Complicated process (ex: requires collective action& collaboration from several sectors)		1	1	2		1		5
Cost (ex: sustainable solutions are 'more' expensive; low budget for sustainability)	1	1	3	1	1	2	1	10
Different regulations in different regions (ex: Inconsistency of regulations; additional work)			1		2			3
Different sustainability agendas for different stakeholders				1	1		1	3
Difficulty in improving past the legislation requirements (ex: difficulty convincing private companies)	2			1	1			4
Difficulty in mapping the impact of transport activities			1		1			2
Government support is required for sustainable solutions				2	2			4
Green Washing			1		1			2
The Inflexibility & amount of cargo required for more sustainable modes of transport (ex: Inland vs truck; or clean zones)			1					1
Lack of demand on new sustainable solutions				2				2
Lack of feasibility & practicality of some sustainable solutions (ex: env. restrictions)	1		3		1			5
Lack of knowledge and awareness			1	1				2
Levelling the field with enforcing legislations makes smaller companies suffer compared to large companies	3		1					4
Losing competitive advantage (ex: increasing price or enforcing regulations)	1		2		2		1	6
Some environmental indicators are not true representation of the impact				1				1
Technology infancy and high cost may drop	2		3				1	6
The chain of responsibility is broken			1		1			2
The environmental impact of the is not yet integrated in the customer's buying decision, the financial or economic system		1	2			1		4
There is an extent to environmental impact to operations that cannot be avoided	1							1
Sustainability is not prioritized (ex: it is not incorporated yet in metrics of a successful business, price is seen more important, or effort & inconvenience)		2	3		1	2	3	11

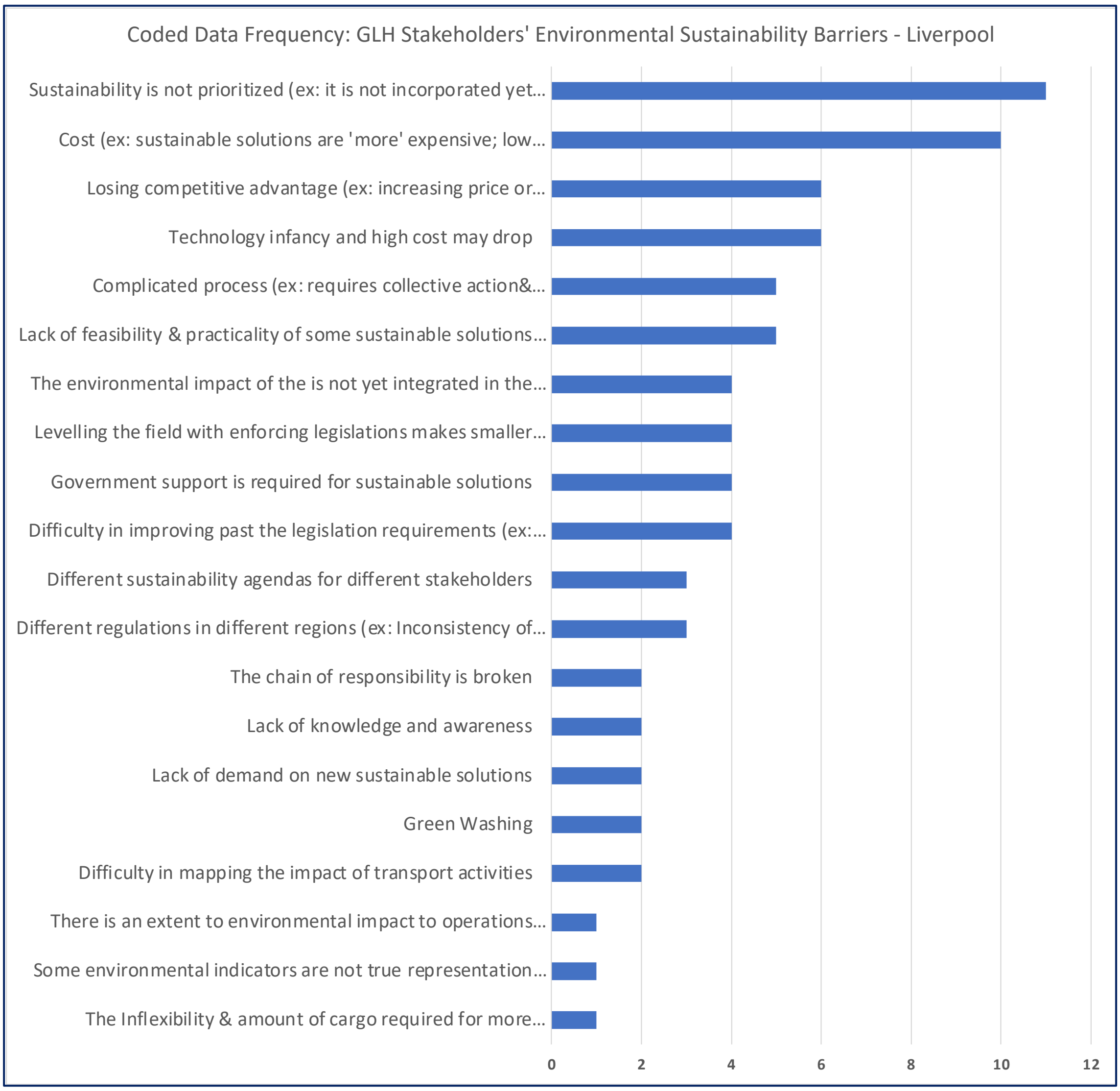


Figure 4.28 Coded Data Frequency: GLH Stakeholders' Environmental Sustainability Barriers – Liverpool (Source: NVivo 12)

Table 4.66 Liverpool Excerpts Supporting: GLH Stakeholders' Environmental Sustainability Barriers Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
C3.3-1	TSP	*"The cost is prohibitive... we will actually seize doing some operations because it becomes just economically unviable" (C3L2P1)*
C3.3-2	PO	*"The primary thing in environmental improvements is commercial viability" (C3L1P2)*
C3.3-3	Ship.	*"IMO 2020 or working on biofuel, this costs a lot of money. So, it has a huge impact on our cost structure" (CEL2P3)*
C3.3-4	LC	*"it's a lot cheaper than the alternatives are" (C3L3P1)*
C3.3-5	Assoc.	*"The shipping line people are absolutely right when they say, we will have the ship in operation for 25-30 years or even longer. So, it is difficult to quickly change the composition of the fleet. So, I know it is not a fair comparison, and trucks got much cleaner because trucks will turn around more quickly and there's probably aviation as well there's a relatively quicker turnaround. But I think in shipping line, the shipping industry it is more difficult because they then get faced with having to install, retrofit end of tailpipe solutions" (C3L3P3)*
C3.3-6	Assoc.	*"I mean they could theoretically require environmental standards from the shipping lines, but this is where it gets very difficult because you get into competitive advantage issues" (C3L3P3)*
C3.3-7	TSP	*"Whether you are an ethical company or not you will ultimately be driven by your bottom line so yes it may be great to say that you have initiative so projects which are leading to environmental sustainability but most of those I believe are driven ultimately by cost and by the profitability of the business in probably 95% of all businesses that has to be that is their primary objective... it has to change..." (C3L3P2)*

Table 4.66 (continued)

Excerpt No.	Participant	Excerpts from Interviews & Data
C3.3-8	PO	*"It is not embedded in our organisation and top priority" (C3L1P1)*
C3.3-9	Ship.	*"It means that we won't be competitive in the market if we want to switch today" (CEL2P3)*
C3.3-10	PO	*"It's great to say to them, you need to switch over to biodiesel, you need to be going electric, but the level of investment they need to make to do that against what their competitors might be doing makes it very difficult for them to necessarily make the change. Not that they don't want to, but it's the pure feasibility of it and the impact on their business" (C3L1P1)*
C3.3-11	TSP	*"I think the government is remote. The government is happy to set or demand of the local council's targets to hit the EU and the minimum expectations" (C3L3P2)*
C3.3-12	Assoc.	*"they're the centre of economic activity but they're not necessarily controlling the solutions to it so it becomes quite an interesting stakeholder engagement exercise and try to get agreement on how they can work together to solve it" (C3L3P3)*
C3.3-13	Gov.	*"Some of the challenges are quite tricky because in the UK is very private sector orientated there is so many different organisations to bring together because it's all privatized. So, it's much more challenging to bring everyone together and align everyone's viewpoints and make sure commercial sensitivities are accounted for" (C3L3P2)*
C3.3-14	Ship.	*"At the end of the day, not all these stakeholders are looking at it. They don't have the same sustainability agenda" (CEL2P3)*

4.5 Case Study D: SCZone GLH

This section will present and describe the themes that emerged from the data collected in the SCZone GLH case study, and provide supporting excerpts from the participants to illustrate these themes. Participants codes and abbreviations used in the discussion and data display of this case study are presented in Table 4.67.

Table 4.67 SCZone Case Stakeholders Abbreviations & Participants Codes

Abbreviation	Description	Participants Codes
PA	Port Authority – Port A	C4L1P1
TO I	Terminal Owner & Operator - Port A	C4L1P2 & C4L1P3
TO II	Terminal Owner & Operator - Port B	C4L1P4
Log I	Multinational Logistics Company	C4L2P1
Log II	Logistics Company	C4L2P3
FFW	Freight Forwarding Company	C4L2P4
T&FFW I	Transport & Freight Forwarding Company	C4L2P2
T&FFW II	Transport & Freight Forwarding Company	C4L2P5
Ship.	Shipping Line (MENA region) - Egypt	CML2P6
LC I	Local Community	C4L3P1
LC II	Local Community	C4L3P2
Gov.	Government	C4L3P3
Ag.	Technical Manager at the Department of Maritime Transport & Representative of the sector at UN Agency	C4L3P4

4.5.1 Theme 1: Building an Understanding of the GLH Concept

This global theme has 5 organising themes that contribute to the understanding of the concept of GLH in the case of SCZone GLH.

4.5.1.1 GLH Definition

Participants in this case defined a GLH as a location that provides logistics and marine services with good accessibility and global connection. These were the two common explanations of the term among participants, as shown in Table 4.68. Other codes were extracted from the data in regards to the GLH concept such as multimodal transport and a major maritime port with infrastructure to accommodate the volume of global cargo (Excerpt D1.1-9). There was also an emphasis by participants on the strategic location of this GLH referring to its proximity to international trade routes and its unique positioning in the middle of the world. The planned establishment of an industrial cluster in the area was also mentioned. Some participants explained that one of the goals of the GLH in Egypt is to attract international brands to the industrial cluster to assemble products using imported components and then export the finished products to global destinations (Excerpts D1.1-1, D1.1-2, D1.1-3).

Furthermore, the importance of accessibility and connection to global routes was emphasized by participants as a key feature of the SCZone GLH. The port authority participant noted the use of infrastructure such as highways, airports, and rail connections to export goods to neighbouring countries, and the importance of a good transport networks to enable efficient export (Excerpts D1.1-4, D1.1-5). Additionally, security and political stability play a role in the functioning and connectivity of this GLH (Excerpt D1.1-6). This is due to the functions of the GLH as a connected ‘Gateway’ with industrial and logistics activities (Excerpts D1.1-6, D1.1-7, D1.1-8). Table 4.68 illustrates the codes used to describe the data defining GLHs according to the primary stakeholders, and Table 4.69 presents excerpts from the data. Furthermore, Figure 4.29 shows the frequency of responses coded under each theme. It suggests that ‘logistics and marine services’, ‘good accessibility and global connection’, ‘import, export, transhipment, and FTZ’, ‘multimodal transport’, and ‘industrial cluster’ are among the most crucial aspects of a GLH. These themes have the highest frequency of responses, emphasizing their importance in the participants' perception.

Table 4.68 SCZone Case NVivo Matrix - GLH Definition Codes Frequency (Source: NVivo 12)

GLH Definition Keywords	Ship.	TO II	PA	TO I	Log I	Log II	FFW	T&FFW I	T&FFW II	Gov.	Ag.	Total
Good Accessibility & Global Connection	1	3	5	1	2		1		2	1	5	21
Economic engine & trade link		1			1						1	3
Infrastructure to accommodate & deliver	1	1	2						1	1	2	8
Logistics & Marine Services	1	3	5	4	4	1	1	1	2		4	26
All types of cargo									1			1
Import, export, transhipment & FTZ		1	5	4	1	1			1		3	16
Safe transport			2	3	1	1						7
Storage capacity											1	1
Tailored, excellent, flexible & smooth service			1								1	2
Major Maritime Port	1		1									2
Port Cluster			1							1	1	3
Multimodal Transport: Road, Rail, River, Air, Ocean, Short-sea shipping, & Pipelines	2	1	2		1				1	4	2	13
Smart Hub						1				1	1	3
Strategic geographical location		1	2		2						2	7
Synergy between maritime, logistics & industrial activities			1								1	2
Industrial cluster	2	1	4								3	10
Security & Political Stability			1									1

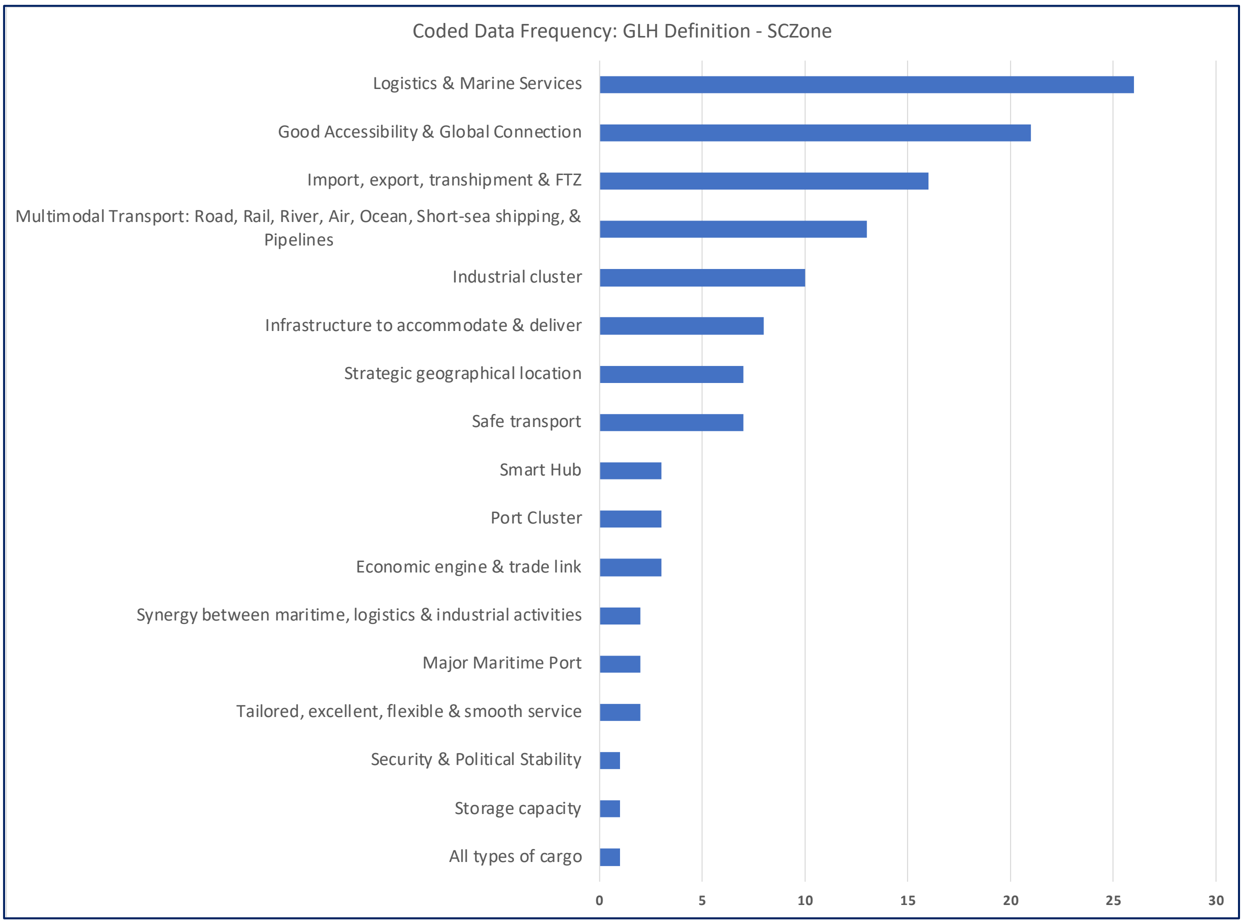


Figure 4.29 Coded Data Frequency: GLH Definition – SCZone (Source: NVivo 12)

Table 4.69 SCZone Excerpts Supporting: GLH Definition Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
D1.1-1	PA	*"This exquisite location... which everyone believes it has a great location, lying on the international trade routes" (C4L1P1)*
D1.1-2	Ag.	*"We are more competitive due to the location, which is quite unique. It is in the middle of the world... facilitating the import of the components and export of the manufactured products. And this is simply the logistical axial hub idea we have" (C4L3P4)*
D1.1-3	Ag.	*"The idea of a GLH in Egypt is that we bring international brands in Port-I seaport, so they assemble their products here and then ship to other countries worldwide. So, the idea is to bring companies… and assemble all this in local manufacturing and then export it from here to other countries" (C4L3P4)*
D1.1-4	PA	*"We use our infrastructure, like the highways, airports and rail connections to be able to export the goods to neighbouring countries. We can only export to these countries if we have a good road network to enable the export, and this is what we are working on now, and achieved a major part of that network till now, so we could deliver the goods to highly populated areas like Greater Cairo, or we can export the goods via the closest seaports with lower logistics costs" (C4L1P1)*
D1.1-5	Ag.	*"Land transport is booming now because of the newly constructed highways in Egypt and the expansion of roads and construction of seaport gates according to international standards and these gates are well-connected to the road network outside the seaport so there won't be congestion inside the seaports, and it is away from the residential areas... it is connected to all expressways... that's why we built an elaborate network of roads and tunnels under Suez Canal, which will speed up the commerce between Africa and Asia or any other countries like Rotterdam or Singapore" (C4L3P4)*

Table 4.69 (continued)

Excerpt No.	Participant	Excerpts from Interviews & Data
D1.1-6	PA	*"Due to the recent events and the closure of El-Salam Bridge had a great impact on the connectivity between both banks of the Canal, which have led to focusing more on transhipment business rather than the logistical exchange activities, import and export, and the local manufacturing and added value industries" (C4L1P1)*
D1.1-7	PA	*"SCEZ is aiming to be 50% local cargo. We are not talking about a transhipment hub from Port-I but rather a 'Gateway'. A Gateway, then it means we are talking about back industrial area as well as adjacent residential area. So, Vision 2030 is 50% local and 50% transhipment. The project was not made as a transhipment hub because SCEZ is planned to be an integrated area" (C4L1P1)*
D1.1-8	PA	*"We are mainly talking about a holistic integrated area. A seaport with import and export area, and another area you could call it an intermediate area in which you receive the material imported from abroad through free trade agreements between Egypt and other countries world-wide. This is where materials can be brought in from the free-trade countries, whether natural raw material or in-process industrial materials, which are then used in this logistical hub. Usually, it is in area adjacent to the seaport allowing assembly, consolidation, packaging, and offering value-added services" (C4L1P1)*
D1.1-9	Ship.	*"It is at the infrastructure stage of adding modes of transport such as river connections and rail connections. It is at the start level and the only active connectivity currently is road transportation" (CML2P6)*

4.5.1.2 GLH Primary Stakeholders

Participants in this case identified GLH primary stakeholders as government and local authorities, terminal owners and operators, logistics and freight forwarding companies, shipping, manufacturers, local community, investors, cargo owners, and associations among others as presented in Table 4.70.

This GLH is characterized by a stronger public sector presence than other cases, with a public-private sector alliance noted by participants. Most participants mentioned the central government and local councils as representing the public sector, despite the fact that the ownership of the SCZone GLH ports is a public-private partnership (PPP). This can be attributed to the political sensitivity of the area, the various levels of government involved in the GLH's operations, and the economic benefits and foreign investments facilitated through the government (Excerpts D1.2-1, D1.2-2, D1.2-3).

Other primary stakeholders identified by participants in this case include employees, NGOs, trade associations, environmental groups, consumers and cargo owners, factories and workers in the local industrial cluster, the local community affected by GLH operations, shipping lines, logistics companies, trucking firms, and freight forwarding companies that are identified as primary customers by port operators. Investors are also considered primary stakeholders in the SCZone GLH. Additionally, the economic growth and benefits of the SCZone GLH have made science and educational institutions primary stakeholders, as one of the main aims of the GLH is to provide job opportunities (Excerpts D1.2-4). Table 4.71 presents excerpts from the data.

Furthermore, Figure 4.30 shows the frequency of responses coded under each theme. It suggests that ‘government and local councils’, ‘logistics companies and freight forwarders’ ‘shipping lines’, ‘associations and interest groups’, and ‘port authorities’ are among the most frequently mentioned primary stakeholders of a GLH. These themes have the highest frequency of responses, emphasizing their importance in the participants' perception.

Table 4.70 SCZone Case NVivo Matrix - GLH Primary Stakeholders Codes Frequency (Source: NVivo 12)

GLH Primary Stakeholders	**Ship.**	**TO II**	**PA**	**TO I**	**Log I**	**Log II**	**FFW**	**T&FFW I**	**T&FFW II**	**Ag.**	**Total**
Associations & interest groups			1		2		1		2		6
Cargo owners or shippers		1			1	1					3
Employees			1	1		1					3
Government & local councils	3	1	1		1		1	1	1	2	11
Industrial cluster	1	1	1								3
Inland vessel sector					1						1
Local community			1		1						2
Logistics Companies & Freight forwarders	2	1			2	2		1		2	10
Financial & legal companies		2			1						3
Investors										1	1
Science & educational institutes		1	1								2
Port Authorities or owners-operators	1		1		1					2	5
Railway operators	1										1
Shipping lines	1		1	1	2					1	6
Terminal operators	1			1	1					1	4
Trucking companies				1		2					3

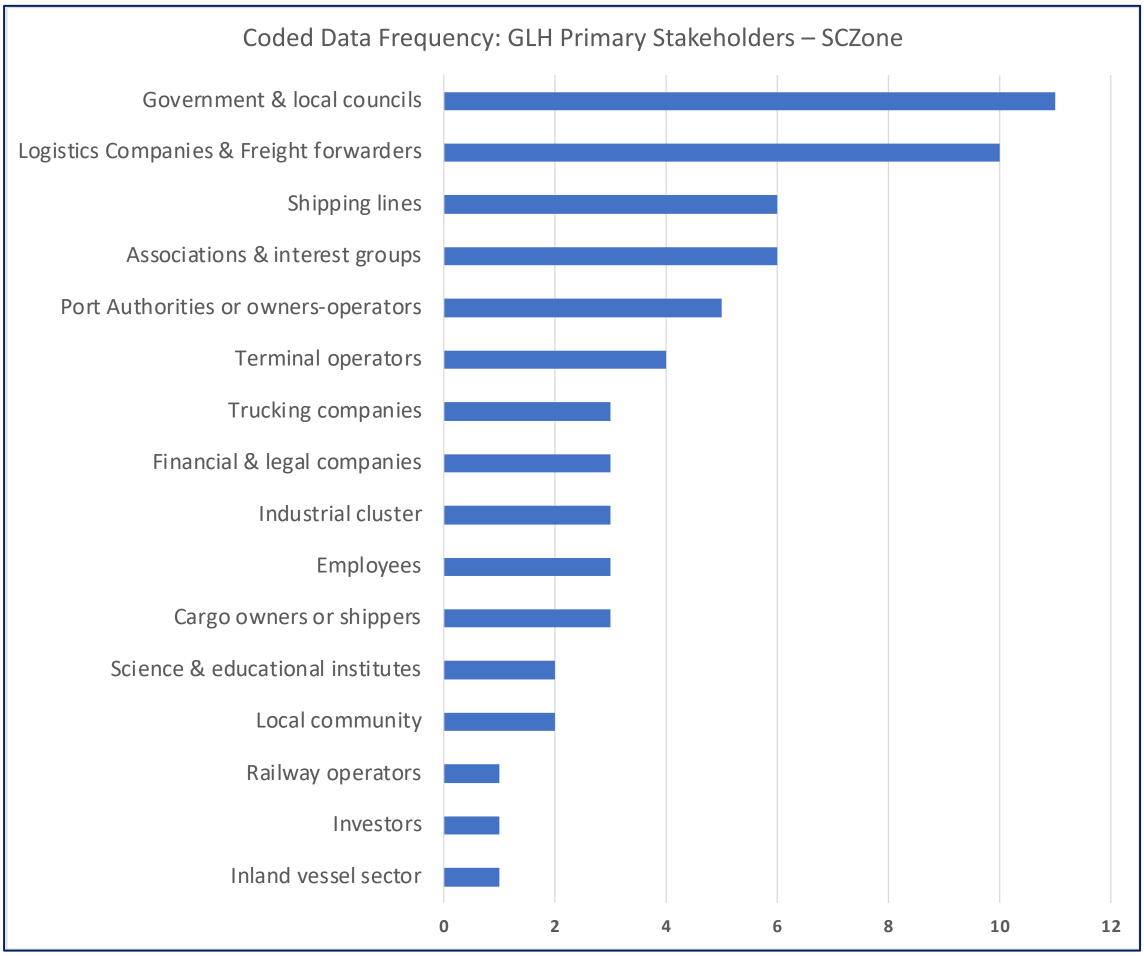


Figure 4.30 Coded Data Frequency: GLH Primary Stakeholders – SCZone (Source: NVivo 12)

Table 4.71 SCZone Excerpts Supporting: GLH Primary Stakeholders Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
D1.2-1	Ship.	*"The stakeholders of operations are going to be the private sector aligned with the public sector... the government is involved especially because it is a very sensitive area... as for the public sector, it will be the railway operator and utility services provider such as electricity, energy and renewable or clean energy" (CML2P6)*
D1.2-2	TO II	*"I would say governments because global logistics hubs encourage economic growth and investments, and they support developing countries' economies and encourage exports" (C4L1P4)*
D1.2-3	PA	*"A presidential decree is set specifically to govern and control the authorities involved in the port community of the SCZone like the customs, security... all these people under the leadership of the chairman of the port authority because he is the one managing the whole place... where not only the chairman of the port authority is involved, but also the chamber of commerce, chamber of marine navigation and other existing authorities, either for security or labour, are all part of the port community as stakeholders" (C4L1P1)*
D1.2-4	PA	*"Universities graduates such as engineers and management staff from the new young generation who can work in such projects, and we are trying to attract investments to provide such work opportunities to our young people" (C4L1P1)*

4.5.1.3 Role, Activities, and Operations of GLH Primary Stakeholders

The role, activities, and operations of the stakeholders were identified by participants depending on the nature of the stakeholder's role or operations within the GLH, as listed in Table 4.72.

The public-private partnership between the port authority, government, and terminal owners and operators allows for the overlapping of responsibilities and operations according to participants. The port authority and terminal operators work together to provide operations in the GLH. The port authority believes this partnership is advantageous because it allows for the sharing of profits and the transfer of expertise (Excerpt D1.3-1).

Furthermore, there is an overlap of activities and operations between the port authority and the terminal operators, as can be seen in Table 4.72. However, the port authority, as a public sector entity, has additional responsibilities, including the provision of infrastructure for the terminal operators and the regulation of the ports. This is due to the partnership agreement and the political and safety sensitivity of the area, as well as a new law that established a separate department for the operations and development of the area. The terminal owner and operator stated that they recently began working with the port authority and governmental agencies, such as the environmental ministry and environmental affairs authorities, in accordance with modified laws that establish the economic area authority and port authority as the primary regulatory bodies, rather than the office of Occupational Safety and Health of the Ministry of Manpower (Excerpt D1.3-2).

On the other hand, the shipping line has overlapping roles and diverse operations, including shipping and ocean transport, supply chain solutions, value-added activities, and logistics services. Logistics, transport, and freight forwarding companies also provide logistics, transportation, and value-added services, but have a significant focus on import and export clearance due to the lack of shared borders with other countries. Although industrial companies and manufacturing firms are not directly involved in this research, participants interviewed in this case emphasized their importance in the SCZone GLH. These companies engage in manufacturing and light assembly, and play a key role in import and export and the utilization of free trade agreements with other countries and foreign investors.

Additionally, the central government plays a macro role in the operations of the SCZone, with responsibilities including the provision of infrastructure such as road and rail networks, inland waterways, negotiation of free trade agreements, and overall safety and security in the area. The port authority and SCZone authority report directly to the government and are not accountable to intermediate levels of government, leading to the implementation of a new law separating the SCZone (Excerpt D1.3-3). According to the port authority, one of the goals of developing the SCZone GLH is to create job opportunities for local individuals (Excerpt D1.3-4). Table 4.73 presents excerpts from the data.

Table 4.72 SCZone Case Role, Activities, and Operations of GLH Primary Stakeholders

Stakeholder	Role, Activities & Operations	Stakeholder	Role, Activities & Operations
PA	-Public Role: Investing & Building Infrastructure & Port facilities Provide Marine Services and Maritime Traffic Regulatory Authority Stevedoring services Cargo Handling Manage PPP with private sector and foreign investors Customs Clearance Cargo Inspection	Gov.	Seeking & obtaining free trade agreements with other countries (Free trade agreements facilitation) GLH area's security and safety Providing funding for the GLH infrastructure Facilitating foreign investments Checking for any infringements, reporting & penalizing Communicating with international organisations to measure the progress, issue codes of practice and keep up with international regulations
Ship.	Ocean transport & related services (Shipping, etc.) Logistics Solutions Inland transport & Truck Operation Warehousing Distribution End-to-end supply chain solutions Insurance Clearance Operations	Industrial area (factories & manufacturers)	Light assembly & product customization Production & manufacturing
		Ag.	Provide information, support, and advice on regulations and issues Liaising with the government to help shape future regulations
		LC	Employees, Economic development of the region, and receiving goods as consumers

Table 4.72 (continued)

Stakeholder	Role, Activities & Operations	Stakeholder	Role, Activities & Operations
Terminal Owners & Operators	Serving commercial marine fleet in both containerized and bulk goods Warehousing Rail terminal operations River terminal operations Road Freight gate operations Stuffing & stripping containers Operate terminal Stevedoring services Cargo Handling Ocean Freight Cross-docking Logistics activities	Logistics, Transport & Freight Forwarding Companies	Value-added logistics services: -Labelling -Assembly -Semi/light manufacturing and customizing - Packaging Warehousing Transportation Inspection Road Freight Ocean Freight Air Freight Distribution planning & activities Door-to-Door Outsourcing transportation & storage facilities Cross-docking Chartering services Consolidation Arranging Customs Clearance Cargo Handling Consultancy Integrated Multi-modal transport

Table 4.73 SCZone Excerpts Supporting: Role, Activities, and Operations of GLH Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
D1.3-1	PA	*"Government or public partner align with a private partner to share the profit and benefit from the transfer of the know-how. And this approach is adoptable now because we have capital as well such as the seaport and the pier and other utilities. So, the international partner will not come to a green field but actually we have a brown field already, so we have the right to share in everything including the industrial area. I totally agree with the approach, which is like a small joint venture, because we have a lot to offer in this PPP in term of capital and investment such as the infrastructure, which is being built so extensively nowadays" (C4L1P1)*
D1.3-2	TO I	*"Recently we started to include the port authority... we deal with governmental agencies directly like environmental ministry and environmental affairs authorities. They have an office here and we started to work with them according to the law, which is communication with environmental affairs authorities. The law has been modified now for the economic area to report directly to the SCZone authority... they are trying to make our relation through the SCZone and port authorities to avoid dealing with the office of Occupational Safety and Health of the Ministry of Manpower. They are trying to collect all the authorities under the port authority's power" (C4L1P2)*
D1.3-3	Gov.	*"Doing business through free trade agreements and the easy release of goods while securing them against the dangers of smuggling and entry of any goods into the country without any violations through free trade agreements and easy release of goods" (C4L3P3)*
D1.3-4	PA	*"When I was marketing for the seaport, the logistical area and the industrial zone as an integrated area, the investors were asking me where workers can be recruited from and where to find employees to work. So, I was telling them that [University Name] and [University Name] graduate engineers and management staff from the new young generation who can work in such projects, and we are trying to attract investments to provide such work opportunities for our young people" (C4L1P1)*

4.5.1.4 GLH Physical Infrastructure and Connections

The participants in this case explained how the multimodal connections, the infrastructure, global connections, and capacity are some of the features that make a location a GLH as they defined the term. The SCZone GLH is currently in its development stage and these features are under development. So far, private multinational companies held concession agreements with the government for using and investing in the ports in the area. However, this is changing with the development of the SCZone GLH. According to the port authority participant, the SCZone project was originally conceived in 1998 but was not fully realized. The multinational companies were granted the seaport and surrounding area as a long-term concession and has been receiving support from the government. The project is now being revived and will be completed according to the original plans, with the goal of creating a "*gateway*" rather than just a transhipment hub. This gateway will include not only the port, but also the hinterland, industrial area, and adjacent residential area (Excerpt D1.4-1)

During the researcher's field trip, it was observed that an adjacent residential area is being constructed as part of the development of this GLH (Appendix 5). This housing will be provided for the workers and employees of the GLH. Additionally, in order for the SCZone to effectively operate as a GLH, the infrastructure and connections to and from the hub must be upgraded and developed to meet the necessary criteria of accessibility, connections, infrastructure, and capacity. So far, the majority of upgrades have focused on transportation connections. The government is working to expand and increase the capacity of road networks, bridges and tunnels within Egypt leading to the GLH, as well as connections to neighbouring countries, in order to facilitate cargo transport and imports and exports through the SCZone GLH (Excerpts D1.4-2, D1.4-3, D1.4-4). Furthermore, as part of the development of this GLH, future projects are being considered to provide multimodal connections options in the region. These projects include the expansion of rail networks and inland connections (Excerpt D1.4-5). These efforts to expand the multimodal connectivity options are intended to meet the criteria for a GLH and provide a range of transportation options for the movement of cargo. According to the port authority, the infrastructure of the ports in the SCZone is also currently undergoing extensive development. This development is being driven, in part, by the potential for capital and investment in the region through public-private partnerships (Excerpt D1.4-6). Furthermore, several renewable energy projects are signed to be implemented in the SCZone Table 4.74 presents excerpts from the data.

Table 4.74 SCZone Excerpts Supporting: GLH Physical Infrastructure and Connections Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
D1.4-1	PA	*"It was an idea that was not completed. So, we did take advantage of the situation. Multinationals companies took the seaport as a concession for a long-term period… So where are now with this today? we are completing the plans laid in 1998. So, we are talking about a strategic vision that already exists. We are not talking about a transhipment hub but rather a 'Gateway'. In the case of a Gateway, then we are talking about hinterland and industrial area as well as adjacent residential area… now we are going back to the original plans according to the original blueprints" (C4L1P1)*
D1.4-2	PA	*"We will be able to export to these countries only if we have a good road network to enable the export. And this is what we are working on now and achieved a major part of that network till now" (C4L1P1)*
D1.4-3	Ag.	*"Land transport is booming now because of the newly constructed highways in Egypt and the expansion of roads and the construction of seaport gates according to international standards and these gates are well-connected to the road network outside of the seaport so we don't have congestion inside the seaports and away from the residential areas... and also to be connected to all expressways" (C4L3P4)*
D1.4-4	PA	*"We are overcoming the challenges and obstacles facing our plans like connecting the two sides of the Canal by establishing connection lines between the west and the east sides. So, it is not only El-Salam Bridge, or the floating bridges but there will be more than one tunnel. About 6 tunnels are under construction, 4 are done and the fifth already exists, and the last one is under construction together with the current bridge" (C4L1P1)*
D1.4-5	Ship.	*"It is at the infrastructure stage of adding means of transport such as river connections or rail connections. It is at the start level and the only active connectivity currently is road transportation... SC zone contains potential for rail transport, but we don't have any timeline for the implementation or execution yet" (CML2P6)*
D1.4-6	PA	*"Because we have a lot to offer in this PPP in term of capital and investments such as the infrastructure, which is being built so extensively nowadays" (C4L1P1)*

4.5.1.5 GLH Governance Structure

The governance structure in this GLH is hierarchical, but there have been efforts to decentralize authority to the SCZone. This involves establishing a separate department to streamline the chain of command and reduce bureaucracy. According to the government representative, the SCZone is "completely separated" from the Ministry of Transportation (Excerpt D1.5-1). In contrast, the UN agency and government participant, explains that the main departments and ministries of the country are still involved in the authorization and operations of the SCZone ports and industrial cluster (Excerpt D1.5-2). Additionally, the terminal operator participant notes that the SCZone authority and the port authority are working to collect all relevant authorities under the port authority in order to avoid dealing with the separate official and governmental departments (Excerpt D1.5-3). Thus, while the SCZone has been separated, it still has connections to various ministries and departments through the SCZone authority to finish paperwork and authorization for the time being.

Furthermore, the political sensitivity of the area requires government and public sector involvement in the decision-making and operations of this GLH (Excerpt D1.5-4). As such, the GLH cannot be managed or owned solely by the private sector. This GLH is in the process of development, and the ports in the area have previously operated under concession agreements with the government. However, the development of the SCZone into a GLH is now leading to a shift in this arrangement (Excerpt D1.5-5, D1.5-6, D1.5-7).

Participants in this case identified the port authority as the landlord (Excerpt D1.5-8). They are responsible for the public infrastructure to build it, maintain it, rent it and manage the concessions. They monitor compliance through evaluations and act as an independent authority overseeing the ports, industrial zones, and branches of governmental departments and ministries operating within the SCZone GLH. While there have been efforts to separate the SCZone and establish it as a holistic regulatory system operating as a separate department, this process is still ongoing. The eventual goal is to create a unified system of governance.

Companies operating within the SCZone are subject to both the SCZone authority and relevant ministries. Logistics, freight, and transport companies operate in connection with both the central government and the SCZone authority. Port operators and owners are managed by the SCZone authority, while branches of ministries and governmental departments are under the SCZone authority with delegation from the central government. Shipping lines, on the other hand, are free to conduct business anywhere and may deal with any port. When using the ports in the SCZone, shipping lines are governed by intergovernmental agencies in addition to the national government. Table 4.75 presents excerpts from the data.

Table 4.75 SCZone Excerpts Supporting: GLH Governance Structure Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
D1.5-1	Gov.	*"The economic zone is not included in the scope of Ministry of Transportation. The Suez Canal Economic Zone is completely separated with its ports by a public decision issued in 2015" (C4L3P3)*
D1.5-2	Ag.	*"The system is linking between different ministries and departments like customs, finance ministry, seaport and ministry of transport, ministry of investments and others. All these partners work under the supervision of the Higher Council of Seaports chaired by the Prime Minister to overcome obstacles. Also, the Ministry of Interior, who inspect the containers" (C4L3P4)*
D1.5-3	TO I	*"We deal with governmental agencies directly like environmental ministry and environmental affairs authority. Currently they have an office here and we start to work with them according to the law, which is communicating with environmental affairs authority. And they have started now to change this law to modify it with the SCZone to report directly to the SCZone authority... They are trying to make our relation through the SCZone authority and the port authority to avoid dealing with the office of Occupational Safety and Health and the Ministry of Manpower" (C4L1P2)*
D1.5-4	Ship.	*"Of course, the government interferes with it especially its very sensitive area" (CML2P6)*
D1.5-5	PA	*"It was an idea that was not completed. So, we did take advantage of the situation. It was the multinationals companies, and they took the seaport as a concession for a long-term period, and the Government gave them the area and built the pier for them and gave them the necessary space to allow the back storage area. So where are now with this today? we are completing the plans laid in 1998" (C4L1P1)*

Table 4.75 (continued)

Excerpt No.	Participant	Excerpts from Interviews & Data
D1.5-6	PA	*"PPP (Public Private Partnership), where we a government or public partner align with a private partner to share the profit and benefit from the transfer of the know-how. And this approach is adoptable now because we have capital as well such as the seaport and the pier and the other utilities. So, the international partner will not come to a green field but actually we have a brown field already, so we have the right to share in everything including the industrial area. I totally agree with approach, which is like a small joint venture, because we have a lot to offer in this PPP in term of capital and investment such as the infrastructure, which is being built so extensively nowadays" (C4L1P1)*
D1.5-7	Gov.	*"We are considered as a government, and they are a private sector. They are the owners of the equipment, and we are the owners of the ports... This is the approach of the government now; it took a step back to allow the private sector to do its business and there are a lot of improvements in this regard" (C4L3P3)*
D1.5-8	PA	*"Because one of the most important roles of the port authority as a landlord, who puts the regulations and everyone in the port related to the concession should follow such regulations and I should monitor that and audit it by evaluation" (C4L1P1)*

4.5.2 Theme 2: Environmental Measurement and Performance in GLHs

This global theme has 5 organising themes that describe environmental measurement and performance related organizing themes in the case of SCZone GLH. The participants responses were complemented by reports, documents, and website data where possible to generate precise data for the environmental impact and the environmental indicators used by the primary stakeholders in this GLH.

4.5.2.1 GLH Stakeholders' Environmental Impact

The environmental impact of the GLH was explored through the primary stakeholders' impact. Table 4.76 presents the environmental impacts of the stakeholders in this case and Figure 4.31 shows the frequency of responses coded under each theme. It suggests that 'waste', 'liquid waste', 'greenhouse gas emissions', 'consumption of natural resources', and 'noise' are among the most mentioned environmental impacts of a GLH. These themes have the highest frequency of responses, emphasizing their importance in the participants' perception.

Furthermore, Table 4.77 presents the environmental impacts in detail linking them to the contribution of each stakeholder. Energy consumption was one of the common impact factors among several stakeholders. This can be due to the relation of energy consumption to financial aspects of business. Therefore, participants could be more aware of this impact for this reason. However, this is not reflected in the word frequency cloud in Figure 4.32, where ‘waste’, ‘water’, ‘oil’ and ‘pollution’ were the most commonly mentioned words among participants. Participants discussed waste including plastic waste, solid waste, and liquid waste resulting from the operations of the GLH (Excerpts D2.1-1, D2.1-2, D2.1-3). In contrast, the terminal owner and operator participant explains that their liquid waste disposal is safe and doesn't impact the environment because it is done according to the regulations and standards (Excerpt D2.1-4). However, the waste and pollution is not just caused by one stakeholder (Excerpts D2.1-3, D2.1-9).

Furthermore, the participants also mentioned the environmental impact of emissions produced from the operations of the GLH. The port authority participant stated that vessels produce large quantities of emissions, but that the Sulphur Cap decisions by the International Maritime Organization (IMO) were implemented in 2020 to reduce the sulphur content in vessel fuel (Excerpt D2.1-5). Additionally, the transport and logistics company participants explained that heavy truck emissions from the transport of containers and goods contribute to environmental pollution, and non-recyclable packaging materials, such as bubble wrap, were main sources of environmental impact (Excerpts D2.1-6, D2.1-7).

The ecological balance was a major concern for some participants in regards to the environmental impact of the SCZone GLH. The government participant explained that the potential effects of oil leakage, noise, and ship movement on marine life, as well as the risks associated with the transfer of ballast water (Excerpt D2.1-8). The local community participant also highlighted ecological and pollution issues such as the disposal of animal carcasses from commercial ships that causes shark attacks, and pollution of the sand and water in the area resulting from oil drainage into the sea water (Excerpt D2.1-9). The introduction of non-indigenous species in ports from global transport and freight operations can further exacerbate these concerns, as it can lead to a decline in biodiversity and negatively impact the marine ecosystem, which could further affect the livelihoods of local communities. Efforts to prevent the introduction and spread of non-indigenous species should therefore be an important consideration in any plans for the development of the SCZone GLH, along with addressing other ecological and pollution issues such as disposal of animal carcasses and oil drainage in the sea water.

Overall, participants in this case demonstrated an awareness that their activities have an environmental impact, but there was a lack of clarity regarding the specifics of this impact. This could be attributed to a lack of knowledge, training, and awareness regarding the environmental consequences of their actions or due to concerns about potential legal action. The participants provided an overview of their perceived environmental impact, but further information and understanding is needed to fully comprehend the extent of this impact. Table 4.78 presents excerpts from the data.

Table 4.76 SCZone Case NVivo–Matrix - GLH Environmental Impact Codes Frequency (Source: NVivo 12)

Environmental Impact	Ship.	TO II	PA	TO I	Log II	FFW	T&FFW I	T&FFW II	Gov.	LC I	LC II	Total
Biodiversity & ecosystem disturbance					1				2		1	4
Consumption of natural resources			1	1	4	1	1	1	1	1		11
Greenhouse Gas emissions	2		2		2			2	5		2	15
CO2 emissions					2		1					3
Nitrogen oxides					1							1
Particulate matter					2				3			5
Sulfur dioxide			1		1							2
Land-use change	2		1							2		5
Noise pollution				1					2	1	2	6
Odour pollution											1	1
Sediment Pollution			2						1		2	5
Waste	1	1	1	3	5	1		2	1	2	1	18
Liquid waste	1		3	3				1	5	1	3	17

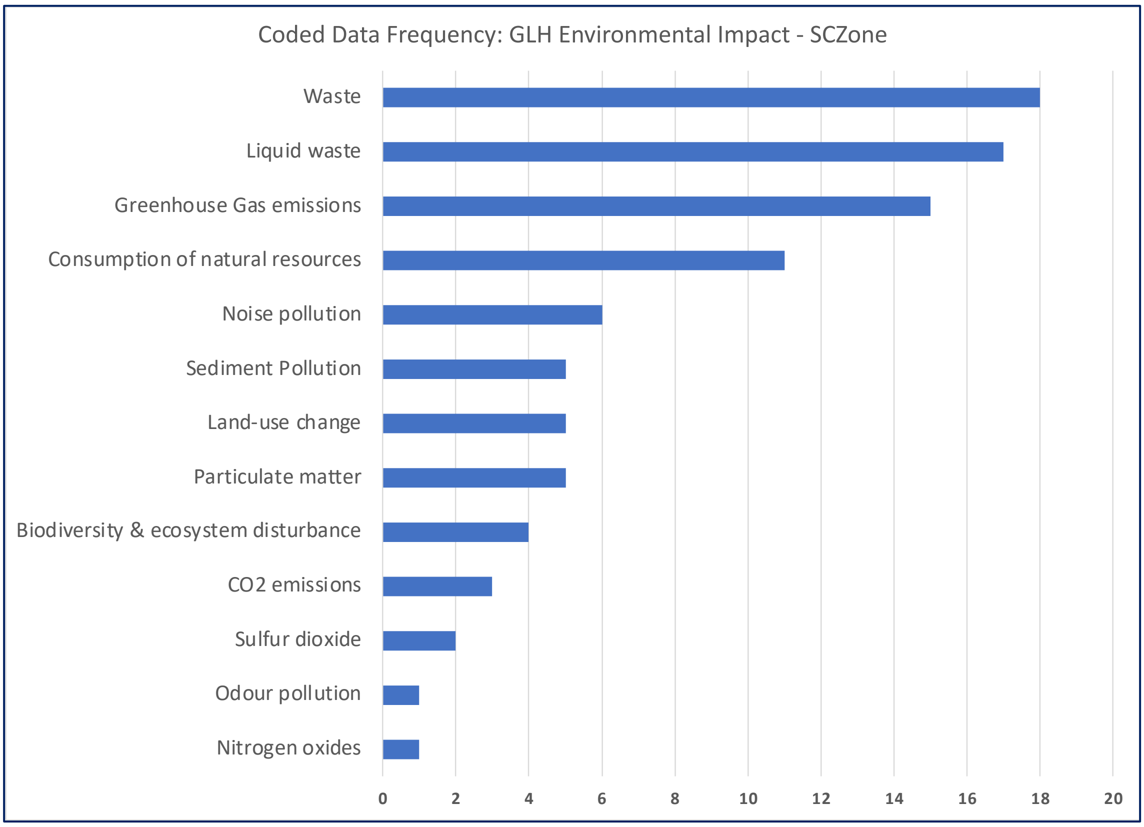


Figure 4.31 Coded Data Frequency: GLH Environmental Impact – SCZone (Source: NVivo 12)

Table 4.77 SCZone Case NVivo Matrix - GLH Environmental Impact Codes - Description

Environmental Impact	Description	Ship.	TO II	PA	TO I	Log II	FFW	T&FFW I	T&FFW II	Gov.	Ag.	LC I	LC II
Biodiversity and ecosystem disturbance	Pollution & disturbance impact on marine life									√			√
	Impact on biodiversity and ecosystem												√
	Biofuel usage and production's impact on biodiversity					√							
Consumption of natural resources	Energy consumption (cranes, vehicles & warehouses) - Electricity/Gas/Fuel			√	√	√	√	√	√	√		√	
	Water consumption			√				√					
Air Pollution	Greenhouse Gas Emissions	√		√					√	√			√
	-CO2					√							
	-NOx					√							
	-Particulate matter					√				√			
	- SOx			√		√							
Water Pollution	Oil Spills	√		√						√			√
	Water Ballast Mg.		√	√	√					√			
	Emissions to water			√						√		√	√
Noise Pollution	Loud noise									√		√	√
Odour Pollution	Strong & unpleasant smell												√

Table 4.77 (continued)

Waste	Liquid, chemical, residual & sanitary water, oily waste			√	√				√				
	Solid Waste			√			√					√	
	Hazardous & Non-Hazardous waste				√				√	√			√
	Organic Waste	√							√				
	Tyres				√								
	Metal			√						√			√
	Paper/cardboard					√							
	Plastic				√	√			√			√	
	Litter, fly tipping, weeds, and damage to the street infrastructure		√	√	√								
Sediment Pollution	Soil contamination			√						√			√
Land-use change	Developing Facilities on wetland	√		√								√	

Figure 4.32 SCZone Case Environmental impact NVivo Word Frequency (Source: NVivo 12)

Table 4.78 SCZone Excerpts Supporting: GLH Environmental Impact Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
D2.1-1	LC I	*"From my personal point of view, it negatively affects the environmental aspect in terms of the disposal of solid and plastic waste by ships and ports in water or in adjacent land" (C4L3P1)*
D2.1-2	FFW	*"Recycling and waste disposal are two problems we are facing in Egypt because it is not done properly like the standards and foundation in Europe" (C4L2P4)*
D2.1-3	T&FFW II	*"The disposal of oils used in the land transport is old fashioned and not environmentally compatible. As for the marine transport, we all know the waste of ships and their problems, the type of fuels used in the ships and the dumping of oil waste in the sea, organic waste disposal in the sea and sometimes environmental pollution happens due to the uploading and downloading of goods in the seaport, such as hazardous goods like urea and fertilizers, where usually there is a lot of waste during downloading at the docks, which goes to the sea. Also, in the process of cleaning the warehouses, the waste goes to the sea... Yes, there are lot of types of pollution" (C4L2P5)*
D2.1-4	TO I	*"The surface drainage, according to the law or according to any terminal design all over the world, runs on the surface of the pier. Is it possible that an environmental incident could happen such as oil leakage from a pipe to the surface of the pier? yes it could...We also have filters. For filters, the specialized licensed company come from the government and the port authority to collect them by invoices according to the law, which dictates that only authorised companies who can handle dangerous waste handle it… the company that dump the hazardous materials in sanctioned cemetery to avoid environmental contamination" (C4L1P2)*
D2.1-5	PA	*"The vessels produce large quantities of emissions, and this was addressed in 2020 by the Sulphur Cap decisions by the IMO, which was issued and implemented this month"*

Table 4.78 (continued)

Excerpt No.	Participant	Excerpts from Interviews & Data
D2.1-6	T&FFW II	*"Yes, in our field there are a lot of factors which could lead to environmental pollution. In the land transport section, there is heavy truck emissions resulting from the transport of containers and the goods, because they are using gasoline or gas in Egypt, which have very harmful impact on our health especially children and the green trees" (C4L2P5)*
D2.1-7	Log I	*"Mostly it would be the carbon emissions... and the packaging... Yes, it is plastic. So, for example the bubble-wrap that is plastic... we have flyers that are recycled all the time, but the bubble-wrap are not recyclable" (C4L2P1)*
D2.1-8	Gov.	*"How is oil leakage and oil spill controlled in the seas and oceans? How are exhaust and strong noise ratios controlled on marine life? How is the magnetic effect of ship movement... according to their intensity that may have an adverse impact on marine life underwater… if you take this water from one place to another and enter it randomly, a biological problem, environmental or marine problem will occur" (C4L3P3)*
D2.1-9	LC II	*"Sometimes they transfer animals or different kinds of birds, and if any of them were dead they throw them off the ship into the sea as they pass by... there was a huge shark attack that happened because a commercial ship threw a number of dead sheep into the sea... the sand surrounding the port is affected also, as its colour turn into black while its real colour is white and the smell of the sea water is different too, it smells like chemicals... commercial ships produce black exhaust, which is sometimes produced from the side of the ship and it causes some oil to be drained into the sea water leaving a black spot on the surface of the water, and I have seen that so many times" (C4L3P2)*

4.5.2.2 GLH Stakeholders' Environmental Indicators

Participants provided the environmental indicators they used to measure their environmental impact (if there were any used). Table 4.79 lists the environmental impact, a detailed breakdown of the impact, and the environmental indicators used by participants to measure them. However, it can be seen in the table that for some environmental impact factors, the indicators used to measure them varied among the stakeholders such as greenhouse gases. Additionally, Figure 4.33 shows the frequency of responses coded under each theme. It suggests that 'CO2 emissions in metric tonnes', 'electricity consumption in MWh', 'light pollution in LUX', 'CO2 efficiency in kg CO2 per tkm', and 'water consumption in cubic meters' are the most mentioned environmental indicators among the stakeholders of this GLH. These indicators have the highest frequency, emphasizing their widespread usage and recognition in the participants' perception.

Regarding the indicators and documents in this case, it should be noted that some participants only utilized the indicators and reports for internal purposes and were unable to share them with the researcher. As a result, the tables that follow present only the indicators shared by the participants, rather than a comprehensive list of all KPIs employed by the stakeholders. For example, the terminal operator participants stated that they have a series of KPIs for management purposes, but they could not share it due to confidentiality and privacy concerns (Excerpt D2.2-1). The absence of certain indicators in Table 4.79 can be an indication that the participant stakeholder does not measure their environmental performance (Excerpts D2.2-4, D2.2-5, D2.2-6). Additionally, some participants did not specify the indicators used, but rather described the environmental impact they measured.

Table 4.79 indicates that energy consumption and fuel consumption are among the indicators used by multiple participants to measure their environmental performance. These indicators are also relevant for cost monitoring and reduction, which may explain why they are of interest to the participants. Other indicators used by some participants are related to greenhouse gas emissions, possibly due to the net zero emissions by 2030 vision that some companies have (Excerpt D2.2-2). On the other hand, some participants indicated that they seek to comply with international environmental standards in order to maintain their business, but face challenges in accessing frameworks, indicators, and human resources to apply their knowledge (Excerpts D2.2-3, D2.2-4, D2.2-5).

Furthermore, the shipping line participant indicated that the indicators and reports required for international reporting do not specifically pertain to Egypt or MENA region, but rather provide an overview of the company's operations globally. This may be due to the nature of the shipping line's activities, which take place in international waters and are geographically dispersed, making it difficult to breakdown the operations by specific locations (Excerpt D2.2-6). In contrast, the multinational private companies owning and operating the terminals in this GLH have indicators and report on their environmental performance to their headquarters in accordance with corporate policies. While confidentiality was a concern for some of the participants, it is clear that they are measuring their environmental performance and have established environmental indicators (Excerpt D2.2-1). One of the terminal operators' participants provided some information on the indicators they use, including noise and vibration measurement, thermal power, and light intensity, as well as monthly sustainability reports on electricity and water consumption, waste generation, and other items (Excerpt D2.2-7). These reports are combined with financial reports and sent to the head office, but it was difficult to share with the researcher.

On the other hand, in the absence of appropriate environmental indicators, some companies use non-compliance costs and percent of fuel cost to total delivery costs as measures of their environmental impact (Excerpt D2.2-8). Similarly, some logistics and freight forwarding companies use their energy and water bills as indicators due to a lack of guidance on how to measure their environmental performance (Excerpts D2.2-9, D2.2-10). Table 4.80 presents excerpts from the data.

Table 4.79 SCZone Case NVivo Matrix - GLH Environmental Indicators Codes Frequency (Source: NVivo 12)

Environmental Impact	Indicators	Measures	PA	TO I	Log I	Log II	FFW	T&FFW I	Gov.	Total
Air Emissions	CO2 Emission	metric tonnes			1	8	1			10
	CO2 Efficiency	Kg of Co2 per tonne.Km (tkm)				3				3
	CO2 Concentrations	micrograms per cubic meter							1	1
	GHG CO2 equivalent	Tonnes of Co2e			1					1
	NOx concentrations	micrograms per cubic meter							1	1
	NOx emissions	Tonnes				1	1			2
	Particulate Matter concentrations	micrograms per cubic meter							1	1
	Particulate Matter emissions	Tonnes				1	1			2
	SOx concentrations	Micrograms per cubic meter							1	1
	SOx Emissions	Tonnes				1	1			2
Energy Consumption	Electricity consumption	Megawatt hour (MWh)		1	1	1	1	1		5
	Diesel, Gasoline, Compressed natural gas	Litres			1			1		2
	Fuel Consumption	Megawatt hour (MWh)				1				1
Sustainability capabilities	Truck engine status (Euro Standard)	Percent %				1				1
		Number of vehicles				1				1
	Vehicles with alternative drive system	Number of vehicles				1				1
	Shore-based power connections	Number of shore-based power connections							1	1

Table 4.79 (continued)

Environmental Impact	Indicators	Measures	PA	TO I	Log I	Log II	FFW	T&FFW I	Gov.	Total
Waste Pollution	Liquid Waste	Cubic meter		1					1	2
	Solid Waste (by type)	Metric tons		1	1					2
	Recycled waste	Tons	1				1			2
	Recycled water	Cubic meter							1	1
Water Quality	Water pollution	number of oil/industrial incidents		1						1
Noise Pollution	Loud noise	Noise level in Decibels (L -den - dB(A))		1						1
Water Consumption	Fresh Water Consumption	Cubic meters			1		1			2
		Million litres				1				1
Non-Compliance Costs	Penalties & fines for breaching environmental legislation	Egyptian Pound			1					1
Supply Chain Miles	Distance of products transportation across the supply chain	Miles			1					1
Soil & Sediment Quality	Soil pollution	Percent % above norms							1	1
Light Pollution	Light Intensity	LUX		3						3

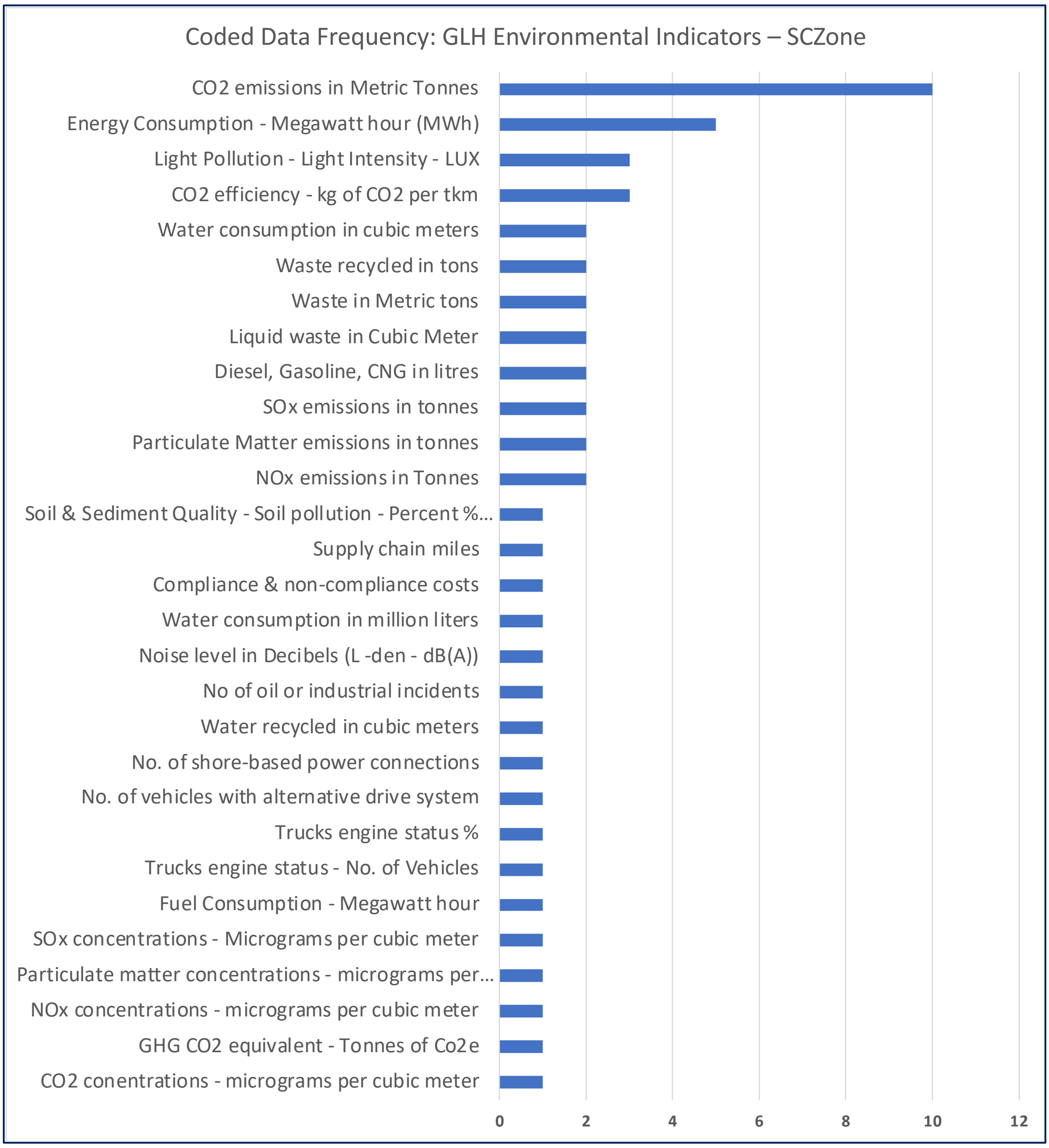


Figure 4.33 Coded Data Frequency: GLH Environmental Indicators – SCZone (Source: NVivo 12)

Table 4.80 SCZone Excerpts Supporting: GLH Environmental Indicators Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
D2.2-1	TO II	*"I cannot really get into that. For this part you need to contact the company's authorized persons in an official letter to get this kind of information and statistics. I can refer to the person responsible for it to answer your question, but I believe this is going to be difficult to get or answer. I don't think they will give it to someone outside the company" (C4L1P4)*
D2.2-2	Log I	*"As for our vision, we have that by 2030 the carbon emissions should be zero... so this is one of the things that we have for the future... Yes, this is in Egypt as well" (C4L2P1)*
D2.2-3	T&FFW II	*"Frankly, in Egypt there are no key performance indicators being applied. However, based on the rules and regulations in place, we try in our company's operations, like land or maritime transport, we try to use what is recommended internationally to avoid environmental pollution... we try to do it to the best of our knowledge without following any criteria, this is how it is done in the whole country, where we try our best to follow the international criteria without having strict implementation of them by the authority, therefore there are no measured KPIs in place" (C4L2P5)*
D2.2-4	TO I	*"The government does not require sustainability reports, but they require every organization to have an environmental record, environmental log and license to be able to operate" (C4L1P2)*
D2.2-5	PA	*"I don't have such standards. I can give you the plan I made, even the environmental plan for the port as a start of a code of practice. However, I lack the proper human resources like some for HST who can deal with what you are talking about. I have a lot of offers to purchase air quality monitors, but who will analyse their measurements? Is it increasing or decreasing and what are the reasons for this? I don't have such human capabilities" (C4L1P1)*

Table 4.80 (continued)

Excerpt No.	Participant	Excerpts from Interviews & Data
D2.2-6	Ship.	*"No, for Egypt we have not. What we normally have is a global report. But is it stated per country? NO... That is the only source that I can point you to, because locally we don't measure it, but what I can get you is the global report" (CML2P6)*
D2.2-7	TO I	*"We always make noise measurement, vibration measurement, feet stress, thermal power, and many different measurements... we have graded instruments for example, light intensity meter and meter stress instrument... Only instruments not stations... to measure and check as an internal monitoring system... of course, I have to send sustainability reports on monthly basis about our consumption of electricity and water, waste generated, either normal wastes or hazardous wastes, filters and other items. Then we generate a monthly report that is combined with our financial monthly report to send to our head office" (C4L1P2)*
D2.2-8	Log II	*"Compliance and non-compliance costs, percent of fuel cost to total delivery costs, carbon emissions, CO2 equivalent, percent of energy consumption saving, supplier environmental sustainability index, supply chain miles, water footprint, waste reduction rate" (C4L2P3)*
D2.2-9	FFW	*"Most businesses will already have facts and figures they can use to produce environmental KPIs. So, for example energy bills" (C4L2P4)*
D2.2-10	T&FFW I	*"I would say amount of energy saved and energy costs per unit of fleet are mainly what we concentrate on..." (C4L2P2)*

4.5.2.3 GLH Environmental Responsibility

Participants in this case suggested that the responsibility for ensuring the environmental sustainability of the GLH, collecting data from stakeholders, and measuring the holistic environmental impact of the GLH should lie either with the government, third party organisation, or the port authority. Table 4.83 lists the reasons behind their choices.

Table 4.82 illustrates the responses according to each stakeholder and Figure 4.34 shows the frequency of responses coded under each theme, suggesting that 'government' is the most frequently mentioned theme, followed by 'third party', and 'port authorities'. The frequency count of these responses emphasizes the importance attached to each theme in the participants' perception, with a higher frequency indicating a greater importance and common opinion among participants. The most common response among the participants was that the government or local governing body should be responsible for the environmental sustainability and measuring the holistic environmental performance of the GLH (Excerpt D2.3-1, D2.3-6). This is due to their overarching authority and regulatory power. However, participants also highlighted that achieving environmental sustainability is a collaborative effort involving various combinations of stakeholders, including the government, seaports, and companies (Excerpt D2.3-1)

Additionally, some participants argued that the port authority is the most appropriate stakeholder to be responsible for the overall environmental sustainability of the GLH (Excerpt D2.3-3). However, companies within the seaport borders and those outside have different authorities (Excerpt D2.3-2). Therefore, the port authority's jurisdiction only extends to stakeholders within the borders of the seaport. Stakeholders outside the seaport borders fall under the purview of a different authority, emphasizing the need for a joint effort in addressing environmental sustainability. Therefore, this highlights the importance of collaboration among stakeholders in ensuring the environmental sustainability of this GLH.

On the other hand, some participants suggested the need for a third party, unbiased body to enforce regulations and measure environmental performance. The third party would have the sole responsibility of the environmental measurement in the SCZone, monitoring and auditing capabilities, and offering solutions to customers (Excerpts D2.3-4, D2.3-5). In this case, the participants identified three potential entities that could be responsible for the environmental sustainability and holistic environmental measurement. Importantly, all three options were discussed in relation to collaboration with other stakeholders, such as a joint effort between the government and the port authority or a third-party company or department and the government. Table 4.81 presents excerpts from the data.

Table 4.81 SCZone Excerpts Supporting: GLH Environmental Responsibility Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
D2.3-1	T&FFW II	*"The Ministry of Environment is responsible for that together with other governmental authorities and the private sector, and there is a person in charge of the monitoring and evaluation of environmental sustainability operations to ensure that they follow international criteria like the rest of the world" (C4L2P5)*
D2.3-2	Gov.	*"No not the companies in the vicinity, only the companies within the borders of the port authority. The ones outside are the responsibility of the governorate environmental authorities... yes, two authorities, but we coordinate together" (C4L3P3)*
D2.3-3	PA	*"One of the most important roles of the port authority as a landlord, who puts the regulations and everyone in the port related to the concession should follow such regulations and I should monitor that and audit it by evaluation" (C4L1P1)*
D2.3-4	Ship.	*"The ideal scenario should be a neutral party who is not part of the system, and of course they should be supervised and audited by the government" (CML2P6)*
D2.3-5	PA	*"There has to be a department totally responsible for the economic zone because it is not limited to this port, it contains 6 other ports and 4 industrial areas... there must be a head with a regulatory system to include the logistics and industrial areas with the ports to measure the impact of all operations... there has to be a firm capable of enforcing the code of practice in the economic zone" (C4L1P1)*
D2.3-6	Gov.	*"The Ministry of Transport is concerned with transportation issues such as: railway transport, issues of public transport, issues of passenger transport, and issues of transporting goods of all kinds, whether liquid or solid, container transport and the role of goods in ports and storage, everything related to loading and unloading and everything related to storage and warehouses... the Ministry of Environment is operating an environmental observatory there. This environmental observatory has laboratories that monitor air pollution, monitor noise, and monitor air pollution due to the handling of goods" (C4L3P3)*

Table 4.82 SCZone NVivo Matrix - GLH Environmental Responsibility Codes Frequency (Source: NVivo 12)

GLH Environmental Responsibility	Ship.	TO II	PA	TO I	Log I	Log II	T&FFW I	T&FFW II	Gov.	Ag.	LC I	LC II	Total
3rd Party Responsibility for GLH Sus	1		1	1		2	1						6
Government Responsibility for GLH Sus		1		1	1	1		2	2	1	1	1	11
Port authority Responsibility for GLH Sus			1	1					1				3

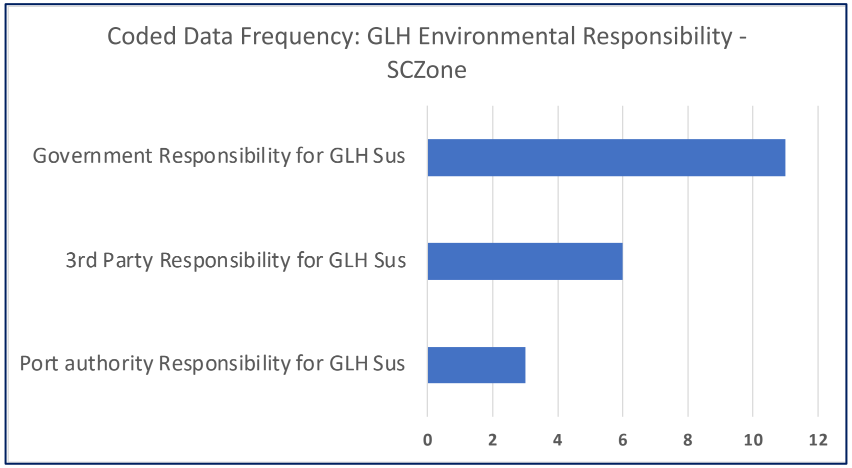


Figure 4.34 Coded Data Frequency: GLH Environmental Responsibility – SCZone (Source: NVivo 12)

Table 4.83 SCZone Case - GLH Environmental Responsibility Reasons

Responsibility	Reason
Government	Overarching authority and regulatory power
Port Authority	Connection to stakeholders inside the port, landlord/owner responsibility, part of the government and capabilities of the port
Third Party	Unbiased position, sole responsibility of the environmental measurement in the SCZone, monitoring and auditing capabilities, offering solutions to customers

Table 4.84 SCZone Case NVivo Matrix - Extent of Connection among GLH Primary Stakeholders Codes Frequency (Source: NVivo 12)

Extent of Connection	Ship.	TO II	PA	TO I	Log I	Log II	FFW	T&FFW I	T&FFW II	Gov.	Ag.	LC I	LC II	Total
Communicating with stakeholders reg. env sus				2			1	2		5	2			12
Mandating, forcing and legislating sustainability				1										1
Very limited or Non-existent	2	1	1		1	3			2		1	3	2	16

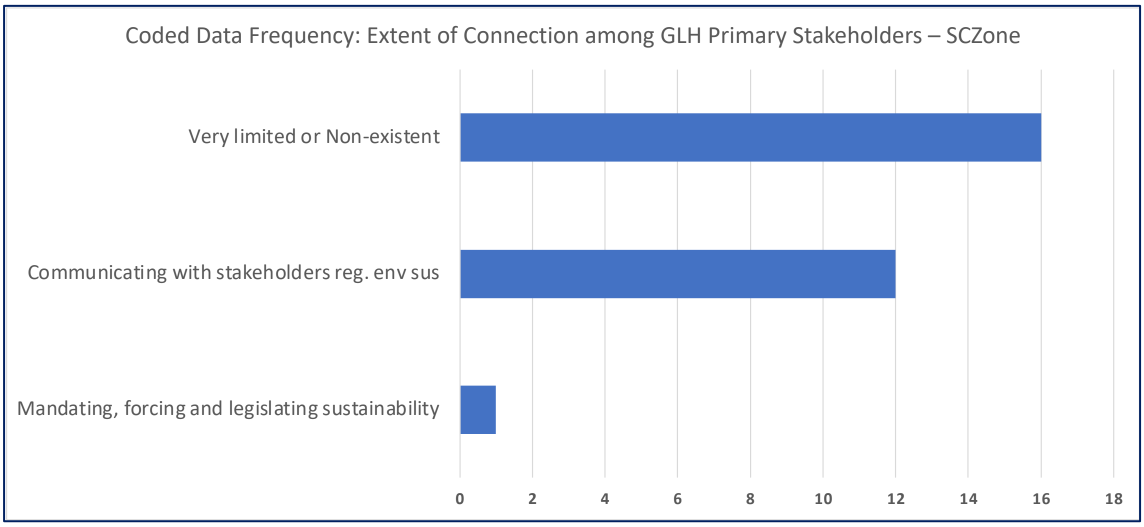


Figure 4.35 Coded Data Frequency: Extent of Connection among GLH Primary Stakeholders – SCZone (Source: NVivo 12)

4.5.2.4 Extent of connection among GLH Primary Stakeholders

Most participants in this case highlighted that there is very limited connection between the stakeholders, or it is non-existent. On the other hand, some participants highlighted that there is communication between them and other stakeholders in the GLH, as shown in Table 4.84. The extent of connection among the GLH primary stakeholders highlights their degree of communication, cooperation, collaboration, or integration. Additionally, Figure 4.35 shows the frequency of responses coded under each theme, highlighting the recurrent mention of 'very limited or non-existent' connection. This indicates that participants frequently expressed concerns about the restricted level of connection among stakeholders. This was followed by 'communication' indicating that certain stakeholders engage in communication with others regarding environmental sustainability. Moreover, 'mandating, forcing, and legislating’ was identified as another form of connection mentioned in this case. The frequency count of these responses emphasizes the significance attached to each theme in the participants' perception, with a higher frequency indicating a greater importance and shared opinion among participants.

Some participants in this case discussed their communication with other stakeholders involved in the operations of the GLH. For example, they explained that communication with the port authority and government is not frequent, but necessary when meetings or authorizations are required (Excerpts D2.4-1, D2.4-2). Other stakeholders are connected through associations, but do not operate under one system.

On the other hand, the government participant reported that ports are required to provide monthly reports on their environmental performance to the Ministry of Environment (Excerpt

D2.4-3). However, overall participants in this case indicated that communication between the GLH stakeholders is limited or non-existent. This may suggest a gap between the top governmental level and the operational level of the GLH, as well as a lack of inclusion of the GLH stakeholders in communication, if it does occur (Excerpts D2.4-5, D2.4-6). This could also be caused by the early developmental stage of the SCZone GLH (Excerpt D2.4-4).

In this case, the level of connection between stakeholders is limited and communication, if it exists, is basic. Most participants emphasized a lack of communication between stakeholders and stated that there are currently no platforms in place for such connection. They also suggested that it would take a long time for such communication channels to be established. Table 4.85 presents excerpts from the data.

Table 4.85 SCZone Excerpts Supporting: Extent of Connection among GLH Primary Stakeholders Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
D2.4-1	TO I	*"There are connections, but is it frequent? It depends on the situation. When we need a meeting with the port authority, we send an email with what we need to discuss with them, and they thankfully respond, and we have our meeting with them accordingly and vice versa. So, there is communication but not frequent" (C4L1P2)*
D2.4-2	FFW	*"I would say there is definitely communication because we have to get authorisations for example, and we are connected through associations, but it is not connection in the sense of reporting and operating under one system" (C4L2P4)*
D2.4-3	Gov.	*"All of them participate in the smart IT system that includes the goods transactions, shipping route movement and the environment data as well" (C4L3P3)*
D2.4-4	Ship.	*"It is not there, and it will not be there very soon... it will not be easy" (CML2P6)*
D2.4-5	Log II	*"Unfortunately, there is not a proper integration or communication. For the time being, we are trying to follow the related decrees of Egyptian Environmental Affairs Agency" (C4L2P3)*
D2.4-6	LC II	*"Not even the community. If you want to contact any of them, you need months. As for the officials, you cannot communicate with them if there is a problem. So, there is no communication" (C4L3P2)*

4.5.2.5 GLH Stakeholders' Environmental Sustainability Frameworks and Management Systems

Table 4.86 lists the measurement frameworks, certificates, management systems, or platforms that any of the participants in this case are using for their environmental performance or sustainability. As shown in the table, there is a limited number of environmental frameworks or management systems adopted by participants in this case. For example, the shipping line explained that it is difficult to use environmental frameworks when they cannot set specific targets:

> *“The environmental sustainability is not really measured. It doesn’t mean we are not interested, but we cannot assign someone because we cannot give them a target” (CML2P6)*

Additionally, some of the mentioned frameworks by participants are a legal obligation of any business. For instance, the terminal operator explained that the framework that they use is required by the government in order to obtain a license to start a new activity:

> *“For every activity there is a hazard, my role when I put control measures, either I do an elimination for the hazard, or I minimize it to the allowed limits. Before I start my activity as business, I must provide an EIA study for my activity, and I give it to the governmental authorities to get my license to start work” (C4L1P2)*

Furthermore, the government participant highlighted the importance of environmental preservation, as a part of Egypt's vision for sustainable development as outlined in Sustainable Development Goals 17 of the United Nations' 2030 Agenda

> *“Sustainable Development 17 Band is present in Egypt vision 2030, Including the preservation of the environment, especially the marine environment” (C4L3P3)*

Overall, there is an interest in adopting environmental frameworks and management systems. However, there are challenges facing the participants in this case to adopt and apply them.

Table 4.86 SCZone Case NVivo Matrix - GLH Stakeholders' Environmental Frameworks and Management Systems Codes

Environmental Frameworks & Management Systems	**TO I**	**Log II**	**FFW**	**Gov.**	**T&FFW I**
Environmental Policy		√	√		
Environmental Impact Assessment (EIA)	√				
17 SDGs				√	
Environmental observatory to measure the environmental impact				√	
ISO14001					√

4.5.3 Theme 3: Environmental Sustainability of GLH Stakeholders

This global theme has 3 organising themes that discuss the drivers and barriers of GLH stakeholders' environmental sustainability in the case of SCZone GLH.

4.5.3.1 GLH Stakeholders' Environmental Sustainability Drivers

Figure 4.36 shows the frequency of responses coded under each theme for this GLH. The top five drivers are 'health and wellbeing of humans and the planet', 'increased awareness', 'long term financial gains', 'legislation', and 'reputation/public image'. The frequency count of these responses emphasizes their importance and suggests a degree of prioritization within the participants' perception. However, it is crucial to note that the importance and ranking of these drivers vary among participants, as their individual perspectives and priorities differ. Further quantitative investigative research is also needed to validate the significance of each of these aspects and their ranking in terms of importance.

Table 4.87 lists the drivers according to the participants in this case. It is evident that the most common driver is the 'health and wellbeing of humans and the planet'. For instance, several participants emphasized the importance of preserving vulnerable species and the marine environment, the value of quality of life in their community, and the standard of living for future generations (Excerpts D3.1-1, D3.1-2, D3.1-3). Additionally, participants also pointed to the increasing demand for sustainability as a motivator for investing in and offering sustainable solutions (Excerpts D3.1-4, D3.1-5).

Another common driver among participants is the increased 'awareness'. For instance, the shipping line participant noted that while corporate-level initiatives have contributed to increased awareness of sustainability issues, there is still a need for broader education and awareness-raising efforts (Excerpt D3.1-6). Additionally, the terminal operator participant highlighted the role of education and targeted initiatives aimed at young people, and also emphasized the importance of employee engagement (Excerpts D3.1-7). Furthermore, the increased efficiency, financial savings, and the prospect of long-term financial gain was identified as drivers for environmental sustainability by several participants. The terminal operator noted that the adoption of "green" port and logistics concepts has led to the generation of environmental profits, which in turn can drive cost reductions and attract further investment (Excerpts D3.1-8, D3.1-9). Table 4.88 presents excerpts from the data.

Table 4.87 SCZone Case NVivo Matrix - GLH Stakeholders' Environmental Sustainability Drivers Codes Frequency (Source: NVivo 12)

Environmental Sustainability Drivers	**Ship.**	**TO II**	**PA**	**TO I**	**Log I**	**Log II**	**FFW**	**T&FFW I**	**T&FFW II**	**Gov.**	**Ag.**	**LC I**	**LC II**	**Total**
Accountability for own operations					1									1
Avoiding Fines				1						2				3
Corporate Policy	1			3		2								6
Demand on sustainability	1				1				1	1	1			5
Efficiency of sustainable options	1				2		1							4
Employees	1	1				1								3
Environmental sustainability is business sustainability						1								1
Gaining Competitive Advantage		1			2				1	2				6
Health and Wellbeing of humans and planet	2	1		1	1	1		1	1	3			2	13
Increased Awareness	3			5		1						1	2	12
Initiatives and incentives			3	3							2			8
Legislation	2			2					1	4				9
Long Term financial gains	2	3			2	2	1							10
Paris Climate Agreement										1				1
Pressures from Government and Society			2							1				3
Reputation-Public Image		1		1	2				1	3				8
Responsibility	1			1	1		1					1		5

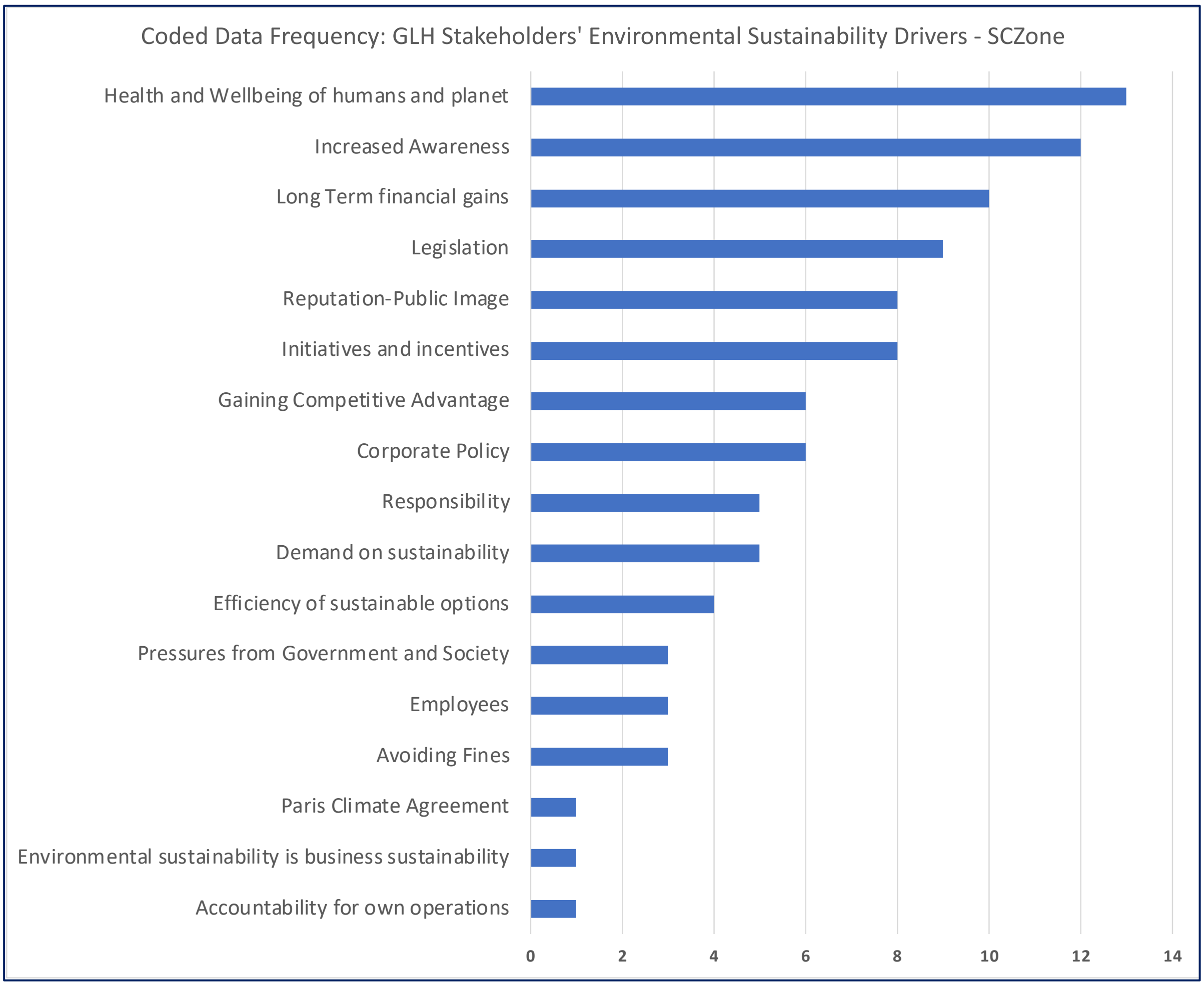


Figure 4.36 Coded Data Frequency: GLH Stakeholders' Environmental Sustainability Drivers – SCZone (Source: NVivo 12)

Table 4.88 SCZone Excerpts Supporting: GLH Stakeholders' Environmental Sustainability Drivers Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
D3.1-1	T&FFW I	*"We believe in sustainable development and the environment. We concentrate on the quality of life in our society, homes, and company" (C4L2P2)*
D3.1-2	Ship.	*"The drivers are that we need to have a better planet to live in. The driver aims for a decent environment and a sustainable clean environment" (CML2P6)*
D3.1-3	LC II	*"Because living things become extinct, and we do not see them again. We have several species that are vulnerable and could become extinct... preserving the marine environment, which I see as a diver, is a real pleasure, as well as people seeing the marine environment and enjoying it and preserving it. I am ready to participate and do anything needed to preserve it" (C4L3P2)*
D3.1-4	Ship.	*"Our partners and our customers refuse solutions that we might offer if it is not very environmentally friendly. There are some customers, on a global scale not on a local scale, that require during our quotation or value proposition that we show how much CO2 emissions we will save for their end-to-end supply chain" (CML2P6)*
D3.1-5	Log II	*"I expect that upon performing in a GLH and to secure business from multinational companies, we have to have a transparent sustainability policy in place. From an environmental perspective, greenness has become a code word for a range of environmental concerns and is usually considered positively... it is more attractive to investors" (C4L2P3)*

Table 4.88 (continued)

Excerpt No.	Participant	Excerpts from Interviews & Data
D3.1-6	Ship.	*"You will start to see this concept, like company's local initiatives, but you will not find the people becoming environmentally aware yet. No, it is not like that, but looking at the corporate level and multinational corporate level it is getting there, big time" (CML2P6)*
D3.1-7	TO I	*"Our company invests in education and health. This way, our target audience is usually the young students. Young people are our future. On the other hand, when the company organizes activities like riding bicycles to work or cleaning the beaches and public parks, it raises awareness... as for our employees, we have been encouraging them through this approach for 12 years. This approach motivates the people" (C4L1P2)*
D3.1-8	TO II	*"Nowadays with modern concepts of green ports and green logistics, I think we are starting to get environmental profits, which became a gain after applying these terms of agreement on the Egyptian ports... so I think nowadays modern ports started gaining environmental profits, which is really a start to getting improvements around the current situation if we compared it to the past... this will contribute to cost reductions and it will attract more investments in the field" (C4L1P4)*
D3.1-9	PA	*"One of the main drivers is cutting costs. Having a good impact in the future on the long term regarding the financial strategy" (C4L2P1)*

4.5.3.2 GLH Stakeholders' Environmental Sustainability Initiatives

Participants in this case have implemented initiatives to reduce their environmental impact and promote sustainability, as demonstrated in Table 4.89. Participants in this GLH have an emphasis on waste initiatives such as ‘cleaning projects’, ‘Recycling’, and ‘Reusing’ materials, as well as on carbon emissions such as using ‘alternative fuels’ and ‘technology’ to reduce emissions from equipment. Additionally, there is a mix of initiatives to help on different environmental issues including energy consumption, green land, and noise isolation.

Despite facing challenges in terms of infrastructure and capabilities, some stakeholders in this case have initiated efforts to promote environmental sustainability, focusing particularly on issues related to air pollution and waste management. However, some stakeholders have encountered resistance to their efforts, as explained by the port authority participant:

> *"By giving incentives to vessels that use this type of fuel. We implemented that, but unfortunately it was not welcomed by the vessels. I was trying my best to deliver this message to the SCZone authority, to implement these incentives to the vessels*

passing the canal and complying with these international standards, which will lead to significant reduction of their emission. But this is still subject to feasibility studies... connecting the ships with external electricity source to reduce its emissions. However, we studied it, and we didn't reach anything yet" (C4L1P1)

Some initiatives are implemented successfully, and others face challenges. Nonetheless, the fact that some initiatives were successfully implemented suggests that progress is being made towards improving environmental sustainability in this case.

Table 4.89 SCZone Case - GLH Stakeholders' Environmental Sustainability Initiatives

Stakeholders	Initiatives
TO I	Using alternative fuels for the ports' equipment and vehicles
	Using anti leaking sheets to prevent water pollution
	Replacing old equipment with green ones
	Using dust fighters or swappers to reduce operations pollution impact
	Increasing the green areas inside the terminals
	Installing isolation material to reduce noise levels
	Digitising workflow to reduce using papers and prints to reduce solid wastes
	Recycling solid and liquid waste (oil, tyres, paper, food etc.)
	Restricting port ballasting containing oil print and wastewater
	Reusing tyres as fenders or barrels
	Awareness Programs (ex: cleaning projects, green days)
	LED lighting replacement in the port
Log II	Load & route optimization
	Use & reusing eco-friendly packaging material
Log I	Recycling paper
	Vehicle fleet technology to reduce carbon emissions
T&FFW II	Vehicles' emission filters
	Disposing material in a safe way
Ag.	Training workshops
Gov.	Electric rail project
Ship.	Aiming for zero percent sulphur by 2050

4.5.3.3 GLH Stakeholders' Environmental Sustainability Barriers

Figure 4.37 shows the frequency of responses coded under each theme for this GLH. The top five barriers in this case are ‘lack of knowledge and awareness’, ‘complicated process’, ‘sustainability is not prioritized’, ‘cost’, and ‘lack of feasibility or practicality of some sustainable technologies’. The frequency count of these responses emphasizes their importance and suggests a degree of prioritization within the participants' perception. However, it is crucial to note that the importance and ranking of these barriers vary among participants, as their individual perspectives and challenges differ. Further quantitative investigative research is also needed to validate the significance of each of these aspects and their ranking in terms of significance.

It is clear from Table 4.90 that the barriers are more than the drivers identified above. Through the responses collected in this case study, several barriers were identified, with several factors centring around the financial considerations and lack of knowledge and awareness. While awareness is increasing in some parts of the world and in some companies in Egypt, a significant gap in knowledge and awareness remains, creating challenges (Excerpts D3.3-1, D3.3-2, D3.3-3). Additionally, some participants discussed the difficulty of considering measures to reduce their impact, adopt greener solutions, or adopt environmentally friendly alternatives due to the financial cost (Excerpts D3.3-4, D3.3-5, D3.3-6).

Furthermore, bureaucracy surrounding the reporting of environmental performance and the management systems involved in the environmental sustainability in this case is another barrier highlighted by participants. For example, the shipping line participant described how bureaucracy hinders the adoption of sustainable solutions (Excerpt D3.3-7). The port authority participant also expressed frustration with the bureaucracy of the system (Excerpt D3.3-8). This approach to environmental sustainability was also emphasized by the UN agency and government representative (Excerpt D3.3-9). The numerous levels, steps, approvals, and people involved in making one decision about environmental sustainability is what is causing this challenge (Excerpt D3.3-10).

Other barriers to the adoption of environmental sustainability solutions and environmental performance measurement were also mentioned by participants, including limited collaboration between stakeholders, the lack of availability and access to sustainable and environmentally friendly alternatives, and the competing priorities of a developing economy, where tackling poverty, health, and education issues may take precedence over environmental concerns. In addition, the lack of infrastructure can also pose a barrier, as stakeholders may reverse the initiatives and solutions of other stakeholders (Excerpt D3.3-11). Table 4.91 presents excerpts from the data.

Table 4.90 SCZone Case NVivo Matrix - GLH Stakeholders' Environmental Sustainability Barriers Codes Frequency (Source: NVivo 12)

Environmental Sustainability Barriers	**Ship.**	**TO II**	**PA**	**TO I**	**Log I**	**Log II**	**FFW**	**T&FFW I**	**T&FFW II**	**Gov.**	**Ag.**	**LC I**	**LC II**	**Total**
Availability and access to environmental options			2			1				1		1		5
Lack of infrastructure to support sustainability initiatives			1	1							1			3
Lack of capabilities to measure environmental impact or apply sustainable solutions			4							1				5
Reversing the sustainability solutions by other stakeholders			1	1									1	3
Bureaucratic System	1		2	1						1	3			8
Complicated process (ex: requires collective action& collaboration from several sectors)			7	8					1	1				17
Cost (ex: sustainable solutions are 'more' expensive; low budget for sustainability)	2		1	1	1	2	1	1		2	3			14
Difficulty in improving past the legislation requirements (ex: difficulty convincing private companies)		1	3		1									5
Difficulty in mapping the impact of transport activities	1													1
Sustainability is not prioritized (ex: it is not incorporated yet in metrics of a successful business, price is seen more important, effort & inconvenience, or developing economy faces social challenges)		1	6			1		1		2	1		2	14
Government support is required for sustainable solutions	2		1	1		2								6
Green Washing									1				1	2
Different regulations in different regions (ex: Inconsistency of regulations; additional work)											1			1
The Inflexibility & amount of cargo required for more sustainable modes of transport (ex: Inland vs truck)					1									1
Lack of data to measure environmental performance	3		2			1	1		1					8

Table 4.90 (continued)

Environmental Sustainability Barriers	**Ship.**	**TO II**	**PA**	**TO I**	**Log I**	**Log II**	**FFW**	**T&FFW I**	**T&FFW II**	**Gov.**	**Ag.**	**LC I**	**LC II**	**Total**
Lack of enforcing environmental sustainability regulations and legislations			3			1			1			1		6
Lack of feasibility or practicality of some sustainable technologies or solutions (ex, env. restrictions)	2					1				2	3			8
Lack of good measurement frameworks									1					1
Lack of human resources			5							1				6
Lack of knowledge and awareness	1	1	11	1			1		1	3	2		2	23
Long timescale of sustainable project implementation										1				1
Losing competitive advantage (price or enforcing sus measures)	1		2							1	1			5
The chain of responsibility is broken			1						1					2
The environmental impact is not yet integrated in the buying decision, the financial or economic system		1	1			1								3
Unknown profitable extent of sustainable technologies investment					1	1								2

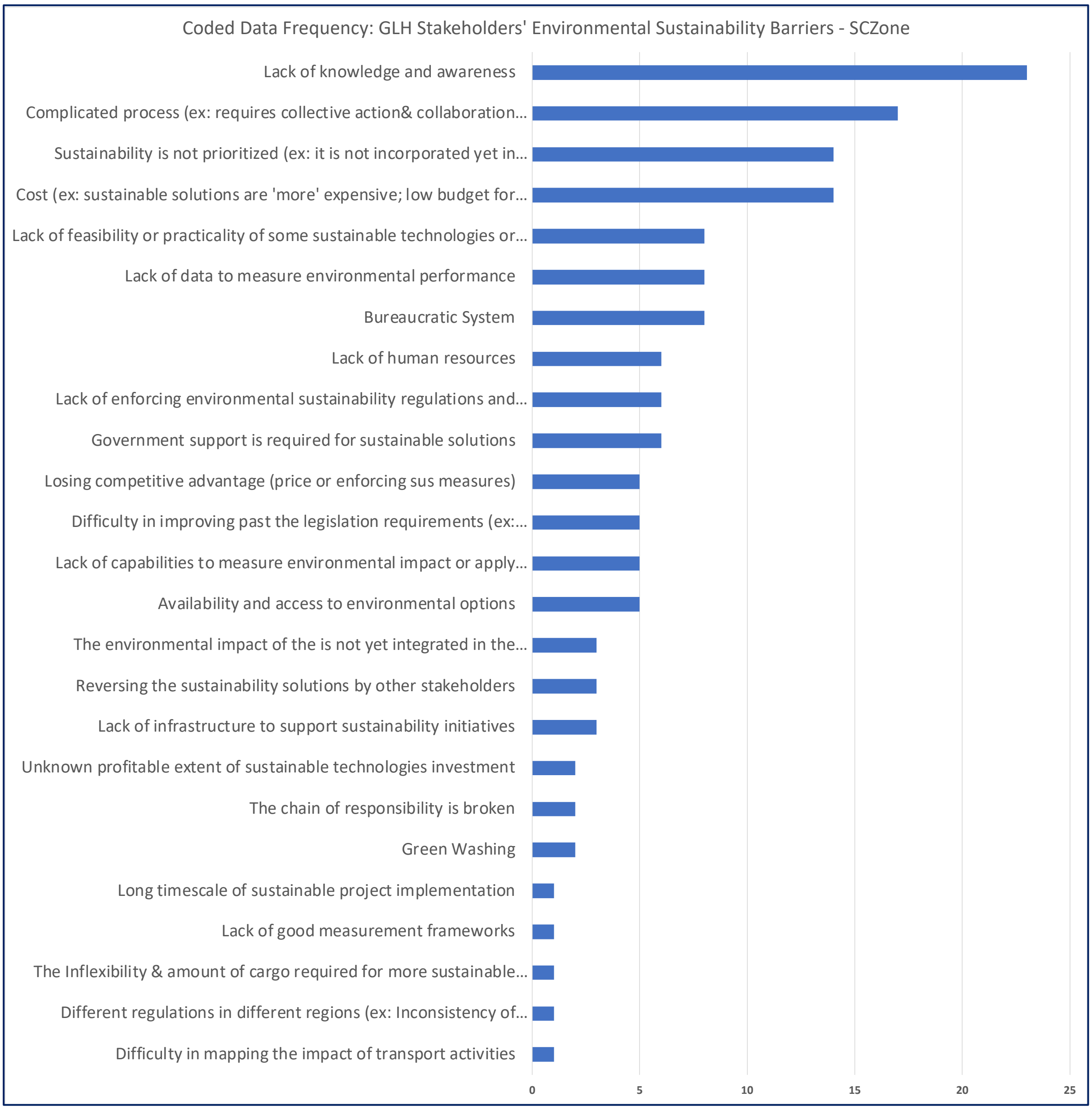


Figure 4.37 Coded Data Frequency: GLH Stakeholders' Environmental Sustainability Barriers – SCZone (Source: NVivo 12)

Table 4.91 SCZone Excerpts Supporting: GLH Stakeholders' Environmental Sustainability Barriers Theme

Excerpt No.	Participant	Excerpts from Interviews & Data
D3.3-1	PA	*"Regarding the environmental part there is no awareness at all, whether in the community or in the people working here... the existing leaders don't have such awareness" (C4L1P1)*
D3.3-2	Gov.	*"The issue depends on the awareness of the factory owners.... in order to achieve sustainability, the biggest need we face is environmental awareness because people do not understand it" (C4L3P3)*
D3.3-3	LC II	*"No one is aware of or demonstrates the importance of preserving the environment... We have to create first awareness for the people, and when they start to save the environment, there would be programs in place to help them and help with the environmental sustainability" (C4L3P2)*
D3.3-4	Ship.	*"If this was optional, the companies would not select a setup that carries an additional $200 cost per container to achieve environmental sustainability, which might endanger my market share, because this is an additional cost" (CML2P6)*
D3.3-5	Ag.	*"The financial cost is the main reason. If the company is working to achieve it, they will be concerned about the financial cost" (C4L3P4)*
D3.3-6	Gov.	*"I am not suggesting we extend the underground pipelines because it is very expensive" (C4L3P3)*
D3.3-7	Ship.	*"If I go to the government with a rail operation solution that will connect me to the port, electric rail operation for example, they are not flexible to participate or at least accept the concept and give us the greenlight to invest, build, and pay for the project. Because we need to have their blessing, but they don't approve, or you are hit with bureaucracy that will delay it for over a year and the delays come with great costs" (CML2P6)*

Table 4.91 (continued)

Excerpt No.	Participant	Excerpts from Interviews & Data
D3.3-8	PA	*"The environmental affair authority is the authority concerned with all the issues related to the environment. How do these guys work in the ports? Laws and decrees… When they want to implement the law, they wait till a disaster happens then they impose fines and deal with that disaster once it happens" (C4L1P1)*
D3.3-9	Ag.	*"The most important thing for me is to fine the violating ship and after that the Ministry of Environment can ask for a report" (C4L3P4)*
D3.3-10	Ag.	*"The higher council for seaports has different levels. Executive level that prepares the topics and decisions and is chaired by the Chairman of the Egyptian Maritime Sector. After that, they are shown in another meeting where the Minister chairs and then it goes up to the Council meeting with the Prime Minister to take the critical decisions in the matters in front of them" (C4L3P4)*
D3.3-11	TO I	*"We were trying to segregate our waste here at the company, but no one helped us. I mean when we segregate the waste to solid and plastic, they mix them up again at the waste centre. So, all the effort and awareness which we did is lost in the end" (C4L1P2)*

4.6 Within-Case Analysis Summary

This chapter has provided a thorough analysis of the four GLH case studies individually. Through the examination of three levels of primary stakeholders and the identification of themes derived from the data, patterns and variations within each case have been highlighted. The 3 global themes and 13 organising themes discussed in this chapter help answer the research questions that guided this study. The contributions of the participants in each case, through their experiences and opinions, have helped shape these themes.

In the next chapter, the focus will shift to a cross-case analysis, in which the cases will be compared to identify any common patterns or differences that may emerge in relation to their heterogenous characteristics. The main lessons drawn from the cases will be summarized and a discussion of similarities and differences between the cases will be presented in the next chapter. This will further enhance the understanding of the research topic and provide insight into the overall trends and variations that exist among the four cases. A summary of the major findings in relation to each research question is provided at the end of the next chapter.

Chapter 5 Cross-Case Analysis

5.1 Introduction

This chapter presents a cross-case analysis of the findings from the individual case studies. The four case studies are analysed in relation to one another in order to identify any common patterns or differences in relation to their heterogeneous characteristics. The findings from both the individual within-case analyses and the cross-case analysis serve as the foundation for the development of theory in the next chapter. This approach allows for the development of theory that explains findings from all cases, while also tracing the developed theory back to the individual cases to ensure that the chain of evidence is maintained (Eisenhardt, 1989).

This chapter follows the same structure as the individual case analyses. It is organized into the same 3 global themes and 13 organizing themes in Figure 4.1, but the focus is on comparing and contrasting the findings from the different cases in relation to these themes. By following this structure, the chapter maintains a clear and consistent organization, making it easy to follow the analysis and draw conclusions from the data. By examining the data from each case individually and then comparing and contrasting the findings across cases, a more comprehensive understanding of the research questions can be achieved. This approach is consistent with the Creswell & Poth's (2016) strategic approach to analysing case studies outlined in Figure 3.7 in the Research methodology chapter.

5.2 Theme 1: Building an Understanding of the GLH Concept

This global theme has 5 organising themes that contribute to the understanding of the concept of GLH across cases.

5.2.1 GLH Definition

In the four case studies, the majority of participants were able to articulate a clear definition of a GLH based on their professional experiences and expertise. However, it was noted that there was some level of ambiguity and inconsistency in the way the term was understood by a minority of participants. Despite these differences, a number of common themes emerged in the definitions provided by the participants. These theme similarities are listed in Table 5.1. Additionally, Figure 5.1 shows the frequency of responses coded under each theme. It suggests that 'logistics and marine services', 'good accessibility and global connection', 'multimodal transport', 'industrial cluster', 'import, export, and transhipment', 'strategic geographical location', and 'major maritime port' are among the most crucial aspects of a GLH. These themes have the highest frequency of responses, emphasizing their importance in the participants' perception.

In addition to these similarities, the definitions provided by the participants also revealed some specific differences among the cases. These differences are outlined in Table 5.2 and pertain to the specific characteristics and development stage of the GLH.

Table 5.1 Cross-Case GLH Definition Similarities

GLH Definition Keywords - Cross Case Similarities
1. Logistics And Marine Services
2. Good Accessibility & Global Connection
3. Multimodal Transport: Road, Rail, River, Air, Ocean, Short-Sea Shipping, & Pipelines
4. Industrial Cluster
5. Import, Export & Transhipment
6. Strategic Geographical Location
7. Major Maritime Port
8. Infrastructure to Accommodate and Deliver
9. Synergy Between Maritime, Logistics, And Industrial Activities
10. Economic Engine & Trade Link
11. Port Cluster
12. Handling All Types of Cargo

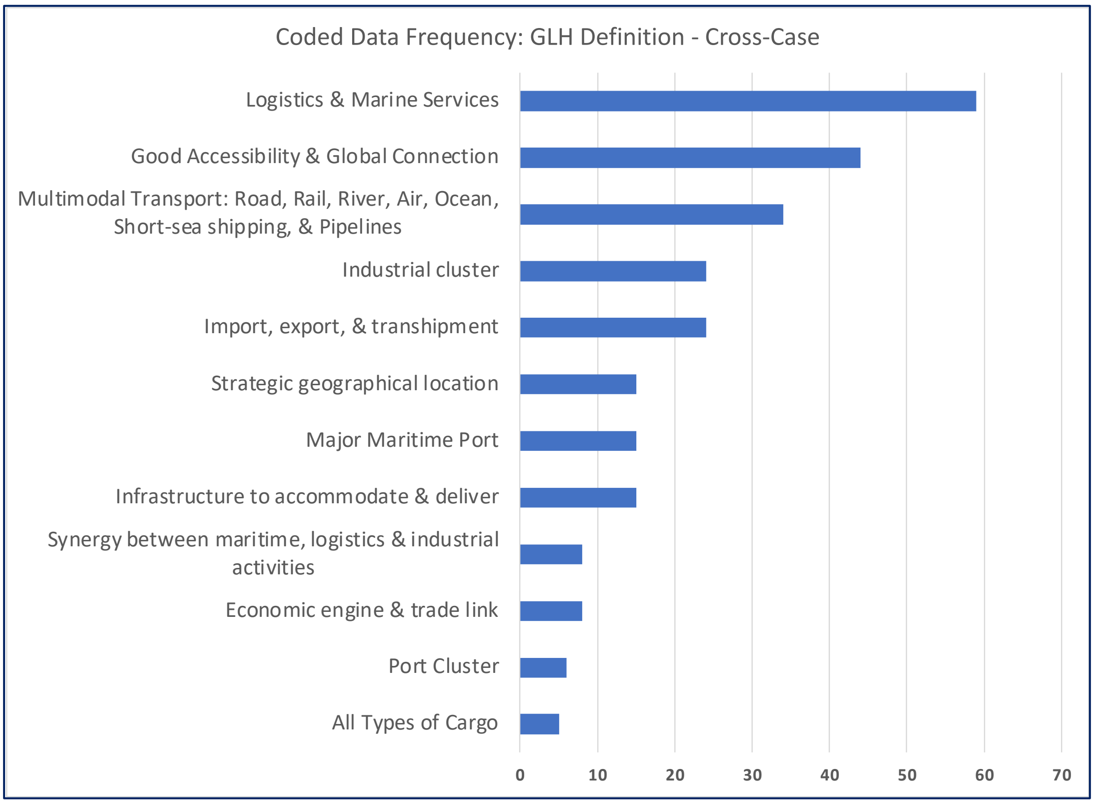


Figure 5.1 Coded Data Frequency: GLH Definition - Cross-Case (Source: NVivo 12)

Table 5.2 Cross-Case GLH Definition Frequency Differences (Source: NVivo 12)

GLH Definition Keywords - Cross Case Differences	Rotterdam	Antwerp	Liverpool	SCZone
Serving a Specific Market	1		1	
Free Trade Zone			1	2
Warehousing & Storage Capacity	3	1		1
Smart Hub	2	1		3
Security & Political Stability				1
Holistic Integrated Area				1

Some of the differences that emerged in the cross-case analysis include the importance of free trade zones in some GLHs. A GLH could require a free trade zone in order to facilitate efficient trade. This is demonstrated by the efforts of both Liverpool and SCZone GLHs to establish such zones within their respective GLHs. In contrast, Rotterdam, and Antwerp GLHs, which are located in countries that are members of the European Union, are able to enjoy the benefits of free trade without the need for such zones. The creation of a free trade zone within the GLH would allow for the smooth flow of imports, exports, and transhipment cargo, as well as the opportunity for value-added activities to take place without the delays and complications of customs clearance. This is particularly important for transhipment cargo and cargo that will be exported following value-added activities within the free trade zone. In the case of Liverpool GLH, the impact of Brexit may have emphasized the need for a free trade zone, as shown in Table 5.2. The imposition of customs duties and changes in customs-related complications in trade between the UK and European countries highlights the pressing need for a free trade zone within the GLH to facilitate trade and minimize such delays and complications. Therefore, the development of Liverpool GLH after Brexit emphasizes the establishment of a free trade zone to ensure smooth and efficient operations as part of the GLH.

Additionally, serving specific markets was another theme that emerged in Rotterdam and Liverpool GLH case studies. Liverpool GLH is currently serving the UK and Ireland, and is connected to global sources through global connections. While Rotterdam GLH is targeting the European market. This demonstrates that a GLH can serve a specific country while in the early stages of development, such as in the case of Liverpool; as well as a larger region or even a continent, as seen in Rotterdam GLH. Furthermore, the importance of having a sufficient capacity for warehousing and storage in the development of a GLH is evident in the cases of Rotterdam, Antwerp, and the SCZone, where multiple stakeholders emphasized its importance. This may be due to the specific market being served, as in the case of the Liverpool GLH, where the focus was more on the efficiency and versatility of the service rather than the need for extensive storage because the market served is within the UK and Ireland currently. Regardless, the availability of sufficient storage space is a crucial factor to consider in the development of a GLH, as it allows for the smooth and efficient handling of the large volumes of cargo that GLHs process. SCZone participants also emphasized the critical role that political stability and security play in ensuring the smooth and secure handling of cargo at the GLH.

The following definition synthesizes the participants' responses of the four case studies regarding the GLH concept:

A GLH is a strategic location that integrates logistics, maritime, and manufacturing operations in order to facilitate the exchange of global cargo through a hub and spoke network configuration. It includes a main deep-water seaport or cluster of seaports situated on major trade routes and served by large ocean carriers, as well as industrial clusters, transportation links, warehousing, value-added activities, logistics, and maritime services. A GLH is equipped to handle all types of cargo for transhipment, import, or export and requires the necessary infrastructure and capacity to handle large volumes of cargo, as well as sufficient space for development. The primary function of a GLH is to allow for the smooth distribution of cargo from global origins to global destinations to serve specific regions and facilitate global trade. This is achieved through well-connected networks and excellent accessibility to global transportation routes and the markets it serves through various multimodal connections, such as deep-sea, short sea, inland waterways, road, rail, air, and pipelines. In some cases, a free trade zone may be necessary for the operation of a GLH. To ensure the smooth, safe, and flexible operations of a GLH, it is essential to have the necessary infrastructure to handle global cargo volumes and to promote collaboration and integration among stakeholders, and the location must be secure and politically stable.

5.2.2 GLH Primary Stakeholders

The cross-case analysis of the primary stakeholders identified in the four case studies revealed that the stakeholders are largely similar across all cases. There is not much variation among the identified stakeholders. Table 5.3 lists the common primary stakeholders across the cases. Additionally, Figure 5.2 shows the frequency of responses coded under each theme. It suggests that 'government and local councils', 'logistics companies and freight forwarders', 'cargo owners or shippers', 'port authorities', 'shipping lines', and 'associations and interest groups' are among the most frequently mentioned primary stakeholders of a GLH across the four cases. These themes have the highest frequency of responses, emphasizing their importance in the participants' perception.

Furthermore, Table 5.4 shows the differences in stakeholders across the cases. Legal and financial service companies are considered primary stakeholders in SCZone GLH as the country's economic capabilities may not fully support the project, and it relies on loans and foreign investments to facilitate its development rather than government funding. Additionally, the ownership structure of the ports in the case studies determines the importance of certain stakeholders. In the case of Rotterdam, Antwerp, and SCZone GLHs, the ports are publicly owned or in PPP and therefore have port authorities as primary stakeholders. On the other hand, Liverpool GLH has a privately owned and operated port, leading to the port owner and operator having authority rather than a port authority.

Furthermore, airports were identified as primary stakeholders in all cases except SCZone GLH. This may be due to the proximity of an airport to the location of the other GLHs, while SCZone GLH relies on airports in other locations for multimodal transport such as Cairo Airport. This may explain why they are not considered primary stakeholders in this case. Finally, science and educational institutions were identified as stakeholders in all cases except for the Liverpool GLH case.

Table 5.3 Cross-Case GLH Primary Stakeholders Similarities

GLH Primary Stakeholders - Cross Case Similarities
1. Government & Local Councils
2. Logistics Companies & Freight Forwarders
3. Cargo Owners or Shippers
4. Port Authorities or Owners-Operators
5. Shipping Lines
6. Associations & Interest Groups
7. Terminal Operators
8. Inland Vessel Sector
9. Industrial Cluster Companies
10. Trucking Companies
11. Local Community
12. Railway Operators
13. Employees
14. Investors

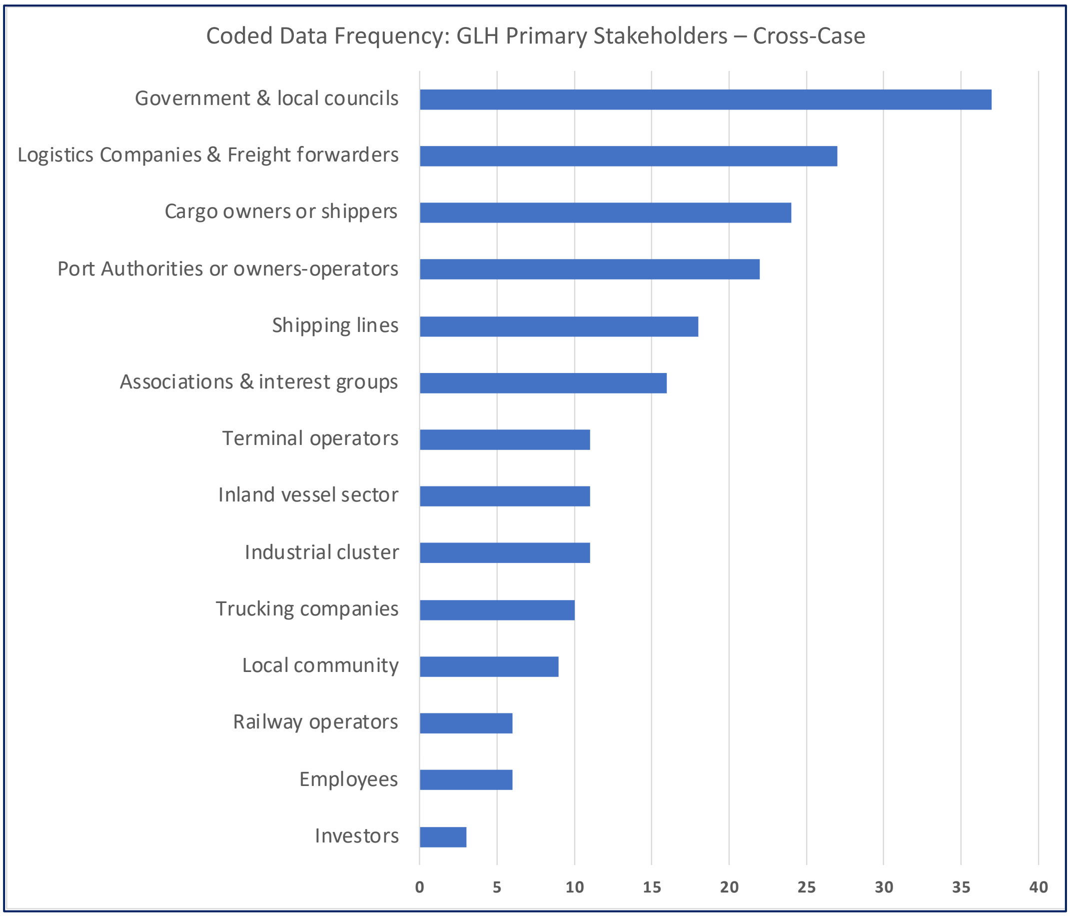


Figure 5.2 Coded Data Frequency: GLH Primary Stakeholders – Cross-Case (Source: NVivo 12)

Table 5.4 Cross-Case GLH Primary Stakeholders Frequency Differences (Source: NVivo 12)

GLH Primary Stakeholders - Cross Case Differences	Rotterdam	Antwerp	Liverpool	SCZone
Airports	1	1	1	
Science & Educational Institutes		2		2
Financial & Legal Companies				3

5.2.3 Role, Activities, and Operations of GLH Primary Stakeholders

It is evident that there is a degree of overlap in the operations of the various stakeholders involved in a GLH. For example, by comparing the cases, it shows that there are similarities in the public role and operations of port authorities or port owners. However, it is important to note that while there are certainly similarities between the various cases outlined in Table 5.5, there are also a number of differences that should be taken into consideration, as shown in Table 5.6.

GLH can include public, private, or public-private port ownership models, where they fulfil both public and private roles. In their public role, port authorities act as regulatory bodies, providing marine services, managing maritime traffic, and investing in and constructing port infrastructure and facilities. Additionally, in Liverpool and SCZone GLHs, the port authority or owner perform cargo inspection and customs clearance as part of their public role. In their private role, port authorities often act as landlords, managing and renting out port facilities. In the SCZone GLH, the port authority also provides stevedoring and cargo handling services in collaboration with the port operator, rather than simply acting as a landlord. In contrast, the Liverpool port does not have a port authority and is privately owned, with the port owner and operator assuming regulatory responsibilities. However, they still rent some facilities to some external companies.

The port owner and operator participant explains:

> *"Some of the models as well we've got some sort of partnerships with strategic partners that provide added-value service on the port estate on our behalf as well, and some joint ventures, as well." (C3L1P2)*

Table 5.5 Cross-Case Similarities: Port Authority and Port Owner Public Role, Activities, and Operations

Port Authority & Port Owner Role and Operations - Cross Case Similarities
Investing & Building Infrastructure & Port facilities
Provide Marine Services & Maritime Traffic
Regulatory Authority

Table 5.6 Cross-Case Differences: Port Authority and Port Owner Role, Activities, and Operations

Port Authority & Port Owner Role and Operations - Cross Case Differences		**Rotterdam**	**Antwerp**	**Liverpool**	**SCZone**
Public Role:	Providing Customs Clearance			√	√
	Cargo Inspection			√	√
Private Role:	Landlord (managing & renting the port facilities)	√	√	√	
	Stevedoring services			√	√
	Cargo Handling			√	√
	Manage PPP with private sector and foreign investors				√

In Rotterdam, Antwerp, and SCZone GLHs, private terminal operators fulfil a role similar to that of the private role of private port operators in Liverpool GLH. These companies do not have a public role and instead provide terminal operating services such as cargo handling, stevedoring, and warehousing, as well as logistics value-added services like freight forwarding and supply chain solutions. The terminal operator in Antwerp GLH is formally both a terminal operator and a logistics service provider, further blurring the lines between the operations of these stakeholders.

In contrast to Rotterdam and Antwerp GLHs, the SCZone GLH port authority is involved in port and terminal operations due to the public-private partnership with terminal operator companies. This partnership allows the port authority to play a role in the actual operations of the port and terminal, rather than simply acting as a regulatory body as is the case in publicly owned ports. Table 5.7 lists the similarities in terminal operators' operations across cases, while Table 5.8 illustrates the differences across cases.

Table 5.7 Cross-Case Similarities: Terminal and Port Operators Role, Activities, and Operations

Terminal Owner & Operator Role and Operations - Cross Case Similarities
Operate Terminals
Warehousing
Logistics Services a. Packaging & repackaging b. Stuffing & stripping containers c. Weighing containers d. Arranging Customs Clearance

Table 5.8 Cross-Case Differences: Terminal and Port Operators Role, Activities, and Operations

Terminal Owner & Operator Role and Operations - Cross Case Differences	**Rotterdam**	**Antwerp**	**Liverpool**	**SCZone**
Transhipment	√			
Cargo Handling	√	√		√
Freight Forwarding	√	√	√	
Landowner			√	
Ensuring Safety & Legal Regulations are met	√			
Stevedoring services		√	√	√
Outsourcing transportation and storage facilities		√		
Barge, Rail, Road Freight		√		
Ocean Freight		√		√
Supply chain solutions		√		

The shipping line company in all cases is the same entity with 2 regional branches included for Europe and MENA regions, resulting in significant similarities between the cases, as shown in Table 5.9. There is only one main difference in the SCZone GLH case, as shown in Table 5.10. This can be due to the need of this service in this GLH in caparison to the other GLHs. Both regional branches carry out the same operations, which primarily involve maritime shipping but also overlap with the operations of other logistics and supply chain stakeholders.

Shipping line operations are largely conducted in international waters, allowing these companies to set up their headquarters in any location and operate globally. These companies are primarily governed by intergovernmental agencies such as the United Nations, which sets standards and regulations for the international shipping industry. The participant of the Europe regional branch of the shipping line explains:

"We have an HSSE manager for each area. And by area we mean like a cluster of companies. Like we have multiple areas form a region and then the regions report to global in that sense... we have global teams, and we have the local or area or regional teams if you want to call them." (CEL2P3)

Table 5.9 Cross-Case Similarities: Shipping Line Role, Activities, and Operations

Shipping Line Role and Operations - Cross Case Similarities
Ocean transport & related services
Logistics Solutions
Inland transport
Warehousing
Distribution
Supply chain management
Insurance

Table 5.10 Cross-Case Differences: Shipping Line Role, Activities, and Operations

Shipping Line Role and Operations - Cross Case Differences	**Rotterdam**	**Antwerp**	**Liverpool**	**SCZone**
Customs Clearance Operations				√

As for the operations and services of logistics, transport, freight forwarding, and logistics departments for cargo owners and manufacturers in the 4 cases, it becomes evident that these stakeholders exhibit a high degree of similarity in their operations. As outlined in Table 5.11, these services typically include the provision of warehousing and distribution services, packaging, and the utilization of various modes of transportation such as ocean, air, and road freight. It is worth noting that a significant number of these companies also tend to outsource their transportation and storage facilities to external providers.

Additionally, other variations of the logistics services typically include the arrangement and optimization of multimodal freight, as well as a range of value-added activities such as labelling, assembly, cross-docking, and consolidation among others, as outlined in Table 5.12. These services may vary depending on the diversification and specialization of the individual companies.

Table 5.11 Cross-Case Similarities: Logistics Companies and Departments Role, Activities, and Operations

Logistics, Transport, Freight Forwarding Companies, & Manufacturers, & Cargo Owners Logistics Operations - Cross Case Similarities
Distribution & Freight Forwarding
Ocean, Road, & Air Freight
Outsourcing transportation and storage facilities
Packaging
Warehousing

Table 5.12 Cross-Case Differences: Logistics Companies and Departments Role, Activities, and Operations

Logistics, Transport, Freight Forwarding Companies, & Manufacturers, & Cargo Owners Logistics Operations - Cross Case Differences	**Rotterdam**	**Antwerp**	**Liverpool**	**SCZone**
Arranging Customs Clearance	√	√		√
Door-to-Door Services	√	√		√
Rail freight	√			
Stevedoring services		√		
Cargo Handling		√	√	√
Barge freight		√		
Stuffing & stripping containers		√		
Value-added services: a. Labelling b. Assembly c. Semi/light manufacturing and customizing d. Production & manufacturing	√	√		√
Supply chain solutions		√		
Commercial Vehicle Maintenance			√	
Export used Trucks and Transport Equipment			√	
Consolidation			√	√
Inspection				√
Cross-docking		√		√
Chartering services				√
Consultancy				√
Integrated Multi-modal transport				√

The third level of stakeholders in the operations of a GLH includes a diverse array of individuals and organizations, including local community members, government representatives, trade associations, NGOs, and UN agencies. These stakeholders play different roles and provide a range of services and support to the operations of the GLH.

The role of government in the operation of the GLH can vary significantly depending on the specific case, with some governments taking on both a macro and micro role, as shown in Table 5.13. At the micro level, the government may be responsible for tasks such as ensuring safety and security, as in the case of SCZone GLH, or checking for infringements and reporting, as in Rotterdam GLH. At the macro level, the government may be involved in securing free trade agreements with other countries, as in SCZone GLH, protecting the environment, as in Rotterdam GLH, and setting strategies and policies, as well as providing financial support to projects, as in Liverpool and SCZone GLHs. The government in Liverpool case only has a macro role due to the highly privatized industry in the United Kingdom. In the case of Antwerp GLH, there was insufficient data on the role and activities of the government as participants from this stakeholder type were not identified during the snowball sampling process.

In addition to governments, trade associations and agencies also play a significant role in the operations of the GLH, providing information, support, and advice on regulations and industry issues (Table 5.14). The local community, on the other hand, can benefit from the economic development brought about by the presence of the GLH, as well as from the diverse range of goods and services made available due to the GLH's activities. Members of the local community may also be employed at or work within the GLH (Table 5.15).

Table 5.13 Cross-Case Differences: Government Role, Activities, and Operations

Government Role & Operations - Cross Case Differences	Rotterdam	Antwerp	Liverpool	SCZone
Analysing data	√			
Checking for infringement	√			√
Reporting and penalizing	√			√
Free trade agreements facilitation				√
GLH area's security and safety				√
Providing funding & financial Support			√	√
Facilitating foreign investments				√
Setting policies, strategies, plans and regulatory frameworks			√	√
Regulatory Body and Local Authority			√	
Lobbying and communicating with national governments			√	
Convening role to link innovation with real-life issues to stimulate demand			√	

Table 5.14 Cross-Case Differences: Associations and Agencies Role, Activities, and Operations

Associations & Agencies Role & Operations - Cross Case Differences	Rotterdam	Antwerp	Liverpool	SCZone
Lobbying			√	√
Policy Campaigning		√	√	√
Provide information, support, and advice on regulations and issues		√	√	
Representing a united voice of the member stakeholders		√	√	
Exchange of best practice			√	
Provide Training		√		
Coordinate with other organizations		√		
Support & Advice on global issues	√	√	√	√

Table 5.15 Cross-Case Differences: Local Community Role, Activities, and Operations

Local Community Role - Cross Case Differences	Rotterdam	Antwerp	Liverpool	SCZone
Employees, Economic development of the region, and receiving goods as consumers	√	√	√	√

5.2.4 GLH Physical Infrastructure and Connections

Be comparing the 4 cases studies regarding the development of the physical infrastructure and connections of GLHs, it is evident that they are constantly being developed and improved upon. This holds true for both more established GLHs, such as Rotterdam and Antwerp GLHs, as well as those that are still in the process of development, like Liverpool and SCZone GLHs. The importance of strong infrastructure and connections to the overall functioning of a GLH cannot be overstated, and therefore, most of the aspects listed in Table 5.16 are consistently being refined in all cases.

The extent of development and improvement can vary significantly between cases, with Rotterdam and Antwerp GLHs often having fewer areas in need of development, and mostly they are improving on existing structures. This is due to the fact that the foundation elements of the GLH, such as the residential areas for employees, hinterland and industrial areas, and maritime trade routes, are already well-established. In contrast, Liverpool and SCZone GLHs are still in the process of developing these core elements, and as such, their focus is more heavily centred on these areas, and they are developing them from scratch.

The development of GLH infrastructure and connections typically requires collaboration between the port and government, and in some cases, additional stakeholders may also be involved. For example, the development of rail networks requires the participation other ports and governments, and rail operators. Regardless of the ownership of the port in the GLH, the development of GLH areas often involves the input of a number of primary stakeholders.

It is worth noting that the development focus of the various cases may differ depending on the stage of development that the GLH is currently in. However, the infrastructure of the port itself is typically a consistent area of development in all cases, as it must be able to accommodate the increasing global cargo capacity demands, as shown in Table 5.16.

Table 5.16 Cross-Case GLH Physical Infrastructure and Connections Differences

Infrastructure and Connections	**Rotterdam**	**Antwerp**	**Liverpool**	**SCZone**
1. Port Infrastructure	Further Development	Further Development	Further Development	Further Development
2. Rail Networks	Further Development	Further Development	Further Development	Developing
3. Road Networks	Further Development	√	Further Development	Developing
4. Pipelines	Further Development	√	x	Plan to Develop
5. Smart Hub	√	Further Development	x	x
6. Inland Waterway Connections	Further Development	√	√	Plan to Develop
7. New Maritime trade routes	x	x	Developing	x
8. Hinterland & Industrial Zone	Further Development	Further Development	Plan to Develop	Developing
9. Residential Area	√	√	√	Developing
10. Renewable Energy Infrastructure	Further Development	√	Developing	Plan to Develop

Legend:

- Further Development: Existing infrastructure or connection being worked on and developed further.
- Developing: New infrastructure or connection being built and developed from scratch.
- Plan to Develop: Intention to develop, but work has not yet started.
- A tick '√': Infrastructure or connection is currently available, developed, and functioning.

5.2.5 GLH Governance Structure

Across the 4 cases, the governance structure for stakeholders of a GLH varies depending on a range of characteristics, including the ownership of the port in the GLH, the regulatory system and governance hierarchy in place in the hosting country, and the stage of development of the GLH. These differences are illustrated in Table 5.17. Additionally, when it comes to trading blocs such as the EU, there may be additional governance structures in place that apply to GLHs within the bloc. These structures may be developed at the EU-level and be applicable to all member states, or they may be developed at the member state-level and apply only to GLHs within that particular country.

In Rotterdam and Antwerp GLHs, the ports are publicly owned and managed by port authorities, who act as landlords responsible for maintaining and managing public infrastructure and concessions. These port authorities also have regulatory responsibilities, including ensuring that relevant legislation is followed. The central government has a limited role in the governance of these GLHs, although it may still be interested in the activities taking place within them due to their public ownership. In SCZone GLH, the ports are owned through a public-private partnership (PPP) and also have port authorities, which have similar responsibilities as those in Rotterdam and Antwerp GLHs. However, port authorities in SCZone GLH are also involved in the port and terminal operations. Terminal operators and other companies in these GLHs have control over their own internal operations, and they fall under the governance of the port authority if they are operating in the boundaries of the port, or the local government if they are operating outside of the ports' boundaries.

On the other hand, in the case of Liverpool GLH, the industry is highly privatized with minimal involvement of the government. The port in the GLH is privately owned by a company that acts as both the landlord and the operator of the port, as well as having certain regulatory authority within the boundaries of the port to ensure legislation is followed by the company's employees, and companies using the port's facilities or running operations within the boundaries of the port. This is because the governance structure in this case is decentralized. Liverpool City Region as the local authority in the region and is devolved from the central government. They are responsible for mandating and governing from a regulatory perspective, but they are not involved in any operations. Despite this decentralization, the governance structure is still subject to various agreements, regulations, and legislation, including those issued by the United Nations, national, and local controls. However, the government only intervenes when there is a need for change or collaboration.

In SCZone GLH, the government is attempting to establish a hybrid governance structure that combines elements of the hierarchical governance structures in Rotterdam and Antwerp cases, with the decentralized, more linear governance structure in Liverpool case. This is being done in an effort to decentralize the operations and authority of the SCZone and minimize the influence of bureaucracy within the regulatory system of Egypt, in order to make operations in this GLH more efficient. However, the sensitivity of the location of the SCZone makes it challenging to fully decentralize the governance structure. As a result, the government is attempting to create a hybrid approach that separates the SCZone GLH and its operations into a separate department, while still maintaining some elements of the hierarchical governance structure in place. This allows for a degree of decentralization while still ensuring oversight and accountability within the governance structure.

Furthermore, in Rotterdam, Antwerp, and SCZone GLHs, the port authorities act as intermediaries between the government, associations, local community, and private companies. They act as a link between the 3 levels of stakeholders of a GLH. This helps facilitate communication and the lobbying of relevant legislation that benefits all stakeholders. The port authorities in these cases have an overall view on the regulations, management, and operations of the GLH, but they don’t control stakeholders. In contrast, due to the linear and decentralized governance structure in Liverpool GLH, this is not applied. This governance structure has its benefits but can create challenges in terms of transparency and accountability.

The second level of stakeholders in all cases are considered customers to each other and the port, such as the logistics companies, cargo owners, freight forwarders, etc. As a result, the relationship between these companies, the government (in the cases of Rotterdam, Antwerp, and SCZone), and the port authority or port owner is not purely authoritarian as there is mutual benefit involved. So, the control over these companies is through well-established legislation and regulations, certificates, and authorizations that pertain to their business and services.

As the port authority participant in Rotterdam GLH explains:

> *"The companies in our area who are our customers, we do not have a direct influence on them. They make their own decisions and often their headquarters are in the United States or in Asia, but we try to influence them because they are in our port, and they are our customers" (C1L1P1)*

On the other hand, the shipping line has more flexibility in terms of its location of headquarters and its operations across various countries in international waters. However, it is still subject to the regulations and legislation of the countries in which it operates, as well as the guidelines set forth by intergovernmental agencies such as the United Nations. While the port authority may exert some level of influence over the shipping line, it has limited control over its operations outside its boundaries.

Trade associations and interest groups serve as a bridge between the various stakeholders of the GLH. These associations have an interest in supporting and providing training to different stakeholders within the GLH, and they also engage in lobbying activities to influence future regulations. They do not have authoritarian power over stakeholders, but they work in collaboration with the government, intergovernmental agencies, and other relevant parties to develop and communicate new policies and regulations. The regulations governing the maritime, freight, and logistics industries operate on both a local and global level, with one side comprising of national and local controls and regulations, and the other comprising of global regulations set forth by organizations such as the United Nations through the International Maritime organization (IMO).

Table 5.17 Cross-Case GLH Governance Structure Differences

GLH Governance Structure	**Rotterdam**	**Antwerp**	**Liverpool**	**SCZone**
Governance Structure Type	Centralized	Centralized	Decentralized	Hybrid
Port Authority has a Regulatory Authority	√	√	x	√
Port or Terminal Owner and Operator has a Regulatory Authority	x	x	√	x
Port Authority is a Link between Government and Other GLH Stakeholders	√	√	x	√
Government is involved in the Operations of GLH	√	√	x	√
Trade Associations are Links between Government and Stakeholders (Ex: Lobbying)	x	√	√	x

5.3 Theme 2: Environmental Measurement and Performance in GLHs

This global theme has 5 organising themes that describe environmental measurement and performance related organizing themes across cases.

5.3.1 GLH Stakeholders' Environmental Impact

Overall, some of the most common environmental impacts across the four cases are listed in Table 5.18. These common impacts include factors such as greenhouse gas emissions, water pollution, and waste generation. Additionally, Figure 5.3 shows the frequency of responses coded under each theme. It suggests that 'waste', 'greenhouse gas emissions', 'consumption of natural resources', 'liquid waste', 'noise', and 'particulate matter' are among the most mentioned environmental impacts of a GLH. These themes have the highest frequency of responses, emphasizing their importance in the participants' perception. This shows some consistency in the view of the environmental impact caused by GLH operations across cases. This consistency could be due to the increased awareness around greenhouse gas emissions and their contribution to climate change, plastic, biodegradable, and landfill issues, freshwater availability, and the impact of water pollution on biodiversity.

Table 5.19 illustrates the variations in environmental impact, accompanied by the frequency of responses, while Table 5.20 lists the detailed differences in environmental impacts mentioned in each case. It can be observed that most of the environmental impact factors highlighted in all cases are similar, although there are some differences in the level of detail provided. For example, the waste impact factor in Antwerp GLH is highly detailed. In contrast, Liverpool and SCZone GLHs provide less detailed descriptions of waste, simply categorizing it as hazardous or non-hazardous or solid and liquid waste. This suggests that all cases are aware of their environmental impact, but the level of detail provided varies. This difference in detail could also be an indication of the level of interest in addressing certain environmental impact factors, with the Antwerp GLH taking a more comprehensive approach to waste pollution.

Table 5.18 Cross-Case GLH Environmental Impact Similarities

GLH Environmental Impact - Cross Case Similarities
1. Waste
2. Greenhouse Gas Emissions
3. Consumption of natural resources a. Water b. Fuel c. Electricity
4. Liquid waste
5. Noise Pollution
6. Particulate Matter
7. CO2 emissions
8. Impact on Biodiversity and Ecosystem
9. Sulfur dioxide
10. Odour pollution

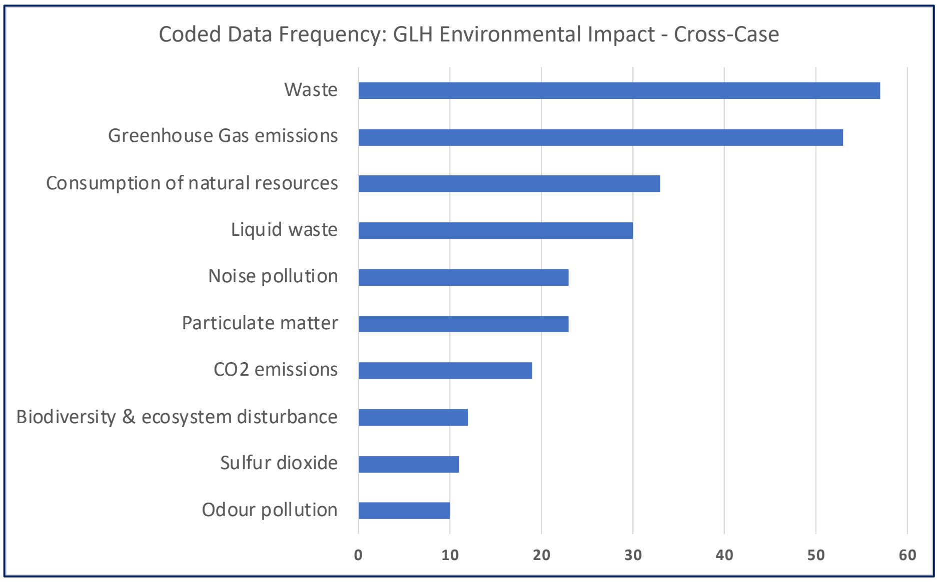


Figure 5.3 Coded Data Frequency: GLH Environmental Impact - Cross-Case (Source: NVivo 12)

Table 5.19 Cross-Case GLH Environmental Impact Frequency Differences (Source: NVivo 12)

GLH Environmental Impact – Cross Case Differences	Rotterdam	Antwerp	Liverpool	SCZone
Light pollution		1		
Land-use change		3	1	5
Sediment Pollution		3	1	5
Nitrogen oxides	8	6		1

Table 5.20 Cross-Case GLH Environmental Impact Differences - Description

Environmental Impact	Description	Rotterdam	Antwerp	Liverpool	SCZone
Biodiversity and ecosystem disturbance	Impact on biodiversity and ecosystem	√	√	√	√
	Biofuel usage and production's impact on biodiversity	√			√
	Pollution & disturbance impact on marine life				√
	Ocean acidification & global warming	√			
Consumption of natural resources	Energy consumption - Electricity/Gas/Fuel	√	√	√	√
	Water consumption	√	√	√	√
Air Pollution	Reduced air quality	√	√	√	
	Greenhouse Gas Emissions	√	√	√	√
	a. CO2	√	√	√	√
	b. NOx	√	√		√
	c. Particulate matter	√	√		√
	d. SOx	√	√	√	√
Water Pollution	Reduced water quality	√			
	Oil Spills	√	√	√	√
	Water Ballast Mg.	√	√	√	√
	Cooling water discharges	√			
	Emissions of metals and polyaromatic hydrocarbons		√		
	Emissions to Water			√	√
Noise Pollution	Loud noise	√	√	√	√
Odour Pollution	Strong & unpleasant smell	√	√	√	√

Table 5.20 (continued)

Waste	Plastic	√	√		√
	Wood/Pallets	√	√		
	Food	√	√	√	
	Paper/Cardboard	√	√	√	√
	Metals	√		√	√
	Contaminated dredging	√	√	√	
	Polystyrene foam		√		
	Industrial waste		√		
	Ship's sewage & garbage		√		
	Cargo Residues		√		
	Batteries		√	√	
	Liquid Waste		√	√	√
	Litter, fly tipping, weeds, and damage to the street infrastructure		√		√
	Hazardous & Non-Hazardous waste			√	√
	Tyres			√	√
	Solid Waste				√
	Organic Waste				√
Sediment Pollution	Soil contamination		√	√	√
Land-use change	Developing Facilities on wetland			√	√
	Green Land Displacement		√		
Light Pollution	Excessive artificial light		√		

5.3.2 GLH Stakeholders' Environmental Indicators

Upon comparing the four cases, it can be observed that there are some similarities in the environmental indicators used, such as those related to air emissions, waste, and energy consumption, as shown in Table 5.21. Additionally, Figure 5.4 shows the frequency of responses coded under each theme. It suggests that 'CO2 emissions in metric tonnes', 'electricity consumption in MWh', 'water consumption in cubic meters', 'Sox emissions in tonnes', and 'particulate matter in tonnes' are the top five mentioned environmental indicators among the stakeholders across cases. These indicators have the highest frequency, emphasizing their widespread usage and recognition in the participants' perception.

However, upon examining the diversity of indicators presented in Table 5.22, it becomes evident that there is a greater variance in the measurement of other environmental impacts across cases. This could be due to a variety of reasons, such as a lack of necessary equipment, lack of capabilities or knowledge on how to accurately assess certain environmental factors.

It is worth noting that all 4 cases use similar indicators for measuring greenhouse gas emissions, likely due to the increasing awareness and concern surrounding this particular impact and the availability of frameworks such as the GHG protocol to provide guidance. Additionally, each GLH may place a particular emphasis on certain environmental factors over others. For instance, Rotterdam and Liverpool GLHs exhibit a larger number of indicators for measuring carbon emissions, while Antwerp GLH has more diverse indicators to measure the water quality. Additionally, SCZone utilizes some indicators that do not overlap with other cases, such as supply chain miles and non-compliance costs, due to a lack of alternative measurement options. Furthermore, the sustainability capabilities of each case are measured differently, as each GLH has implemented different initiatives in this regard.

However, it is also apparent that certain environmental impact factors, such as light pollution, soil quality, biodiversity impact, and land use, are not consistently measured across all four cases. This demonstrates a discrepancy in the way the environmental impacts of GLHs are assessed. There is a lack of a unified set of measurements or indicators that can be utilized by stakeholders in these hubs to uniformly assess and mitigate their environmental impacts.

Furthermore, by comparing the environmental impact similarities listed in Table 5.18 with the environmental indicators presented in Table 5.21, it becomes clear that even though there is a shared understanding among the 4 GLHs of their environmental impacts, not all of these impacts are consistently measured across all cases. For example, indicators for assessing the impacts on biodiversity and noise are absent in both Liverpool and SCZone GLHs, while odour is only measured in Rotterdam GLH. Despite being identified as important environmental impacts in all

4 cases, these factors are not uniformly measured, indicating a lack of standardized approach to assessing such impacts.

Table 5.21 Cross-Case GLH Environmental Indicators Similarities

GLH Environmental Indicators - Cross Case Similarities		
Environmental Impact	**Indicators**	**Measures**
Air Emissions	CO2 Emission	metric tonnes
	NOx concentrations	micrograms per cubic meter
	NOx emissions	Tonnes
	Particulate Matter concentrations	micrograms per cubic meter
	Particulate Matter emissions	Tonnes
	SOx concentrations	Micrograms per cubic meter
	SOx emissions	Tonnes
Energy Consumption	Electricity consumption	Megawatt hour (MWh)
	Diesel, Gasoline, Compressed natural gas	Litres
Sustainability capabilities	Truck engine status (Euro Standard)	Percent %
Waste Pollution	Liquid Waste	Cubic meter
	Solid Waste (by type)	Metric tons
	Recycled waste	Tons
Water Quality	Water pollution	number of oil/industrial incidents
Water Consumption	Fresh Water Consumption	Cubic meters

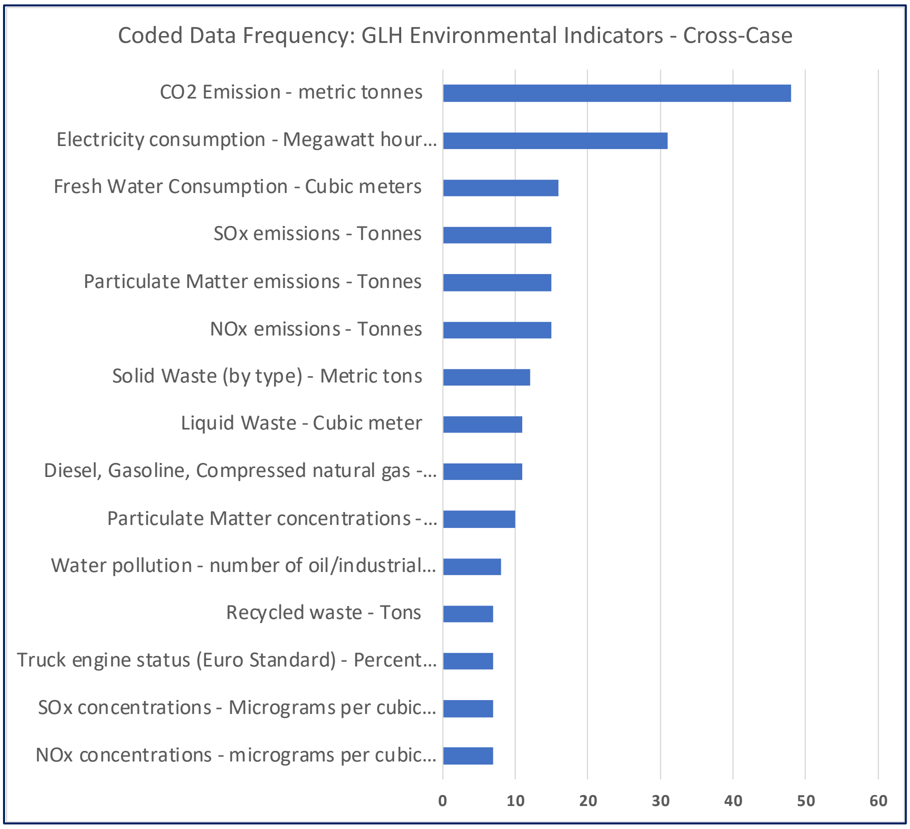


Figure 5.4 Coded Data Frequency: GLH Environmental Indicators - Cross-Case (Source: NVivo 12)

Table 5.22 Cross-Case GLH Environmental Indicators Frequency Differences (Source: NVivo 12)

Environmental Impact	Indicators	Measures	Rotterdam	Antwerp	Liverpool	SCZone
Air Emissions	CO2 Emission	Kg of CO2 per Vehicle.Km (VKM)			1	
		Average tonne of CO2 per member			1	
	CO2 Efficiency	Kg of Co2 per tonne.Km (tkm)	3		3	3
	CO2 Intensity	tons per fulltime employee (FTE)	1			
		gram per square meter	1			
	CO2 Reductions	metric tonnes	2		2	
		% per square meter	3			
	CO2 Concentrations	micrograms per cubic meter				1
	GHG Emission Reduction	metric tonnes per million dollars of revenue			1	
	GHG CO2 equivalent	Tonnes			2	1
Biodiversity & Ecosystem	Biodiversity	average % of species compared with objective or lower limit	1	8		
		number of incidents with impact on biodiversity	2			
	Land Use	Number of hectares created compared with Regional Land Use Plan	2	5		
Energy Consumption	Gas	Cubic Meter		1		
	Energy (Efficiency)	Petajoule (PJ)	1	3	1	
	Fuel consumption	Megawatt hour (MWh)	1	1		1
		Tonnes	1	1	2	
		Kilometres per litre (Km/L)	1			
	Fuel Efficiency	Miles per Gallon (mpg)			1	
	Consumption of Shore-based power	Megawatt per year	1			

Table 5.22 (continued)

Environmental Impact	Indicators	Measures	Rotterdam	Antwerp	Liverpool	SCZone
Sustainability capabilities	Ship visits with ESI discounts	number of ESI discounts	2	4		
	Providing ships with LNG bunkering	number of LNG bunkering ships	2			
	Shore-based power connections	Number of shore-based power connections	1			1
	Sustainable Energy Capacity	Megawatt electric (MWe)	2	4		
	Share of renewable energy	Percent %	2			
	Truck engine status (Euro Standard)	Number of vehicles	1			1
	Vehicles with alternative drive system	Number of vehicles	1			1
	Employee vehicles with alternative drive system	Number of vehicles	2			
	Compliance of vessels with international maritime legislation	Number of ships complying with international maritime regulations		2		
	Vessels with emission reducing tech.	No. of ships with emission reducing technology		2		
	Truck container pick-up & delivery	Percent % of trucks that manage to combine container delivery with pick-ups to avoid empty trips		1		
	Employees Mobility Modal split for transport between home and work	Percent %		2		
	Vehicle Utilisation/Fill	Percent % of trucks combining delivery with pick-ups			1	
	Emission Reduction Measures	Percent % of operators using them			2	
	Uptake of alternative fuels (CNG, LNG, Electricity, Biodiesel, LPG, Biomethane, Hydrogen)	Litres, litres/kg – kwh – litres – kg – kg			1	
Waste Pollution	Recycled waste	Per item	1			
	Recycled water	Cubic meter				1

Table 5.22 (continued)

Environmental Impact	Indicators	Measures	Rotterdam	Antwerp	Liverpool	SCZone
Water Quality	Water acidity	PH Levels	2			
	Emissions into water	above or below normal percent %	2	5		
	Water Nutrients	Meeting the norm levels of nutrients		6		
	Chemical water quality	Number of priority substances that exceed or do not exceed the water quality norm.		3		
Noise Pollution	Loud noise	Number of complaints	4	2		
		Noise level in Decibels (L -den - dB(A))		5	1	1
Odour Pollution	Strong & unpleasant smell	Number of odour related complaints	3			
Water Consumption	Fresh Water Consumption	Million litres	1			1
Soil Quality	Soil pollution	Number of sites requiring clean-up		7		1
Non-Compliance Costs	Penalties & fines for breaching environmental legislation	Amount of money				1
Supply Chain Miles	Distance of products transportation across the supply chain	Miles				1
Light Pollution	Light Intensity	LUX				3
Natural Material Consumption	Paper Consumption	Quantity printed & copied		1		
Modal Split	Cargo transported by greener modes	Percent of modal split %	2	7		

5.3.3 GLH Environmental Responsibility

The issue of who bears responsibility for the environmental performance measurement and sustainability of GLHs is addressed in this theme. Table 5.23 and Table 5.24 presents the similarities and differences in the responses of participants across cases. Figure 5.5 shows the frequency of responses coded under each theme, suggesting that 'government' is the most frequently mentioned theme across the four cases, followed by 'port authorities', 'third party', ‘voluntary participation’, and ‘supranational legislator’. The frequency count of these responses emphasizes the importance attached to each theme in the participants' perception, with a higher frequency indicating a greater importance and common opinion among participants. Additionally, Table 5.25 presents a matrix indicating the responses of participants along with the corresponding reason in each case.

Across all cases, participants generally favoured the government as the most suitable stakeholder to take on this holistic, overarching responsibility of the environmental measurement and sustainability of GLHs. This preference was discussed for various reasons, such as the government's authority and regulatory power, neutral position, financial capabilities, and ability to connect with and oversee all relevant stakeholders, ensuring consistency in approach.

In cases where the port is publicly owned or partially publicly owned (Rotterdam, Antwerp, and SCZone GLHs), the port authority was also identified as a suitable stakeholder for being responsible for the holistic environmental measurement and sustainability of the GLH. However, in Rotterdam GLH, this preference was ranked second to third-party organisations’ responsibility, with some participants citing this preference for the unbiased position and confidentiality of a third-party organisation. Additionally, in GLH cases in developed countries (Rotterdam, Antwerp, and Liverpool GLHs), voluntary participation was also emphasized by some participants as a means of addressing the complexity of multiple stakeholders and geographical issues, as well as competition and the fear of losing customers. This approach was viewed as more flexible for stakeholders compared to being mandated and monitored by a specific entity. However, this option was not mentioned in the case of the developing country (SCZone GLH). Additionally, voluntary participation was ranked as a second preference after the government in the highly privatized industry of the Liverpool GLH case, and no mentioning of the port being responsible for environmental measurement and sustainability in this case.

Table 5.23 Cross-Case GLH Environmental Responsibility Similarities

GLH Environmental Responsibility - Cross Case Similarities
1. Government Responsibility for GLH Sus
2. Port authority Responsibility for GLH Sus
3. 3rd Party Responsibility for GLH Sus

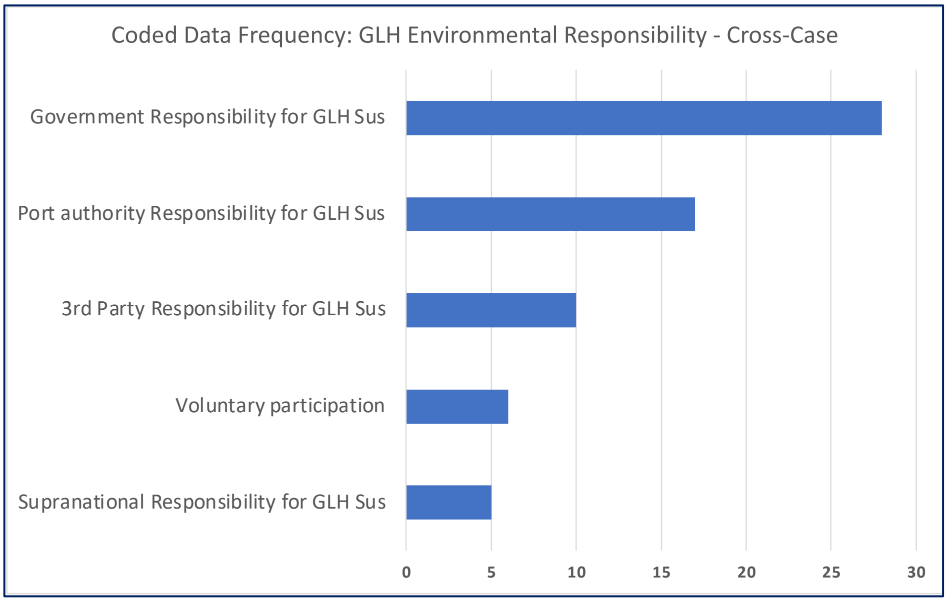


Figure 5.5 Coded Data Frequency: GLH Environmental Responsibility - Cross-Case (Source: NVivo 12)

Table 5.24 Cross-Case GLH Environmental Responsibility Frequency Differences (Source: NVivo 12)

GLH Environmental Responsibility – Cross Case Differences	**Rotterdam**	**Antwerp**	**Liverpool**	**SCZone**
Voluntary participation	1	2	3	
Supranational Responsibility for GLH Sus		3	2	

Table 5.25 Cross-Case GLH Environmental Responsibility and Reason Differences

Responsibility	Reason	Rotterdam	Antwerp	Liverpool	SCZone
Government	Overarching authority and regulatory power	√		√	√
	Neutral position		√	√	
	Financial Capabilities		√	√	
	Overview and connections to all stakeholders (consistency)			√	
Port Authority	Connection to stakeholders	√			√
	Capabilities of the port	√			√
	Landlord/owner responsibility		√		√
	Part of the government		√		√
Third Party	Unbiased position	√	√		√
	Confidentiality and reliability	√	√		
	Sole responsibility for the environmental measurement				√
	Monitoring and auditing capabilities & offering solutions to customers				√
Voluntary participation	Everyone should be responsible for sustainability	√		√	
	To overcome the multiple stakeholders and geographical issues		√		
	To overcome competitive issues and the fear of losing customers			√	
Supranational Legislators (EU)	Levels the field in competitiveness and appeal between GLHs		√		
	Decreases distortions			√	

5.3.4 Extent of connection among GLH Primary Stakeholders

The extent of connection between GLH primary stakeholders differs significantly among the 4 case studies, as shown in Table 5.27. However, there are commonalities among cases in certain types of connections, as illustrated in Table 5.26. Additionally, Figure 5.6 shows the frequency of responses coded under each theme, indicating that 'communication' is the most commonly mentioned theme. This suggests that it is the most prevalent form of connection among stakeholders across the cases. This is followed by 'very limited or non-existent' connection, indicating that despite the presence of communication among certain stakeholders, there remains a substantial level of restriction and lack of overall connection among stakeholders in GLHs. Additionally, 'encouraging or influencing,' 'collaborating,' 'reporting on behalf of,' and 'mandating, forcing, and legislating' were also identified as notable themes, respectively. The frequency count of these responses emphasizes the significance attached to each theme in the participants' perception, with a higher frequency indicating a greater importance and shared opinion among participants.

In the 4 cases, there were some participants who reported minimal or no connection with other stakeholders, and others who explained that there is only communication. However, larger and more developed GLHs (Rotterdam and Antwerp GLHs) tend to have more connection pathways than developing GLHs (Liverpool GLH) and those that are still under development (SCZone GLH). The degree of connection among stakeholders can not only aid in the holistic measurement of the environmental performance and sustainability of primary stakeholders in a GLH, but also improve the operations of the GLHs. For example, in Rotterdam and Antwerp GLHs, connections spans a range from minimal or non-existent among some stakeholders to the government mandating and enforcing sustainability legislation and stakeholders complying, to communication about environmental sustainability, to encouraging and influencing stakeholders towards sustainability, to collaboration, to integration and partnerships. This is the level of connection where reporting on behalf of stakeholders can happen, which requires visibility into stakeholders' operations and environmental performance. In Liverpool GLH, the extent of connection among some stakeholders is collaborating with each other towards sustainability. In contrast, in SCZone GLH, the connection is restricted to merely communication.

Furthermore, the extent of connection among stakeholders in GLHs varies among cases and even within cases among different stakeholders. This results in some stakeholders in certain cases having limited or no connection in terms of information sharing, while other stakeholders in the same case may engage in collaboration and partnerships for environmental sustainability and may even report on the environmental performance of other stakeholders with which they are involved. Consequently, the degree of connection among stakeholders spans a spectrum of levels of connection within each GLH, depending on various factors including capabilities, level of GLH development, and infrastructure that facilitate the establishment of connection.

GLHs located in developing countries, such as SCZone GLH, tend to have a lower extent of connection with their primary stakeholders in terms of sustainability. In contrast, Rotterdam, Antwerp, and Liverpool GLH all exhibit various stages of connection. However, they are capable of not only communicating with stakeholders about environmental sustainability, but also encouraging and influencing stakeholders towards sustainability, collaborating, integrating and forming partnerships, and in Rotterdam and Antwerp GLHs even reporting on behalf of their stakeholders in the GLH. Figure 5.7 demonstrates the position of each GLH on a spectrum of levels of connection based on the extent of connection of the primary stakeholders in the respective GLH.

Table 5.26 Cross-Case GLH Extent of Connection Similarities

GLH Extent of Connection - Cross Case Similarities
1. Communicating with stakeholders regarding environmental sustainability
2. Very limited or non-existent
3. Mandating, forcing, and legislating sustainability

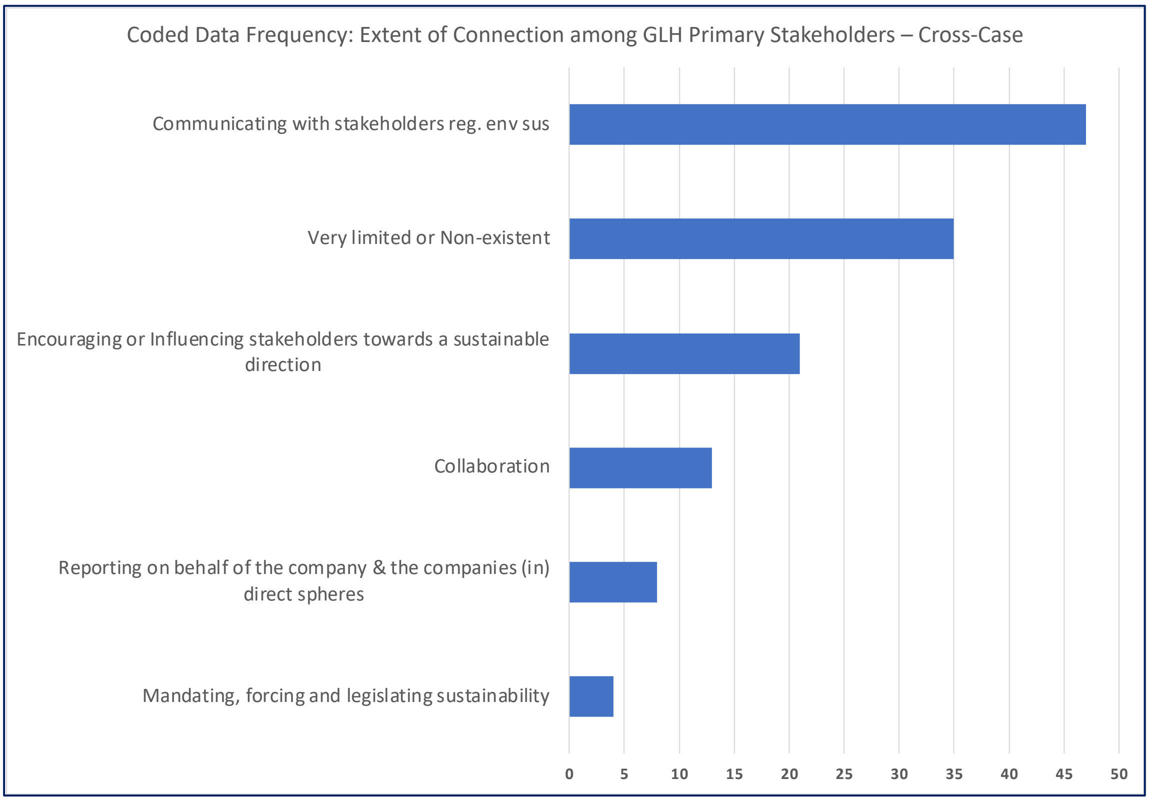


Figure 5.6 Coded Data Frequency: Extent of Connection among GLH Primary Stakeholders – Cross-Case (Source: NVivo 12)

Table 5.27 Cross-Case GLH Extent of Connection Frequency Differences (Source: NVivo 12)

GLH Extent of Connection - Cross Case Differences	Rotterdam	Antwerp	Liverpool	SCZone
Encouraging and Influencing stakeholders towards sustainability	10	7	4	
Collaboration and partnerships regarding sustainability	4	6	2	
Reporting on behalf of the company and the companies (in)direct spheres	3	5		

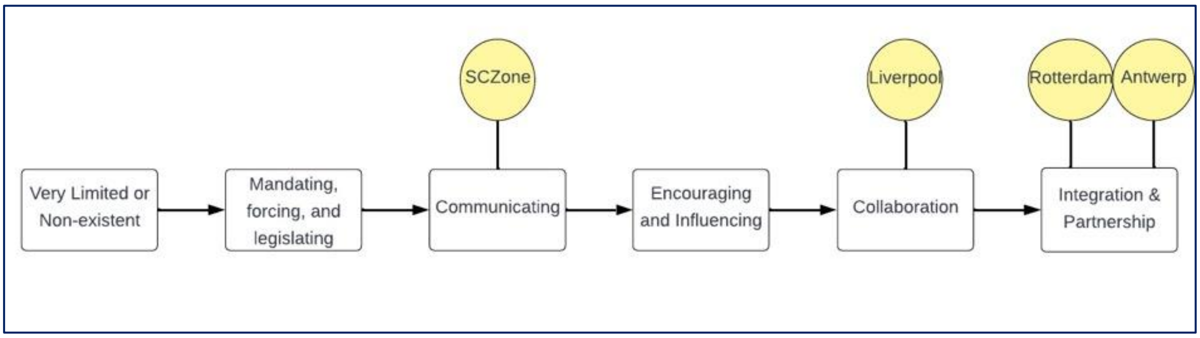


Figure 5.7 Cross-Case GLH Primary Stakeholders Extent of Connection Spectrum

5.3.5 GLH Stakeholders' Environmental Sustainability Frameworks and Management Systems

Table 5.28 demonstrates the variations in measurement frameworks, certificates, management systems, or platforms referenced across the four cases. It is noteworthy that the common frameworks across the four cases are quite limited, comprising only the ISO 14001 Management System and the 17 Sustainable Development Goals (SDGs). The ISO 14001 is a widely implemented and adaptable framework that allows organizations to align their environmental policies and strategies with it. The 17 SDGs provide a comprehensive set of objectives that have gained global recognition. However, the remaining frameworks, measurement and management systems listed in Table 5.28 exhibit significant discrepancies among the cases, indicating a lack of uniformity in the guidance used to assess and manage environmental performance and sustainability.

In the 4 cases, participants reference various international frameworks, including the Greenhouse Gas Protocol (GHG), Environmental Impact Reporting (EIR), Global Reporting Initiative (GRI) standards, Environmental Ship Index (ESI), and Organisation for Economic Co-operation and Development (OECD) framework. However, there are also company-specific frameworks, such as Enviro365, NEPTUNES, and carbon calculator, which indicates a lack of consistency among the cases in regards to the frameworks and management systems used. It is also worth noting that a common focus of the environmental frameworks is specifically on carbon emissions, with the remainder being more general in nature.

Table 5.28 Cross-Case GLH Environmental Frameworks and Managements Systems

Environmental Frameworks & Management Systems – Cross-Case	**Rotterdam**	**Antwerp**	**Liverpool**	**SCZone**
ISO14001	√	√	√	√
17 SDGs (Sustainable Development Goals)	√	√	√	√
A dynamic sustainability website		√		
Carbon calculator	√			
Carbon Efficiency Index (CEX)	√			
Carbon Trust Standard			√	
Cleanliness Index		√		
CO2 performance Ladder and Envirometer	√			
EMMOSS shipping emissions model		√		
Enviro 365 Framework			√	
Environmental Impact Report (EIR)	√			√
Environmental observatory to measure the environmental impact				√
Environmental Policy				√
Environmental Ship Index (ESI)		√		
Foundation for Climate Friendly Procurement and Business (SKAO)	√			
Greenhouse Gas Protocol (GHG Protocol) (Scopes 1, 2 & 3)	√	√	√	
GRI Sustainability Reporting Framework	√			
NEPTUNES (Noise Exploration Program to Understand Noise Emitted by Seagoing ships)		√		
OECD Guidelines for Multinational Enterprises (Benchmark)	√			
Online platform to provide members with knowledge and best practice		√		
Portbase: Portbase manages the Port Community System (PCS) of the Dutch ports	√			
Ports Sustainability report (all member ports)		√		
Ships and ports emission toolkits (GloMeep Project)		√		
Sustainability Report - TBL	√	√	√	
Voluntary Reporting Schemes			√	
Waste Mg. Hierarchy – Recycling			√	

5.4 Theme 3: Environmental Sustainability of GLH Stakeholders

This global theme has 3 organising themes that discuss the drivers and barriers of GLH stakeholders' environmental sustainability across cases.

5.4.1 GLH Stakeholders' Environmental Sustainability Drivers

Figure 5.8 shows the frequency of responses coded under each theme for this GLH. The top five drivers are 'legislation', 'demand for sustainability', 'responsibility', 'reputation/public image', and 'increased awareness'. The frequency count of these responses emphasizes their importance and suggests a degree of prioritization within the participants' perception. However, it is crucial to note that the importance and ranking of these drivers vary among participants, as their individual perspectives and priorities differ. Further quantitative investigative research is also needed to validate the significance of each of these aspects and their ranking in terms of importance.

Table 5.29 identifies the common drivers for stakeholders in all cases. Drivers related to business strength and stability are more prevalent among the cases, with demand for sustainable solutions, improved public image and reputation, and competitive advantage being the primary reasons cited. External factors, such as legislation, pressure from the government and society, Paris Climate Change Agreement, and increased awareness are common across all cases. Philanthropic motivations and a sense of responsibility towards society, human and planetary health, and accountability for the impact of operations, are also other drivers common across all cases.

Internal pressures from employees, representing a bottom-up approach to sustainability, were identified as drivers in Rotterdam, Antwerp, and SCZone GLH cases. However, in Liverpool GLH, employees were not mentioned as a driver of sustainability. However, the corporate policy, which dictates a top-down commitment to certain sustainability goals, was identified as a driver or pressure for sustainability.

On the other hand, financial drivers, including long-term financial gains from sustainable solutions and avoidance of fines, are the least influential among all drivers. In fact, participants in Liverpool GLH case did not identify any financial drivers that motivated them towards sustainability. This suggests that financial rewards for sustainable solutions are currently insufficient. Therefore, it appears that drivers related to business strength, external pressures, and corporate policies outweigh financial drivers and other subcategories of drivers identified by participants in the four cases, as shown in Table 5.30.

Table 5.29 Cross-Case GLH Environmental Sustainability Drivers Similarities

Environmental Sustainability Drivers – Cross-Case Similarities	
Factors	**Drivers**
Business Strength Factors	Demand for Sustainability
	Reputation/Public Image
	Gaining Competitive Advantage
External Factors	Paris Climate Agreement
	Increased Awareness (social pressure)
	Legislation
	Pressures from Government and Society
Philanthropic Factors	Responsibility
	Health and Wellbeing of humans and planet
Intra-Organisational Factors	Corporate Policy

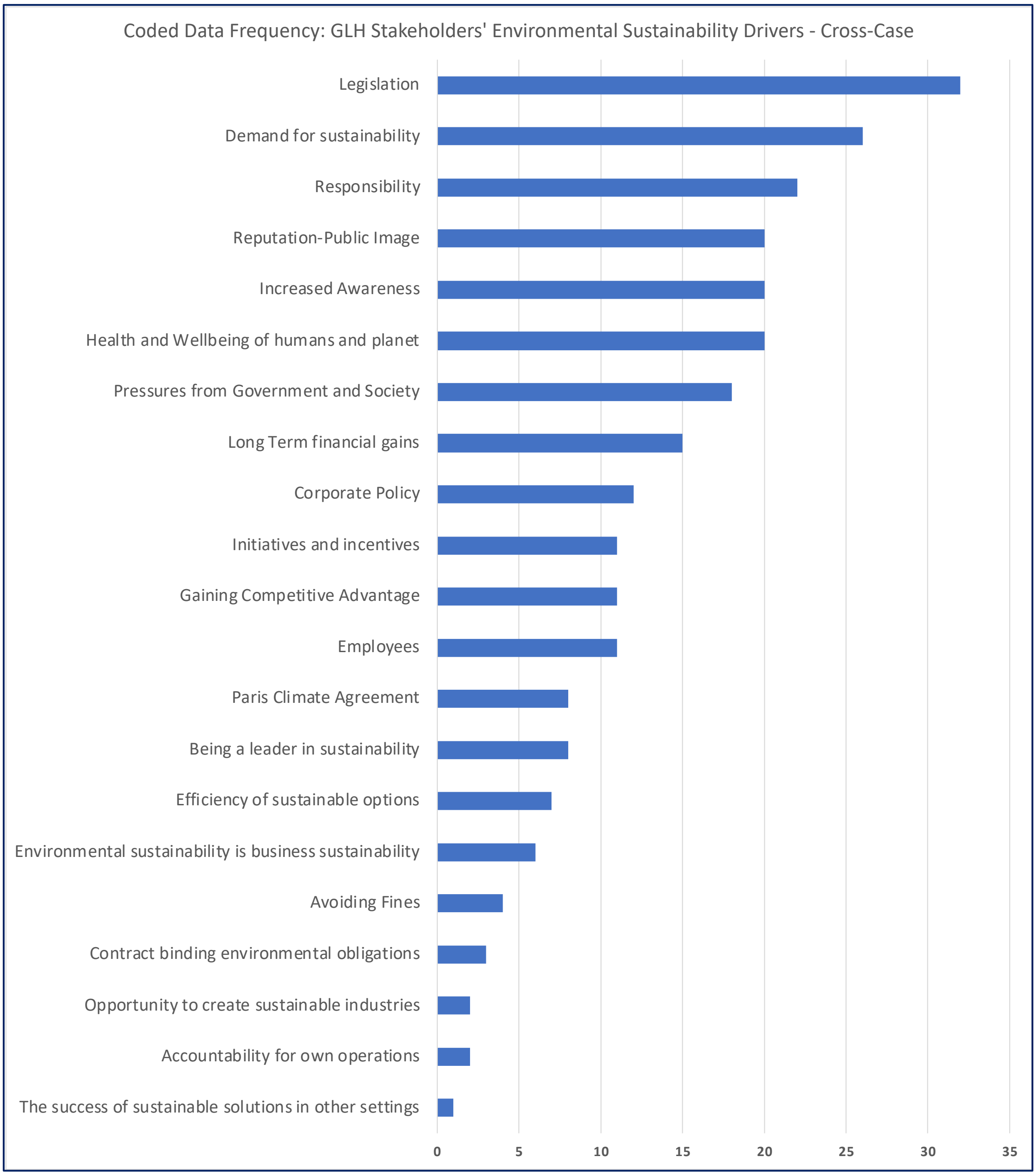


Figure 5.8 Coded Data Frequency: GLH Stakeholders' Environmental Sustainability Drivers - Cross-Case (Source: NVivo 12)

Table 5.30 Cross-Case GLH Environmental Sustainability Drivers Frequency Differences (Source: NVivo 12)

Environmental Sustainability Drivers – Cross-Case Differences					
Factors	**Drivers**	**Rotterdam**	**Antwerp**	**Liverpool**	**SCZone**
Business Strength Factors	Being a leader in sustainability	7	4	3	
	Environmental sustainability is business sustainability	2	3		1
	Efficiency of sustainable options/solutions			3	4
	Opportunity to create sustainable industries			2	
	The success of sustainable solutions in other settings			1	
External Factors	Contract binding environmental obligations		3		
Philanthropic Factors	Accountability for own operations	1			1
Intra-Organisational Factors	Employees	5	3		3
Financial Factors	Long Term financial gains	3	2		10
	Avoiding Fines		1		3
	Initiatives and incentives		3		8

5.4.2 GLH Stakeholders' Environmental Sustainability Initiatives

By comparing the environmental initiatives adopted in the 4 GLHs, a diverse range of initiatives aimed at addressing a range of environmental impacts is revealed. As illustrated in Table 5.32, the most common initiatives are those focused on mitigating greenhouse gas emissions and addressing climate change. Most of them adopted and implemented in Rotterdam GLH. Additionally, there are several initiatives aimed at addressing waste management, mostly adopted in Antwerp and SCZone GLHs. This focus on climate change in Rotterdam GLH, and waste in Antwerp and SCZone GLH is also evident in the within case analyses. Despite the limited resources and the developing economy of the hosting country, it is noteworthy that SCZone GLH, has made efforts to implement initiatives promoting and improving environmental sustainability.

Additionally, it is evident that there is also an interest in improving environmental sustainability through initiatives addressing issues such as noise pollution, green land development, and biodiversity conservation across the 4 cases. Furthermore, a comparison of the general initiatives implemented in each GLH reveals that Rotterdam and Liverpool GLHs have the most extensive focus on such initiatives. This suggests that these two cases place a strong emphasis on the overall approach to environmental sustainability and the implementation of initiatives to address a variety of environmental impacts.

Overall, this analysis illustrates the multifaceted approach being taken to address environmental concerns across the GLHs through environmental sustainability initiatives. Table 5.31 provides a key to the colour categories found in initiatives matrix in Table 5.32.

Table 5.31 Initiatives Matrix Colour Key

	General
Climate Change	Green Land
Energy Consumption	Waste
Biodiversity	Noise, Odour, & Dust

Table 5.32 Cross-Case GLH Stakeholders' Environmental Sustainability Initiatives Differences

Environmental Sustainability Initiatives	Rotterdam	Antwerp	Liverpool	SCZone
1. A program to encourage voluntary cooperation between stakeholders to reduce GHG emissions		√		
2. Agriculture Innovation Fund		√		
3. Aiming for zero percent sulphur by 2050				√
4. An initiative platform to provide members with knowledge and best practice		√		
5. Awareness Programs (ex: cleaning projects, green days)				√
6. Ban on sales of new diesel lorries in 2040			√	
7. BRC Climate Action Roadmap			√	
8. Carbon calculator	√			
9. Carbon Capture and storage studies and research	√	√		
10. Carbon Tax law	√			
11. Catalysing demand for new technologies and innovation			√	
12. Clean Air Zones (CAZ), Ultra-Low Emission Vehicle (ULEV) and Zero Emission Zones			√	
13. Climate Emergency Declaration			√	
14. Community Programs	√			
15. Controlled use of gas fired heaters	√			
16. Disposing material in a safe way				√
17. Electric rail project				√
18. Employees environmental commuting	√	√		

Table 5.32 (continued)

Environmental Sustainability Initiatives	Rotterdam	Antwerp	Liverpool	SCZone
19. Energy Savings Opportunity Scheme (ESOS)			√	
20. Environmental training programmes	√		√	√
21. Environmentally friendly road resurfacing project			√	
22. ESI discounts	√	√		
23. Government Green Solution Truck Subsidies		√		
24. Green Logistics Network & Warehouse Optimization & Modal Shift	√		√	√
25. Handing in Ship's waste discounts		√		
26. Heat Alliance: residual heat repurposed	√			
27. Institutions and corporations Environmental Reporting Encouragement	√			
28. LED lighting	√		√	√
29. Maintaining & increasing green land	√	√		√
30. Member of the Clean Cargo Initiative	√	√	√	
31. Noise Elimination Projects (ex: NEPTUNES)	√			√
32. Ocean Clean-up Project	√	√	√	
33. Odour detection Sensors	√	√		
34. Offsetting unavoidable emissions through climate protection projects	√			
35. Plastic & solid waste Clean-up Initiatives (ex: Nul-O-Plastic, Clean Sweep, Plastic collective)		√	√	
36. Reduce speed in reach-stackers, terminal tractors & heavy forklift trucks	√			
37. Reduce, Reuse, Recycle Initiatives	√	√		√
38. Renewable Energy Clusters	√	√		

Table 5.32 (continued)

Environmental Sustainability Initiatives	Rotterdam	Antwerp	Liverpool	SCZone
39. Replacing old equipment with green ones				√
40. Restricting port ballasting containing oil print and wastewater				√
41. Ship Recycling	√	√	√	
42. Shore-based power for vessels	√	√		
43. Species Protection Programme		√		
44. Supporting the Getting to Zero Coalition		√		
45. Sustainable subcontractor management (carrier scorecards)	√			
46. The World Ports Climate Action Program (WPCAP)	√	√		
47. UN Global Compact	√	√	√	
48. Using alternative fuels	√	√	√	√
49. Using anti leaking sheets to prevent water pollution				√
50. Using dust fighters or swappers to reduce operations pollution impact				√
51. Vehicle fleet technology to reduce carbon emissions & Electric vehicle fleet	√			√
52. Water Quality: Dredging and sustainably processing the most polluted sludge in the docks		√		
53. Wind and solar arrays	√	√		
54. ZES lease exchangeable battery containers (ZES-Packs) to inland shipping operators	√			

5.4.3 GLH Stakeholders' Environmental Sustainability Barriers

Figure 5.9 shows the frequency of responses coded under each theme for the four cases. The top five barriers are ‘cost’, ‘lack of knowledge and awareness’, ‘complicated process’, ‘sustainability in not prioritized’, and ‘losing competitive advantage’. The frequency count of these responses emphasizes their importance and suggests a degree of prioritization within the participants' perception. However, it is crucial to note that the importance and ranking of these barriers vary among participants, as their individual perspectives and challenges differ. Further quantitative investigative research is also needed to validate the significance of each of these aspects and their ranking in terms of significance.

In comparing the barriers to the drivers in the four GLH cases, it was observed that the barriers were less consistent. The similar barriers identified by participants across cases are listed in Table 5.33. There is a similarity in the overarching factors such as lack of capabilities, losing competitive advantage, the complication of the process, and the fact that sustainability is still not prioritized over other business aspects. Overall, there were more barriers identified than drivers. Table 5.34 demonstrates the differences across cases in the barriers identified in each case.

Feasibility was one of the most consistently mentioned overarching factor among all of the barriers in all 4 cases, such as difficulty in mapping the impact of transport activities, or the inflexibility of sustainable solutions. Other barriers related to regulations and legislation were also very common among cases, such as different regulations in different regions, which requires companies to navigate a complex web of regulations.

For example, in Rotterdam GLH, financial barriers present one of the most common overarching area of barriers for stakeholders despite the developed economy of the country hosting the GLH. These barriers include the costs associated with implementing sustainable solutions, which may be perceived as more expensive by customers who prioritize price over sustainability. Additionally, the technology necessary for sustainable practices is often in its infancy and carries high costs, which may be a deterrent for adoption. Moreover, the environmental impact is not integrated into the financial or economic system yet, and there are insufficient incentives in place to encourage sustainable practices. For Antwerp and Liverpool GLHs, the most common barriers are related to feasibility.

On the other hand, it is evident in SCZone GLH that the lack of capabilities is the main barrier facing participants in this case, such as the availability and access to environmental options, lack of human resources, or lack of data. These barriers may be more pronounced in this case compared to other cases due to the developing economy of the country. The combination of financial, feasibility, and capabilities barriers in SCZone GLH means that other factors, such as stakeholders or voluntary barriers, are less likely to be significant issues, as sustainable solutions may not be considered in the first place due to these foundational challenges.

The barriers facing stakeholders in GLHs are diverse and varied, as demonstrated by the four cases studied in this research. However, the most prevalent barriers across these cases relate to regulations and legislation, feasibility, and financial factors.

Table 5.33 Cross-Case GLH Environmental Sustainability Barriers Similarities

Environmental Sustainability Barriers – Cross-Case Similarities	
Factors	**Barriers**
Capability	Lack of knowledge and awareness
Competitive Advantage	Losing competitive advantage (ex: increasing price or enforcing regulations)
Feasibility	Lack of feasibility or practicality of some sustainable technologies or solutions (ex: env. restrictions)
Financial	Cost (ex: sustainable solutions are 'more' expensive; low budget for sustainability)
Process	Complicated process (ex: requires collective action& collaboration from several sectors)
Voluntary	Sustainability is not prioritized (ex: it is not incorporated yet in metrics of a successful business, price is seen more important, or effort & inconvenience)
Regulations/Legislation	Different regulations in different regions (ex: Inconsistency of regulations; additional work)

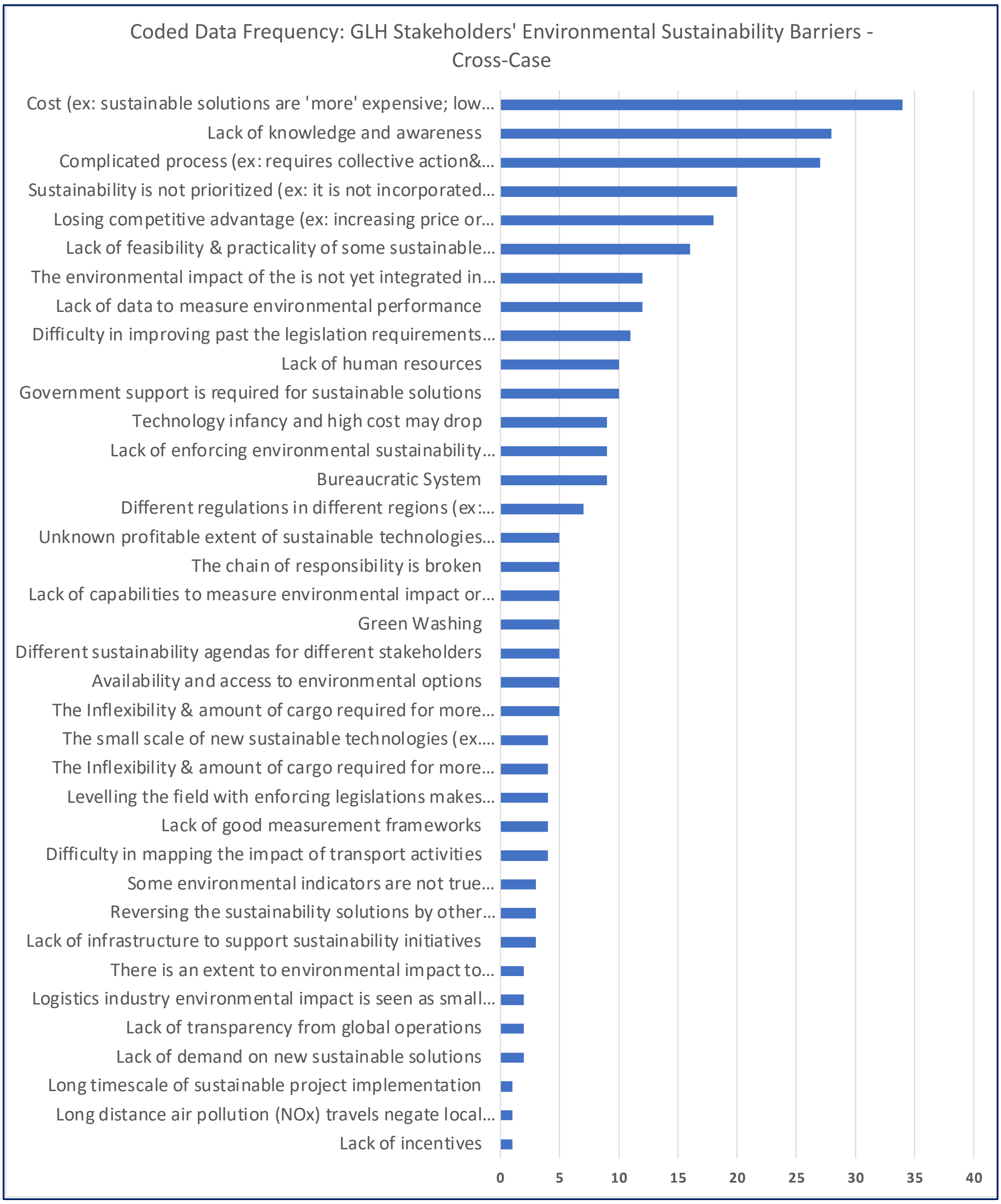


Figure 5.9 Coded Data Frequency: GLH Stakeholders' Environmental Sustainability Barriers - Cross-Case (Source: NVivo 12)

Table 5.34 Cross-Case GLH Environmental Sustainability Barriers Frequency Differences (Source: NVivo 12)

Environmental Sustainability Barriers – Cross-Case Differences					
Factors	**Barriers**	**Rotterdam**	**Antwerp**	**Liverpool**	**SCZone**
Capability	Availability and access to environmental options				5
	Lack of data to measure environmental performance	1	3		8
	Lack of good measurement frameworks		3		1
	Lack of human resources	3	1		6
	Lack of infrastructure to support sustainability initiatives				3
Feasibility	Difficulty in mapping the impact of transport activities		1	2	1
	Government support is required for sustainable solutions			4	6
	Inflexibility of alternative or sustainable options (inland vs truck or clean zones)		3	1	1
	The small scale of new sustainable technologies (ex: availability & access to environmental options)	1	3		
	There is an extent to environmental impact to operations that cannot be avoided	1		1	
Financial	Lack of incentives	1			
	Long timescale of sustainable project implementation				1
	Technology infancy and high cost may drop	3	2	6	
	The environmental impact of the is not yet integrated in the customer's buying decision, the financial or economic system	5		4	3
	Unknown profitable extent of sustainable technologies investment	1	2		2
Process	Bureaucratic way of reporting	1			8
	Long distance air pollution (NOx) travels negate local decrease in emissions		1		
	Reversing the sustainability solutions by other stakeholders				3
	Some environmental indicators are not true representation of the impact	1	1	1	

Table 5.34 (continued)

Environmental Sustainability Barriers – Cross-Case Differences					
Factors	**Barriers**	**Rotterdam**	**Antwerp**	**Liverpool**	**SCZone**
Regulations/Legislation	Green Washing	1		2	2
	Lack of enforcing environmental sustainability regulations and legislations	2	1		6
	Levelling the field with legislations makes smaller companies suffer compared to large companies			4	
Stakeholders	Different sustainability agendas for different stakeholders	2	2	3	
	Lack of transparency from global operations	2			
	The chain of responsibility is broken	1		2	2
Voluntary	Difficulty in improving past the legislation requirements (difficulty convincing private companies to)		2	4	5
	Logistics industry environmental impact is seen as small compared to other sectors or services (ex: chemical cluster)	1	1		
Competitive Advantage	Lack of demand on new sustainable solutions			2	

5.5 Summary of Major Findings

The analysis of the four cases has allowed the identification of patterns, trends, and themes that provide important insights into the GLHs and their environmental sustainability. The major findings and key insights that have emerged from the within-case and cross-case analyses of the four GLH case studies in relation to each research question are presented below. Figure 5.10, Figure 5.11, Figure 5.12, and Figure 5.13 link the extracted global and organising themes to each of the research questions, with darker blue shade indicating that the theme is key and more pertinent in answering the research question, and lighter blue shade indicating that the theme is supportive in answering the research question. These visual representations allow for a clear and concise understanding of how the themes were used to answer the research questions and how each theme contributes to the overall understanding of the research topic.

5.5.1.1 Research Question 1: What is a GLH? Who are its primary stakeholders?

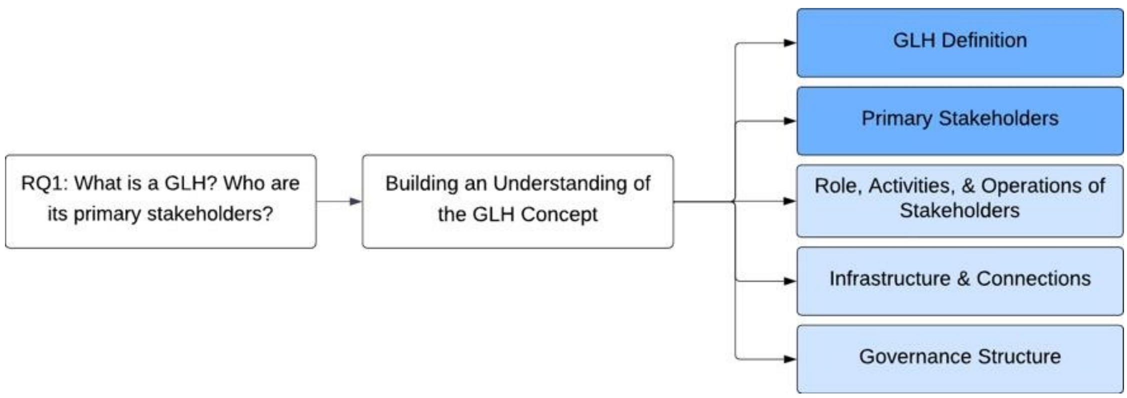


Figure 5.10 Themes Link to RQ1

In the four GLH case studies, participants provided a GLH definition through their professional experience. The summary of the definition is: "A GLH serves as strategic central location in a hub and spoke network configuration providing logistics, manufacturing and maritime operations. It comprises a main deep-water seaport or group of ports on major trade routes, industrial clusters, transportation links, warehouses, and services that support cargo transhipment, import, and export. It must have the capacity to handle large cargo volumes, room for development, and good multimodal transport connectivity to a specific region that it is serving". However, the findings of the study also revealed a certain degree of ambiguity and variability in the understanding of the concept of GLH among a minority of the participants.

A free trade zone may be required in cases where an overarching trade agreement, such as that found within the European Union, does not exist. This would facilitate the smooth, safe, and flexible operations of the GLH by providing a legal framework that supports the value-added and industrial activities to be carried out on global cargo in the GLH.

Additionally, the GLHs appeared to progress through a series of stages, as seen in the cases of SCZone and Liverpool GLHs. At present, SCZone primarily comprised operational ports in the designated location, with further development planned in the future and some are already being implemented to reach this goal. Similarly, in Liverpool case, the GLH is currently emerging as a GLH serving the United Kingdom market, with further development necessary for it to reach its full potential as a GLH. In contrast, Antwerp and Rotterdam GLHs are already established as functioning GLHs to the surrounding areas and regions within the European Union. However, the physical infrastructure and connections are in constant development to maintain their position.

Participants also identified the primary stakeholders in each GLH. The analysis of the primary stakeholders identified in the four case studies revealed that the stakeholders are largely similar across all cases. There is not much variation among the identified stakeholders. They include governments, port authorities and operators, logistics, freight forwarding, and shipping companies, and associations to name a few.

By exploring the role and operations of GLHs' primary stakeholders, it provided a deeper understanding of the concept of GLH. Through the analysis of this aspect of the concept, an overlap between the operations of the primary stakeholders was identified. The operations of a GLH often overlapped and merged between its stakeholders. For example, cargo handling, stevedoring, shipping, industrial and light manufacturing, operating terminals, are some of the overlapping activities and operations between the primary stakeholders. They did not have a clear-cut distinction, but rather merged on the borders of the different levels of the GLH. This overlapping of operations was seen between the port authority, terminal operators, logistics and shipping lines companies, government, and other stakeholders. Additionally, a GLH may encompass a port with various forms of ownership, such as public, private, or public-private partnerships; and regardless of ownership, the GLH will have both a public and private role within its port boundaries. This also plays a role in the governance structure of the GLH.

By exploring the governance structure of GLHs, it provided insights into the relationship and authority dynamic between its various stakeholders. The role of the government in a GLH can vary across cases, and may encompass both micro and macro levels of involvement. The relationship between the government and the other stakeholders in a GLH can be centralized, decentralized, or hybrid in nature, depending on the industry and the governance structure in the host country.

On the other hand, trade associations and interest groups served as a bridge between the various stakeholders in a GLH, facilitating communication and collaboration. While logistics companies, shipping lines, cargo owners, freight forwarders, ports, and manufacturers were considered customers to each other, which makes their relationship built on mutual benefits. They are all bound under the same regulations and legislation set and enforced by the government of the host country. However, shipping lines may have more flexibility in terms of their location of headquarters and their operations across various countries in international waters. Therefore, they are more bound by legislation and regulations set forth by intergovernmental agencies such as the United Nations.

A GLH is complex and multi-faceted, involving a diverse array of stakeholders with overlapping roles, responsibilities, and operations.

5.5.1.2 Research Question 2: How are the primary stakeholders connected in a GLH? Who is responsible for the environmental sustainability of GLH?

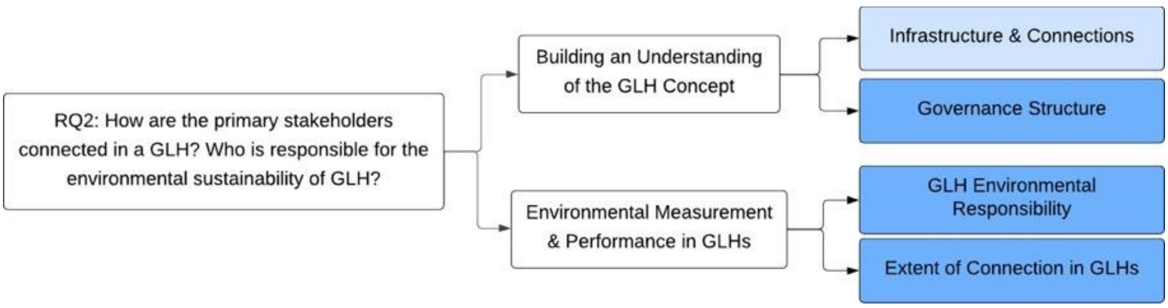


Figure 5.11 Themes Link to RQ2

By exploring the extent of connection among stakeholders in the four GLHs regarding environmental sustainability, it showed that it varied within cases and across cases. Within cases, some stakeholders (such as terminal operator in the Antwerp case) had limited or no connection in terms of environmental information sharing, while others (such as the port authority in the same case) collaborated and had partnerships for environmental sustainability with many other stakeholders, and even reported on the environmental performance of their stakeholders.

Therefore, the level of connection among stakeholders within these GLHs ranged from minimal to extensive.

Additionally, the cross-case analysis of the four cases revealed the extent of connection among stakeholders, with ‘communication’ emerging as the most frequently mentioned response by participants. This finding emphasizes the significance placed on communication as a means of interaction within GLHs. However, despite the considerable focus on communication, the recurring mention of ‘very limited or non-existent’ connection indicates the existence of a substantive gap or shortfall in establishing connections among GLH stakeholders. This implies that while communication may be prevalent, there remains a lack of cohesive and integrated connection among some stakeholders in GLHs.

Furthermore, the extent of connection also varied across the cases. For example, developed GLHs like Rotterdam and Antwerp GLHs had more integration and partnerships among stakeholders on environmental sustainability, with some stakeholders reporting on behalf of each other. In the case of the developing GLH, Liverpool GLH, it had stakeholders collaborating towards sustainability. While the underdeveloped GLH like SCZone had the level of connection among stakeholders on environmental sustainability limited to mere communication. These variations could be dependent on various factors such as the stakeholders’ capabilities, level of GLH development, and infrastructure that facilitate the establishment of connection.

Furthermore, the governance structure gives us an understanding of the relationship and authority dynamic among the GLH various stakeholders. The presence of associations that serve as facilitators of communication and engage in lobbying with government entities and companies contribute to this understanding. Also, the understanding of the distribution of authority, whether it is centralized within the hands of the government such as in the Rotterdam and Antwerp GLHs, decentralized within the hands of each stakeholder with specific responsibilities such as in the Liverpool GLH, or hybrid such as in the SCZone GLH. Additionally, the physical infrastructure and the responsibility for building and developing such infrastructure within a GLH can serve as an indicator of the level of connection among the stakeholders. Exploring who is responsible for investment in the infrastructure provided insight into the degree of collaboration among stakeholders. It is apparent in all cases that the government plays a significant role in projects aimed at developing and maintaining the status of GLHs, such as investments in rail networks and road networks. Additionally, ports play a big role in investing and building the port infrastructure. Industrial clusters are built by companies establishing their manufacturing operations in the GLH. This is indicative of the importance of several stakeholders’ involvement in the development and maintenance of GLHs, and the interconnectedness of stakeholders in the process.

The responsibility for environmental sustainability in GLHs was explored in all cases. Participants discussed five entities or options for assuming responsibility for environmental sustainability within a GLH, namely, the government, port authority, third-party organizations, voluntary participation, and supranational legislators. Among these options, the government was most commonly identified as the most suitable entity to assume responsibility, primarily due to its authority and overarching regulatory power, neutral position, financial capabilities, and ability to connect with and oversee all relevant stakeholders, thus ensuring consistency in approach. This consensus among the participants provides insight into the perceptions and expectations regarding the appropriate allocation of responsibility for environmental sustainability in GLHs.

5.5.1.3 Research Question 3: How do GLH operations impact the environment? How is the impact measured?

Figure 5.12 Themes Link to RQ3

Participants across all cases identified their environmental impact of their respective operations in the GLH. Additionally, they shared information pertaining to the environmental indicators, as well as any frameworks or environmental management systems that were in use, if such information was permissible to be shared.

Within cases, the environmental impacts slightly varied between the primary stakeholders of a GLH depending on their specific operations and activities. In all cases, all participants reported greenhouse gas emissions as part of their environmental impact, but the focus on other impacts such as water pollution and energy consumption varied. For example, port authorities, terminal operators, and shipping lines tended to focus more on water pollution, while freight forwarders and transport service providers tended to focus more on energy consumption. Furthermore, some stakeholders acknowledged that their impact may be perceived as relatively minimal compared to that of other stakeholders within the GLH, such as those in the chemical cluster.

Despite variations in the specific environmental impacts of stakeholders within cases, there was a general consistency in the overall environmental impact across cases when examined holistically. The most common environmental impacts across cases include factors such as greenhouse gas emissions, water pollution, and waste generation. This shows consistency in the view of the environmental impact caused by GLH operations across cases. However, it was also evident that there is more focus on detailing specific impacts across cases. For example, in the case of Antwerp, the focus was more on detailing waste pollution, while in Rotterdam and Liverpool, the focus was on greenhouse gas emissions, and in the case of SCZone, the focus was on energy consumption.

Moreover, it is noteworthy that the general level of detail provided by the participants in describing their environmental impacts varied across cases. This suggests that while all cases were aware of their environmental impact, there were variations in the level of detail provided. It highlights that the awareness and understanding of environmental impact can vary among stakeholders in different GLH.

As for the measuring the impact, it was observed that there were some similarities in the environmental indicators used to assess environmental impact across cases, such as those related to air emissions, waste, and energy consumption. However, a greater variance in the measurement of other environmental impacts, such as noise and sustainable capabilities, was observed. This variation in the measurement of environmental impact could be attributed to a variety of reasons, such as a lack of necessary equipment or measurement techniques, or a lack of expertise or knowledge in accurately assessing certain environmental factors. Additionally, the variation could also be due to differences in the regulations, best practices and available data reporting systems that were present in the respective locations.

Furthermore, it was evident from the comparison of the four cases that certain environmental impacts, such as light pollution, soil quality, biodiversity impact, and land use, were not measured in all cases. This observation highlights a discrepancy in the way the environmental impacts of GLHs are assessed. The lack of a unified set of measurements or indicators that can be utilized by stakeholders in these GLHs to uniformly assess and mitigate their environmental impacts. This suggest that there is a shared understanding among the four GLHs of their environmental impacts, but not all of these impacts are consistently measured across all cases.

Additionally, within each case, variations in the use of environmental indicators among stakeholders was observed. For example, in the case of Antwerp GLH, the port authority was had a wider range of indicators for assessing the environmental impacts of the operations of various stakeholders, while other stakeholders such as the terminal operator did not use any indicators beyond energy consumption for cost-related reasons. In the case of SCZone, participants were found to use unconventional indicators such as non-compliance costs and the distance of product transportation due to the lack of guidance on how to measure their environmental performance. This variation in the use of environmental indicators among stakeholders suggests that there is a lack of standardization and consistency in the way that environmental impacts are being assessed even within the same GLH. Additionally, it could also highlight that there are different motivations and concerns among stakeholders in a GLH that can lead them to use different indicators for assessing their environmental performance.

Furthermore, participants across all cases shared information about the environmental frameworks or management systems that they used. The ISO 14001 standard was a common management system mentioned across all cases, as well as the 17 SDGs, which were adopted as an overarching objective framework by all cases. However, a wide variety of other frameworks, certificates, measurements, and management systems were also mentioned within and across cases, with very few being common among GLHs or even within the same GLH. This variety of different frameworks and management systems used exhibits discrepancies and lack of uniformity in the guidance that is used to assess and manage environmental performance and sustainability in GLHs.

5.5.1.4 Research Question 4: What are the drivers of and barriers to environmental sustainability in a GLH?

Figure 5.13 Themes Link to RQ4

All participants in the four cases studies shared their drivers and barriers to environmental sustainability. Common drivers for stakeholders across cases were found to be related to business strength and stability, such as the increased demand for sustainable solutions, improved public image and reputation, and the pursuit of a competitive advantage. External factors, such as legislation, pressure from the government and society, the Paris Climate Change

Agreement and COP agreements, and increased awareness were also commonly mentioned drivers across all cases. Additionally, philanthropic motivations and a sense of responsibility towards society, human and planetary health, and accountability for the impact of operations were also drivers commonly mentioned in all cases. This highlights that the motivations for environmental sustainability in GLHs are driven by societal and ethical considerations. On the other hand, financial drivers, such as the long-term financial gains from sustainable solutions and the avoidance of fines, were found to be the least influential among all drivers. This could indicate that financial gains or losses may not be sufficient yet to be a significant driver for environmental sustainability.

Furthermore, participants shared information about the various environmental sustainability initiatives that they have implemented. The initiatives adopted across the four GLHs were diverse, aimed at addressing a wide range of environmental impacts and sustainability issues. The most common initiatives identified were those focused on mitigating greenhouse gas emissions and addressing climate change. The majority of such initiatives were implemented in developed economies cases such as in the case of Rotterdam GLH. However, there was also an effort to implement initiatives promoting and improving environmental sustainability in developing economies such as in the case of SCZone GLH, although fewer initiatives were identified in these cases.

A myriad of environmental initiatives was revealed in the within-case and cross-case analyses, which illustrates a multifaceted approach being taken to address environmental issues across GLHs. This is in contrast to the fewer number of environmental measurement and management systems across the cases, which could be a result of the level of requirements and commitment needed for measurement in comparison to implementing initiatives. The initiatives shared indicates that the GLHs are actively seeking ways to minimize their environmental impact and promote sustainability, although the level of efforts may vary depending on the GLHs.

On the other hand, in all cases, a greater number of barriers were identified in comparison to drivers, both within and across cases. It was also observed that the barriers were less consistent across cases than the drivers. While there was similarity in the overarching factors such as lack of capabilities, the risk of losing competitive advantage, and the complexity of the process, the detailed barriers across cases varied. However, the most prevalent barriers across these cases were found to relate to regulations and legislation, feasibility, and financial factors. This suggests that the barriers facing stakeholders in GLHs may vary in general, but there are certain common factors that are recognized across all cases. Furthermore, within the cases, the most common barriers identified were found to vary slightly. Participants in Rotterdam GLH identified several factors centring around feasibility and legislation as the major barriers. In Antwerp and Liverpool GLHs, several factors were found to focus primarily on financial considerations. In SCZone GLH, the focus was on financial barriers as well as lack of knowledge and awareness among stakeholders. These variations in the most common barriers identified within the cases suggest that the specific barriers facing stakeholders in GLHs may be dependent on the heterogenous characteristics of each GLH and the capabilities of the stakeholders.

In this chapter, a thorough examination of the cross-case analysis was performed across the four GLH case studies. This helped in identifying any common patterns or differences that emerged in relation to their heterogenous characteristics. Additionally, a comprehensive summary of the major findings derived from both within-case and cross-case analyses in relation to each research question was presented. The next chapter will discuss these findings and compare them to the existing, broader literature within the field to provide a more holistic understanding of the results.

Chapter 6 General Discussion

6.1 Introduction

This chapter brings together all the previous chapters by providing an in-depth interpretation of the empirical findings from the within-case and cross-case analyses of the four GLH cases, reflecting on the extant literature, while taking into consideration the research methodology employed. The aim of the thesis is to better understand and position GLHs and their environmental sustainability research within the scholarly literature. This chapter will discuss the extent to which the findings support, challenge, or extend existing theories on GLHs or identify any new emerging theories or concepts that may emerge from the research. This will serve as a foundation for identifying the implications of the findings for theory, practice, and future research, and present the unique contribution of this research to the concept of GLHs and their environmental sustainability.

The chapter is structured according to the research questions in order to provide a clear and concise presentation that aligns the discussion with how the four research questions were addressed.

6.2 Research Question 1: What is a GLH? Who are its primary stakeholders?

In this research, the first question was concerned with clarifying the confusion and ambiguity around the GLH concept that was found in both academic literature and professional contexts. It aims to construct a holistic, up-to-date definition of the term that will contribute to the body of knowledge. Additionally, another part of the first question was aimed at exploring and identifying the primary stakeholders of GLHs to build a framework of the primary stakeholders to help emerging GLHs with their development.

6.2.1 GLH Definition

In the academic literature, a GLH has been defined in various ways across different studies. Several studies referred to the concept as a maritime port (Gordon et al., 2005; Hsu, 2006; Mangan et al., 2008; Lee et al., 2009; Brito & Botter, 2012; Yang & Chen, 2016). Others have defined it as a distribution centre for manufacturers or specific industries, with access to seaports and airports (Lee, 2007; Hammad et al., 2021); a gateway or point of entry into a specific continental region (Essaadi, 2019); a strategically located logistics city (Lee, 2007;

Sundarakani, 2017); a cluster of organizations with interrelated activities (Bolumole et al., 2015); a centre for transhipment, transportation, and distribution of national and international cargo (Lee et al., 2009; Anderson, 2017); or a location with multimodal transport intersection (Esqueda, 2012). Each perspective contributes to a nuanced understanding of the concept of GLHs.

Furthermore, the highlighted aspects, as indicated by the frequency of responses, emphasize the distinguishing factors between GLHs and other terms such as port generations, port clusters, and port-centric logistics. For instance, port-centric logistics and GLHs differ in purpose, scale, and function despite their shared concept of centralized logistics. Port-centric logistics is a supply chain approach applicable to any port with available space, while GLHs are larger in scale and scope. The distinguishing factors include the vital importance of 'logistics and marine services', 'good accessibility and global connection', 'multimodal transport', 'industrial cluster', 'import, export, and transhipment', 'strategic geographical location', and 'major maritime port'. Further quantitative research is necessary to validate the significance of each of these aspects and their ranking in terms of importance. However, it should be noted that 'major maritime port' applies specifically to maritime GLHs, and that GLHs can also be based on major airports or Belt and Road Initiative (BRI) locations.

By comparing this range of perspectives on GLHs found in the literature with the findings of this research, it shows that while each perspective offers valuable insights, none of them alone fully capture the complexity of a GLH. Rather, it is the combination of all these viewpoints that comprise the full holistic concept of a GLH. Therefore, a GLH can be defined as:

> *A GLH is a strategic location that serves as a hub and spoke network for the exchange of global cargo. It is characterized by the integration of logistics, multimodal transport intersection, and manufacturing operations, and typically includes a deep-water seaport (public, private, or PPP ports) or cluster of seaports situated on major trade routes, served by large ocean carriers to access global cargo (major airports or Belt and Road Initiative (BRI) locations can also serve this purpose). Additionally, industrial clusters, manufacturing, transportation links, warehousing, value-added activities, logistics, and maritime services are present in a GLH. These elements are necessary to handle all types of national and international cargo for transhipment, import, or export and to have the necessary infrastructure and capacity to handle large volumes of cargo, as well as sufficient space for further development.*
>
> *Some of the primary functions of a GLH are to allow for the smooth distribution of cargo from global origins to global destinations to serve specific regions or continents, and to act as a distribution centre for manufacturers or specific industries. This is achieved through well-connected networks and excellent accessibility to global transportation routes and the markets it serves through various multimodal connections, such as deep-sea, short sea, inland waterways, road, rail, air, and pipelines. In some cases, a free trade zone may be necessary for the operation of a GLH. To ensure the smooth, safe, and flexible operations of a GLH,*

> *it is essential to have the necessary infrastructure to handle global cargo volumes, to promote collaboration and integration among stakeholders, and the location must be secure and politically stable.*

This definition incorporates the relevant features mentioned in previous studies and the findings of this research. It aims to clarify the confusion found in the literature surrounding the definition of a GLH. By providing a more comprehensive and up-to-date understanding of the concept, it will assist emerging GLHs in identifying the necessary aspects and features that must be developed in order to become a fully functioning and competitive GLH. Furthermore, this definition will provide guidance to policymakers, practitioners, academics, and stakeholders involved in the development and operation of GLHs by highlighting the key elements that should be considered in the establishment of a GLH.

It is important to note that the concept of a GLH is dynamic and evolving in nature, making it challenging to establish a definitive boundary for the concept. The definition provided in this research is based on the current understanding of GLHs and the relevant features identified through the literature review and analysis of the case studies. However, as the global economy and trade continue to change and evolve, it is likely that this definition will evolve as well.

6.2.2 GLH Multi-Stage Development

Furthermore, the literature review conducted in this research indicates that GLHs are frequently associated with maritime ports (Gordon et al., 2005; Hsu, 2006; Lee, 2007; Mangan et al., 2008; Lee et al., 2009; Brito & Botter, 2012; Yang & Chen, 2016). This could be attributed to the diverse nature of ports and their varying functions, spatial and organizational structures, roles, and services (Bichou & Gray, 2005). Despite efforts in the literature to define and classify ports through models such as the port evolution UNCTAD model (1999), the WORKPORT model (Beresford et al., 2004), or the Port Ladder model (Flynn & Lee, 2010), there remains a lack of a universally accepted definition or framework for ports as they are constantly evolving in response to the global economy and there are several perspectives that can be taken to describe a seaport (Bichou and Gray, 2005; Kaliszewski, 2018). These evolutionary, developmental, and generative models have led to different boundaries, functions, and definitions for seaports, which may have contributed to the ambiguity and confusion of the concept of GLHs. While it is evident from the findings of this research that maritime ports play a crucial role in the functioning of a GLH, and that port clusters could be part of the configuration of a GLH. However, it is important to note that the concept of a GLH is more complex, multi-dimensional, and encompasses a broader scope than a port cluster or a maritime port, regardless of their level of sophistication or development as demonstrated in the recommended definition. Additionally, it could be a land locked GLH as in the case of a link to major airports or Belt and Road Initiative locations with access to global cargo (CBRE, 2015).

On the other hand, this highlights the multi-staged and evolutionary process that GLHs go through to fully develop into a competitive GLH. The development of GLHs from maritime ports and other entities, such as a strategic location or a city, is evident in the literature and the research findings. Several studies highlighted the development of GLHs from various entities, such as strategic locations or cities (Esqueda, 2012; Sundarakani, 2017, Hammad et al., 2021), points of entry into a specific region (Essaadi, 2019); or seaports with specific traffic, location, and capabilities (Gordon et al., 2005; Brito & Botter, 2012; Yang & Chen, 2016).

This evolution was also evident in this research, as demonstrated in the case studies. It is seen in the development of GLHs from various entities, such as strategic locations with access to gateway maritime ports in the under-development stage, as in the case of SCZone GLH, and from a functioning regional logistics hub in the developing stage, as in the case of Liverpool GLH. Furthermore, Rotterdam and Antwerp GLHs were found to be fully functional GLHs, however, they were still engaging in efforts to enhance and develop features of the GLH in order to maintain their competitive position in the global logistics landscape. This highlights the ongoing nature of the development and evolution of GLHs, which is consistent with the extant literature. However, the literature tends to lack the description of the specific elements or 'building blocks' that need to be developed during each stage of this process. The model presented in Figure 6.1 provides a clarification of the specific aspects and building blocks that are developed during each stage until a competitive GLH stage is reached, characterized by a unique infrastructure, access, capabilities, and spoke network that is consistently developed to maintain its competitive advantage. This framework links to Scott and Bruce's (1987) theoretical model for originations development, where it explains that businesses go through five stages of development or growth: Inception, survival, growth, expansion, and maturity. Therefore, this provides a more comprehensive understanding of the multi-staged development process of GLHs. This is the first attempt, to the author's knowledge, that a multi-stage development framework for GLHs has been developed.

Additionally, this research was focused on GLHs with maritime port access to global cargo, however, it is worth considering airports and BRI locations based GLHs as well for future research to explore any differences in the concept.

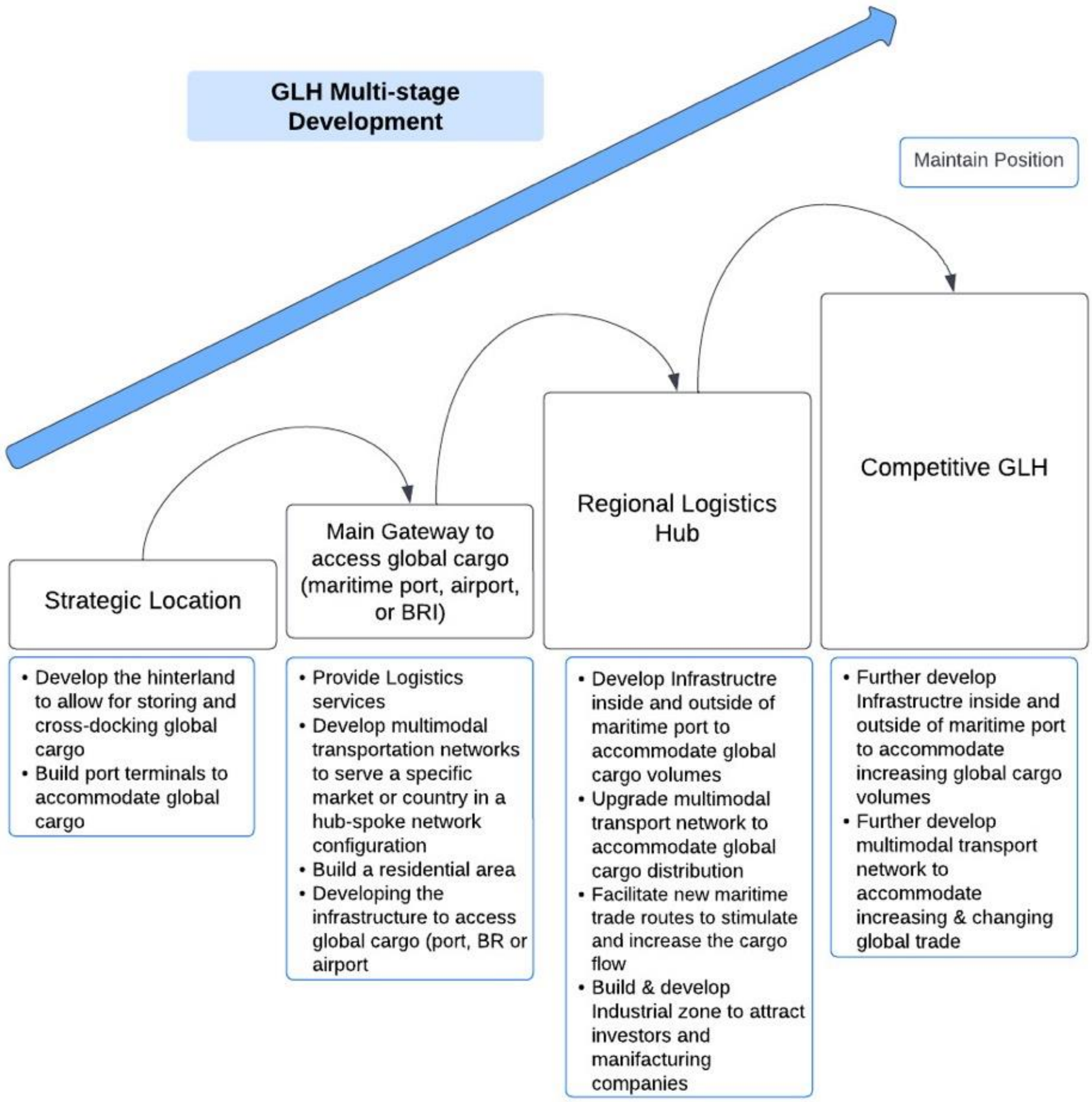


Figure 6.1 GLH Multi-Stage Development (Author)

6.2.3 GLH Primary Stakeholders Framework

The second part of Research Question 1 pertains to the identification of the primary stakeholders of a GLH. As outlined in the definition provided earlier, a GLH comprises of various constituents that contribute to its main operations and stakeholders that are essential to its development and operation. Therefore, this aspect of the research question aims to define and identify the primary stakeholders of a GLH in order to gain a deeper understanding of the concept. The identification of primary stakeholders is important as it allows for a more comprehensive understanding of the key players and their roles in GLHs.

The empirical findings of this research support the existing literature and further elaborate the identification of the primary stakeholders of GLHs as well as the ‘supporting actors’ as indicated in Table 6.1. The primary stakeholders are categorized under ‘providers of logistics and maritime services’, government and regulators’, and ‘demanders of logistics services’. This categorization of primary and supporting is based on the indicative ranking of stakeholder importance based on the frequency of responses obtained through data analysis. However, it is crucial to note that further quantitative investigative research is required to validate the significance of these findings and ascertain their precise ranking in terms of importance.

Previous studies have identified GLH stakeholders in relation to their perspective of a GLH (Lee, 2007; Hammad et al., 2021), other also classified them into direct and indirect stakeholders (Brito & Botter, 2012), or primary, functional, and supporting stakeholders (Lee et al., 2009). However, due to the fragmented definition of GLH in the literature, the identification of primary stakeholders was also fragmented, as they were identified from the perspective of the GLH definition adopted in the respective research. The findings of this research align with the collection of previous studies and ties them together. Most primary stakeholders identified in this research were common across all cases, indicating that there is a general consensus on who the primary stakeholders are regardless of the GLH development stage, port ownership adopted in the GLH, the economic development of the host country or the market, region, or continent served. This is likely due to the core roles and operations that are carried out in a GLH, which are essential to its functioning regardless of the heterogeneous characteristics of the GLHs. Furthermore, the highlighted stakeholders, as indicated by the frequency of responses, emphasize the primary stakeholders most frequently mentioned in relation to GLHs, namely ‘government and local councils’, ‘logistics companies and freight forwarders’, ‘cargo owners or shippers’, ‘port authorities’, ‘shipping lines’, and ‘associations and interest groups’. This suggests that these stakeholders may hold greater significance in the context of GLHs. However, it is important to acknowledge that further quantitative investigative research is essential to validate the significance and establish a ranking of their importance.

Table 6.1 offers a stakeholder framework based on the findings of this research, which aligns with the combination of primary stakeholders identified in the literature (Lee, 2007; Lee et al., 2009; Brito & Botter, 2012; Hammad et al., 2021). This framework, however, also provides details of the stakeholders' role, operations, and activities in order to gain a holistic and comprehensive understanding of the concept of GLHs. Previous literature extensively discussed the operations and services carried out in maritime ports and port clusters (Flynn et al., 2011; Nam & Song, 2011; De Langen & Haezendonck, 2012; Lee & Lam, 2015; De Langen, 2021), however, there is less detail available on the operations of GLHs as a whole. Brito and Botter

(2012) and Lee et al. (2009) have highlighted some operations that take place in GLHs, but they lack the level of detail seen in other entities. Therefore, this framework brings a level of detail to the operations and services in a GLH that enhances the information available in the literature.

Table 6.1 also highlights the extent of overlapping of operations between GLH stakeholders as identified in this research. The operations of each stakeholder are not limited to the functions of their respective core activities, but rather expanded beyond it. This can be explained through stakeholder theory, where the instrumental aspect of the theory highlights the links and coordination (or lack thereof) between the stakeholders to achieve performance goals (Donaldson & Preston, 1995). This also aligns with Notteboom and Rodrigues (2005) explanation on the integration of logistics functions under single entities and the changing role of ports and port authorities in the value chain. They argue that the combination of logistics functions under single entities can help overcome issues associated with a fragmented system, such as costs and delays, and has changed the traditional scene. This highlights that the responsibility and operations of a port as a stakeholder in a GLH is not limited to its traditional functions but rather linked and integrated with other logistics functions and stakeholders. This might be one of the reasons for the increasing popularity of GLHs around the world as evident in the various studies on emergent GLHs in the literature review chapter.

Therefore, studying the concept of a GLH from one perspective, such as industrial manufacturing, transhipment, port, or logistics is not sufficient and does not accurately convey the complexity and significance of the concept. As seen in the definition provided above, it is the global connectivity and accessibility, the agglomeration of these players, and their complementing operations and activities that make up the GLH. This highlights the importance of understanding the relationships and interactions between the stakeholders and their operations and services, in order to fully grasp the concept of a GLH.

Table 6.1 Primary stakeholders & GLH Operations and Activities

<table>
<tr><th>Category</th><th>Type of Stakeholder</th><th>Description</th><th colspan="2">Role, Operations, & Activities</th></tr>
<tr><td rowspan="2">Providers of Logistics & Maritime Services</td><td>Transportation & Logistics</td><td>Shipping Lines - Logistics, Road transport & FFW Companies - Railway operators - Inland Vessel Sector</td><td>1. Warehousing
2. Distribution
3. Supply chain management
4. Insurance
5. Customs Clearance
6. Logistics Solutions & Value-added services:
a. Labelling
b. Assembly
c. Semi/light manufacturing and customizing
d. Production & manufacturing
e. Packaging
f. Consolidation
7. Integrated Multi-modal transport</td><td>8. Distribution & Freight Forwarding
9. Ocean, Rail, Road, Inland, & Air Freight
10. Outsourcing transportation and storage facilities
11. Door-to-Door Services
12. Stevedoring services
13. Cargo Handling
14. Stuffing & stripping containers
15. Supply chain solutions
16. Commercial Vehicle Maintenance
17. Export used Trucks and Transport Equipment
18. Inspection
19. Cross-docking
20. Chartering services
21. Consultancy</td></tr>
<tr><td>Maritime Port(s)
(Main ports & Feeder ports)</td><td>Port Authority - Port Owner & Operator (depending on the ownership of the port)
- Terminal Operators</td><td>1. Investing & Building Port Infrastructure & facilities
2. Provide Marine Services & Maritime Traffic regulation
3. Regulatory Authority
4. Operate Terminals
5. Warehousing
6. Logistics Services
a. Packaging & repackaging
b. Stuffing & stripping containers
c. Weighing containers
d. Arranging Customs Clearance
7. Barge, Rail, Ocean, Road Freight</td><td>8. Customs Clearance
9. Cargo Inspection
10. Landlord (managing & renting the port facilities & PPP concessions)
11. Stevedoring services
12. Cargo Handling
13. Transhipment
14. Freight Forwarding
15. Ensuring Safety & Legal Regulations are met
16. Stevedoring services
17. Outsourcing transportation and storage facilities
18. Supply chain solutions</td></tr>
</table>

Table 6.1 (continued)

Government & Regulators	Government	Central & local governments	1. Checking for infringement 2. Analysing data, Reporting, & penalizing 3. Free trade agreements facilitation 4. GLH area's security and safety 5. Convening role to link innovation with real-life issues to stimulate demand 6. Building infrastructure, networks & facilities	7. Facilitating foreign investments & liaising with other governments 8. Setting policies, strategies, plans and regulatory frameworks 9. Regulatory Body and Local Authority 10. Lobbying and communicating with national governments 11. Providing funding & financial Support
	International Bodies & Organisations	Unions, Associations & Interest Groups	1. Lobbying 2. Policy Campaigning 3. Provide information, support, and advice on regulations and issues 4. Support & Advice on global issues	5. Representing a united voice of the member stakeholders 6. Exchange of best practice 7. Provide Training 8. Coordinate with other organizations
Demanders of Logistics Services	Cargo & Manufacturing	Cargo Owners – Shippers – Manufacturers & Industrial Cluster Companies	9. Warehousing 10. Cross-docking 11. Packaging 12. Transportation 13. Distribution planning & activities 14. Door-to-Door	15. Outsourcing transportation & storage facilities 16. Logistics Consolidation Operations 17. Distribution planning and activities 18. Light assembly & product customization 19. Production & manufacturing
Supporting Actors	Community	Employees – Local Community - Science & Educational Institutes	1. Employees 2. Benefit from economic development of the region 3. Receive goods as consumers	
	Investors and Financiers	Investors	1. Invest	
	Supplementary Activities	Legal and Financial companies - Airports	1. Supporting Services	

This research has explored the operations and activities of GLHs in a holistic manner, which has not been previously done in the academic literature. Thus, it contributes to the knowledge, theory, and academic literature on GLHs. Specifically, this research goes beyond prior studies by identifying the specific operations and services provided by each stakeholder, thereby providing an additional level of detail to enhance the comprehensive understanding of the GLH concept. This is valuable as it serves to reinforce the new definition of GLHs provided through this research. This gives a more comprehensive picture of the activities and operations of GLHs and its stakeholders, not only at a strategic level, but also at an operational level. This will enable a wide range of applications, such as the measurement of performance (both operational and environmental), benchmarking with other GLHs, and improving sustainability. This detailed view of the operations and activities of GLH stakeholders improves the understanding of the scope of a GLH and all the stakeholders involved, which may extend beyond the physical boundaries of the GLH, such as the governments and associations, but are crucial to its success.

6.3 Research Question 2: How are the primary stakeholders connected in a GLH? Who is responsible for the environmental sustainability of GLH?

The second research question aimed to explore the extent of connection between the primary stakeholders of a GLH and identify the responsibility of GLH environmental sustainability within the agglomeration of operations and if it lies on a specific entity. This research question sought to understand the connections and interactions between the primary stakeholders of a GLH and how they relate to the implementation, measurement, and maintenance of environmental sustainability within a GLH. Given the magnitude of global cargo, logistics, and transportation activities that occur within a GLH, the environmental sustainability of these facilities is of critical significance. It is essential to understand the responsibility and interactions among primary stakeholders in relation to environmental sustainability within a GLH. This research question aimed to explore these connections and interactions in order to gain a better understanding of the environmental sustainability of GLHs. This understanding is crucial for the development of effective strategies for the management of the environmental impact of these GLHs.

6.3.1 GLH Governance and Environmental Sustainability Responsibility

Through exploring the environmental responsibility of GLH, it was possible to gain a deeper understanding of the dynamic relationship and authority among the various stakeholders operating within it. The governance structure of a GLH is closely linked to the holistic responsibility for its environmental sustainability. The second aspect of this research question addressed the question of determining the responsibility for the environmental impact of the global agglomeration of operations that are contributed to by multiple stakeholders. In a complex system where several independent organizations are affecting the environment through their operations, but with significant outsourcing and overlapping, determining the holistic responsibility for environmental sustainability within the GLH presented challenges due to the presence of loopholes in responsibility and the perception of a minimal impact compared to other industries or companies within the GLH.

6.3.1.1 GLH Governance Structures

The present study offers insights into the variations in governance found in GLHs. Governance is the "the combination of policies, politics, administration and legislation" (Cormier et al., 2022:2). Governance refers to the processes involved in planning, implementing, and carrying out activities aligned with the collective objectives of citizens and organizations, irrespective of their formal authority or policing capabilities (Bingham et al., 2005). The findings of this research indicate that the nature of government involvement in a GLH can vary depending on various factors such as the degree of privatization within the industry, the governance structure implemented in the host country, and the ownership of the primary port. These findings suggest that different GLHs may have different levels of government oversight and regulation, depending on the specific context in which they operate. In light of these findings, the example of Air Pollution Control (Fuel for Vessels) Regulation in Hong Kong serves as a good illustration of how governments can effectively enforce environmental compliance in a GLH, even when there are multiple stakeholders involved, such as companies or other neighbouring cities. The regulation in Hong Kong effectively reduces air pollution caused by shipping emissions and this is possible due to a cooperation between Hong Kong and its neighbouring cities in China's Pearl River Delta (Kim et al., 2022).

Furthermore, this research suggests that the governance in a GLH can take on centralized, decentralized, or hybrid governance models. This aligns with the literature, which explains the governance structures of regional logistics hubs through the lens of two types of transaction cost theory: relational and hierarchical governance models (Bolumole et al., 2015). Bolumole et al. (2015) suggest that the more privatized the industry is, the more relational governance is appropriate, whereas the more publicly inclined the industry is, the more hierarchical governance is appropriate. This theory can also be extended to explain the governance structures in GLHs as per the findings of this research. It suggests that GLHs with more public involvement and publicly owned ports are more centralized, whereas in GLHs with public-private partnership ports, a hybrid governance structure is adopted. In contrast, in a privatized industry, a decentralized governance structure is more appropriate.

On the other hand, this research highlights the complexities of governance and authority within GLHs. The government is not the only authority. The research findings indicate that GLHs can comprise one or more ports that are owned by the public sector, private sector, or a combination of both in a public-private partnership (PPP). Despite variations in ownership, the port authority or owner has both public and private roles within the boundaries of the port, with the public role involving a regulatory authority over companies operating within the port. According to De Langen (2006), port authorities in most ports are typically responsible for managing the conflicting interests of their stakeholders through port planning, regulation of land use, implementation of environmental standards, and establishment of firms. However, the extent to which this occurs varies depending on the ownership of the port. De Langen (2006) explains a similar context of governance in port clusters, where there are several stakeholders involved in a location. He explains that cluster governance is different from corporate governance as there are several stakeholders of independent organizations involved in an agglomeration of economic activities with little governing interactions between them, unlike a corporate hierarchy. There is a variety of actors in a GLH, but not all stakeholders have the same power, which can even vary for the same type of stakeholder. In some configurations, port authorities play an important role in governance and influence, however, in others, and if they are privately owned, this power shifts to different stakeholders. It was evident in the case studies that governments may be heavily or hardly involved. For instance, in SCZone GLH the government is heavily involved in the GLH development and in the operations of the ports and facilitating investments for the development of the GLH through the public port authority. In contrast, in Liverpool GLH, the government is hardly involved due to the highly privatized nature of the industry in the UK. This could be because of how the regulatory systems are set for certain countries. Additionally, some stakeholders, such as shipping lines are governed more by intergovernmental agencies, such as the International Maritime Organisation (IMO), due to the nature of their operations. This indicates multifaceted levels of governance and different levels of power within a GLH.

Multi-level governance (MLG) theory can be applied here to explain the multi-faceted levels of governance seen in a GLH. Daniell and Kay (2017) explain that MLG refers to a flexible form of governance where power is shared among different tiers of government and non-state actors, such as international bodies, trade associations, community groups, and private corporations. It is commonly used to emphasize the transfer of power and responsibility to various stakeholders and scales of governance. MLG systems refer to governance where there is a dispersion of authority upward, downward, and sideways between levels of government, including local, regional, national, and supra-national, as well as across spheres and sectors, such as states, markets, and civil society (Daniell & Kay, 2017). This concept can be used to understand the different levels of governance and power dynamics within a GLH, which is crucial for effective management and policymaking in such complex systems. The multi-level governance theory posits that governance in complex systems (such as GLHs) involves multiple actors operating at different levels such as local, national, and international, and these actors have different levels of power and autonomy, which is seen in this research findings. The theory also suggests that effective governance in such systems requires coordination and cooperation among actors operating at different levels (Armitage, 2008). Additionally, Cormier et al. (2022) also discuss the different levels of policies and legislation and the required integration to overcome jurisdictional boundaries on a global, regional, national, and local levels. They explain that horizontal integration ensures coherence across different sectors and activities, while vertical integration connects policies, plans, and technical measures from local to global levels, enhancing their effectiveness.

To better understand the variation seen in GLHs, a stakeholder grid can be used as a visual representation of the power vs interest of stakeholders within a GLH, as presented in Figure 6.2. This is across the cases for highly privatized through to more public GLH cases and is based on the interpretation of findings and the indicative importance ranking derived from primary stakeholder identification. The four quadrants of the matrix are monitor, satisfy, inform, and work with/manage (Kigenyi et al., 2023). The monitor quadrant includes stakeholders with low power and interest, who should be kept informed and their concerns monitored. The satisfy quadrant consists of stakeholders with high interest but low power, requiring efforts to address their concerns and ensure their engagement. The manage quadrant comprises stakeholders with high power and interest, necessitating close involvement and active participation. The inform quadrant includes stakeholders with high power but low interest, who should be kept informed and aware of their role's significance. The government (central and local) in all cases have the most power among the stakeholders. However, in the highly privatized case, the government (central and local) has less interest than in more public cases. Therefore, those in the upper right quadrant (with high interest and power) should have the highest influence to be responsible for the governance of GLHs.

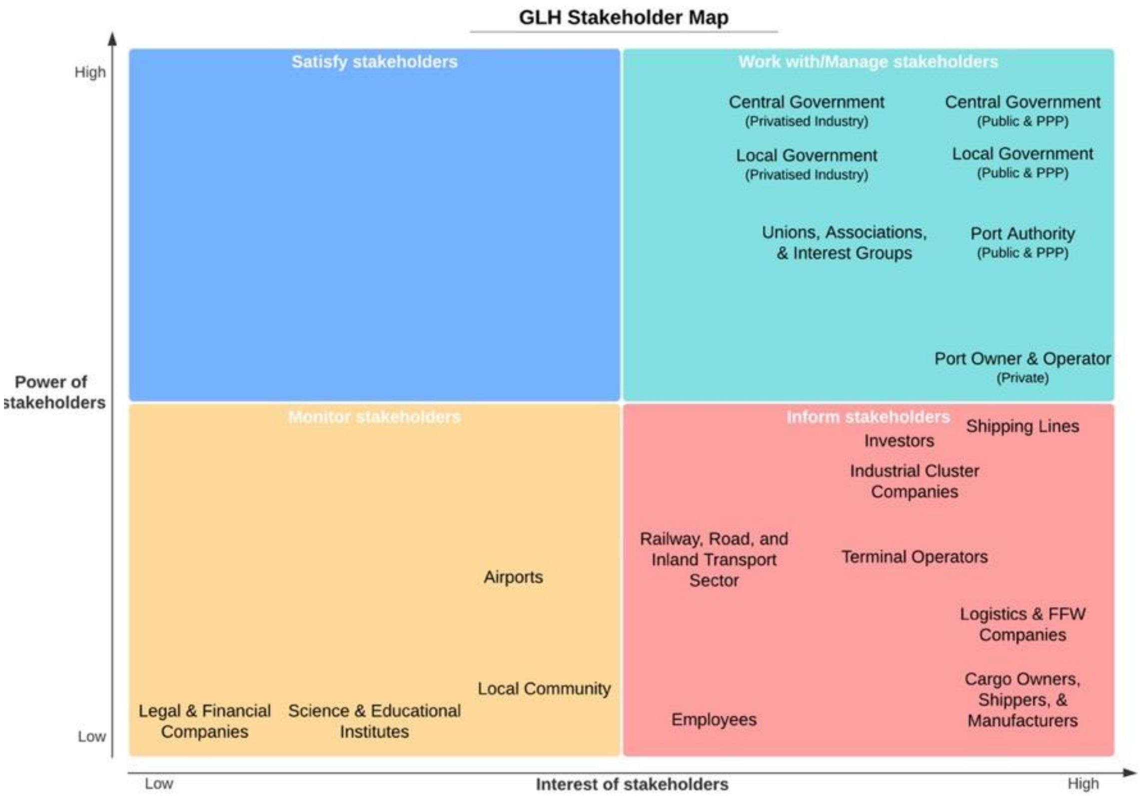


Figure 6.2 GLH Stakeholders Map - Power vs. Interest

6.3.1.2 GLH Environmental Responsibility

According to the research findings, there were different suggestions as to who is considered to be the most appropriate stakeholder to take on the holistic environmental sustainability responsibility in a complex system such as the GLH. It suggested that various entities or options may be considered. Those however who carry impact and influence i.e., governments and port authorities, should be leading the way.

One of the strong options suggested in all cases was for the government to be responsible due to their oversight, connections, power, and authority. This is also in line with the mandatory reporting required by governments under the Paris Climate Change Agreement for greenhouse gas emissions (Falkner, 2016). Institutional theory supports this idea through institutional pressures playing a crucial role in determining the level of environmental participation (Valenciano-Salazar et al., 2021). Additionally, the port authority, specifically in cases of public ownership or public-private partnership ports, was suggested due to being part of the government and having connections to the stakeholders. Similarly, (De Langen, 2015) explains that leader firms in a port cluster are the stakeholders that can enable and enforce cooperation, they have the capabilities to steer change, and they have the incentive to invest for the whole network of companies to be competitive.

Furthermore, supranational legislators were suggested to take the responsibility for the environmental performance and sustainability of GLH in order to address the complexities of geographical boundaries, fragmentation of responsibility among different stakeholders, and levelling the field of competitiveness between GLHs. This approach aims to enhance the competitiveness of environmentally sustainable GLHs by ensuring that their sustainable practices do not put them at a disadvantage in the market. However, the implementation of this suggestion can be difficult because the enforcement of legislation is the responsibility of each individual country. This means that even if supranational legislation is passed, the enforceability of the legislation may vary among different countries, making it challenging to effectively regulate the environmental performance and sustainability of GLHs across borders. Additionally, the traditional system of international law, which recognizes only states as subjects, makes it difficult to impose obligations on multinational corporations which operate across boundaries (Buhmann, 2006). As a result, it may be difficult for supranational legislators to effectively regulate and enforce environmental sustainability in GLHs.

There were, however, other responsibility suggestions for the environmental performance and sustainability of a GLH such as voluntary participation. This was only suggested in cases in developed economies in Europe (Rotterdam, Antwerp, and Liverpool GLHs) to overcome complexities associated with multiple stakeholders and to address issues related to identifying geographical boundaries, the fact that responsibility should fall on everyone, and competitiveness issues. However, this option was not mentioned in the case in developing economy (SCZone GLH), where pressures from other sources than the governments (such as the customers, community, or competitors) may not be as pronounced. This is in accordance with institutional theory explaining that institutional pressures play a role in environmental participation (Valenciano-Salazar et al., 2021). Therefore, this can be attributed to the influence of the three forces of institutional theory in GLHs in developing economies (coercive from the government, normative from society, and mimetic from other participating companies). However, it can only be attributed to the influences from coercive forces in GLHs in developing economies (such as government regulations and laws).

Institutional theory suggests that organizations conform to societal norms and values in order to be perceived as legitimate by stakeholders such as customers and government regulators (Glover et al., 2014). In the context of environmental sustainability, organizations may feel pressure from customers and government regulators to adopt environmentally sustainable practices, such as measuring carbon emissions or using renewable energy sources. This pressure can create an incentive for organizations to voluntarily participate in environmental initiatives in order to align with institutional expectations and avoid negative consequences such as fines or reputational damage (Babiak & Trendafilova, 2011). In this research, the cases in developed economies face pressures from governments, legislation, and the threat of fines (such as fines imposed by the European Court of Justice for violating EU directives in the cases of Rotterdam and Antwerp, or other regulatory bodies and the government entities for the cases of Liverpool and SCZone). Additionally, there are increased pressures from local community and customers due to the increased awareness around environmental sustainability. In contrast, in developing economies, the pressures are mostly only from governments and therefore, the voluntary participation option was not mentioned. This finding is important because it highlights the need to consider the institutional context when developing policies and strategies for addressing environmental performance and sustainability of GLHs. It suggests that the approaches that are effective in GLHs in developed economies may not necessarily be viable for GLHs in developing economies, and vice versa.

6.3.2 The extent of connection among GLH Primary Stakeholders

The empirical findings of this research indicate that the extent of connection among the stakeholders within the GLHs in the case studies varies. Additionally, the four case studies appear to be at different stages of this extent of connection. The diagram in the cross-case section (Figure 5.7) illustrates the varying degrees of communication, collaboration, as well as integration, which represents a level of connection that is more holistic and interconnected (Wong et al., 2015). This is in line with previous studies that explain that stakeholder relationships typically transition from an arm's-length, adversarial, to a collaborative relationship through 'C3 Framework': cooperation, coordination, and collaboration (Wilding & Humphries's, 2006; Keast et al., 2007; Wong et al., 2015). Cooperation is the initial level of interaction, involving the exchange of essential information. Coordination involves the exchange of information and workflows to ensure smooth operations, and collaboration entails joint planning with external partners. However, according to Bratton et al. (2000) establishing trust can be challenging and remains a significant barrier in horizontal collaborations. On the other hand, Keast et al. (2007) explain that the requirement for horizontal integration reflects an increased complexity of the system model, and it ranges on a continuum from fragmented to fully connected for intra- and inter-organisational integration.

This aligns with the study conducted by Wong et al. (2015) which explains that there are different levels and forms of integration depending on the stakeholder, such as supplier, customer, internal or community. The external integration ranges from exchanging information regarding environmental issues, to coordinating through communication, engagement, voluntary participation, and monitoring, to collaboration with stakeholders on environmental improvement, to integrating and measuring the performance with stakeholders.

These varying levels of relationship connection between GLH stakeholders regarding environmental performance and sustainability practices align with Wong et al. (2015). They explain that there are different forms and levels of integration that can occur between stakeholders, including suppliers, customers, internal stakeholders, and the community. External integration can range from simple information exchange to more complex forms of collaboration and performance measurement. They explain that these variations are due to the inclusion of wider stakeholders in a complex system of supply chains environmental impact.

In this research, all cases and stakeholders had at least some level of connection regarding environmental sustainability. This is not surprising given that one of the levels is ‘mandating and complying with environmental legislation’ and the other is ‘simple communication with other stakeholders’ as the most emphasized form of connection across cases, which is relevant with sending environmental reports to governmental departments or communication of environmental initiatives. However, on one hand, the more developed the GLH was, the more the stakeholders were connected to other stakeholders regarding environmental sustainability. This is likely due to the fact that many stakeholders in developed GLH are required to comply with environmental legislation and also need to communicate with other stakeholders about environmental initiatives and reports. On the other hand, within individual cases, stakeholders' connection varied, and this variation was not linked to size or type of organization. Some larger organizations were more connected, and some were not, and some smaller organizations were more connected, while others were not. Even with the type of stakeholders, some logistics companies, or terminal operators, or local communities were more connected, and others were not. This is likely due to the interest, motivation, and drivers of these stakeholders regarding environmental sustainability. This is in line with previous research (Darnall et al., 2010; Huge-Brodin et al., 2020). Darnall et al. (2010) found that variations in environmental sustainability practices exist across organizations and are not solely dependent on the size of the organization. While larger companies may have more resources and capabilities to be proactive with their environmental performance and may be under more external pressure to do so, smaller companies may have the ability to respond with greater vigour due to their resource scarcity, simplified decision-making process, and tendency towards innovation. This suggests that the capabilities and size of an organization may not necessarily have a direct link to the extent of connection with other stakeholders regarding environmental sustainability, but rather, how the organization views the importance and awareness of environmental sustainability. Additionally, Huge-Brodin et al. (2020) explain that the extent to which stakeholders engage in connection or communication regarding environmental sustainability can be attributed to the level of importance and awareness placed on the topic by the individual stakeholder, such as a top-down corporate policy or a bottom-up employee pressure. This suggests that the level of connection in environmental sustainability practices among the stakeholders of a GLH is not reliant on the size or capabilities of the stakeholders, but rather upon the perceived relevance and significance of such issues for the respective stakeholder.

Furthermore, the diversity of the stakeholders brings different perspectives about inter-organisational relationships and collaboration practices (Ha et al., 2019), as well as conflict of interests among stakeholders, such as environmental groups and port authorities, can serve as a source of tension and hinder cooperation (De Langen, 2006). Conversely, Huge-Brodin et al. (2020) found that overlapping interests among multiple stakeholders may also lead to a low degree of communication and connection. Additionally, the complexity of the system plays a role in the varying degrees of connection among stakeholders. The complexity of the system has been highlighted in several studies as a hinderance to connectedness, interaction, cooperation and collaboration between the stakeholders (Hervani et al., 2005; Abbasi & Nilsson, 2012; Björklund & Forslund, 2013b; Lam & Song, 2013; Bjørgen et al., 2019). Carlan et al. (2016) highlight that port actors have varying relationships, while some collaborate and connect, other stakeholders compete. Therefore, conflicting and overlapping interests, as well as the complexity of the system can have an impact on the level of connection among stakeholders in a GLH. This is important because the level of connection can facilitate the environmental performance.

On the other hand, the research findings indicate that there is a difference in the extent of connection among stakeholders in relation to the level of development of the GLH. Specifically, that as the level of development of the GLHs increased, the extent of connection among stakeholders improved. This suggests that the level of development of the GLH may act as a facilitator of stakeholder connection and engagement on environmental sustainability issues.

By exploring the governance structures, power dynamics, and extent of connection among stakeholders in a GLH, this research helped shed light on the multi-level governance structures in GLHs, stakeholders' integration levels in a GLH, and the power versus interest of GLH stakeholders. These insights can assist in clearly defining accountability and responsibilities among stakeholders, promoting effective communication and collaboration to improve visibility regarding environmental performance and sustainability, and ultimately enhancing the overall environmental sustainability of the GLH.

6.4 Research Question 3: How do GLH operations impact the environment? How is the impact measured?

The third research question aimed to shed light on the environmental impacts that result from the operations and activities of the primary stakeholders within a GLH. Additionally, it helped identify indicators used by stakeholders to measure these impacts across the four cases.

6.4.1 GLH Environmental Impact

The research findings revealed a general consistency of the environmental impacts identified across cases when evaluated holistically. The most frequently observed environmental impacts across the cases studied were factors such as greenhouse gas emissions, water pollution, and the generation of waste. These findings suggest that there is a degree of uniformity or set of core environmental impacts associated with the cases studied, with certain impacts being particularly prevalent.

Table 6.2 lists the main environmental impact categories of GLHs, ranked based on the frequency of responses coded under each theme, indicating their perceived importance. However, it is crucial to emphasize that further quantitative investigative research is required to validate the significance of each of these environmental impacts. This research can help prioritize those impacts that strongly resonate within and across different cases.

A more detailed presentation of the environmental impacts can be found in Figure 6.3. The main environmental impact categories are aligned with the literature on the environmental impact of maritime ports (Darbra et al., 2004, Puig et al., 2014; Di Vaio et al., 2018, Lim et al., 2019; Široka et al., 2021; ESPO, 2022; Puig et al., 2022). This can be due to the close relation between the port operations, shipping activities, and hinterland transport (Moon et al., 2018). Additionally, the research findings align with the literature indicating that port and industrial activities can have a significant impact on biodiversity of coastal areas by introducing non-indigenous species, altering the physical chemical properties of the environment, degrading habitats, and disrupting the natural ecological balance (McLusky & Elliott, 2004).

However, upon closer examination of the detailed environmental impacts, it was found that some of them are industrial or logistics-related and not accounted for in the literature on the environmental impact of maritime ports. For example, the category of waste generation includes impacts such as paper and cardboard (Lo-Iacono-Ferreira et al., 2020; Bozhanova et al., 2022) and batteries (Slattery et al., 2021), which are attributed to the impacts resulting from manufacturing and logistics operations, as demonstrated in the findings of this research. This finding highlights the importance of considering manufacturing and logistics-related environmental impacts in GLHs in addition to those typically associated with maritime ports, hinterland transport, and shipping activities. Despite the overlap of the impacts of these activities, it is evident that the environmental impacts of manufacturing and logistics must also be considered in order to gain a comprehensive understanding of the environmental impacts of GLHs and to inform the development of effective environmental performance measurement and mitigation strategies. Previous literature has tended to adopt a siloed approach, neglecting the consideration of the environmental impacts of all primary stakeholders.

Table 6.2 GLH Environmental Impact Categories

GLH Environmental Impact Categories
1. Waste
2. Air Pollution
3. Consumption of natural resources
4. Water Pollution
5. Noise Pollution
6. Biodiversity and ecosystem disturbance
7. Odour Pollution
8. Sediment Pollution
9. Land-use change
10. Light Pollution

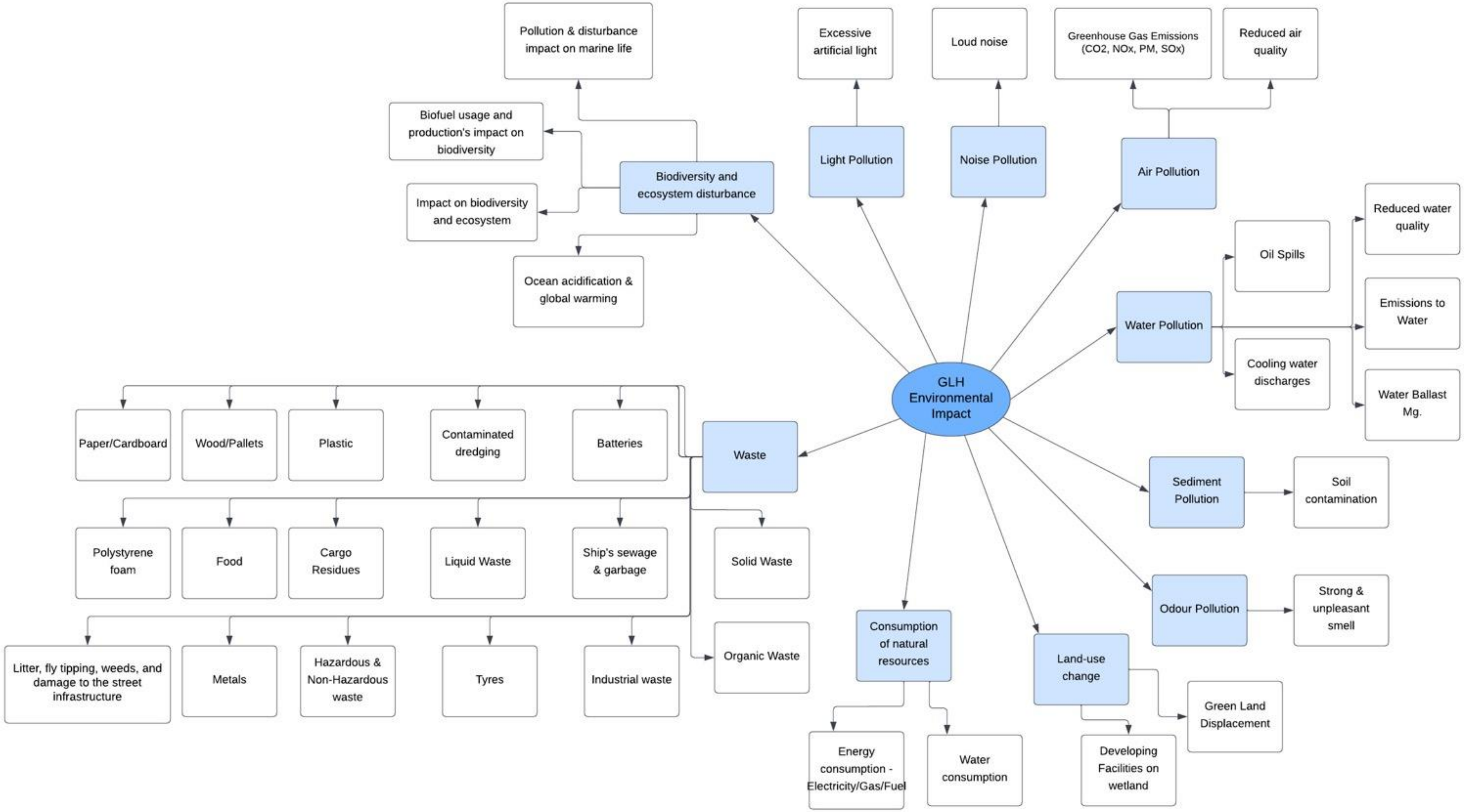


Figure 6.3 GLH Environmental Impact

6.4.2 GLH Environmental Indicators and Holistic Framework

6.4.2.1 Greenhouse Gas Emissions Emphasis

One of the research findings is the prevalence of greenhouse gas emissions as an environmental impact and in the indicators and measures used by stakeholders across cases. This research identified 13 indicators and 17 measures for air emissions alone across the four GLH cases. This emphasis on greenhouse gas can be attributed to the projected consequences of inaction regarding climate change. According to the Intergovernmental Panel on Climate Change (IPCC, 2019), without substantial and immediate efforts to mitigate greenhouse gas effects, the planet may experience a 1.5 degrees Celsius temperature increase by 2030, with the potential for irreversible damage. Therefore, this popularity can be linked to the relationship between greenhouse gas emissions and climate change, where the pressure of legislation passed on regarding the emissions of companies, as well as the mandatory reporting under the Paris Climate Change Agreement and the Climate Emergency Declaration are forcing companies, organisations, and governments to pay more attention to greenhouse gas emissions (Ellram & Monique, 2017). Additionally, this focus is aligned with the literature, where studies on the greenhouse gas emissions resulting from ports, logistics, and multimodal transportation activities is a major focus in the literature (Evangelista, 2014; Ellram & Monique, 2017; Klumpp, 2017; To & Lee, 2017; Evangelista et al., 2018; Khalili, 2019; Lee et al. 2019; Alamoush et al., 2020; Alamoush et al., 2022). This is due to the significant amount of GHG emissions resulting from the consumption of fossil fuels in the logistics sector and multimodal transportation activities. In 2017, air transportation accounted for 3.8, road transportation contributed 21%, and rail transportation contributed 1.6% of the EU's CO2 emissions (European Commission, 2022a). Additionally, despite being more energy efficient than other modes, maritime transportation contributed 2.9% of global greenhouse emissions in 2018 (European Commission, 2022b). In GLHs, these emissions are attributed to global amounts of cargo transportation, logistics, shipping, in addition to any industrial and manufacturing activities related emissions. This highlights the interrelation among various stakeholders and their collective contribution to greenhouse gas emissions in a GLH. According to stakeholder theory, actors that affect or are affected by an organization are considered its stakeholders (Freeman, 1984). Therefore, the primary stakeholders of a GLH, including transportation companies, government, logistics, ports, shipping line, manufacturers, and industrial cluster companies have a role to play in their contribution to the GLH greenhouse gas emissions. Therefore, a stakeholder-inclusive approach that involves collaboration and cooperation among the primary stakeholders is essential to address the issue of greenhouse gas emissions in a GLH.

6.4.2.2 Variation in Measures, Indicators, Frameworks, and Management Systems

One of the key findings of this research is the lack of unity in relation to the ways GLHs and stakeholders within the GLHs in the four cases measured their environmental impact. It was observed that there were some similarities in the environmental indicators and measures used to assess environmental impact across cases, such as those related to air emissions, waste, and energy consumption. However, a greater variance in measures and indicators used in the measurement of other environmental impacts, such as noise, biodiversity, and sustainable capabilities, was observed among participants. Additionally, the variation was also observed in the environmental frameworks and measurement systems adopted by stakeholders in a GLH. This observation highlights a discrepancy in the way the environmental impacts of GLHs are assessed. The lack of a unified set of indicators and measures that can be utilized by stakeholders in these GLHs to uniformly assess and mitigate their environmental impacts. When compared to the environmental impacts identified in this research, it suggests that there is a shared understanding of the GLH's environmental impacts, but not all of these impacts are consistently measured across all types of stakeholders. This makes it challenging to benchmark the environmental performance of different GLHs, leads to confusion and a lack of action in addressing identified impact, and undermines accountability and the ability to effectively track progress over time.

The variation in the measurement of environmental impact could be attributed to a variety of reasons, such as a lack of capabilities, necessary equipment, measurement techniques available to the stakeholder organisation, or organisation or lack of direction from government through legislation. This can be linked to the resource-based view (RBV) theory. The RBV theory suggests that a firm's internal resources and capabilities are primary determinants of its competitive advantage (Teece, 1987; Wernerfelt, 1984). In the context of this research, the resources, knowledge, and capabilities that an organization has to measure its environmental impact could play a significant role in determining how and if it is able to assess that impact. Additionally, the RBV theory emphasizes the importance of a company's management in identifying and utilizing its resources and capabilities effectively (James & Joseph, 2015). The variation in the measurement of environmental impact across the different stakeholders and across the 4 cases in this research could be attributed to the way that different organizations identify, prioritize, and use their resources and capabilities towards environmental sustainability. Furthermore, this emphasizes Hart's (1995) views on the relationship between integrating environment sustainability as part of the capabilities of an organisation and sustaining its competitive advantage.

On the other hand, the variation was also observed across the four cases, where this could be due to differences in the regulations posed on each GLH based on the host country, best practices that are suitable and known for different countries, and different levels of pressures posed by customers, local community, governments, or other stakeholders within GLHs in different countries or different governance models. This can be linked to institutional theory, where the variations across the cases could be attributed to the influence of formal and informal institutions based on each case context. Formal institutions are the laws, regulations, and standards that provide "*authoritative behavioural guidelines"*, while informal institutions are cultural norms, beliefs, and values that shape coordination and cohesion (Holmes et al., 2013). Formal institutions may vary across different jurisdictions, leading to differences in the indicators and measures used to assess the environmental impact. For example, different countries or regions may have different laws and regulations regarding the measurement of air emissions, waste, and energy consumption. This can lead to variations in the indicators and the level of detail of the measures used to assess environmental impact across different GLHs. Additionally, informal institutions may also play a role in shaping the indicators and measures used to assess the environmental impact. For example, different communities, countries, or customers may have different norms and beliefs regarding what constitutes an acceptable level of environmental impact. Additionally, GLH that operate in areas with high levels of public concern about environmental issues may be under pressure to use more stringent indicators and measures to assess their environmental impact. This can lead to variations in the indicators and measures used to assess environmental impact across GLHs in different regions and countries.

Furthermore, when linked to the existing literature, it becomes evident that the stakeholders of GLHs are studied in a siloed manner rather than holistically, which could be contributing to the lack of a unified perspective on indicators, measures, and environmental frameworks. As highlighted in the literature review chapter, several research studies (listed in Table 2.16 of the literature review chapter) have examined the environmental performance or environmental impact of specific primary stakeholders individually, such as ports, freight transportation, logistics services (Darbra et al., 2004; Peris-Mora et al., 2005; Rohacs & Simongati, 2007; Kuhl and Zhou, 2009; Dinwoodie et al., 2012; Acciaro et al., 2014; Lam & Notteboom, 2014; Lee and Wu, 2014; Puig et al., 2014; Kuznetsov et al., 2015; Shiau & Chuang, 2015; Wang & Zhao, 2016; Ha e al., 2017; Klumpp, 2017; To and Lee, 2017; De Vaio et al., 2018; Rodrigues et al., 2021; Ecoports, 2022). Some of this research developed frameworks and tools for environmental performance measurement that are tailored to the specific type of stakeholder and nature of operations (Darbra et al., 2004; Peris-Mora et al., 2005; Kuhl and Zhou, 2009; Dinwoodie et al., 2012; Kuznetsov et al., 2015; Wang and Zhao, 2016). This approach has contributed to the fragmentation of guidance available to stakeholders and further exacerbates the lack of a unified perspective on indicators and measures of environmental impact.

Therefore, there is a lack of studies that address a framework or the indicators for the environmental performance of GLHs that consider all the primary stakeholders under one umbrella. Given the lack of unity and fragmentation found in the indicators and guidance available for GLHs to assess their environmental impacts, this research proposes a holistic environmental measurement conceptual framework. This framework extends and builds on the framework presented by Peris-Mora et al. (2005) and the research of Puig et al. (2014). Peris-Mora et al.'s (2005) framework multi-decision level and the incorporation of other stakeholders in the framework make it suitable to build and extend upon. Peris-Mora's et al. (2005) conceptual measurement framework was designed for maritime ports, and it considered stakeholders from the port's perspective and their environmental impact. However, their framework did not specifically address GLHs and did not include all primary stakeholders associated with GLHs. The framework presented in this study address these limitations by providing a holistic perspective that considers all primary stakeholders associated with GLHs and their environmental impact. Furthermore, this framework adopts the three levels of indicators used in Puig's et al. (2014) research, which are based on the three categories of ISO 14031: Environmental Condition Indicators (ECI), Management Performance Indicators (MPI), Operational Performance Indicators (OPI). The framework also highlights the different indicators that are relevant to the environmental impact of each stakeholder type on each level. Therefore, this framework is an important contribution to the existing literature, as it addresses the fragmentation of environmental performance in GLHs and the gap in understanding and knowledge regarding the holistic environmental performance of GLHs.

The framework presented in Figure 6.4 serves as an initial step towards closing the loop on the environmental impact of stakeholders operating within a GLH. It is built using the environmental indicators and categories, listed in Table 6.3 and Table 6.4, as well as the environmental indicators per stakeholder type collected through this study. It will assist in building a system that facilitates measuring the environmental performance of the GLH as a whole. It is an important tool that aims to provide a comprehensive understanding of the environmental performance of the GLHs. Therefore, it will aid in the development of strategies to mitigate the environmental impact of the stakeholders and the GLHs as a whole. This framework is an important contribution to the existing literature, as it addresses the fragmentation of environmental performance in GLHs and the gap in understanding the holistic environmental performance of GLHs and its stakeholders.

This proposed framework aims to address the holistic impact of the GLH and will provide guidance to GLHs on measuring the holistic environmental performance, including small companies, shipping companies, manufacturers, retailers, logistics companies, and freight forwarding companies. Additionally, indicators from industrial cluster companies can be incorporated into this framework in the future, as this type of stakeholder was not included in the research. Additionally, this framework can also facilitate the mandatory reporting of greenhouse gas emissions required by governments under the Paris Climate Change Agreement to intergovernmental organizations such as the United Nations. It can also assist in complying with the requirements of other global and regional conventions, treaties, and agreements such as the Convention on Biological Diversity (CBD), the International Convention for the Prevention of Pollution from Ships (MARPOL), and the Marine Strategy Framework Directive (MSFD) of the European Union.

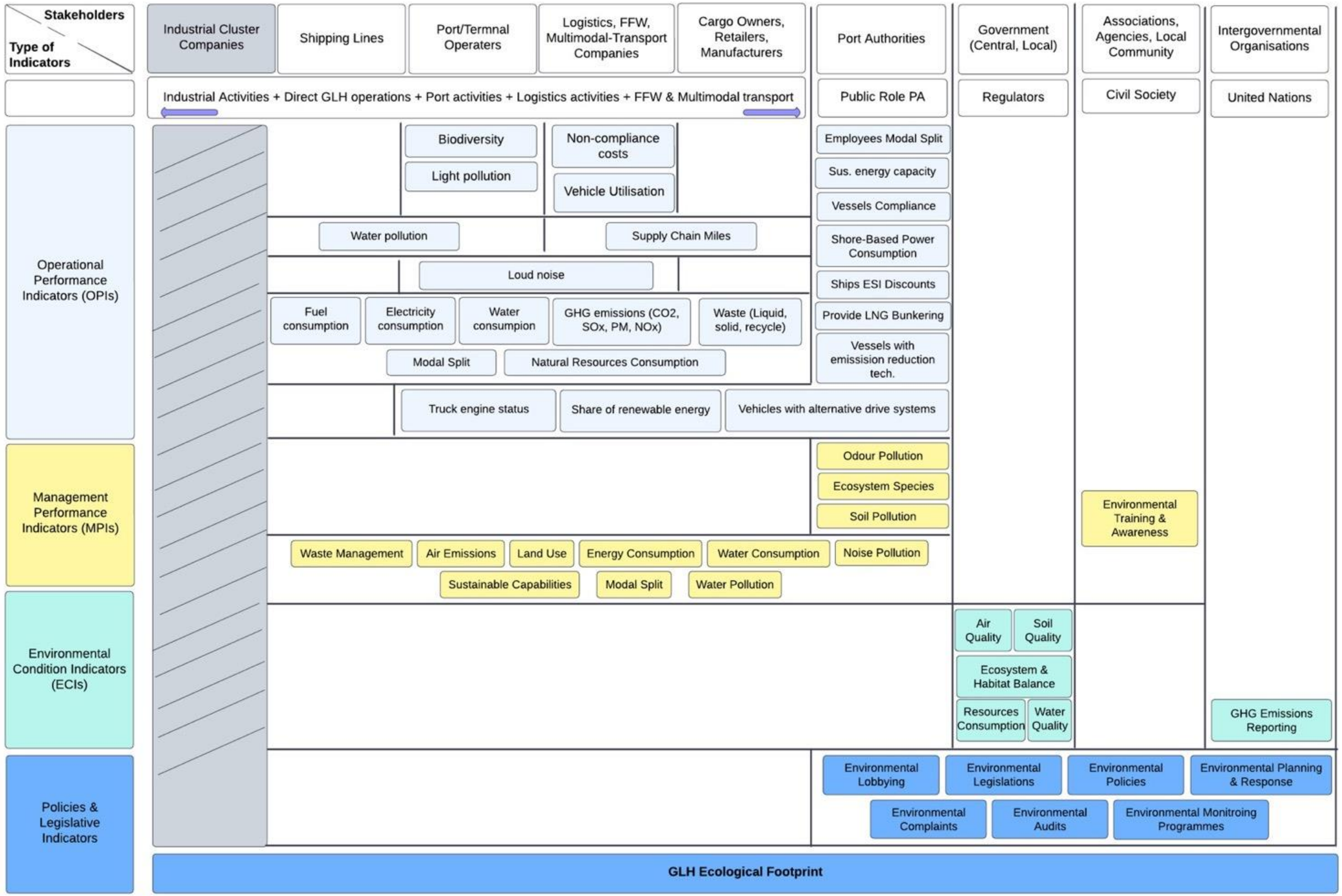
Furthermore, this framework considers the overlap and outsourcing of operations and activities between the stakeholders and as a result have common and overlapping environmental impacts. This aspect was not previously considered in the literature on this scale of stakeholders. Moreover, the four levels in the framework feed into each other, starting from the operational performance indicators level to the management performance indicators level to the environmental condition indicators, and lastly to the fourth level of policy and legislation indicators. This is where environmental management programmes, lobbying, audits, complaints, and planning indicators can provide top level gauges to assist in decision-making and setting an overall direction of the GLH environmental sustainability based on the GLH Ecological footprint that this framework provides.

Table 6.3 GLH Environmental Indicator Categories

GLH Environmental Indicator Categories
Air Emissions
Biodiversity & Ecosystem
Energy Consumption
Sustainability capabilities
Waste Pollution
Water Quality
Noise Pollution
Odour Pollution
Water Consumption
Soil Quality
Non-Compliance Costs
Supply Chain Miles
Light Pollution
Natural Material Consumption
Modal Split

Table 6.4 GLH Environmental Indicators

GLH Environmental Indicators		
GHG Emission Reduction	Recycled waste	CO2 Reductions
GHG CO2 equivalent	Recycled water	CO2 Concentrations
CO2 Efficiency	Truck engine status (Euro Standard)	Water pollution
CO2 Intensity	Ship visits with ESI discounts	Water acidity
CO2 Emission	Providing ships with LNG bunkering	Emissions into water
NOx concentrations	Shore-based power connections	Water Nutrients
NOx emissions	Sustainable Energy Capacity	Chemical water quality
Particulate Matter concentrations	Share of renewable energy	Fresh Water Consumption
Particulate Matter emissions	Vehicles with alternative drive system	Biodiversity
SOx concentrations	Employee vehicles with alternative drive system	Land Use
SOx emissions	Truck container pick-up & delivery	Loud noise
Electricity consumption	Vessels with emission reducing technology	Soil pollution
Fuel consumption, Diesel, Gasoline, Compressed natural gas	Compliance of vessels with international maritime legislation	Penalties & fines for breaching environmental legislation
Energy (Efficiency)	Employees Mobility Modal split	Strong & unpleasant smell
Fuel Efficiency	Vehicle Utilisation/Fill	Distance of products transportation across the SC
Shore-based power Consumption	Emission Reduction Measures	Light Intensity
Liquid Waste	Uptake of alternative fuels: CNG, LNG, Electricity, Biodiesel, LPG, Biomethane	Modal Split: Cargo transported by greener modes
Solid Waste (by type)	Paper Consumption	



Stakeholders
Type of Indicators
Industrial Cluster Companies
Shipping Lines
Port/Termnal Operaters
Logistics, FFW, Multimodal-Transport Companies
Cargo Owners, Retailers, Manufacturers
Port Authorities
Government (Central, Local)
Associations, Agencies, Local Community
Intergovernmental Organisations
Industrial Activities + Direct GLH operations + Port activities + Logistics activities + FFW & Multimodal transport
Public Role PA
Regulators
Civil Society
United Nations
Operational Performance Indicators (OPIs)
Biodiversity
Light pollution
Non-compliance costs
Vehicle Utilisation
Employees Modal Split
Sus. energy capacity
Vessels Compliance
Water pollution
Supply Chain Miles
Shore-Based Power Consumption
Loud noise
Ships ESI Discounts
Fuel consumption
Electricity consumption
Water consumpion
GHG emissions (CO2, SOx, PM, NOx)
Waste (Liquid, solid, recycle)
Provide LNG Bunkering
Modal Split
Natural Resources Consumption
Vessels with emissision reduction tech.
Truck engine status
Share of renewable energy
Vehicles with alternative drive systems
Management Performance Indicators (MPIs)
Odour Pollution
Ecosystem Species
Soil Pollution
Environmental Training & Awareness
Waste Management
Air Emissions
Land Use
Energy Consumption
Water Consumption
Noise Pollution
Sustainable Capabilities
Modal Split
Water Pollution
Environmental Condition Indicators (ECIs)
Air Quality
Soil Quality
Ecosystem & Habitat Balance
Resources Consumption
Water Quality
GHG Emissions Reporting
Policies & Legislative Indicators
Environmental Lobbying
Environmental Legislations
Environmental Policies
Environmental Planning & Response
Environmental Complaints
Environmental Audits
Environmental Monitroing Programmes
GLH Ecological Footprint

Figure 6.4 GLH Holistic Environmental Performance Conceptual Framework

6.5 Research Question 4: What are the drivers of and barriers to environmental sustainability in a GLH?

The fourth research question aimed to gain a comprehensive understanding of the environmental sustainability drivers and barriers that are experienced by the primary stakeholders of GLHs. The research findings identified 5 categories and 21 subcategories of drivers, and 8 categories and 37 subcategories of barriers. These findings are visualized using the Fishbone (Ishikawa) diagram in Figure 6.5, which illustrates the common and most frequently mentioned drivers (highlighted in blue) and the common and most frequently mentioned barriers (highlighted in red) across all cases. The drivers and barriers that were identified in this research can be linked back to previous literature, however, some of the findings are unique to this particular study.

6.5.1 GLH Environmental Sustainability Drivers

The majority of the drivers' categories were common among all cases and all types of stakeholders, with slight variations in the subcategories. For example, all cases were motivated by the need to strengthen their businesses and gain a competitive advantage due to the increasing demand for sustainability. This aligns with the existing literature on the subject, which suggests that businesses are striving to protect their reputation and public image from environmental issues caused by their operations (Evangelista et al., 2010; Tay et al., 2015; Lozano et al., 2019). Additionally, 'demand for sustainability' was one of the common subcategory drivers in business strength across the cases. Customers' demands on alternatives or sustainable solutions is an important driver. However, this is still not a huge demand, and therefore 'lack of demand for new sustainable solutions' is also identified as a barrier. Some customers have a role to play to drive environmental sustainability upstream because organisations will not want to lose customers if they can't offer what they want. Furthermore, within cases, 'demand for sustainability' was also common among most stakeholder types. This driver has been identified in the literature as 'customers' (Tay et al., 2015), 'customer pressure' (Evangelista et al., 2010; Williamsson et al., 2022), and 'customer satisfaction' (Lozano et al., 2019).

The findings of this research also suggests that various drivers may be interconnected. For instance, the demand for sustainability can influence an organization's ability to gain a competitive advantage by offering sustainable solutions. This is because if there is a heightened demand for sustainable products and practices, it can affect an organization's reputation and customer base if they do not, which in turn can impact their competitive advantage. This finding aligns with previous research on the interplay between customer requirements, corporate image, and competitive advantage as drivers of environmental sustainability (Evangelista et al., 2010; Tay et al., 2015; Lozano et al., 2019; Serra & Fancello, 2020; Williamsson et al., 2022).

On the other hand, an interesting difference was observed among cases in the business strength category, specifically in the driver of 'being a leader in sustainability. This driver was only identified in all GLH cases hosted in developed economies countries. This was also met with a barrier that was specific to the GLH case hosted in a developing economy country, which was 'sustainability is not prioritized' because 'developing economy faces social challenges' such as providing food and education that take priority over environmental sustainability. This barrier highlights the prioritization of providing basic human needs over environmental sustainability in developing economies because of the restriction of available resources. This finding aligns with previous research on the differences in approaches to environmental sustainability among developed and developing economies (Karnani, 2007; Hossain & Khan, 2016; Barros et al., 2020).

This can be linked to institutional and RBV theories. It is established in the literature that the sustainability adoption in the public sector is more complex than that of private organizations, as highlighted in the literature review chapter (Roman, 2017). Additionally, external pressures (institutional theory) can have an impact on internal resource configuration (RBV theory) in private and public administration organizations (governments) (Zheng et al., 2013). In the context of this research, institutional theory serves to explain that external pressures, such as social pressures on developing economies' governments to provide decent education and resources for supplying food, have an impact on resources allocation through RBV theoretical lens. This explains the prioritization and allocation of the restricted capabilities that developing economies might have to what the social pressures is directing them towards. Similarly, pressures in developed economies from customers and society for example on being more sustainable, directs the allocation of resources to more sustainability solutions for the purpose of 'being a leader in sustainability'. These sources of external pressure and internal resource allocation can help in understanding the discrepancy found between the driver identified for GLHs in developed economies regarding 'being a leader in sustainability' versus 'sustainability is not prioritized due to social pressures' in the GLH in developing economy. This reflects the pressure from society based on their needs versus the government's capabilities and its impact on improving environmental sustainability. This highlights that there are differences in approaching environmental sustainability by developed versus developing economies. Furthermore, this finding aligns with the research of Wang et al. (2019) who highlighted the differences in sustainability consumption and production between developed and developing economies. They explain that in developing economies, there is a struggle to meet basic needs, and now these economies are also facing environmental pressures. In contrast, developed economies have more resources, including governmental and corporate action plans, funding, and approaches to sustainable consumption and production (Wang et al., 2019).

Additionally, the 'environmental sustainability is business sustainability' driver was highlighted only in the public and Public-Private Partnership (PPP) cases. This finding aligns with previous research that has identified differences in the drivers of environmental sustainability between private and public sectors (Walker et al., 2008). More specifically, Bjerkan et al. (2021) highlighted the differences in the drivers and barriers between private and public ports, explaining that these differences could be due to *"political governance"* and steering in public ports as they play a role in "*community management and societal functions*" that is not found in private ports. On the other hand, in a more privatized industry setting, the 'opportunity to create sustainable industries' driver was referring to new business opportunities. This could indicate the two different perspectives of sustainability benefits in a more public versus a more private industry setting. Also, 'the success of sustainable solutions in other settings' was only highlighted in highly privatized industry GLH. This is likely because as a large private business, the success of sustainable solutions in other settings alleviates the risk associated with a new technology or solution investment. This was also highlighted in the literature by Tay et al. (2015) as a driver – 'internal risk management' - and by Williamsson et al. (2022) as an influencing factor – 'investments in infrastructure'. This finding suggests that the level of privatization plays a role in the drivers and barriers of environmental sustainability in GLHs.

The remaining driver categories, such as 'external factors' (e.g. legislation, increased awareness, pressures, contracts), 'philanthropic factors' (e.g. sense of responsibility, accountability for own operations, health and wellbeing of humans and planet), and 'intra-organizational factors' (e.g. employees, corporate policy) were found to be common across all cases and most stakeholder types. These drivers and their subcategories align with previous research on drivers of environmental sustainability (Hervani et al., 2005; Evangelista et al., 2010; Tay et al., 2015; Lozano et al., 2019; Serra & Fancello, 2020; Shaw et al., 2021; Williamsson et al., 2022). This finding can also be linked to the 17 Sustainable Development Goals (17 SDGs) since they cover a wide range of issues including poverty, hunger, health, education, clean water, energy, and gender equality, as well as several others (UN, 2022).

6.5.2 Conflicting Drivers and Barriers for GLH Environmental Sustainability

There were some factors that were mentioned for both drivers and barriers, such as 'financial factors', 'competitive advantage', and 'regulations/legislation' categories. However, they are considered drivers or barriers for different reasons. This is similar to the findings of Lozano et al. (2019) who highlighted a similarity between the drivers and barriers identified by ports' stakeholders and explained that there are similarities and tensions between the drivers and barriers because of the hybrid nature of ports' organization and the involvement of many stakeholders (internal and external) in the structure, which "*offers new insights into organizational change management towards sustainability*" (Lozano et al., 2019:415). This suggests that the categories and subcategories that are considered both drivers and barriers are closely interconnected and need to be managed accordingly for sustainable development.

For the ‘financial factors’ category, it was the only driver category that was not common across all cases. The decentralized, highly privatized GLH case did not mention any financial drivers. This can be attributed to the highly privatized industry and smaller companies in this case, which may not offset the costs of being environmentally sustainable and measuring environmental performance against their small operations. In the cases that mentioned financial drivers, ‘long-term financial gains’ was the most common driver across the 3 GLH cases and among most stakeholders. The public and governmental presence in these cases can support the claim that public-owned or partly owned companies and multinational companies have the capacity to take on environmental sustainability for its long-term benefits with little immediate financial benefits because they can offset the cost against other operations due to the size of the operations and the governmental support. Evangelista et al. (2010) supports the claim that some of the financial barriers are relevant to the long payback period for Small and Medium Enterprises (SMEs) in transport and 3PL industry, while Serra and Fancello (2020) identifies the "*unlikely payback of sustainable investments*" as a barrier for the shipping industry. Additionally, Tay et al. (2015) highlight that in addition to cost and financial capability, one of the barriers for sustainable practices is sectoral barriers, meaning that some industries are less regulated than others, which explains why ‘avoiding fines’ and ‘initiatives & incentives’ were highlighted by some stakeholders but not others, such as port authorities, terminal operators, and governments. This could be an indication that fines and incentives are not significant for other stakeholders of smaller size companies or that operate in different parts of the sector such as logistics or manufacturing. This finding aligns with previous research that has shown that the level of regulation and incentives in a particular industry can impact the adoption of sustainable practices (Tay et al., 2015; Lozano et al., 2019; Serra & Fancello, 2020; Williamsson et al., 2022).

The other conflicting factor is ‘competitive advantage’, where it was highlighted as both a driver and a barrier. The detailed subcategories of drivers under ‘competitive advantage’ were ‘gaining competitive advantage’ because there is demand on sustainability by some customers and the increasing awareness about sustainability. Therefore, to keep competitive, stakeholders were keeping up with these customers' demands by providing these alternative sustainable solutions. On the other hand, in the Liverpool GLH Case, the government participant highlighted that there is a lack of demand on new sustainable solutions and that the cost of setting up infrastructure with little demand is very difficult. This could be linked to another barrier that was highlighted by participants, which is ‘technology infancy & high cost may drop’. There is a situation of "*chicken or the egg*" as Serra & Fancello (2020) explain when it comes to lack of demand on sustainable technology and the challenge of the industry supplying the technology because there is no demand, and the high cost of new technology being offered. So not necessarily conflicting as it is mainly highlighting the demand on new sustainable solutions that is stable and affordable to businesses. Additionally, losing competitive advantage was highlighted as a barrier in all cases and by most stakeholders, but for different reasons than the gaining competitive advantage as a driver. This is mainly because enforcing certain level of sustainable measures may not be compatible with customers or may result in a price increase. Therefore, competitive advantage, much like incentives, is an influential factor that can be considered as a driver or a barrier depending on the reason or purpose behind it. This is consistent with previous research that has highlighted the trade-offs between competitiveness and sustainability (Hervani et al., 2005; Evangelista et al., 2010; Shaw et al., 2010; Tay et al., 2015; Lozano et al., 2019; Serra & Fancello, 2020; Shaw et al., 2021; Williamsson et al., 2022), and that organizations need to find a balance between these competing objectives to achieve sustainable development.

Another conflicting driver and barrier were ‘environmental sustainability is business sustainability’ and ‘sustainability is not prioritized as it is not incorporated yet in metrics of a successful business’. This was highlighted in the literature by Tay et al. (2015) as "*other supply chain management priorities*" and in Lozano’s et al. (2019) study as "*economic focus that disregards environmental and social aspects*", and by Williamsson et al. (2022) as "*priorities & organizational agenda*". However, it could also be seen that ‘sustainability is not prioritized as it is not incorporated yet in metrics of a successful business’ barrier as a link to another barrier ‘there is an extent to environmental impact of operations that cannot be avoided’. Even though it is believed by stakeholders among most cases that environmental sustainability is business sustainability, it is also believed that there is an extent of environmental impact of operations that cannot be avoided. This is justified given the current level of sustainable solutions and technologies. Therefore, even though businesses and organizations are now striving for environmental sustainability and awareness is increasing, at this point in time environmental solutions and technologies are not sufficient or sophisticated enough yet. This aligns with the literature (Tay et al., 2015; Williamsson et al., 2022), where the availability and maturity of sustainable solutions and technologies can act as a barrier to the adoption of sustainable practices.

The last conflicting drivers are barriers are relevant to legislation and regulations, where legislation was identified as a driver factor in all cases and by most stakeholders. The relevant barriers were 'legislation is not stringent', 'inconsistency of regulations', 'different regulations in different regions (additional work)', 'lack of enforcing environmental sustainability regulations and legislation. This conflict highlights that even though legislation is considered a driver for environmental sustainability and environmental performance measurement, they still need improvement since current legislation is seen as not stringent enough to bring about change. Additionally, inconsistencies and variations in regulations and legislation across different regions and different levels of governance create distortions in their implementation. This challenge is also noted by Boyes and Elliott (2014), who refer to the 'horrendogram' of complex marine legislation, policies, directives, and regulations available, which make consistency and coherence challenging across different actors. Furthermore, the conflict in legislation being a driver and barrier can also be seen in the literature, where studies have identified regulations, policies, and legislation as an influencing factor for environmental sustainability or as both drivers and barriers in the same research (Tay et al., 2015; Lozano et al., 2019; Serra & Fancello, 2020; Williamsson et al., 2022). This emphasizes the need for consistency and enforcement of regulations and legislation to promote sustainable practices and improve environmental performance.

6.5.3 GLH Environmental Sustainability Barriers

According to the research findings, the barriers identified were far more diverse and larger in number of categories and subcategories in comparison to drivers. All barrier categories were mentioned and highlighted in all cases, with varied subcategories. All cases had barriers relevant to feasibility, capability, process, financial, regulations/legislation, stakeholders, voluntary, and competitive advantage. These are aligned with the extant literature that address the barriers of environmental sustainability individually for GLH stakeholders (Veleva et al., 2003; Hervani et al., 2005; Walker et al., 2008; Evangelista et al., 2010; Abbasi & Nilsson, 2012; Giunipero et al., 2012; Al Zaabi et al., 2013; Rauer & Kaufmann, 2015; Tay et al., 2015; Lozano et al., 2019; Serra & Fancello, 2020; Bjerkan et al., 2021; Williamsson et al., 2022).

For example, 'cost', which is the immediate cost of environmental performance measurement and environmental sustainability was common among all cases and all stakeholders. This finding is in line with previous studies (Evangelista et al., 2010; Tay et al., 2015; Lozano et al., 2019; Serra

& Fancello, 2020; Williamsson et al., 2022). Moreover, the 'lack of knowledge and awareness' was a prominent barrier among participants and emerged as one of the top barriers. This finding emphasizes the need for training to address this awareness issue. GLHs' should focus on implementing and integrating SDGs, with a particular emphasis on upskilling and talent management for green skills. Additionally, under the 'regulations/legislation' category 'greenwashing' was mentioned (Tay et al., 2015), and 'levelling the field with legislation makes smaller companies suffer compared to large companies' because large companies can offset the accompanying costs against other things, but it is difficult for smaller companies. This is also highlighted in the literature by Serra and Fancello (2020) as distortions resulting from unlevelled adoption of environmental standard and regulations globally, and "*unnecessary fragmentation and complexity of the international scene*" (page 20). These studies suggest that while regulations and legislation are a driver for environmental sustainability, they also create challenges when they are not adopted globally.

Furthermore, 'stakeholders' as a barrier category with an emphasis on 'limited collaboration between stakeholders regarding environmental sustainability' as the common reason among all cases and most stakeholders. This highlights a certain degree of fragmentation among GLH stakeholders regarding environmental sustainability. Another interesting barrier identified under this category that is linked to this fragmentation is 'the chain of responsibility is broken'. This barrier is highlighted in most cases, where participants explained that there is a fragmentation between stakeholders of the GLH that creates a barrier for implementing environmental sustainability and measuring environmental performance, and there is a lack of coordination and responsibility for following through. This barrier highlights the benefit and importance of the holistic environmental performance measurement framework proposed in this research (Figure 6.4). Additionally, these barriers align with the literature, where studies have highlighted the importance of collaboration and coordination among stakeholders in achieving sustainable development (Hervani et al., 2005; Shaw et al., 2010; Lozano et al., 2019; Williamsson et al., 2022). Furthermore, Evangelista et al. (2010) discuss the importance of a shared vision and common goals among stakeholders to improve sustainability.

The last category of barriers to environmental sustainability in GLH is the 'voluntary' category, which encompasses difficulties associated with voluntary environmental performance measurement and sustainability initiatives. This includes factors such as prioritizing other concerns over environmental sustainability, as well as 'difficulties in improving past existing legislation'. This is highlighted in the literature as proactive versus reactive stakeholders regarding environmental sustainability voluntariness (Hervani et al., 2005). Another barrier within the 'voluntary' category is the perception that the impact of the logistics industry on the environment is relatively small compared to other sectors. As a result, some companies may not see a pressing need to address their environmental performance and sustainability, particularly when compared to highly polluting industries in proximity such as chemical clusters in GLHs. Additionally, some companies may also outsource their transportation, shifting responsibility for environmental performance and sustainability to the transportation or freight forwarding companies.

In conclusion, this research identified a variety of drivers and barriers that influence environmental sustainability and environmental performance measurement in GLHs. Additionally, it also identified some factors that were mentioned as both drivers and barriers such as financial and competitive advantage factors, highlighting the complexity and multi-faceted nature of environmental sustainability and environmental performance measurement in GLHs.

Previous literature has explored and identified the drivers and barriers of environmental sustainability for GLH stakeholders, yet not in a holistic manner specifically not in the context of GLHs. Furthermore, the number of barriers identified in this research were far more than the drivers, indicating that the challenges faced by stakeholders in GLHs are more significant than the recognized benefits. In contrast, when these factors are studied separately in the context of supply chains (Shaw et al., 2021) or freight transportation (Ellram & Monique, 2017) for instance, the number of drivers typically outweighs or equals the number of barriers. This discrepancy can be attributed to the unique characteristics of GLHs, such as their complex structure, which involves multiple entities and sectors, as well as their strategic and unique location, which limits the availability of alternatives. This aspect has not been previously addressed in the literature and therefore is considered a contribution to this gap in knowledge.

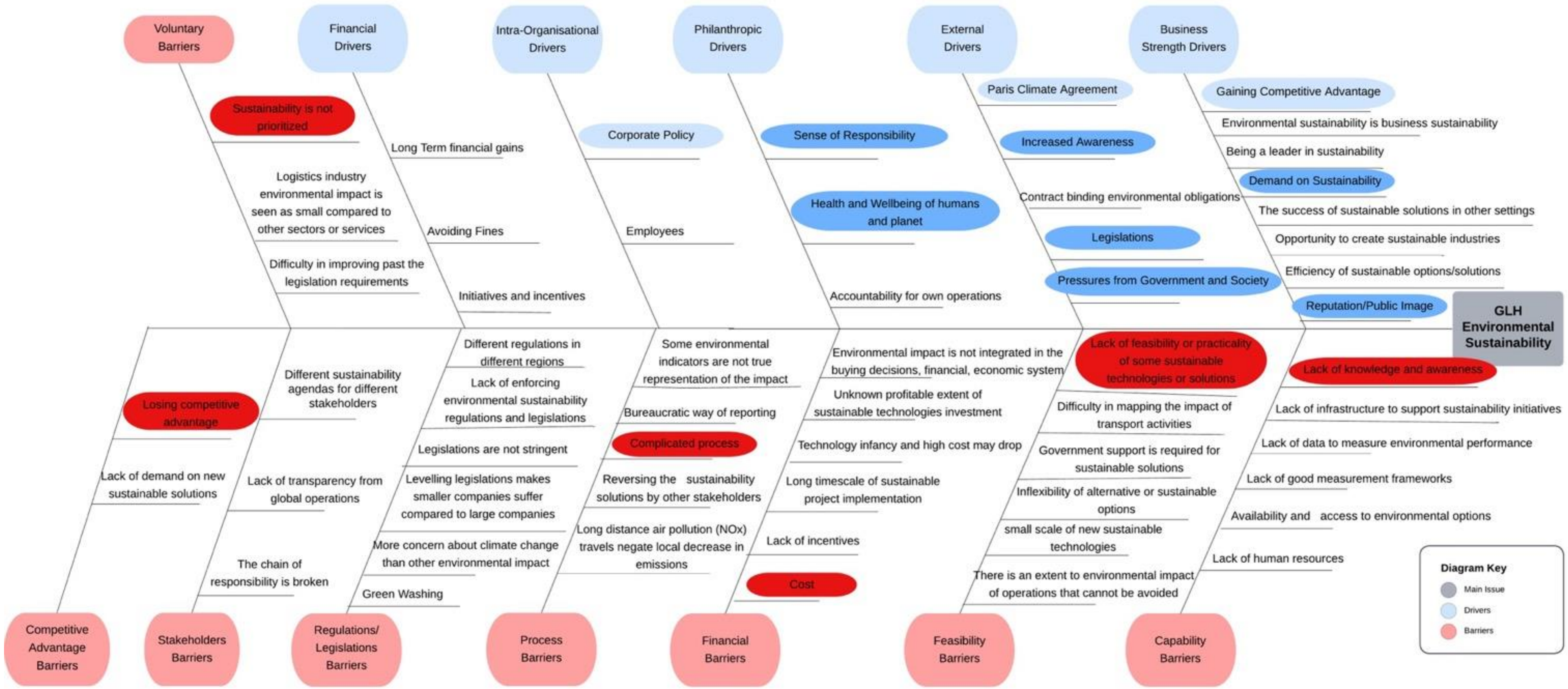


Figure 6.5 Fishbone Diagram of Drivers and Barriers for GLH Environmental Sustainability

6.6 General Discussion Summary

In this chapter, the key empirical findings from the research were explored in a holistic and integrated approach against the relevant literature. The findings from the within-case and cross-case analyses for each of the four research questions were compared and contrasted with the existing literature. As a result, this chapter provided an up-to-date definition of GLHs, a multi-stage development framework for GLH, and a holistic environmental performance measurement framework was proposed. Through the discussion of findings and the comparison to the literature, the key gaps, differences, and similarities in the existing body of knowledge were identified and discussed.

The next chapter will conclude the research, summarize the key contributions, highlight the implications for practitioners and academics, and discuss the limitations and directions for future research.

Chapter 7 Conclusions and Implications

7.1 Thesis Summary

This research study encompassed four overarching objectives and was guided by four specific research questions, as outlined in Chapter One. The purpose of this thesis was to provide an up-to-date definition of GLHs, as well as identify the primary stakeholders, their operations, the extent of their integration, and shine a light on governance structure models in GLHs for future academic and industrial applications. Additionally, it aimed to identify the environmental impact and indicators used by GLHs primary stakeholders to develop a holistic conceptual environmental measurement framework adapted for the agglomerated and connected functions of GLHs. Furthermore, it aimed to explore the drivers and barriers of environmental sustainability of GLHs stakeholders. This chapter concludes the research by providing a summary of the key contributions, highlight the implications for practitioners and academics, and discuss the limitations and directions for future research.

This research has reviewed the extant literature on GLHs and their environmental performance and sustainability. The first stage of the literature review focused on the concept of GLHs. This stage of the literature review highlighted that there is a lack of studies on GLHs, only 36 articles in the last 26 years (1997-2022) have been published on GLHs. Definitions of the term 'Global Logistics Hub' (GLH) started appearing in the literature from 2006 despite the first use of the term in the academic literature and other publications, such as industry reports and newspapers, from 1997. This is also supported by the empirical data in the SCZone having laid the plans for developing into a GLH in 1998, which are being implemented currently. However, these definitions had varying degrees of specificity in the literature and to an extent conflicting views on what a GLH is. This lack of consistency in defining the term contributed to confusion and ambiguity surrounding the concept of GLHs in the literature.

The majority of scholarly articles reviewed on GLHs focused on hub port competition. This theme included articles on the development, location selection, resilience, and berth allocation in maritime ports, which is not considering the GLH in its full picture. The second most researched theme was the potential, benefits, or feasibility of developing ports, cities, countries, or regions into GLHs. Even though these studies were encouraging the development of GLHs, they did not provide a unified and clear definition of the concept, a holistic framework of operations, identify the stakeholders involved in a GLH, or discuss the governance structure of GLHs. Additionally, these studies did not consider a variety of locations, different economic development hosting countries, governance, sustainability, or stakeholders' perspectives. They based their studies on an individual case.

As such this research provides a clear, holistic, and up-to-date definition of GLHs, based on four GLHs with varying characteristics. Additionally, this research identifies the primary stakeholders and their operations, the extent of integration and connection among them, and explores the governance structures across cases. This is reflective of a fully developed, developing, and under development GLHs, but also with a perspective of private, PPP, and public ownership of the ports within GLHs built into this. Additionally, three of the case studies are hosted in developed countries and one case is hosted in a developing country. The cases also serve different markets, three cases serve the European market, and one case serves the Middle East and North Africa (MENA) region. This caters for the heterogeneity of GLHs and facilitates the transferability of the theoretical contributions to other settings.

As such this study has provided a multi-stage framework of the development stages of GLHs to highlight the different stages that GLHs go through and highlighted the development factors for each stage. This is the first attempt, to the author's knowledge, that a multi-stage development framework for GLHs has been developed.

Prior to this research, it was not clear how GLHs are governed or how stakeholders interact within GLHs. This study has 'shone a light' on this in-depth by identifying a typology of these stakeholders, their role, activities, and operations considering the public, PPP, and private ownership of ports within these GLHs. It has also discussed the extent of integration among stakeholders regarding environmental sustainability. The research findings indicate that there is a difference in the extent of connection among stakeholders in relation to the level of development of the GLH. Specifically, that as the level of development of the GLHs increased, the extent of connection among stakeholders improved. This highlighted that the level of development of the GLH may act as a facilitator of stakeholder connection and engagement on environmental sustainability issues.

Additionally, this research identified the multi-level governance that is found in GLHs, involving multiple actors operating at different levels such as port, local, national, and international authorities. These actors have different levels of power and autonomy, which is seen in this research findings. The effective governance in such systems requires coordination and cooperation among actors operating at the different levels. This research has provided a stakeholder grid map highlighting the power versus influence of stakeholders, with slight differences shown in the highly privatized industry case (Liverpool GLH) indicating less interest of the government compared to the more public cases. These insights can assist in clearly defining accountability and responsibilities among stakeholders, promoting effective communication and collaboration to improve visibility regarding environmental performance and sustainability, and ultimately enhancing the overall environmental sustainability of the GLH.

Furthermore, according to professional sources and academic sources, there is a rise in the development of GLHs because of their benefits to the economy, and several regions and countries are taking advantage of their strategic locations and putting plans to develop into a GLH into action. This has been largely driven by globalization and the need to buy cheap and sell high, to remain competitive in global supply chains. However, the complexity associated with GLHs in terms of the number and variety of operations, the various types of stakeholders within a GLH, and the ambiguity around the concept contributed to a key barrier to implementing successful holistic environmental performance measurement. This is because there is first a need to understand what the entity of measurement is, the operations or activities which need measuring, and who should measure and be responsible for the holistic environmental sustainability of the GLH given the involvement of various stakeholders in GLHs operations.

The second stage of the literature review revealed that there is a lack of studies on the environmental impact, performance measurement, and sustainability of GLHs. This is important to tackle because the business landscape is changing. We are facing a climate change emergency (IPCC, 2022), and there is an urgent need to decarbonize global logistics and supply chains. With transportation being a key contributor to greenhouse gas emissions and being one of the main operations in a GLH, it is crucial to address the environmental impact of GLHs for the benefit of present and future generations. While the focus in the literature is on individual businesses to decarbonise their operations, there is an urgent need also to decarbonise the operations of GLH holistically because of their significant impact in concentrated geographical areas. GLHs are the juncture at which most supply chains transit through, resulting in a magnifying environmental impact on an epic scale, highlighting the contribution of different stakeholders to this environmental impact. Therefore, this research identified the environmental impacts of GLHs, and developed a holistic conceptual environmental performance measurement framework to help measure the holistic impact of GLHs and improve their environmental sustainability.

Furthermore, the drivers and barriers of environmental sustainability for GLHs' stakeholders have been explored in the literature, but not in the context of GLHs. The common driver factors for GLHs stakeholders were found to be business strength, such as gaining competitive advantage; external, such as legislation; philanthropic, such as a sense of responsibility; and intra-organisational, such as the corporate policy. On the other hand, the common barriers for GLHs' stakeholders were lack of knowledge and awareness, losing competitive advantage, lack of feasibility of some sustainable solutions, cost, complicated process, and not yet prioritizing sustainability. Barriers were found to be much more than the drivers indicating that the motivation and pressure surrounding environmental sustainability in GLHs are not yet superseding the barriers, which is an issue when considered in light of the climate emergency and the need for immediate action.

7.2 Contribution to Theory

7.2.1 RQ1: What is a GLH? Who are its primary stakeholders?

This study provides an up-to-date, clear, and holistic definition which encompasses the views on GLHs in fully developed, developing, and under development stages of GLHs in developed and developing economies, also with a perspective of private, PPP, and public ownership of the ports within GLHs built into this.

> *A GLH is a strategic location that serves as a hub and spoke network for the exchange of global cargo. It is characterized by the integration of logistics, multimodal transport intersection, and manufacturing operations, and typically includes a deep-water seaport (public, private, or PPP ports) or cluster of seaports situated on major trade routes, served by large ocean carriers to access global cargo (major airports or Belt and Road Initiative (BRI) locations can also serve this purpose). Additionally, industrial clusters, manufacturing, transportation links, warehousing, value-added activities, logistics, and maritime services are present in a GLH. These elements are necessary to handle all types of national and international cargo for transhipment, import, or export and to have the necessary infrastructure and capacity to handle large volumes of cargo, as well as sufficient space for further development.*
>
> *Some of the primary functions of a GLH are to allow for the smooth distribution of cargo from global origins to global destinations to serve specific regions or continents, and to act as a distribution centre for manufacturers or specific industries. This is achieved through well-connected networks and excellent accessibility to global transportation routes and the markets it serves through various multimodal connections, such as deep-sea, short sea, inland waterways, road, rail, air, and pipelines. In some cases, a free trade zone may be necessary for the operation of a GLH. To ensure the smooth, safe, and flexible operations of a GLH, it is essential to have the necessary infrastructure to handle global cargo volumes, to promote collaboration and integration among stakeholders, and the location must be secure and politically stable.*

This definition clarifies the ambiguity and variation found in the literature surrounding the concept by providing a comprehensive definition. The distinguishing factors that emerged in this study emphasize that GLHs extend beyond being solely port-centric logistics, showcasing their capacity for boundary spanning. This means that GLHs encompass a broader scope and are not limited to the confines of traditional port-centric logistics. They have the ability to span boundaries and incorporate various elements beyond ports, thereby encompassing a more extensive range of functions and connections. This has extended what has been documented in the scholarly literature, addressing a gap in the body of knowledge, and will be exceptionally useful to future research.

Additionally, this study has contributed methodologically by adopting an in-depth multiple case study approach to explore inductively GLHs in the context of environmental performance and sustainability, to really understand contextually the views of key GLH actors. This has not been done previously in the literature. A key theoretical contribution has been to generate a multi-stage framework of the development stages of GLHs to highlight the different stages that GLHs go through and highlighted the development factors for each stage. This is the first attempt, to the author's knowledge, that a multi-stage development framework for GLHs has been developed. The case study design, in-depth exploration, and the heterogenous case selection (including cases of GLHs in different developmental stages) in this research have been critical in facilitating inductively the development of a multi-stage development framework. This could help emerging GLHs and developing economies on their journey to develop a fully functional and competitive GLH. It will also help future research in conducting further research on the different stages of a GLH.

This study has also identified a typology of GLH stakeholders, their role, activities, and operations considering the public, PPP, and private ownership of ports within these GLHs. It has provided a comprehensive list of the key and typical stakeholders involved in a GLH operations, which has not been identified before in the literature. This is of critical importance as it has not been fully documented before in the context of the GLH operations, and is a key enabler to environmental performance measurement and reporting i.e., understanding who is accountable and responsible for measuring in GLHs.

7.2.2 RQ2: How are the primary stakeholders connected in a GLH? Who is responsible for the environmental sustainability of GLH?

This study provided a typology of GLHs stakeholders and revealed the varying levels of integration among stakeholders regarding environmental sustainability in different GLHs stages. The more developed the GLH, the better the level of integration of stakeholders regarding environmental performance and sustainability. These varying levels of integration can have a significant impact on the holistic environmental performance in GLHs. When stakeholders are not connected and do not have a shared understanding and commitment to environmental sustainability, it can lead to conflicting goals, inadequate environmental performance measurement, and inconsistent sustainability policies and practices. As a result, this will have a negative impact on the overall environmental sustainability of GLHs. This provides new insights into the varying levels of integration among GLH stakeholders in different development stages and how this could have a significant impact on the environmental performance and sustainability of GLHs. Thus, this adds new knowledge to the field. This will open opportunities for further research in this area on understanding the relationship of stakeholder connectivity and impacts on measuring environmental performance and sustainability.

Furthermore, regarding the responsibility of environmental sustainability in GLHs. One of the strong suggestions in all cases was for the government (central or local depending on their involvement) to be responsible due to their oversight, connections, power, and authority, which links to coercive forces influence in institutional theory. The port authority, specifically in cases with lower degree of privatization (public ownership or public-private partnership ownership of ports within GLHs), was also suggested to be the responsible stakeholder due to being part of the government and having connections to the rest of stakeholders. There were also other suggestions including supranational legislators and voluntary participation, which highlights different levels of authority and pressure. This research suggests that the governance in a GLH can take on centralized, decentralized, or hybrid governance models. It depends on the government varying degree of involvement in a GLH. The research suggests that several factors such as the degree of privatization within the industry, the governance structure implemented in the host country, and the ownership of the primary port can affect the degree of government integration in the GLH. This finding contributes to theory since it has not been addressed in the academic literature before. It will help future research in conducting further research on governance in GLHs and its influence on environmental sustainability.

Additionally, the research shed light on a multi-level governance structure in GLHs highlighting different levels of power and autonomy among stakeholders within GLHs and the different authorities that come into play in a complex system such as GLHs. This has not been addressed in the literature before. Therefore, it contributes to the theoretical understanding of the governance structures in GLHs under an institutional theory lens.

7.2.3 RQ3: How do GLH operations impact the environment? How is the impact measured?

This research identified the environmental impacts of GLHs, and the environmental indicators used by GLHs primary stakeholders. GLHs' environmental impact identified in this study showed a general consistency across cases. The most common environmental impacts of GLHs are greenhouse gas emissions, water pollution, and waste generation, with a particular emphasis on greenhouse gas emissions. Other environmental impacts resulting from GLH operations include impact on biodiversity and ecosystem, energy and water consumption, noise, and odour. These environmental impacts largely mirror the exiting literature addressing the constituents of a GLH individually. Despite the abundance of literature on the environmental impact and environmental performance measurement of separate stakeholders and constituents of GLHs, there has been a lack of research that presents a holistic view of GLHs' environmental impact and environmental performance measurement. This study bridges this gap by providing a comprehensive understanding of the environmental impacts of each stakeholders' contribution to the environmental impact of GLHs in order to guide the measurement process and include the impact all primary stakeholders in the measurement.

Additionally, regarding the measurement of these impacts, this research identified some similarities in the environmental indicators and measures used to assess the environmental impact across cases, such as those related to air emissions, waste, and energy consumption. However, a greater variance in measures and indicators used in the measurement of other environmental impacts, such as noise, biodiversity, and sustainable capabilities was revealed. The study identified 13 indicators and 17 measures for air emissions alone across stakeholders in the four GLH cases. This emphasis on greenhouse gas is attributed to the projected consequences of inaction regarding climate change. However, it also highlighted the fragmentation of indicators used by stakeholders in GLHs. This presents a significant challenge in comparing environmental performance and benchmarking against other stakeholders and other GLHs. Additionally, the use of different indicators and measures also makes it challenging to establish a comprehensive and holistic understanding of environmental performance in GLHs. there is a lack of research that studies the stakeholders of GLHs in a holistic manner, which contributes to the lack of a unified perspective on indicators, measures, and environmental frameworks in GLHs. This highlights the need for a more standardized approach to evaluating environmental performance in GLHs that considers multiple aspects of environmental performance and is based on a set of commonly agreed upon indicators and measures. Through this study, the environmental indicators are combined and provided under a holistic framework to address this gap and fragmentation in the literature. This study identified 15 environmental measurement categories and 51 environmental indicators (encompassing the 13 air emissions indicators) for the holistic environmental performance measurement of GLHs. These are combined and unified considering the contributing and interrelated environmental impacts of the primary stakeholders. Additionally, this framework categorizes the indicators according to different levels that would aggregate the indicators he further they move up governance levels for an overall environmental condition level of indicators and environmental policies, strategies, and legislative indicators. Thus, this framework unifies the fragmentation of indicators found in the literature and addresses this gap in knowledge. This framework can be used as a tool for policymakers and governments, GLHs developers, and intergovernmental organizations to evaluate and improve the environmental performance of GLHs.

Furthermore, there is a lack of studies in the literature that provides a holistic framework for the measurement of GLHs’ holistic environmental impact that consider all the primary stakeholders under one umbrella. This study provides a holistic conceptual environmental measurement framework adapted for the agglomerated and connected functions of GLHs. This framework builds upon the work of Peris-Mora et al. (2005), who developed a conceptual measurement framework for maritime ports that considered several stakeholders from the port's perspective and their environmental impact under one holistic reporting framework. However, the framework proposed by Peris-Mora et al. (2005) did not specifically address GLHs and did not include all primary stakeholders associated with GLHs. The framework presented in this study address these limitations by providing a holistic perspective that considers all primary stakeholders associated with GLHs and their environmental impact. Therefore, this framework is an important contribution to the existing literature, as it addresses the fragmentation of environmental performance in GLHs and the gap in understanding and knowledge regarding the holistic environmental performance of GLHs. This will help countries achieve their net zero and climate change ambitions by providing a measurement tool for carbon intensive operations, such as GLHs.

7.2.4 RQ4: What are the drivers of and barriers to environmental sustainability in a GLH?

This research developed a fishbone diagram highlighting the drivers and barriers of GLHs' stakeholders regarding environmental performance and sustainability. The number of barriers identified were far more than the drivers, indicating that the challenges faced by stakeholders in GLHs are more significant than the recognized benefits. Previous literature has explored and identified the drivers and barriers of environmental sustainability for GLH stakeholders, yet not in a holistic manner specifically not in the context of GLHs. Furthermore, when these factors are studied separately in the context of supply chains (Shaw et al., 2021) or freight transportation

(Ellram & Monique, 2017) for instance, the number of drivers typically outweighs or equals the number of barriers. This discrepancy can be attributed to the unique characteristics of GLHs, such as their complex structure, which involves multiple entities and sectors, as well as their strategic and unique location, which limits the availability of alternatives. This aspect has not been previously addressed in the literature and therefore is considered a contribution to this gap in knowledge.

This study identified 5 categories and 21 subcategories of drivers, and 8 categories and 37 subcategories of barriers for measuring environmental performance and improving environmental sustainability in GLHs. The common driver factors for GLHs stakeholders were found to be business strength, such as gaining competitive advantage; external, such as legislation; philanthropic, such as a sense of responsibility; and intra-organisational, such as the corporate policy. On the other hand, the common barriers for GLHs' stakeholders were lack of knowledge and awareness, losing competitive advantage, lack of feasibility of some sustainable solutions, cost, complicated process, and not yet prioritizing sustainability. The drivers and barriers identified in this research aligned with the extant literature in separate studies.

Furthermore, this study identified that certain factors can be considered as both drivers and barriers to environmental sustainability, yet for distinct reasons. For instance, in the financial category, it was identified that 'long term financial gains' as a driver while 'high cost of sustainable solutions' as a barrier. This finding is aligned with the extant literature and strengthens it. As this can be attributed to the complex nature of an entity and the presence of numerous stakeholders (both internal and external) within the structure. This can result in both similarities and tensions between the drivers and barriers. Identifying the drivers and barriers is important because it enables the host country, their government, the port authority, and other GLH primary stakeholders to understand how they 'implement' environmental performance within a GLH setting. What also are the obstacles they need to navigate through to achieving success in key climate change goals and improving overall GLH environmental sustainability. In addition, what things need to be in place, and more of, to drive success.

7.3 Practical Implications

This thesis provides several implications for practitioners and policy makers involved with GLHs. Firstly, given the importance of GLHs in global trade and commerce, as well as the growth of emerging GLHs around the world, this thesis has provided a comprehensive understanding of the concept and its operations to guide emerging GLHs in their development stage. This will enable practitioners to manage the development of emerging GLHs more effectively, and will aid governments, policymakers, and regulators in their efforts to govern and regulate them.

Additionally, this study has provided a multi-stage framework of the development stages of GLHs to highlight the different stages that GLHs go through and highlighted the development factors for each stage. This will help emerging GLHs and developing economies on their journey to develop a fully functional and competitive GLH.

Furthermore, this study has identified the role, activities, and operations of the primary stakeholders of a GLH. This is of critical importance to guide emerging GLHs regarding the operations necessary for a fully functional and competitive GLH based on a 'best in class' perspective. Additionally, identifying the specific operations of a GLH is a key enabler to measuring the environmental performance of these operations to improve the sustainable development of these GLHs and alleviate their environmental impact holistically.

This research revealed the varying levels of integration among stakeholders regarding environmental sustainability in different GLHs settings. Additionally, this research identified a multi-level governance structure in GLHs highlighting different levels of power and autonomy among stakeholders within GLHs. These insights can assist in clearly defining accountability and responsibilities among stakeholders, promoting effective communication and collaboration to improve visibility regarding environmental performance and sustainability, specifically regarding the traceability of greenhouse gas emissions to aid governments in their path towards achieving net zero emissions due to the climate emergency and the need for immediate action. Ultimately this will result in enhancing the overall environmental sustainability of the GLH.

Moreover, the proposed framework aims to address the holistic impact of the GLH and will provide guidance to GLHs on measuring the holistic environmental performance in emerging and fully developed GLHs, including small companies, shipping companies, manufacturers, retailers, logistics companies, and freight forwarding companies. Additionally, indicators from industrial cluster companies can be incorporated into this framework in the future, as this type of stakeholder was not included in the research. Additionally, this framework can also facilitate the mandatory reporting of greenhouse gas emissions required by governments under the Paris Climate Change Agreement to intergovernmental organizations such as the United Nations. It will assist in building a system that facilitates measuring the environmental performance of the GLH as a whole. It is an important tool that aims to provide a comprehensive understanding of the environmental performance of the GLHs. Therefore, it will aid in the development of strategies to mitigate the environmental impact of the stakeholders and the GLHs as a whole.

Additionally, this framework could be developed into a dashboard format for use by governments and GLHs.

Furthermore, another finding of this study is a disparity in the influence of institutional pressures on the environmental performance and sustainability of GLHs in developed and developing economies. It revealed that in GLHs in developed economies, pressures from government, society, and competitors all play a role in shaping environmental performance, while in GLHs in developing economies, pressures from government are the dominant influence. This finding is important for practitioners and policy makers, as it highlights the need to consider the institutional context when formulating policies, regulations, and strategies aimed at enhancing the environmental performance of GLHs.

Finally, this study highlighted the drivers and barriers of GLHs' stakeholders regarding environmental performance and sustainability. Cost and lack of knowledge awareness emerge as prominent barriers, indicating the pressing need for comprehensive training programs across all involved parties. This finding is important for practitioners and policymakers, as it emphasizes the need for urgent action in training and upskilling stakeholders and improving their understanding of climate change and sustainability. Moreover, it emphasizes the necessity of addressing the financial considerations associated with the adoption of environmentally sustainable practices.

7.4 Limitations and Suggestions for Future Research

The present thesis has several limitations that could be addressed in future research. The most prominent limitations and suggestions for future research directions are as follows:

- This research has been focused on a limited sample of four case studies of GLHs due to the research design, three of which are located in Europe and in developed economies, while one is located in North Africa and in a developing economy. As a result, the findings of this study are transferrable but not generalizable to all GLHs. Therefore, future research could benefit from expanding the sample size to include a more diverse range of GLHs in other locations, such as GLHs in China or the US, where there are developed GLHs operating under various regulations, economies, and governance structures. This could provide insight into additional interesting characteristics of GLH development and the dynamic and extent of connection between the primary stakeholders.
- This research has adopted an exploratory and inductive approach to comprehensively understand and explore GLHs and their environmental sustainability, given the limited

availability of existing research on the topic. The primary objective of this research was to develop a thorough understanding rather than testing concrete quantitative hypotheses. However, it is important to recognize the potential advantages that further quantitative analysis could offer. Therefore, future research should consider incorporating quantitative methods and analyses to further investigate and validate the significance of the findings. By adopting quantitative approaches, future research can assess the statistical significance of the observed relationships and patterns, identify potential correlations, and test the magnitude of the responses.

- This research has developed a conceptual a holistic environmental performance measurement framework for GLHs. However, it did not apply the framework to actual environmental performance measurement. Consequently, future research could benefit from conducting studies that investigate the application of this framework, test its applicability, and apply it to the GLHs to measure their environmental performance holistically. Furthermore, it would be of interest for future research to determine the proportion of global greenhouse emissions that originate from GLH operations as a means to prioritize focus and decarbonization efforts.
- This research has also been affected by the COVID-19 pandemic, which has restricted the majority of the data collection process to video and phone call interviews and cancelled the field trip to Antwerp GLH. This has resulted in a lack of data from observations in the Antwerp GLH case. Therefore, future research could benefit from conducting more in-depth field studies and face-to-face interviews, to investigate any additions to this case. However, this did not have a significant impact on this research due to conducting field trips for the three other cases.
- This research has identified industrial cluster companies as primary stakeholders of GLHs. Through the snowball sampling technique, industrial cluster company participants were identified by other participants and contacted by the researcher. However, the interviews were never conducted due to the companies backing out of the research. This has resulted in the environmental impact and indicators of the industrial cluster stakeholder type to not be included in the holistic conceptual framework. Future studies should consider alternative methods for recruiting industrial cluster companies, such as reaching out to industry associations or using a more targeted sampling technique. This is to include the perspectives and environmental performance indicators of industrial cluster companies to the holistic framework.
- This research was focused on GLHs that have maritime port access to global cargo, however, it is worth considering GLHs that are reliant on airports and those that are connected to the Belt and Road Initiative (BRI) for global cargo access for future research. This could provide

insight into any differences in the concept of GLHs based on their location and access to global trade routes.

Despite the limitations outlined above, this thesis makes several unique and significant contributions to the body of knowledge on GLHs.

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Appendix 1 Interview Guide

<u>Introduction</u>

- Interviewer introduction.
- Reiterating confidentiality and anonymity according to the signed consent form.
- Asking permission to start voice-recording the interview.
- Ask interviewee to introduce themselves.
- Briefly reiterate the purpose of the research.
- Advise interviewee that the objective of the interviewee is to solicit their experience and opinions.

<u>Interview Questions</u>

Exploring the Concept of Global Logistics Hubs

1. Do you know what is meant by the term Global Logistics Hub? (If so, can you define it?

2. In your opinion, who are the primary stakeholders in a Global Logistics Hub?

3. What role or operations, if any, do you/your organization contribute to the Global Logistics Hub? (can you give examples?)

Global Logistics Hubs Stakeholders' Environmental Impact and Measurement

Questions 5 & 6 are for organisations:

4. What are the negative environmental impacts resulting from your organisation's operations?
5. How does your organisation measure and report its environmental impact? (Example: Environmental KPIs, are there any reports that can be provided to the researcher)

Question 7 is for local community:

6. From your experience, how does Global Logistics Hub's operations impact you positively or negatively from an environmental perspective, either from a personal or community point of view? (Any examples? Can you elaborate?)

Stakeholder Connection and Environmental Responsibility

7. In your opinion, how important is environmental sustainability? (Can this be seen in the organisation? Examples of initiatives or incentives?)

8. Who is responsible for the environmental sustainability in your organisation/community?

9. In your opinion, what is the extent of connection between your organisation/community and the rest of the stakeholders in the Global Logistics Hub? (Is that same level of connection seen across all stakeholders?)

10. If there is connection on any level, can the environmental impact of the whole Global Logistics Hub be measured holistically? (All stakeholders under one framework)

11. In your opinion, who should be responsible for Global Logistics Hub's environmental performance and sustainability? (All stakeholders reporting under one framework)

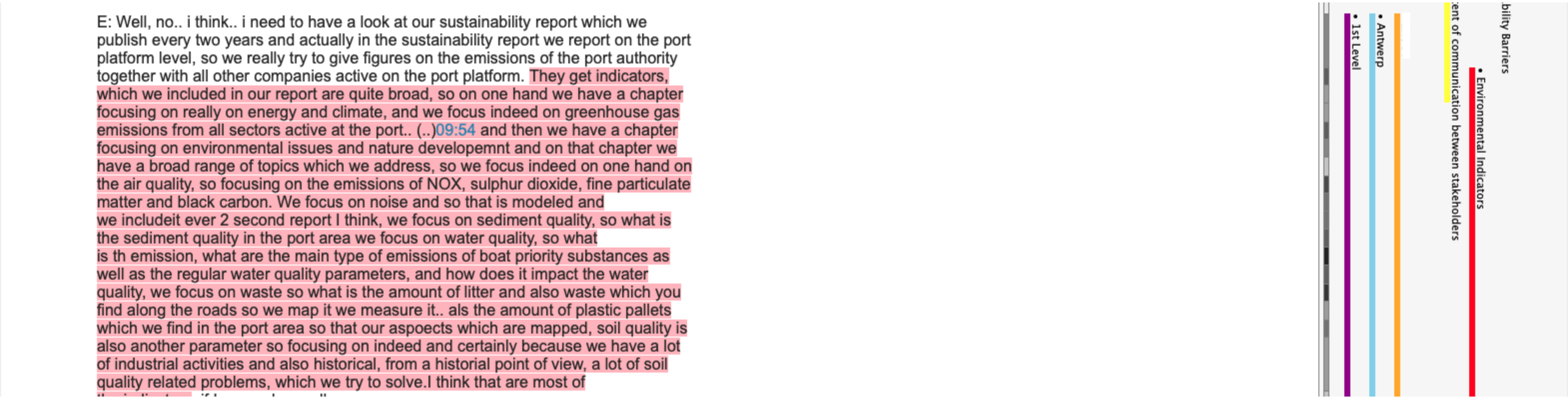
Drivers & Barriers of Environmental Sustainability in Global Logistics Hubs

12. What could prevent Global Logistics Hub' stakeholders from measuring their environmental performance under one holistic framework?

13. What prevents you/your organisation from being environmentally sustainable?

14. What drives you/your organization to be environmentally sustainable?

Appendix 2 NVivo Coding



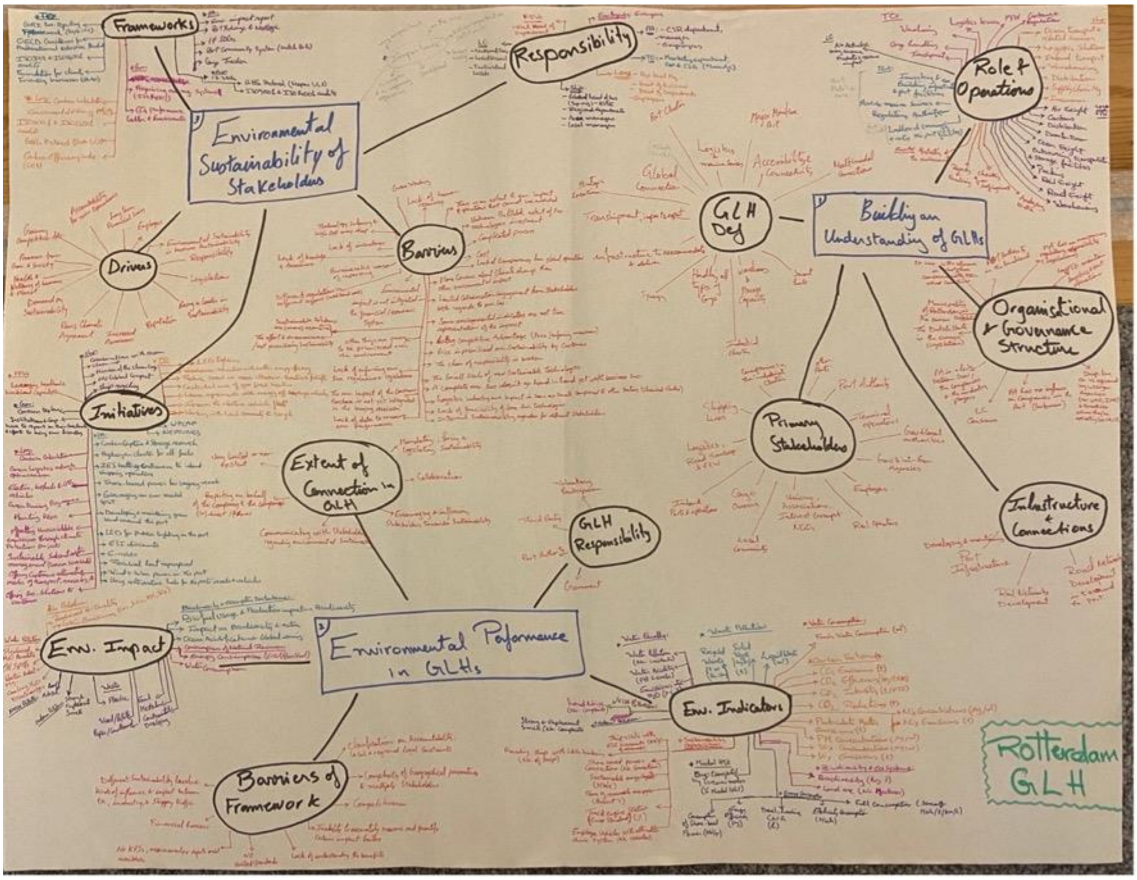
E: Well, no.. i think.. i need to have a look at our sustainability report which we publish every two years and actually in the sustainability report we report on the port platform level, so we really try to give figures on the emissions of the port authority together with all other companies active on the port platform. They get indicators, which we included in our report are quite broad, so on one hand we have a chapter focusing on really on energy and climate, and we focus indeed on greenhouse gas emissions from all sectors active at the port.. (..)09:54 and then we have a chapter focusing on environmental issues and nature developemnt and on that chapter we have a broad range of topics which we address, so we focus indeed on one hand on the air quality, so focusing on the emissions of NOX, sulphur dioxide, fine particulate matter and black carbon. We focus on noise and so that is modeled and we includeit ever 2 second report I think, we focus on sediment quality, so what is the sediment quality in the port area we focus on water quality, so what is th emission, what are the main type of emissions of boat priority substances as well as the regular water quality parameters, and how does it impact the water quality, we focus on waste so what is the amount of litter and also waste which you find along the roads so we map it we measure it.. als the amount of plastic pallets which we find in the port area so that our aspoects which are mapped, soil quality is also another parameter so focusing on indeed and certainly because we have a lot of industrial activities and also historical, from a historial point of view, a lot of soil quality related problems, which we try to solve.I think that are most of

Appendix 3 Rotterdam Logistics and Freight Companies

Appendix 4 Liverpool Environmental Impact

Appendix 5 SCZone Residential Area Development

Appendix 6 Rotterdam GLH Case Thematic Network



Appendix 7 Research Ethical Considerations

Ethical considerations are critical to any research especially when human participants are involved, as is the case in business and management research (Saunders et al., 2019). Management and business research can cause economic harm to the business or employees' dismissal if confidentiality and data protection are not thoroughly considered (Easterby-Smith et al., 2021). Collecting primary data through semi-structured interviews, photos, documents, and observations for research purposes has to follow ethical codes and principles to ensure that there are not any harmful consequences to the participants or the business. Easterby-Smith et al. (2021) highlight key ethical principles that should be followed by any researcher, as shown in Table 1.

Table 1: Key Principles in Research Ethics (Source: Easterby-Smith et al., 2021:173)

Protection of research participants	1. Ensuring that **no harm** comes to participants 2. Respecting the **dignity** of research participants 3. Ensuring a fully **informed consent** of research participants 4. Protecting the **privacy** of research participants 5. Ensuring the **confidentiality** of research data 6. Protecting the **anonymity** of individuals or organisations
Protection of integrity of research community	7. **Avoiding deception** about the nature or aims of the research 8. **Declaring affiliations**, funding sources and conflicts of interest 9. **Communicating research honestly** and transparently 10. **Avoiding misleading** or false reporting of research findings

Research ethics relates to almost every aspect of the research such as being clear about the research purpose, gaining access to data; storing, processing, collecting, interpreting, and analysing data; and writing up the findings (Saunders et al., 2019). Therefore, the researcher ensured that the research design is built on ethical foundation regarding all these aspects. The following guidelines mentioned in the literature and specified by the university were followed (Bell & Bryman, 2007; Saunders et al., 2019; Easterby-Smith et al., 2021):

1. The university's ethics guidelines were followed and the 'Ethics Proforma' - the required ethical form outlining the measures taken to ensure proper data management and confidentially - was submitted to the university research ethics committee for approval

before data collection commenced. University Research Ethics Committee approval was received on 26 November 2018 per the attached letter (Figure 1).

2. In the beginning of interviews, participant ethical consent forms were signed by the participants to ensure they understand the purpose of the research and ensure their consent for collecting data for the purpose of this research.
3. During initial contact with participants, an 'information and invitation' sheet is sent via email, so participants get a chance to understand the purpose of the research. The sheet also includes a copy of the interview guide and a consent form. The interview questions are included so that participants can prepare for the meeting and be aware of the questions before agreeing to take part in the research.
4. Participants were requested to suggest the interview date and time that was most suitable to them.
5. Participants were given the right to withdraw consent at any time. The consent form was sent to participants to ensure that they are also aware that their identity will remain confidential and any quotes that they require to omit from the research is possible during or after the interview.
6. Two copies of the consent form were signed by the researcher and the participant so that each can have a copy.
7. Before conducting the interview, participant's permission for recording was requested. Also, the researcher informed participants that they have the right to request turning it off at any point during the interview.
8. Interviews were transcribed and translated (for the non-English speaking participants). All transcriptions were sent to participants to ensure that the researcher understood what they meant and to review the transcribed interview in case they wish to omit anything.
9. Samples of the translated transcripts were also checked by English-Arabic Speaking PhD Colleagues to ensure nothing was lost in translation.

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Ref: HUBSREC 2018/13

26 November 2018

Dear Sandy

Research Title: Exploring Environmental Performance and Sustainability in Global Logistics Hubs

Thank you for your research ethics application.

I am pleased to inform you that on behalf of the Faculty of Business, Law and Politics Research Ethics Committee at the University of Hull, Dr Ashish Dwivedi has approved your application on 26 November 2018. You now have permission to proceed with the research.

I am advised by the committee to remind you of the following points:

- You must comply with the Data Protection act 1998;
- You must refer proposed amendments to the committee for further review and obtain the committee's approval prior to implementation (except only in cases of emergency where the welfare of the subject is paramount).
- You are authorised to present this University of Hull Research Ethics committee letter of approval to outside bodies in support of any application for further research clearance.

On behalf of the committee may I wish you every success with your research.

Yours sincerely,

Hilary Carpenter
Secretary,
Research Ethics Committee
Faculty of Business, Law and Politics

Faculty of Business, Law and Politics
University of Hull
Hull, HU6 7RX
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http://www2.hull.ac.uk/Faculties/fblp/hubs.aspx

Figure 1: Research Ethics Approval Letter

Appendix 8 Logistics and Supply Chain Theories

According to Defee et al. (2010), the majority of theories adopted in logistics and supply chain research have been borrowed from different disciplines. Logistics and supply chain management field is considered multidisciplinary (Croom et al., 2000; Lancioni et al., 2001), therefore authors have been adopting and modifying theories from other academic fields. For example, Mentzer et al. (2004) gathered different organizational theories to better understand logistics and form a "*unified theory of logistics*", and they included economic and behavioural theories. Skjoett-Larsen (1999) used three different theoretical lenses to study supply chain management: transaction cost theory (TCT), network theory, and resource-based view theory (RBV). Table 1 lists the most frequently used theories in logistics and supply chain.

Table 1: The 25 Most Frequently Identified Theories in Logistics and Supply chain (Defee et al., 2010:407)

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
Resource dependence theory	2.5	26.9
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	38.0
Social network theory	1.6	39.6
General inventory theory	1.4	41.0
Relationship marketing	1.4	42.4
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 risk	1.1	53.7
Total cost	1.1	54.8

TCT is the most commonly used theory in logistics and supply chain management, followed by RBV theory. TCT was outlined by Coase (1937), he is believed to be the forefather of this theory. The theory was developed later by Williamson (1975) by treating the firm as a governance structure. Williamson (1985:1) claims that a transaction "*occurs when a good or a service is transferred across a technologically separable interface*". This economic transaction cost is weighed between the cheaper option of outsourcing the activity or performing it in-house (Altin et al., 2018). On the other hand, RBV theory explains the competitive advantage of firms and how they fail or succeed by acquiring valuable (V), rare (R), inimitable (I) and non-substitutable (N) tangible and intangible resources (Barney, 1991). This theory was popularized by Barney (1991). However, it originated in the work of Wernerfelt (1984) and Penrose (1959) (Otola et al. 2013).

Appendix 9 Research Paradigms and Approaches

Burrell and Morgan (2017) illustrated a 4-window paradigm spectrum showcasing the difference between opposite paradigms within the context of social sciences research, which highlights the difference between positivist and interpretivist paradigms. The four paradigms (shown in Figure 1) are radical humanist, radical structuralist, interpretive, and functionalist. In their classification, they positioned the assumptions of the social world nature on the vertical axis and the social science nature on the horizontal axis to produce the four paradigms that help view organizations from different angles (Managan et al., 2004).

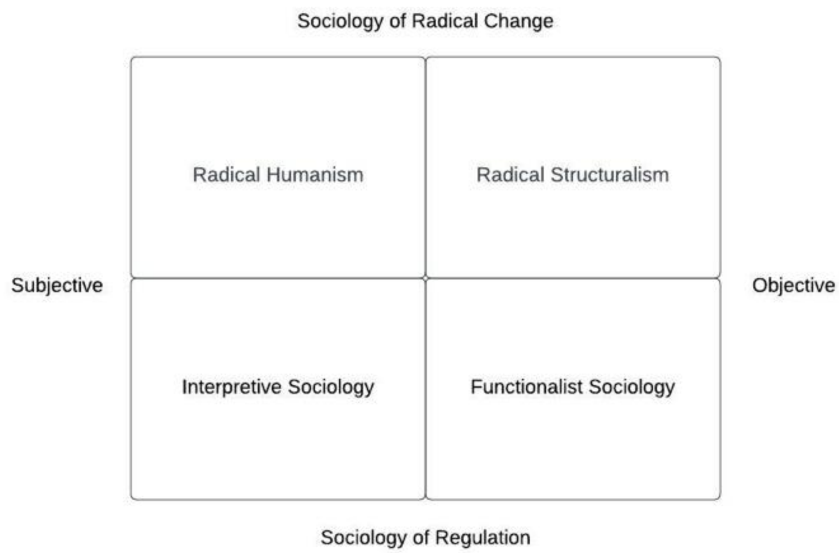


Figure 1: Four Paradigms (Source: Burrell & Morgan, 1979:3)

Even though Burrell and Morgan's (1979) matrix is considered a foundation in the management body of literature when it comes to paradigm distinction, it is criticised that the four paradigms cannot be combined (Saunders et al., 2019). There are many other approaches and paradigms among them forming a continuum rather than a concrete set of ideas for distinctive paradigms (Tashakkori & Teddlie, 1998). Morgan and Smircich (1980) propose three problematics with blurred lines to illustrate the fluidity between the paradigms. Table 1 illustrates their viewpoint.

Table 1: Morgan and Smircich's Three knowledge problematics (Cunliffe, 2011:9)

	Intersubjectivism	*Subjectivism*	*Objectivism*
Relationality — the nature of relationships.	Interrelationships emerging & shifting in a dialectical interplay between ourselves, others & our surroundings. Experienced differently by different people. ***Intersubjectivity.***	Relationships contextualized between people & their surroundings. People are reflexively embedded in their social world, influenced by and influencing discursive practices, interpretive procedures etc. ***Interactions.*** ***Intertext***	Relationships between entities in a pre-existing society, between network mechanisms & system/information processes, cognitive & behavioral elements. Or relationships between discourses (when treated as objects). ***Inter-network/objects/discourses***. ***-uality***
Durability — of society, meanings, knowledge etc., across time & space.	Social experience and meanings as ephemeral, fleeting moments. Although some common 'sense' of social & linguistic practices play through our interactions.	Social realities, meanings, discourses, knowledge are contextual: constructed yet experienced as objective and relatively stable. Perceived, interpreted & enacted in similar ways but open to change.	Enduring social structures (e.g., class), institutionalized rules, norms, practices, appropriate behaviors, and traits, etc. Discourses and networks have relative stability but are subject to resistance and change.
Meanings — what & where meaning is located.	Indeterminate. Neither fully in nor fully out of our control. Language is metaphorical & imaginative. Meanings in the moment between people.	Shared meanings immanent to the 'artful practices of everyday life', to discourses and texts. Negotiated & specific to time & place.	Common meaning situated in words, structures, roles, words, behaviors. Transcend time & space. Language is literal.
Historicity — concept of time & progress.	We are inherently embedded & embodied in historical, cultural & linguistic communities. Time experienced in the present — in living conversations with others.	Time & place are subjectively experienced. Progress as a situated human accomplishment — potentially iterative, ruptured or hegemonic.	Time experienced sequentially & universally. Progress is linear, recursive, or emerging over time.
Mediation — the place of the researcher in the research.	*Reflexive hermeneutic.* Research as a dialectical interplay between research participants. Focuses on experiences *between* people. Embodied & embedded researcher.	*Double hermeneutic*. Researcher embedded in the world, shaped by & shapes experiences & accounts, mediates meanings of actors. Experience *in* the world. Researcher as outsider or insider.	*Single hermeneutic*. Knowledge & researcher are separate from the world. Research er observes, discovers facts & develops predictive theories. Experience *of* the world. Detached, sometimes critical researcher.
Form of ***knowledge*** — epistemology.	*Pragmatic knowing*: in-situ, knowing-from-within. Transitory understandings and 'withness' thinking (Shotter, 2008). Micro level focus. Research as embedded and embodied.	*Pragmatic or syntagmatic*: common sense knowledge — naturally occurring actions, interactions, conversations. Mundane ac tivities. Non-replicable knowledge, situated validity. Macro and micro level focus.	*Syntagmatic*: interdependent or dependent relationships between st ructural or linguistic elements. Sequences. Replicable or sharable knowledge leading to the accumulation of knowledge & social progress or emancipation. Mainly macro focus.

Table 1: (continued)

Core ontological assumptions of research methodologies *(The nature of social reality)*	Social reality relative to interactions between people in moments of time & space. Relationally embedded. Social community.	Socially constructed realities, emerging, objectified, & sometimes contested in the routines & improvisations of people. Context is human action & interpretation.	Reality as symbolic & linguistic meanings & interpretations. Contextualized in a social site.	Discursive realities constructed by discursive & non-discursive practices & systems. Contested & fragmented. Discursively contextual.	Reality as process: interrelated actions, elements, structures, and systems. Generalizable or context-dependent.	Reality as concrete structures & behavioral patterns, subject to rules & laws. Structural integration or disintegration. Naive realism.
	←		*Research as Craft*	→		*Research as Science*
Assumptions about human nature *(How we relate to our world)*	Humans as intersubjective, embodied, relational, & reflexively embedded.	Humans as intentional & reflexive subjects, constructors & enactors of social realities within linguistic conventions or routines. Storytellers.	Actors, interpreters, sensemakers. Choosing linguistic resources, managing impressions.	Humans as subjectivities, products of discourse, contested & conflicted discursive sites.	Humans as an element in the process, adapting to & sometimes managing elements. Information processors & network coordinators.	Humans determined by their environment, socialized into existing social & institutional practices & requirements. Characterized by traits etc.
Research Approaches *(Philosophical/theoretical underpinnings)*	Hermeneutic phenomenology, relational constructionism, dialogism.	Ethnographic, existential phenomenology, hermeneutic. Constructionism & constructivism. Dialogic. Inductive.	Ethnomethodology, aesthetics, symbolic interactionism, hermeneutic, syntagmatic or pragmatic. Detached or involved researcher. Inductive. Interpretive procedures.	Poststructuralism, postmodernism, postcolonialism. Syntagmatic. Detached researcher. A critical stance.	Systems & process theories. Critical realism. Critical theory. Institutional theories, Structuration theories, actor network theories.	Positivism, empiricism, functionalism, nomothetic science, statistical or structural connections. A-temporal laws & validity criteria. Rational choice models. Deductive approaches.
	←	*Interpretivism*	→	←	*Postpositivist/Positivist*	→
Research Methods *(Examples of methods used)*	Narrative ethnography, reflexive autoethnography, dialogic action research, social poetics, dialogic analysis, poetry.	Narrative & discourse analysis, story, grounded theory, content analysis, poetry, participative inquiry, Autobiography.	Dramaturgy, story analysis, discourse & conversation analysis, symbolic analysis, grounded theory, content analysis, action research. Semiotics.	Semiotics, textual analysis, critical discourse analysis, deconstruction.	Network & systems analysis, historical analysis, material semiotics, boundary object analysis, ideology critique.	Surveys, observation, structured/coded interviews, case studies, focus groups, grounded theory, action research.
	Dialogic				*Monologic*	
Some linguistic features of research. *(Typical words used in research accounts)*	Betweeness, living conversations, possible meanings, la parole (embedded speech & relationships), interpretive insights.	Narratives, talk, text, metaphor, culture, themes, multiple meanings, sense making, la parole/la langue (Saussure, 1959).	Scripts, plots, performances, roles, stage, mask. Symbolic meaning, artifacts. Managing impressions. Actor, actions, & talk. La langue. Social practices.	Discourses, marginalization, resistance, power, domination, colonization, suppression, subjectivity, body.	Materiality, objects, mechanisms, power, control, 'the system', 'the process mechanisms', emancipation.	Categories, norms, roles, properties, variables, schema, rules, structures, causality, patterns, efficiency, 'the organization', measurement. Progress.

Morgan and Smircich (1980) illustrate that along the continuum the assumptions and theories of each paradigm are relaxed as you border on to the next paradigm and are replaced in different areas making subtle differences along the continuum. For a long time, the positivist paradigm was the only paradigm adopted for research because researchers focused on things such as physics. However, with the evolution of the world we live in, different paradigms evolved and integrated to address the need to study other areas (Collis & Hussey, 2021).

The choice of paradigm depends on the researcher, the topic under investigation and the aim of the research (Mackenzie & Knipe, 2006). Each paradigm comes with a set of assumptions, appropriate methodologies, and philosophical stances. Guba and Lincoln (1994:105) explain that:

> *questions of method are secondary to questions of paradigm, which we define as the basic belief system or worldview that guides the investigation, not only in choices of method but in ontologically and epistemologically fundamental ways.*

So, for example, a researcher adopting an interpretivist paradigm (also referred to as phenomenology paradigm) will have a nominalist ontological position They will be subjective and look for interpretations and meaning rather than measuring numbers. Reality for them will be socially constructed, which will translate into using data collection methods such as in-depth interviews, case studies, focus groups, etc. to gather rich qualitative data about social phenomena in their natural settings (Bell et al., 2022). The data for this type of research is gained through a social process of interaction between the researcher, the social actors, and the role they play while acknowledging that there are multiple realities for each person (Holden & Lynch, 2004; Collis & Hussey, 2021). "There is no way of experiencing the real relations of a particular society outside of its cultural and ideological categories" Denzin (1997:245). Therefore, researchers tend to minimize the distance between them and what is being researched to inductively build theory. Mangan et al. (2004:568) refer to it as the "bottom-up, inside out" approach, which is the approach followed in this research.

- Induction versus Deduction

Inductive and deductive are two approaches to theory development (Saunders et al., 2019). According to Collis and Hussey (2013), the deductive approach is "when a conceptual/theoretical structure is developed and then tested by empirical observations, thus particular instances are deduced from general inferences" (page 8). Therefore, the theoretical framework paves the pathway for the research and guides the researcher to test the theory or the hypothesis to generalise the findings. This approach is traditionally associated with positivism. In contrast, the inductive approach is "where theory is developed from observation of empirical reality, thus moving from the specific to the general" (Collis & Hussey, 2013:8). Therefore, the researcher is guided by the research context, interpretations, and inferences to build theory as a product of the research. This approach is traditionally associated with interpretivism. Table 2 illustrates the approaches' impact on conducting research and theory development.

Table 2: Deduction vs. Induction (Adapted from Saunders et al., 2019:153)

	Deduction	Induction
Logic	In a deductive inference, when the premises are true, the conclusion must also be true	In an inductive inference, known premises are used to generate untested conclusions
Generalisability	Generalising from the general to the specific	Generalising from the specific to the general
Use of data	Data collection is used to evaluate propositions or hypotheses related to an existing theory	Data collection is used to explore a phenomenon, identify themes and patterns and create a conceptual framework
Theory	Theory falsification or verification	Theory generation and building

Easterby-Smith et al. (2021) explain that if the researcher is aiming to deeply understand an ambiguous and complex phenomenon, then designing the study to test a theory is not possible. Therefore, the paradigmatic assumptions not only shape the research approach but also shape the design of the study and the methodology used to collect and analyse data. Burrell and Morgan (1979), illustrated this by distinguishing between two extreme research approaches, as shown in Figure 2.

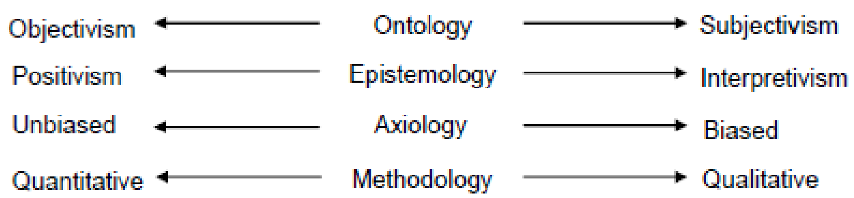


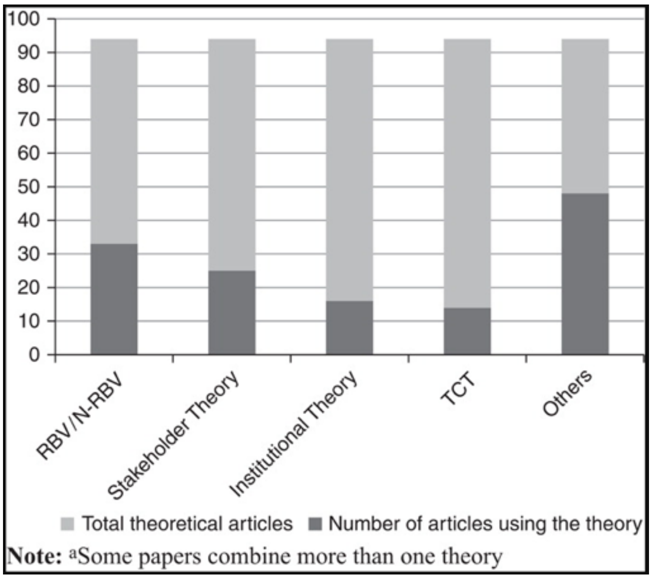
Figure 2: Dimensions of Opposite Research Approaches (Source: Burrell & Morgan, 1979:3)

To elaborate on this, the characteristics of conducting qualitative and quantitative research are compared in Table 3.

Table 3: Characteristics of Quantitative and Qualitative Research (Adapted from Saunders et al., 2019:180)

	Quantitative Research	**Qualitative Research**
Researcher	is generally seen as independent from those being researched	Researcher is generally recognised as not being independent from those researched
Those taking part	are usually referred to as respondents	are referred to as participants or informants
Designed	to examine relationships between variables	to study participants' attributed meanings and associated relationships.
Sampling	Often uses probability sampling techniques to ensure generalisability	Generally, uses non-probability sampling techniques
Method(s) used to collect data	are rigorously defined and highly structured	are unstructured or semi-structured
Results	in numerical and standardised data	in non-standardised data generally requiring classification into categories
Analysis	conducted using statistics and diagrams	conducted using conceptualisation
Resulting meaning(s) derived	from numbers	from words (spoken or text) and images. Based on meanings expressed through words (spoken and textual) and images

Appendix 10 Popular Theoretical Lenses in SSCM



Most popular theories in SSCM literature (Touboulic & Walker, 2015:26)

Appendix 11 Different Case Study Designs Advantages and Disadvantages

Advantages and Disadvantages of Different Case Study Designs (Source: Voss et al., 2002:203)

Choice	Advantages	Disadvantages
Single cases	Greater depth	Limits on the generalisability of conclusions drawn. Biases such as misjudging the representativeness of a single event and exaggerating easily available data.
Multiple cases	Augment external validity, help guard against observer bias	More resources needed, less depth per case
Retrospective cases	Allow collection of data on historical events	May be difficult to determine cause and effect, participants may not recall important events
Longitudinal cases	Overcome the problems of retrospective cases	Have long elapsed time and thus may be difficult to do

Each design has its advantages and disadvantages, and it depends on the research aim and purpose to find the appropriate design to conduct the research. While Voss et al. (2002) favoured the single and fewer case studies for their richness and depth, Voss et al. (2002) and Yin (2014) categorized single case studies as more suitable for longitudinal investigation and unique cases. Single case study research is powerful in situations where the rationale of the design cannot be satisfied by multiple case study research such as extreme or unique cases. Even within a single case, there can be several layers, levels, cases, contexts and periods of time that can be dissected (Voss et al., 2002; Yin, 2014). However, single case study research can be seen as limiting to generalizability of findings, theory, or models developed (Voss et al., 2002). Additionally, it risks bias, exaggeration, and misjudgement. On the other hand, multiple case study research can be considered as reducing the depth of the study when resources are constrained (Voss et al., 2002). Therefore, the researcher has to be careful when deciding on a multiple case study design to consider the role of resources available when it comes to deciding on how many cases to include in the multiple case study (Yin, 2014).

Appendix 12 Comparison of Case Study with Experimental and Survey Approaches

A Schematic Comparison of Case Study with Experimental and Survey approaches (Source: Gomm et al., 2000:4)

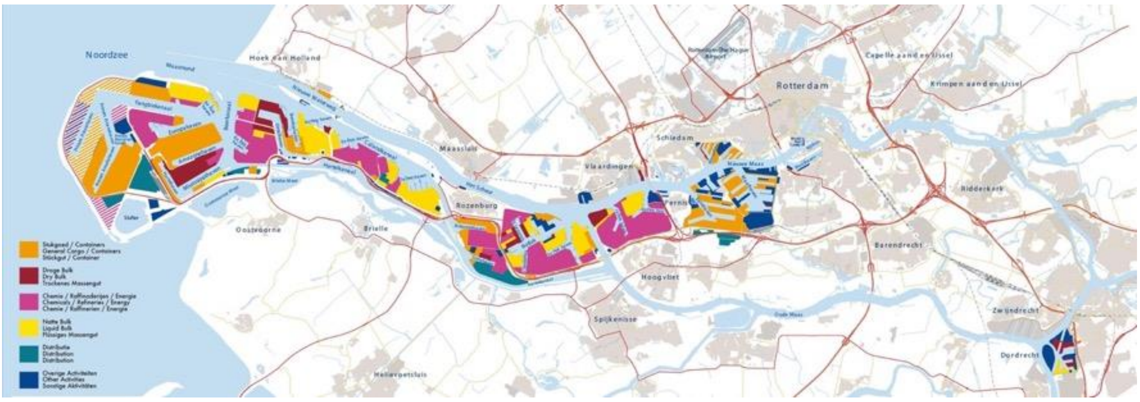
Experiment	Case Study	Survey
Investigation of a relatively small number of cases.	Investigation of a relatively small number of cases (sometimes just one).	Investigation of a relatively large number of cases.
Information gathered and analysed about a small number of features of each case.	Information gathered and analysed about a large number of features of each case.	Information gathered and analysed about a small number of features of each case.
Study of cases created in such a way as to control the important variables.	Study of naturally occurring cases, or, in 'action research' form, study of cases created by the actions of the researcher but where the primary concern is not controlling variables to measure their effects.	Study of a sample of naturally occurring cases, selected in such a way as to maximize the sample's representativeness in relation to some larger population.
Quantification of data is a priority.	Quantification of data is not a priority.	Quantification of data is a priority.
The aim is either theoretical inference – the development and testing of theory – or the practical evaluation of an intervention.	The main concern may be with understanding the case studied in itself, with no interest in theoretical inference or empirical generalization. However, there may also be attempts at one or other, or both, of these. Alternatively, the wider relevance of the findings may be conceptualized in terms of the provision of vicarious experience, as a basis for 'naturalistic generalization' or 'transferability'.	The aim is empirical generalization, from a sample to finite population, though this is sometimes seen as a platform for theoretical inference.

Appendix 13 Four Perspectives on Validity, Reliability, and Generalizability

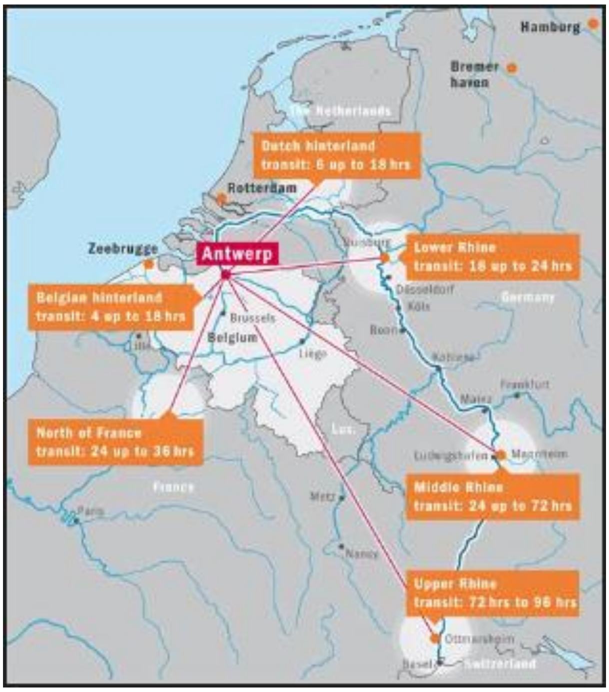
Four Perspectives on Validity, Reliability, and Generalizability (Source: Easterby-Smith et al., 2021:171)

	Strong Positivist	Positivist	Constructionist	Strong Constructionist
Validity	Has the design excluded all rival hypotheses?	Does the design make it possible to eliminate plausible alternative explanations?	Have a sufficient number of perspectives been included?	Does the study clearly gain access to the experiences of those in the research setting?
Reliability	Do the measures correspond closely to reality?	Do the measures used provide a good approximation to the underlying concepts of interest?	Will similar observations be reached by other observers?	Is there transparency about data collection and interpretation?
Generalizability	Does the study confirm or contradict existing findings in the same field?	Are the patterns observed in the sample data consistent with findings from other studies?	Is the sample sufficiently diverse to allow inferences to other contexts?	Do the concepts and constructs derived from this study have any relevance to other settings?

Appendix 14 Four Case Studies Maps

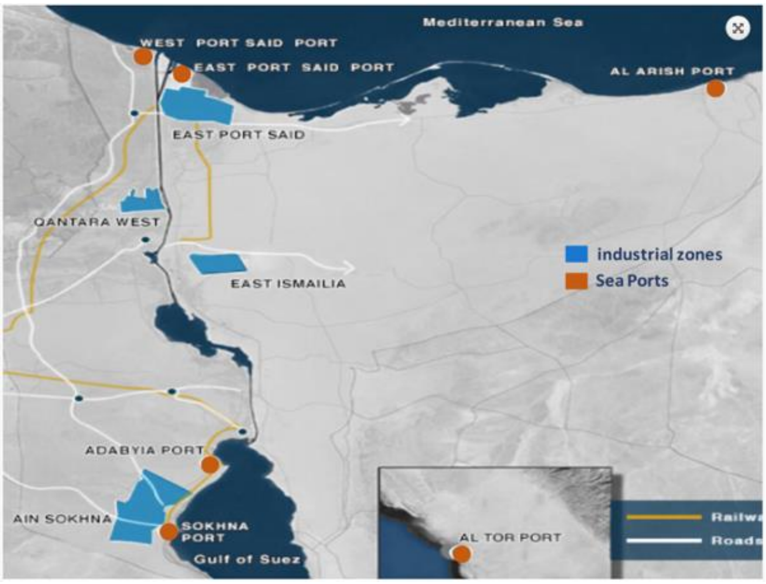


Rotterdam (Port of Rotterdam, 2022)



Antwerp (Port of Antwerp, 2018)

Liverpool (Peel Ports, 2020)



SCZone (SCZone, 2022)

Appendix 15 Definitions and Glossary

Supply Chain Management

> *Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies (CSCMP, 2018)*

Logistics Management

> *that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverses flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements (CSCMP, 2018).*

Logistics Management Activities

> *Logistics management activities typically include inbound and outbound transportation management, fleet management, warehousing, materials handling, order fulfilment, logistics network design, inventory management, supply/demand planning, and management of third-party logistics services providers. To varying degrees, the logistics function also includes sourcing and procurement, production planning and scheduling, packaging and assembly, and customer service (CSCMP, 2018).*

Appendix 16 Five Port Generations

The following tables summarize the differences between the port generations. Table 1 illustrates the differences between the first four generations and Table 2 illustrates the differences between the fourth and the fifth generations.

Table 1: Functional and Spatial Development of a Seaport (Source: Notteboom, 2001:10)

	First Generation, stage I	**Second Generation, stage II**	**Third Generation, stage III**	**Fourth Generation, stage IV**
External environment				
Period of Development	Before 1960s	After 1960s	After 1980s	2000s
Exogenous developments	Colonization, Steam ships, Rise of nations, Rise of trade	Petrochemistry, Lorry and pipeline, Structural prosperity, Industrialization	Multinationals container, Ecological protection, Internationalization	Global economy, Information systems, Environment, Informatisation
Functional Organization				
Port functions	Transhipment (1) Storage (2) Trade (3)	(1) to (3) = Industry (4)	(1) To (4) + Distribution (5)	(1) to (5) + Logistic control
Production characteristics	Cargo flow, Simple service, Low value-added	Cargo flow, Cargo transformation, Combined services, Improved value-added	Cargo/ information flow, Cargo distribution, Multiple service package, High value-added (port-oriented)	Cargo/ information flow, Cargo/information distribution, Multiple service package, High value-added (network-oriented), Chain management
Type of Cargo	Break bulk cargo	Break bulk and dry/ liquid bulk cargo	Bulk and unitised/ Containerised cargo	General cargo/ containers information
Spatial Organisation				
Spatial expansion of port	Quay and waterfront area	Enlarged port area	Terminals and distribelt towards landside	Network-related functional expansion
Principal locational factors	Presence of market, Availability of labour	Access to raw materials, Access to sales market, Availability of capital	Availability of transhipment facilities, Access to sales market, Space Flexibility and costs of labour	Availability of trans-shipment facilities, Access to sales market, Space Flexibility and costs of labour, Available know-how, Quality of life

Table 1: (continued)

	First Generation, stage I	**Second Generation, stage II**	**Third Generation, stage III**	**Fourth Generation, stage IV**
Port organization and strategy				
Organization characteristics	Independent activities within port, Informal relationship between port and port users	Closer relationship between port and port users, Loose relationship between activities in port Causal relationship between port and municipality	United port community, Integration of port with trade and transport chain, Close relation between port and municipality, Enlarged port organization	Port network community, Close relation between port network and public authorities on different levels
Port authority's task	Nautical services (1)	(1) + development of grounds and infrastructure (2)	(1), (2) + Port marketing (3)	(1) to (3) + Network management
Attitude and strategy of port development	Conservative Port as changing point of transport	Expansionist Transport, industrial and commercial centre	Commercial-oriented integrated transport and logistics centre	Commercial oriented Integrated transport, logistic and information complex, and network

Table 2: Comparison of Key Features of the Fourth and the Fifth-Generation Ports (Flynn et al., 2011; Lee & Lam, 2016:193)

Items	**The 4GP by UNCTAD**	**The 5GP proposed by Flynn et al. (2011)**	**The 5GP modified by Lee and Lam (2016)**
Service quality	Meeting regulations and general levels of standards	Finding dynamic incentives to perform beyond basic standards	Finding dynamic incentives to perform beyond basic standards and to meet customers' satisfaction
IT	Cargo clearance and tracking	Measures focused on service, security, and performance impact. IT is not only based on tracking and tracing but also on event management (anticipation) and performance measurement.	IT focuses on one stop service and security to improve port performance and users' satisfaction. IT is not only based on tracking and tracing of both cargoes and information via a "single window" system but also on performance measurement including gas emission information
Community environmental impact	Regulatory compliance with environmental impact and planning statutes	Active outreach to community in planning and decision-making process	Active outreach to community stakeholders in port-city interface, planning and decision-making process, in particular waterfront development. Active green port policy with rewarding system is envisaged.
Port cluster	Handled through land-use planning	Port services provision integral to mission and vision. Port leaders have role as "port cluster managers" contributing to generating value-added.	Port services provision integral to mission and vision. Port leaders have role as "port cluster managers" in tandem with maritime cluster contributing to generating value-added in in the context of logistics hub.
Maritime cluster	Treated as separate from port function	Still functionally independent of the port cluster, but creative financial incentives to attract ship-owner and cargo by creating jobs and value-added	Still functionally independent of the port cluster, but subject to clustering, functionally interrelated with creative financial incentives to attract ship-owner and cargo by creating jobs and added value
Logistics hub	Logistics developed as a back of port function; and Physical Free Trade Zones and Logistics Parks	Logistics seen as part of a maritime logistics chain; Airport interface for high-value added flexibility; and Advanced Free Trade Zone and Logistics Park functions.	Logistics seen as part of a maritime logistics chain; Airport interface for high-value added flexibility; and Advanced Free Trade Zone and Logistics Park functions. This logistics function is interrelated to the feature of "inland" to maximize its synergy effect.
Inland	Inland connections develop through natural evolution	Ports develop hinterland strategies through pricing and incentive policies ensuring that evolution does not disadvantage interest of cargo owners.	Ports develop hinterland strategies through pricing and incentive policies ensuring that evolution does advantage interest of cargo owners and generates efficiency of intermodal system with possible reduction of total transportation costs.
Waterside	Port marketing as two-dimensional price and quantity approach	Ports developing foreland strategies through pricing and other incentive policies	Ports developing foreland strategies to capture transhipment cargoes in tandem with SCM through pricing and other incentive policies