Sustainability Performance and Competitive Advantage in Container Ports

By

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ABSTRACT

Ports have transformed their daily operations and management activities more sustainably in response to international regulations related to sustainable development. However, there is ambiguity about the impact of sustainability practices on port performance, making it more challenging to develop strategic sustainability management that secures competitive opportunities for port viability. Hence, the present study aims at investigating strategic opportunities for generating a competitive advantage through port sustainability performance. To achieve the research aim, first, this study sheds light on meaningful sustainability activities for strengthening the competitive advantage of ports using Relative Importance Index method (RII). Second, this study validates the relationship between port sustainability performance and the competitive advantage of ports using Structural Equation Modelling (SEM). A questionnaire survey was developed based on key indicators identified through a systematic literature review. A total of 248 completed questionnaires collected from container ports in 37 countries were used in the study.

The RII results show that social and economic sustainability are more important than environmental sustainability for strengthening the competitive advantage of ports. Additionally, top three sustainability activities from each sustainable aspect were identified: “Waste pollution management”, “Green port management”, and “Energy and resource management” from environmental sustainability; “Health and safety”, “Job training”, and “Public relations” from social sustainability; and “Port operational efficiency”, “High quality services”, and “Port infrastructure construction” from economic sustainability. The SEM results show that environmental and economic sustainability performance have significant positive relationships with the competitive advantage of ports. However, the social sustainability performance has no direct impact on the competitive advantage of ports. The positive relationship between social sustainability performance and the competitive advantage of ports was supported by the mediating effects of environmental and economic sustainability performance.

In conclusion, the study findings suggest the strategic directions of sustainability performance to strengthen the competitive advantage of ports: (1) the focus on a detailed action plan for social sustainability implementation, (2) the development of a synergistic strategy for eco-economy dynamics such as circular economy, and (3) the establishment of an organised port network for joint initiatives of social sustainability. It also emphasises the internal capacity to design and deliver strategic port sustainability management by participative decision-making of port managers at different managerial levels.

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LIST OF ABBREVIATIONS

Abbreviations	Full words
AAPA	American Association of Port Authorities
AAPMA	Association of Australian Ports and Marine Authorities
ABP	Associated British Ports
AGFI	Adjusted Goodness-of-Fit Index
AHP	Analytic Hierarchy Process
AMOS	Analysis of Moment Structure
AVE	Average Variance Extracted
BPA	British Ports Association
BS	Business and Servicing
CEBR	Centre for Economics and Business Research
CEO	Chief Executive Officers
CFA	Confirmatory Factor Analysis
CMV	Common-Method Variance
CFI	Comparative Fit Index
CR	Composite Reliability
CSR	Corporate Social Responsibility
COP	Conference of the Parties
DEA	Data Envelopment Analysis
EFA	Exploratory Factor Analysis
EM	Environmental Management
EMS	Environmental Management System
EO	Environmental Operation
ES	Economic Structure
ESE	East and Southeast
ESO	European Seaports Organisation

ESPO	European Sea Ports Organisation
EP	External Population
EPE	Environmental Performance Evaluation
GDP	Gross Domestic Product
GFI	Goodness-of-Fit Index
IAPH	International Association of Ports and Harbours
IFI	Incremental Fit Index
IHR	Internal Human Resource
IMCO	International Maritime Consultative Organisation
IMO	International Maritime Organisation
IPA	Importance Performance Analysis
ISO	International Organisation for Standardisation
KMO	Kaiser-Meyer-Olkin
MAR	Missing At Random
MARPOL	The International Convention for the Prevention of Pollution from Ships
MCAR	Missing Completely At Random
MCDM	Multiple Criteria Decision Making
ML	Maximum Likelihood
MNAR	Missing Not At Random
MSV	Maximum Shared Variance
NEPTUNES	Noise Exploration Program to Understand Noise Emitted by Seagoing ships
NFI	Normed Fit Index
NGO	Non-Governmental Organisation
NRBV	Natural-Resource-Based View
OECD	Organisation for Economic Co-operation and Development
PC	Principal Components
PERS	Port Environmental Review System

PGFI	Parsimony Goodness-of-Fit Index
PIANC	Permanent International Commission for the Navigation Congress
PNFI	Parsimony Normed Fit Index
RBV	Resource-Based View
RII	Relative Importance Index
RMSEA	Root Mean Square Error of Approximation
SD	Standard Deviation
SEM	Structural Equation Modelling
SIE	Specific indirect effect
SPSS	Statistical Package for Social Sciences
SRMR	Standardised Root Mean Residual
TE	Total Effect
TEU	Twenty-foot Equivalent Unit
TIE	Total Indirect Effect
TLI	Tucker-Lewis Index
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNCSD	United Nations Commission on Sustainable Development
UNCTAD	United Nations Conference on Trade and Development
VAF	Variance Accounted For
VIF	Variance Inflation Factor
VMS	Valid Mean Substitution
WCED	World Commission on Environment and Development
WPSP	World Port Sustainability Program
WS	West and South
WSSD	World Summit on Sustainable Development

Chapter 1. Introduction

This chapter provides an overview of this doctoral study investigating the topic of "sustainability performance and competitive advantage in container ports". It presents the research background and provides a discussion on the motivations for the study. The research aim and the four research questions examined in this research are introduced, and the structure of the thesis is outlined.

1.1 Research background

"Our ports are the engines that power our economy. They must also be the forces that drive our region toward a greener, more sustainable future" (Mongelluzzo 2017)

The maritime transport industry plays a pivotal role in the economic growth between regions and countries, as it enables to increase the internationalisation of the marketplace and liberalisation of economic transitions (van Veen-Groot and Nijkamp 1999). Fuelled by globalisation and containerisation, international seaborne trade volumes reached 11.1 billion tons in 2019, and shipping also accounted for more than 80 per cent of the world's merchandise trade transport (UNCTAD 2020). Maritime transport has enriched the world economy by lowering trade barriers and disseminating prosperity among nations and people. As maritime transport deepens the interaction at all geographical levels, the role of ports has been emphasised on integrating economic and cultural connections as a node of linking logistic chains of international transport between industrial sectors (Wakeman 1996; I2S2 2010). Several socio-economic impacts are generated by ports, such as creating job opportunities, increasing Gross Domestic Product (GDP), creating port value-added, and attracting foreign direct investment (Hou and Geerlings 2016).

With its positive economic aspect, the most significant concern of ports in the past was to maximise economic benefits from efficient and effective operations. The operational capacity of ports was one of the keys to attracting shippers, and ports have continuously committed their capacity extension plans in order to facilitate container traffic and satisfy the needs of port users (Tongzon and Sawant 2007). However, ports have been criticised for slow response to its social agenda such as environmental destruction, working conditions, safety and gender diversity (Chatzinikolaou and Ventikos 2011). The reckless expansion of port infrastructures and facilities have engendered significant adverse effects on the natural environment, such as biodiversity and noise pollution. Increasing international seaborne trade has also affected water pollution from ballast water discharge, increased energy consumption and accident frequency, as well as shipping-related carbon dioxide emissions. Even though ports provide relatively safe and environmentally friendly services, their negative impacts on the environment cannot be overlooked, given a substantial proportion of total world trade. In this regard, ports have increasingly been required to align their performance with sustainability considerations (UNCTAD 2019).

Sustainability or sustainable development is a process to pursue the shared vision where the economy, environment, and society improve in harmony over time, conceiving they are interconnected. Today, many organisations have been recognising that the integration of sustainability into their management is an ineluctable issue. The ability to manage their sustainability performance has become an issue of strategic importance in the current competitive environment (Goyal et al. 2013). From a strategic management perspective, an operationalisation of sustainability management as a core strategy allows organisations to create value-added for long-term success in the future while satisfying environmental and social requirements, which ensure gaining a better position in the competition (Porter 1985a). Ports have also acknowledged the need to recalibrate their operational mechanisms strategically, reducing negative externalities of port operation and management while ensuring their economic viability.

The general idea of sustainable development sounds so good that no one can help but agree with it since it emphasises the ideal planet like paradise on earth. However, it has been assailed by the concern that economic growth can be incompatible with environmental and social responsibility from a business perspective (Russo and Fouts 1997). The port industry also acknowledges that the challenge lies in the cost implications for implementing more sustainable ports, in that further investment is required in the development or transformation into new systems and capabilities (UNCTAD 2019). It is argued that sustainability performance has brought positive financial benefits to ports in terms of eco-efficiency and effectiveness. However, the circumstance where implementing sustainability practice is more costly than is worthwhile makes it difficult for ports to sustain their viability in a competitive marketplace (Gelhard and Von Delft 2016). Additionally, the execution of sustainability is a fundamentally different way of operating, which requires organisations to change their motives and strategic outlook (Thakhathi et al. 2019). This recognition was reflected by De Matos and Clegg (2013), asserting that "there is no bigger challenge for organisational change management in the contemporary world than achieving greater sustainability". Therefore, it is important to explore a strategic way to implement port sustainability that enables the transformation process to be sustainable and beneficial to port performance.

1.2 Motivations for the research

Given that the adoption of sustainability practice of ports is not an option due to internal and external forces, it is necessary to elucidate the contribution of sustainability performance to the economic growth of ports. Further, a strategic approach should be developed to increase the potential long-term value of ports while embracing all three aspects of sustainability—environmental, social, and economic. Hence, this study arises from the intention of exploring strategic action to strengthen port performance through sustainability implementation from a competitive point of view. Four principal motivations underpin the intent of this study.

The first motivation of this study is the need for the shift in a manner of response to the international sustainable development agenda from a simple guideline to a certain plan of action to generate concrete outputs, namely sustainable development strategy. The 2002 World Summit on Sustainable Development (WSSD) defined a sustainable development strategy as "… is a cyclical and interactive process of planning, participation and action in which the emphasis is on managing progress towards sustainability goals rather than producing a 'plan' as an end product" (UNCSD 2002, p. 1). This underlines a strategic management approach to the implementation issue of sustainable development, which serves as both a framework for analysis, planning, implementation, and review and an action plan with specific goals (Meadowcroft 2007). The United Nations Sustainable Development Goals for 2030 declared in 2015 also explicated the importance of developing strategies that support the implementation of programmes and initiatives of sustainable development action. More recently, the United Nations Climate Change Conference—referred to as Conference of the Parties 26 (COP26)—emphasised the need for every country to update emissions reduction targets and plans leading to more credible action across their entire economy and sectors (UN 2021). This international awareness accelerates the maritime transport industry's commitment to seeking effective ways of putting in place sustainable development initiatives and formulating more viable strategies that mitigate the impacts of the transition journey and generate the desired outcomes of implementing sustainable development (Sciberras and Silva 2018).

The second motivation for this study concerns evaluating sustainability performance for systematic follow-up and review, which is emphasised in the 2030 Agenda for the 17 Sustainable Development Goals. Performance measurement has a variety of purposes as integral feedback within management systems; for example, to assess and react to the current performance trends, to provide information on benchmarking, and to identify opportunities for improvement (Warhurst 2002). Nonetheless, the common intention of all the performance measurements is to provide indications of the consequences of current practice and find effective points of development (Parris and Kates 2003). It elucidates not only what happened in terms of action, but also what could be done to manage or tackle issues, which can be analytical evidence to readjust plans and directions of sustainability implementation in port organisations (Sciberras and Silva 2018). Therefore, it is crucial to provide an insight into sustainability practices for concrete outcomes in the port industry and introduce the strategic change of actions to direct towards the intended purposes by analysing the capacity of ports to deliver performance (Warhurst 2002).

Aligned with the two preceding motivations, the third motivation of this research arises from a perceived need to understand, evaluate, and manage sustainability activities that support desirable outcomes to port operations. The organisation management literature asserts that a competitive position of an organisation can be gained by implementing “best practices” of sustainability management (Christmann 2000). Numerous variables and factors are combined in port operations and management. Moreover, achieving sustainable development goals is not a spontaneous but a dynamic process where multiple elements, such as human societies and ecological regimes, are integrated into non-linear ways (Hjorth and Bagheri 2006). In this sense, managers in organisations are faced with making a strategic decision about what is considered the main priorities, what needs to be developed, and what resources and competencies they need to adapt to sustainability management (Sciberras and Silva 2018). Thus, it is meaningful to discern desirable sustainability activities and establish best practices in managing sustainability performance, securing a better port competitive position. Consequently, best practices consisting of a set of crucial sustainability activities can facilitate a strategy development process that decision-makers in the port industry plan their policies and business operations regarding sustainable development in a more structured way.

The last motivation for this study is to reflect the need to consider environmental and social responsibility as one of the crucial factors which influence port competitiveness. Traditionally, port competitiveness has been determined by human and material resources for logistics activities in ports, such as port facilities, infrastructures, shipping services, and port rates (Kim 2015). In recent years, environmentally and socially driven regulations are increasingly affecting port market dynamics, and sustainable operations is a significant concern in the port industry (UNCTAD 2019). In this regard, the scope of factors should be redefined to enable port organisations to adapt to the changing environment where they are continuously required to transform their managerial and organisational processes and expand their internal and external capabilities under the transition to sustainable development. However, there is currently a dearth of research that sustainable operations and management can be assured as a pivotal element in enhancing the competitive positioning of ports.

1.3 Research aim and research questions

This study aims to investigate how ports could capture competitive growth opportunities through strategic sustainability management and to provide empirical evidence of the value of sustainability performance in the port industry. In order to accomplish the aforementioned aim, the following specific research questions are formulated:

RQ1: What are the main factors supporting strategic sustainability management in ports?

RQ2: What are the influential sustainability activities that have an impact on strengthening the competitive advantage of ports?

RQ3: How are the influential sustainability activities specified depending on the attributes of ports?

RQ4: To what extent does sustainability performance contribute to gaining the competitive advantage for ports?

This research intends to substantiate the economic value of port sustainability performance and propose strategic port sustainability management that leads to improvement in port business capability from a competitive point of view. Therefore, this research focuses on addressing two objectives: assessing the impact of implementing sustainability practices on reinforcing the competitive position of ports and clarifying a set of critical sustainability activities that can provide a competitive advantage for ports.

Centre for Economics and Business Research (CEBR) (2019, p. 10) defines the port industry as an aggregate of activities in and around ports, including ship-related activities such as shipping and shipbuilding, and the activities of ports themselves in terms of ports operations and management. The constituent activities of the port industry can be categorised into four major activities: warehousing and storage; stevedores; cargo and passenger handling; port activities and management; public sector-related activities such as border agency, Her Majesty's Revenue and Customs, operating in ports (CEBR 2019). Accordingly, this study defines a port as a geographical area in which cargo carried by seagoing vessels is handled and serves as an interface point between maritime and inland transportation. Particularly, this study delimits container port activities concerning sustainable management within the port industry. The cornerstone activities of container ports include the reception of container vessels, receiving and delivering of freight, and loading and unloading of containers using container handling equipment. (ESCAP 2005; Stopford 2009). Moving from traditionally focused on the spatial function of simply handling containers, a container port is today more understood as a key value-added system for the economy and society by connecting transport and logistics networks around the world (Geerlings et al. 2017). As international logistics hubs, they are emphasised as responsible organisations for shaping not only a nation's competitiveness but also contributing to the global progress toward sustainable development.

The research draws upon the strategy-as-practice approach (Whittington 2006; Jarzabkowski et al. 2016) and the Natural-Resource-Based View (Hart 1997; Hart and Dowell 2011) to address the above research questions. The strategy-as-practice view is adopted as it helps explore how port sustainability practices can be conceptualised as a competitive strategy driving the competitive advantage of ports. Using the strategy-as-practice view, this research develops a conceptual strategy model in the context of port operations and management, contributing to extending discussions in port sustainability studies regarding port sustainability management from a strategy perspective. Additionally, this study takes the Natural-Resource-Based View to clarify the relationship between port sustainability performance and competitive advantage and offer strategic directions on how ports can facilitate sustainability management capability shaping differences in competitive performance. In this sense, the research contributes to enriching the port sustainability literature by providing theoretical insights from the Natural-Resource-Based View regarding the impact of sustainability performance on the competitive advantage of ports. Consequently, the integration of these theoretical lenses allows the research to understand the logic of the relationship between port sustainability practices and its recognised outcomes from a strategic view and explore how environmental, social, and economic sustainability can create a competitive advantage for ports. The theoretical implications and contributions are discussed in greater detail in the last chapter, and the practical implications are offered accordingly.

From a methodological aspect, this study holds a positivist perspective and employs a quantitative approach, which measures the phenomenon of interest using analytical and statistical tools. The research questions will be addressed using the methods shown in Figure 1.1.

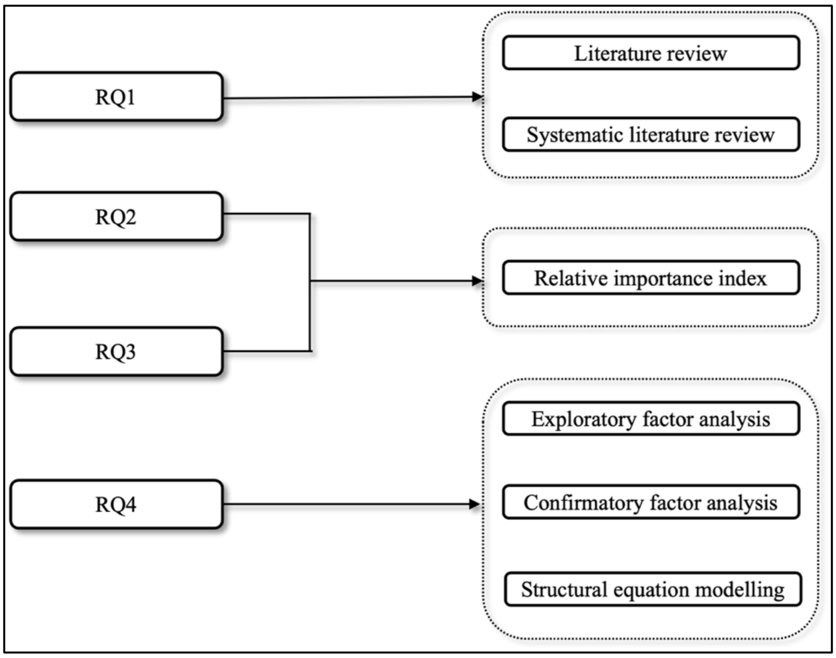

Figure 1.1 Methods employed to address the research questions

The first question is concerned with assessing the current state of literature as an exploratory study regarding the performance of port sustainability and its evaluation in terms of port operations and management. A systematic literature review is used to synthesise sustainability indicators regarding environmental, social, and economic aspects, and port sustainability activities are defined. The second and third questions focus on providing a holistic view of meaningful sustainability activities by quantifying the data collected from a questionnaire survey for the relative importance weight using the Relative Importance Index method as an analytical technique. The fourth question concerns examining the statistical relationship between port sustainability performance and competitive advantage, which is addressed using Structural Equation Modelling (SEM), including Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA).

1.4 Structure of the thesis

This thesis consists of nine chapters, which are arranged as illustrated in Figure 1.2.

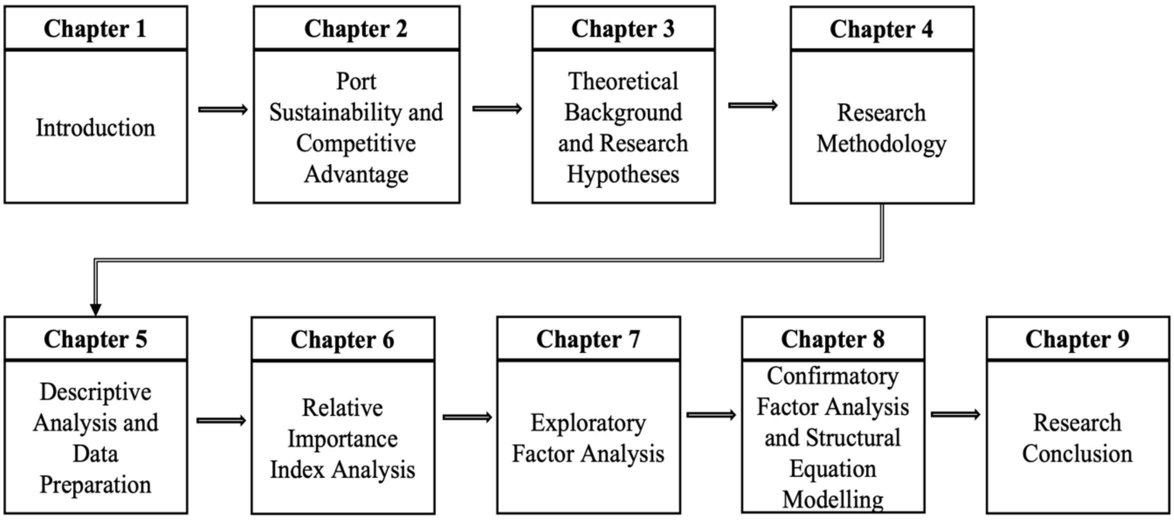

Figure 1.2 Thesis structure

The first four chapters of the thesis provide the conceptual and theoretical underpinning of the research, through which the research topic is discussed, research gaps are identified, and methodological positioning is justified.

Chapter 1 provides an introduction to the study, covering the research motivation, research aim and questions, and structure of the thesis.

Chapter 2 examines the extant literature review relevant to this study through narrative and structured literature reviews. The central concept of sustainability in the port industry is explained, and the knowledge of competitive advantage is explored to define the boundaries of this thesis. This chapter also includes a systematic literature review to investigate the current issues and characteristics of sustainability performance in container ports. This approach contributes to identifying factors supporting sustainability management and establishing the key sustainability activities used in conducting empirical analyses in the current research.

Chapter 3 discusses the theoretical background on which this study is based. By adopting a strategy-practice view and a Natural-Resource-Based View, this chapter presents a research model and study hypotheses to examine the relationship between port sustainability performance and competitive advantage.

Chapter 4 addresses the methodological issues of the study. This includes research philosophical position, research approach, research strategy, and data collection and analysis methods. In association with the systematic literature review in Chapter 2, the methodological status of port sustainability performance research is examined to provide the justification of the methodological choices of this study. This chapter also delineates the procedures of data collection methods and analysis techniques of this research.

The following four chapters present the findings of empirical analysis of the research. Each chapter commences with an overview of its purpose, method, and the way in which the research is carried out. At the end of each chapter, a summary of the results of the analysis is provided.

Chapter 5 provides descriptive statistics of the data collected from the questionnaire survey with regard to the demographic profile of participants and the results of their responses to the survey questions. This chapter also discusses data preparation and screening procedures for further analysis, including the treatment of missing data and outliers.

Chapter 6 examines the relative importance of sustainability activities by quantifying the degree to which each activity is perceived as strengthening the competitive positioning of ports. This chapter contributes to identifying the most influential sustainability activities by characteristics category of ports and respondents and raking them based on the relative importance index analysis results.

Chapter 7 conducts EFA as a preliminary statistical procedure for further multivariate analyses, namely confirmatory factor analysis and structural equation modelling (Chapter 8). This chapter provides the results of testing the assumptions of factor analysis and the structure and interrelationships of the variables, contributing to the refinement of the initial research variables.

Chapter 8 examines the research model of the study and tests the study hypotheses. In this chapter, four measurement models, which are Competitive advantage, Environmental sustainability, Social sustainability, and Economic sustainability, are firstly validated using CFA. Subsequently, the hypothesised relationships among these four constructs are tested using SEM.

The findings of the study are presented in the final chapter.

Chapter 9 provides the conclusion of this study, drawn together by the work of preceding chapters. This chapter highlights the discussion of research findings, theoretical implications, practical implications, contributions to knowledge. It also discusses the limitations of this study and future research directions are suggested.

The nine chapters are supported by six appendices, each of which provides supplementary information to support the study.

Appendix A provides a systematic literature review published in Transportation Research Part D: Transport and Environment, which contains the entire procedure and results of the review.

Appendix B presents the material regarding the ethical considerations of this study, providing the questionnaire in the study and copies of research ethics forms approved by Cardiff University.

Appendix C presents the results of the non-bias test to determine the issue of non-response bias.

Appendix D considers multivariate outliers, which are detected in the data collected using the Mahalanobis D^2 measure.

Appendix E presents bivariate scatterplots of variables to examine the assumption of homoscedasticity.

Appendix F provides the component loading plots to confirm the issue of cross-loading between competitive advantage and social sustainability variables and social sustainability and economic sustainability variables.

Chapter 2. Port Sustainability and Competitive Advantage

This chapter provides a fundamental understanding of this research concerning relevant concepts and academic contributions to the sustainability performance field of study in the context of port operations and management. Firstly, the general definition of sustainable development is presented, and the concept of port sustainability in the study is understood. Secondly, the academic interest in port sustainability performance is addressed by conducting a systematic literature review. Evaluating the existing literature through scientific procedure aims to: (1) describe important similarities in ideas and findings in the field of port sustainability performance research; (2) to synthesise diverse evidence from existing data for the primary research investigation of this study; (3) identify gaps in the previous literature. Finally, this chapter presents clear research directions for the current study by providing a summary of research gaps.

2.1. Sustainability inside the port industry

The concept of sustainable development emerged in response to concerns about environmental degradation resulting from irresponsible exploitation of resources for economic growth in the 1960s (McKenzie 2004). Its fundamental idea is that natural systems have been severely impacted by human activities for development, leading to environmental degradation, resource depletion, poverty, inequity in power among countries and governments, and thus, human society should be responsible for the current decisions of economic progress. Given the finite character of nature, it has become essential to move away from the exploitative economic paradigm and transform it into a new course capable of restoring essential ecosystem functions without alteration (Johnston et al. 2007). As the call for such changes increases, sustainable development has been ingrained in all congeries of societies to date. Multitudinous governments, businesses, organisations, and industries, including the port industry, have reorganised management structures and taken thousands of global, national, and local initiatives regarding sustainable development. It is perhaps one of the few areas of consensus on the need for transformation along with its importance being reached among disparate groups of the world.

2.1.1 The definition of sustainability

The core notion of sustainable development was the most influentially articulated and popularised by the Brundtland Commission's report, *Our Common Future* (WCED 1987), which underlined it as a path of poverty alleviation, environmental improvement, social equitability, economic prosperity, and political advancement. The report defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987, p. 43). Although this definition has been subject to much criticism (see Owens 2003; Castro 2004), it has been highly instrumental in developing a new global view with respect to humans' future (Mebratu 1998). Institutional mechanisms have been recalibrated for socio-cultural changes that pursue the ethical principle of equity between the present and future generation and guarantee "the security, well-being, and very survival of the planet" (WCED 1987, p. 23).

Since the Brundtland's report, great efforts have been made to understand and decipher what sustainable development really means. It has been variously interpreted in manifold fields, and the different ways of achieving it have been suggested from interdisciplinary and multicultural perspectives, for example, alteration of values (Clark 1989), ecological economics (Gore 1992), sensible management (Lee 1993), sustained values (Ludwig et al. 1993), development of ethics in the environment (Rolston 1994), or transformation of systems toward a desired future or better world (Viederman 1994; Gladwin et al. 1995). The diverse understandings of the concept of sustainable development have led to many concerns about its twisted usages, such as making it meaningless in practice, or worse, destroying its integrity by advocating socially or environmentally unsound practices (Robert et al. 2005). Despite these critiques and openness to interpretation, the fundamental principle underlying the concept is consistent: the continuous development of current conditions to achieve a shared goal embracing ecology, economics, politics, and social well-being (Pearson 1985; McKenzie 2004).

The terminology of "sustainable development" has been interchangeably used with "sustainability" as a whole by most researchers and practitioners (see Gladwin et al. 1995; McKenzie 2004; Owens 2003; Johnston et al. 2007), in the sense that both embrace consistency in their fundamental principles and constructions (Glavič and Lukman 2007). However, there is the argument that two terms should be understood as different notions from semantic point of views (e.g. Lélé 1991). Sustainability is regarded as long-term goals or ideas for development efforts while sustainable development as reflected in its word emphasises a characteristic of a process in which the changes of environment, society, and economy are in harmony. Thus, this study considers “sustainable development” as a progressive transformation of human society to move towards desired goals of “sustainability” where humane ecosystem equilibrium is achieved, and its state is capable of being sustained indefinitely at a certain rate for level (Shaker 2019).

Sustainable development posits a dynamic system approach that is integrated and intersectional of developmental objectives to work towards a common sustainable future from a long-term perspective (UNCED 1992). This understanding is usually embodied with overlapping circles of environmental, social, and economic aspects, as shown in Figure 2.1.

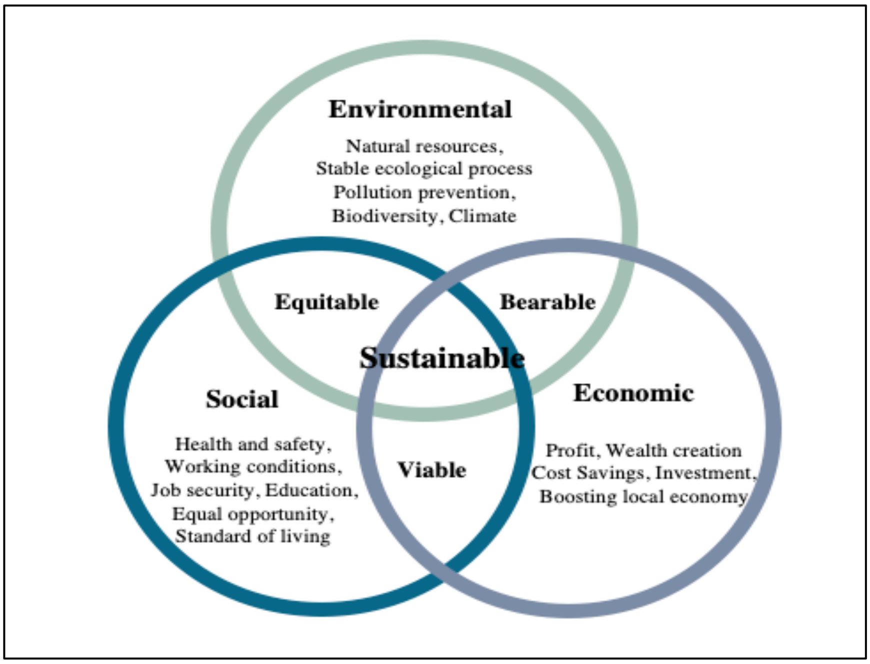

Figure 2.1 Three aspects of sustainable development (Source: Author)

It indicates that they are mutually interacting and reinforcing, but not all three are exclusive realms, nor are they nested into one (Giddings et al. 2002). In other words, a balanced mechanism for human and natural systems is regulated only when the three aspects are explicitly and simultaneously interconnected to each other, enabling the viability of all ecosystems, including human-based systems, to be balanced and kept functional. This balanced viability consequently facilitates controlling the state of a system and maintains at a balanced level, allowing the ecosystem’s ability to work everlastingly, i.e. to reach a state of sustainability (Hjorth and Bagheri 2006).

The environmental aspect of sustainability involves conserving natural resources and increasing biological capacity to support stable ecological processes and the continued environmental performance of an ecosystem (Giddings et al. 2002). Given that the resource use or production by humans fundamentally depend on the flow of ecosystems intensively managed and modified, environmental sustainability corresponds to the interaction of human activities with the functioning of supporting ecosystems (Morelli 2011). From Brundtland's perspective, environmental sustainability delineates a state of balanced, resilient, and interconnected human society to continuously regenerate the services without compromising the capacity of its supporting ecosystems by our actions diminishing biological diversity.

The social aspect of sustainability can be defined as "a positive condition within communities, and a process within communities that can achieve that condition" (McKenzie 2004, p. 12). While the ultimate goals of sustainability are said to achieve the balanced and coherent development among environmental, social, and economic domains (Murphy 2012), the role of social sustainability, in fact, has rarely received an equal level of attention to other domains (McKenzie 2004; Cuthill 2010), with critics on the conceptual vagueness of the meaning and objectives of social sustainability (see Dempsey et al. 2011; Vifell and Soneryd 2012). Barron and Gauntlet (2002) also noted that, "… while there has been considerable work done on the environmental and economic aspects, the social has tended to fall off the sustainability agenda". However, social sustainability has been increasingly becoming an essential component because it reflects cultural and ethical frameworks to find sustainable solutions (Vavik and Keitsch 2010).

From an economic standpoint, economic sustainability focuses on identifying ways of minimising costs or business continuity and reducing social costs for environmental impacts caused by activities of organisations, and of maximising revenue from environmental assets while at the same time maintaining desirable levels of environmental resources (Giddings et al. 2002; Duić et al. 2015). Economists are inclined to justify the exploitation of natural resources on account of the inevitability of economic growth and avoid addressing the issue of sustainability (Glavič and Lukman 2007). Meanwhile, there has been a growing recognition that environmental issues cannot be separated from economic development. Maximising the economic performance results from implementing sustainable development initiatives without adversely affecting social and environmental development (Cabezas-Basurko et al. 2008).

2.1.2 Developing the concept of sustainability in terms of port operation and management

Two international conferences have contributed to expanding the global awareness of the human impact on the environment and providing a foundation of subsequent various environmental conventions, laws, and agreements beyond the limits of national jurisdiction: the United Nations Conference on the Human Environment in 1972, known as the Stockholm Conference; and the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in 1992, also referred to as the Earth Summit. These conferences have contributed significantly to outlining a vision of sustainable development and a general convergent set of strategies and tactics for reaching a globally sustainable future. The guidelines provided by the conferences also awakened international organisations in the maritime industry, such as the International Maritime Organisation (IMO), to the environmental impacts of maritime activities and broadening actions on the preservation and enhancement of the port environment. However, they were not detailed enough to forge functional action plans towards sustainable development in the maritime sector.

In the maritime industry history, the International Conference on Marine Pollution by the International Maritime Consultative Organisation in 1973 (IMCO)—later named the International Maritime Organisation in 1982—made the concentrated efforts into sustainable development of the maritime sector. A total of 79 countries developed and agreed on the convention towards the sustainable maritime industry, which focused on reducing pollution caused by a wide range of shipping-related activities, for example, oil discharge, bulk liquid or dry noxious substances, noxious substances in cargos and containers, shipboard sewage, and ship-generated garbage (Waldichuk 1973). While this conference provided the specified sustainable development plan for maritime transport, it was more related to ship operations rather than ports themselves. The pursuit of sustainable development of port organisations has become increasingly important as ports are the sites where seagoing vessels generating major pollutants operate. The operational activities occurring in port areas have consumed an intense amount of energy and resources and have generated detrimental consequences on sea, land, and air such as water discharge, noise, dust, effluent, greenhouse gas emissions, and dredging as well as security, safety, and health issues of employees, which have accelerated the proliferation of sustainability concept in the port industry (UNCTAD 1993; Peris-Mora et al. 2005; Acciaro et al. 2014).

Table 2.1 Port sustainability defined by international organisations in the maritime sector

Organisation	Definition of port sustainability
American Association of Port Authorities (AAPA)	For ports, sustainability means business strategies and activities that meet the current and future needs of the enterprise and its stakeholders, while protecting and sustaining human and natural resources. Recognizing that each port operates within a unique business, political, environmental and social context, we further our sustainability resolve by putting forth guiding principles for consideration by member ports.
Association of Australian Ports and Marine Authorities (AAPMA)	Australian ports see sustainability planning as essential to business success for both the present and the future, to ensure we have an environment that is operational over the long-term and is supported by those we operate and interact with, creating positive change to future generation.
Associated British Ports (ABP)	As the leading port operator in the UK, our goal is to be the centre of Clean Growth by transforming our ports and terminals into low carbon, resilient hubs, which can help build the sustainable supply chains of the future. We share our objectives for safety, sustainability, environmental protection, employee wellbeing and promoting UK trade and job generation with our customers, contributing to positive change.
The British Ports Association (BPA)	The British Ports Association is committed to grasping a sustainable development framework in the UK that preserves our incredible natural environment and habitats whilst giving port greater certainty and the ability to grow sustainably. Careful management of our seas and waters is key to a sustainable future and ports and harbours will continue to provide safe, secure, and sustainable operations.
Department of the Environment, Transport and Regions (The UK government policy statement 1998)	Social progress which recognizes the needs of everyone; effective protection of the environment, limiting global effects; efficient use of natural resources; and maintenance of high and stable levels of economic growth and employment.
The European Sea Ports Organisation (ESPO)	Ports as facilitators in helping the whole port community including partners in the logistic chain should deliver compliance with legislation, prevention of pollution, reduction and mitigation of environmental impacts, sustainable development and evidence of satisfactory performance.
International Association of Ports and Harbours (IAPH)	Ports require commitment to a cleaner, safer and more environmentally sustainable industry with greater efficiency for the benefit of the global community.
International Maritime Organisation (IMO)	Sustainable development objective for a port 'involves a balancing proves which ensures harmony, safeguarding the short-term commercial performance of the port and its industry, yet aiming at viability in the long term'. This should cover the needs to find the best and most effective balance between economic development and environmental protection, pursuing high degree of cost efficiency, and each port should develop and adopt different policies and strategies for implementing environmental necessities and practical economic in harmony.
PIANC, The World Association for Waterborne Transport Infrastructure	Sustainable waterborne transportation is interpreted as the long-term maintenance of environmental, economic, and social well-being. Waterborne transportation systems can provide opportunities to meet these demands while reducing congestion, emissions, and fragmentation.
World Port Sustainability Program (WPSP)	The world ports sustainability program aims to demonstrate global leadership of ports in contributing to the sustainable development goals of the United Nations, engaging with business, governmental and social stakeholders in creating sustainable added value for the local communities and wider regions in which their ports are embedded. The projects are mainly focused in five aspects toward sustainable development of ports: Environment climate and energy; Resilient infrastructure; Governance and ethics; Corporate citizenship; Health, safety, and security.

There is neither a universalised definition nor a set of guidelines for defining port sustainability (Cabezas-Basurko et al. 2008), but various international organisations establish many applicable definitions and interpretations. The definition of sustainability in the maritime sector is summarised in Table 2.1.

The basic features of the definition of a sustainable port that they are proposing are as follows:

1. It integrates the primary principles of sustainable development (interconnected environmental, social, and economic development).
2. It ensures both the short-term outcomes of port performance (business success) and the long-term value-added through the positive transition to stability and viability.
3. It is operational and manageable as business plans and activities.

According to the proposed features, port sustainability is conceptualised by the simultaneous long-term pursuit of economic prosperity, environmental quality, and social responsibility. A sustainable port is required to be "economically viable" to "achieve their missions and contribute to the economic prosperity of their regions and nations" (Cheon and Deakin 2010, p. 11). Port sustainability should also be reflected by business strategies or systems which make it possible to measure its impacts (Chatzinikolau and Ventikos 2011). Based on the previous literature and the relevant maritime organisations' viewpoints, port sustainability in this study is defined as a long-term business strategy to seek safe, socially, and environmentally acceptable port management while increasing the capacity of creating economic profits.

Port sustainability is rooted in the three aspects of sustainable development (so-called triple bottom line) that entail environmental, social, and economic goals, which are inextricably linked (Figure 2.2). Practical and multidisciplinary management approaches are required to integrate the socio-economic, legal, technical, and environmental practices, thereby analysing the performance of sustainable responsibilities with appropriate data of components of sustainability (Wooldridge et al. 1999).

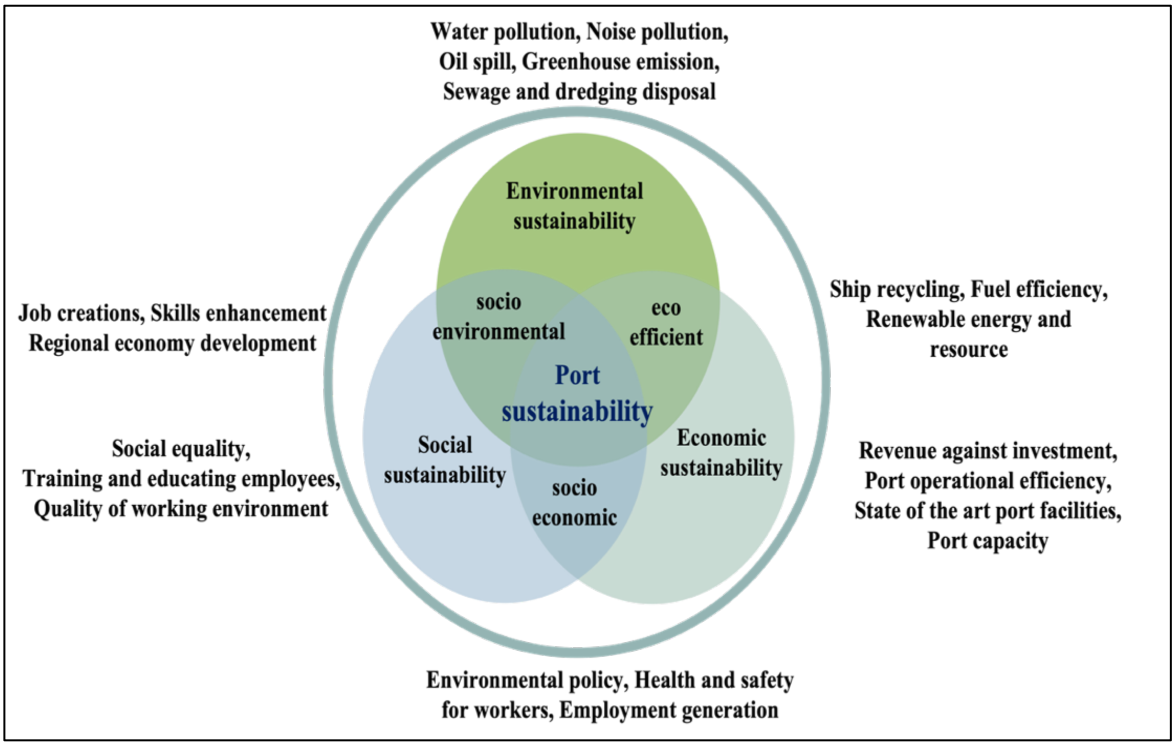

Figure 2.2 Three aspects of sustainability in the context of ports (Source: Author)

Each aspect of port sustainability can be defined as follows:

- The environmental aspect of port sustainability involves minimising the negative impacts generated by the activities of ships and a wide range of operational implementation within the vicinity of the port (Narula 2014; Shiau and Chuang 2015). Its main issues are the reduction of air emissions from multifarious operational activities, the conservation of natural resources, and the contamination management of water, wastes, odour, soil within the ambit of ports.
- The social aspect of port sustainability focuses on enhancing people's quality of life by supporting port activities that satisfy socio-economic priorities. Examples include employment opportunities, social equality, human rights, work conditions, education for employees and communities, and improving the quality of life around the port (Narula 2014). Port social sustainability emphasises the interaction and relationship between port and people as well as city, ultimately attempting to fulfil the viability of the areas surrounding the port (ESPO 2012).
- The economic sustainability in the port industry is concerned with the economic feasibility of ports by possessing the capability to increase their profitability. Port should seek to maximise their economic performance through efficient operations

and the provision of services and facilities that port users are satisfied with, without adversely affecting social and environmental development (Cabezas-Basurko et al. 2008).

2.2 Perspectives on sustainability within the port industry

The interest in sustainability management in the port industry has been found from a variety of viewpoints: the study on sustainable port logistics system (see Li and Yang 2010; Martinsen and Björklund 2012; Kutkaitis et al. 2014; Psaraftis 2016; Zheng et al. 2020); the environmental impact costs of shipping operations and management on ports (see Ng and Song 2010; Lun et al. 2016; Spengler and Tovar 2022); the analysis of exhaust emissions from vessels activities in port areas (see Abrutytė et al. 2014; Winnes et al. 2015; Papaefthimiou et al. 2016; Martínez-Moya et al. 2019; Kose et al. 2022); and the development of regulatory and political frameworks for environmental port management (see Wooldridge et al. 1999; Gilman 2003; Di Vaio and Varriale 2018; Christodoulou and Cullinane 2019; Teerawattana and Yang 2019).

Considerable academic commitment has been to integrating sustainability issues into port management and operations by identifying a variety of policies, actions, decrees, practices, and initiatives (e.g. I2S2 2010; Homsombat et al. 2013; Shiau and Chung 2015; Hossain et al. 2019; Hua et al. 2020). For example, Abood (2007) investigated sustainability initiatives related to port development and operational activities and classified them into a green rating system. Kim and Chiang (2017) made an effort to conceptualise the structures and attributes of port sustainability practices from an operational perspective using semi-structured interviews. In addition, with the need to take the integration of sustainability concerns into port activities (Beleya et al. 2015; Roh et al. 2016), research related to port sustainability has been focused on daily port activities such as loading and unloading, dredging, material disposal. Critical environmental issues of port operations have been identified such as processed oil, exhaust emissions, renewable energy, energy-efficient, noise, waste, and other polluting substances (e.g. Bateman 1996; Rao et al. 2000; Joseph et al. 2009; Lashin and Shata 2012; Tan et al. 2018; Iris and Lam 2019; Fredianelli et al. 2021). According to Özispa and Arabelen (2018) and Lim et al. (2019), a great number of studies on port sustainability studies from 2005 to 2018 have covered the environmental aspect, and the social aspect has been scarcely considered. In the recent years, however, it has been observed that more studies have contributed to expanding port sustainability by considering social sustainability factors, such as port occupational health and safety (Gul 2020; Shan 2021), port employees' job satisfaction (Mira et al. 2019; Liu et al. 2021), port stakeholder relationship (Vitellaro et al. (2021), and gender equality in the port industry (Barreiro-Gen et al. 2021).

From an economic perspective, port authorities, in most cases, serve as private organisations aiming at maximising profits with less financial investment (Van den Berg and De Langen 2017). A challenge for profit-driven organisations when moving towards sustainability management is how to integrate environmental and social management with economic business goals (Wagner and Schaltegger 2003). In this sense, sustainable economic growth is the most critical issue for port authorities, and an ongoing debate has been focused on the financial feasibility of implementing sustainability performance (Nebot et al. 2017). It has provoked the surge in the port sustainability research that demonstrates the economic performance of port sustainability (e.g. Park and Yeo 2012; Kutkaitis et al. 2014; Liao et al. 2016; Puig et al. 2015b; Wan et al. 2018).

When it comes to evaluating the economic performance of organisations, efficiency and effectiveness are the most common measures for identifying the success or improvement opportunities of the current initiatives (Bartuševičienė and Šakalytė 2013). Organisations evaluate their operational efficiency by measuring the relationship between input and output ratio, which is used to reflect the optimal use of resources to achieve the desired output by the improvement of internal processes of organisations (Bartuševičienė and Šakalytė 2013). The effectiveness focuses on measuring the extent to which an organisation reaches the level of the financial and nonfinancial achievement of the ongoing process, mission, or strategy that the organisation expects to create value (de Waal and Kourtit 2013). Productivity, social responsibility, safety, competencies, and process quality can be included in the effectiveness assessment (de Waal and Kourtit 2013). The two performance assessment approaches facilitate organisations to gain competitive advantage in management, productivity, and profitability in the industry by understanding the business strategy and process and reacting and adapting to external changes efficiently (Bounds et al. 1995). In a similar context, the existing performance evaluation of port sustainability is typically classified into three major categories: measuring the economic efficiency of sustainability management; evaluating sustainability system effectiveness; and developing indicators for port sustainability performance assessment.

The first research stream has focused on the joint evaluation of economic and environmental efficiency and has provided evidence that the undesirable outputs from port activities and operations, such as carbon emission, waste generation, and energy consumption, do adversely affect the whole operational efficiency of ports (see Martínez-Moya et al. 2019; Park et al. 2019; Jiang et al. 2020). For example, Berechman and Tseng (2012) confirmed that the inefficient environmental management had a large financial impact by incurring environmental costs of port-related emissions, which were estimated at over $123 million per year. Furthermore, Castellano et al. (2020) evaluated the environmental and economic efficiency of 24 Italian ports. Their empirical evidence showed that ports with the lowest environmental impact had a substantial performance improvement in efficiency, highlighting that eco-environmental efficiency can support the competitiveness of ports by allowing them to gain the expected performance. These studies imply that efficient environmental management at the operational level enables to prevent a considerable financial impact by high operative costs of use of fuels and resources.

The second research stream, which is related to the evaluation of the effectiveness of sustainability, has been addressed with the view to determining the relationship between economic effectiveness and sustainability objectives. For example, Lu et al. (2016) examined the effects of sustainable supply chain management on port sustainability performance. Also, Asgari et al. (2015), Laxe et al. (2016), and Cheon et al. (2017) analysed the relationship between economic and environmental performance in the port context. As far as the effective environmental performance of port activities, atmospheric and water pollution have been mainly taken into account, and well-managed environmental activities produced economic benefits to ports.

In terms of the last research stream, the majority of research has developed key indicators from the multitude of port activities related to sustainable operations and management. The concept of sustainability is entangled with a multitude of internal and external factors, and thus it is complicated to define evaluation criteria and assess the performance of sustainability (Robert et al. 2005; Dixon et al. 2008; Magee et al. 2013). This complexity has contributed to the development of a variety of qualitative and quantitative indicators for evaluating the performance of sustainability in the port industry (Lirn et al. 2013; Puig et al. 2015a) using weighting tools and evaluation methods, such as Environmental Management System (EMS), Analytic Hierarchy Process (AHP), and synthetic index calculation methodology (see Chiu et al. 2014; Le et al. 2014; Liao et al. 2016; Lu et al. 2016b; Laxe et al. 2017; Oh et al. 2018; Rodrigues et al. 2021; Stanković et al. 2021). However, the massive collection of activities and indicators identified from different techniques could make it more complicated to evaluate port sustainability performance and to determine appropriate indicators or activities that ports should take into account in establishing an operational strategy for successful sustainability performance.

2.2.1 A systematic literature review regarding port sustainability performance

The current study conducted a systematic literature review for a deeper understanding of the current state of academic interest regarding port sustainability performance, which is the focus of the current study. A systematic literature review is defined as "a systematic, explicit and reproducible method for identifying, evaluating and synthesising the existing body of completed and recorded work produced by researchers, scholars, and practitioners" (Fink 2005, p. 3). It has become a popular method in that it is particularly useful to explore background knowledge in a specific research area and to synthesise existing original data from primary research through the literature investigation with scientific relevance (Petticrew and Roberts 2008; Gu and Lago 2009). The systematic literature review in this study was adopted for the three purposes: firstly, to explore the issues and characteristics of the existing literature regarding sustainability management and performance in container ports; secondly, to synthesise analytical evidence of port sustainability performance; and lastly, to identify opportunities and directions for the current study.

The systematic literature review of the current study has been published in an academic journal, which is attached in Appendix A where the full procedure and results of the review are presented. An initial search identified a total of 704 papers from 1990 to 2018 using keyword combinations. The first filtering step was conducted with inclusion and exclusion criteria, and the number of articles was reduced to 68. In the second filtering step, quality criteria that enable more focused and relevant classification were applied (Pittaway et al. 2004, Petticrew and Roberts 2008; Easterby-Smith et al. 2012), and the number of articles was reduced to 32. Lastly, after the assessment of the full context of the papers, a total of 21 articles were selected for the systematic literature review. The final number of 21 papers (a 97% reduction from the original 704 papers) aligns with other studies of this type, ranging between 95% and 98% (see Miemczyk et al. 2012; Abidi et al. 2014; Gimenez and Tachizawa 2012; Tachizawa and Wong 2014).

The systematic literature review provided a descriptive overview of the information by analysing the main characteristics of the articles and methodological and empirical features and synthesising important data and findings regarding the performance and evaluation of sustainability management in container ports. The analysis focused on the similarities within diverse evidence in order to understand the mechanism of port sustainability evaluation and to develop a further understanding and directions for future research. The focal points of the review were on the trends in the academic interest of the sustainability performance of ports, in terms of geographical features, research methods and analysis techniques, and synthesis of empirical evidence related to sustainability management. The overall summary of the analysis and synthesis of the review is as follows.

2.2.2 The characteristics of port sustainability performance research

From 2005 to 2018, the 21 studies were identified with respect to sustainability performance and assessment in the context of port operations and management. It indicates that the evaluation studies on port sustainability performance are still an emerging field of research, showing more academic attention is needed in this field. A continuous increase in the number of papers each year suggests that empirical and practical approaches have been emphasised to identify challenges in port sustainability performance from an economic perspective, under pressure on compliance of international environmental and social responsibility and attentions in container ports (Lun 2011; Liao et al. 2016).

Geographical location was analysed to identify the distribution of academic interest in this field. The greatest density was found in the Asian region, with Taiwanese and Chinese ports being the most frequently researched ports, followed by ports in South Korea and Spain. This result can be supported by the fact that there are the largest and busiest ports concentrated in Asia, which handle the highest container throughput in the world, and regulations addressing the environmental impact caused by their activities have been strengthened (Chen and Pak 2017). Furthermore, studies have been increasingly involved in the effectiveness and feasibility of port sustainability implementation in Asian ports, reflecting pervasive doubts among Asian ports that financial gains are not sufficient by implementing sustainable practices (Yang et al. 2013; Acciaro 2015).

When it comes to the aspects of sustainability studied, it is worth noting that the social aspect of sustainability has been overlooked. None of the papers focused on the social aspect only, and the social aspect was investigated along with other aspects. On the other hand, most papers investigated the sustainable performance of ports from an environmental perspective, and the number of papers increased further when considering foci overlap with social and economic aspects. More importantly, they focused only on one or two aspects of sustainability, and none of the papers provided a holistic view by including all three aspects of sustainability.

In the early 2010s, research on port sustainability have been predominantly examined from the environmental and economic aspects, overlooking port operations and management from the social impact perspective. This phenomenon is also in line with other disciplines, such as transport (Zhao et al. 2020), logistics (Qaiser et al. 2017), multi-tier supply chain (Govindan et al. 2021), corporate entrepreneurship (Das et al. 2020), and business management (Mio 2020), which have identified the unequal level of attention in social sustainability management compared to the environmental aspect. On one hand, Liao et al. (2016) argued that the concept of green port has been developed from the operational impacts of ports on the environment, and port sustainability performance has relied on evaluating the attainment of environmental requirements. On the other hand, Mckenzie (2004) argued that the rationale for the biased investigation of sustainability aspects was attributed to difficulties to assess social impacts quantitatively with quantitative measures. Adding to that, there has been an argument that social sustainability tended to be interpreted subjectively and understood as the most theoretically ambiguous dimension, and thus, social concerns have been mainly regarded as sub-activities or complementary of environmental and economic concerns rather than a distinct and separable scope (Ajmal et al. 2018).

Notwithstanding of the vague characteristics of social sustainability, it has been recently emphasised that it is critical to consider port operations and management including social sustainability factors. De Martino (2021) argued creating value from port social roles for the community and the network with stakeholders could contribute to maintaining financial viability, highlighting a comprehensive and systematic view of value creation logic through not just ecological but social outcomes of ports. This argument supports the rising emphasis on the integrated approach, including the social aspect of port sustainability for a feasible fulfilment of ultimate environmental responsibility and solid progress in sustainability (Shin et al. 2018; Hossain et al. 2019). Such academic focus is also reflected in port performance studies, which show the attempts to include the social factors of sustainability with a recent considerable increase. Stanković et al. (2021) expanded sustainability indices by encompassing all aspects of sustainability (environmental, social, and economic), contributing to the development of synthetic measuring for sustainability performance in the Mediterranean port regions. Sulaiman et al. (2021) analysed Belawan port sustainability performance from ecology, economy, technology, social culture, institutions and law aspects based on the UN's Sustainable Development Goals. MacNeil et al. (2021) also utilised an international standard, the Global Reporting Initiative, and contributed to developing unified port sustainability strategies. Argyriou et al. (2021) explored the integrated approach to measure sustainable operations policy in Souda port by including environmental, energy, technological, economic, and social aspects. Their analysis results underlined the impact of port social performance on the constructive decision-making for sustainability strategy by confirming that staff safety, service security, and employee training for skill building were the most critical measures. Such recent attention in the port research area buttresses the need for research on evaluating port sustainability performance from a holistic view that encompasses all three sustainability aspects.

Since successful performance assessment depends on establishing accurate indicators as a criterion for measurement, most research has been involved in identifying sustainability indicators for evaluating port sustainability performance. The indicators for sustainability performance evaluation were mainly developed based on green management and operation currently implemented by ports or on sustainable development evaluation guidelines provided by international organisations. The indicators developed are considered the most representative of port activities by being confirmed and prioritised by the recognition of experts in the port industry, such as researchers in academia, port authorities, terminal operators, and shipping companies (Rodrigues et al. 2021). In addition, Analytic Hierarchy Process (AHP) was the most favoured method for the purpose of establishing key indicators, followed by the Delphi method and Data Envelopment Analysis (DEA) in evaluating and measuring port sustainability performance.

Table 2.2 Clustering of analytical sustainability indicators

Aspect of sustainability	**The most identified indicators by researchers (Number of papers)**	**Dominant research (%)**
Environmental aspect (10 indicators)	Water pollution management (16) Air pollution management (14) Energy and resource usage (11) Noise pollution (9) Green port management (8) Ecosystem and habitats (6) Soil pollution management and occupation (5) Waste pollution management (4) Green construction and facilities (3) Odour pollution management (1)	Environmental Pollution (64%)
Social aspect (8 indicators)	Health and safety (7) Job generation and security (5) Job training (4) Public relations (2) Gender equality (2) Social image (1) Quality of living environment (1) Social participation (1)	Human Resources Management (78%)
Economic aspect (11 indicators)	Foreign direct investment (4) Value generated productivity (2) Port operational efficiency (2) High quality business services (2) Benefits from external stakeholders (2) Port development funding (2) Port infrastructure construction (2) Port throughput (2) GDP (1) Operating costs/revenue (1) Cost-efficiency (1)	Port Management (38%) Investment (19%)

The most frequently identified sustainability indicators are summarised in Table 2.2. From an environmental aspect, the most studied indicators were *Water pollution management, Air pollution management, Energy and resource usage,* and *Noise pollutio*n. Most of the environmental indicators were associated with port operational aspects, addressing negative environmental consequences resulting from port activities (Puig et al. 2014). In terms of the social aspect, the most frequently used indicators by researchers and experts were related to human resources management, such as *Health and safety, Job generation and security,* and *Job training* among the eight social activities. Lastly, the most frequently identified economic indicator was *Foreign Direct Investment*, and other economic sustainability indicators accounted for similar frequencies.

2.2.3 Summary of the systematic literature review

The systematic literature review identified that only recently has there been growing interest in the evaluation of port sustainability performance. Although the concept of sustainable development has been influentially proliferated in the maritime industry after the Rio conference in 1992, Hakam and Solvang (2013) confirmed that the academic interest in sustainability in the port industry has surged since 2004 and peaked in 2012. This implies that the saturation level of academic contributions has not reached yet in this field, raising the need for more research regarding port sustainability performance. Also, as the UN has presented more actionable targets and indicators for the 2030 Agenda for Sustainable Development in 2015, it is timely to assess the benefits from the current green practices and operations of ports and to identify opportunities for improvements in future performance. Additionally, although there has been an increasing interest in port social sustainability, it is far less than environmental and economic sustainability. A lack of attention to social sustainability can hinder ports from assessing the impacts of social sustainability performance and establishing comprehensive and detailed plans to realise authentic sustainable development in the port industry. Sustainable performance of ports can be fulfilled only when environmental, social, and economic concerns are taken into consideration together in the decision-making process of sustainability management in ports. This lack of the previous literature motivates to conduct research that encompasses all three aspects of sustainability.

Furthermore, the previous research implies that the adoption of green management practices generates an economic benefit in effectiveness and efficiency of strategic port operation such as energy efficiency and operational costs reductions. Although some studies have made efforts to elucidate the relationship between sustainable operations and management of ports and their economic benefits to ports (e.g. Lun 2011), most research involved in the empirical analysis has focused on providing a set of indicators for the assessment of port sustainability performance. Few statistical analyses have been demonstrated in explaining the implementation of sustainability integrated into daily practices and activities of ports and its impacts on organisational performance. More importantly, up to date, few studies have empirically addressed the impacts of port sustainability performance on competitive positioning that is considered as one of the measures for organisational performance (see Adams et al. 2009; Oh et al. 2018). In this regard, it is difficult for ports to be convinced of substantial investment for implementation towards sustainable port growth, and it is required to validate port sustainability performance and its economic value in terms of gaining competitive advantage of ports.

2.3. Competitive advantage and sustainability performance

As the globalisation of the market expands the connection of economics, policies, and cultures with different societies, the market structure has become more sophisticated, and competition has intensified (Köhler 2014). Furthermore, moving toward sustainable development directions inevitably requires businesses to transform organisational systems and management practices, which accordingly change the competitive structure of industries in products, services, regulations, and competitive opportunities (Shrivastava 1995). Such increased competition and change were no exception in the field of the maritime transport sector. Container shipping, the core of the global service industry, has undergone overcapacity and low rates under intense competitive pressures (Brooks 1993). Ports also face reduced demands and the increasing control by a single line or alliance due to mergers and acquisitions among the shipping lines, and pressures to comply with international requirements of sustainable development. These have caused serious competition among ports to attract port customers (Tongzon and Sawant 2007). In this circumstance, many organisations, including ports, have moved away from the traditional goal of achieving operational efficiency and have begun pursuing strategies to determine the value of competitive advantage in an effort to survive in the global marketplace (McClell 1994; Li et al. 2006).

2.3.1 Understanding competitive advantage

Competitive advantage has been a cornerstone of understanding the success of organisations and accepted across strategy, economic, marketing, and human resource management as it explains what makes one organisation superior in performance to others (Sigalas 2015). In strategic management, a traditional interest of organisational phenomena has been placed in "strategy implementation", developing ideas and theories from organisational economic perspectives such as agency theory, leadership, and individual and group decision making (Barney and Zajac 1994). However, as some of the studies were failed to explain the process of strategy implementation of a firm's strategy from a competitive context, the argument emerged that the strategy implementation skills should take into account the competition context of a particular market in which a firm's strategy was operated (Barney and Zajac 1994). The argument has underlined the concept of competitive advantage that a firm can compete and sustain success in the market by developing diverse initiatives to improve its competitive context and outperform its competitors (Raduan et al. 2009).

From a semantics viewpoint, competitive advantage refers to the capability to compete successfully with other companies, countries, organisations with the element of being better than others in the same industry or market. Ansoff (1965, p. 79) was the first scholar who attempted to define competitive advantage as the "properties of individual product or markets which will give the firm a strong competitive position". After, Andrews (1971) referred to competitive advantage as the determination regarding how firms converted their skills and resources into distinctive competencies to position themselves among their competitors. Similarly, Hayes and Wheelwright (1984) defined competitive advantage as strategic preferences in which a firm chooses to compete in the market. Ansoff (1965) focused on the sources of competition with competitive advantage itself, whereas Andrews (1971) and Hayes and Wheelwright (1984) viewed competitive advantage as firms' potentialities in support of actions.

The above definitions of competitive advantage suggest that both competition and competencies are important issues mutually linked in achieving competitive advantage status (Barney and Zajac 1994). Understanding the competitive context within which a firm operates allows it to adopt manifold initiatives that enhance the quality of the business environment, which clearly impacts the development of competitively valuable competencies within a firm. Consequently, the expanded managerial core competencies are directly connected to maximising the potential of competitive advantage in the targeted industry or market (Levinthal and Myatt 1994). Therefore, this study views competitive advantage as ports' competence to integrate its resources and skills into its value-creating strategy and to sustain core business and services that can differentiate themselves from other ports and be more attractive to port users.

Although the foundation of competitive advantage in strategic management was traditionally provided in the 1960s, its idea began to gain popularity with Porter's books, *On Competition* (1980) and *Competitive advantage* (1985). Porter (1985a) asserted that a firm could achieve a competitive advantage by performing strategic actions that made it more attractive and created new or better opportunities in the industry than competitors. In this sense, he recognised competitive advantage as a discrete set of activities creating value for firms. He also argued that for a valuable and unique positioning, the firm's activity system should provide a critical basis for creating a strategic position, which enabled the improvement of the high level of operational effectiveness, and eventually contributed to achieving sustained competitive advantage for firms.

Porter (1985a) identified three generic strategies by which a firm could achieve a competitive advantage over its rivals: cost leadership strategy; differential strategy; and focus strategy. Cost advantage arises from performing particular activities at a lower cost than other competitors, providing a price value to the customers. This strategy is intended to reduce the cost of production by increasing efficiency and reducing input (Christmann 2000). Differentiation strategy is when a business provides unique products or services that make it different from competitors. The differentiation involves tailoring the product or service to the market needs, contributing to high customer loyalty (Porter 1985a). In the focus strategy, a firm adopts a narrow competitive scope within an industry, as targeting a specific market by narrowing the market down to smaller segments, for example, customer group, product range, geographical area, or service line (Allen and Helms 2006). In terms of industry-involved scope, cost leadership and differentiation strategies attempt to address a whole industry, while the focus strategy focuses on specific and smaller clusters of consumers within an industry (Wright 1987).

Additionally, many researchers have put the importance of distinctive activities of firms for creating competitive advantage. For example, Barney (1991, p. 102) emphasised the implementation of unique actions which created values to a firm when it comes to achieving a competitive advantage, defining "a firm is said to have a competitive advantage when it is implementing a value-creating strategy not simultaneously being implemented by any current or potential competitors. A firm is said to have a sustained competitive advantage when it is implementing a value creating strategy not simultaneously being implemented by any current or potential competitors and when these other firms are unable to duplicate the benefits of this strategy". Consistent with Barney (1991), Porter (1985a) also argued that competitive advantage was fundamentally on the numerous activities of firms that interacted to create, produce, and operate their products or services. That is, he underlined that gaining a competitive advantage or disadvantage consequently depended on the competency of firms in performing important activities strategically.

Agreeing with their assertions, the current study's underlying argument is that competitive advantage can be obtained when the concept of sustainability is strategically integrated into port operations and management and maintained through sustainability-based differentiation. Moreover, the importance of the study is to explore the strategic implementation of sustainability within the port industry by identifying sustainability activities creating added value to port performance, where ports should concentrate their competencies and resources.

2.3.2 The relationship between sustainability performance and competitive advantage in the context of port industry

As sustainability activities have increasingly been essential for gaining a competitive advantage by ensuring long-term success in the future, the ability of ports to manage their sustainability performance is emerging as a strategic issue. For example, Acciaro et al. (2014) highlighted that energy management of ports could increase operational efficiency and facilitate economic activities, helping improve the competitive position of ports. Beleya et al. (2015) suggested the theoretical directions on how Malaysian seaports could be attractive with strategic green management and attain superior performance and sustained competitive advantage from a resource-based view. More recently, Parola et al. (2017) perceived that environmental and safe port management contributed to the whole strategic port operation in the long-term through technical and process innovation, which could increase the quality of port services, ultimately boosted operational efficiency and competitiveness of ports. In addition, the benefits of implementing port sustainability practices have been confirmed in terms of increasing its public image as cleaner ports and attracting other industries or businesses to share the green orientation, and thereby gaining a better position than competitors (Denktas-Sakar and Karatas-Cetin 2012; Acciaro 2015; Lu et al. 2016; Kim and Chiang 2017; Senarak 2020).

Competitive advantage in the port industry has been perceived as a business value that influences the decisions of port customers, such as shipping lines and cargo owners, to select a port (Mileski et al. 2015). According to Ding et al. (2019), the attractiveness of ports is a pre-requisite and necessary condition for ports to obtain the competitive advantages of ports and eventually sustain their competitiveness. Hence, the verification of competitive advantage of ports has typically focused on identifying certain factors of port competitiveness and developing port selection criteria, applying multicriteria decision-making methods to the evaluation (see Tongzon and Sawant 2007; Yeo et al. 2008; Yuen et al. 2012; van Dyck and Ismael 2015; Hales et al. 2017; Argyriou et al. 2021). Traditionally, the determinants of competitive advantage of ports have been mainly suggested from internal attributes including port facilities, port location, port rates and charge, and service quality and labour stability, to external attributes such as local and regional policy and legal environment outside ports (Ding et al. 2019).

With the awareness of the importance of sustainability performance, researchers have recognised that sustainability management is a key determinant of port selection (see Pallis and Vaggelas 2005; De Martino and Morvillo 2008; Wiegmans et al. 2008; Parola et al. 2017; Liu et al. 2020). However, conflicting evidence has been witnessed regarding the relationship between port sustainability management and its competitiveness. On the one hand, there has been an argument that sustainability management is one of the crucial factors enhancing the competitive positions of ports in the market. For example, Thai (2016) measured customer satisfaction in the port sector in terms of port service quality, and the factor of image and social responsibility was one of the significant factors to impact positively on customer satisfaction. On the other hand, others have failed to identify a positive impact of sustainability performance on the competitive advantage of ports. For example, Ding et al. (2019) evaluated factors of the attractiveness of ports, including sustainability elements such as "sound security management system" and "implementation of green energy policy", to explore the competitive advantages of Taiwan ports. The results showed that the sustainability-related factors were not included in the top six key determinants, and they were found to have little effect on determining a better competitive advantage. More recently, Kaliszewski et al. (2020) proposed a set of 20 factors, including Corporate Social Responsibility (CSR), to examine key factors of the global competitiveness of container ports from shipping lines perspectives. Their study analysed that the CSR was ranked 17th, identified as low significant factors of port competitiveness. Furthermore, Adams et al. (2009) attempted to elucidate the relation between sustainability performance and competitive advantage in the context of ports, with an assumption that more proactive management through the integration of environmental and economic sustainability objectives would create competitive gains. However, the survey results indicated that the positive relation between environmental performance and competitive advantage were not ensured.

Such inconsistency in the research findings poses a question of whether ports have appropriately been integrating and performing the concept of sustainable development into port operations management, and accordingly, they have been gaining economic benefits. There has been, moreover, limited empirical evidence to explicate sustainability performance and its direct impacts on economic growth, particularly on obtaining a competitive advantage in the port industry. Some research related to the competitive position of ports has understood a competitive advantage either as a mediator factor or as incidental outcomes generated from firm performance. For example, Lun (2011) demonstrated that sustainability management positively affected gaining a competitive advantage as implementing green management practices improved container terminals performance in terms of terminal throughput, profitability, cost-effectiveness, and efficient operation. On the other hand, Kim and Chiang (2017) clarified the port sustainability performance moderates the relationship between competitiveness and operational efficiency, service quality, and port daily operations. However, no research has been conducted to determine the direct effect of port sustainability performance on enhancing the competitive advantage of ports. Additionally, concerning the numerous practices and activities identified up to date, there is a lack of understanding on influential sustainability activities that can particularly contribute to creating a better competitive position of ports. Given that ports are profit-driven organisations, it is important to develop effective strategies for successful sustainable development in the port industry, focusing on certain activities of sustainability involved in improving the competitive position of ports.

2.4. Research gaps

Numerous studies regarding port sustainability have contributed to understanding the concept of sustainable development in the context of port operation and management and developing a range of indicators and models to assess port sustainability performance. Notwithstanding, there has been still an academic need to fulfil the interest in port sustainability performance and its potential outcome. The comprehensive previous literature review enables this study to identify four research gaps that need to be filled, and the summary is as follows.

Research gap 1. Studies on the competitive position of ports are still lacking.

The growing awareness of economic benefits by implementing sustainability practices emphasises the need to understand how ports can create added value and shape port systems through sustainability performance, which can be interpreted as "a competitive advantage". From a performance management perspective, a competitive advantage can be achieved by the high level of operational effectiveness in operations (Porter 1985a), used as one of the leading measures of organisational performance along with efficiency and effectiveness in the port industry. In fact, extensive research has been conducted in the field of business management to clarify the competitive advantage of firms as economic outcomes from their sustainability performance (e.g. López-Gamero et al. 2009; Chang 2011; Gupta and Benson 2011; Gadenne et al. 2012; Jorge et al. 2015). Govindan et al. (2020) provided solid evidence using a systematic literature review that the implementation of sustainability practices increases firms' competitive advantage due to increased operational and financial performance, which enables attaining long-term benefits. This is strengthened by Hermundsdottir and Aspelund (2021) that identified the positive and direct effect of sustainability innovations on firm competitiveness in terms of reducing costs and increasing a firm's value creation and non-financial assets. Nonetheless, sustainability literature in the port management field is still scarce in successfully suggesting the relationship between port sustainability performance and competitive advantage.

The above literature review regarding port sustainability management and performance has suggested that port sustainability management can draw positive benefits to the operational performance of ports in terms of efficiency and effectiveness. Also, there has been an understanding that ports can enhance their competitive positions by implementing integrated green management practices. Notwithstanding, the scare attention has been paid regarding whether sustainability performance can create desirable outcomes of port performance. More specifically, the thorough investigation of the relevant literature identified that no attempts have been made to clarify the direct effects of implementing sustainable operations and management on the competitive positioning of ports. In this sense, the current study recognises the need to examine sustainability performance and its effects on strengthening ports' competitive position. This study attempts to investigate the direct relevance between port sustainability performance and its impact on the competitive advantage, thereby capturing improvement opportunities of port performance by implementing sustainability operations and management from a strategic perspective. Given that the first research gap can be realised by confirming the actual effects of sustainability performance, empirical evidence needs to be presented, which is identified as the second research gap.

Research gap 2. There is a deficiency in empirical evidence to determine the relationship between port sustainability management and its desired outcomes in securing the competitive positioning of ports.

It is reasonable to empirically analyse the impacts of port sustainability performance on the competitive advantage of ports, in that sustainability is widely regarded and accepted as a business strategy where verifying its effectiveness of operations is essentially required to assure organisational growth (Barba-Sánchez and Atienza-Sahuquillo 2010; De Martino 2021). However, little empirical evidence exists in the port literature to validate the effectiveness of sustainable management to business performance. What is less clear from the extant literature in the port industry is the extent to which the adoption of sustainability practices impacts the competitive advantage of ports. Moreover, the existing literature has provided mixed results in identifying whether sustainability management is a key factor that enhances port competitiveness, adding to the uncertainty of benefits from port sustainability performance. Therefore, this study focuses on statistical analysis to examine whether ports have been obtaining desirable outcomes in terms of competitive advantage by adopting sustainability practices, and to provide the justification of implementing port sustainability practices.

Research gap 3. The need is to integrate sustainability activities benefiting the competitive advantage of ports in order to gain value from executing port sustainability.

The literature related to sustainability management has suggested that organisations can secure their competitive positions while minimising the negative effects of their operational activities on the environment by implementing certain best practices of sustainability management (Christmann 2000). As these best practices have contributed to creating a competitive advantage and achieving the desired benefits, considerable efforts in the field of organisational management research have been made to identify best practices through an operational strategy of sustainability-related management (e.g. Smart 1992; Shrivastava 1995). The best practices are developed for the more efficient and sensible action in a given business situation, constituting a set of optimal operational activities through analysing the current state (Barba-Sánchez and Atienza-Sahuquillo 2010; Nawaz and Koç 2019). In this regard, a deeper understanding of port sustainability activities is key to determining whether they can confer a competitive advantage on ports by enabling them to capitalise on existing capabilities and resources to implement sustainable development (Christmann 2000).

As sustainability activities can play an important role in the perceived success, ports need to implement meaningful activities to realise sustainable development and a better operational performance of ports. Capturing decisive activities of port sustainability performance can shape the overall flow and process optimisation for designing, managing, and integrating various port functions, providing a comprehensive strategy on what ports should do to be more sustainable (Bichou 2006; Puig et al. 2017). Since the various sustainability activities are at play in achieving sustainable goals, a critical issue is to know which sustainability activities directly affect the competitive positioning of ports and introduce the integration of these activities from a strategic perspective. Gupta and Benson (2011) emphasised the systematic integration of sustainability activities since well-integrated sustainability activities enabled the configuration of one activity to raise the value of other activities, thereby allowing firms to sustain a competitive advantage over a longer time. Furthermore, Kannika et al. (2019) pointed out that for the effective sustainable development and competitiveness of ports, it is important for ports to prioritise criteria of sustainability activities and integrate them into the decision-making process on a strategic level, further than on an operational level.

However, this point of view has been under-researched in the context of the port industry. Much research regarding port sustainability operation and management has contributed to developing key indicators from numerous managerial and operational sustainability practices that ports currently implement, and those indicators have been utilised in evaluating the sustainability performance of ports. Despite the plethora of sustainability activities identified as the indicators for the assessment, no research has been investigating which sustainability activities directly influence improving the competitive advantage of ports. Thus, the current study seeks to support the decision-making process in terms of port sustainability by investigating optimal operational activities of sustainability that benefit the competitive advantage of ports and developing best sustainability practices to foster long-term sustainability performance of ports strategically.

Research gap 4. A fragmented focus on one or two aspects of port sustainability has provided partial evidence in the port industry.

Sustainable development as an integrative concept between the three aspects of sustainability—environmental, social, and economic—has been perceived that encompassing the three sustainability aspects is needed to facilitate effective sustainable development and to maximise positive synergies by mutually influencing each other (Cohen et al. 2008; Hansmann et al. 2012). Notwithstanding, a fragmented contribution when it comes to sustainability has been prevalent across the various fields of study. The relationship between sustainability performance, competitive advantage, and economic performance of organisations have primarily been examined by one or two of the three aspects (e.g. Schaltegger and Synnestvedt 2002; Wagner et al. 2002; Wagner and Schaltegger 2003). This biased interest has been observed similarly in port sustainability literature, despite the fact that there has recently witnessed a growing interest in encompassing all three aspects of sustainability in port operations. They focused on developing integrated key indicators by considering environmental, social, and economic activities, and few studies on evaluating port sustainability management and performance have taken a more comprehensive perspective by covering all three aspects of sustainability (e.g. Oh et al. 2018; Molina-Serrano et al. 2020). This is reinforced by the systematic literature review of this study, which identified the research focus on the environmental and economic aspects of port sustainability, with less attention on the social aspect, implying the importance of a holistic view in optimising port sustainability strategy.

Academic literature regarding sustainable management has increasingly focused on holistic system thinking, emphasising the interrelationships of three sustainability aspects with many parts of an entire system of organisations (Gupta and Benson 2011; Hansmann et al. 2012). The controversial interests within the three aspects of sustainability (i.e. conflicts among different values; or preference among the three aspects) have much foregrounded the balanced and integrated development for sustainability. Hence, the current study addresses this gap by considering all three aspects of port sustainability. By doing so, this study attempts to capture possible relevant constructs of sustainability management and develop a holistic strategy of sustainable development, positively creating the competitive position of ports.

2.5 Summary

Since the concept of sustainable development was introduced in the port industry, substantial academic contributions have been made not only to understanding and integrating the concept in the context of port businesses, but also to evaluating port sustainability performance. The vast amount of literature leads to an agreement that ports should accept the concept of sustainability either mandatorily or voluntarily and that it should be integrated into the day-to-day operational and managerial port practices. However, there has been still a scarcity of research determining the definite relationship between sustainability efforts and economic benefits in terms of operational performance of ports. The lack of evidence of empirical analysis certainly makes it difficult for ports to examine their current capability to implement sustainability practices and develop productive sustainability management that secures competitive opportunities in the long-term period. The previous literature review observed that some studies examined the desired benefits of sustainability management in terms of its efficiency and effectiveness. Nonetheless, the existing research has not provided insights into how ports could gain a competitive advantage by adopting the concept of sustainable development.

Although some ports are fully or to some extent operated by the central government, many cases are operated as a private organisation pursuing profits with reduced financial investment, and this trend is gradually increasing with the devolution of port managerial and operational responsibility (Lim et al. 2019). In this sense, it is worthwhile to assess the economic value of sustainable operations of ports in order to confirm the current implementation of sustainable development and identify the direction in which it should be improved in the future. The desirability for port sustainability performance can provide the justification of strategic investments in sustainable operations and management while satisfying environmental and social responsibility. Hence, this study focuses on empirically validating port sustainability practices by examining a link between the current state of sustainability performance and the competitive advantage of ports.

Further to that, the varied operational and managerial sustainability activities of ports have been addressed in the previous literature. Indeed, the implementation of sustainability management is generally influenced by a set of actions adopted by individual ports, which may hinder or accelerate the positive impacts (Evangelista et al. 2017). Hence, the concern of the current study is incorporating sustainability activities and identifying the most appropriate ones in strengthening the competitive advantage of ports. Given that ports increasingly operate similar to profit-seeking organisations, it is important to allocate limited resources to leading activities strategically so that ports can support sustainability management in a more distinguishable and operationalisable way and generate optimal port sustainability performance (Day and Jean-Denis 2016). In this regard, this study seeks to foster sustainability management practices in ports and to capture strategic opportunities for more beneficial sustainability performance through a set of meaningful sustainability activities based on comparing their relative importance in increasing the competitive advantage of ports.

Chapter 3. Theoretical Background and Research Hypotheses

Chapter 2 was devoted to exploring the previous literature and identifying research gaps to justify this research. This chapter focuses on addressing a theoretical background on which this study is based for developing a research model and hypotheses for empirical analysis. The first part of this chapter involves integrating the concept of sustainability as a business strategy in ports. The strategy-as-practice approach is adopted to understand and clarify the more integrated and strategic sustainability performance of ports. A theoretical framework suggested by the strategy-as-practice view provides the basis for the discussion of relevant theory and the development of a research model for an empirical analysis of the current study. The second part of this chapter includes understanding an underlying theory for the current study, called a Natural-Resource-Based View, which has evolved from a Resource-Based View. The third part of this chapter addresses the development of hypotheses through extensive literatures, taking the perspectives of the strategy-as-practice and the natural-resource-based view. In the last part of this chapter, the research model established for this research is presented.

3.1 Integrating sustainability into port strategy to gain a competitive advantage

Most organisations including ports can no longer operate without taking the interplay between environment and society, and sustainability concerns have progressively more influence on the business agenda in compliance with the steady increase of regulations, policies, and guidelines of sustainable development. The business management and strategy literature have explored the strategic benefits of sustainability that contributed to improving positioning and strategic fit by integrating sustainability principles into a business strategy within organisations (e.g. Figge et al. 2002; Gupta and Benson 2011; Murthy 2012). Strategic adoption of sustainability practices is also stressed in the study of port sustainability practices to realise sustainable port development (e.g. Dooms and Macharis 2003; Dinwoodie et al. 2012; Acciaro et al. 2014; Hou and Geerlings 2016). Gupta et al. (2005) highlighted the urgent need for practical strategies for controlling and monitoring environmental impacts in the area of Indian ports. More recently, Vejvar et al. (2018) examined the theoretical adoption of sustainability practices from an integrated perspective of both institutional and resource dependence theory and presented potential strategic responses facilitating inland ports to be more strategically actionable for sustainable development. Furthermore, Hossain et al. (2019) demonstrated that Canadian ports which executed well-advanced strategic initiatives to improve environmental performance had positive performance in general environmental management. Their studies affirm that strategic actions of ports can determine better sustainability management that increases overall port performance, suggesting the need to develop business strategies for sustainable practices and activities in the port sector (Puig et al. 2015b; Kim and Chiang 2017).

More recently, although Dooms (2019) and Schrobback and Meath (2020) made great attempts to understand port sustainability from a strategic perspective, the field of port management study appears to less focus on understanding sustainability performance as a strategy. Further, building or integrating sustainability issues into the overall strategy of port management and operations at the practice level has been limited. One possible reason can be attributed to the inherent complexity that both ports themselves and the concept of sustainable development have. Ports are complex systems intertwined by numerous internal and external factors, embracing various activities networked (Parola and Maugeri 2013). Cheon and Deakin (2010) categorised the complex organisational characteristics of ports into four identities: service provision private corporations, value chains generating economic influence, infrastructure systems optimised operations and systems performance, and quasi-public organisation supporting operational performance and social responsibility. These various identities of ports make it much challenging to realise sustainability performance in port business strategy.

In addition, achieving sustainable development goals is not straightforward but dynamic interactions where the multiple elements, such as ecosystems, economic structure, political powers, and human societies, are considered. In this regard, businesses have been struggling to redirect their single traditional objective of financial performance to two additional elements of strategic performance, namely environmental and social sustainability (Murthy 2012). Lubin and Esty (2010) described this ongoing challenge of organisations that environmental issues have steadily encroached on the capacity of organisations to create value for customers, shareholders, and other stakeholders due to environmental pressures and the accompanying business liabilities. It is also apparent in the port industry that the conflicted nature of social and environmental responsibility and financial goal of business has been acknowledged (Nebot et al. 2017), giving the rationale to understand port performance by questioning how sustainability activities can persistently create more value (Rodriguez et al. 2002).

In other words, the sustainability issue is a challenge to organisations threatening their existing systems. However, it is also an opportunity to develop an operational performance that ensures differentiation over other ports. The two faces of sustainability suggest that ports should actively seek to understand and build new strategic capabilities that will draw the desired outcomes such as competitive advantage while fulfilling the societal responsibilities of ports. Thus, port sustainability should be understood and implemented within a strategy that facilitates the implementation of effective practices addressed to port sustainability impacts and plays a role as a foundation for the competitiveness and long-term thriving of ports (Di Vaio and Varriale 2018).

3.1.1 Conceptualising a strategy and a strategy-as-practice approach

Strategy is a crucial subject determining the development, success and failure of all kinds of organisations, from multinational entrepreneurs to non-profit-driven organisations (Johnson et al. 2017). Furthermore, the concept of sustainability has been recently emphasised as one of the key strategies to success for businesses. Porter and Kramer (2006, p. 84) made an argument that business "must integrate a social perspective into the core frameworks it already uses to understand competition and guide its business strategy", underlining the integrated and practical strategy of sustainability that can be used as a lever for value creation and competitive advantage. Several leading strategy theorists have defined strategy from a strategic management perspective, summarised in Table 3.1. Chandler (1962), Andrews (1997), and Johnson et al. (2017) emphasised a set of decisions for the long-term goals, and Porter (1996) focused on the organisations' ability to form activities creating different value with others. More recently, Khalifa (2019) viewed strategy as a corporate theory that guides firms' decisions to solve high-risk challenges through the capability of using resources and opportunities in an uncertain environment.

Table 3.1 Summary of definition of strategy from a strategic management perspective

Author	Definition of strategy
Chandler (1962, p. 13)	"…the determination of the long-run goals and objectives of an enterprise and the adoption of courses of action and the allocation of resources necessary from carrying out these goals"
Andrews (1997, p. 52)	"…the pattern of decisions in a company that determines and reveals its objectives, purpose, or goals"
Porter (1996, p. 8)	"Competitive strategy is about being different. It means deliberately choosing a different set of activities to deliver a unique mix of value"
Andersen (2004, p. 1275)	"…as organisational activities that systematically discuss mission and goals, explore the competitive environment, analyse strategic alternatives, and coordinate actions of implementation across the entire organisation"
Mintzberg (2007, p. 2)	"…a pattern in a stream of decisions"
Johnson et al. (2017, p. 4)	"…the long-term direction of an organisation"
Khalifa (2019, p. 136)	"Strategy, rendered as a cohesive core of guiding decisions, is an entity's evolving theory of winning high-stake challenges through power creating use of resources and opportunities in uncertain environments"

Their definitions of strategy suggest three attributes that organisations should take account into when considering the formulation of strategy: "directions" which are concerned with what goals and aims they attempt to achieve; "techniques" involved in what skills and methods they utilise within organisations; and "actions" regarding what the level of activity they implement (Khalifa 2019). In other words, a strategy should be developed in a way that optimises and guides the process with activities associated with the principle of organisations, through which they ensure greater power than their competitors within the marketplace. Drawing upon the previous literature and the work of competitive advantage scholars (Ansoff 1965; Andrews 1971; Porter 1985a; Barney 1991), for this study, strategy is concerned with a plan of actions to develop and undertake core activities of a port to build and sustain their competitive advantage through achieving the long-term mission on sustainability.

As strategic management approaches have been largely developed based on the grounds of Porter's competitive advantage (1985a), many studies in strategy research have focused on the effects of strategies on organisational performance by elucidating how firms behave and why firms are different in performance (Prahalad and Hamel 1993; Jarzabkowski et al. 2007). Recently, some research claim that differences in performance impact are attributed to performing different practices (Bloom and Van Reenen 2007; Bloom et al. 2012; Jarzabkowski et al. 2022), focusing on a more in-depth analysis of the relationship between actual practice management of an organisation and a set of activities concerned with strategy. In other words, researchers have begun to be concerned with the process and implementation of organisational strategising: who does it, what they do, how they do it, what they use, and what implications this has for shaping strategy (Jarzabkowski and Spee 2009). The academic interest in this subject has stimulated the development of a *Strategy-as-practice view* to understand strategic planning and execution and provide insights about strategic activities of an organisation.

The strategy-as-practice view emphasises how strategies are formed in practice, being concerned with the things that organisations and people do. The strategy-as-practice approach conceptualises a strategy as something that people do as an ongoing activity, recognising the importance of actors engaged with the practices (Johnson et al. 2003). Its focus is on detailed practices that constitute the day-to-day activities of organisations and are crucial for the organisation's success, survival, mission fulfilment and the actualisation of potential value (Mantere 2008). The advantage of the practice approach to strategy enables an attempt to develop closer connections between what goes on deep inside organisations and broader phenomena outside organisations in strategy formulation (Whittington 2006). In other words, the strategy-as-practice approach is concerned with the micro-level strategy activities that take into account continuous social interactions (Regnér 2008). Such interactions facilitate analysis for strategy build-up and development by understanding the interrelationships between organisational-level practices and the myriad activities that underpin the strategy, and examining the influence of strategic practices on societies or sectors (Johnson et al. 2003; Whittington 2006; Regnér 2008). This emphasises that an organisation's strategy should be developed by taking into account its responsibilities and roles in society.

Based on this, Whittington (2006) proposed a framework where practices, practitioners, and praxis are integrated for strategising, as shown in Figure 3.1. In reality, the three elements function highly intertwined with each other: For example, practices cannot be formed and performed without practitioners, and practices cannot be fully realised without pertinent activities. Also, each comprises different analytic choices as components of a strategy, which facilitates integrating and building certain concepts into each component (Jarzabkowski

2007). In other words, the useful function of the framework lies in its flexibility in which three core elements can be linked together as an integrated whole (Schatzki 2002; Jarzabkowski et al. 2007), while at the same time allowing a methodological focus by taking one or more elements depending on a particular task (Whittington 2006).

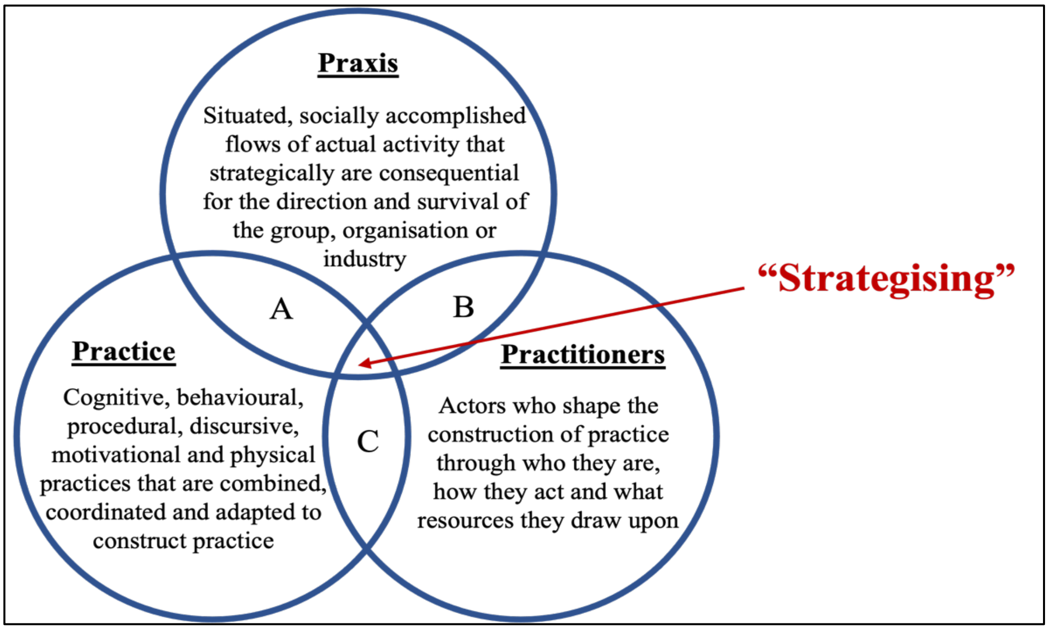

Figure 3.1 Strategy practice framework, adapted from Jarzabkowski et al. (2007)
(Note: A, B, and C indicate stronger foci on one or more of these interconnections, depending on the research problem.)

3.1.2 Building a strategic model for port sustainability from a strategy-as-practice perspective

Practices are related to what is undertaken within organisations, a repeated action consisting of a myriad of activities that bundle together (Schatzki 2002; Jarzabkowski et al. 2016). Bromiley and Rau (2014, p. 1249) defined a practice as "a defined activity or set of activities that a variety of firms might execute". Beyond merely describing what people do, they can forge the way of thinking, understanding, and acting strategy activities (Whittington 2006). Practices are mainly perceived by tools, norms, techniques, or procedures through which the stream of strategic activity is constructed. From an organisational management perspective, practices of management include goals setting, performance monitoring, and people management (Bloom et al. 2012). Whittington (2006) claimed that strategy's practices are characterised by a multi-level structure from an organisational level to a social level. Practices can be organisation-specific embodied in the routines, operating procedures, and corporate cultures. On the other hand, practices can be at a higher level beyond organisations by encompassing societal practices. For example, an organisation's environmental monitoring routines or socially responsible operations derive from its formal responsibility to a larger social function or system. In this regard, researchers in strategic management have increasingly perceived sustainability management, such as corporate responsibility reporting and sustainability performance objectives and indicators, as essential practices of organisational strategies (see Bettley and Burnley 2008; Pérez-López et al. 2015; Silva and Figueiredo 2017; Gond et al. 2018; Thakhathi et al. 2019; Begkos et al. 2020).

Practitioners are those who shape a strategy through an array of actions such as developing, transferring, and enacting practices. Jarzabkowski and Whittington (2008) explained that practitioners widely included both those directly involved in making a strategy and those indirectly influencing shaping legitimate activity and practice. Practitioners have substantial implications for practice development, and they are consequential to organisations by ensuring the relationship between standard practices and performance. The strategy-as-practice view emphasises the element of practitioners in strategy development as the different outcomes of practice implementation depend on the skills and operational capabilities of practitioners (Whittington 1996). Many researchers in the strategy-as-practice have categorised practitioners by the specific characteristics of practitioners: for example, cognitive traits (Powell et al. 2011), roles (Mantere 2008), and organisational positions (Balogun and Johnson 2004). Additionally, Jarzabkowski and Spee (2009) identified strategy practitioners based on organisational boundaries—internal and external practitioners. Internal practitioners are those who have an allocated hierarchy, line or staff role within the organisation, such as chief executive officers (CEO), managing directors, middle managers, and project managers. Alternatively, external practitioners are actors who might influence an organisation's strategy, but do not have an allocated hierarchy within the organisation, and consultants, chamber of industry and commerce, regulators, and other interest groups (such as environmentalists) are included.

Praxis is concerned with what practitioners actually do—all the various actual activities by which strategy is formulated and implemented. From the strategy practice view, activities relate to how formalised practices are employed and what effects are generated from them. That is, they intermediate between practices and outcomes (Jarzabkowski et al. 2016). Whittington (2006) explicated praxis in terms of micro-and macro-properties. From intraorganisational work, praxis can be everyday activities required to make and execute strategy through management retreats, consulting interventions, projects etc. At the same time, it also comprises the broader domain, which embraces routine and non-routine, formal and informal activities at the periphery of the organisation. Furthermore, Jarzabkowski and Spee (2009) categorised three levels of praxis within the literature: micro praxis, meso praxis, and macro praxis. Micro praxis refers to individual or group levels of individuals engaged in particular activities such as decisions, meetings or workshops, while meso praxis refers to the organisational or sub-organisational level, such as a change programme, a strategy process, or a pattern of strategic actions. Finally, macro praxis refers to the institutional level, which is associated with explaining patterns of action within a specific industry.

The framework was further developed by Jarzabkowski et al. (2016), who argued that performance outcomes of practices should be included in the strategy practice perspective. Accordingly, Jarzabkowski et al. (2016) presented the integrated model of strategy practice including strategic outcomes and the interaction of all three elements (practices, practitioners, and praxis) of strategy practice (Figure 3.2). In comparison with Whittington's framework, there are two distinctive features with the model of Jarzabkowski et al. (2016).

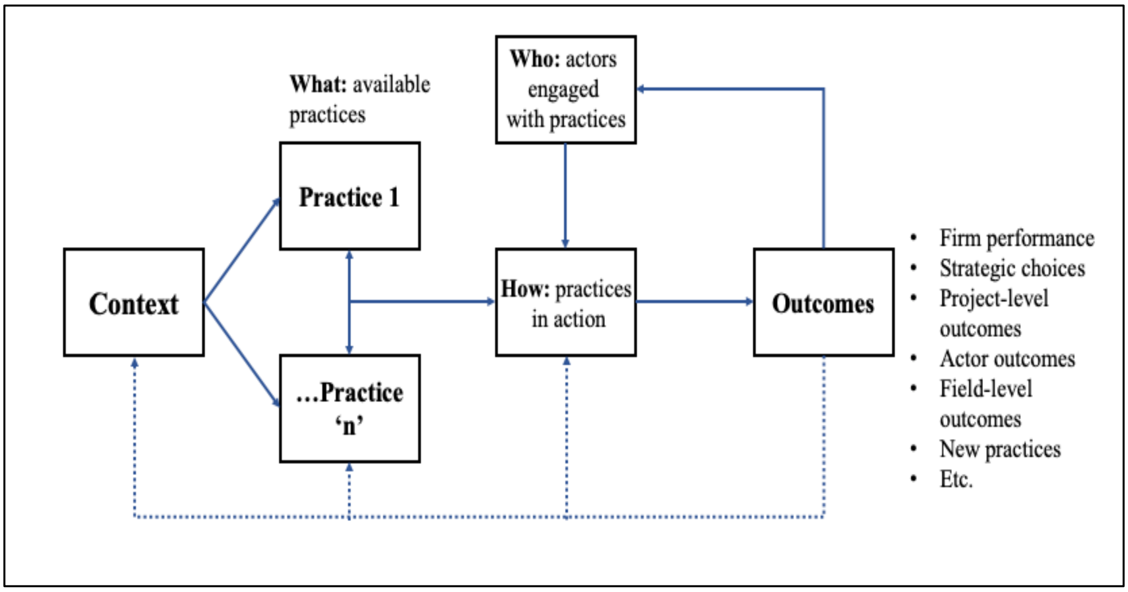

Figure 3.2 Integrated strategy model of practice-theoretic approach, adapted from Jarzabkowski et al. (2016)

First, it emphasises understanding practices in a specific context and treats these practices as interdependent on each other and explicitly influencing certain outcomes. Second, outcomes are importantly considered as a result of conducting practices. In addition, the model informs that outcomes are not only any types of business consequences such as economic performance, but also serve as a means of constructive feedback for making decisions to change, revise, and modify the role of actors and the way practices function. Since the focus of the current study is the impacts of sustainability performance on the competitive positioning of ports, outcomes are defined as a competitive advantage. Hence, this study assumes that environmental, social, economic sustainability practices lead to outcomes in the form of competitive advantage. By applying the strategy-as-practice perspective, the four elements—practice, practitioner, praxis, and outcome—are construed in this study as follows:

- *Practice,* in this study, focuses on port sustainability management practices, namely, environmental, social, and economic practices. Given that practice includes a set of coherent activities, and its impact is strongly influenced by the decisions of operations management within organisations (Bloom and Van Reenen 2007), the port sustainability practices are concerned with performing a set of sustainability activities managed and operated at the port in a certain way. The port sustainability practices influence port sustainability performance and build societal and global legitimate routines for port strategy.
- *Practitioner* is defined as actors strategising a sustainability agenda in practice, who are directly and indirectly involved in sustainability management and operations within ports. They are regarded as important resources which create a better competitive positioning of ports as their capability and competencies in terms of managerial adaptation, combination, and transformation play a key role in making decisions of strategic choices and actions for sustainability performance (Regnér 2008).
- *Praxis* is considered as sustainability activities that constitute sustainability practices widely embraced within ports. Accordingly, this study takes the macro-level praxis of the strategy practice. By focusing on sustainability-related activities, this study attempts to investigate those that are important to port performance, in particular, the competitive positioning of ports.
- *Outcome* is related to the meaningful consequences generated by performing port sustainability practices. In the current study, the outcome considers the impacts of port sustainability performance on the competitive advantage of ports. In addition, it can serve as evidence that evaluates the feasibility of current sustainability practices

in fulfilling the port's responsibility for sustainability issues from a strategic context of port operations management.

Based on the definition of the four elements in this study, a strategy practice model was developed in line with the purpose of the present study (Figure 3.3), which is employed as a conceptual basis for this study. By taking the strategy-practice view, this study focuses on the connection between practices, activities and desired outcomes of sustainability, namely competitive advantage, investigating how the concept of sustainable development can be strategically integrated into productive practice in container ports. Focusing detailed practices are essentially concerned with strategic management to establish the specific performance targets, allowing simultaneously and immediately sustainable and competitive improvements (Barba-Sánchez and Atienza-Sahuquillo 2010; Kearney et al. 2019; Kohtamäki et al 2022).

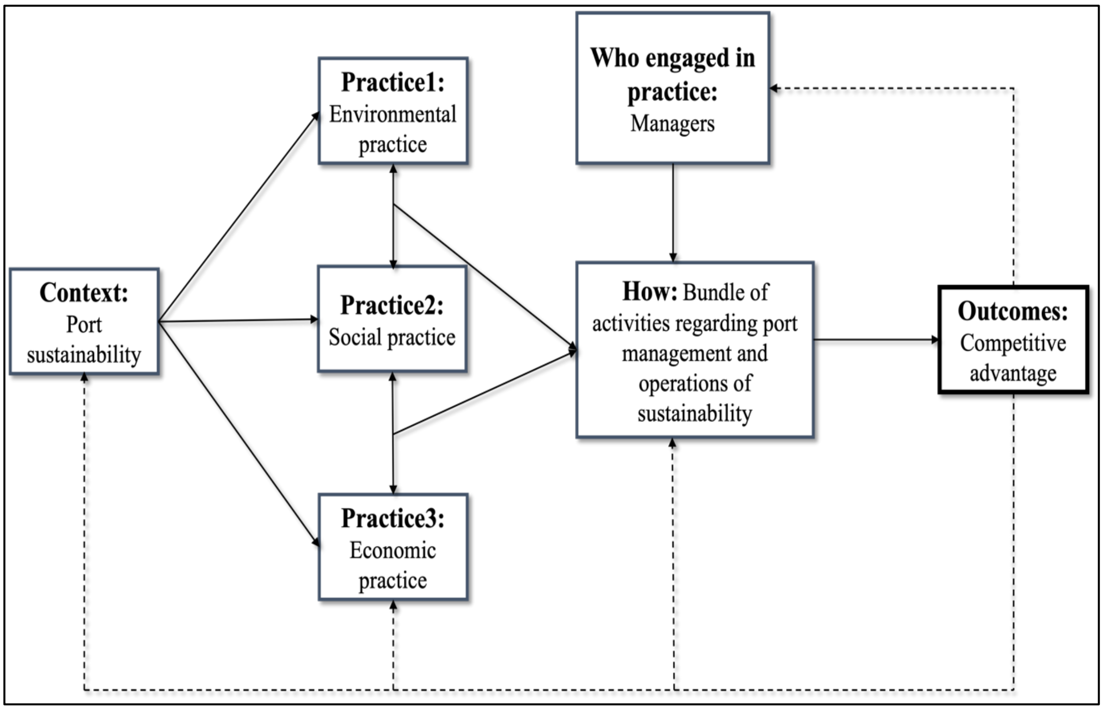

Figure 3.3 Modified strategy practice model for this study

Furthermore, the sustainability management literature has highlighted that the key to securing competitive positions and reducing their negative externalities to the environment and society is implementing certain "best practices" of sustainability as a strategic management approach (Christmann 2000). Jarzabkowski et al. (2007, p. 7) conceptualised strategy as a "situated, socially accomplished activity, while strategizing comprises those actions, interactions, and negotiations of multiple actors and the situated practices that they draw upon in accomplishing that activity", arguing that the success and failure of strategy can be determined by identifying what activity is strategic. They also suggested focusing on leading activities that draw on strategic practices. Consequently, practices and activities are strongly interrelated, and determining best practices of port sustainability is related to a set of core activities that are useful and closely connected with particular outcomes (Johnson et al. 2003; Jarzabkowski et al. 2007). Hence, the current study assumes that sustainability practices directly affect performance outcome, the competitive advantage of ports, and their influence depends on individual sustainability activities. By focusing on crucial practices and activities of port sustainability, the central concern of this study is to develop strategic sustainability management that contributes to achieving optimal success for ports operational performance from a competitive view.

3.2 Underlying theory: the Resource-Based View and the Natural-Resource-Based View

The Natural-Resource-Based View (NRBV) expanded from the Resource-Based View (RBV) provides the logic to understand how ports can simultaneously seek strategic opportunities of sustainability performance and competitive advantage, which is adopted as the underlying theory in this study. The RBV of firms has emerged as the most popular theory of competitive advantage. It was originally developed by Penrose (1959), who described a firm as a collection of resources and argued that the way to possess, deploy, and use firms' resources gave each firm its unique character. Later, the term "resource-based view" was coined by Wernerfelt (1984). By shedding light on the fundamental sources and drivers of competitive advantage, the RBV has contributed to elucidating and understanding firms' competitive advantage and performance. The basic tenet of the RBV is that the particular types of resources and capabilities possessed and controlled by a firm are the sources of competitive advantage and the fundamental determinants of superior performance (Barney 1991; Ma 2000). In other words, the RBV suggests that an organisation' resources should be valuable, rare, inimitable, and non-substitutable (Barney 1991), and those resources are treated as inherently related to performance implications in the sense that they generate economic rent for the organisation and its competitive advantage (Ma 2000).

3.2.1 The Resource-Based View

Organisations adopt the RBV in order to identify unique resources and conceive strategies for exploiting existing assets (Teece et al. 1997). Some researchers have also applied the RBV to develop new or core capabilities in managerial strategies of firms, considering firm resources as a strength that can be utilised to formulate and implement their strategies (see Wernerfelt 1984; Porter 1985a). Teece et al. (1997) argued that if scarce resources were exploited as a significant source of economic benefits within a firm, then organisational intangible or invisible assets, such as skill acquisition, managerial knowledge and know-how, were the greatest potential for contributions to strategy. In the field of port research, a variety of tangible and intangible resources have been identified as key resources that have contributed to ensuring the competitive position of ports—for example, infrastructures, linear shipping connectivity, operating efficiency, information technology, and operational activities of port (Gordon et al. 2005; Azevedo and Ferreira 2008; Hyuksoo and Sangkyun 2015).

According to Barney (1991, p. 101), resources include all of financial, physical, human, and organisational capital, described as "all assets, capabilities, organisational process, firm attributes, information, knowledge, etc. controlled by the firm that enable the firm to conceive and implement strategies that improve its efficiency and effectiveness". While he explained capability as one example of resources, other researchers argued that resources and capabilities are different in nature. For example, Wernerfelt (1984) and Grant (1991) defined resources as tangible and intangible assets owned and controlled by a firm, which were regarded as the source of a firm's capability; while capabilities were defined as the capacity to perform some task or activity with given assets of firms, which were the main source of driving competitive advantage (Grant 1991; Fahy 2000). In this regard, resources are generally classified into three sub-groups: tangible resources, intangible resources, and capabilities (Fahy 2000).

Tangible resources refer to the fixed and liquid assets of an organisation with a fixed long-run capacity (Wernerfelt 1989; Fahy 2000). Examples of tangible resources include plant, buildings, equipment, land, geographical location, raw material, energy, capital goods, stocks, equity, and retained earnings (Fahy 2000). They are conceptualised as a financial or physical value with ownership attributes and are relatively easy to be measured. As a foothold for the development of other potential intangible resources, tangible resources are recognised as an indispensable aspect in the context in which organisational activities take place (Schriber and Löwstedt 2015). However, it has been argued that tangible resources themselves have failed to meet critical factors of competitive advantage such as value, heterogeneity, and ex-ante limits to competition (Barney 1995; Čater and Čater 2009).

Wernerfelt (1989) perceived *intangible resources* were relatively unlimited capacity, and a firm could exploit their value by using them in-house, selling them, or forming a joint venture. Intangible assets acquire increasingly competitive significance in rapidly changing domestic and global markets in the sense that they are relatively resistant assets to imitation by competitors (Petrick et al. 1999). As the pace of acquisition and imitation of comparable tangible assets by competitors has increased, it has been emphasised that an organisation is required to protect, exploit, and enhance its unique intangible assets to sustain a distinctive global competitive advantage. Examples of intangible resources include intellectual property such as trademarks, patents, and brand (Wernerfelt 1989; Hall 1992), human resources such as experience, knowledge, judgment (Barney 1995), organisational assets such as trust, culture, and management control systems (Barney 1991), and reputational assets such as brand identity, word of mouth, and stakeholder trust (Hall 1992; Roberts and Dowling 2002).

Capabilities are what an organisation can do with a set of resources in carrying out activities, acknowledged as the combinations of organisational, functional, and technological skills (Teece et al. 1997). Capabilities are said to be the highest order of all resources that are the most difficult to duplicate because they are inextricably embedded inside an organisation in the form of experience, routines, knowledge, learning, and practice (Galbreath 2005). From a strategic management viewpoint, capabilities are a key factor in adapting, integrating, and reconfiguring internal and external resources and skills to respond to the changing business environment (Teece et al. 1997). Indeed, with empirical analysis, Galbreath (2005) confirmed that capabilities contributed more significantly to firm success than intangible or tangible resources. The term “capability” is often interchangeably used with the term “competencies” or frequently in combination with the adjective “core”, such as core capability or core competency (Fahy 2000). According to many scholars (e.g. Barney 1991; Prahalad and Hamel 1993; Teece et al. 1997), core capabilities or competencies are understood as identified resources and capabilities to bear on particular value-added tasks and provide an organisation with a potential competitive advantage. If an organisation maintains profits by developing core competencies, the collection of strategically important and helpful resources and competencies transforms competitive advantage into a sustainable competitive advantage (Jorge et al. 2015). These resources and competencies become a critical category of resource (Wernerfelt 1989; Prahalad and Hamel 1993), enabling firms to be relatively more efficient and effective (Barney 1991; Peteraf 1993).

Additionally, Hall (1992) identified intangible resources as either assets (what an organisation has) or skills (what an organisation does). If the intangible resource is something that an organisation "has", it is an asset; and if the intangible resource is something that the firm "does", it is a skill or capability (Galbreath 2005). From the RBV, the present study understands that the balance between the port's possession (tangible and intangible resource) and the port's ability (capability) improves its competitive advantage in the market. Both resources and capabilities should be developed based on success factors in the port industry in order to ensure the foundation for a long-term strategy of ports and the primary source of profit that ports can obtain (Grant 1991).

The RBV theory emphasises developing and managing meaningful resources and capabilities which not only are not readily obtained or imitated by competitors, but also contribute to economic benefit and enduring value (Galbreath 2005). Furthermore, the RBV allows an organisation to apply strategic thinking to identity, nurture, and maintain valuable resources and capability (Barney 2001) and discover or develop best practice business processes by capturing sufficient value delivering long-term financial performance (Teece 2007). In this sense, the theoretical and empirical research of the RBV has been utilised as benchmarking evidence that provides ideas for managers to decide resource allocation and create competitive advantages (see Nath et al. 2010).

The RBV has been adopted in the port research to explore the competitive advantage of ports and to suggest effective port strategies according to the changing competitive environment faced by ports. Some port studies used the RBV to identify the key resources to increase port competitiveness. For example, Haezendonck et al. (2001) presented a conceptual framework based on the RBV and identified the key determinants of a port cluster's competitiveness, explaining that the strong competitive position of ports could be driven by the competencies of facilitating non-cost related and qualitative elements. Gordon et al. (2005) argued that a sustainable advantage for ports was determined by a combination of resources, from tangible (e.g. information technology, port location, a natural deep harbour) to intangible (e.g.

supportive government policies). Pak et al. (2015) confirmed that customer-relational resources contributed to the high level of port service quality, arguing that intangible resources were a key to obtaining a sustainable competitive advantage of container ports. Recently, as the advanced technologies have been perceived as crucial to better port performance (Ghiara and Tei 2021), the ability to align process standardisation and deploy advanced technology is identified as valuable resources which can translate into positive port operational performance (Want et al. 2018; Vrakas et al. 2020).

Others utilise the RBV as a theoretical foundation to understand the association between distinctive resources and competence that ports have and the competitive advantage and performance of ports and to facilitate the hypothesis-testing of these relationships. For example, Cho and Kim (2015) argued that the combination of tangible and intangible resources enables obtaining port competitiveness and confirmed that traffic volume, linear shipping connectivity, and operating efficiency positively affected the competitive advantage of ports. Karakas et al. (2020) adopted the RBV with Transaction Cost Economics and Corporate Social Responsibility to establish a holistic multi-dimensional framework for container terminal performance evaluation, while Laksmana et al. (2020) identified common resources from the RBV and empirically examined the impact of container terminals' common resources on effectiveness of service performance. These previous studies confirm that a port's competitive advantage has been created by a collection of tangible and intangible resources and capability in port operations and management, not limited to one attribute of resources.

Although the RBV has made important contributions to knowledge in strategic management, limitations have been posed. Due to causal ambiguity, it is not always possible to identify the advantage-creating resources and capabilities. (Barney 2001). If resources are intangible, or capabilities are interaction-based, they are even more difficult to notice the initial states or causes. In addition, the RBV failed to address new resources or capabilities. Since it focuses on internal resources, a lack of consideration of shifts in the external environment renders existing competencies obsolete (see McWilliams and Siegel 2011; Wang 2014). Particularly, the RBV has been criticised for taking a narrow view on key resources for competitive advantage in that it has ignored the interaction between an organisation and its natural environment. In a global market where rapid shifts in the external environment and its strong influence are observed, planning strategic business with conventional approaches would make it difficult for an organisation to grasp core competencies and develop new resources and capabilities (Hart 1995). Consequently, such an organisation is likely to lag and lose its competitive position in the market. Considering the limitation of RBV, the complementary perspectives of the RBV has been suggested, the Natural-Resource-Based View (NRBV) of the firm developed by Hart (1995).

3.2.2 The Natural-Resource-Based View

While the RBV considers a variety of potential resources in organisation and explain a logic of competitive advantage from strategic management perspective (Hart et al. 2011), it has little regard for the competitive implications of the interaction between an organisation and its environmental and other sustainable business practices (Fowler and Hope 2007). Therefore, Hart (1995) expanded traditional RBV to the NRBV by inserting a vision based on the natural environment and an organisation's capabilities to manage it. The NRBV stands that the ability to manage and leverage constraints and challenges posed by the biophysical environment is a major source of competitive advantage for an organisation. Hart (1995, p. 991) argued that "it is likely that strategy and competitive advantage in the coming years will be rooted in capabilities that facilitate environmentally sustainable economic activity", promoting organisations to include sustainability activities that can contribute to both financial performances and sustained competitive advantage.

Competitive advantage from the NRBV can be found not in traditional structure but in environmental consciousness, which has been observed in the form of resource productivity, eco-efficiency, and sustainability. The NRBV considers that a proactive integration of environmental issues into a business strategy generates an organisation's core capability to utilise and preserve natural resources that can benefit organisations (Graham et al. 2018). According to Barney (1991) and Hart (1995), environmental management practices allow organisations to gain experience and skills through repeated practices or develop complementary assets such as technological knowledge, which can convert potential threats posed by the natural environment into competitive opportunities for organisations (Sharma et al. 2007; Wong et al. 2011; Fraj et al. 2013; Rahman et al. 2021).

Organisations have changed the way of thinking about their operational and managerial processes based on the NRBV, which has transformed the competitive mechanism between sustainable actions and economic profit (see Menguc and Ozanne 2005; Shi et al. 2012;

Longoni and Cagliano 2015; Mishra and Yadav 2021). Sustainability practices change the day-to-day operations and routines of organisations through the process of coordinating multiple human and technical skills and resources to reduce the negative impact of organisational activities on the environment and society (Christmann 2000; McDougall et al. 2019). The NRBV claims that this change contributes to identifying organisational core competencies, and thereby the organisation's competitiveness can be maintained or increased (Hart 1995). Accordingly, based on the NRBV, port activities and functions with sustainable management practices are understood as distinctive operational and managerial capabilities that can be embedded into valuable, rare, imitable assets for competitive advantage (Sandberg and Abrahamsson 2011). Built on the logic of the NRBV, Venus (2011) confirmed that green management practices expanded the capability of container ports to internal continuous environmental and organisational performance and employ sophisticated, sustainable strategies. Eventually, through green management actions, container ports can improve their experience and knowledge of internal operations, achieve greater efficiencies, and take further opportunities for comparative advantage.

Hart (1995) suggested three key strategic capabilities that foster the development of competitive advantage from the NRBV: pollution prevention, product stewardship, and sustainable development. These strategies build upon key resources to facilitate and manage environmentally responsible activities and enable sustained competitive advantage (Barney et al. 2011). Pollution prevention seeks to minimise or eliminate emissions and waste from organisational operations, which creates a cost advantage through reducing the inputs, process, and compliance and liability costs (Markley and Davis 2007; Barney et al. 2011; Graham and McAdam 2016; Graham 2018). Accordingly, pollution prevention strategy is associated with managing and controlling waste, emissions, and effluents generated from daily port operations. Product stewardship expands the scope of environmental responsibility to include the value chain or life cycle of a product (Hart 1995). Product stewardship, by definition, focuses on the entire product life cycle from natural resource extraction to product disposal or reuse (Maas et al. 2014). Hence, Tsoulfas and Pappis (2006) have argued for a service stewardship strategy for service-focused organisations such as port organisations or logistics companies, which spans all relevant activities throughout the service lifecycle, from service introduction to service completion to users. In that sense, sustainability activities at every step of port operations and management have responsibility for environmental impacts that can certainly be internalised in the future (Markley and Davis 2007; Jayarathna et al.

2022). Finally, a sustainable development has a strong sense of internally and externally driven activities for shared vision encompassing the social environment. Barney et al. (2011) emphasised a sustainable development strategy should produce a practical way to maintain future development and recognise the links among environmental and social concerns to increase the economic benefits for less developed markets.

According to the NRBV, pollution prevention and product stewardship strategies are concerned with port environmental operations activities that focus on the reduction of environmental damages and pollution generated from daily operations and management in ports. The two strategies, hence, require well-defined environmental improvement objectives to guide the selection of port sustainability activities that sever the negative links between port operations and the environment (Barney et al. 2011). On the other hand, a sustainable development strategy goes beyond simply reducing environmental impact and encompasses social and economic concerns. Therefore, a sustainable development strategy involves a set of port activities performed through repeated daily practices for balanced growth in environmental, social, and economic aspects. The NBV asserted the interrelated response among three elements (Hart and Dowell 2011), which is in line with the conceptual underpinning of the strategy-practice view, which underlines the interaction among practices acting upon organisational performance (Jarzabkowski et al. 2016).

Albertini (2019) claimed that a sustainable development strategy could support pollution prevention and product stewardship strategies, allowing incremental improvement to current operational processes with green technology, stakeholder integration, and continuous learning. In turn, the improvement accumulated brings a differentiation advantage to organisations, developing organisational capacity to internalise operational, physical, technical, and reputational resources into distinctive superior benefits (Albertini 2019). In this context, port sustainability strategy is built through key functional activities and processes of port sustainability management capabilities that enable to accumulation of the resources necessary for sustainable development more quickly and hence gain a competitive advantage (Barney 1991; Hart 1995; Hart and Dowell 2011).

Being adopted in organisational management disciplines including business, supply chain management, and logistics, the NRBV has been further elaborated through the investigation that sustainable practices as a strategic asset have contributed to better organisational performance. For example, Choi and Hwang (2015) considered that eco-design and investment recovery of supply chain management that required expertise from multiple stakeholders could generate economic and financial performance through a firm's collaborative capability of the entire supply chain. Taylor et al. (2018) contended that CSR strategies accumulated expertise, knowledge, intellectual property and trade secrets of the firm, and hence a firm that implements social, environmental, and governance initiatives benefited from better firm performance. In the maritime studies, the NRBV has been utilised to understand the logic of sustainable operations and management and examined the relationship between sustainability performance and port operational performance. Tran et al. (2020) proposed sustainable shipping management as a strategic resource to meet sustainability goals and regulatory requirements, which served as immediate cost savings of operation costs. Cheon et al. (2017) posited ports' resources and capabilities facilitated environmental performance and demonstrated the positive relationship between ports' economic performance and environmental performance. More recently, Phan et al. (2020) developed a port service quality model of port's resources, including social responsibility operations and fulfilment and confirmed that port social responsibility practices were one of the key service factors to influence positive customer satisfaction.

Those previous studies made significant contributions to exploring the relationship between sustainable performance, particularly environmental, and organisational performance. According to Hart and Dowell (2011), it is reasonable in that the essence of research questions in organisational management from the NRBV has been whether the adoption of environmental practices is beneficial to financial performance. In this sense, hypothesis-testing studies based on the NRBV have been focused on environmental strategies from pollution prevention and product stewardship perspectives, with less attention to empirical research on sustainable development strategies. Furthermore, the NRBV claimed that a sustainable development strategy has a strong link with the substantial impacts of technological changes for the environment, which is understood, within the context of ports operations, as one of the environmental activities (Molavi et al. 2020). In other words, while the sustainable development strategy from the NRBV asserts the social and economic concerns, in fact, they are understood as collateral outcomes through environmental practices. However, Barney et al. (2011) argued that the NRBV is not simply restricted to environmental concerns and a sustainable development strategy should be established by upholding a sustainable development principle embracing economic and social concerns. Hence, this research adds a discussion about the attributes of port social and economic sustainability to a sustainable development strategy from the NRBV and explores it more in-depth from a holistic view. This addition also seems reasonable given an increasing emphasis on the social responsibility of firms to the human and society itself (Bansal et al. 2019; Zimon et al. 2020; Cecchin et al. 2021).

Besides, few studies in port sustainability studies explicitly adopted and discussed how to integrate sustainability performance from the NRBV (e.g. Cheon et al. 2017; Haezendonck et al. 2018), providing the limited contributions to a body of knowledge and insights from the NRBV in the context of port sustainability management. More importantly, little attention has been devoted to the empirical investigation of the direct relationship between sustainability performance and its impact on the competitive advantage of ports based on the NRBV, where this study attempts to provide theoretical contributions. Consequently, this study proposes that a port proactively developing certain sustainability practices in its operations strategy is more likely to secure a competitive advantage because those practices may reduce costs and achieve port service differentiation (Russo and Fouts 1997; Christmann 2000; Longoni and Cagliano 2015). As both the strategy-as-practice view and the NRBV share the importance of key sustainable activities on the competitive advantage, this research focuses on the correlations between port performance from influential sustainability activities and competitive advantage. In the sense, the NRBV as the theoretical base of the present study contributes to understanding the relationship between sustainability performance and competitive advantage and developing research hypotheses for an empirical analysis of the relationship accordingly.

3.3. Research hypothesis development

A hypothesis is concerned with researchers' prediction of interactions involving two or more factors, and it is established by enquiring about the interactions through contextual or theoretical analysis (Borsboom 2008). In this study, hypotheses are developed by understanding the relationship between sustainability practices and their impact on the competitive advantage of ports, based on the strategy-practice view and the NRBV.

3.3.1 The interrelated port sustainability practices

According to the strategy-as-practice framework, practices are seen as fundamental to performance, and the potential for interconnected effects among practices are recognised (see

Figure 3.3). Practice theorists have perceived that the effect of one practice varied depending on the presence or absence of another, generally analysing practices as "bundles" rather than individual (Jarzabkowski et al. 2016). Besides, the essence of sustainable development pursues the shared vision through a whole development approach. The concept of sustainable development, illustrated as overlapping circles (see Figure 2.1), presents not only a holistic scope, but also a characteristic argument for integration. Within boundaries, they are undifferentiated and closely embedded in one another, conveying the meaning that the interrelated growth is an unambiguous goal for a win-win-win strategy (Connelly 2007). Therefore, decision-making to advance action on sustainable development goals should be made fundamentally by understanding interactions between the three sustainability practices.

From a business perspective, the multidimensional character of sustainability is consistently stressed that an organisation's environmental and social sustainability performance should be integrally linked with economic outcomes (Lehtonen 2004). As a traditionally dominant focus of organisations has been changed from financial or economic performance to non-financial aspects of their operations, substantial economic benefits no longer indicate the survival of organisations in the short-term, nor guarantee a long-term economic future (Doane and MacGillivray 2001). It is apparently difficult or impossible to have a fair, stable and harmonised society where natural resources are relentlessly exploited. Similarly, a sustainable economy depends on a sustainable flow of materials, energy, and environmental resources (Morelli 2011). Without all-inclusive progress, the economic system cannot stand alone as a sustainable system. However, in actual practice, the relationship between the three aspects is represented by trade-offs, alternatives, and conflicting goals, and the interactions between them are rarely included in the analysis (Lehtonen 2004). The fragmented evaluation of sustainability generates inconsistency with the understanding of sustainability, and therefore analytically unsupported and practically problematic (Hukkinen 2003). By considering sustainability from an integrated perspective, organisations can ensure that sustainable development actions are on track with the absence of power disparity and adopt a co-evolutionary direction for successful sustainable development (Lehtonen 2004).

In this regard, analysing the effect of sustainable development from a holistic view has been raised as one of the critical issues in strategic management, supporting practical analysis and providing effective guidance for structuring operational strategies for genuine growth (Gao and Bansal 2013). Cohen et al. (2008) argued that the combined sustainability performance presented a functional way to balance value creation (environmental and social value) and value capture (profit maximisation) within organisations. Oktem et al. (2004) also underlined that a management system that integrated the environment, health, and safety influenced the overall firm's performance positively. Additionally, a synergistic relationship among the three components has been acknowledged (Cohen and Winn 2007). Hart (1995), from the RBV, asserted that interlinked sustainability performance facilitated and accelerated the pace of resource accumulation and capability in the organisational decision-making process, which, in turn, affected the competitive advantage of organisations. For example, an operational strategy that is to be met to achieve integral conservation of the environment contributes to shifts in new and high technology. Then, the advanced technologies in operations enhance workers' working environment and their competency in managing environmental systems, which creates the short-and long-term economic value of organisations (Hart 1995; Glavič and Lukman 2007). His argument implies that the quality of sustainability performance is determined by the capacity of implementing all three aspects of sustainability. Organisations should perform and develop not separate, but interactive business strategies, encompassing environmental and social responsibility as well as economic development (Nilsson et al. 2018). Accordingly, it is important that all three mechanisms are organised and work together to maximise the synergy of sustainability management as a port strategy and to establish a strong foundation for sustainability performance that increases the competitive advantage of ports.

The relationship between social sustainability and environmental sustainability

The interaction between environmental and social aspects is relatively getting the least attention when it comes to measuring sustainable development (OECD 2001). However, their relationship is inseparable in that society exists and is flourished within the ambit of the natural environment, and exploited natural resources facilitate the elimination of social unfairness and exclusion, unstableness, and disagreement (Chiu 2003). It is apparent that a sustainable environment has more capacity to produce a stable resource foundation, which enables society to sustain itself longer (Lehtonen 2004). Also, social conditions perceive as necessary to support ecological sustainability by enabling societal attempts to harness the human potential to generate improved environmental outcomes (Chiu 2003; Vallance et al. 2011).

The social sustainability literature has explicitly emphasised that the connections between people and the bio-physical environment promote eco-friendly behaviours or stronger environmental ethics and distribute equal power and influence within society (see Lehtonen 2004; Foladori 2005). Social sustainability in a business context encompasses human resource management practices concerning education, employment, social equity, health, and justice of an organisation and its employees. These practices are positioned as "the soul of business" in the environmental context (Amrutha and Geetha 2020, p. 2). Jabbour and Santos (2008) demonstrated that employees were stimulated by adopting appropriate human resource management practices, and in turn, organisations benefited best results in terms of environmental performance. Similarly, Kim et al. (2019) confirmed that human resource management influenced employee attitudes and behaviours, and their commitment positively impacted environmental performance. Considering the interconnection of environmental and social performance from the RBV, port employees are one of the organisations' resources that have the distinctive capability to manage and control certain sustainability-related activities of a port (Das 2017), leading to positive environmental benefits in port operations. Based on the discussion above, the study proposes the first hypothesis as follows:

H1: Port social sustainability has a positive influence on port environmental sustainability.

The relationship between social sustainability and economic sustainability

When introducing the concept of sustainable development, the relevant principles and guidelines were concentrated first and foremost on ecological strategies in which nature was utilised as the most important source for satisfying economic and social life (Lehtonen 2004). However, as sustainable development has been increasingly recognised as ethical thinking that needs to be considered and developed from a holistic philosophy, social sustainability management has been emphasised (Vavik and Keitsch 2010). Social and cultural conditions, efforts, and values have been deemed resources that need to be preserved to create economic growth (Littig and Griessler 2005). Therefore, organisations have acknowledged the significance of adopting social sustainability into their management, which is usually expressed by CSR, social entrepreneurship or socially responsible organisations.

The economic system relies upon society and the existence of humans, while at the same time, humans are satisfied partly or wholly from various activities that take place in the economy (Giddings et al. 2002). Social well-being is ensured by the societal impact of production activities, such as processed goods and labour rights by enterprises (Joung et al. 2013). Employees, consumers, and communities are directly or indirectly affected by the organisational activities, including appreciating the cultural variety and maintaining basic human rights. Such social influence is transferred to business opportunities that organisations capture more economic benefits (Sarkar et al. 2020). According to Zelenski et al. (2008), a contented employee can foster better organisational productivity, customer services, and economic values by being more self-motivated, sensitive to opportunities, and willing to help co-workers. Additionally, a socially friendly organisation enjoys certain powers of attracting more customers, favourable brand images, wider recognition, and public support by serving society, thus allowing the organisation to gain more economic desirability in the market (Lundgren et al. 2019). Specifically, the contribution of organisations to employees' education and training plan has positive impacts on the efficient and effective performance of employees, which motivate organisations to invest further into their future values (Khan 2012). In the context of port operations, training and educating workers are identified as one of the most important social activities in the sense that well-trained workers are the key to reducing the rate of accidents within the port area. Cost-saving and a higher level of services brought about by skilled workers ultimately impact the sustainable economic benefits of ports (Wagner 2017; Liu et al. 2019; A Kadir et al. 2020). Based on the discussion above, the second hypothesis is suggested as follows:

H2: Port social sustainability has a positive influence on port economic sustainability.

The relationship between environmental sustainability and economic sustainability

There have been conflicts between ecologists and economists in terms of environmental sustainability. Ecologists emphasise maintaining maximum levels of ecological assets from a physical perspective, while economists perceive them as artificial or natural capital elements for an overall financial accumulation (Morelli 2011). In this respect, it has been said that concurrent growth in the environment and economy are incompatible goals (Chang and Kuo 2008). However, a sustainable economy can be realised based on a sustainable provision of ecological assets such as natural materials, energy, and resources (Lehtonen 2004). Although profitable financial results and extensive economic performance can imply the viability and operational success of organisations in the short term, they do not necessarily secure long-term economic future benefits and positive environmental outcomes (Doane and

MacGillivray 2001). Indeed, when it comes to sustainable development, economic growth is outweighed as the primary concern of organisations and businesses in most cases, but they have increasingly acknowledged that none of the economic systems can sustain without a stable provision of natural resources (Menguc and Ozanne 2005; Hart and Dowell 2011; Guan et al. 2020). Many studies have explored the relationship between the environmental management and economic performance of organisations, including in the field of port management research. Various environmental practices have encouraged organisations to adopt green engineering or technologies such as solar panels and energy-saving machinery, contributing to efficient operations, high quality of services and saving costs (Hart 1995; Porter 1985b). This leads to the long-term economic benefits of organisations, which facilitate, in turn, to proactively plan and operate environmental management (Shrivastava 1995; Aragón-Correa and Sharma 2003). Based on the discussion above, the third hypothesis is suggested as follows:

> *H3: Port environmental sustainability has a positive influence on port economic sustainability.*

3.3.2 Port sustainability practices and competitive advantage

In the last decade, a rapid increase has been witnessed in organisational performance focusing on sustainability, recognising the concept of sustainable development as a powerful source of enhancing the competitive advantage of organisations. There has been, however, the prevailing belief that the adoption of sustainability management would hamper international competitiveness by requiring organisations to raise costs and reduce profits for treating negative externalities and complying with regulations (Gupta and Benson 2011). On the contrary to the belief, much empirical research has demonstrated that sustainability practices improve the competitive advantage of organisations by lowering costs and improving differentiation (e.g. Shrivastava 1995; Christmann 2000).

Porter (1991, p. 168) also disagreed with the conventional acceptance by affirming that “strict environmental regulations do not inevitably hinder competitive advantage against rivals; indeed, they often enhance it”. He argued that implementing environmental management under strict environmental standards might raise costs by redirecting products and processes, and thus threaten organisations’ competitive position in the market. However, properly constructed environmental standards can serve as a source of innovation and technological upgrades, resulting in eventually more efficient organisations that rival by lowering costs and improving quality, as well as generating fewer pollutants.

The relationship between environmental sustainability and competitive advantage of ports

Environmental strategy encompasses all efforts to minimise the adverse environmental consequences of organisations' daily activities. The recent concerns of organisations have been focused on how to reduce their impact on the environment, while achieving better profits and market share than others within the current competitive circumstances (Dwyer et al. 2009). As organisations have been required to integrate environmental concerns into management practices, there has been a great deal of empirical evidence to show that the adoption of environmental elements has a strong bearing on the overall performance and competitiveness of organisations (see Klassen and McLaughlin 1996; Wagner and Schaltegger 2003; Centobelli et al. 2019; Makhloufi et al. 2022). The port industry has also increasingly recognised environmental performance as an integral element for achieving both commercial success and competitive position (Wiegmans et al. 2008; Lun 2011).

Although implementing environmental practices requires investments in new methods or tools and changes in organisational structures and processes, the environmental investments engender the long-term economic benefits of efficiency in organisations. From the NRBV, environmental strategy is people-intensive, involving the tacit skills of employees to minimise pollution using continuous improvement methods (Hart 1995; Zhao et al. 2020). These skills, which are represented as distinctive capabilities that are difficult to replicate in practice, determine an organisation's competitive advantage. Parola et al. (2017) argued that the development of technology and managerial processes provides solutions to increase environmental operations' quality or capacity and ultimately boost operational efficiency and competitiveness in ports. Alberti et al. (2000) also took a similar argument regarding the advantage of environmental management, claiming that the use of the most up-to-date techniques and equipment can contribute not only to better performance and efficiency in port construction, maintenance, and daily operations, but also to the reduction of accidental events, which are potentially dangerous to the environment. Additionally, such green technological aspects can attract port users, creating new markets (Ding et al. 2019). Lun (2011) argued that adopting the environmental practice creates opportunities to gain a competitive advantage of ports, as it enhances ports' capability of internal operations by expanding linkages with other firms to increase greater organisational efficiency. Based on the discussion above, the fourth hypothesis is developed to test the direct impact of environmental practice of ports on competitive performance:

> *H4: The implementation of environmental sustainability has a positive influence on the achievement of a competitive advantage of ports.*

The relationship between social sustainability and competitive advantage of ports

Social sustainability performance is communication-oriented, relating to people, organisation, and society, forming a foundation for the entire structure of sustainability (Ajmal et al. 2018). Organisations cannot evade social issues in that they affect and are affected in any form to economic conditions, working conditions, health, safety, equity, and education of its employees and the surrounding community (Das 2017). The social practices mainly involve ensuring proper and socially conscious corporate governance structure, labour rights, community culture, and sustainable human development. The social sustainability concept from an organisation management perspective is mainly divided by internal and external practices. For example, Labuschagne et al. (2005) categorised social practices into internal human resources, external population, stakeholder participation, and macro social performance, depending on the attributes of social-related activities. Rendtorff (2009) also understood that social sustainability relates to the responsibility of organisations toward their internal and external stakeholders and constituencies.

The positive impacts of human resources on organisational performance as a source of competitive advantage have been supported by many studies (see Wright et al. 1994; Greening and Turban 2000; Hamadamin and Atan 2019), including the field of port management (see Ngao and Mwangi 2013; Acciaro 2015; Shiau and Chuang 2015; Thai 2016). The improved reputation of an organisation can be held for the attributes that distinguish from its competitors, which produce opportunities to yield competitive differentiation outcomes (Pomering and Johnson 2009). This argument is also stressed in the NRBV that maintaining legitimacy and building a reputation through openness and transparency regarding sustainability performance to the public would not penalties an organisation's competitive advantage (Hart 1995). It can drive the success of cooperation with other organisations or investors by increasing their willingness to engage with contractual relationships (Rendtorff 2009; Jeffrey et al. 2018). This can provide benefits beyond their costs for enhancing the image of an organisation that is eventually reflected in better financial performance such as sales growth and market share (Day and Jean-Denis 2016). Clarkson (1991) also emphasised the importance of fostering sound relationships with stakeholders by satisfying their expectations regarding socially responsible management of organisations, by which they may experience increased levels of organisational performance. An organisation's commitment to reputation is regarded as one of the important factors influencing the better performance of an organisation and its competitiveness because investors have increasingly shown their desire to invest in socially responsible organisations (Arvidsson 2010; Jeffrey et al. 2018). For example, local governments will be attracted by socially responsible operations of ports and their contributions to local society, and they will increase their relevant investment in fixed assets, which can be used for the development of infrastructure of ports (Hou and Geerlings 2016). In turn, ports' capacity will increase and provide better port operations performance, ultimately contributing to achieving above-average in port users' satisfaction and service quality than its competitors.

The outcome of the implementation of social practices is generally represented by value creation which is necessary for sustainable profit maximisation (Day and Jean-Denis 2016). Furthermore, it contributes to the scaling of social impact, such as mitigating resource restraints and increasing opportunities for social capital (Rendtorff 2009; Acciaro 2015). Many empirical studies reveal the relationship between social responsibility-related performance and the economic or financial performance of firms (see Van Beurden and Gössling 2008; Raza et al. 2012; Javed et al. 2020). Additionally, the commitment to social value has become a strategic issue to improve competitiveness by strongly impacting the long-term outlook for the business (Gadenne et al. 2012; Acciaro 2015). Social responsibility-related activities not only improve the image and reputation of an organisation, but also promote customers' trust in products and services, ultimately resulting in differentiation advantage achieving long-term benefits, including financial performance (Christmann 2000; Singh and Misra 2021). Ports, particularly, play a role as both social enterprises and public agencies, often independently managed and financed by local or state governments (Cheon 2017). Since ports are closely related to regional economic growth, legal and ethical port management is important to attract local stakeholders and mobilise port investments. Hence, if ports operate unethically, they are more likely rejected by port users or investors, and then this effect will be strong enough to lose their benefits and competitive positioning in the market (Frooman 1997). The discussion above suggests the following fifth hypothesis to test the direct impact of the social practice of ports on competitive performance:

> *H5: The implementation of social sustainability has a positive influence on the achievement of a competitive advantage of ports.*

The relationship between economic sustainability and competitive advantage of ports

Economic sustainability aims to safeguard the economic vitality of organisations by maximising the flow of income and consumption (Ciegis et al. 2009). From a business perspective, the main purpose of organisations is to increase their economic growth; thus, economic sustainability has been well-developed and established with various relevant tools, measurements, and strategies, compared to environmental and social sustainability aspects. The economic practices of sustainability focus on the ability that an organisation produces financial and economic benefits continuously (Arowoshegbe et al. 2016), determined by the present value calculation such as revenue (Norton and Toman 1997). It is also regarded as a fundamental component of sustainability since economic viability can extend not only environmental and social business operations but also the lifespan of a feasible organisation (Doane and MacGillivray 2001; Centobelli et al. 2019). It is capital that an organisation allocates resources and operates environmental and social performance effectively at both the micro and macro level, consequently supporting the competitive positioning of sustainable development (Davies 2009; Alexopoulos et al. 2018).

Organisations are traditionally concerned with how to allocate scarce resources for increased efficiency in management and operations. A sustainable economy promotes a long-term competitive advantage by multiplying skilled activities and physical assets that support an organisation's efficient operations (Davies 2009; Hang et al. 2018). Therefore, ports that appropriately allocate and efficiently protect scarce resources by implementing economic sustainability practices are more likely to increase cost-efficiency and provide better port services. Consequently, they will obtain a competitive position in services and finance than others. The implementation of economic sustainability activities affects the internal efficient operation and direct financial value of an organisation by utilising resources, reducing costs from poor quality operations, and creating monetary value for the organisation (Warhurst 2002; Hermundsdottir and Aspelund 2021). These financial benefits are used as a vital means of monitoring the current levels of profitable viability and competitiveness of organisations (Warhurst 2002; Hermundsdottir and Aspelund 2021).

According to the RBV, the economic activities are mainly created by people (human resources) in the form of distinct businesses and services by integrating their competencies and cultivating intra-organisation collaboration (Kindström 2010). The activities of business servicing practice in the context of port operations can form the centre of the value proposition by satisfying the port users' needs and improving the competitiveness of ports (Yeo et al. 2011). Internally functional business and services can be also unique internal resources of a port that other ports will find more difficult to isolate and copy (Prahalad and Hamel 1993). In other words, ports that adopt the business and servicing practice from economic sustainability will reach a differentiation advantage position by attracting more port users with better quality of port services than rivals in the port industry. Accordingly, the economic sustainability practice with the attributes of financial benefits and business and servicing is crucial in creating superior value for ports. Based on the discussion above, the sixth hypothesis is suggested to test the direct impact of the economic practice of ports on competitive performance as follows:

> *H6: The implementation of economic sustainability has a positive influence on the achievement of a competitive advantage.*

The mediating role of environmental sustainability and economic sustainability on competitive advantage

The earlier discussion addressed the positive relationship between environmental sustainability and economic sustainability, and each of them is directly linked to the competitive advantage of ports. These connections further suggest that the effect of environmental sustainability on competitive advantage would be affected by economic sustainability. Russo and Fouts (1997), based on the NRBV, argued that environmental sustainability enabled to secure a competitive advantage from cost reduction and reputation enhancement that were reflected in economic benefits. Their argument was in line with Porter and Van der Linde (1995), who claimed that strict environmental regulations and standards shaped the competitive landscape where innovation and upgrading managerial strategies were triggered, making organisations more efficient and reducing environmental compliance costs. Dinwoodie et al. (2012) and Di Vaio and Varriale (2018) also accentuated that environmentally favouring behaviour is involved in drawing not only monetarily and quantitatively outcomes such as economic benefits and efficiency in port operations, but also creating long-term value and competitiveness of ports. Based on these arguments, this study proposes the seventh hypothesis regarding the indirect effect of environmental sustainability on competitive advantage through economic sustainability as follows:

> *H7: The implementation of environmental sustainability has a positive influence on the achievement of a competitive advantage of ports through mediated by economic sustainability.*

In a similar context, there have been empirical results evidencing the positive impact of social sustainability on both environmental sustainability and economic sustainability (e.g. Jabbour et al. 2013; Chang 2011). In addition, the relationship between social sustainability and competitive advantage have been supported by the previous research (e.g. Wright et al. 1994; Du et al. 2010). Consequently, these connections can follow that environmental and economic sustainability would serve as potential mechanisms through which the impact of social sustainability can be leveraged to improve competitive advantage. Drawing upon the RBV, this study posits that social-related activities develop employees' competencies for environmental performance by acquiring the requisite knowledge, technical know-how and experience (Agyabeng-Mensah et al. 2020). These skilled and competent employees may serve as valuable, rare, imitable, and non-substitutable assets for organisations to establish sustained environmental performance, boosting economic benefits and competitive advantage (Teece 2007; Singh, Chen et al. 2019). Furthermore, Branco and Rodrigues (2006) argued that socially responsible organisations attracted not only customers but also external investors, which had positive impacts on financial performance and a better competitive position of organisations in the market. Thus, considering the interconnectional and multidimensional concept of sustainability, this study suggests the indirect effect of social sustainability on competitive advantage through environmental sustainability and economic sustainability, respectively. The eighth and ninth hypotheses are proposed as follows:

> *H8: The implementation of social sustainability has a positive influence on the achievement of a competitive advantage of ports through mediated by environmental sustainability.*

H9: The implementation of social sustainability has a positive influence on the achievement of a competitive advantage of ports through mediated by economic sustainability.

3.4. Summary

The current study adopts the strategy-practice approach and the Natural-Resource-Based View (NRBV) evolved from the Resource-Based View (RBV) in order to postulate causal links between sustainability performance and competitive advantage. The strategy-practice view has been used to substantiate the relationship between sustainability practices and outcomes (i.e. competitive advantage) from a strategic perspective. Specifically, this view has contributed to integrating and developing the idea of sustainability into a feasible port strategy by understanding the interrelated concepts of practice, practitioners, and praxis in the context of port management. The development of the theoretical model of this study from the strategy-practice view has been involved, suggesting that the desired outcome of competitive positioning is related to the interconnection between sustainability practices which are consists of successful sustainability activities. The model serves as the basis for the conceptual understanding of the strategic implementation of port sustainability from a competitive view.

Additionally, the NRBV was adopted as the theoretical base for the current study. The RBV understands that the competitive advantage of organisations can be obtained by valuable, rare, inimitable, and non-substitutable resources the organisations have, which are categorised into tangible and intangible resources, and capabilities. Recently, with the acknowledgement that the idea of sustainable development should be included as a source of competitive advantage of organisations, the NRBV was developed with the inclusion of organisational ability to manage and control sustainability actions.

From the NRBV, sustainability management has a positive impact on operational performance, leading to enhancing the competitive positioning of organisations. Taking the NRBV, the current study has attempted to understand the relationship between port's competitive advantage and sustainability practices. Based on the relevant conceptual and theoretical understanding as well as the extant literature reviews, this study has developed nine hypotheses, including three mediating relationships in terms of sustainability performance and the competitive advantage of ports. Table 3.2 presents the summary of the hypotheses proposed in this study.

Table 3.2 Summary of research hypotheses in the current study

Hypothesis	Description
H1	Port social sustainability has a positive influence on port environmental sustainability.
H2	Port social sustainability has a positive influence on port economic sustainability.
H3	Port environmental sustainability has a positive influence on port economic sustainability.
H4	The implementation of environmental sustainability has a positive influence on the achievement of a competitive advantage of ports.
H5	The implementation of social sustainability has a positive influence on the achievement of a competitive advantage of ports.
H6	The implementation of economic sustainability has a positive influence on the achievement of a competitive advantage of ports.
H7	The implementation of environmental sustainability has a positive influence on the achievement of a competitive advantage of ports through mediated by economic sustainability.
H8	The implementation of social sustainability has a positive influence on the achievement of a competitive advantage of ports through mediated by environmental sustainability.
H9	The implementation of social sustainability has a positive influence on the achievement of a competitive advantage of ports through mediated by economic sustainability.

Hypotheses 1, 2, and 3 are concerned with testing the relationships among environmental, social, and economic sustainability in the context of port management and operations, while hypotheses 4, 5, and 6 examine the direct impacts of port sustainability on the competitive advantage of ports. The last three (hypotheses 7, 8, and 9) analyse the indirect effects between port sustainability and the competitive advantage, arising from the interconnected characteristics of sustainability. Furthermore, a theoretical model for this study was developed as shown in Figure 3.4, based on the strategy practice framework (see Figure 3.3) and the listed assumptions above.

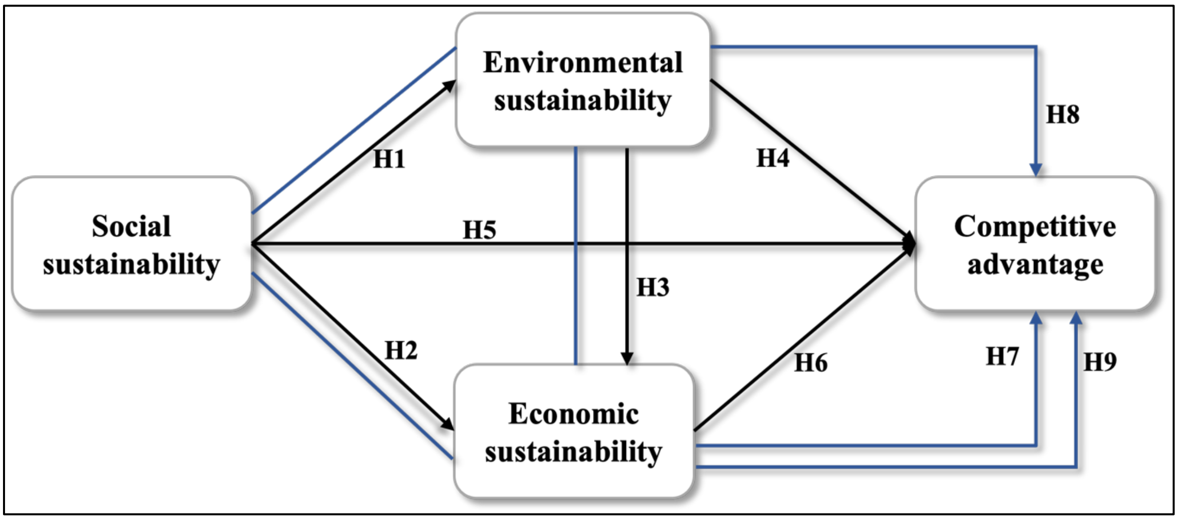

Figure 3.4 Research model of the study (Note: Black line indicates direct relationship; blue line indicates indirect relationship)

The theoretical model is constituted with four constructs, which reflects the direct relationships that could exist between environmental, social, and economic sustainability performance and competitive advantage. In addition, the proposed theoretical model implies the mediating effects on three relationships: the impact of environmental sustainability on competitive advantage via economic sustainability; the impact of social sustainability on competitive advantage via environmental sustainability; and the impact of social sustainability on competitive advantage via economic sustainability. Based on the hypotheses and research model developed in this chapter, the following chapters focus on addressing the processes and results for empirical analyses that examine the relationship between sustainability performance and the competitive advantage of ports.

Chapter 4. Research Methodology

This chapter presents the methodological background, which determines decisions for appropriate research methods and analysis techniques for exploring the research model and hypotheses developed in Chapter 3. This chapter consists of three main parts. The first part presents the methodological positioning of the current study by discussing its research paradigm, research approach, and research design. The second part discusses the decision for data collection method and the step-by-step procedure of applying the method. The third part presents data analysis methods and provides their clarification of purposes and procedures.

4.1 A systematic approach to designing research methodology

Research methodology is concerned with studying how research is to be carried out. In other words, the central point of research methodology is to explain specific approaches or techniques for the scientific research process through which research can gradually progress to find proper answers to research problems. A series of rational choices of research methodology not only supports the explanation, description, and prediction of research phenomena, but also influences the conclusion of research findings and recommendations (Ekinci 2015). Saunders et al. (2019) proposed a research methodology framework (Figure 4.1), which pictorially explains the various associated aspects of research to be investigated to derive a systematically established research design.

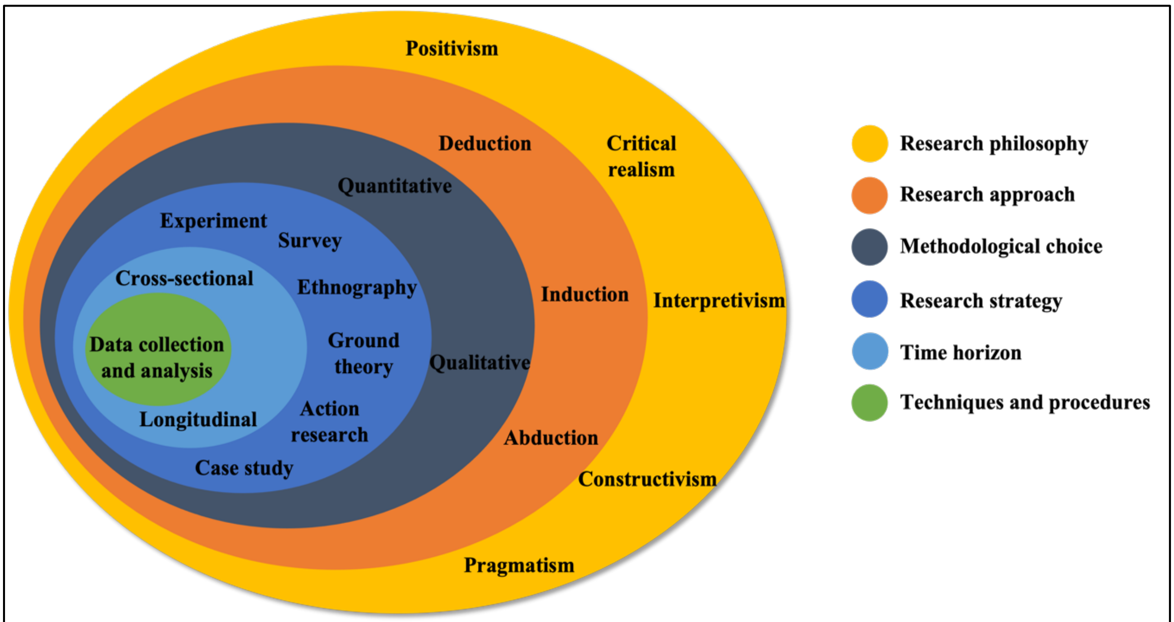

Figure 4.1 Research methodology framework, adapted from Saunders et al. (2019)

The framework delineates the decisions regarding research philosophical approach, research approach, research design (i.e. methodological choice, research type, research strategy, time horizon), data collection and analysis methods to allow the development of a robust research methodology scholarly. Additionally, the framework layered implies the interrelation and interdependency between choices of each aspect of research methodology. In other words, research philosophy influences the choice of approach, which in turn leads to the decision of methodological choice, strategy, time horizon, and data collection and analysis techniques.

4.2 Research methodology status of port sustainability performance research

The structured literature review was conducted to explore methodological characteristics in the field of port sustainability performance research. A methodological analysis of the identified 21 papers was conducted in terms of research paradigm, research methods, and data analysis techniques.

First, the types of research paradigm were categorised by the framework of Burrell and Morgan (1979): functionalism, interpretivism, radical humanism, and radical structuralism. Although none of the identified papers explicitly specified their research paradigm, they could be identified according to methodological attributes embodied in the studies. Woo et al. (2011) also examined the research paradigm in the field of port research with the same framework. The results of research paradigms in both research areas are summarised in Table 4.1.

The functionalist paradigm centres upon "providing explanations of the status quo, social order, social integration, consensus, need satisfaction, and rational choice" (Goles and Hirschheim 2000, p. 253), which is mainly aligned with the nature of positivism (Burgess et al. 2006). As shown in Table 4.1, this philosophical approach has been dominantly adopted in port research, including port sustainability performance where the current study is positioned. It implies that objective and statistical evidence using scientific methods have been appreciated in the port industry. The interpretivism paradigm involves seeking "explanation within the realm of individual consciousness and subjectivity, and within the frame of reference of the perspective" (Goles and Hirschheim 2000, p. 253). Few studies have taken this paradigm, with 4 out of 840 papers in port research and 3 out of 21 papers in port sustainability performance research. It is noticeable that there were no papers that followed radical humanism, which seeks “radical change, emancipation, and potentially, and stresses the role that different social and organisational forces play in understanding change” (Goles and Hirschheim 2000, p. 253). Similarly, no papers in the field of port sustainability performance research have adopted radical structuralism, which “focuses primarily on the structure and analysis of economic power relationships” (Goles and Hirschheim 2000, p. 253).

Table 4.1 Research paradigms in port research and port sustainability performance research

Paradigm	Number of papers		Total
Functionalism	830	18	848
Interpretivism	6	3	9
Radical humanism	-	-	-
Radical structuralism	4	-	4
Source	Woo et al. (2011)	The present study	
Research area	Port research	Port sustainability performance research	

Second, the identified papers were categorised based on the characteristics of research method. According to Wacker (1998), research methods were divided into two groups: analytical research mainly using deductive methods; and empirical research mainly using external data from organisations or businesses. Each classification can be further divided into three sub-categories: mathematical, statistical, and conceptual for analytical research; and statistical, experimental, and case studies for empirical research, as shown in Table 4.2.

Table 4.2 Various types of research methods in port sustainability performance research

Type of research method	Proportion	Description	Reference
Analytical research	43%	Research uses logical, mathematical, and/or statistical methods to arrive at conclusions.	Wacker (1998)
Mathematical research	19%		
Statistical research	19%		
Conceptual research	5%		
Empirical research	57%	Research uses data from external organisations or businesses to test if relationships hold in real world.	Wacker (1998)
Statistical research	57%		
Experimental research	-		
Case study	-		

It should be pointed out that all empirical research has been undertaken using statistical approaches which analyse data gathered from external sources such as interviews, surveys, archival research, and Delphi techniques. In other words, research types were found in neither empirical experimental research (field experiments) demonstrating causal relationships under controlled environments nor empirical case studies investigating a limited number of samples to generalise theoretical ideas (Meredith et al. 1989). On the other hand, analytical research methods were used across the three sub-categories. One paper (5%) used analytical conceptual research to add new insights to traditional problems, illustrating developed concepts by case study. Four papers (19%) using mathematical research studied the relationships of concepts based on numerical examples. Another four papers (19%) used analytical statistical research to measure the relationship of variables and to develop integrated models for empirical statistical tests (Wacker 1998).

Finally, the examination was conducted regarding data analysis techniques. Figure 4.2 illustrates the number of papers by data analysis techniques. Most researchers (11 papers) used Multiple Criteria Decision Making (MCDM) methods. Particularly, the most preferred data analysis technique of MCDM was Analytic Hierarchy Process (AHP), followed by the Delphi method and Data Envelopment Analysis (DEA) to evaluate and measure port sustainability performance. Researchers adopted these methods in conducting not only case studies but also survey-based research. This is because each port is influenced by different characteristics such as geography, regulations, size, and the different types of cargo handled, and thus it is practical to understand certain relationships and potentials with survey-based MCDM methods.

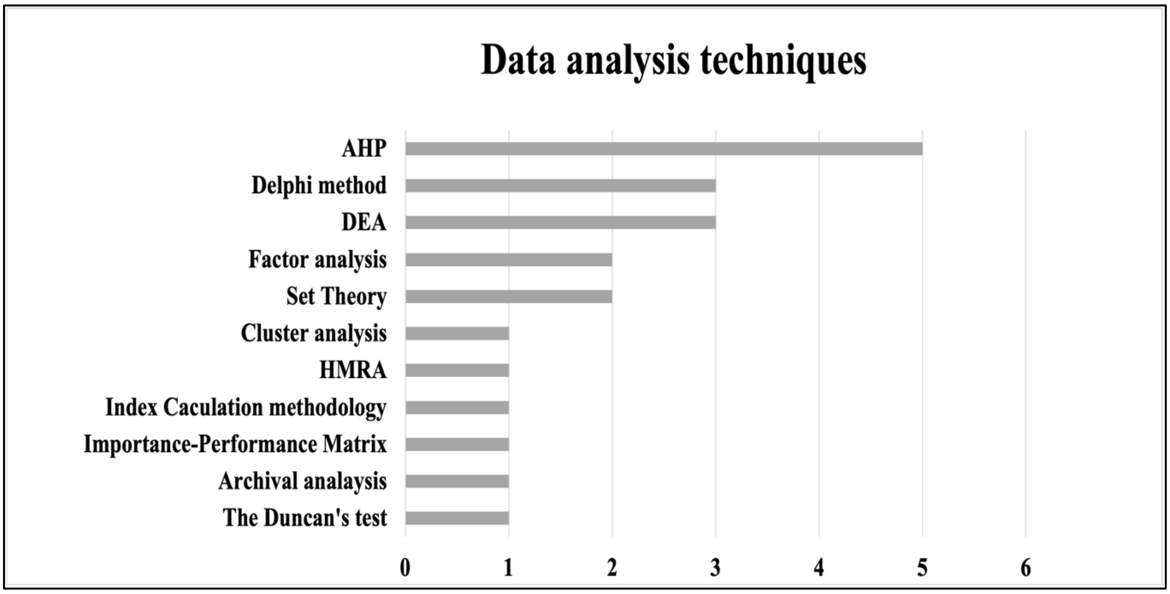

Figure 4.2. Number of papers by data analysis techniques

4.3 Research philosophical approach: Positivism

A philosophical stance, also known as a research paradigm, refers to a set of philosophical beliefs, assumptions, and values regarding the nature and conduct of research (Antwi and Hamza 2015). It captures the idea that research is conducted in accordance with a particular philosophy and worldview, which inevitably underpins consistent choices throughout the whole research process (Crotty 1998). This provides logical criteria for designing a coherent research plan involving understanding and investigating the study, which is significantly connected to the arguments that the study will present in the conclusion (Saunders et al. 2019).

The research philosophy of a study is typically determined by three philosophical assumptions and beliefs of knowledge: ontology, epistemology, and axiology (Aliyu et al. 2015). *Ontology* is "the study of being" (Crotty 1998, p. 10), concerned with elucidating what can exist in reality, what might be its conditions of existence, and what are relations of dependency (Scott and Marshall 2009). Ontological assumptions shape the way in which the subject domain or the research area is determined, which in turn influences the research questions or research objectives to investigate (Saunders et al. 2019). *Epistemology* is associated with forms of knowledge embodying "how we know what we know of research" (Crotty 1998, p. 8). Epistemological assumptions are typically reflected in a methodology. They focus on how knowledge is created, acquired, and communicated (Scotland 2012) and on defining criteria, standards, and methods for understanding reality (Walsh 2021). In the context of business and management, there are diverse types of knowledge, such as numerical data, textual data, visual data, facts, and narratives, which constitute acceptable, valid, and legitimate knowledge (Saunders et al. 2019). *Axiology* is the study of the values of the researcher and research participants influencing the research process. Explicit axiology contributes to articulating what research they should conduct and how they undertake it by clarifying the standards and requirements of action on rigorous research approaches and research techniques (Antwi and Hamza 2015). In this sense, axiological assumptions are related to reflecting and influencing researchers making judgements and decisions in the research process based on their great importance (Antwi and Hamza 2015; Saunders et al. 2019). The choice of philosophy reflects the researcher's values, as is the choice of data collection techniques (Saunders et al. 2019).

The present study aims not only to identify crucial sustainability activities affecting better competitive positioning of ports, but also to examine the causal relationships between environmental, social, and economic sustainability performance and the competitive advantage of ports. The first aim employs objective analysis to prioritise sustainability activities using a mathematical technique, while the second aim involves the development of hypotheses to test causal relationships based on established theory and previous literature. Considering the characteristic of this research, it can be inferred that this study primarily holds a positivist paradigm.

As shown in the paradigm status in port sustainability performance research, the positivist paradigm has been widely adopted by numerous individual researchers in social sciences including sustainability-related disciplines to understand and define phenomena of research knowledge (Goles and Hirschheim 2000). This is supported by the argument of Vildåsen et al. (2017), who accentuated that the structure of corporate sustainability had elements both positivism and constructivism. Particularly, they claimed that the positivist approach was reasonably advocated for sustainability performance at a systematic and organisational level, allowing to capture information and data collection in variance underlying temporal conditions and spatial aspects in different countries.

The central belief of positivism is that knowledge is to be found rather than created or interpreted. It can be considered as an accepted understanding, namely science when it is observable and measurable. Hence, the positivist position is mainly described by words "discovery", "descriptive", and "scientific". Ontologically, positivism embraces an objective, unchangeable, immutable reality where the social world operates according to natural cause-effect laws. It postulates that reality is based on experience that can be discovered, and research means gathering evidence about stable pre-existing patterns or orders that can be generalised (Aliye et al. 2015; Martin 2015). Reality exists as an empirical entity and should be observed independently from the human mind. In this sense, the fundamental stance of positivists is to reject metaphysical speculations such as abstractions and transcendental knowledge (Vildåsen et al. 2017).

Epistemologically, positivism underlies objective reality, or a set of laws and principles governing how things work (e.g. what gives a port a competitive advantage), which can be discovered (Wicks and Freeman 1998). Burrell and Morgan (1979, p. 5) explained that positivism is the belief to seek "to explain and predict what happens in the social world by searching for regularities and causal relationships between its constituent elements". Their argument highlights that knowledge from a positivist point of view is explained, predicted, and controlled under verified hypotheses, and research findings are accordingly considered fact as they are observed and measured (Aliye et al. 2015). Additionally, the positivism sheds light on the assumption that research is axiologically conducted in a value-free manner, whereby researchers are independent of data generation and maintain mathematical demonstration for regularities and causal relationships among the study elements to establish law-like generalisations (Ekinci 2015).

By taking the positivist approach, the current research embraces the belief that knowledge consists of objective and external entities given independently of human interpretation. Also, this study recognises that they can be comprehended through collecting observable data and verifying them with the help of empirical observation and experimental testing (Vildåsen et al. 2017).

4.4 Research approach: Deductive approach

The research approach is concerned with the relationship between theory and research (Bell et al. 2019). Depending on the extent to which the nature of research is based on theory testing or theory building (Saunders et al. 2019), the research reasoning is described as deductive, inductive, and abductive approach. The deductive approach is a theory-testing process, which deduces conclusions from assumptions or propositions, focusing on validating established theories or hypotheses. In contrast, the inductive approach is a theory development process that seeks particular patterns and regularities from observation to generate general explanation (i.e. theory). In other words, the former moves from the general inferences to the particular occurrences based on a conceptual and theoretical structure, and the latter is in a reverse way of the former, moving from particular instances to statements of general patterns or laws (Aliyu et al. 2015). Additionally, the abductive approach combines the deductive and the inductive approaches, integrating the particularities of specific phenomena into building a plausible theory that is tested with empirical observation. According to Kovács and Spens (2005), the abductive reasoning is suitable when the intuition of research results from an unexpected observation that existing theories cannot explain. Figure 4.3 illustrates the reasoning process of the three research approaches.

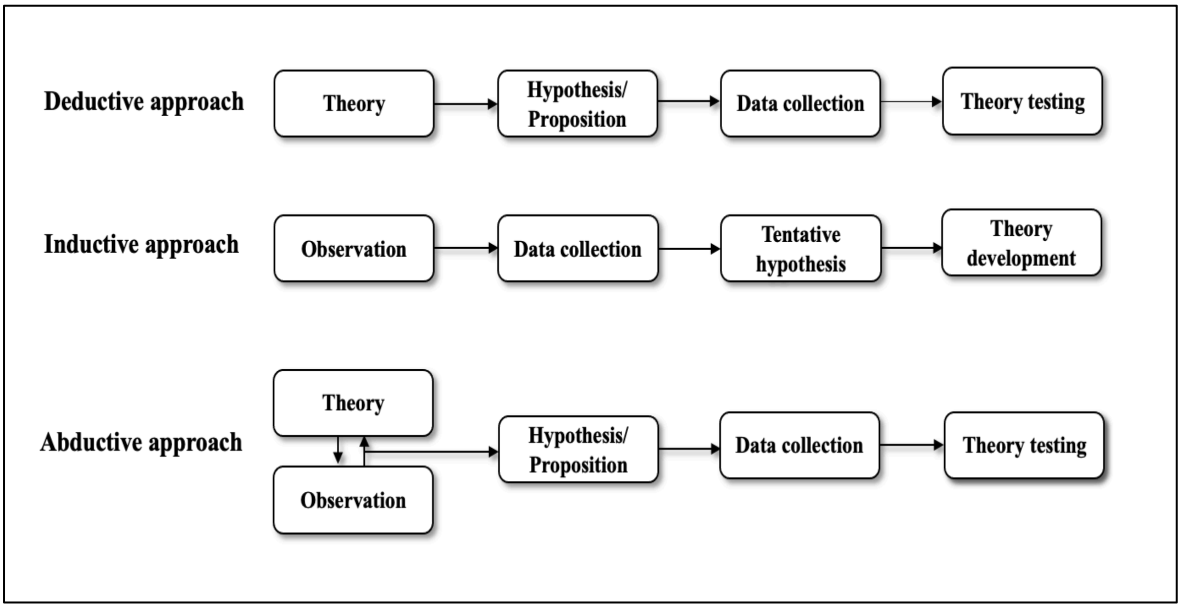

Figure 4.3 Reasoning process of research approaches, adapted from Bell et al. (2019) and Kovács and Spens (2005)

From a positivist approach, the principle of verification is at the core. In other words, knowledge can be valid truth from mere opinion only when the process of testing confirms it. Hence, positivists accept deductive reasoning to understand and interpret concepts or knowledge and use a theory to present a model of general propositions from observable phenomena. The theory is postulated as being tested to empirically support or falsify hypotheses through a process of experimentation in a controlled setting (Aliyu et al. 2015). In this sense, the present study takes a deductive approach, and theories are used to form testable hypotheses for testing relationships among different variables and provide scientifically demonstrative evidence of the closest approximation of reality.

4.5 Research design

A research philosophical approach guides research in the right direction to obtain the correct answers to research questions by providing standard methods and procedures appropriate to the nature of individual research. Every paradigm encompasses its own ontological and epistemological assumptions. However, they contain abstract properties in nature, and the philosophical underpinnings proposed by research paradigms cannot be empirically proven or disproven (Scotland 2012). Therefore, a particular research approach is underpinned to reveal ontological and epistemological assumptions of reality and knowledge that each research paradigm possesses (Guba and Lincoln 1994), which is reflected in its methodology clarified by a research design (i.e. the research method and strategies employed to conduct the investigation). The research design represents an overall structure that guides a study to appropriate data collection and analysis (Saunders et al. 2019). It shows how the study will be conducted, involving the elucidation for methodological choice, the types of the study, research strategy, data collection technique and subsequent data analysis procedures.

4.5.1 Methodological choice: Quantitative research

Designing research is based on a methodological choice among qualitative, quantitative, or mixed methodology. Decision on methodological choices influences the selection of data collection method and analysis techniques (Bell et al. 2019). Table 4.3 presents the differences among the three methodological options in research.

Table 4.3 Differences among the methodological options in research

Orientation	Qualitative	Quantitative	Mixed
Research paradigm	Interpretivism/Constructivism	Positivism/Realism	Pragmatism/Critical realism
Research purpose	Subjective description Understanding social constructed meanings Exploration	Numerical description Casual explanation Prediction	Understanding of research problem from both quantitative and qualitative approaches in a single study
Data collection methods	Ethnographies Case studies Narrative research Interview Focus group discussion Videography	Measurement Hypothesis testing Randomisation Structured protocols Questionnaire	Both quantitative and qualitative methods
The role of theory	Inductive approach, generation of theory	Deductive approach, testing of theory	Deductive, inductive, or abductive approach
Nature of data instruments	Non-measurable data Words Images In-depth interviews Field notes Open-ended questions	Measurable data Variables Structured and validated-data collection instruments	Both measurable and non-measurable data
Data analysis	Exploring patterns, themes, and holistic features	Statistical analysis to test relationships among variables	Both quantitative and qualitative analysis
Results	Provision of insider viewpoint	Generalisable findings	Generalising findings and further understanding of particular phenomenon

Source: Adapted from Antwi and Hamza (2015) and Saunders et al. (2019).

Qualitative research designs are underpinned by interpretivist or constructivist philosophies, in which social reality is seen as constructed, interpreted, and experienced by people (Antwi and Hamza 2015). Research using qualitative methodology emphasise non-numerical data such as words and images in interpreting the phenomenon and leading deeper understanding and insight of research problem, but less interested in generalisability (Antwi and Hamza 2015). It is often formed by an inductive approach to theory development using analytical procedures to develop a conceptual framework and theoretical contribution (Saunders et al. 2019). *Mixed research* designs integrate quantitative and qualitative research methods, procedures, and paradigm characteristics. The combination of quantitative and qualitative research can be conducted concurrently or sequentially depending on research purposes and questions addressed (Antwi and Hamza 2015). This methodological choice is useful to test theoretical propositions and develop profound theoretical understanding by expanding the boundaries of the scope of the study (Saunders et al. 2019).

The current study uses *Quantitative research* designs which focus on numerical representation by quantifying the collection and analysis of the data. As the quantitative methodology is shaped by positivist philosophies and entailed by a deductive approach where the emphasis is placed on testing theory (Bell et al. 2019), it is often used to explain opinions, attitudes, or behaviours through measurable data with highly standardised tools such as questionnaires in a controlled setting (Antwi and Hamza 2015). Quantitative studies intend to describe, predict, and verify causal relationships between variables through statistical and mathematical based methods and techniques (Saunders et al. 2019).

4.5.2 Research type: Combined research

Depending on the purpose of research, research type can be classified into exploratory, descriptive, evaluative, or combined research. *Exploratory research* focuses on discovering ideas and insights about a topic of interest and investigating a research problem which is not understood yet (Saunders et al. 2019). A key characteristic of exploratory research is its flexibility—research direction can be changed as new pieces of information is revealed (Ghauri et al. 2020). In this sense, it is often conducted at a preliminary stage of research with the purpose of identifying issues or discovering new initiatives that are the focus of future research. The data is collected by interviews, focus groups, observations and surveys using open-ended questions with what, why, and how (Saunders et al. 2019). *Descriptive* *research* is used to provide a precise profile of persons, situations, or phenomenon by defining an opinion, attitude, or behaviours shaped by a group of people on a research problem (Saunders et al. 2019). The purpose of descriptive research is to identify characteristics, frequencies, categories, correlations, and trends in the overall population. Unlike exploratory research, a research problem is structured and pre-planned, where a detailed-research design is made to collect data (Ghauri et al. 2020). Hence, it focuses on answering what, who, how, when, and where questions (Saunders et al. 2019).

Explanatory research, also referred to as causal research, is to identify the causes and effects of a phenomenon and assess whether and to what extent these "causes" result in effects (Ghauri et al. 2020). The primary purpose of explanatory research is to explain why particular phenomena occur and to predict future occurrences (Sue and Ritter 2016). In this sense, research hypotheses are usually involved in establishing the nature and direction of the relationships among variables using a statistical test such as correlation (Saunders et al. 2019). Research questions are likely to commence with why or how. *Evaluative research* is concerned with assessing performance and activities in terms of projects, values, strategy, or process (Saunders et al. 2019). Evaluative research is also suitable when research aims at determining whether a particular action or task has yielded the desired outcomes to enhance effectiveness or performance in organisation management. Research questions seek an evaluation understanding and begin with how, what, and to what extent. In addition, studies that combine multiple purposes in the research design is termed *combined research*.

Based on the nature of the research questions, the current research can be classified as combined research that focuses on: providing the participants' opinion of sustainability activities that strengthen the competitive advantage of ports (descriptive purpose); identifying the relationship between port sustainability performance and competitive advantage (explanatory purpose); and determining the overall value of sustainability performance by assessing the impact of sustainability practice on the competitive positioning of ports (evaluative purpose). Furthermore, this study is cross-sectional, which involves collecting information from a specific sample of population elements at one given point in time (Saunders et al. 2019).

4.5.3 Research strategy: Survey

A strategy is referred to as an overall plan of action to achieve a goal, and therefore, a research strategy is a step-by-step plan that guides direction to the research process to answer research questions. The research strategy links the methodological choice and the method for data collection and analysis. The choice of research strategy should be coherently made with research philosophy, research approach, methodological choice, and research purpose, including the extent of existing resources or concerns such as accessibility to participants, time, and money (Saunders et al. 2019). Principally, the choice of a research strategy is based on a methodological choice—qualitative, quantitative, or mixed research. Qualitative research strategies include narratives, documentary, ethnographic, grounded theory, or case studies (Bahari 2010). On the other hand, examples of quantitative research strategies are experiments and surveys designed to generate statistical data (Bahari 2010).

In the current study based on quantitative research, a survey strategy is employed, which is widely employed in quantitative research in the field of business and management (Rowley 2014). Survey research is used to answer what, who, where, how much, and to the extent questions, focusing on capturing beliefs, attitudes, and behaviours of participants (Saunders et al. 2019). Particularly, a survey using questionnaires is useful to produce research findings that can be generalised, allowing the collection of standardised responses from a relatively large number of people in remote locations (Krosnick 1999). The survey is considered an appropriate research strategy in this study where the opinions of a large group of people are engaged to evaluate and compare the relationship between port sustainability performance and competitive advantage (Bell et al. 2019).

4.6 Data collection method

The data collection method, the centre of the research onion (see Figure 4.1), involves decisions about tactics that construct the finer details of data collection (Saunders et al. 2019). A questionnaire was used as the data collection tool for gathering the necessary information in the current study. The questionnaire is typically considered suitable for descriptive or explanatory research and in survey research settings where a large number of responses are engaged (Saunders et al. 2019). According to Rowley (2014), the questionnaire survey is employed with a variety of research purposes: firstly, to generate a profile of the characteristics of the sample in terms of numbers or frequency of occurrence of processes, behaviours, perspectives, experiences, opinions, and attitudes; secondly, to predict the future instances or patterns by understanding the relationships between variables; lastly, to develop a set of measurement scale to measure a complex variable and the test their validity.

In the present study, a web-based questionnaire was carried out to collect data, designed for individuals to be completed and submitted through online survey software. The use of web surveys is widely expanding with its convenience in the dissemination of questionnaires, time and cost-effectiveness, and flexibility of changes (Rea and Parker 2014). This section describes the rationale for selecting respondents and the procedure for developing a questionnaire for the data collection.

4.6.1 Sampling design

When using questionnaires, it is crucial to make decisions about the sample, for example, the size of the sample and target population. Sampling associates the selection process of appropriate subjects from the research population in sufficient numbers to address the research problem (Ekinci 2015). Fundamental methodological issues can be affected by the process of sampling, such as the quantity of responses, questionnaire development, data collection process, and sample characteristics which are used to make inferences about the population parameters (Malhotra et al. 2017; Saunders et al. 2019). In order to obtain reliable, valid, and rigorous results, it is important to select the desired sample which is representative of the population and is suitable for research in terms of costs, accessibility, and time. The sampling procedures should consider four fundamental factors: target population, sampling frame, sampling technique, and sample size.

Target population

In sampling, target population is the assemblage of elements or objects that possess the information explored by the researcher and about which inferences are to be made (Malhotra et al. 2017). The important issue in defining the target population is determining who should be included or excluded in the sample (Churchill and Iacobucci 2002). The scope of the target population can be the group of people, firms, organisations, products, or things that the researcher desire to investigate (Forza 2002).

The current study defines the target population as a container port and terminal that provide container handling services, and the term a "port" is henceforth taken to mean a "container port". Container ports serve as logistics centres to provide service and cost advantage in the global supply chain. Due to the globalisation and integration of transport networks in the maritime logistic industry, containerised cargo has been boosted, and hence the role of container ports has been central to maritime transport activities (Chen 2009). The global container shipping volume accounts for 775 million TEUs in 2020, which have been consistently increasing (Statista 2021). Accordingly, the international requirements have imposed the responsibility of anthropogenic effects on container ports, and they have integrated various environmental and social initiatives into daily port activities to fulfil their social responsibility (Lim et al. 2019). In this sense, it is reasonable to focus on sustainability performance and its effect on competitive advantage within the realm of container ports.

Puig et al. (2014) argued that experts who use sustainability indicators in the port industry could be considered port authorities, port users (e.g. terminal operators or shipping companies), policy makers, and public organisations (e.g. Non-Governmental Organisations (NGOs) or local communities). In line with the argument, the systematic literature review identified port managers, researchers in academia, and port operators as the key participants whom the previous researchers obtained information regarding port sustainability performance. Therefore, the target population for the current study includes professionals at the management level (mainly called port managers) in container ports and terminals. They are involved in operating and administering general activities within a port area, being mainly affiliated to a port authority with the highest hierarchy of port management. Having responsibility for managing environmental performance in ports, port managers subsequently establish and modify goals and actions toward sustainability (Lam and Notteboom 2014; Hakam 2015). Asgari et al. (2015) also considered port managers as important target participants who evaluate the practical implementation of sustainability performance in internal port organisations, with direct control over developing and managing strategies and policies toward sustainability.

Furthermore, the strategy-as-practice view acknowledges managers in organisations as key participants in formulating and executing practices. The strategy perspective generally focuses on the opinions of senior managers at the top of their organisations, such as presidents and CEO. However, this focus has been extended to middle managers and lower-level managers (Whittington 2006). Their understanding of the strategic direction of their organisations not only supports top management's decisions, but also facilitates their active involvement in organisational practices and activities, which in turn increases the potential of organisations' survival (Whittington et al. 2017). Hence, the present study encompassed the target population of port managers from the high level of management to the frontline level of management engaged in general port operations and management, including sustainability-related activities.

Sampling frame

A sampling frame is concerned with creating a list or set of directions for identifying the target population (Malhotra et al. 2017). Framing the sample can be drawn from available sources or databases to the researcher, such as telephone books, an association directory in an industry, and a customer database (Malhotra et al. 2017; Saunders et al. 2019). The sampling frame for the current study was created using Lloyd's list directory. It is one of the trusted journals in the shipping industry, providing not only the latest shipping news and reports, but also comprehensive web directories and data related to maritime logistics. The list of container ports was compiled based on the web directory of ports provided by Lloyd's list (Lloyd List 2021).

Sampling technique

Sampling technique can be determined by either non-probability or probability sampling. Non-probability relies on subjective methods to decide which elements are included in the sample rather than the probability of individuals selected from the target population. Although probability sampling is useful to generalise the results to a research population by assuring the representativeness of the sample, in practice, most business and management research relies heavily upon non-probability sampling (Saunders et al. 2019); because it is usually vague for the researcher to ascertain boundaries regarding who might or might not be included in the population, and to compile a complete sampling frame (Rowley 2014).

Hence, the present study employed non-probability sampling using a convenience sampling technique. Convenience sampling is a method of collecting samples with non-probability, where the target population is conveniently located in terms of easy accessibility, geographical proximity, availability at a given time, approachability through internet service, or the willingness to participate (Etikan et al. 2016). It is prominently accepted in social research and organisation studies due to its advantages regarding time, effort, and cost (Bryman 2016).

Sample size

Determining sample size is necessary for the sampling process because it involves the robustness and generalisation of the study (Rowley 2014). The sample size for the study mainly relies on a data analysis method, which is, in the study, structural equation modelling (SEM). The appropriate sample size is considered more serious in the SEM in that it is widely known to be sensitive to sample size. It is often perceived that larger size samples are more likely to be representative of the target population, and thus reducing the issue of bias. However, when it comes to the SEM using maximum likelihood estimation, it is noted that the sample size larger than 400 increases the sensitivity, producing poor fit measures in the model. In this regard, the sample size for the SEM is suggested in the range of 100 to 400 (Hair et al. 2014). Moreover, some researchers suggested a ratio of five to 10 respondents for each estimated parameter (Westland 2010), while others proposed a sample size of 200. As a rule of thumb, the sample size of 200 or more is considered to offer sufficient statistical power for data analysis, widely adopted as a ground rule for determining sample size for the SEM (Hoe 2008). Based on the above arguments, the study's sample size was aimed at a minimum of 200 samples and a maximum of 400 samples.

4.6.2 Questionnaire development process

The present study developed a web-based questionnaire using online survey software called Qualtrics. This subsection describes the questionnaire development process for this study, following a step-by-step procedure for developing a questionnaire suggested by Churchill and Iacobucci (2002) to enable the collection of data in a standardised manner. Figure 4.4 presents the nine steps of questionnaire development for the current study.

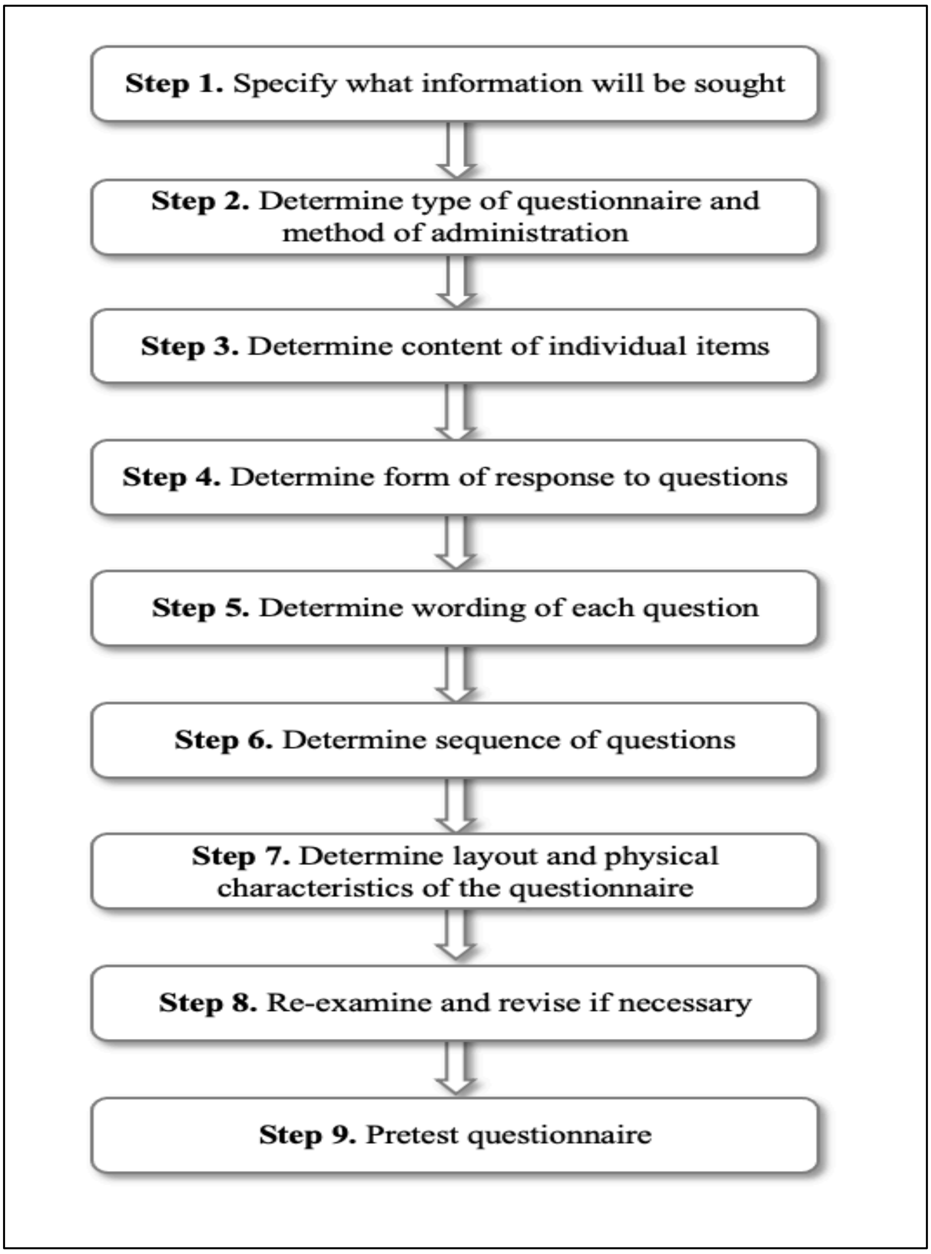

Figure 4.4 Questionnaire development steps, adapted from Churchill and Iacobucci (2002)

Step 1: Specify what information will be sought

The present study focused mainly on two purposes: First, to identify the influential sustainability activities to strengthen the competitive advantage of ports; and second, to clarify the hypothesised relationships established in the research model. Therefore, the measurement instrument was designed to solicit responses to the study constructs mentioned in the research model and responses to the relative importance of sustainability activities to the competitive advantage of ports, respectively. Demographic information was also sought to understand the background of individual respondents and to group the data according to different respondent characteristics. The measurement items of each construct will address in step 3 in detail.

Step 2: Determine type of questionnaire and method of administration

According to Mitchell and Jolley (2010), self-administered questionnaires allow respondent anonymity, whereas investigator-administered questionnaires, in which questionnaires are administered in the presence of researchers, reduce the assurance of anonymity. Thus, this study conducted the survey using a self-administered questionnaire in order to ensure respondents' anonymity. Under the survey setting of the self-administered questionnaire, the respondents were entirely left alone to complete the structured questionnaire after being introduced regarding the questionnaire, required to be completed and self-administered by themselves in the absence of the researcher by selecting fixed options introduced by the researcher (Ekinci 2015).

Step 3: Determine content of individual items

This step involves operationalising key concepts or hypothetical relationships by developing appropriate measurements for the study constructs and the generation of items that require respondents to respond to a series of questions (Rattray and Jones 2007). Furthermore, this step includes ensuring the content validity of the questionnaire. As mentioned earlier, the survey has two purposes, and thus the questionnaire was divided into two main parts and one part for demographic questions. Survey items for each part were developed according to the survey purpose, respectively. Part A included questions for the hypothesised relationships, and Part B included questions about respondents' opinions on the importance of sustainability activities to strengthen the competitive advantage of ports. In addition, the questions pertaining to the background information of respondents were formulated in Part C to identify the sample characteristics.

Individual questions were formulated corresponding to the measurement items of each theoretical construct (Rowley 2014). A set of measurement items for the study constructs used the indicators synthesised through the systematic literature review. The questions were phrased by adapting some of the previous research in diverse disciplines to the context of the port industry (Chow and Chen 2012; Lirn et al. 2014; Marshall et al. 2015; Lu, Lai et al. 2016;

Banihashemi et al. 2017; Walsh and Dodds 2017). The detailed explanation and rationale of measurement items of each construct are as follows.

Items for competitive advantage

Competitive advantage has been used as one of the measures for organisational performance. However, researchers have had different perspectives on understanding competitive advantage and organisational performance. Some researchers argue that competitive advantage is sufficient to increase the likelihood of better organisational performance, but does not ultimately lead to superior performance, and superior performance can derive from combinations of multiple competitive advantages, for example, price or costs, locations, technologies, properties of markets or products (Ma 2000; Powell 2001). In other words, they treat them as distinct concepts with two different constructs. On the other hand, some researchers recognise that competitive advantage is conceptually interchangeable with economic value, specifically the end results of organisational performance. They perceive a firm's competitive advantage is to accrue financial benefits or profits as a result of the process of competition (Flint 2000). The main reason for this lack of consensus is the selection of variables of competitive advantage depending on the definition of measurement and the environment where individual organisations or industries accept the concept of competitive advantage (López-Gamero et al. 2008). Therefore, it is important to pin down the perspective for the evaluation of competitive advantage and to create valid and robust measures (Sigalas and Economou 2013).

The interchangeable use of the concepts between competitive advantage and an economic value has been dominant in the literature. Competitive advantage has been used as a measure reflecting the economic success of strategy (i.e. ends or results) (Warhurst 2002). One reason for taking economic performance measures to assess the competitive advantage of organisations could be that it is difficult to define and measure competitive advantage, which is usually related to firm-internal factors (Wagner and Schaltegger 2003). Furthermore, significant literature explained competitive advantage in terms of superior profitability or financial performance to their competitors created systematically for an extended period (Thomas 1986; Schoemaker 1990; Winter 1995; Ghemawat and Rivkin 1999; Besanko et al. 2010), the benefit-cost gaps (Ghemawat 1991), and the condition when a firm outperforms its rivals in the same industry (Oster 1990). Peteraf and Barney (2003, p. 314) also claimed that "an enterprise has a competitive advantage if it is able to create more economic value than the competitors in is product market", and "the economic value is created in the course of providing a good or service which is difference between the perceived benefits gained by the purchasers of the good and the economic cost to the enterprise".

In the above arguments, several things are highlighted in terms of understanding competitive advantage as a measure of organisational performance. Firstly, they take a value-based approach of net benefits produced by operating the business net of their costs. This is an attempt to broaden Porter's (1995) approach wherein he defined "value" only in terms of the benefits side (Peteraf and Barney 2003). Secondly, they hold a view of value creation closely linked to fundamental economic principles. Value is expressed by the difference between perceived benefits or customers' willingness to pay for the good and the economic costs a firm should pay for producing the product or service. In other words, their viewpoints of competitive advantage focus on the value for the money created by perceptions of consumers rather than for the absolute notion of differentials in the quality of products. Lastly, to create more value than its rivals, a firm should produce greater benefits for the same cost or the same benefits for a lower cost than the least competitor, which is closely related to the capability of a firm to produce its products or services efficiently. The last point is also in line with the argument of Porter (1985a) that if a firm is able to utilise its inputs than others better, differences in operational effectiveness among companies occur, and such differences are an important source of differences in profitability among competitors.

Furthermore, Porter (1985a) asserted that competitive advantage stemmed from a firm's ability to create superior value by offering lower prices than competitors for equivalent benefits or by providing unique benefits that more than offset the higher price. His argument treated competitive advantage as an outcome of positioning, equating to performance profitability (Ma 2000). Since Porter's view of competitive advantage has strongly influenced strategic management research, it is understandable that extensive research on the concept of competitive advantage has been investigated under a firm's performance. Finally, Hamel and Prahalad (1994, p. 127) argued that competitive advantage should be "creating for the future". According to this view, an organisation should be concerned not only with profitability in the present and growth in the medium, but also with competencies to create and respond to new opportunities for its future position.

In summary, competitive advantage can be understood by the ability of a firm to make a "difference" in a competitive market and superior "value" created by that. The advantage is a comparative concept and involves comparing with competitors regarding the end result (e.g. benefit and value) or pre-requisites (Maximova 2017). It is also impractical to inherently exclude economic value, especially financial performance, from the concept of competitive advantage. The overriding goal of most organisations is to yield profits, and producing more profits than others increase the likelihood of survival successfully in the marketplace. Besides, business competitiveness of ports has also been measured by factors related to the economic performance of port operations, for example, traffic volume, productivity, and terminal efficiency (Haezendonck et al. 2000; Kim et al. 2016).

Consequently, this study is in line with the perspective that competitive advantage has financial characteristics as the end outcome of port performance. Since there have been no studies involved directly measuring the relationship between competitive advantage and port sustainability performance, the measures for competitive advantage in this study were adopted from diverse disciplines, for example, Iraldo et al. (2009) and Aigner and Lloret (2013) from sustainability management, Lirn et al. (2014) from shipping management, Jorge et al. (2015) and Gelhard and Von Delft (2016) from organisational management. The measures for competitive advantage cover both an economic financial outcome advantage and superior differentiation in port services for comprehensive evaluation of the competitive advantage of ports. Additionally, better performance in port sustainability management is included as a measure of competitive advantage of ports according to the growing attention and adoption of sustainability operations and management. A total of nine questions were formed, and their descriptions are summarised in Table 4.4.

Table 4.4 Description of competitive advantage items

Competitive advantage characteristic	Item (Within the model)	Description	Reference
Economic financial performance	A market share (EFP1)	Occupying a larger port market.	Iraldo et al. (2009), Lirn et al. (2014), Jorge et al. (2015)
	Level of benefits (EFP2)	Generating a higher return.	Jorge et al. (2015)
Competitive differentiation performance	The quality of port services (CDP1)	Providing a higher quality of port services.	Jorge et al. (2015)
	User's satisfaction (CDP2)	Obtaining higher satisfaction from users.	Iraldo et al. (2009), Lirn et al. (2014), Jorge et al. (2015)
	A technological level (CDP3)	Providing a superior technology.	Iraldo et al. (2009), Jorge et al. (2015)
	Capacity to respond to user's needs (CDP4)	Operating a full capacity to user's need.	Aigner and Lloret (2013)
Sustainability performance	Port reputation (SP1)	Obtaining a reputation for performing sustainability management.	Iraldo et al. (2009), Gelhard and Von Delft (2016)
	Leading sustainability performance (SP2)	Being respected as a leading port in sustainability management.	Iraldo et al. (2009), Gelhard and Von Delft (2016)
	Responsiveness to port social responsibility (SP3)	Taking responsibility of social and ethical demands.	Gelhard and Von Delft (2016)

Items for environmental sustainability

According to key performance indicators of Environmental Performance Evaluation (EPE) of International Organisation for Standardisation (ISO) 14031 (ISO 1999), the environmental practice identified are categorised into two types: Environmental Management (EM); and Environmental Operation (EO). EM is related to activities that "provide information about the management efforts that influence the environmental performance of the port" (Puig et al. 2014, p. 125). As a management orientation, the EM activities are involved in effective environmental management within the organisation, such as establishing internal standards and goals and planning for environmental performance improvements. The EM activities support ports in establishing a long-term perspective to devise proper policies and strategies for this long-term view and allocate the necessary resources accordingly (Menguc and Ozanne 2005). A bundle of technological and organisational practices and tools can also be developed specifically for searching solutions to the impact of organisational operations on the natural environment, leading to greater economic benefits and reduction of environmental impact (Shrivastava 1995; Anne et al. 2015).

EO refers to activities which "provide information about the environmental performance of the port's operations", concentrated on activities, products, and services (Puig et al. 2014, p. 125). Environmental operations can be indicated by both inputs such as materials, energy and services, and outputs such as wastes and emissions. Ports mainly involves treatment activities to mitigate the adverse impacts arising out of the port's operations (see Peris-Mora et al. 2005; Lu, Shang et al. 2016b). Pollution prevention can consequently support a win-win situation where not only organisations appreciate competitiveness and profitability but also the environment will benefit (Porter and Van der Linde 1995). In many cases, environmental operation intends to increase environmental efficiency and considerable cost savings, allowing ports to obtain a competitive cost advantage over other ports (Porter 1995; Hart 1995). For example, port operational costs can be reduced by energy conservation by the rational use of energy and the adoption of more efficient technologies (Iris and Lam 2019). Similarly, input and disposal costs can be reduced by reducing the amount of general and hazardous wastes (Christmann 2000; Alberti et al. 2000). In addition to general operational costs, these more comprehensive environmental operations can also lower a range of other costs, such as environmental liability costs and legal fees (Shrivastava 1995).

Based on the previous research and the systematic literature review, ten measures for environmental sustainability were formed. Table 4.5 summarises the description of environmental sustainability items.

Table 4.5 Description of environmental sustainability items

Environmental sustainability characteristics	Item (Within the model)	Description	Reference
Environmental operation	Water pollution management (EO1)	Controlling deterioration of water quality due to the operation phases.	Peris-Mora et al. (2005), Park and Yeo (2012), Lirn et al. (2013), Chiu et al. (2014), Puig et al. (2014), Asgari et al. (2015), Puig et al. (2015a), Laxe et al. (2016), Lu, Shang et al. (2016b), Chen and Pak (2017), Cheon et al. (2017), Laxe et al. (2017), Roos and Neto (2017), Jiang et al. (2018), Oh et al. (2018), Wan et al. (2018)
	Air pollution management (EO2)	Reducing air pollutants and emissions of particles from general port operational activities.	Peris-Mora et al. (2005), Lirn et al. (2013), Chiu et al. (2014), Puig et al. (2014), Asgari et al. (2015), Puig et al. (2015a), Shiau and Chuang (2015), Lu, Shang et al. (2016b), Chen and Pak (2017), Roos and Neto (2017), Oh et al. (2018), Jiang et al. (2018), Wan et al. (2018)
	Energy and resource usage (EO3)	Using energy efficient control systems and substituting renewable energy or fuels such as solar, geothermal, and biomass, ethanol, biodiesel, and biogas.	Peris-Mora et al. (2005), Park and Yeo (2012), Chiu et al. (2014), Puig et al. (2014), Asgari et al. (2015), Puig et al. (2015a), Shiau and Chuang (2015), Laxe et al. (2016), Lu, Shang et al. (2016a), Roos and Neto (2017), Chen and Pak (2017), Laxe et al. (2017)
	Noise pollution management (EO4)	Reducing noise and vibration generation by port operations, transport operations, and the use of machinery.	Peris-Mora et al. (2005), Park and Yeo (2012), Lirn et al. (2013), Chiu et al. (2014), Puig et al. (2014), Asgari et al. (2015), Puig et al. (2015a), Shiau and Chuang (2015), Lu, Shang et al. (2016a), Chen and Pak (2017), Oh et al. (2018), Wan et al. (2018)
	Soil pollution management and occupation (EO5)	Prevention soil erosion and pollutants and disposal of dredging sediment and contaminated sludge.	Peris-Mora et al. (2005), Park and Yeo (2012), Chiu et al. (2014), Puig et al. (2014), Puig et al. (2015a), Lu, Shang et al. (2016b), Oh et al. (2018)
	Ecosystem and habitats (EO6)	Minimising habitat losses and prevention and protection of aquatic life and nature structure within and around port area.	Park and Yeo (2012), Lirn et al. (2013), Chiu et al. (2014), Puig et al. (2014), Puig et al. (2015a), Lu, Shang et al. (2016b), Chen and Pak (2017), Roos and Neto (2017), Oh et al. (2018)
	Waste pollution management (EO7)	General and hazardous waste handling generated by port operational activities.	Peris-Mora et al. (2005), Park and Yeo (2012), Lirn et al. (2013), Chiu et al. (2014), Puig et al. (2014), Asgari et al. (2015), Puig et al. (2015a), Shiau and Chuang (2015), Laxe et al. (2016), Liao et al. (2016), Roos and Neto (2017), Laxe et al. (2017), Wan et al. (2018)
	Odour pollution management (EO8)	Handling odours from perishable bulk solids, waste treatment, and water purifiers.	Peris-Mora et al. (2005), Puig et al. (2015a)
Environmental management	Green construction and facilities (EM1)	Sustainable building construction plans and design and replacing environmental-friendly port facilities.	Liao et al. (2016), Lu, Shang et al. (2016b), Oh et al. (2018)
	Green port management (EM2)	Implementing sustainability management plan, system, policy and legislation including monitoring and assessment of sustainability in port activity area.	Park and Yeo (2012), Puig et al. (2014), Asgari et al. (2015), Laxe et al. (2016), Liao et al. (2016), Chen and Pak (2017), Cheon et al. (2017), Wan et al. (2018)

Items for social sustainability

Taking the categorisation of Labuschagne et al. (2005) and Rendtorff (2009), this study understands social practice under two perspectives: Internal Human Resource (IHR) that is related to the human resource within ports; and External Population (EP) that refers to the societal role of ports emphasised the interaction with society. Internal human-based activities are related to regulatory and voluntary actions for employees' welfare, such as job opportunities, health and safety, working conditions, training and learning, and professional growth. Employee-centred activities enable employees to develop their capabilities within an organisation, creating tacit knowledge and skills that will be difficult for others to observe and imitate (Das 2017). For example, ports may introduce new technologies or equipment to ensure a better working environment and safety, and learning and training of employees should be entailed for their proper application. This organisational learning leads to developing competitively organisation's resources and capabilities both at the individual and group level, which will be difficult for others to imitate and reproduce (Menguc and Ozanne 2005).

EP involves community-based activities, focusing on the social interactions of people engaged in port operations and the communities around which a port operates. Examples of benefits from implementing the activities of external commitment include the improvement in the organisation's image and reputation (Pomering and Johnson 2009), organisational legitimacy (Arvidsson 2010), and better relationships with stakeholders (Gadenne et al. 2012). The improved reputation by implementing socially responsible management can be held for the attributes that distinguish it from its competitors, which produce opportunities to yield competitive differentiation outcomes (Pomering and Johnson 2009). These opportunities have been found to lead to better organisational outcomes, such as improving attitudes and loyalty of customers and other stakeholders (Du et al. 2010) and maximising long-run value (Arvidsson 2010).

Consequently, the items to measure social sustainability consist of eight measures identified from the systematic literature review. The social sustainability items are described in Table 4.6.

Table 4.6 Description of social sustainability items

Social sustainability characteristic	Item (Within the model)	Description	Reference
Internal Human Resource	Health and safety (IHR1)	Ensuring port area safety and orders by reducing accidents and injured including occupational health and safety.	Shiau and Chuang (2015), Lu, Shang et al. (2016b), Laxe et al. (2017), Jiang et al. (2018), Oh et al. (2018)
	Job generation and security (IHR2)	Job creation and offering internship and employment opportunities.	Chiu et al. (2014), Lu, Shang et al. (2016b), Cheon (2017), Laxe et al. (2017), Oh et al. (2018)
	Job training (IHR3)	Employee training and education by providing learning and working program.	Chiu et al. (2014), Laxe et al. (2016), Laxe et al. (2017), Oh et al. (2018)
	Gender equality (IHR4)	Supporting gender diversity and professional education and career development opportunities for women in the maritime sector.	Laxe et al. (2017), Oh et al. (2018)
	Quality of living environment (IHR5)	Employee's satisfaction and the creation of a safe and pleasant working and living environment.	Lu, Shang et al. (2016b)
External Population	Public relations (EP1)	Developing and sharing communications tools, activities, programs, and best practices for sustainability ports with relevant social groups and stakeholders.	Chiu et al. (2014), Lu, Shang et al. (2016a), Lu, Shang et at. (2016b), Cheon (2017), Oh et al. (2018)
	Social image (EP2)	Eco-friendly and socially responsible image with transparency of port operation and management.	Kim and Chang (2014), Shiau and Chuang (2015), Roh et al. (2016), Kang and Kim (2017)
	Social participation (EP3)	Interaction with relevant stakeholders and cooperative synergies with local communities and cities for socioeconomic sustainability of ports.	Chiu et al. (2014), Lu, Shang et al. (2016a), Lu, Shang et al. (2016b), Cheon (2017), Oh et al. (2018)

Items for economic sustainability

As economic practice in ports have focused on internal operational initiatives directly contributing to the overall profitability of ports, this study classified them into Economic Structure (ES) and Business and Servicing (BS) depending on the characteristics of activities (Laxe et al. 2016). The ES involves activities concerning the creation of market valuation of transactions, taking financial performance characteristics. Turnover, profit, market capitalisation and earning per share can be included (Doane and MacGillivray 2001). In ports, it can be defined in the form of operational efficiency, GDP, container throughput etc. The BS relates to service-oriented activities and focuses on how organisations provide them cost-efficiently (Matthyssens and Vandenbempt 1998). Ports provides a service-based business where the business success of a port depends largely on whether port users are attracted by the services the port provides (Ding et al. 2019). In this regard, the port activities of business and servicing practice include creating and providing various operational services in terms of technical, functional, and professional port operations and management.

Through the systematic literature review, 11 main indicators of economic sustainability in ports were identified. After thoroughly examining the characteristics of each indicator to define it as a measure of economic sustainability, it has been decided to consider "Operating costs/revenue" as two separate activities. Consequently, a total of 12 items are designed to evaluate economic sustainability in the current study and presented in Table 4.7.

Table 4.7 Description of economic sustainability items

Economic sustainability characteristic	Items (Within the model)	Description	Reference
Economic structure	Foreign direct investment (ES1)	An open and direct investment environment from outside the country into assets and into equity stakes in port owners.	Shiau and Chuang (2015), Laxe et al. (2016), Lu, Shang et al. (2016b), Oh et al. (2018)
	Operating costs (ES2)	The cost of general operation and maintenance of ports (e.g. repair of facilities, cost of water, electricity, gas, consumable substances, labour costs)	Kim and Chiang (2017)
	Port development funding (ES3)	Private and other forms of funding for port development	Lu, Shang et al. (2016b), Laxe et al. (2016), Laxe et al. (2017), Oh et al. (2018)
	Port throughput (ES4)	Annual throughput of container cargoes	Shiau and Chuang (2015), Cheon (2017), Jiang et al. (2018), Wan et al. (2018)
	GDP (ES5)	A value-added contribution to GDP by the port sector	Oh et al. (2018), Wan et al. (2018)
	Operating revenue (ES6)	Revenue from the use of port facilities and services (e.g. service fees, ship and port dues, etc)	Shiau and Chuang (2015), Laxe et al. (2016)
	Cost-efficiency (ES7)	Saving money and maximising revenue by optimising various costs of port activities	Asgari et al. (2015)
Business and servicing	Value-added productivity (BS1)	Creation value-added port services such as modern facilities, wide logistics service, trained expert staff, skills, etc.	Laxe et al. (2016), Laxe et al. (2017)
	Port operational efficiency (BS2)	Operational capability of ports to deliver efficient operation management with high quality of service and support	Liao et al. (2016), Wan et al. (2018)
	High quality services (BS3)	Providing reliable, responsiveness, efficient, punctual, and safe port service	Asgari et al. (2015)
	Benefits from external stakeholders (BS4)	External collaboration with port stakeholders for port operations and development (e.g. academia, employees, environmental NGOs, financial community, local community, regulators and policy makers, etc.)	Liao et al. (2016)
	Port infrastructure Construction (BS5)	Monitoring and upgrading port infrastructure and facilities	Lu, Shang et al. (2016b), Oh et al. (2018)

Questions for Part B and C

The questionnaire in Part B included a total of 30 questions for each item on environmental (10 items), social (8 items), and economic sustainability (12 items) as presented above. The questions and scales adapted from Heravi et al. (2015) were structured to examine respondents' perceptions regarding the relative importance of sustainability activities on strengthening the competitive advantage of ports. Also, for obtaining the demographic profile of the sample, Part C includes the questions regarding socio-demographics such as port location, port container throughput, job title, and working experience years.

Step 4: Determine form of response to questions

The type of question can be categorised into open and closed response questions. This study was determined to use the structured questionnaire with closed-response questions. These closed response questions are considered suitable for descriptive and hypothesis testing where a large number of samples mainly need to be collected, because they enable to provide quick and easy format to answer and in turn to obtain higher response rates than open-ended questions (Saunders et al. 2019). Furthermore, Rowley (2014) emphasised that the responses to closed questions facilitate easy information coding and analysis, which is particularly important in the research with a number of questionnaires collected.

In the current study, the closed-responses questions were formed using a Likert-style rating. Likert-type questionnaires aim at collecting respondents' opinions about a given issue by allowing them to express a rating on a given response scale. In this regard, the Likert rating scale has been widely used for its usefulness "to allow respondents to express both the direction and strength of their opinion about a topic" (Garland 1991, p. 1). Accordingly, the questionnaire was designed using a seven-point end-anchored Likert scale (strongly disagree 1 2 3 4 5 6 7 strongly agree), including a *Not Known* option as an alternative response. This option is mainly considered one of "no-opinion" response option, named variously, such as an uncertain or indefinite response (Coombs and Coombs 1976), neutral opinion (Chyung et al. 2017), or non-attitude response (Converse 2006). No-opinion response options include *Not applicable, Don't know, Undecided, No opinion,* and *Unsure*, indicating a state of lack or absence of knowledge and commonly offered in survey research (Saunders et al. 2019).

However, it is true that there has been a debate on whether or not to provide a no-opinion response option. Some researcher argued that it discouraged the respondents from providing adequate answers with additional effort, creating missing data and analytic difficulties (Beatty and Herrmann 1995). On the other hand, some researchers claimed that a no-opinion response option precluded respondents from answering questions on the basis of insufficient knowledge or experience, and consequently, researchers avoided producing biased data and increased the validity of results (Beatty and Herrmann 1995; Krosnick 1999). That is, a condition in which respondents are forced to select a point on the scale without alternative response to the absence of knowledge is more likely to result in random and meaningless answers that increase measurement error and decrease reliability (Carpini and Keeter1993; Lam et al. 2002). Besides, several studies empirically supported that a no-opinion response option decreased the proportion of guessing responses or non-responses (see Dolnicar and Grün 2014).

Feick (1989) claimed that whether to offer a no-opinion response option or not can be attributed to types of questions and characteristics of respondents. According to the empirical results of Sanchez and Morchio (1992), the no-opinion response option is appropriate to opinion surveys. The survey questions in this study are included in a type of opinion expressing the degree of agreement to the questions with multiple scales (Feick 1989). Consequently, it was decided to provide a no-opinion response option in this study for the convenience and benefit of respondents. In an effort to mitigate potential problems that may be caused by a lot of no-opinion responses, such as random error and data reliability issues, the respondents were informed before and during survey participation to choose the best answer based on their knowledge as much as possible.

Step 5: Determine wording of each question

In formulating the questions, it is important to design the questionnaire using words whose meanings are understood and agreed on by all of the respondents (Peterson 2000b). This process concerns the validity and reliability of data collected by reducing the risk of obtaining unreliable and biased responses and a high rate of missing data because respondents failed to understand the questions and complete the questionnaire (Fallowfield 1995; Synodinos 2003). The questions were evaluated for their suitability in accordance with four criteria, brevity, objectivity, unambiguity, and specificity, suggested by Peterson (2000b). Firstly, every question was as clear and specific as possible, focusing on a single topic. Secondly, ambiguous words and jargon were avoided, and simple words were used. Thirdly, double-barrelled questions were minimised. Fourthly, questions that were presented in a way that led respondents to give certain responses or made implicit assumptions were avoided. Fifthly, questions consisted of 20 words or less. Finally, questions which might breach the confidentiality of respondents were avoided.

The survey questionnaire was written in English. To facilitate data collection from container ports in multiple countries, it was additionally translated into other languages, namely Korean and Chinese, which were available within the researcher's resources. Based on the guideline suggested by Douglas and Craig (2007) for translating questionnaires, the translation process was conducted by a back-translation technique. This technique is performed in three steps: first, to translate from English to the target language by a bilingual speaker; second, to translate back from the target language to English by a second bilingual translator; and third, to compare two translated questionnaires to make conceptual equivalence. The study questionnaire was translated by two Korean including the author and two Chinese colleagues. They were native speakers of Korean or Chinese and were competent in the English language. They are also familiar with maritime transport terminologies in both languages, having backgrounds working either in maritime transportation research institutions or in port authorities.

Step 6: Determine sequence of questions

The order in which questions are presented is an important issue in a questionnaire design in that it involves evaluating not only the individual content of each question and response but also the larger context in which it is situated (Dillman et al. 2014). An adequately structured questionnaire can influence the motivation of respondents to complete the questionnaire and minimise measurement errors and non-response bias by increasing the response rate (Rea and Parker 2014). Question sequencing in the study questionnaire was framed based on the guideline proposed by Churchill and Iacobucci (2002) and Dillman et al. (2014). Firstly, the related questions were grouped together, and items were arranged by topics. The questionnaire was constructed based on the grouping with four parts—introduction, main body, respondent demographic characteristics, and ending letter. Secondly, the study questionnaire was determined to begin with salient questions closely connected to the purpose of the questionnaire so that respondents were convinced to respond and build their cooperation and commitment throughout the questionnaire. Finally, the questions referring to the respondent background were placed at the end of the questionnaire because such questions are regarded as sensitive.

Step 7: Determine layout and physical characteristics of the questionnaire

The quality of responses can be enhanced by the layout and presentation of the questionnaire (Rowley 2014). The visual presentation is particularly significant when surveys use web-based and self-administered questionnaires (Saunders et al. 2019). The study questionnaire was designed in a professional and easy-to-read layout in order to enable respondents to complete the questionnaire or administer it by themselves. To ensure the legibility of the text, the basic page layout of the questionnaire was set to white background and black text colour, and a sans serif font with at least a size 14 point was used for the questions (Dillman et al. 2014). The questionnaire was divided into sections, and the questions were numbered per section to allow respondents to navigate the questions. A short introductory paragraph was provided at the beginning of each section regarding the subject matter and throughout the questionnaire. In addition, definitions for each item were specified to help respondents to understand the context.

Furthermore, the length of the survey time was considered in this step. A long and cumbersome questionnaire can make respondents reluctant to complete the survey, while a short questionnaire is the likelihood to exclude important questions (Saunders et al. 2019). Although a general guideline for web-based surveys is approximately 15 minutes (Rea and Parker 2014), it should be determined depending on the nature of research questions and the characteristics of the sample, and the types of data analysis (Rowley 2014). The study questionnaire was designed to take no longer than 30 minutes to complete, which is the point where dropout rates exceed 50% (Galesic 2006).

Step 8: Re-examine and revise if necessary

The re-examination of the questionnaire developed was conducted to identify any ambiguities and potential problems such as bias inducing or difficulties in answering the questions (Churchill and Iacobucci 2002; Williams 2003). Each question was reviewed with colleagues and supervisors who have experience in designing questionnaires and participating in surveys. The questions and layout were modified in this stage to be unambiguous, relevant, and acceptable to respondents.

Step 9: Pretest questionnaire

Pretesting the questionnaire with potential respondents is a crucial phase in that their responses can provide evidence of the validity and reliability of the questions (Synodinos 2003). The subjects of the pre-test can vary from family, friends, or colleagues to potential respondents who are similar to the targeted study population (Saunders et al. 2019). Peterson (2000b) also mentioned that for pretesting to be cost-effective, an expert panel is recommended, usually consisting of experts in a questionnaire design and general research methodology. In these senses, the draft questionnaire was pretested to experts who were satisfied with two criteria: those with working experience as practitioners in the port industry; and those familiar with designing questionnaires.

A total of ten experts were selected and asked to evaluate the draft questionnaire in terms of the clarity and comprehensiveness of individual questions, the quality of the questionnaire construction, and the acceptability of the overall questionnaire such as ethical or moral standards and privacy of respondents (Rea and Parker 2014). Consequently, four out of ten experts provided feedback, and accordingly, the questionnaire was restructured, and the items were re-written based on their comments. The final questionnaire is attached in Appendix B.

4.7 Validity and reliability of measurement

In survey research, it is required to assess the validity and reliability of measurement (Bryman 2016). Assessing the quality of measurement occurs at various stages of survey research: during pre-testing, data collection, and hypothesis testing (Forza 2002). Since most business and management studies include indirect measurements that comprise questions asking peoples' perceptions, responses and quantitative data are required to test the validity and reliability of measurement. In this regard, it is common to demonstrate the validity and reliability of measurement after the collection of the data using analytical techniques (Ekinci 2015). This section outlines the tests used to ensure the study's validity and reliability: content validity, construct validity, and reliability.

4.7.1 Validity

A questionnaire can be said to be valid if it is constructed with individual questions that contain the full scope of the research question (Williams 2003). In other words, validity is concerned with assessing the accuracy of research instruments, which explains the extent to which a designed set of measurements accurately measures what it is intended to measure. The most widely accepted validity assessments are content and construct validity (Hair et al. 2014).

Content validity

Content validity, also known for face validity, refers to the degree to which individual items adequately capture the key contents of a construct (Forza 2002). It involves an assessment of a survey instrument to ensure that it includes essential and relevant items to a construct domain (Taherdoost 2016). However, there is no rigorous statistical approach for assessing content validity, and subjective assessment based on expert or researcher judges is usually accepted to establish the content validity (Dunn et al. 1994). Nevertheless, content validity is considered assured if constructs and items are generated from an exhaustive review of associated literature (Rattray and Jones 2007; Hair et al. 2014). All the survey items of competitive advantage and sustainability performance are extracted from the previous studies conducting interviews and surveys. It is, therefore, believed that the content validity of the study is deemed to be established.

Construct validity

Construct validity refers to the extent to which a set of measures represent the theoretical concept of a construct in which they are designed to measure (Hair et al. 2014). It concerns the operationalisation and generalisation of a construct by focusing on how well a concept or idea that the research is intended to measure is translated or transformed into the scale items (Taherdoost 2016). Construct validity can be established through convergent and discriminant validity and unidimensionality.

Convergent validity assesses the extent to which variables of a specific construct are designed to measure the same construct. They should converge or have a high correlation with each other (Hair et al. 2014). To ensure convergent validity, this study investigated the size of the factor loadings and Average Variance Extracted (AVE). All factor loadings are required to be greater than 0.50 and preferably 0.70 or higher for a robust convergent validity. The AVE measures the overall amount of variance in the variables captured by the latent construct (Hair et al. 2014).

It is calculated using standardised loadings as:

$$AVE = \frac{\sum_{i=1}^{n} \lambda_i^2}{n}$$

The λ_i is the standardised factor loading, and i represents the number of items. The 0.50 or higher value of AVE suggests adequate convergence. The results of convergent validity are presented in Chapter 8.

Discriminant validity refers to the extent to which a latent construct and its variables are distinct from other constructs and their variables. High discriminant validity provides evidence that a construct is empirically distinct, and each measured variable represents only a single construct. According to Fornell and Larcker (1981), discriminant validity can be undermined if a measured variable in a construct shares with other constructs in the same model. The discriminant validity can be verified by comparing the AVE values of each construct with Maximum Shared Variance (MSV) or the square root of AVE with the correlation estimate between other constructs in the model (Henseler et al. 2015). If the AVE for each construct is greater than the MSV and the square root of AVE is greater than inter-construct correlations, discriminant validity is supported. Discriminant validity results are demonstrated in Chapter 8.

Unidimensionality can assure the construct validity by defining the existence of one construct underlying a set of items (Steenkamp and Van Trijp 1991) and the degree to which measured items are not contaminated with elements from the domain of other constructs (Dunn et al. 1994). In other words, a set of measured items should be explained by only a single underlying construct (Hair et al. 2014). According to Dunn et al. (1994), it is acceptable to have a multidimensional construct, but each measured variable must be unidimensional, estimated by only one construct. Traditionally, the most used techniques to evaluate unidimensionality are Cronbach's Alpha, item-to-total correlation, and exploratory factor analysis (EFA). In addition to these, based on the suggestions of previous research (see Dunn et al. 1994; Ziegler and Hagemann 2015), the current study performs confirmatory factor analysis (CFA) and assesses overall measurement model fit using goodness-of-fit indices as a diagnostic measure to affirm unidimensionality. Fit indices used for CFA in the study is addressed in detail in subsection 4.8.2 below. The unidimensionality in the study is demonstrated in Chapters 7 and 8.

4.7.2 Reliability

Reliability is concerned with the stability, reproducibility, and internal consistency of measurement instrument (Rattray and Jones 2007). Reliability refers to evaluating the degree to which individual items on a scale measure the same construct, and thus they are highly correlated (Hair et al. 2014). The most common two types of diagnostic measures are used to demonstrate reliability: Item-to-total and Inter-item correlation and Cronbach's alpha. *The item-to-total and inter-item correlation* enable to assess not only reliability but also convergent validity of variables by generating the value of correlations among the variables (Hair et al. 2014). If the values exceed 0.50 in the item-to-total correlations and 0.30 in the inter-item correlations, it demonstrates that the variables correlate with each other and accurately represent the measures of concept (Robinson et al. 1991). *Cronbach's alpha* is the most widely used measure of the consistency for the entire scales, and the generally agreed limit is at least 0.60.

However, it has been perceived that Cronbach's alpha is inflated with the increase of the number of items and produces that all the measured items have a high value of reliability (Hair et al. 2014; Malhotra et al. 2017). Thus, alternative methods derived from CFA have been suggested: the AVE and the Composite Reliability (CR) (Hair et al. 2014). The CR refers to the reliability consistency of a latent construct, and high CR values indicate that the internal consistency is achieved, and all the variables consistently represent the same latent construct (Hair et al. 2014). It is calculated as:

$$CR = \frac{(\sum_{i=1}^{n} \lambda_i)^2}{(\sum_{i=1}^{n} \lambda_i)^2 + (\sum_{i=1}^{n} e_i)}$$

The λ_i represents the squared sum of factor loadings for each construct, and e_i is the measurement error. The recommended level of CR is 0.70, with the minimum level of 0.60 when other validity assessments with the model are sufficient. The results of reliability are presented in Chapters 7 and 8.

4.7.3 Managing common method bias

Common method bias refers to the magnitude of discrepancies between the observed and actual relationships between constructs created due to common methods variance (Doty and Glick 1998). The common method variance is caused by the measurement approach rather than the constructs of interest. The common method variance is a main source of measurement errors and can inflate or deflate the observed relationships between measures of different constructs. Therefore, the presence of common method variance in measures is regarded as one of the major threats to construct validity and internal consistency (Doty and Glick 1998; Podsakoff et al. 2003). Common method bias likely occurs in studies in which the data are obtained from the same source (i.e. a single respondent) in the same measurement context using similar scale formats (Podsakoff et al. 2003). Given that the questionnaire of the current study designed the measured items for a single survey, concerns for common method bias should be considered.

In order to control the effects of common method bias, this study attempted procedural remedies suggested by Podsakoff et al. (2003) at the stage of designing the questionnaire. Firstly, the questionnaire was designed with psychological separation to make it apparent that the items are not connected or related to each other. The partition was created between the parts of the questionnaire. Similarly, the questions from each study construct measuring competitive advantage, environmental sustainability, social sustainability, and economic sustainability were located in different sections of the questionnaire and with different sets of instructions. Secondly, according to Podsakoff et al. (2003), common method bias may be produced by consistent answers of respondents across all survey items. Hence, this study collected responses from different sources in an attempt to obtain diverse answers for the survey items and reduce the level of common method variance (Tehseen et al. 2017). The various aspects of ports and respondents, for example, port location, port sizes and the different levels of management responsibility of respondents within the same port were considered in the process of distributing the questionnaire and collecting the responses. Thirdly, this study ensured the anonymity and confidentiality of respondents in order to lessen their evaluation apprehension. The questionnaire was distributed after respondents were assured that their responses, including their personal information, would be anonymously and confidentially protected. Fourthly, they were informed that the questions would ask their opinions according to their experience and knowledge, where there were no right or wrong answers. Lastly, the careful construction of the scale items was conducted. Item ambiguity was reduced by avoiding unfamiliar terms and adding definitions of certain concepts that this study uses, such as sustainability and competitive advantage. Furthermore, unnecessary questions were removed, and the questionnaire was restructured through a pilot study to increase the simplicity and precision of the scale items.

Despite the efforts to control the potential effects of common method variance by the careful designing procedure of the survey, eliminating threats totally are not always possible (Podsakoff et al. 2003). In such cases, several statistical remedies after data collection are available to mitigate the bias caused by the common method variance. This study adopted the two most widely used techniques in business research to detect and control common method bias: Harman's one-factor test and the unmeasured latent method construct test (Fuller et al. 2016). The *Harman's one factor (or single-factor) test* checks the extent to which a single factor accounts for the variance in the data by loading all the variables in the study into an exploratory factor analysis. If either a single factor emerges from the factor analysis or one general factor accounts for more than 50% of the variance among the measures, it is regarded that there is a common method variance issue in the study.

However, there is an argument that the Harman's single-factor test has limitations. Podsakoff et al. (2003) argued that the technique is not sensitive enough to detect common method bias in that it is unlikely that a single factor model will fit the data. Moreover, Tehseen et al. (2017) noted that the Harman's one-factor test is useful to obtain information regarding the absence or presence of common method variance, whereas it fails to control or correct the common method bias. Accordingly, another statistical technique, the unmeasured latent method construct test, was used as a complementary method. This technique adds a latent common methods factor to the theoretical measurement model of the study and explores the potential increase in model fit obtained by accounting for the common methods factor (Dulac et al. 2008). A significant increase in model fit suggests the presence of common methods variance. The results of common method bias are presented in Chapter 8.

4.8 Data analysis methods

As mentioned earlier, the present study has two main objectives: first, to examine sustainability activities that are perceived as important to creating better competitive advantage of ports; second, to verify the statistical relationship between port sustainability performance and competitive advantage. Hence, the data collected from the questionnaire were analysed using two methods to accomplish the respective study objectives: Relative Importance Index analysis for the first purpose and Structural Equation Modelling for the second purpose. Their empirical analyses are provided in Chapters 6 and 8, respectively. This section focuses on providing the clarification of purposes and procedures for utilising each data analysis method.

4.8.1 Relative Importance Index (RII) method

Relative Importance Index (RII) is a type of relative importance analysis, which computes each rating of survey question and uses the weight as the basis for its relative significance with other ratings of questions (Taylan et al. 2014). The method is used to prioritise factors or attributes of study for further quantitative assessment or response analysis, based on the calculation of rankings assigned to each factor according to their relative importance (El-Sayegh 2008). The usefulness of the RII method has been acknowledged in that it is adaptable for Likert scales, specifically ordinal scales, and it is precise and straightforward to determine the relative weight of each variable among total variables (Princy and Shanmugapriya 2017). When it comes to the survey research that involves participants' opinions, response ratings are likely to be clustered around the high end of the scale because respondents tend to rate all issues as necessary for fear that those not given high importance ratings would not be considered (Johnson and LeBreton 2004). The RII method is a proven system that mitigates this problem by enabling a better examination of relative weights on different issues as a greater proportion of responses are devoted to issues that received higher relative weights (Lundby and Fenlason 2000; Hickson and Ellis 2014). The analysis using the RII method reveals certain elements that should be considered most importantly in organisational management, which help decision-makers establish priorities for limited organisational resources (Whanger 2002). An additional benefit of the RII method is that it can be used not only alone, but also with other techniques for a complementary analysis, such as Analytic Hierarchy Process (AHP) (Soham and Rajiv 2013; Taylan et al. 2014), SEM (Heravi et al. 2015; Omoush 2020), Confirmatory Factor Analysis (CFA) (Lu et al. 2016a), and correlation and regression analysis (Otchere et al. 2013).

With the analytical advantages of the RII method, it has been utilised in a wide variety of research areas with the purpose of examining the level of importance of diverse factors and identifying key factors by ranking them based on their relative importance values: for example, education (Aziz et al. 2016), construction projects (Othman et al. 2005; Gündüz et al. 2013; Hatkar and Hedaoo 2016; Shahsavand et al. 2018; Princy and Shanmugapriya 2017), labour productivity (Soham and Rajiv 2013; Hickson and Ellis 2014; Annigeri and Kelkar

2018; Singh, Tejaswini et al. 2019), risk assessment (Kometa et al. 1995; Okoroh et al. 2002; Taylan et al. 2014), supply chain management (Otchere et al. 2013; Akbari and Hopkins 2016; Omoush 2020), transportation (Mahmoudi et al. 2019), maritime logistics and freight transport (Islam et al. 2019), human resource management (Dey et al. 2017; Hashim and Alamen 2019), total quality management (Ajayi and Osunsanmi 2018), and organisational management (Kometa et al. 1994; Zeng et al. 2005; Ribeiro and Fernandes 2010; Mahamid 2012; Akbari and Hopkins 2016).

The analysis method has been utilised in studies interested in identifying certain activities or elements that affect organisational performance, and the results of the RII analysis have contributed to capturing new directions or opportunities in organisational management. For example, Akbari and Hopkins (2016) identified the most significant outsourcing elements in terms of the reasons, types, and levels of outsourcing. They suggested a practical strategy establishing best practices for outsourcing based on the results of the RII analysis. In the construction industry, many researchers have investigated and established a set of critical factors affecting labour productivity, suggesting the directions for successful construction project management by the application of relative importance index (e.g. Soham and Rajiv 2013; Hickson and Ellis 2014; Annigeri and Kelkar 2018; Singh, Tejaswini et al. 2019). Additionally, Otchere et al. (2013) proposed a pragmatic approach to implement supply chain integration to achieve competitive advantage in the cocoa industry by adopting the RII method in a benchmark evaluation procedure. They utilised the method to evaluate the attribute of individual variables related to supply chain integration and further confirm the relationship between supply chain integration and improved performance as well as a competitive advantage.

Besides, the increasing adoption of the RII method has been witnessed in the sustainability management literature, for the purpose of not only establishing sustainability management factors affecting organisational performance, but also presenting a set of evaluation criteria for sustainability performance (see Dey et al. 2017; Aghili et al. 2019). For example, Weerasiri et al. (2012) used the RII method to identify critical factors that affected the implementation of environmental management systems in manufacturing small and medium enterprises. Rooshdi et al. (2018) investigated the most important criteria in terms of sustainable design and construction activities for developing green highways in Malaysia by analysing the survey data through the formula of the RII method. More recently, Nair and

Nayar (2020) developed a set of performance indicators for sustainable construction from the three aspects of sustainability—environmental, social, and economic—using the RII method.

Objective of the RII method in the study

In the current study, the RII method is used to prioritise sustainability activities in terms of their importance to the overall competitive advantage of ports and to identify potential development opportunities in sustainability performance. The vast amount of data of key variables in terms of port performance makes it challenging to manage the integrated port. It is more difficult when it comes to port sustainability management in that the multiple elements are engaged (Molina-Serrano et al. 2020). Sustainability performance involves different operations and management activities, and the activities can be differently accepted depending on the managerial perception of the importance of these (Banerjee 2001). Such decisions for actions affect the overall operational performance of ports. Hence, it is important that each activity is carefully weighted so as to support the decision-making process for the development of port sustainability strategy. The methodological purpose of the RII method in this study is to provide a more profound and broader view of managing sustainability practice that can deliver long-term value in port operations by identifying critical management operations activities that affect ports' competitive advantage. In order to achieve the purpose, this study using the RII method presents quantitative information about the perception of practitioners in ports regarding sustainability activities affecting the competitive advantage of ports, and examines how the activities are differently perceived according to their background characteristics.

Furthermore, although the relative importance indices method has increasingly gained academic interest by researchers in recent years, it is still acknowledged in its infancy, opening the opportunity to expand the use of the method (Johnson and LeBreton 2004). Indeed, researchers in the maritime field of study have used alternative methods in order to examine the relative importance of factors and rank them. The most frequently used is AHP (Chiu et al. 2014; Asgari et al. 2015), and other techniques include the Best-worst method (Rezaei et al. 2019), DEA (Park et al. 2019), Multiple regression (Kim and Chiang 2017), and Importance Performance Analysis (IPA) (Oh et al. 2018). Some studies analysed the mean scores or the percentage of response frequency to compare the importance level of factors. For example, Puig et al. (2017) investigated a comprehensive benchmark performance of the port sector regarding environmental performance and identified key components for the implementation of environmental management in European ports based on the numerical evidence of the percentage of frequency of responses. Lu et al. (2016a) was also involved in calculating the relative importance of 31 sustainability assessment criteria in the context of container ports by aggregating their scores of the agreement for impotence in order to identify crucial indicators, and those were further confirmed by conducting CFA. Additionally, Lam and Bai (2016) compared and prioritised customer requirements and maritime risks according to their importance based on Likert's five-point scale and calculated their relative importance with equations for relative importance weights derived from the absolute importance degree and correlation matrix for each attribute. However, no attempt has been made to adopt the RII method in the field of the port study, allowing this research to make a unique methodological contribution.

Computation formular of RII value

The relative important index method is designed to reflect participants' perceived importance of each variable identified for research purposes. The relative importance is measured by numerical scores of their opinions, established with a Likert scale. In this study, the ranges were from 1 to 7, where 1 = strongly disagree, and 7 = strongly agree, including the no-opinion answer. The RII method for the current study quantifies the degree to which the importance of each activity is perceived as strengthening the competitive positioning of ports by processing numerical values through relative importance weights. The RII value ranges from 0 to 1 (0 means not inclusive), and the higher RII value represents the more significant sustainability activity influencing the competitive advantage of ports. Additionally, the analysis includes a ranking decision process where each element is assigned a ranking depending on its perceived importance (Akbari and Hopkins 2016).

The relative importance indices are calculated for each by using the following equation, which is the most frequently used for a RII analysis in the previous literature:

$$Relative\ importance\ index = \frac{\sum W}{A \times N}$$

Where W is the weighting given to each attribute by the respondents, ranging from 1 to 7, with 1 being the least important and 7 being the most important; A is the highest weight (7 in the case of this study); and N is the total number in the sample (Kometa et al. 1995).

The formula has been expanded:

$$Relative\ importance\ index = \frac{\sum_{i=1}^{n} ixFrequency_i}{A \times N}$$

Where 1 and n represent A_{min} and A_{max}, respectively (Lam et al. 2007; Holt 2014).

Anther expansion equation is based on a weighted score of ranking assigned the target set of variables, presented as (Olawande 2011; Holt 2014):

$$WS_{i=1-n} = \left\{\sum[(P_1 \times n_1 r_1 c_1) + (P_2 \times n_2 r_2 c_2) + \cdots + (P_n \times n_n r_n c_n)]\right\} / N$$

Where:

WS = weighted importance score.

P_{i-n} = point for each criterion.

i = 1, 2, … *N*.

n = number of respondents returning a choice for a particular criterion.

r = ranking.

c = criterion.

N = total number of respondent sample.

Holt (2014) conducted RII analyses using the above equations with hypothetical respondent data to identify the best equation that offered the optimal value of RII and demonstrated that they produced the same results. Therefore, this study determined to use the first formula since it is widely used due to its simplicity.

4.8.2 Structural Equation Modelling (SEM) method

SEM, which is used for the second analysis of this study, is a multivariate statistical analysis technique utilised to analyse a structural theory bearing on a phenomenon. It enables a more explicit conceptualisation of theoretical relationships between constructs, allowing researchers to determine whether a structural model is consistent with the data collected (Byrne 2010). If a hypothetical model explains the relationships among measured variables and latent constructs based on a theory or concept, SEM assesses how well the model supports reality as represented by the data collected (Hair et al. 2014). Kaplan (2000, p. 1) proposed that "structural equation modelling can perhaps best be defined as a class of methodologies that seeks to represent hypotheses about the means, variances, and covariances of observed data in terms of a smaller number of structural parameters defined by a hypothesised underlying model". This explains two important characteristics of the SEM method: it is based on theoretical questions for testing hypotheses; and it represents a multitude of techniques. As SEM combines not only single simple or multiple linear regression, but also factor analysis, it is considered a robust tool in estimating multiple and quantitative interdependent relationships between variables (Hair et al. 2014). Hoe (2008) noted that the SEM method is especially appropriate for data analysis and testing hypotheses for the inferential purpose in the sense that it enables to examine the pattern of interconnections among the constructs of the study posited by the existing theory or a priori inference.

The most prominent feature of SEM is a theoretical construct that cannot be observed directly, called latent variables. Because latent variables are not measured, they are linked to multiple observable variables that can be measured by a measurement model. In this regard, SEM encompasses two components: a measurement model (i.e. confirmatory factor analysis (CFA), which specifies the relationships among the variables to the constructs; and a structural path model (also referred to as a hypothesised model or a casual model), which identifies specific relationships between the constructs to other constructs. The measurement model developed based on theory is tested by how well the observed variables of the underlying constructs are related to each other, which is captured in a covariance matrix (Hair et al. 2014). On the other hand, the structural path model is represented by structural equations and measured in the manner of a linear system. The structural relationships between the study constructs can be evaluated by estimating the extent to which variances in one variable corresponded to variations in one or more variables based on correlation coefficient (Hoe 2008; Hair et al. 2014).

Objectives of using SEM in this study

The SEM method has a variety of functions and advantages, and thereby it has become one of the popular statistical techniques by researchers in many disciplines. One particular advantage of SEM is that it allows the measurement of several variables and their interrelationships simultaneously (Hoe 2008). In this regard, it has been widely applied to test the reliability of the items to the latent variables and causal relationships among variables in a complex model (Schreiber 2008). According to Byrne (2010), the advantages of SEM can be summarised as follows:

1. It takes a confirmatory rather than an exploratory approach to the data analysis.
2. It is capable of assessing estimates of error variance parameters, contributing to fewer inaccuracies in measurement results and finer diagnostics for model improvement.
3. It enables the incorporation of both unobserved (i.e. latent) and observed variables in simultaneous analysis of the entire system of variables.
4. It is particularly powerful to identify multivariate relations, estimating structural portion and direct or indirect effects of the model.
5. It reduces problems with multicollinearity.

Given these desirable characteristics, the SEM method has been utilised to address numerous research problems involving experimental and non-experimental research. The SEM method has been applied in the port industry with purposes and usages assessing both direct and indirect impacts of port operations on port performance. For example, Bichou and Bell (2007) employed SEM to assess the impacts of consolidation on the channel relationship, Shang and Lu (2009) examined the extent to which employees agreed about the impact of safety management on the safety performance of port operations. Additionally, Caldeirinha et al. (2020) assessed the effect of port community system and its influence on port performance using a SEM model with the significant factors. Moreover, port studies have utilised the SEM method to link sustainability management and its impacts on overall port performance. Lu et al. (2016a) developed a SEM model to investigate the relationship between internal and external sustainability practices and sustainability performance in Port of Kaohsiung. Sislian and Jaegler (2018) used the SEM method to identify the feasibility of a sustainable maritime balanced scorecard and important actions for green port operations and management.

In the context of competitive advantage, most studies employed the SEM method to identify the determinants of competitiveness in ports. For example, Ahn et al. (2010) analysed container terminal integration factors affecting the competitive performance in Busan port using SEM, and Hyuksoo and Sangkyun (2015) utilised the SEM technique to verify the causal relationships among six variables affecting the competitiveness of container ports identified through theoretical foundations. More recently, Chen (2020) developed a SEM model in order to identify key factors influencing the competitiveness of ports located in the main coastal in China.

According to the application of the SEM method in the port industry, it has been adopted with two main purposes: first, to assess impacts of specific phenomena or issues on port performance; second, to confirm significant factors influencing certain outcomes of port performance. In this study, SEM is adopted to examine the direction and strengths of the relationship between sustainability performance and competitive advantage. The SEM method is considered most appropriate when a theory or a priori conceptual foundation allows a researcher to posit the relationships among the factors and the variables in the model (Hussey and Eagan 2007). Additionally, SEM involving factor analysis helps this study statistically validate consistent and reliable sustainability activities, which explain the three corresponding aspects of sustainability conceptually (Cheng 2001). Furthermore, one of the most significant advantages of using the SEM method is that it allows examining multiple equations involving a series of dependence relationships simultaneously (Hair et al. 2014). This study developed the hypothetical model incorporating connections between three aspects of sustainability and competitive advantage, and both latent and measured variables are included in the model. Hence, the SEM technique is appropriate in the current study to evaluate the multiple relationships between sustainability performance of ports and its impacts on specific competitive outcomes and understand the reality of how port sustainability practices are being carried out.

Basic terminology of SEM

There are diverse terms used in a SEM analysis. For a more precise interpretation of the analysis technique, it is advised to comprehend basic terminology regarding SEM (Schreiber 2008). The two basic types of variables used in SEM are unobserved and observed variables. *Unobserved variables*, also termed *latent variables*, *factors*, or *constructs*, are referred to as theoretical constructs of the study that researchers are interested in, but often cannot be directly observed and thereby cannot be measured (Byrne 2010). They are graphically illustrated with circles or ovals in a path diagram depicting a particular SEM model. Since they are unmeasurable, variables that are observable and make their measurement possible are necessary. Such variables are *Observed variables.* Observed variables are also called *measured variables, indicators,* or *manifest*, schematised as squares or rectangles in the path diagram. They are presumed to represent an underlying construct, operationally defining the unobserved variables of interest (Byrne 2010). In order to avoid confusion in the terminology of variables, this study henceforth uses "(latent) constructs" for unobserved variables and "measured variables" for observed variables. Additionally, *Error*, represented with the small circles connected single head arrows to the measured variables, are variance in the responses that are not explained by the latent construct. Two other terms associated with SEM are *Exogenous* and *Endogenous*, similar to independent variables and dependent or outcome variables, respectively.

SEM analysis procedure

An appropriate procedure is important when applying the SEM technique in that the decisions involved in each step of SEM may impact overall fit indices and estimation of variables. Hair et al. (2014) suggested a six-stage for a SEM analysis (Figure 4.5), applied in the current study for the proper data analysis.

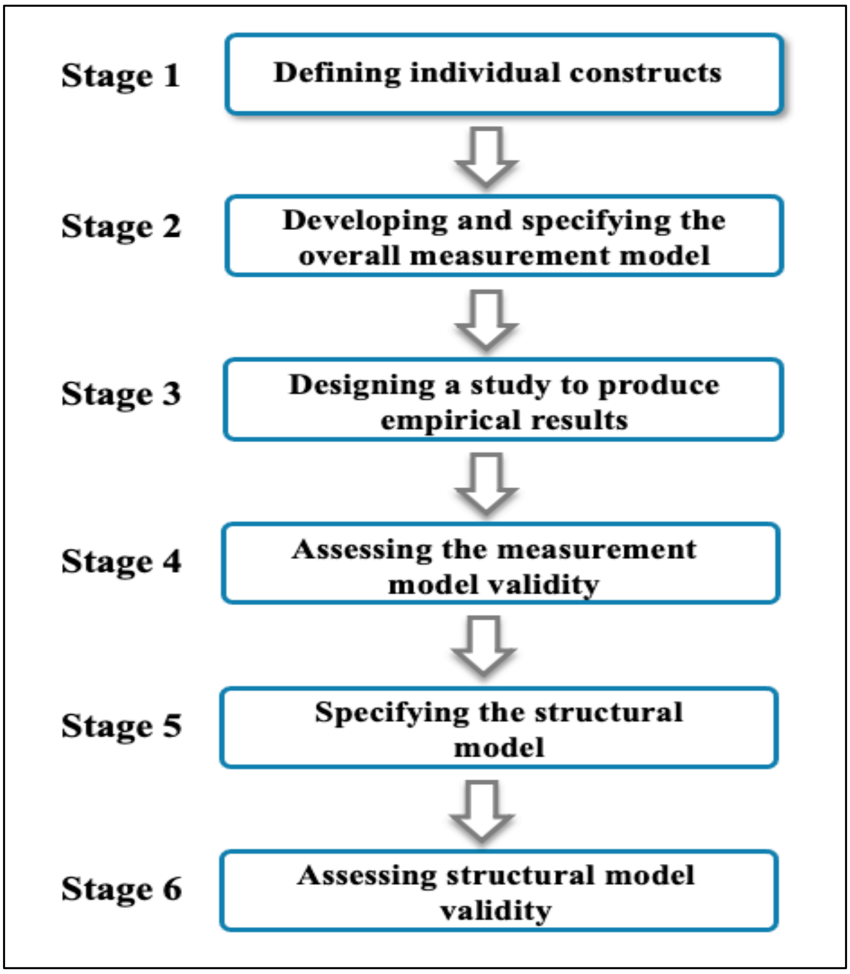

Figure 4.5 Six-stage decision process in SEM, adapted from Hair et al. (2014)

Stage 1. Defining individual constructs

The first stage involves constructing a good measurement for individual constructs. Testing hypotheses of structural relationships among constructs depends on how well the constructs are constructed as theoretical rationale with reliable measurement scale items. According to Hair et al. (2014), a researcher can operationalise a construct by selecting measurement scale items and their scale type that underline the entire SEM analysis. Scale items could be defined from previous studies or could be developed. In most cases, a literature search is conducted to identify previously used scales for individual constructs. The development usually occurs when the area of study is undeveloped and is faced with the lack of scale items established. The current research decided to establish a set of measurement items using the Likert-type scale, which is the most common format used in the previous research of SEM.

Stage 2. Developing and specifying the overall measurement model

After the scale items are specified, each latent construct should be included in the model, and a set of measured variables are assigned to the respective latent constructs. In this study, the overall measurement model is constituted with four latent constructs, which are competitive advantage, environmental sustainability, social sustainability, and economic sustainability. Total of 39 measured variables are correspondingly assigned to each latent construct: 9 variables of competitive advantage; 10 variables of environmental sustainability; 8 variables of social sustainability; and 12 variables of economic sustainability. When specifying the overall measurement model, the validity and unidimensionality and the number of measured variables of the construct should be addressed. The assessment of construct validity and unidimensionality have been discussed in subsection 4.7.1 above. In terms of the sufficient number of measured variables, Hair et al. (2014) recommended a minimum of three measured variables per construct for adequate identification of a construct, which is satisfied with the current study. This stage also involves representing the identification and assignment by an equation or a pictorial description via a schematic presentation of the structural model. The complete measurement model should be illustrated with three major elements: (1) measurement relationships for constructs and measurement variables; (2) correlational relationships among constructs; and (3) error terms for measured variables (Hair et al. 2014). A pictorial representation of the measurement model in the study is provided in Chapter 8.

Stage 3. Designing a study to produce empirical results

This stage considers issues related to both research design and model estimation. According to Hair et al. (2014), research design involves three main issues: (1) the type of data to be analysed; (2) the impact of sample size; and (3) the assessment of missing data and remedies. The first two issues have been discussed in the process of designing the questionnaire and collecting data in this chapter (see section 4.6), and the issue of missing data will be addressed in detail in Chapter 5. Regarding a model estimation method, maximum likelihood estimation was decided to be used since it is robust to violations of normality assumption commonly occurring in a Likert-scale survey (Hair et al. 2014). Additionally, maximum likelihood estimation has been widely used by researchers in SEM studies as a flexible approach to parameter estimation. Analysis of Moment Structure 25 (AMOS) software program is used to conduct the SEM analysis for the current study. The AMOS is designed to facilitate the SEM analysis, and its biggest advantage is that it allows researchers to draw path diagrams using drag-and-drop drawing tools as a more straightforward way to summarise equation statements of SEM.

Stage 4. Assessing the measurement model validity

Assessing the validity of the measurement model is a verification process regarding whether the measurement model is valid for testing the structural model, considered the most fundamental step in SEM testing (Hair et al. 2014). The decision depends on evidence of fit statistics assessing how well the measurement model is supported by the data collected. In other words, the measurement model should be established with acceptable goodness-of-fit levels to confirm its validity. Hair et al. (2014) recommended investigating the construct validity of the measures to ensure the validity of the measurement model, which has been discussed in subsection 4.7.1 of this chapter. Furthermore, model fitness is often the most convincing empirical evidence to support the measurement model along with factor loadings. There are a wide variety of fit measures that can be classified into three general groups: absolute measures, incremental measures, and parsimony fit measures.

Absolute fit indices assess how adequately a model fits the sample data. Chi-Square (χ^2) value is the most popular, and non-significant value of χ^2 indicates a good model fit. However, the criterion has been criticised by many researchers because it is sensitive to sample size. It means that as the sample size increases, χ^2 value is inflated, and the χ^2

statistic is almost always significant, having little empirical support. Hence, the ratio of the χ^2 statistics to degrees of freedom (χ^2/df) has been suggested as an alternative criterion, with a recommendation of χ^2/df not exceeding 3.0 (Kline 2016). Although Goodness-of-Fit Index (GFI) and Adjusted Goodness-of-Fit Index (AGFI) are also included in the family of absolute fit indices, they have become less popular in recent years in that they are also affected by sample size, and some researchers even recommended not to use it (Sharma et al. 2005). In this sense, Root Mean Square Error of Approximation (RMSEA) and Standardised Root Mean Square Residual (SRMR) are more favoured because they choose the model with the lesser number of parameters (Hooper et al. 2008). A recommendation for SRMR thresholds is below 0.05, and cut-off points of RMSEA have been in the range from 0.05 to 0.10, with a stronger range close to 0.06 and not exceeding 0.07, which is generally considered a sufficient indication of good fit (Hu and Bentler 1999; Steiger 2007).

Incremental fit indices measure the proportionate improvement in fit by comparing a target model with a more restricted nested baseline model (Hu and Bentler 1999). A null model is that all the measured variables are uncorrelated. Included in this family are Normed-Fit Index (NFI), the Tucker-Lewis Index (TLI), and Comparative Fit Index (CFI). These three indices are frequently used to evaluate the model fit, and their thresholds are usually between 0.90 to 0.95.

Parsimonious fit indices adjust GFI and NFI for the degrees of freedom in a model and identify whether the model fit is obtained by estimating all possible parameters (Kelloway 1998). Unlike the other fit indices, no threshold level has been determined for neither the Parsimony Goodness-of-Fit Index (PGFI) and the Parsimony Normed Fit Index (PNFI). Instead, these indices are used to compare two competing theoretical models, and it is recommended to calculate a parsimonious fit index for each model and choose a model with a higher level of parsimonious fit (Kelloway 1998).

The various fit indices available and their cut-offs are summarised in Table 4.8.

Table 4.8 Summary of goodness-of-fit indices

Fit Index	Description	Acceptable fit	Limitation
Absolute fit indices			
Chi-square (χ^2)	Test of null hypothesis that the estimated variance-covariance matrix deviates from the sample.	Non-significant with p-value of at least 0.05 ($p > 0.05$).	Greatly sensitive to sample size. The larger the sample, the more likely it is that the p-value will imply a significant difference between model and data.
Normed Fit Chi-square (χ^2/df)	A ratio of χ^2 to the degrees of freedom for a model.	Values less than 2 and as high as 5 indicate an acceptable fit. ($2 < \chi^2/\text{df} < 5$)	It is widely used instead of traditional Chi-square. It minimises the impact of sample size on the model.
Root Mean Square Error of Approximation (RMSEA)	Representing how well the fitted model approximates per degree of freedom.	Values < 0.05 good fit < 0.08 reasonable fit < 0.10 mediocre fit Above 0.10 poor fit	Sensitive to the number of estimated parameters in the model.
Goodness-of-Fit Index (GFI)	Representing a comparison of the square residuals for the degree of freedom.	Value > 0.95 good fit 0.90-0.95 adequate fit 0.80-0.90 acceptable fit	Sensitive to sample size. Some researchers recommend that this index should not be used.
Standardised Root Mean Residual (SRMR)	Representing a standardised summary of the average covariance residuals. Covariance residuals are the difference between observed and model-implied covariance.	Value < 0.05 good fit 0.05-0.08 adequate fit	It is appropriate for a questionnaire containing items with varying levels (e.g. range from 1 to 7).
Incremental fit indices			
Buntler-Bonnet Normed Fit Index (NFI)	Representing a comparative index between the proposed and more restricted nested baseline model not adjusted for degree of freedom.	Value > 0.95 good fit 0.90-0.95 adequate fit 0.80-0.90 acceptable fit	For sample size less than 200, the detrimental effects occur more often.
Tucker-Lewis Index (TLI)	Comparative index between proposed and null models adjusted for degrees of freedom. Can avoid extreme underestimation and overestimation.	Values > 0.95 good fit 0.90-0.95 adequate fit	It is revised form of NFI. It is generally robust against sample size and one of the most popularly used for fit index.
Comparative Fit Index (CFI)	Comparative index between proposed null models adjusted for degrees of freedom.	Values > 0.95 good fit 0.90-0.95 adequate fit	It is less affected by sample size than NFI. Highly recommended as the index.
Bollen's Incremental Fit Index (IFI)	Comparative index between proposed and null models adjusted for degrees of freedom.	Values > 0.95 good fit 0.90-0.95 adequate fit	It is relatively insensitive to sample size.
Parsimony fit indices			
Parsimony Goodness-of-Fit Index (PGFI)	This index considers both the model being evaluated and the baseline model.	Comparison between alternative models. Higher values indicate good fit.	It is based upon the GFI by adjusting for loss of degrees of freedom.
Parsimony Normed Fit Index (PNFI)	This index considers both the model being evaluated and the baseline model.	Comparison between alternative models. Higher values indicate good fit.	It is based on NFI by adjusting for degrees of freedom.
Adjusted Goodness-of-Fit Index (AGFI)	Goodness- of-fit adjusted for the degrees of freedom.	Value > 0.95 good fit 0.90-0.95 adequate fit 0.80-0.90 acceptable fit	Less often used due to sensitivity to sample size and not performing well in some application.

While there is no golden rule about which indices should be used to assess model fit, there is general agreement that researchers should report the χ^2, SRMR, and CFI. In addition to these fit indices, this study determined to adopt RMSEA, SRMR, IFI, and TLI for the assessment of model fitness for two reasons. First, given that many of the fit indices are affected by sample size, this study was decided to use fit measurements, which are relatively less susceptible to sample size. Second, each family serves to optimise different aspects of model fitness with a different objective function, and these different indices provide complementary information. In this regard, many researchers recommend a variety of indices to be adopted to assess model fit (see Hu and Bentler 1999; Barrett 2007; Hooper et al. 2008). Accordingly, multiple fit indices were selected from different fit families rather than multiple fit indices from the same family (DiStefano and Hess 2005).

Stage 5. Specifying the structural model

This stage concerns the specification of the structural model by assigning the relationships from one construct to another based on the structural hypotheses of the research model developed. In other words, researchers should identify the dependence relationships drawn from the hypotheses among constructs, and each hypothesis represents a specific relationship specified by adding single-headed, directional arrows to represent the hypotheses in the research model. Given that the estimation of SEM model entails specifying the measurement model, the path diagram of the overall model represents both the measurement model, which consists of the complete set of constructs and measured variables and the structural part of SEM, which establishes the structural relationships between constructs. In this way, the overall model should be ready to test the entire theory, including both the measurement relationships of measurement variables to constructs and the hypothesised structural relationships among constructs (Hair et al. 2014).

Stage 6. Assessing structural model validity

The final stage of SEM requires testing not only the validity of the overall structural model but also the corresponding theoretical relationships established through the phase of hypothesis development. Only when the measurement model is achieved with the recommended values of reliability and validity and model fit, testing the structural relationships is allowed because the model fit is not improved when the structural relationships are specified (Hair et al. 2014). Therefore, it is essential to achieve a satisfactory model fit for the measurement model before proceeding with the test of the structural relationships. The overall validity of the structural model can be assessed using the same goodness-of-fit criteria as the measurement model. The overall fit of the structural model is recommended for comparison with the measurement model. Additionally, individual parameter estimates representing each hypothesis should be examined in order to support a proposed structural theory. Consequently, the structural model can be acceptable only when it demonstrates acceptable model fit and the standardised parameter estimates of the hypothesised relationships are significant (Hair et al. 2014).

4.9 Summary

This chapter provided a detailed explanation of the methodological issues in the current study. Firstly, the methodological states of port sustainability performance research were presented with the result of the structured literature review. This showed a biased tendency towards the positivism paradigm and empirical studies using statistical analysis techniques in the field of port sustainability performance studies. Secondly, positioned within the positivist research paradigm, the present study was designed as quantitative research based on a deductive approach, focusing on testing the established theories or hypotheses with quantitative data. The questionnaire survey was applied as the research strategy of the current study to collect data, which is an appropriate method for descriptive, explanatory, and evaluative research. The process of sampling design and development of the questionnaire were delineated, and the issues of measurement validity and reliability, including common method bias, were also addressed. Finally, this chapter discussed two data analysis methods—RII and SEM—used in the study. The rationales for adopting the two methods in the current study were discussed, respectively, and the analysis procedure of SEM and the formula of RII were explained in detail.

Chapter 5. Descriptive Analysis and Data Preparation

This chapter focuses on a descriptive analysis of initial data and treatment of data for further analysis. The role of descriptive statistics is not only to understand the data that describe the relevant phenomena and the constructs examined in the present study, but also to provide fundamental associations for empirical analysis. The first part of the chapter presents a general picture of survey responses through exploring and summarising the data. The descriptive analysis of the data discusses response rates and basic statistics concerning the respondents' characteristics and the measured items. The statistics employ the Statistical Package for Social Sciences (SPSS) version 27.0 and are calculated with typical values such as percentage frequency, mean, and standard deviation. Additionally, the second part of the chapter includes the data preparation for further analysis. Screening procedures are discussed in terms of the treatment of missing data and the detection of outliers.

5.1 Response rate

Data collection using the questionnaire was conducted throughout five months from March to July 2020 on container ports in the world. The questionnaire distribution was initially organised based on the email list on the Lloyd's list directory, and 467 survey invitations were distributed via email. However, 319 emails were returned, either because the email addresses were unavailable or because the potential respondents were retired, and therefore the questionnaire was delivered to 148 potential respondents via email. Due to the lack of delivery via email, an alternative platform, namely *LinkedIn*, was utilised to distribute the questionnaire. LinkedIn is a social network platform used for professional business networking, enabling access to multiple professionals in container ports. The questionnaires were distributed to individual potential respondents identified based on their job descriptions on LinkedIn. The steps from accessing the potential respondents to distributing the questionnaire are summarised as follows.

- Step 1: An invitation message was sent with a brief self-introduction and the reason for access to him or her in order to create a personal connection with them.
- Step 2: A formal invitation to participate in the survey was sent to those who accepted the invitation to connect.

- Sept 3: Only to those who expressed their consent to participate in the survey, the survey link was sent with a detailed description of the survey, including survey purpose, the completion time of the survey, and confidentiality and anonymity.

Figure 5.1 illustrates the three steps of questionnaire distribution via LinkedIn and the number of respondents at each step. Via LinkedIn, the first invitations were distributed to 2,494 potential respondents. Of these, 705 accepted the connection and received a formal survey invitation to participate in the survey with a brief explanation regarding the survey. Lastly, 357 potential respondents who agreed to participate in the survey received the questionnaire link, excluding 282 non-responders and 66 people who refused the participation either because they were not knowledgeable about port sustainability or too busy to participate in the survey.

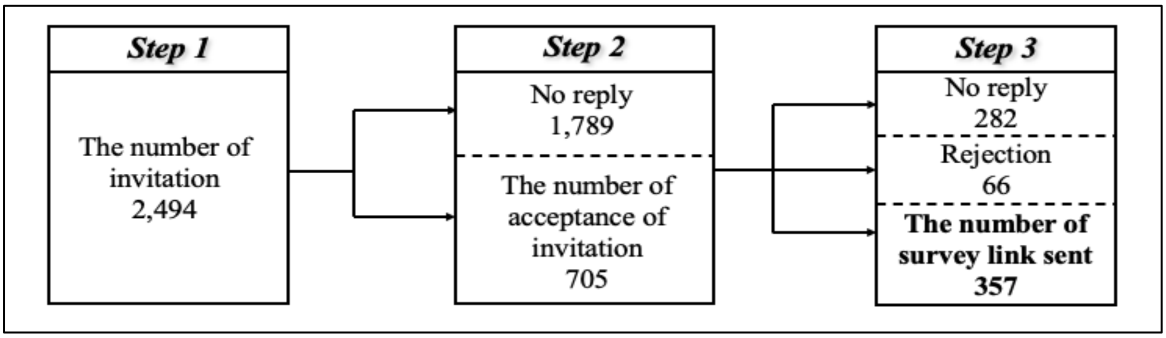

Figure 5.1 Number of respondents at each step of questionnaire distribution via LinkedIn

From 505 questionnaires distributed via two approaches (148 via email and 357 via LinkedIn), a total of 253 completed questionnaires were returned to the researcher. Of these, five responses that expressed the dissent from participating in the survey were deleted. Consequently, a total of 248 responses were useable for analysis, giving an effective response rate of 49%. This response rate is close to the average response rate of 50%, observed by Baruch and Holtom (2008) in organisational research. Furthermore, the required number of responses in SEM research to achieve acceptable estimates is generally a minimum of 200 responses (Hox et al. 2010). Hence, this response rate is considered to be satisfactory for the current study.

5.2 Non-response bias

Non-response bias, also known as non-response error, occurs when there are significant differences between respondents and non-respondents on the characteristics of interest in the study (Dooley and Lindner 2003). The sufficient evidence of non-response bias in survey research indicates that conclusions and recommendations drawn in a study can be invalid and not be generalised (Dooley and Lindner 2003). In order to diagnose non-response bias, the *extrapolation method* suggested by Armstrong and Overton (1977) is utilised, which assumes that respondents who respond less readily are more like non-respondents.

The distribution of the questionnaire was completed in June, including follow-up, and the data collection was officially terminated in July. Therefore, it is reasonable to use time trends, which is a type of extrapolation, assuming that responses collected later are similar to non-responses (Armstrong and Overton 1977). The respondents were divided into two groups, early respondents and late respondents, based on the date the respondents completed the questionnaire, and each group accounted for 10 per cent of the completed questionnaire. The two groups of respondents were compared using an independent sample t-test to determine significant differences between the two data samples. The summary of the non-bias test is presented in Appendix C. The results showed that the two groups of respondents were not significantly different, having p-values greater than 0.05 in all variables except for one variable. Therefore, it can confirm that non-response bias is not an issue in the current study.

5.3 Demographic profile of the sample

This section describes the overall demographic profile of respondents to ensure that the respondents have sufficient knowledge and experience for providing reliable answers to the questionnaire. The demographic information addresses the basic information about ports in which the respondents are engaged, such as port location and annual container throughput, and the personal information of respondents regarding their job positions in their ports and the length of working experience in the port industry. Additionally, each demographic variable of the respondents' backgrounds was sub-categorised depending on their characteristics for a comprehensive investigation.

Table 5.1 presents descriptive statistics for the survey respondents in terms of port location. The questionnaire was distributed to various container ports and terminals over the world, and the data were collected from a total of 37 countries. As to *port location*, the largest number of ports were located in the United States (8.9%) with 22 responses out of 248, followed by Brazil (7.3%) with 18, Malaysia (6.9%) with 17, and Great Britain (6.0%) with 15. The proportion of responses with no answers was 2.8%, with 7 out of 248 responses.

Table 5.1 Descriptive statistics of survey respondents for port location

Demographic variable	Category	Sample (=248)	
		Frequency	Percentage
Port location	Australia	13	5.2%
	Belgium	4	1.6%
	Brazil	18	7.3%
	Canada	5	2.0%
	China	6	2.4%
	Colombia	3	1.2%
	Cyprus	1	0.4%
	Denmark	3	1.2%
	Ecuador	1	0.4%
	Egypt	2	0.8%
	France	1	0.4%
	Germany	6	2.4%
	Great Britain	15	6.0%
	India	7	2.8%
	Indonesia	11	4.4%
	Malaysia	17	6.9%
	Malta	1	0.4%
	Morocco	7	2.8%
	Netherlands	7	2.8%
	New Zealand	15	6.0%
	Norway	4	1.6%
	Panama	2	0.8%
	Philippines	5	2.0%
	Portugal	3	1.2%
	Saudi Arabia	3	1.2%
	Singapore	7	2.8%
	Slovenia	2	0.8%
	South Africa	9	3.6%
	South Korea	11	4.4%
	Spain	13	5.2%
	Sri Lanka	2	0.8%
	Sweden	1	0.4%
	Thailand	2	0.8%
	Turkey	5	2.0%
	UAE	6	2.4%
	USA	22	8.9%
	Vietnam	1	0.4%
	Non-response	7	2.8%

The 37 countries were grouped based on the continents in which they are located. Considering similarities in locations and cultures, it was decided to divide the Asian region into two parts: East and Southeast Asia (ESE Asia) and West and South Asia (WS Asia). ESE Asia included eight countries which were China, Singapore, South Korea, Indonesia, Malaysia, Philippines, Thailand, and Vietnam, while WS Asia consisted of six countries which were Egypt, India, Saudi Arabia, Sri Lanka, Turkey, and UAE. Consequently, the seven regions were considered in the descriptive analysis—Africa, South America, North America, Oceania, ESE Asia, WS Asia, Europe. Figure 5.2 illustrates the proportion of survey respondents for geographical location based on their regions. The largest share was in Europe (25%) with 61 responses, followed by East and Southeast Asia (24%) with 60, and Oceania (11%) with 28. The Africa region accounted for the least proportion of responses with 6% (16 responses in total).

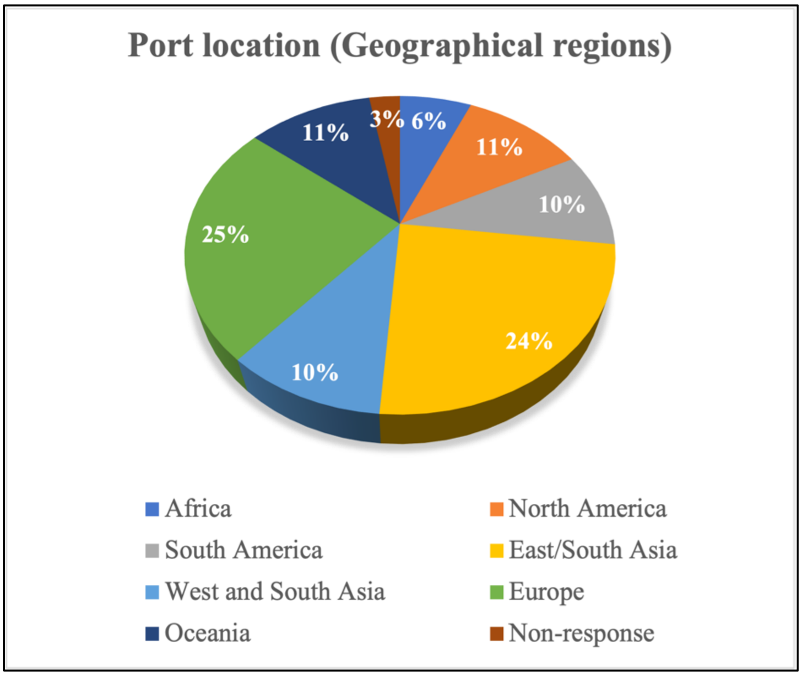

Figure 5.2 Proportion of survey respondents by geographical regions

With regard to *container throughput*, the sample showed that 22.6% (56 out of 248) of respondents' ports handled under 500,000 TEUs, and 20.6% (51 out of 248) of ports handled between 2 and 5 million TEUs. 16.9% (42 out of 248) of respondents handled from 1 to 2 million TEUs. The least number of respondents' port with 8.9% (22 out of 248) handled more than 10 million TEUs annually, while 3.2% (8 out of 248) of respondents did not answer the question. Table 5.2 shows the descriptive statistics of survey respondents regarding port container throughput.

Table 5.2 Descriptive statistics of survey respondents for port container throughput

Demographic variable	Category	Sample (=248)	
		Frequency	Percentage
Container throughput (TEUs)	Under 500,000	56	22.6%
	500,000-1 million	38	15.3%
	1-2 million	42	16.9%
	2-5 million	51	20.6%
	5-10 million	31	12.5%
	Over 10 million	22	8.9%
	Non-response	8	3.2%

Container throughput has been utilised as an indicator of port size. Countries and ports have different understandings and definitions of port size, but a port can be typically grouped into large, medium, or small-sized ports (Mitchell 1970). Cullinane and Wang (2006) defined small container ports with annual container throughput of less than 100,000 TEUs and medium-size container ports with annual container throughput from more than 100,000 TEUs to less than 1 million TEUs. Finally, when container ports handled more than 1 million TEUs per year, it was classified as large container ports. More recently, Feng and Notteboom (2013) considered ports with an annual cargo throughput of fewer than 300 million tons (approximately 18 million TEUs) as small-medium sized. This classification criterion has also been adopted in other research to determine the port size (Lu et al. 2018).

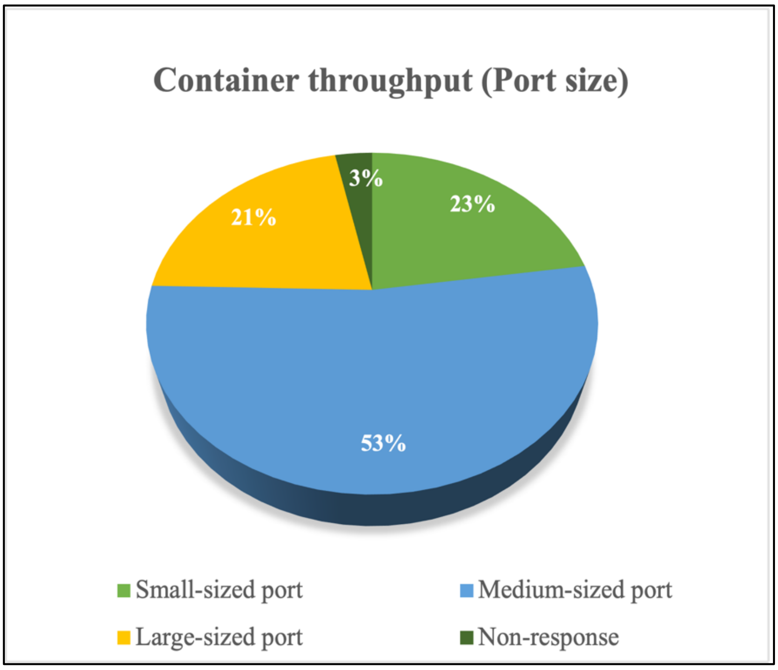

Figure 5.3 Proportion of survey respondents by port size

Based on the above criteria, this study classified: a small port with annual container throughput of 500,000 TEUs or less; a medium port with annual container throughput between 500,000 and less than 5 million TEUs; and a large port with annual container throughput more than 5 million TEUs. As shown in Figure 5.3, more than half of the respondents (53%) were engaged in medium-sized ports. Small-sized and Large-sized ports accounted for a similar share of responses, with 23% and 21%, respectively.

Table 5.3 shows the descriptive statistics of survey respondents regarding *job position*. The position of manager was the largest group of the respondents with 45.6%, followed by others (12.1%), supervisors (10.5%), and directors (8.5%). Others include employees, advisors, analysts, and environmental or sustainability specialists, and they are considered key external actors whose actions and interactions influence strategic implementation in organisations (Whittington 2006). The proportion of responses with no answers was 2.4%, with 6 out of 248 responses.

Table 5.3 Descriptive statistics of survey respondents for job position

Demographic variable	**Category**	**Sample (=248)**	
		Frequency	**Percentage**
Job position	President	8	3.2%
	Vice president	7	2.8%
	CEO	19	7.7%
	Senior director	6	2.4%
	Director	21	8.5%
	Manager	113	45.6%
	Supervisor	26	10.5%
	Operator	7	2.8%
	Harbour master	5	2.0%
	Others	30	12.1%
	Non-response	6	2.4%

The management level is primarily classified into three types depending on job positions in an organisation: top-level, middle-level, and frontline-level managers. Each of these management levels determines the different amount of authority to use organisational resources and influence the decision-making process accrued by managerial positions (Jarzabkowsk and Spee 2009). Top-level managers have responsibilities in overseeing organisational goals, policies, and procedures with the ultimate source of power and authority. Their main priority is not only on directing strategic planning and execution but also on communicating with external stakeholders in order to achieve overall business success

(Bartlett and Ghoshal 1995). Middle-level managers are those who perform goals or actions established by top managers, taking responsibility for top-level management over activities in their departments. They give and receive directions, playing a role as a bridge between top management and frontline management. They concern with various strategic decisions by supervising frontline managers to achieve business objectives, but still provide valuable information or suggestions to top managers to improve the foundation of organisations (Ahearne et al. 2014). Frontline-level managers are involved in managing and executing day-to-day operations by interacting with workers. They contribute to maintaining functional and technical expertise to optimise specific operational processes. As essential personnel for the basis of operations, their roles are to ensure efficient functions of organisations by training, supervising, and directing operative employees and by organising essential machines, tools, and materials required to operate (Hornsby et al. 2009).

Based on their responsibilities and authority within port organisations, this study classified: president, vice president, and chief executive officer (CEO) into top management level; senior director, director, and manager into middle management level; and supervisor, operator, harbour master, and others into frontline management level. Figure 5.4 depicts the proportion of respondents based on their management levels. More than half of the respondents (58%) were middle-level managers, and front-line and top-level managers accounted for 27% and 14%, respectively.

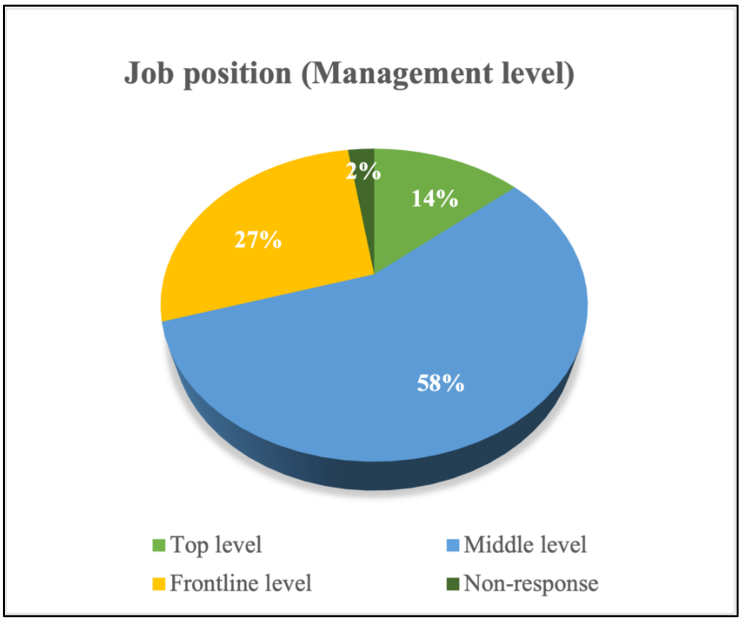

Figure 5.4 Proportion of survey respondents by management level

When it comes to the length of working experience of the survey respondents in the port industry, the largest working experience group had greater than 15 years working experience (39.1%) with 97 respondents out of 248, followed by between 1 and 5 years (25.4%), between 6 and 10 years (17.3%), and between 11 and 15 years (12.5%). Only 7 respondents (2.8%) had less than one year of working experience in the port industry. The proportion of responses with no answers was 2.8%, with 7 out of 248 responses. Table 5.4 summarises the descriptive statistics of survey respondents depending on their working experience years.

Table 5.4 Descriptive statistics of survey respondents for working experience

Demographic Variable	**Category**	**Sample (=248)**	
		Frequency	**Percentage**
Working experience	Less than 1 year	7	2.8%
	1-5 years	63	25.4%
	6-10 years	43	17.3%
	11-15 years	31	12.5%
	Greater than 15 years	97	39.1%
	Non-response	7	2.8%

Job expertise can be classified into three levels depending on the length of work experience years in the industry: entry-level, mid-level, and senior-level. The respondents who have worked in the port industry between less than 1 year and 5 years were specified as entry-level, between 6 to 15 years as mid-level, and greater than 15 years as senior-level. As shown in Figure 5.5, the proportion of respondents' expertise had a relatively similar. The largest group of the respondents (39%) had senior-level expertise, 30% had mid-level expertise, and 28% had entry-level expertise in the port industry.

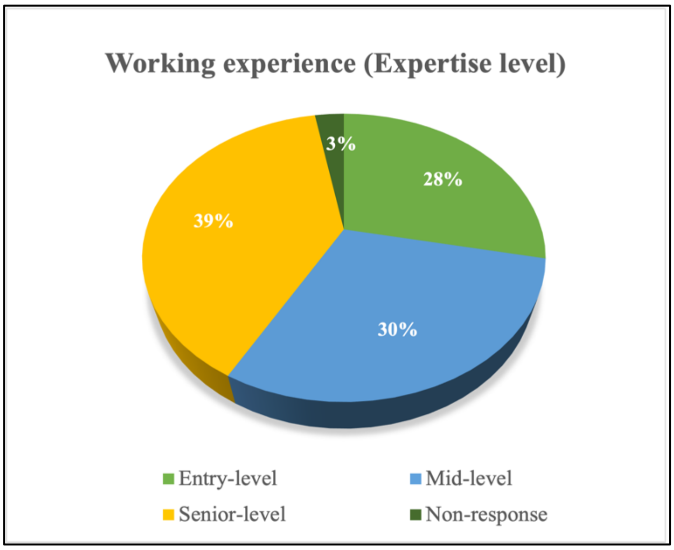

Figure 5.5 Proportion of survey respondents by expertise level

Given the position and work experience characteristics of the respondent profiles, it can be assumed that the responses were obtained from the respondents with expertise and reliable knowledge in the field of port management and business.

5.4 Descriptive statistics for the items

This section focuses on the result of responses to the survey questions. As mentioned earlier (Chapter 4, subsection 4.6.2), the main questions were divided into Part A and Part B of the questionnaire based on the two purposes of research, respectively. Each item in Part A of the questionnaire is designed for SEM analysis to measure the research model's components: competitive advantage, environmental sustainability, social sustainability, and economic sustainability. The respondents specified their opinions on the status of sustainability performance and competitive advantage of their ports. In Part B of the questionnaire, the respondents were requested to indicate their opinions regarding the extent of agreement and disagreement with each item in order to measure the relative importance of sustainability activities using the RII method. All the items were measured through a seven-point Likert scale in which 1 = “Strongly disagree” and 7 = “Strongly agree”.

5.4.1 Descriptive statistics for the survey questions in Part A

Table 5.5 presents the questionnaire items measuring the constructs and the mean and standard deviation (SD) of each item. The overall scores for competitive advantage were above the midpoint of the scale (i.e. 4), ranging between 4 and 5 points.

In general, the items of CDP and SP were rated higher than the midpoint. Specifically, 5 out of 9 items (CDP1, CDP2, CDP4, SP1, SP3) obtained greater than the mean value of 5 points, and 4 items (EFP1, EFP2, CDP3, SP2) were above the mean value of 4.5 points. The highest was SP3 (mean=5.38), which is “My port more thoroughly responds to social and ethical demands”. The lowest was CDP3 (mean=4.54), which is “My port is technologically superior”. It can be presumed that the respondents evaluated the competitive advantage of their ports at a relatively medium level.

Table 5.5 Descriptive statistics for the questionnaire Part A

Construct	Item	Description	Mean	SD
Competitive advantage	EFP1	My port has a larger market share.	4.99	1.90
	EFP2	My port gets a higher return.	4.55	1.93
	CDP1	The quality of port services is higher.	5.26	1.59
	CDP2	Port user's satisfaction is higher	5.07	1.74
	CDP3	My port is technologically superior.	4.54	1.76
	CDP4	My port has a greater capacity to respond to port user's need.	5.29	1.69
	SP1	My port's reputation in terms of sustainability management is better.	5.06	1.72
	SP2	My port is considered as a leading port in terms of sustainability management in the industry.	4.86	1.87
	SP3	My port more thoroughly responds to social and ethical demands.	5.38	1.62
Environmental sustainability	EO1	My port has reduced water pollution.	5.52	1.55
	EO2	My port has reduced air pollutants and emissions.	5.44	1.41
	EO3	My port has reduced energy consumption and used renewable energy or fuels.	5.10	1.55
	EO4	My port has reduced noise and vibration generation.	4.59	1.78
	EO5	My port has reduced soil pollutants from disposal of dredging sediment and sludge.	4.98	2.13
	EO6	My port has reduced the impact on natural structure and habitat.	5.30	1.64
	EO7	My port has reduced general and hazardous waste.	5.43	1.51
	EO8	My port has reduced odours from perishable bulk solids, waste treatment, water purifiers, etc.	4.68	2.14
	EM1	My port has used environmental-friendly port facilities.	5.29	1.63
	EM2	My port has undertaken sustainability management plan and regularly conducted sustainability monitor or assessment.	5.47	1.80

Social sustainability	IHR1	My port has implemented health and safety practices within port area.	6.40	0.93
	IHR2	My port has increased employment opportunities.	5.85	1.21
	IHR3	My port has provided employee training and education.	6.07	1.10
	IHR4	My port has supported gender equality.	5.74	1.58
	IHR5	My port has created a safe and satisfying working and living environment around port area.	5.66	1.38
	EP1	My port has developed communication tools to share the social impact of port operations.	5.55	1.56
	EP2	My port has improved its eco-friendly and socially responsible image.	5.78	1.28
	EP3	My port has interacted with relevant stakeholders and local communities.	6.03	1.34
Economic sustainability	ES1	My port has created an open and direct investment environment outside the country.	3.49	2.65
	ES2	My port has reduced the costs of general operation and maintenance of port.	5.07	1.85
	ES3	My port has attracted public, private, and other forms of funding for development.	4.68	2.39
	ES4	My port has increased annual container throughput.	5.45	1.87
	ES5	My port has contributed to total gross value added of the port industry.	5.68	1.74
	ES6	My port has obtained revenue from the use of port facilities and services.	6.02	1.44
	ES7	My port has developed the current resources for maximum cost-efficiency.	5.78	1.28
	BS1	My port has provided value-added port services.	5.54	1.65
	BS2	My port has delivered efficient operation and management.	5.79	1.28
	BS3	My port has provided reliable, responsive, efficient, punctual, and safe port services.	5.91	1.12
	BS4	My port encouraged collaboration with external stakeholders for port operations and development.	5.58	1.62
	BS5	My port has continuously upgraded port infrastructure and facilities.	5.85	1.46

Regarding environmental sustainability performance, the mean of all 10 items was calculated as 5.18, significantly above the midpoint level 4. It indicates that most ports relatively executed moderate levels of environmental activities. The highest mean was EO1 with the mean value of 5.52, which is the question regarding water pollution management, while the lowest was EO4 with the mean value of 4.59, which is the question of noise pollution management. Other than EO4, two items, EO8 about odour pollution management and EO5 related to soil pollution management, were also recorded as having the mean value of 4 points.

As to social sustainability performance, a notable observation was that the mean value of all items was between 5 and 6 points, substantially above the midpoint. The highest item was IHR1 (mean=6.40), which is "My port has implemented health and safety practices within the port area", and the lowest item was EP1 (mean=5.55), which is "My port has developed communication tools to share the social impact of port operations". Particularly, it was observed that 3 out of 9 items were above 6 points: IHR1 with the mean value of 6.40, IHR3 with the mean value of 6.07, and EP3 with the mean value of 6.03. Overall, it is highlighted that the survey respondents evaluated their ports as performing a relatively high degree of social sustainability-related activities.

Although the mean value of items varied, ranging between 3 and 6 points, the majority of items for economic sustainability performance were observed above the midpoint level 4. It was observed that the item ES6, which is "My port has obtained revenue from the use of port facilities and services", ranked the highest item with the mean value of 6.02. On the other hand, the item ES1, "My port has created an open and direct investment environment outside the country", was shown as having the lowest score of 3.49.

In summary, the means of items related to sustainability performance were significantly above the midpoint, mostly remaining around 5 points. This suggests that the respondents perceived that their ports had made efforts to realise sustainable performance. Also, it can generally state that there are variations in the answers to the items, given that most items have standard deviation values of greater than 1.50.

5.4.2 Descriptive statistics for the survey questions in Part B

This subsection focuses on a descriptive analysis of the Part B questions of the questionnaire. The results are summarised in Table 5.6 in terms of their mean and standard deviation (SD). For the convenience of analysis, environmental, social, and economic sustainability activities were denoted as EN, SO, and ECO, respectively. The mean values of items for environmental sustainability revealed that the respondents' perception of the effects of environmental activities on competitive advantage is well above the midpoint 4. The highest item was EN8 (Waste pollution management) with the mean value of 5.48, while the lowest item was EN4 (Noise pollution management) with the mean value of 4.77. Except for EN4, only EN10 (Odour pollution management) had the mean value of 4 points (mean=4.89).

For social sustainability, all items had mean values between 5 and 6 points, substantially above the midpoint level of 4. This implies that the respondents recognised social-related activities as a high importance level on strengthening competitive advantage. SO1 (Health and safety) was recorded as the highest item with the mean value of 6.25, while SO5 (Gender equality) was the item that had the lowest mean value of 5.50.

Similarly, the mean values of items for economic sustainability were calculated as considerably above the mid-point level of 4. 4 out of 12 items had the mean value of 6 points (ECO2, ECO3, ECO4, ECO8), 7 items showed the mean value of 5 points (ECO5, ECO6, ECO7, ECO9, ECO10, ECO11, ECO12), and only one item (ECO1) recorded the mean value of 4 points. The highest item was ECO3 (mean=6.29), which is "Port operational efficiency", and the lowest item was ECO1 (mean=4.19) which is "Foreign direct investment".

Overall, all 30 items had mean values between 4 and 6 points, above the midpoint level of 4, and no significant differences were observed in the range of mean values among three aspects. Additionally, 17 items out of 30 items have standard deviation values greater than 1.50, indicating that most responses to the items deviated from above the mean.

Table 5.6 Descriptive statistics for the questionnaire Part B

Sustainability aspect		Item	Mean	SD
Environmental sustainability	EN1	Water pollution management	5.02	1.84
	EN2	Air pollution management	5.28	1.64
	EN3	Energy and resource usage	5.28	1.83
	EN4	Noise pollution management	4.77	1.73
	EN5	Green port management	5.45	1.56
	EN6	Ecosystem and habitats protection	5.19	1.74
	EN7	Soil pollution and occupation management	5.11	1.80
	EN8	Waste pollution management	5.48	1.54
	EN9	Green construction and facilities	5.32	1.55
	EN10	Odour pollution management	4.89	1.85
Social sustainability	SO1	Health and safety	6.25	1.10
	SO2	Job creation and security	5.83	1.30
	SO3	Job training	5.98	1.20
	SO4	Public relations	5.92	1.28
	SO5	Gender equality	5.50	1.57
	SO6	Social image	5.96	1.17
	SO7	Quality of working and living environment	5.93	1.20
	SO8	Social participation	5.71	1.45
Economic sustainability	ECO1	Foreign direct investment	4.19	2.53
	ECO2	Value-added productivity	6.04	1.26
	ECO3	Port operational efficiency	6.29	1.06
	ECO4	High quality services	6.23	0.91
	ECO5	Reducing operating costs	5.88	1.37
	ECO6	Benefits from external stakeholders	5.39	1.75
	ECO7	Port development funding	5.27	1.98
	ECO8	Port infrastructure construction	6.13	1.04
	ECO9	Container throughput	5.83	1.60
	ECO10	GDP	5.39	1.91
	ECO11	Operating revenue	5.95	1.33
	ECO12	Cost-efficiency	5.85	1.51

5.5 Data preparation

Screening data process is necessary when research is involved in multivariate analysis. Depending on data characteristics, the results of parameter estimates, standard errors, and fit indices may be affected (Hair et al. 2014). Therefore, data preparation should be considered before a SEM analysis to reduce bias and increase credibility in the results (Kline 2016). SEM research typically includes diagnosing the normality of data and handling missing data and outliers as a data preparation process. In this section, the data preparation of the present study focuses on screening missing data and outliers, including their treatments accordingly. The normality of the data will be addressed in Chapter 7, along with other assumptions for multivariable analysis.

5.5.1 Missing data

Missing data is a common problem when data are collected by a questionnaire (Peugh and Enders 2004). In particular, missing data is prevalent in survey research using Liker-type scales because each scale consists of several items, and it is likely to miss several items per scale (Dodeen 2003). Data can be missing in several ways and most often are directly related to respondents (Raaijmakers 1999). They may be (1) unwilling or unable to respond to a question or set of questions, (2) no opinion or insufficient knowledge to answer questions, or (3) fail to complete the entire questionnaire due to lack of time or interest (Schafer and Olsen 1998). Also, no-opinion types of response, such as *Not applicable, Not known, Don't know, No opinion* and the midpoint *Neutral* responses, are included as missing data (De Leeuw 2001; Weems and Onwuegbyzie 2001). In multivariate analysis, missing data can raise an issue about the bias of statistical results and threaten their generalisability by decreasing the efficiency of parameter estimates and reducing the sensitivity of statistical techniques due to a loss of information (Hair et al. 2014). Hence, it is crucial to proceed with the appropriate treatment of incomplete data sets before conducting further multivariate analysis.

The decision to treat missing data depends on two issues related to identifying the characteristics of missing data: randomness and quantity of missing data. The randomness of missing data is a critical issue because it determines an appropriate remedy (Hair et al. 2014). There are three types of mechanisms underlying missing values: Missing At Random (MAR), Missing Completely At Random (MCAR), and Missing Not At Random (MNAR). MAR refers to when missingness has a relationship with other variables in the dataset, but not to the values of the missing data itself. MCAR missingness occurs when nonresponses are a purely random sample of complete data. Thus, MCAR missingness is independent of observed and missing components of all study variables. Lastly, the data is considered MNAR when missingness is related to the answer to the question itself. MAR and MCAR are regarded as ignorable mechanisms as their adverse effects on bias, validity, and statistical power can be mitigated through relatively simple imputation procedures. MNAR, on the other hand, is not ignorable and will lead to seriously biased results. In this case, nonstandard imputation techniques using additional modelling are required for analysing MNAR data (Sinharay et al. 2001). One way to diagnose the missing data mechanism is to test Little's MCAR test (Little 1988). The null hypothesis of the test is that the missing data is MCAR, and hence, p-value of less than 0.05 is interpreted as being that the missing data is not MCAR (i.e. classified as either MAR or MNAR). As a result of the test with 69 variables in this study, it was ascertained that the missing data were MCAR (p-value=0.075).

The extent or amount of the missing is another critical issue that might significantly affect the results. The extent of missing data can be assessed by the proportion of individual and total missing data for variables and responders (Raaijmakers 1999). Overall, the study data contained an average of 4.63 per cent of missing values for 69 variables and an average of 8.73 per cent for 248 respondents, which was a result including no-opinion responses. Seven variables were identified with having more than 10 per cent missing data. However, the rest of the variables were sufficiently low, under 10 per cent. Moreover, 30 per cent of missing data for an individual case and observation would be acceptable when the data are MCAR (Leite and Beretvas 2010). Furthermore, a sample size larger than 200 and a low level of correlations between the variables reduce the impacts of missing data (Raaijmakers 1999; McNeish 2017). Consequently, this study decided to proceed with missing data remedy for all 69 variables.

Missing data treatment

According to Hair et al. (2014), if the data is MCAR, any kind of approach for remedying missing data may be applicable. Since the study data was confirmed as MCAR, simple imputation methods that create a complete data set by filling in missing values with plausible substituted ones are available. In addition to imputation methods, several procedures have been proposed to remedy missing data; for example, listwise and pairwise deletions, which ignore missing data and omit respondents with missing data from the study, and model-based methods such as an expectation-maximisation algorithm and data augmentation techniques (Hair et al. 2014). For missing values with Likert-type scales, the replacement procedures are accepted as a sensible treatment throughout literature rather than deletion or model-based estimation approaches (Raaijmakers 1999).

A multitude of imputation methods available have been developed, for example, Total mean substitution, Subgroup mean substitution, Case mean substitution, Regression imputation, Hot-deck imputation. After a thorough examination of their advantages and limitations, this study determined to use a Valid Mean Substitution (VMS) technique for handling the missing data, in that the questionnaire was designed using the Likert-type scales, and there was a relatively low percentage of the missing data (Tsikriktsis 2005). Dodeen (2003) also advocated using the VMS by providing empirical evidence that the technique was superior in estimating parameters and reproduced accurate target means and standard deviations for the Likert-type scales. Even though the imputation methods, including the VMS, have been taken criticism for increasing biased results, this is not a major problem if the missing data is MCAR. Furthermore, Raaijmakers (1999) affirmed that when data were MCAR, the differences among imputation approaches were insignificant. Based on the argument above, it is reasonable to use the VMS in handling the missing values in this study.

No-opinion response

As mentioned earlier, no-opinion responses are mainly included within the missing data category because they occur for similar reasons with missing data (Raaijmakers 1999). Previous studies have explained several reasons why respondents select a no-opinion response option, summarised in three reasons. Firstly, it can occur due to item ambiguity (Coombs and Coombs 1976). This involves an incomplete understanding of questions, such as misleading wording, poor question order, ambiguous phrasing, and lack of attention to the item (Feick 1989). Secondly, selecting a no-opinion response option indicates a reluctance or reticence to provide an opinion (Denman et al. 2018). This is more likely to occur with a desire to conceal opinions or information as the survey contains sensitive questions, such as drug use, sexual behaviours, or social desirability (De Leeuw 2001; Chyung et al. 2017). Lastly, it can be uncertainty and ambiguity. That is, a respondent may select a no-opinion option when they have difficulty forming a point of view because of inaccessibility of information, lack of knowledge, or lack of motivation. Dolnicar and Grün (2014) found that no-opinion responses were mainly explained by a lack of familiarity, indicating respondents' uninformedness.

Another issue regarding no-opinion responses is how to manage them analytically. There are four most commonly used analytic strategies for treating them (Manisera and Zuccolotto 2014; Denman et al. 2018):

1. Treating them as a meaningful categorical response
2. Coding them as missing and excluding them from analyses
3. Recoding them into the neutral midpoint in a Likert-type response scale (i.e., neither agree nor disagree)
4. Recoding them with the computed item-level mean

There is, however, no best approach, and each strategy has analytical or methodological limitations. The first way poses a potential risk to discourage general statistical methods for modelling ratings, resulting from imposing a nominal scaling level to the random variable generating responses (Manisera and Zuccolotto 2014). Furthermore, this way is mainly adopted in some surveys such as plebiscite as an additional valid opinion for undecided apart from bipolar answers (Rubin et al. 1995). The second results in loss of information, and hence reduces statistical power (Denman et al. 2018). The third is not appropriate for the survey scale in this study, which can interpret a four-point as a midpoint out of seven-point Likert scales. Also, the Likert-type scales of the questionnaire was designed as forced-choice scales—forcing respondents to select the extent of disagreement or agreement option—without a midpoint of neutrality such as neutral or neither agree nor disagree (Chyung et al. 2017). The fourth is the most common ad hoc method for dealing with no-opinion responses due to its simplicity from an analytic standpoint, notwithstanding some opponents of this approach (e.g. Feick 1989). It is an approach where no-opinion responses are replaced by estimates of corresponding rates drawn from the observed data, imputed as mean, median, or mode (Manisera and Zuccolotto 2014). Denman et al. (2018) ascertained that the imputation strategy strengthened the magnitude of correlations, providing more precise and robust statistical significance in the results. By considering the applicability in this study and the empirical results of previous studies, the fourth approach was adopted to treat no-opinion responses, which is consistent with the handling approach of the missing data in this study.

5.5.2 Outliers

Outliers are observations that are markedly distant from the other observations of the same construct (Aguinis et al. 2013). The presence of outliers can be either a legitimate or an illegitimate value of the distribution. When legitimate, outliers may shed light on interesting features of the population that would be missed in the ordinary course of analysis (Hair et al. 2014). However, it is widely believed that outliers can exert a problematic influence on the statistical analysis and radically alter the results of analysis, such as inflated error rates, distortions of parameters, violations of normality, and erroneous interpretations of the relationship between variables (Osborne and Overbay 2004; Garson 2012; Leys et al. 2019). Additionally, treating multivariate outliers occurring when more than two variables are considered is even more imperative before performing SEM, given its deleterious effect on fit indices (Leys et al. 2018).

The multivariate outliers were detected in the current study using the Mahalanobis D^2 measure. This method measures the distance of each observation in multidimensional space from the means or centre of all observations, providing a single value for each observation no matter how many variables are considered (Hair et al. 2014). A conservative level of statistical significance suggests with D^2 probability of 0.001 as the threshold value for an outlier (Hair et al. 2014; Kline 2016). The procedure of detecting outliers was conducted separately in Part A and Part B of the questionnaire, and the results are presented in Appendix D.

The way to handle outliers can affect substantive conclusions, including parameter estimates or the magnitude of effects or relationships. Therefore, it is important to select the proper method by understanding the reasoning for the occurrences of outliers in a given data set. Aguinis et al. (2013) classified outliers into three types for the possible presence of outliers. The first type refers to *error outliers* when a data point deviates from other data points due to errors in observation, recording, preparing data, computation, coding, sampling, or data manipulation. The second type represents *interesting outliers*, which are data points that lie far from other data points, and unexpected phenomena may be observed. The third type involves *influential outliers*, which are neither error nor interesting outliers and affect changes in substantive conclusions discussed within particular statistical techniques such as regression or SEM.

According to the above classification, the outliers in the data set for this study were clearly neither error nor interesting outliers. In order to confirm influential outliers, it is recommended to check whether the removal of outliers increase the fit of the model, such as one of comparative fit indices (e.g. CFA) and root mean square error of approximation (e.g. RMSEA) (Aguinis et al. 2013). With the outliers in the current study, the CFI and RMSEA were 0.832 and 0.075, respectively, and without them, they were 0.848 and 0.070, respectively. The difference in change was minor, but the outliers generally decreased the model fit, and accordingly, can be confirmed as influential outliers.

The influential outliers can be handled by one of three techniques: respecification of the model, deletion, or using robust approaches (Aguinis et al. 2013). The deletion of outliers is frequently suggested as the most suitable way to deal with them. For example, Goerzen and Beamish (2005) deleted outliers, considering the possible effects on the model fit, even though they were acknowledged that the overall results did not change significantly with or without outliers. Osborne and Overbay (2004) supported the deletion of outliers with empirical evidence that the accuracy of estimates enhanced. Furthermore, Leys et al. (2019) claimed that removing outliers is not a significant problem if there is enough data after the removal procedures, as it does not compromise the statistical power. Accordingly, it was decided to remove outliers in this study.

5.6 Summary

This chapter contributed to presenting fundamental statistics from an initial analysis of data collected from the questionnaire survey. The analysis of descriptive statistics on the background of respondents and measured items can be summarised as follows:

1. The survey obtained 248 valid responses and achieved an effective response rate of 49%. The result of non-response bias suggested that the study had no severe impact from problems caused by non-response bias.
2. Most of the respondents who participated in the questionnaire were engaged in European and Asian ports. When it comes to the size of ports, medium-sized ports accounted for the most considerable portion.
3. The respondents mainly had responsibility in port management as middle-level position in ports. In addition, they had a senior level of working experience, indicating

that responses were gained from respondents with sufficient knowledge and expertise in the port industry.

4. The respondents evaluated their ports as moderately competitive in the port industry. They also perceived that their ports performed sustainability at a relatively high level, as shown that the mean values of items were well above the mid-point 4.
5. The respondents recognised sustainability-related activities were crucial to enhance the competitive advantage of ports. Specifically, the items with the highest mean values from each sustainability aspect were “Waste pollution management” for environmental sustainability, “Health and safety” for social sustainability, and “Port operational efficiency” for economic sustainability.
6. It is pointed out that the average scores of the environmental sustainability and social sustainability items in Part B were lower than those in Part A. In contrast, the means of economic sustainability items in Part B were higher than those of Part A. This implies that there is a gap between actual sustainability performance and the perceived importance of sustainability performance on the competitive advantage of ports.

Furthermore, this chapter included the data preparation process with screening the missing data and outliers. The missing data were imputed to the data set for further analysis using the VMS imputation approach, while the outliers were treated by deleting them based on the criteria of Mahalanobis D^2 measure. After the treatment process, the total number of data is 236 for Part A and 224 for Part B. The study data includes seven variables with more than 10 per cent of missing data, and the VMS approach for treating the missing data might increase the biased results. However, the data are MCAR, and its amount does not exceed 30 per cent of the entire data (Raaijmakers 1999). Besides, the remaining data are still above the number of 200, and the reliability test (Cronbach’s Alpha) showed 0.953 for the data of Part A and 0.957 for the data of Part B. Consequently, the data were confirmed to be acceptable for use in SEM and RII analyses.

Chapter 6. Relative Importance Index Analysis

Chapter 5 presented the general picture of the responses obtained from the survey, and the data cleaning procedures were performed on the data for outliers and missing data. This chapter focuses on the Relative Importance Index analysis. The main objective of this chapter is to quantify the relative importance of sustainability activities and practices to demonstrate their rankings and importance levels on the competitive positioning of ports. The results of the analysis using the RII method consist of two parts. The first part of this chapter provides overall the RII analysis for sustainability practices and activities from environmental, social, and economic sustainability aspects. The second part of this chapter presents the comparative RII analysis of sustainability activities by categories—geographical location, port size, and management level of respondents.

6.1 Relative Importance Index analysis

A total of 30 activities from the three aspects of sustainability identified through the systematic literature review were used for the RII analysis with the purpose of prioritising them according to their importance on strengthening the competitive positioning of ports. The questions in the Part B of the questionnaire were designed for the analysis of RII. The participants provided numerical scores of their opinions concerning the effect of each sustainability activity on the port's competitive advantage. Of the 224 responses after the data treatment (see Chapter 5, section 5.5), 7 responses that did not provide demographic information were deleted to facilitate the examination of relative importance according to the background of the respondents. Consequently, a total of 217 responses were used for the RII analysis.

The calculations were performed utilising SPSS and spreadsheet software, Excel version 16.50. The scores for each question provided by the respondents were transformed to relative importance values using the RII equation (see Chapter 4, subsection 4.8.1), determining the relative ranking of the activities. This ranking enables cross-compare the relative importance of port sustainability activities as perceived by the respondents. All activities from environmental, social, and economic sustainability were ranked, and their priorities were specified. An activity with the highest RII value or rank first indicates that it has the top priority, while an activity with the lowest RII value indicates that it has the bottom priority given by the respondents in strengthening the competitive advantage of ports.

In order to provide a deeper picture of significant sustainability activities to the competitive advantage of ports, the prioritisation of sustainability activities was examined depending on the characteristics of respondents: geographical location, port size, and manager levels. Additionally, the importance weights were further explained by the level of importance impact, which is utilised as a criterion to indicate the degree of importance that a sustainability activity has in strengthening the competitive advantage of ports. According to the criteria of Rooshdi et al. (2018), the current study adopted the four influence levels of the RII values: high ($0.8 \leq RII \leq 1$), high-medium ($0.6 \leq RII \leq 0.8$), medium ($0.4 \leq RII \leq 0.6$), medium-low ($0.2 \leq RII \leq 0.4$), and low ($0 \leq RII \leq 0.2$).

6.2 Overall RII results

For a comprehensive comparative examination of the relative importance, the sustainability activities from each aspect of sustainability were grouped. The overall group indices were calculated by taking the average RII values of sustainability activities of each aspect. Furthermore, the relative importance values for all 30 sustainability activities were examined.

6.2.1 Overall RII results of the three sustainability aspects

The average relative importance values and rankings for each aspect of sustainability are presented in Table 6.1. The average relative importance values were calculated at 0.782 from environmental sustainability, 0.862 from social sustainability, and 0.856 from economic sustainability, suggesting social sustainability was considered as the most significant practice strengthening the competitive advantage of ports. However, the average relative importance value differences were not considerable between social sustainability (0.862) and economic sustainability (0.856).

Table 6.1 RII average values and rankings among the aspects of sustainability

Sustainability aspect	Group importance index (Average value)	Ranking
Environmental sustainability	0.782	3
Social sustainability	0.862	1
Economic sustainability	0.856	2

6.2.2 Overall RII results of sustainability activity

The relative importance values for all 30 sustainability activities were calculated, and the activities were arranged in ascending ranking. As shown in Table 6.2, all the sustainability activities scored more than 0.700 on the relative importance scales. The most important sustainability activity perceived as affecting the better competitive positioning of ports was “Health and safety” of social sustainability (the RII value of 0.909), followed by “Port operational efficiency” (the RII value of 0.907) and “High-quality services” (the RII value of 0.905) of economic sustainability. On the other hand, the least important activity was as to establishing an open and direct foreign investment for ports, having the RII value of 0.733. In addition, the impact level of importance index indicated that all the activities were considered as relatively high influence levels on enhancing the competitive advantage of ports, ranging between high and high-medium influence. Overall, sustainability activities from the economic aspect were in higher ranking, those from social aspect were in the middle ranking, and those from environmental were in the lower ranking.

Table 6.2 RII values and rankings of all 30 sustainability activities

Sustainability aspect	Sustainability activity	Degree of importance quoted by respondents							RII	Ranking	Impact level
		1	2	3	4	5	6	7			
Social	Health and safety	0	0	2	9	25	54	127	0.909	1	High
Economic	Port operational efficiency	0	0	0	10	23	65	119	0.907	2	High
Economic	High-quality services	0	0	2	7	28	59	121	0.905	3	High
Economic	Port infrastructure construction	0	0	1	10	37	65	104	0.886	4	High
Economic	Value-added productivity	0	2	0	12	32	77	94	0.877	5	High
Economic	Operating revenue	0	0	2	8	45	67	95	0.876	6	High
Economic	Container throughput	0	1	1	11	44	67	93	0.871	7	High
Economic	Cost-efficiency	0	0	4	10	49	58	96	0.871	8*	High
Social	Job training	1	0	6	11	32	69	98	0.870	9	High
Social	Public relations	0	0	6	14	45	53	99	0.867	10	High
Economic	Reducing operating costs	0	0	4	16	42	61	94	0.864	11	High
Social	Social image	0	0	3	14	50	53	97	0.862	12	High
Social	Quality of working and living environment	0	0	7	16	42	68	84	0.862	13*	High
Social	Job creation and security	0	1	4	19	37	76	80	0.850	14	High

Social	Social participation	0	1	4	16	50	74	72	0.850	15*	High
Economic	GDP	1	3	11	20	45	55	82	0.840	16	High
Economic	Port development funding	0	2	6	15	65	66	63	0.824	17	High
Social	Gender equality	1	2	4	18	62	57	73	0.822	18	High
Economic	Benefits from external stakeholders	0	2	12	21	51	64	67	0.819	19	High
Environmental	Waste pollution management	0	2	11	25	49	59	71	0.812	20	High
Environmental	Green port management	2	3	11	25	49	56	71	0.811	21	High
Environmental	Energy and resource usage management	0	5	8	28	58	63	55	0.803	22	High
Environmental	Air pollution management	0	3	12	30	58	55	59	0.789	23	High-medium
Environmental	Green construction and facilities	0	9	13	28	50	58	59	0.787	24	High-medium
Environmental	Soil occupation and pollution management	0	6	13	26	62	51	59	0.780	25	High-medium
Environmental	Ecosystem and habitats protection	1	6	14	24	65	57	50	0.777	26	High-medium
Environmental	Water pollution management	0	0	2	13	42	65	95	0.769	27	High-medium
Environmental	Odour pollution management	0	7	12	39	55	58	46	0.758	28	High-medium
Environmental	Noise pollution management	1	7	19	40	57	54	39	0.733	29	High-medium
Economic	Foreign direct investment	9	9	12	36	48	55	48	0.733	30*	High-medium

*: Equal relative importance indices were ranked in accordance with the percentage of respondents scoring 5 or more (Kometa et al. 1994).

Environmental sustainability activity

The degree of importance of each of the 10 environmental sustainability activities in terms of competitive advantage of ports was weighted from respondents' point of view. The relative importance values and rankings were provided in Table 6.3. The most influential environmental sustainability activity that was perceived to bring the competitive advantage of ports was "Waste pollution management", while the least important one was "Noise pollution management". According to the impact level of the relative importance, the sustainability activities from environmental practice were found to have from high-medium to high influence. The environmental activities with the RII values above 0.800, which indicated high influence on competitive advantage, included: "Waste pollution management", "Green port management", and "Energy and resource usage management". The environmental activities with average to high influence, having RII values ranging between 0.600 and 0.800, are: "Air pollution management", "Green construction and facilities", "Soil occupation and pollution management", "Ecosystem and habitats protection", "Water pollution management", "Odour pollution management", and "Noise pollution management".

Table 6.3 RII values and rankings of environmental sustainability activities

Sustainability aspect	Sustainability activity	RII	Ranking	Impact level
Environmental sustainability	Waste pollution management	0.812	1	High
	Green port management	0.811	2	High
	Energy and resource usage management	0.803	3	High
	Air pollution management	0.789	4	High-medium
	Green construction and facilities	0.787	5	High-medium
	Soil occupation and pollution management	0.780	6	High-medium
	Ecosystem and habitats protection	0.777	7	High-medium
	Water pollution management	0.769	8	High-medium
	Odour pollution management	0.758	9	High-medium
	Noise pollution management	0.733	10	High-medium

Social sustainability activity

The relative importance values and rankings were weighed for each of the 8 social sustainability activities, and the summary of the result was provided in Table 6.4. The respondents perceived the implementation of health and safety-related activities as the most critical to enhancing the competitive advantage of ports, with the relative importance index value of 0.909. "Job training" for employees was ranked in the second position with the RII value of 0.870, followed by "Public relations" with the RII value of 0.867. According to its relative evaluation, the social activity that might have the least importance on the port's competitive advantage was "Gender equality" with the RII value of 0.822. However, it is interesting to mention that all social sustainability showed a high level of importance impact with the RII values above 0.800. Therefore, it might be inappropriate to confirm that "Gender equality" is a minor activity to affect the competitive advantage of ports.

Table 6.4 RII values and rankings of social sustainability activities

Sustainability aspect	Sustainability activity	RII	Ranking	Impact level
Social sustainability	Health and safety	0.909	1	High
	Job training	0.870	2	High
	Public relations	0.867	3	High
	Social image	0.862	4	High
	Quality of working and living environment	0.862	5*	High
	Job creation and security	0.850	6	High
	Social participation	0.850	7*	High
	Gender equality	0.822	8	High

*: Equal relative importance indices ranked in accordance with the percentage of respondents scoring 5 or more (Kometa et al. 1994).

Economic sustainability activity

Table 6.5 illustrates the importance values and rankings of 12 sustainability activities from economic sustainability aspect. "Port operational efficiency" (RII=0.908) was the top activity with a very high impact level. According to the impact level of relative importance, all economic sustainability activities were considered to have high levels of importance other than "Foreign direct investment" with the high-medium level. In other words, the respondents believed that obtaining an open and direct investment outside the country for port development was unlikely to contribute to a better competitive position of ports.

Table 6.5 RII values and rankings of economic sustainability activities

Sustainability aspect	Sustainability activity	RII	Ranking	Impact level
Economic sustainability	Port operational efficiency	0.908	1	High
	High quality services	0.905	2	High
	Port infrastructure construction	0.886	3	High
	Value-added productivity	0.877	4	High
	Operating revenue	0.876	5	High
	Container throughput	0.871	6	High
	Cost-efficiency	0.871	7*	High
	Reducing operating costs	0.864	8	High
	GDP	0.840	9	High
	Port development funding	0.824	10	High
	Benefits from external stakeholders	0.819	11	High
	Foreign direct investment	0.733	12	High-medium

*: Equal relative importance indices ranked in accordance with the percentage of respondents scoring 5 or more (Kometa et al. 1994).

Furthermore, Table 6.6 provides useful points of reference regarding which activities should be considered in decision-makings on securing port competitiveness by presenting the top and bottom three sustainability activities from each sustainability aspect. The sustainable activities being ranked in the top three were classified as the most important activities affecting the competitive advantage of ports. This suggests that they can serve as baseline activities that drive the competitive advantage of port sustainability performance. On the other hand, the sustainability activities in the bottom three provide information on the least important activities for strengthening the competitive advantage of ports.

Table 6.6 Top and bottom three activities of the aspects of sustainability

Priority	**Aspect of sustainability**		
	Environmental sustainability	**Social sustainability**	**Economic sustainability**
Top 3 activities	Waste pollution management	Health and safety	Port operational efficiency
	Green port management	Job training	High quality services
	Energy and resource management	Public relations	Port infrastructure construction
Bottom 3 activities	Water pollution management	Job creation and security	Port development funding
	Odour pollution management	Social participation	Benefits from external stakeholders
	Noise pollution management	Gender equality	Foreign direct investment

6.3 The examination of RII values depending on the characteristics of ports and respondents

Ports are regarded as complex organisations which are affected by various internal and external factors intermingled. In this regard, each port takes its own sustainability operations and management position depending on its size and type of port, organisational structure, location, and so on (Lim et al. 2019). Specifically, the issue of sustainable development is responsibility and compliance required of all ports in the world, not limited to one port. However, the diversified characteristics of port administrations make it challenging to conduct an integrated sustainability performance across ports. Indeed, the individual port has adopted and developed a plethora of variations in sustainability practices and activities, and these variations may cause different perceptions regarding the impacts of sustainability performance on the competitive position of ports. Additionally, the strategy-as-practice view recommended a comparative analysis of the three elements (practitioners, practice, and praxis) to explain how their variations affect organisational outcomes, which can be significant evidence of supporting practitioners' decisions about their performance of strategy (Jarzabkowski and Spee 2009).

Therefore, examining and combining the different perceptions across ports can provide a deeper understanding of the relationship between sustainability performance and competitive advantage in ports, contributing to the development of an integrated strategy that reflects both international benchmarks and each characteristic of ports. The current study examined RII analysis by category in order to understand differences in perceptions between ports in terms of the importance of each sustainability practice and activity that affect the competitive advantage of ports. Three categories were formed depending on the characteristics of ports and respondents. The first and second categories were related to the characteristics of ports, that is, geographical location and port size. The third category involved the attribute of respondents, which was their management levels in their ports. The category analysis based on the characteristics of respondents is in line with the previous studies which investigated perceptional differences in the relative importance of organisational performance, such as depending on rater and ratee (Cochran 1999), employees and supervisors (Johnson and Johnson 2001), and countries (Robie et al. 2001). Furthermore, Puig et al. (2017) presented the top ten environmental priorities in terms of port location and port size, supporting reasonable grounds to the categorisation of this study.

6.3.1 Geographical location

The questionnaire survey forms were distributed to ports and terminals around the world handling containers. The complete responses were collected from a total of 37 countries, and the list of the countries and the rate of responses were described in Chapter 5. The data collected from Ecuador and Vietnam were removed based on the treatment of outliers and missing data. Accordingly, a total of 35 countries were considered in the RII analysis. For a comparison examination, the 35 countries were grouped, and the RII values and rankings were compared among seven regions: Africa, North America, South America, ESE Asia, WS Asia, Europe, and Oceania. Table 6.7 shows a list of countries and the number of responses in the seven regions used in the analysis.

Table 6.7 List of countries and number of responses in each region

No.	Region	Country	Number of countries	Number of responses
1	Africa	Morocco, South Africa	2	14
2	Oceania	Australia, New Zealand	2	27
3	North America	Canada, USA	2	23
4	South America	Brazil, Colombia, Panama	3	21
5	East and Southeast Asia (ESE Asia)	China, Indonesia, Malaysia, Philippines, Singapore, South Korea, Thailand	7	54
6	West and South Asia (WS Asia)	Egypt, India, Saudi Arabia, Sri Lanka, Turkey, UAE	6	21
7	Europe	Belgium, Cyprus, Denmark, France, Germany, United Kingdom, Malta, Netherlands, Norway, Portugal, Slovenia, Spain, Sweden	13	57
	Total		35	217

Environmental sustainability aspect

The relative importance values and rankings for 10 environmental sustainability activities were assessed and compared by the seven regions. Their results are summarised in Table 6.8. Each environmental sustainability activity was ranked by its RII value, and the average of RII values for 10 activities was calculated by each of the seven regions. According to the average RII values by each region, the level of importance impact ranged between high and high-medium influence. The regions showing in the high level of importance in environmental sustainability practice were WS Asia (0.834), Africa (0.825), and South America (0.815). The regions in the high-medium level of importance were Oceania (0.785), North America (0.784), Europe (0.781), and ESE Asia (0.744).

There were different perceptions among the seven regions in terms of the most important activity and the least important activity enhancing the competitive advantage of ports. Africa gave the highest priority to “Waste pollution management” (RII=0.898) and the lowest priority to “Noise pollution management” (RII=0.765), which Oceania considered as the most important activity (RII=0.818). North America perceived “Air pollution management” (RII=0.845) as the most important while “Odour pollution management” (RII=0.689) as the least important, which was consistent with Oceania (RII=0.746) and WS Asia (RII=0.796).

Table 6.8 RII values and rankings of environmental sustainability activities by the seven regions

No.	Environmental sustainability activity	Region													
		Africa		Oceania		North America		South America		ESE Asia		WS Asia		Europe	
		RII	Ranking	RII	Ranking	RII	Ranking	RII	Ranking	RII	Ranking	RII	Ranking	RII	Ranking
1	Water pollution management	0.837	4	0.804	3	0.770	7	0.844	3	0.730	7	0.796	9	0.744	9
2	Air pollution management	0.847	3	0.815	2	0.845	1	0.789	8	0.757	4	0.830	6	0.769	5
3	Energy and resource usage management	0.806	7	0.783	5	0.832	2	0.748	10	0.751	5	0.864	1	0.847	1
4	Noise pollution management	0.765	10	0.818	1	0.752	9	0.755	9	0.683	10	0.803	8	0.702	10
5	Green port management	0.796	8	0.775	8	0.814	3	0.830	5	0.802	1	0.864	2	0.825	3
6	Ecosystem and habitats protection	0.816	6	0.792	4	0.801	4	0.884	1	0.706	9	0.857	3	0.752	8
7	Soil occupation and pollution management	0.827	5	0.777	6	0.764	8	0.850	2	0.746	6	0.844	5	0.757	7
8	Waste pollution management	0.898	1	0.777	7	0.795	5	0.837	4	0.767	2	0.857	4	0.830	2
9	Green construction and facilities	0.796	9	0.763	9	0.776	6	0.796	7	0.765	3	0.830	7	0.810	4
10	Odour pollution management	0.857	2	0.746	10	0.689	10	0.816	6	0.730	8	0.796	10	0.769	6
Average RII (Impact level)		0.825 (High)		0.785 (High-medium)		0.784 (High-medium)		0.815 (High)		0.744 (High-medium)		0.834 (High)		0.781 (High-medium)	

Ports in the region of South America gave "Ecosystem and habitats protection" (RII=0.884) as the highest important activity and "Energy and resource usage management" (RII=0.748) as the least important activity to affect the competitive advantage of ports. ESE Asia gave a top priority to "Green port management" (RII=0.802) while "Noise pollution management" (RII=0.683) was the lowest priority, which was consistent in Europe (RII=0.702). WS Asia (RII=0.864) and Europe (RII=0.847) considered "Energy and resource usage management" the most significant activity to strengthen the competitive advantage of ports.

For the examination of patterns in ranking, identical environmental sustainability activities were mapped with the same colour in each region for easy identification, as shown in Table 6.9. The colouring map was adopted from Puig et al. (2017). The key examination can be summarised as follows:

- **Africa** ranked "Waste pollution management" as the most important activity, followed by "Odour pollution management" (2^{nd}). However, these activities relatively considered very low important in the other regions. The distinct importance of these activities in African ports seems to reflect the growing need for mechanisms and capacity to detect and handle garbage and oil products that are potentially a source of foul odours around the port area (Barnes-Dabban et al. 2017).
- **Oceania** only considered "Noise pollution management" as the most important activity. This implies the increasing noise issues from seagoing vessels that have been highlighted in ports of New Zealand as it has adversely impacted the quality of living of the residents around the port area (Miller 2019). Australian ports have also participated in joint research called the Noise Exploration Program to Understand Noise Emitted by Seagoing ships (NEPTUNES) to control ship noise-related issues (Marcellin 2019). With the growing interest in noise issues, noise pollution management seems to be recognised as an important activity that can provide a better competitive advantage among Oceanian ports.
- It is worth mentioning that **South America** ranked "Energy and resource usage management" (10^{th}) as lowest, while it ranked relatively high in the other regions. This suggests that ports in South America have an opinion that is contrary to the general view on the importance of successful port environmental management.
- Overall, a similar pattern of environmental sustainability activity ranking was found between **ESE Asia and Europe**. For example, ESE Asia and Europe put a lower

priority on "Ecosystem and habitats protection" (9th and 8th, respectively). On the other hand, other regions regarded it as relatively important, as the activity ranked 1st in South America, 3rd in both WS Asia, and 4th in both Oceania and North America. A similar pattern was also examined in "Green construction and facilities" where ESE Asia and Europe gave higher importance (3rd and 4th, respectively) than other regions where the activity ranked from 6th, 7th, or 9th. The largest container ports are mainly located in the regions of ESE Asia and Europe, playing as a role in global hub and industrial complex. In this regard, they seemed to consider that the development of green construction and facilities that enable efficient environmental operations are more important for creating competitive advantage.

Table 6.9 Comparison of environmental sustainability activity rankings by the seven regions

Rank -ing	Africa	Oceania	North America	South America	ESE Asia	WS Asia	Europe
1	Waste pollution management	Noise pollution management	Air pollution management	Ecosystem and habitats protection	Green port management	Energy and resource usage management	Energy and resource usage management
2	Odour pollution management	Air pollution management	Energy and resource usage management	Soil occupation and pollution management	Waste pollution management	Green port management	Waste pollution management
3	Air pollution management	Water pollution management	Green port management	Water pollution management	Green construction and facilities	Ecosystem and habitats protection	Green port management
4	Water pollution management	Ecosystem and habitats protection	Ecosystem and habitats protection	Waste pollution management	Air pollution management	Waste pollution management	Green construction and facilities
5	Soil occupation and pollution management	Energy and resource usage management	Waste pollution management	Green port management	Energy and resource usage management	Soil occupation and pollution management	Air pollution management
6	Ecosystem and habitats protection	Soil occupation and pollution management	Green construction and facilities	Odour pollution management	Soil occupation and pollution management	Air pollution management	Odour pollution management
7	Energy and resource usage management	Waste pollution management	Water pollution management	Green construction and facilities	Water pollution management	Green construction and facilities	Soil occupation and pollution management
8	Green port management	Green port management	Soil occupation and pollution management	Air pollution management	Odour pollution management	Noise pollution management	Ecosystem and habitats protection
9	Green construction and facilities	Green construction and facilities	Noise pollution management	Noise pollution management	Ecosystem and habitats protection	Water pollution management	Water pollution management
10	Noise pollution management	Odour pollution management	Odour pollution management	Energy and resource usage	Noise pollution management	Odour pollution management	Noise pollution management

Note: Each activity is represented by separate colours.

Social sustainability aspect

The RII values of sustainability activities in terms of social practice were calculated as shown in Table 6.10. High significant impact levels were measured across all regions showing from the average RII of 0.835 in Oceania to the average RII of 0.878 in South America. This implies that social sustainability activities were perceived as more important in South America compared to other regions. In terms of each geographical analysis, Africa gave prime importance to "Health and safety" (RII=0.918), which was consistent with Oceania (RII=0.899), South America (RII=0.925), ESE Asia (RII=0.923), WS Asia (RII=0.864), and Europe (RII=0.885). However, the respondents working in North American ports considered "Job creation and security" as the most important social activity for the competitive advantage of ports, with the RII of 0.907. An activity perceived as the least significant in the region of Africa was "Social participation" with the RII of 0.847, which was consistent with North America with the RII of 0.857. Oceania (RII=0.783), South America (RII=0.857), ESE Asia (RII=0.786), and Europe (RII=0.812) perceived "Gender equality" as the least important activity, while WS Asia considered "Quality of working and living environment" (RII=0.803) as the least important.

Based on the RII values obtained, the social sustainability activities were ranked as shown in Table 6.11. Each social sustainability activity is represented by separate colours. The examination of each sustainability activity by its priority was summarised as follows:

- "Health and safety" activity secured the top rank in all regions except North America (3rd), indicating that it is the top priority for creating a better competitive position of ports. This also reinforces the argument of previous studies that ensuring occupational health and operational safety is the most crucial practice contributing to increasing operating costs and reducing uncertainty and threats to human and physical assets of ports (Antão et al. 2016).
- There was a contrasting perception regarding "Job creation and security". It was given a high priority in North America (1st), Africa (2nd), and South America (3rd); On the contrary, it was given a low priority in Europe (6th), Oceania (7th), and ESE Asia (7th). This indicates that there might be a potential correlation between financial capacity and employment stability regarding port competitiveness, in that ports in the latter region are more likely to achieve financial soundness as they handle relatively higher container throughput in the world.

Table 6.10 RII values and rankings of social sustainability activities by the seven regions

No.	Social sustainability activity	Region													
		Africa		Oceania		North America		South America		ESE Asia		WS Asia		Europe	
		RII	Ranking	RII	Ranking	RII	Ranking	RII	Ranking	RII	Ranking	RII	Ranking	RII	Ranking
1	Health and safety	0.918	1	0.899	1	0.882	3	0.925	1	0.923	1	0.864	1	0.885	1
2	Job creation and security	0.908	2	0.794	7	0.907	1	0.878	3	0.817	7	0.857	4	0.840	6
3	Job training	0.898	3	0.836	3	0.876	5	0.857	7	0.868	2	0.844	5	0.875	3
4	Public relations	0.847	5	0.868	2	0.894	2	0.864	5	0.831	6	0.857	3	0.880	2
5	Gender equality	0.888	4	0.783	8	0.857	6	0.857	8	0.786	8	0.830	7	0.812	8
6	Social image	0.847	6	0.836	4	0.857	7	0.871	4	0.854	4	0.864	2	0.862	5
7	Quality of working and living environment	0.847	7	0.825	6	0.882	4	0.905	2	0.854	5	0.803	8	0.867	4
8	Social participation	0.847	8	0.836	5	0.857	8	0.864	6	0.857	3	0.830	6	0.827	7
Average RII (Impact level)		0.875 (High)		0.835 (High)		0.877 (High)		0.878 (High)		0.849 (High)		0.834 (High)		0.856 (High)	

- **Africa** recognised "Gender equality" as a higher important activity (4th) than other regions. This reflects the African port authority's focus on pursuing social justice by designing activities that support the social value of African ports to the community under the influence of national laws on poverty and inequality (Molelu and Enserink 2018).
- The region of **ESE Asia** ranked "Social participation" as a relatively more important activity (3rd) compared to other regions where the activity was below 5th. This implies that ports in ESE Asia focus on securing their port competitiveness by achieving socio-economic sustainability through interaction and collaboration with relevant stakeholders and local communities.

Table 6.11 Comparison of social sustainability activity rankings by the seven regions

Rank-ing	Africa	Oceania	North America	South America	ESE Asia	WS Asia	Europe
1	Health and safety	Health and safety	Job creation and security	Health and safety	Health and safety	Health and safety	Health and safety
2	Job creation and security	Public relations	Public relations	Quality of working and living environment	Job training	Social image	Public relations
3	Job training	Job training	Health and safety	Job creation and security	Social participation	Public relations	Job training
4	Gender equality	Social image	Quality of working and living environment	Social image	Social image	Job creation and security	Quality of working and living environment
5	Public relations	Social participation	Job training	Public relations	Quality of working and living environment	Job training	Social image
6	Social image	Quality of working and living environment management	Gender equality	Social participation	Public relations	Social participation	Job creation and security
7	Quality of working and living environment	Job creation and security	Social image	Job training	Job creation and security	Gender equality	Social participation
8	Social participation	Gender equality	Social participation	Gender equality	Gender equality	Quality of working and living environment	Gender equality

Note: Each activity is represented by separate colours.

Economic sustainability aspect

The relative importance index of economic sustainability activities for each region is provided in Table 6.12.

Table 6.12 RII values and rankings of economic sustainability activities by the seven regions

No.	Economic sustainability activity	Africa		Oceania		North America		South America		ESE Asia		WS Asia		Europe	
		RII	Ranking	RII	Ranking	RII	Ranking	RII	Ranking	RII	Ranking	RII	Ranking	RII	Ranking
1	Foreign direct investment	0.735	12	0.593	12	0.714	12	0.803	12	0.759	12	0.803	12	0.729	12
2	Value-added productivity	0.837	2	0.868	7	0.876	8	0.878	8	0.881	4	0.946	3	0.862	4
3	Port operational efficiency	0.837	3	0.899	2	0.932	3	0.891	3	0.915	1	0.966	1	0.895	2
4	High quality services	0.806	6	0.899	3	0.944	2	0.898	2	0.894	2	0.959	2	0.910	1
5	Reducing operating costs	0.786	9	0.852	8	0.876	9	0.884	5	0.860	8	0.918	5	0.860	5
6	Benefits from external stakeholders	0.776	10	0.836	9	0.801	11	0.857	9	0.820	11	0.884	9	0.789	11
7	Port development funding	0.765	11	0.794	11	0.882	7	0.837	11	0.828	10	0.857	11	0.810	9
8	Port infrastructure construction	0.847	1	0.899	4	0.901	6	0.884	6	0.884	3	0.878	10	0.890	3
9	Container throughput	0.806	7	0.910	1	0.907	5	0.912	1	0.881	5	0.932	4	0.807	10
10	GDP	0.827	4	0.799	10	0.863	10	0.850	10	0.852	9	0.912	6	0.812	8
11	Operating revenue	0.816	5	0.889	5	0.957	1	0.891	4	0.868	6	0.905	8	0.842	7
12	Cost-efficiency	0.806	8	0.873	6	0.913	4	0.884	7	0.862	7	0.912	7	0.857	6
Average RII (Impact level)		0.825 (High)		0.843 (High)		0.881 (High)		0.872 (High)		0.859 (High)		0.906 (High)		0.839 (High)	

Note: "Region" spans all seven region column groups.

The average RII values for 12 economic activities indicated that they had significant impacts at very high levels in all regions, ranging from the average RII value of 0.825 in Africa to the average RII value of 0.906 in WS Asia. This suggests that economic-related sustainable activities are considered a high degree of effect on strengthening the competitive advantage of ports. According to the RII values and rankings in Table 6.12, it appeared that all regions considered “Foreign direct investment” was not effective activity to strengthen their ports’ competitive advantage. On the other hand, the seven regions had slightly different opinions in terms of the most important activity. The activity perceived as the most important by each region was “Port infrastructure construction” in Africa (RII=0.847), “Container throughput” in Oceania and South America (RII=0.910 and 0.912, respectively), “Operating revenue” in North America (RII=0.957), “Port operational efficiency” in ESE Asia and WS Asia (RII=0.915 and 0.966, respectively), “High quality services” in Europe (RII=0.910).

The economic sustainability activities were ranked according to their relative importance index values. Table 6.13 provides a ranking map for the seven regions regarding the priorities of 12 economic sustainability activities represented by different colours. The examination of the ranking map can be summarised as follows:

- “Foreign direct investment” ranked 12th across all regions, indicating that it had the lowest priority to strengthen the competitive advantage of ports. The activity has been accepted the key indicator to assess port economic sustainability (Lim et al. 2019). However, it was recognised as an activity that has little effect on the competitive advantage of ports, suggesting an inappropriate indicator to evaluate port sustainability performance in terms of competitiveness.
- A similar pattern was identified between **ESE Asia, WS Asia, and Europe** regarding the relative importance of economic sustainability activities. As mentioned earlier, the busiest container ports in the world are concentrated in these regions, which seems to affect forming similar economic concerns regarding port sustainable development.
- Overall, different perceptions have been established across the regions in terms of economic activities strengthening the competitive advantage of ports. This indicates that individual port has developed different plans or goals for sustainable economic growth in order to ensure their competitiveness.

Table 6.13 Comparison of economic sustainability activity rankings by the seven regions

Ranking	Africa	Oceania	North America	South America	ESE Asia	WS Asia	Europe
1	Port infrastructure construction	Container throughput	Operating revenue	Container throughput	Port operational efficiency	Port operational efficiency	High quality services
2	Value-added productivity	Port operational efficiency	High quality services	High quality services	High quality services	High quality services	Port operational efficiency
3	Port operational efficiency	High quality services	Port operational efficiency	Port operational efficiency	Port infrastructure construction	Value-added productivity	Port infrastructure construction
4	GDP	Port infrastructure construction	Cost-efficiency	Operating revenue	Value-added productivity	Container throughput	Value-added productivity
5	Operating revenue	Operating revenue	Container throughput	Reducing operating costs	Container throughput	Reducing operating costs	Reducing operating costs
6	High quality services	Cost-efficiency	Port infrastructure construction	Port infrastructure construction	Operating revenue	GDP	Cost-efficiency
7	Container throughput	Value-added productivity	Port development funding	Cost-efficiency	Cost-efficiency	Cost-efficiency	Operating revenue
8	Cost-efficiency	Reducing operating costs	Value-added productivity	Value-added productivity	Reducing operating costs	Operating revenue	GDP
9	Reducing operating costs	Benefits from external stakeholders	Reducing operating costs	Benefits from external stakeholders	GDP	Benefits from external stakeholders	Port development funding
10	Benefits from external stakeholders	GDP	GDP	GDP	Port development funding	Port infrastructure construction	Container throughput
11	Port development funding	Port development funding	Benefits from external stakeholders	Port development funding	Benefits from external stakeholders	Port development funding	Benefits from external stakeholders
12	Foreign direct investment	Foreign direct investment	Foreign direct investment	Foreign direct investment	Foreign direct investment	Foreign direct investment	Foreign direct investment

Note: Each activity is represented by separate colours.

6.3.2 Port size

The number of responses for port sizes is 49 responses for small-sized ports, 120 responses for medium-sized ports, and 47 responses for large-sized ports, respectively. This subsection compares the RII values and rankings based on port size from each aspect of sustainability.

Environmental sustainability aspect

Table 6.14 presents the RII values and rankings of the 10 environmental sustainability activities by port size. The environmental sustainability practice had the level of high-medium importance impact across all sizes of ports: large-sized ports (average RII=0.776), medium-sized ports (average RII=0.780), and small-sized ports (average RII=0.790). The highest impact level was assessed with small-sized ports, suggesting that the environmental sustainability activities can be considered as higher importance among small-sized ports. According to the rankings of sustainability activities, large-sized ports put the highest priority to “Energy and resource usage management” (RII=0.833), while both medium-sized ports (RII=0.806) and small-sized ports (RII=0.837) perceived “Waste pollution management” as the most important activity affecting competitive advantage of ports. However, medium-sized ports put the lowest priority to “Odour pollution management” (RII=0.745) while large-sized ports (RII=0.690) and small-sized ports to “Noise pollution management” (RII=0.743) as the lowest priority.

Table 6.14 RII values and rankings of environmental sustainability activities by port sizes

No.	Environmental sustainability activity	Port size					
		Large		Medium		Small	
		RII	Ranking	RII	Ranking	RII	Ranking
1	Water pollution management	0.739	9	0.776	8	0.778	7
2	Air pollution management	0.784	5	0.789	4	0.793	5
3	Energy and resource usage management	0.833	1	0.790	3	0.808	3
4	Noise pollution management	0.690	10	0.746	9	0.743	10
5	Green port management	0.827	2	0.804	2	0.810	2
6	Ecosystem and habitats protection	0.760	7	0.785	5	0.773	8
7	Soil occupation and pollution management	0.757	8	0.780	6	0.799	4
8	Waste pollution management	0.799	3	0.806	1	0.837	1
9	Green construction and facilities	0.796	4	0.780	7	0.793	6
10	Odour pollution management	0.775	6	0.745	10	0.770	9
Average RII (Impact level)		0.776 (High-medium)		0.780 (High-medium)		0.790 (High-medium)	

The ranking comparison of the relative importance of the environmental sustainability activities depending on port size is illustrated in Table 6.15. Identical environmental sustainability activities were indicated with the same colours. Although the overall pattern in rankings was shown similar, it should be mentioned that large ports considered "Odour pollution management" more important compared to medium and small ports. This is likely related to the fact that large amounts of garbage and ship waste are produced during cargo transportation and daily repair and maintenance of ships, causing odour issues in larger ports (Zhang et al. 2021).

Table 6.15 Comparison of environmental sustainability activity rankings by port sizes

Ranking	Large	Medium	Small
1	Energy and resource usage management	Waste pollution management	Waste pollution management
2	Green port management	Green port management	Green port management
3	Waste pollution management	Energy and resource usage management	Energy and resource usage management
4	Green construction and facilities	Air pollution management	Soil occupation and pollution management
5	Air pollution management	Ecosystem and habitats protection	Air pollution management
6	Odour pollution management	Soil occupation and pollution management	Green construction and facilities
7	Ecosystem and habitats protection	Green construction and facilities	Water pollution management
8	Soil occupation and pollution management	Water pollution management	Ecosystem and habitats protection
9	Water pollution management	Noise pollution management	Odour pollution management
10	Noise pollution management	Odour pollution management	Noise pollution management

Note: Each activity is represented by separate colours.

Social sustainability aspect

Table 6.16 summarises the result of RII values and rankings in terms of the 8 social sustainability activities and the average RII values for each size of ports. Regardless of port size, "Health and safety" was given the highest importance in strengthening the competitiveness of ports, with the RII value of 0.921 by large ports, the RII value of 0.908 by medium ports, and the RII value of 0.898 by small ports. A consistent perception was also shown in the least important activity, "Gender equality" with the RII value of 0.827 by both large and medium ports and the RII value of 0.808 by small ports. According to the average RII values for each port size, high importance levels were presented by all the sizes of ports, and large-sized ports showed the highest level of importance impact (0.874). This indicates that large-sized ports recognised the social sustainability activities as more important in strengthening the competitive advantage of ports.

Table 6.16 RII values and rankings of social sustainability activities by port sizes

No.	Social sustainability activity	Port size					
		Large		Medium		Small	
		RII	Ranking	RII	Ranking	RII	Ranking
1	Health and safety	0.921	1	0.908	1	0.898	1
2	Job creation and security	0.869	5	0.851	6	0.828	7
3	Job training	0.900	2	0.862	3	0.863	4
4	Public relations	0.872	3	0.864	2	0.869	3
5	Gender equality	0.827	8	0.827	8	0.808	8
6	Social image	0.872	4	0.860	4	0.863	5
7	Quality of working and living environment	0.866	6	0.854	5	0.880	2
8	Social participation	0.863	7	0.848	7	0.845	6
Average RII (Impact level)		0.874 (High)		0.859 (High)		0.857 (High)	

All social sustainability activities were ranked based on their RII values. The result is presented in Table 6.17 by marking the same colours to identical social sustainability activities. A clear difference in priorities was identified in the activity of "Quality of working and living environment", which small ports regarded as a higher priority (2nd) than large ports(6th) and medium ports (5th). Other than that, when it comes to the analysis by the category of port size, a similar ranking pattern of the social sustainability activities were shown.

Table 6.17 Comparison of social sustainability activity rankings by port sizes

Ranking	Large	Medium	Small
1	Health and safety	Health and safety	Health and safety
2	Job training	Public relations	Quality of working and living environment
3	Public relations	Job training	Public relations
4	Social image	Social image	Job training
5	Job creation and security	Quality of working and living environment	Social image
6	Quality of working and living environment	Job creation and security	Social participation
7	Social participation	Social participation	Job creation and security
8	Gender equality	Gender equality	Gender equality

Note: Each activity is represented by separate colours.

Economic sustainability aspect

In terms of RII analysis for the 12 economic sustainability activities, large ports considered "Port operational efficiency" (RII=0.930) as the most important activity, while both medium and small ports perceived "High quality services" (RII=0.906 and 0.895, respectively) as the main activity contributing the competitive advantage of ports. There was an identical opinion regarding the least important activity, "Foreign direct investment" with the RII value of 0.784 by large ports, the RII value of 0.723 by medium ports, and the RII value of 0.708 by small ports. The highest level of importance impact (average RII=0.868) was revealed in large-sized ports according to the result of the average RII values. The summary of the RII analysis for the economic sustainability activities is presented in Table 6.18.

Table 6.18 RII values and rankings of economic sustainability activities by port sizes

No.	Economic sustainability activity	Port size					
		Large		Medium		Small	
		RII	Ranking	RII	Ranking	RII	Ranking
1	Foreign direct investment	0.784	12	0.723	12	0.708	12
2	Value-added productivity	0.875	7	0.881	4	0.872	4
3	Port operational efficiency	0.930	1	0.905	2	0.892	2
4	High quality services	0.915	2	0.906	1	0.895	1
5	Reducing operating costs	0.866	9	0.868	8	0.854	6
6	Benefits from external stakeholders	0.842	11	0.812	11	0.816	9
7	Port development funding	0.857	10	0.817	10	0.813	10
8	Port infrastructure construction	0.912	3	0.879	5	0.883	3
9	Container throughput	0.900	4	0.889	3	0.802	11
10	GDP	0.872	8	0.836	9	0.822	8
11	Operating revenue	0.894	5	0.879	6	0.854	7
12	Cost-efficiency	0.881	6	0.870	7	0.866	5
Average RII (Impact level)		0.868 (High)		0.845 (High)		0.829 (High)	

Additionally, a ranking pattern of economic sustainability activity by port size was examined. Each economic sustainability activity is represented by separate colours. According to Table 6.19, the examination of raking pattern can be summarised as follows:

- **Large-sized ports** gave lower priority to "Value-added productivity" (7^{th}), whereas it was regarded as a higher priority as it ranked 4^{th} by both medium and small ports. In this study, value-added productivity was defined as the benefit generated by providing port services, such as modern facilities and a more comprehensive range of logistics services. Hence, it is reasonable that these activities were considered less important to strengthen the competitive advantage in most large ports where state-of-the-art port facilities and systemised logistics services have been already established.
- The difference in the ranking order among port sizes was not significant except "Container throughput". **Small-sized ports** put a lower priority to this activity (11^{th}). On the contrary, it was perceived more important activity, ranking 4^{th} in large-sized ports and 3^{rd} in medium-sized ports. Considering that securing container throughput has been one of the determinants of port competitiveness (Parola et al. 2017), the low importance of this activity in small ports may suggest that they have experienced a shortage of container handling capacity to capture their competitive advantages.

Table 6.19 Comparison of economic sustainability activity rankings by port sizes

Ranking	Large	Medium	Small
1	Port operational efficiency	High quality services	High quality services
2	High quality services	Port operational efficiency	Port operational efficiency
3	Port infrastructure construction	Container throughput	Port infrastructure construction
4	Container throughput	Value-added productivity	Value-added productivity
5	Operating revenue	Port infrastructure construction	Cost-efficiency
6	Cost-efficiency	Operating revenue	Reducing operating costs
7	Value-added productivity	Cost-efficiency	Operating revenue
8	GDP	Reducing operating costs	GDP
9	Reducing operating costs	GDP	Benefits from external stakeholders
10	Port development funding	Port development funding	Port development funding
11	Benefits from external stakeholders	Benefits from external stakeholders	Container throughput
12	Foreign direct investment	Foreign direct investment	Foreign direct investment

Note: Each activity is represented by separate colours.

6.3.3 Management level of respondents

The conceptual framework from the strategy-practice perspective emphasises that an organisation's outcomes can vary depending on the type of practitioner (person) and the level of practice (activity). In other words, the decision of practitioners on which activities to adopt and carry out affects the outcome of organisational operations, implying that the opinions of practitioners are essential when considering strategy execution and formulation. Particularly, managers are considered key practitioners in strategic management who have the capability to build a more integrated understanding of strategy practice (Whittington 2006).

Depending on the job position information from the sample (see Chapter 5, section 5.3), the respondents were classified into three management levels: top manager, middle manager, and frontline manager. The number of responses accounted for management levels is 31 responses of top-management level, 128 responses of middle-management level, and 58 responses of frontline-management level, respectively.

Environmental sustainability aspect

The RII values by respondents' management levels were calculated, and the result is shown in Table 6.20. The average RII values were 0.783 of top-management level, 0.778 of middle-management level, and 0.788 of frontline-management level, indicating the impact level of high-medium significance of the environmental activities at all management levels. The respondents who had responsibility in the top management level perceived "Green port management" (RII=0.829) as the most important activity to create a better competitive position of ports, while "Odor pollution management" (RII=0.733) as the least important. Middle managers also agreed with top managers regarding the most important activity, "Green port management" (RII=0.813) and put "Noise pollution management" (RII=0.723) as the lowest priority to port competitive advantage. Frontline managers prioritised "Waste pollution management" (RII=0.815) and the lowest priority to "Noise pollution management" (RII=0.743).

Table 6.20 RII values and rankings of environmental sustainability activities by management levels

No.	Environmental sustainability activity	Management level					
		Top-management level		Middle-management level		Frontline-management level	
		RII	Ranking	RII	Ranking	RII	Ranking
1	Water pollution management	0.797	4	0.754	8	0.778	7
2	Air pollution management	0.788	5	0.785	5	0.800	3
3	Energy and resource usage management	0.806	3	0.799	3	0.808	2
4	Noise pollution management	0.742	9	0.723	10	0.743	10
5	Green port management	0.829	1	0.813	1	0.798	4
6	Ecosystem and habitats protection	0.774	7	0.776	7	0.781	8
7	Soil occupation and pollution management	0.779	6	0.781	6	0.776	9
8	Waste pollution management	0.820	2	0.808	2	0.815	1
9	Green construction and facilities	0.760	8	0.789	4	0.796	5
10	Odour pollution management	0.733	10	0.751	9	0.786	6
	Average RII (Impact level)	0.783 (High-medium level)		0.778 (High-medium level)		0.788 (High-medium level)	

Table 6.21 presents a ranking pattern of the environmental sustainability activity by respondents' management level, identifying each activity in different colours. **Frontline managers** perceived "Green port management" as a less important activity, showing a different perception from top managers and middle managers. This activity was ranked the top priority by top managers and middle managers and considered the highest effect on improving the competitive advantage of ports. This implies that the role of port managers according to the level of management authority within the port hierarchy appears to influence the formation of the importance perceptions of environmental activities. Both top and middle managers have a higher level of evaluative and diagnostic responsibility than frontline managers, focusing on

monitoring sustainability management plans and systems and guiding their processes toward the intended direction (Egels-Zandén and Rosén 2015). Thus, they are likely to consider the greater importance of green port management concerning their ports' competitive advantage.

Table 6.21 Comparison of environmental sustainability activity rankings by management levels

Ranking	Top-management level	Middle-management level	Frontline-management level
1	Green port management	Green port management	Waste pollution management
2	Waste pollution management	Waste pollution management	Energy and resource usage management
3	Energy and resource usage management	Energy and resource usage management	Air pollution management
4	Water pollution management	Green construction and facilities	Green port management
5	Air pollution management	Air pollution management	Green construction and facilities
6	Soil occupation and pollution management	Soil occupation and pollution management	Water pollution management
7	Ecosystem and habitats protection	Ecosystem and habitats protection	Odour pollution management
8	Green construction and facilities	Water pollution management	Ecosystem and habitats protection
9	Noise pollution management	Odour pollution management	Soil occupation and pollution management
10	Odour pollution management	Noise pollution management	Noise pollution management

Note: Each activity is represented by separate colours.

Social sustainability aspect

Table 6.22 illustrates the RII values and rankings of the 8 social sustainability activities by the respondents' management level. All management levels had the same opinion in terms of the most important activity, which was "Health and safety", with the RII value of 0.899 by top managers, the RII value of 0.907 by middle managers, and with the RII value of 0.916 by frontline managers. However, different perceptions were shown in the least important activity: "Gender equality" by both top managers and middle managers with the RII values of 0.811 and

0.810, respectively; and "Social participation" by frontline managers with the RII value of 0.830. The average RII implied that frontline managers perceived the social sustainability activities as more important with the highest average RII value of 0.871 than top managers and middle managers with the average RII values of 0.862 and 0.857, respectively.

Table 6.22 RII values and rankings of social sustainability activities by management levels

No.	Social sustainability activity	Management level					
		Top-management level		Middle-management level		First-management level	
		RII	Ranking	RII	Ranking	RII	Ranking
1	Health and safety	0.899	1	0.907	1	0.916	1
2	Job creation and security	0.825	7	0.846	7	0.872	3
3	Job training	0.871	4	0.869	2	0.872	4
4	Public relations	0.880	2	0.865	3	0.865	6
5	Gender equality	0.811	8	0.810	8	0.855	7
6	Social image	0.876	3	0.855	4	0.872	5
7	Quality of working and living environment	0.871	5	0.850	6	0.884	2
8	Social participation	0.866	6	0.855	5	0.830	8
Average RII (Impact level)		0.862 (High)		0.857 (High)		0.871 (High)	

According to the RII values, rankings of social sustainability activities were explored using a map marked in the same colours for the identical activities, as shown in Table 6.23. Overall, **frontline managers** perceived more importance in internal human resource management related activities, while **top and middle managers** recognised that the activities related to port's external reputation were much important to strengthen the competitive advantage of ports. For example, frontline managers considered "Quality of working and living environment" (2nd) and "Job creation and security" as a more important activity (3rd) than top managers (5th and 7th, respectively) and middle managers (6th and 7th, respectively). However, top and middle managers gave a higher priority on “Social image”, “Public relations”, and “Social participation” than frontline managers.

Table 6.23 Comparison of social sustainability activity rankings by management levels

Ranking	Top-management level	Middle-management level	Frontline-management level
1	Health and safety	Health and safety	Health and safety
2	Public relations	Job training	Quality of working and living environment
3	Social image	Public relations	Job creation and security
4	Job training	Social image	Job training
5	Quality of working and living environment	Social participation	Social image
6	Social participation	Quality of working and living environment	Public relations
7	Job creation and security	Job creation and security	Gender equality
8	Gender equality	Gender equality	Social participation

Note: Each activity is represented by separate colours.

Economic sustainability aspect

The RII values calculated for each of the 12 economic sustainability activities were compared by the respondents’ management level. As shown in Table 6.24, the least significant activity was “Foreign direct investment” across all management levels, with the RII value of 0.756 by top-management level, the RII value of 0.733 by middle-management level, and the RII value of 0.719 by frontline-management level. Additionally, the average RIIs ranged between 0.841 and 0.869, indicating high importance impact levels. The highest level of importance impact was shown in the top-management level with the average RII value of 0.869.

Table 6.24 RII values and rankings of economic sustainability activities by management levels

No.	Economic sustainability activity	Management level					
		Top-management level		Middle-management level		Frontline-management level	
		RII	Ranking	RII	Ranking	RII	Ranking
1	Foreign direct investment	0.756	12	0.733	12	0.719	12
2	Value-added productivity	0.903	3	0.876	4	0.865	7
3	Port operational efficiency	0.912	2	0.904	1	0.911	1
4	High quality services	0.922	1	0.904	2	0.899	2
5	Reducing operating costs	0.899	6	0.866	6	0.840	9
6	Benefits from external stakeholders	0.866	9	0.816	11	0.800	11
7	Port development funding	0.857	10	0.824	10	0.808	10
8	Port infrastructure construction	0.903	4	0.883	3	0.884	4
9	Container throughput	0.903	5	0.857	8	0.884	5
10	GDP	0.829	11	0.839	9	0.847	8
11	Operating revenue	0.880	8	0.866	7	0.894	3
12	Cost-efficiency	0.889	7	0.867	5	0.869	6
Average RII (Impact level)		0.869 (High)		0.843 (High)		0.841 (High)	

A ranking pattern of the economic sustainability activities according to the management level of respondents is illustrated in Table 6.25. Each economic sustainability activity was marked with a separate colour. Overall, a similar pattern was shown among managers for the relative importance of economic sustainability activities. Regardless of the management levels, business and servicing related activities were perceived as much more important than economic structure characterised activities. For example, “High quality services”, “Port operational efficiency”, and “Value-added productivity” ranked higher than “Operating revenue”, “Cost-efficiency", and "Operating revenue". Additionally, the rankings were not significantly different with the results of overall relative importance of economic sustainability activities (see subsection 6.2.2 above).

Table 6.25 Comparison of economic sustainability activity rankings by management levels

Ranking	Top-management level	Middle-management level	Frontline-management level
1	High quality services	Port operational efficiency	Port operational efficiency
2	Port operational efficiency	High quality services	High quality services
3	Value-added productivity	Port infrastructure construction	Operating revenue
4	Port infrastructure construction	Value-added productivity	Port infrastructure construction
5	Container throughput	Cost-efficiency	Container throughput
6	Reducing operating costs	Reducing operating costs	Cost-efficiency
7	Cost-efficiency	Operating revenue	Value-added productivity
8	Operating revenue	Container throughput	GDP
9	Benefits from external stakeholders	GDP	Reducing operating costs
10	Port development funding	Port development funding	Port development funding
11	GDP	Benefits from external stakeholders	Benefits from external stakeholders
12	Foreign direct investment	Foreign direct investment	Foreign direct investment

Note: Each activity is represented by separate colours.

6.4 The average RII values by the category

Additionally, the average RII values for each sustainability aspect were compared depending on the three contexts: the geographical location of ports, port size, and respondents' management level within their organisations. The overall comparison of relative importance from the three aspects of sustainability is presented in Table 6.26, and the highest average RII values are shown in bold. In terms of geographical locations, there were three regions, Africa (average RII=0.875), South America (average RII=0.878), and Europe (average RII=0.856), where the social sustainability aspect was regarded as the most significant sustainability practice for the better competitive position of ports. The rest of the regions, Oceania, North

America, ESE Asia, and WS Asia, showed more importance in economic sustainability practice, with the average RII values of 0.843, 0.881, 0.859, and 0.906, respectively. The overall examination of RII values by port sizes suggested that regardless of port sizes, the social aspect of sustainability was perceived as a top priority to enhance the competitive advantage of ports in the maritime industry. When it comes to the reference to the respondents' management levels within their ports, both middle and frontline managers considered the social aspect of sustainability as more important than the environmental or economic aspects of sustainability. However, top managers had a different perception that economic sustainability was more significant than social sustainability in terms of the competitive positioning of ports.

Table 6.26 Comparison of average RII values of each sustainability aspect by geographical locations, port sizes, and management levels

Category	Sustainability aspect	Average RII						
Geographical location		Africa	Oceania	North America	South America	ESE Asia	WS Asia	Europe
	Environmental	0.825	0.785	0.784	0.815	0.744	0.834	0.781
	Social	**0.875**	0.835	0.877	**0.878**	0.849	0.834	**0.856**
	Economic	0.825	**0.843**	**0.881**	0.872	**0.859**	**0.906**	0.839
Port size		Large		Medium		Small		
	Environmental	0.776		0.780		0.790		
	Social	**0.874**		**0.859**		**0.857**		
	Economic	0.868		0.845		0.829		
Management level		Top management		Middle management		Frontline management		
	Environmental	0.783		0.778		0.790		
	Social	0.862		**0.857**		**0.871**		
	Economic	**0.869**		0.843		0.841		

Table 6.27 summarises the groups by each category showing similar ranking patterns. In summary, no significant differences in priorities of sustainability activities were identified in the category of port size. In the category of geographical location, ESE Asia and Europe showed a similar ranking pattern from environmental sustainability activities, ESE Asia and Oceania from social sustainability activities, and ESE Asia, WS Asia, and Europe from economic sustainability activities.

Table 6.27 Similarities under each category of ranking patterns

Aspect of sustainability	Ranking pattern (Similarity)		
	Geographical location	Port size	Management level
Environmental sustainability	ESE Asia and Europe	Overall similar pattern among port size	Top managers and middle managers
Social sustainability	ESE Asia and Oceania	Overall similar pattern among port size	Top managers and middle managers
Economic sustainability	ESE Asia, WS Asia, and Europe	Overall similar pattern among port size	Overall similar pattern among managers

Given that ESE Asia and Europe had similar ranking patterns in both the environmental and economic aspects of sustainability, this implies that countries within the two regions share the most similar perceptions regarding the relationship between sustainability activities and the competitive advantage of ports. In terms of the management level category, similar ranking patterns were found between the top-management and middle-management levels, indicating that both top managers and middle managers in ports shape similar perceptions regarding the most important activities for enhancing the competitive position of ports.

6.5 Summary

The RII method was utilised to quantify the perception of respondents in the port industry regarding the relative importance of sustainability activities for strengthening the competitive advantage of ports. The RII analysis was conducted in the three examinations: (1) the overall relative importance of the three sustainability aspects, (2) the overall relative importance of environmental, social, and economic sustainability activities, and (3) the relative importance of sustainability activities by categories (geographical location, port size, and management level of respondents). The examinations of the RII analysis can be summarised as follows:

- According to the overall RII analysis for the three aspects of sustainability, the respondents perceived social sustainability as the most important practice for enhancing the competitive advantage of ports with the average RII value of 0.862. However, there was not much difference with economic sustainability, with the average RII value of 0.856. This indicates that the respondents had almost the same priorities of social and economic sustainability practices.
- Top three activities perceived as the most important for strengthening the competitive advantage of ports have been identified: “Waste pollution management”, “Green port

management", and "Energy and resource management" from environmental sustainability; "Health and safety", "Job training", and "Public relations" from social sustainability; and "Port operational efficiency", "High quality services", and "Port infrastructure construction" from economic sustainability.

- "Health and safety" of social sustainability was perceived as the most important social activity to strengthen the competitive advantage of ports, emphasising the need for a detailed action plan to promote occupational health and operational safety management within port areas. On the other hand, "Foreign direct investment" of economic sustainability were regarded as the least important activity for the competitiveness of ports under all categories, suggesting that it is not a determinant that do have a significant influence on the competitive advantage of ports.
- The results of the relative importance of environmental activities suggest that varied perceptions have been established across the regions concerning important activities for port competitiveness. This is mainly due to the fact that ports have developed regionally oriented environmental activities in compliance with the national and local policies and regulations in the area (Wooldridge et al. 1999). The formation of diverse environmental activities also implies the possibility of securing port competitiveness through differentiated environmental performance from inter-regional competitors.
- According to the examination of relative importance from port managers' perspective, frontline managers emphasised internal human resource management activities, whereas top and middle managers underlined sustainability activities related to public impressions of ports in order to increase their social images perceived to the stakeholders. It suggests the association between sustainability engagement and port organisational structure, which can contribute to the development of strategic sustainability management in line with the relevance of sustainability issues for the different management levels (Baumgartner 2014).
- Ports seem to consider external factors less important in terms of economic sustainability. For example, "Port investment funding", "Benefits from external stakeholders", and "Foreign direct investment" ranked the low importance. These activities have traditionally been considered essential because they contribute to the physical port development, such as the expansion of port infrastructure and facilities (see Baird 1999; Musso et al. 2006). The shift in the importance of these activities

suggests that most ports are in a mature stage of physical development, placing greater importance on their internal capacity to leverage current resources to create advantages.

- The similar pattern of sustainability activity ranking was found between ESE Asia and Europe. This is supported by the fact that the leading container ports in the world are mainly located in ESE Asia and Europe, sharing similar operational functions as focal points of international logistics. Particularly, social responsibility for ports in the two regions has been much imposed under international regulations and agreements related to the control of environmental pollution within ports, contributing to the establishment of similar perceptions regarding sustainable development (Feng et al. 2012; Lam and Notteboom 2014).

This chapter has examined the perceived results of sustainability activities that strengthen the competitive advantage of ports in a comprehensive approach. Additionally, the results of RII analysis in this chapter presented managerial implications for key sustainability activities that should be considered in the decision-making process for better sustainability performance on port competitiveness. In the following chapters, statistical analysis will be conducted in order to determine the relationship between sustainability performance and the competitive advantage of ports.

Chapter 7. Exploratory Factor Analysis

This chapter involves a preliminary statistical procedure via Exploratory Factor Analysis (EFA) for further multivariate analysis, CFA and SEM of this study. The pre-test of the initial theoretical model developed is included in this chapter in order to ensure the theoretical model is acceptable for CFA and SEM analyses. According to the results of assessing the theoretical model, this study determines to carry out EFA. The primary purpose of conducting EFA is to remedy the problems of overall goodness-of-fit and discriminant validity detected in the pre-test of the initial theoretical model. Furthermore, the EFA is performed to identify the variables that describe the most appropriate information from the data, where the removal of unnecessary and noised variables is undertaken. A total of eight steps of EFA is addressed in this chapter, including the assessment of the four relevant assumptions of factor analysis. Each step is discussed regarding the criteria, requirements, and methods to analyse in detail. Through the EFA, this study provides information about sufficient variables representing each of the four constructs and develops a better theoretical model prepared to undertake SEM.

7.1 Pre-test of theoretical model

According to the SEM procedure of Hair et al. (2014), assessing a measurement model specified should be fundamentally conducted before specifying a structural model. This procedure provides information about how well the specified theoretical model reproduces the observed covariance matrix among the items, ensuring the acceptable level of the model for SEM analysis. Taking their recommendation, this study carried out the validity of the initial research model developed (Figure 7.1). The assessment of the validity of the measurement model was conducted in three aspects: factor loadings, goodness-of-fit, and convergent and discriminant validity. A detailed explanation of the three criteria for evaluating the measurement model and the acceptable cut level is addressed in Chapter 4 (see subsection 4.8.2).

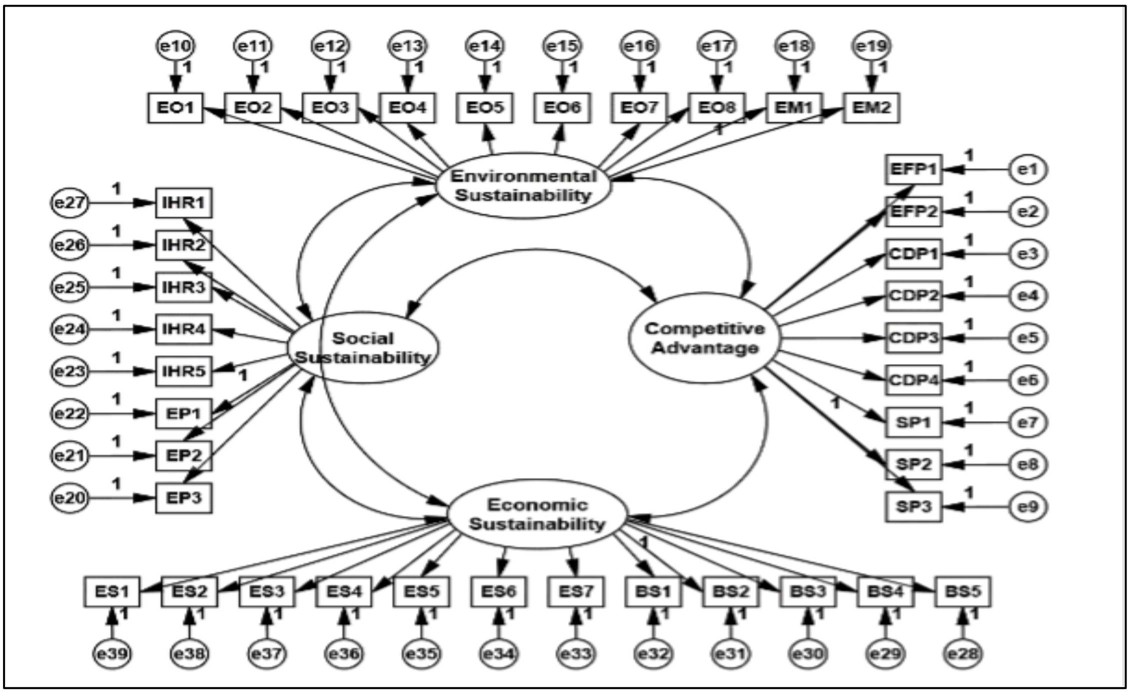

Figure 7.1 Initial research model for the current study

All 39 study items were loaded on each latent construct with acceptable loading estimates from 0.505 to 0.853. At a minimum, standardised loading estimates are recommended higher than 0.50, and ideally 0.70 or higher (Hair et al. 2014). Though 8 variables were within the level of 0.50 (EFP1, EFP2, EO3, IHR4, ES1, ES3, ES4, ES6), most of them ranged between 0.60 to 0.80, which provided initial evidence of convergent validity. Table 7.1 summarises the standardised factor loadings for the four constructs individually.

Table 7.1 Factor loadings of the initial research model

Construct	Item	Factor loading	Construct	Item	Factor loading
Competitive advantage	EFP1	0.574	**Social sustainability**	IHR1	0.647
	EFP2	0.588		IHR2	0.640
	CDP1	0.772		IHR3	0.763
	CDP2	0.690		IHR4	0.565
	CDP3	0.697		IHR5	0.745
	CDP4	0.682		EP1	0.754
	SP1	0.853		EP2	0.731
	SP2	0.812		EP3	0.721
	SP3	0.678			
Environmental sustainability	EO1	0.639	**Economic sustainability**	ES1	0.513
	EO2	0.707		ES2	0.684
	EO3	0.580		ES3	0.505
	EO4	0.674		ES4	0.539
	EO5	0.669		ES5	0.765
	EO6	0.715		ES6	0.542
	EO7	0.717		ES7	0.701
	EO8	0.787		BS1	0.806
	EM1	0.838		BS2	0.818
	EM2	0.781		BS3	0.802
				BS4	0.661
				BS5	0.625

However, the evaluation of overall goodness-of-fit indices and construct validity suggested that the initial research model was invalid for the structural model. The goodness-of-fit indices were overall below the cut-off level, indicating insufficient fit (χ^2/df=2.158; SRMR=0.0620; CFI=0.848; IFI=0.849; TLI=0.838; RMSEA=0.070). Furthermore, the model failed to satisfy convergent and discriminant validity. The AVE for both social sustainability and economic sustainability were less than the MSV, indicating that they were highly correlated with other constructs. The results of construct validity and inter-construct correlations of the initial research model were summarised in Table 7.2, and the problematic figures were marked red.

Table 7.2 Construct validity and inter-construct correlations of the initial research model

Construct	CR	AVE	MSV	Competitive advantage	Environmental sustainability	Social sustainability	Economic sustainability
Competitive advantage	0.900	0.505	0.496	**0.711**	0.612	0.579	0.704
Environmental sustainability	0.912	0.510	0.469	0.612	**0.714**	0.685	0.627
Social sustainability	0.883	0.488	0.564	0.579	0.685	**0.699**	0.751
Economic sustainability	0.906	0.453	0.564	0.704	0.639	0.751	**0.673**

The failure of discriminant validity implies that the associated variables of social sustainability and economic sustainability were explained by variables of other constructs in the same model, sharing their predictive power. Establishing discriminant validity is crucial for conducting SEM to confirm hypothetical structural paths and statistical discrepancies between study constructs (Farrell 2010). To remedy the problem of discriminant validity, Farrell (2010) suggested removing offending items that might deteriorate discriminant validity through EFA. Henseler et al. (2015) also advocated conducting EFA to establish discriminant validity by examining the loading patterns of variables and identifying variables having high correlations with variables of other constructs (i.e. cross-loadings). Therefore, this study performed EFA to inspect offending variables of discriminant validity.

7.2 Exploratory Factor Analysis (EFA)

EFA is one of the multivariate statistical techniques widely used for factor analysis along with CFA. The primary purpose of conducting EFA is to explore a data set and uncover underlying patterns or relationships for a large number of variables (Hair et al. 2014). The basic assumption of EFA is that there are factors that share a common variance in the theoretical constructs, and the goal is to condense or summarise the factors that explain the pattern of correlations within a set of observed variables (Yong and Pearce 2013). This factor analytic approach is exploratory, which means it is appropriate for exploring a data set as a preliminary step before testing subsequent hypotheses with other multivariate analysis techniques such as CFA or SEM (Conway and Huffcutt 2003).

EFA is mainly utilised for two purposes: data summarisation and data reduction. *Data summarisation* is suitable for analysing complex patterns of variables, labelling and naming them, or reconstructing them into a group of highly correlated variables (Hair et al. 2014). This approach facilitates the interpretation and understanding of the relationships between the measured variables that comprise the theoretical constructs, which leads to discovering new patterns or composite measures (Child 2006). *Data reduction* is concerned with identifying the minimum number of variables by removing unnecessary and redundant variables and noises induced by sampling or measurement errors while retaining variables that describe the most important information from the original data (Matsunaga 2010). It is important to determine the primary purpose of adopting EFA in the early stages of the analysis because different methods should be designed depending on the purpose.

Conway and Huffcutt (2003) clarified that EFA serves as a heuristic strategy to verify that a measurement model is sufficiently linked with measurements to ensure that the model is correctly specified for subsequent analysis by CFA or SEM. Furthermore, according to Hair et al. (2014), if there is a conceptual basis for understanding the relationship between variables, the measures have meanings for what they collectively represent. The variables in this study have already been grouped based on theoretical concepts regarding competitive advantage and the three sustainability aspects in the literature review phase. In addition, the discriminant validity problems were detected in the early research model. Thus, EFA in the current study was used to handle the problem of validity by managing unnecessary variables. The analysis proceeds to diagnose whether the collected data correspond to the theoretically established constructs and ensure that the measured variables sufficiently explain what they should be measured (Durdyev et al. 2018). In addition to the attempt to determine the extent to which the measured variables are related to each of the four latent constructs, EFA was applied to assess the measurement scales' validity. The deletion of unmeaningful variables can be made for validation of instrument scales for the latent constructs, facilitating easier analysis and interpretation in multivariate analysis (Conway and Huffcutt 2003; Yong and Pearce 2013).

7.3 Assumptions in factor analysis

From a statistical standpoint, when the sample and population satisfy certain conditions, an underlying assumption of statistical analysis is established, and valid inferences can be drawn (Nimon 2012). These conditions are called statistical assumptions, and it is vital to meet the statistical requirements for robust statistical results (Hair et al. 2014). In factor analysis including SEM, Normality, Homoscedasticity, Linearity, and Multicollinearity should be met as key statistical assumptions to diagnose the relevance of the set of variables and the data selected.

7.3.1 Multivariate normality

Multivariate analysis is based on the assumption that the data follow a normal distribution; it is assumed that the data from which the samples are taken for an individual metric variable is normally distributed (Hair et al. 2014). This assumption should be considered seriously because nonnormality impairs the accuracy and reliability of statistical tests (Ghasemi and Zahediasl 2012). Violating the assumption of normality is especially critical when constructing variance-based analysis such as SEM analysis. Testing with nonnormal distributed data can produce incorrect model fit information for the model developed, concluding incorrect hypothesis (Hair et al. 2014). Therefore, it is important to ascertain whether or not multivariate normality is satisfied before undertaking multivariate analysis of the data. However, the assumption of multivariate normality is not readily assessed because it is impractical to examine an infinite number of linear combinations of variables for normality (Tabachnick and Fidell 2013). Moreover, the rejection of normality assumption has been recognised for the Likert scale adopted in the current study (Clason and Dormody 1994). Nonetheless, screening the data for univariate normality is an accepted approach to verify whether multivariate normality may be violated (Weston et al. 2008). If the existence of univariate normality is confirmed, the variables are assumed to have also achieved multivariate normality (Looney 1995).

Skewness and kurtosis are the most common measures to assess deviations from the multivariate normality of Likert-type items. *Skewness* relates to the degree to which the distribution for a variable is asymmetric. A skewed variable means that its mean is off the centre of the distribution. If there is a positive skew, the distribution is shifted to the left with a long tail to the right, and the mean and median are greater than the mode. Conversely, a negative skew indicates a shift to the right with a long tail to the left, and the mean and median values are less than the mode (Hair et al. 2014). *Kurtosis* is a measure to describe the peakedness or flatness of a distribution compared with the normal distribution (Hair et al. 2014). A positive kurtosis reflects that a distribution is more peaked with short and thick tails than the normal distribution, whereas a negative kurtosis indicates a flatter distribution with long and thin tails (Weston et al. 2008). When the values of skewness and kurtosis are zero, a distribution is normal. In SEM analysis, the kurtosis values are more concerned than the skewness because kurtotic data tend to have detrimental impacts on estimating variances and covariances (DeCarlo 1997; Hair et al. 2014).

The skewness and kurtosis for the study items were examined by the AMOS program. The assessment considers the 39 variables used, and the results are as shown in Table 7.3. Curran et al. (1996) considered that absolute values greater than 2.0 for the skewness suggest a problem, and values over 7.0 for the kurtosis are indicative of departure from normality. According to those indices, the results reveal that none of the items in the current study is substantially skewed or kurtotic, where all the items show the skewness values of less than 2 and the kurtosis values of less than 7. Additionally, when a sample is large enough greater than 100, it is believed that nonnormality is not a major problem, in that the negative impact of nonnormality is diminished with the increase of sample size (Waternaux 1976; Ghasemi and Zahediasl 2012). Moreover, the maximum likelihood estimation technique (i.e. SEM) has been demonstrated to be fairly robust to departures from multivariate normality (Iacobucci, 2009; Bagozzi 2010).

Table 7.3 Assessment of normality

Construct	Item	Skewness	Kurtosis
Competitive advantage	EFP1	-0.558	-0.669
	EFP2	-0.220	-0.862
	CDP1	-0.519	-0.448
	CDP2	-0.478	-0.176
	CDP3	-0.313	-0.719
	CDP4	-0.857	0.772
	SP1	-0.496	-0.240
	SP2	-0.602	-0.305
	SP3	-0.757	-0.111
Environmental sustainability	EO1	-0.702	-0.114
	EO2	-0.597	-0.186
	EO3	-0.638	-0.162
	EO4	-0.356	-0.597
	EO5	-0.857	0.450
	EO6	-0.768	0.030
	EO7	-0.571	-0.399
	EO8	-0.374	-0.524
	EM1	-0.576	-0.345
	EM2	-1.118	0.616
Social sustainability	IHR1	-1.556	2.172
	IHR2	-0.947	0.553
	IHR3	-0.956	0.010
	IHR4	-1.107	0.503
	IHR5	-0.963	0.868
	EP1	-0.923	0.376
	EP2	-1.056	0.649
	EP3	-1.412	1.711
Economic sustainability	ES1	-0.725	-0.479
	ES2	-0.750	-0.079
	ES3	-1.075	0.472
	ES4	-1.132	0.867
	ES5	-1.068	1.035
	ES6	-1.380	2.138
	ES7	-0.780	0.328
	BS1	-1.053	0.976
	BS2	-0.985	0.660
	BS3	-1.061	1.012
	BS4	-0.950	0.617
	BS5	-1.354	1.445

7.3.2 Homoscedasticity and linearity

Homoscedasticity refers to whether the variance of one variable exhibits equal levels of variance across the range of the other independent variables (i.e. the variance of errors should be constant). When the homoscedasticity is not satisfied, it is heteroscedasticity where the variability in scores has an uneven distribution of an independent variable. When it comes to multivariate analysis, much of the importance lies in fulfilling normality and little attention paid to homoscedasticity. In contrast to popular belief, the homoscedasticity assumption plays a critical role in the validity of statistical findings in that multivariate methods are more sensitive to departures from homoscedasticity than normality (Yang et al. 2019). According to Osborn and Waters (2002) and Tabachnick and Fidell (2013), slight heteroscedasticity has little effect on invalidating the analysis; however, when it is considerable, it can influence the outcome of severe statistical distortion of findings and seriously weaken the analysis by increasing the possibility of a Type 1 error (the rejection of a true null hypothesis).

Homoscedasticity is related to normality and linearity assumptions. Linearity means that independent variables have a straight-line relationship with dependent variables. When the assumption of multivariate normality is confirmed, the relationships between variables are considered linear and homoscedastic. In this sense, the skewness can indicate the existence of failure of homoscedasticity (Tabachnick and Fidell 2013). No evidence of extreme skewness of the study data was observed, and thus it can assume that the homoscedasticity is satisfied. For more detailed verification, residual scatterplots are typically used to examine homoscedasticity, including normality and linearity. Figure 7.2 shows examples of residual scatter plots for the case of homoscedastic and heteroscedastic data.

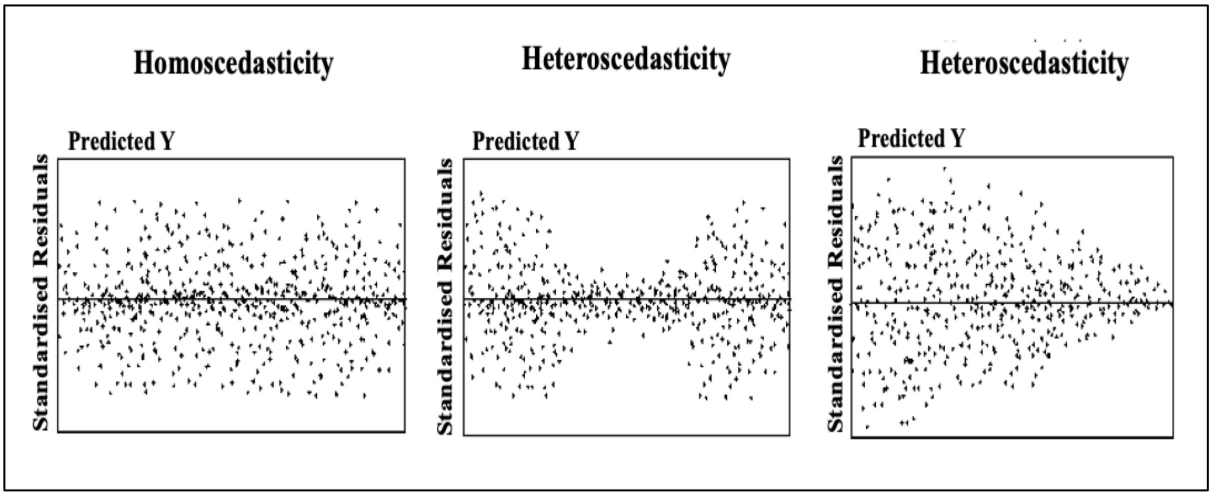

Figure 7.2 Examples of homoscedasticity and heteroscedasticity (Osborn and Waters 2002)

Homoscedasticity is violated if (Garson 2012; Schützenmeister et al. 2012; Tabachnick and Fidell 2013):

1. The residuals seem to increase or decrease in average magnitude with the fitted values, which is an indication that the variance of the residuals is not constant.
2. The points in the plot lie on a curve around zero rather than fluctuating randomly.
3. A few points in the plot lie a long way from the rest of the points.

That is, if the assumption of homoscedasticity is satisfied, residuals should vary randomly around zero, appearing pattern-less cloud of dots, and the spread of the residuals should be about the same throughout the plots. The examination of residuals scatter plots was run by SPSS, illustrated in Figure 7.3. According to the loess line, the variables were scattered without a systematic pattern, confirming that there was no violation of the assumption of homoscedasticity.

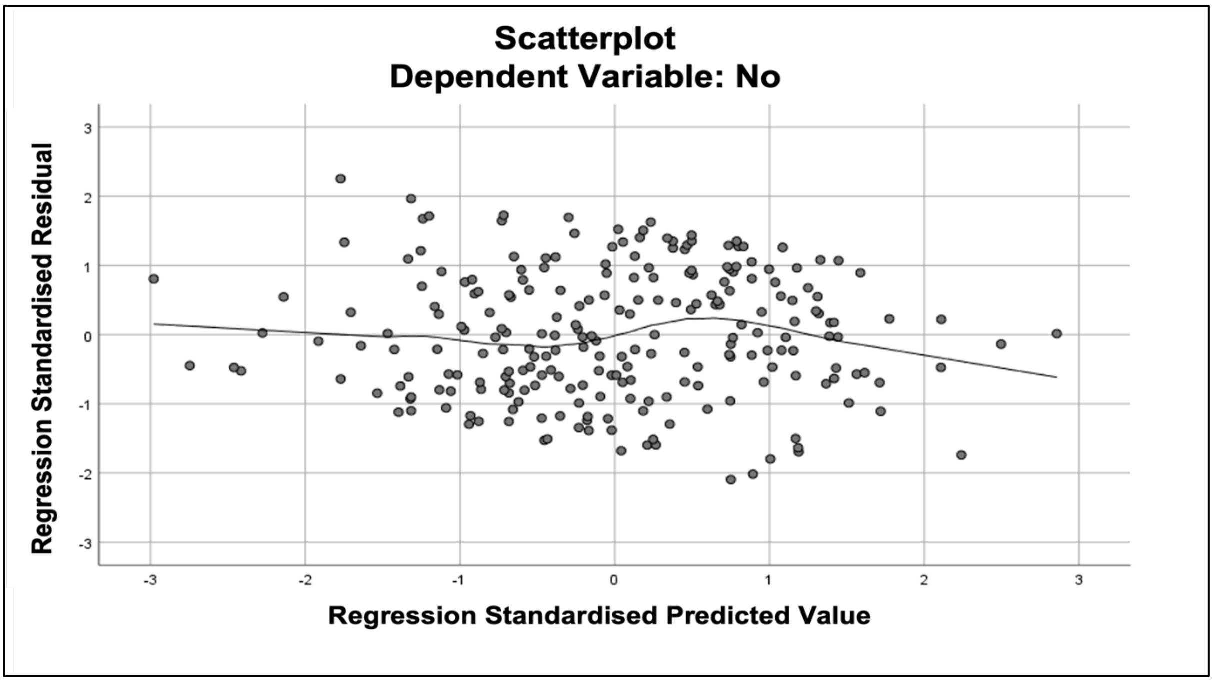

Figure 7.3 Residuals scatter plots of variables

Additionally, the assumption of linearity was examined by the results of bivariate scatterplots of variables. The bivariate scatterplot could not run all at once because a total of 1521 panels generated with the data exceeded the allowable limit of 500 panels for analysis in SPSS. Therefore, the assumption of linearity was examined by analysing a bivariate scatter plot between two variables. Figure 7.4 is the example of a bivariate scatterplot between the variables of competitive advantage and environmental sustainability. The rest of bivariate scatterplots are attached in Appendix E. The variables had linear relationships with each other overall, and the linearity assumption was also fulfilled.

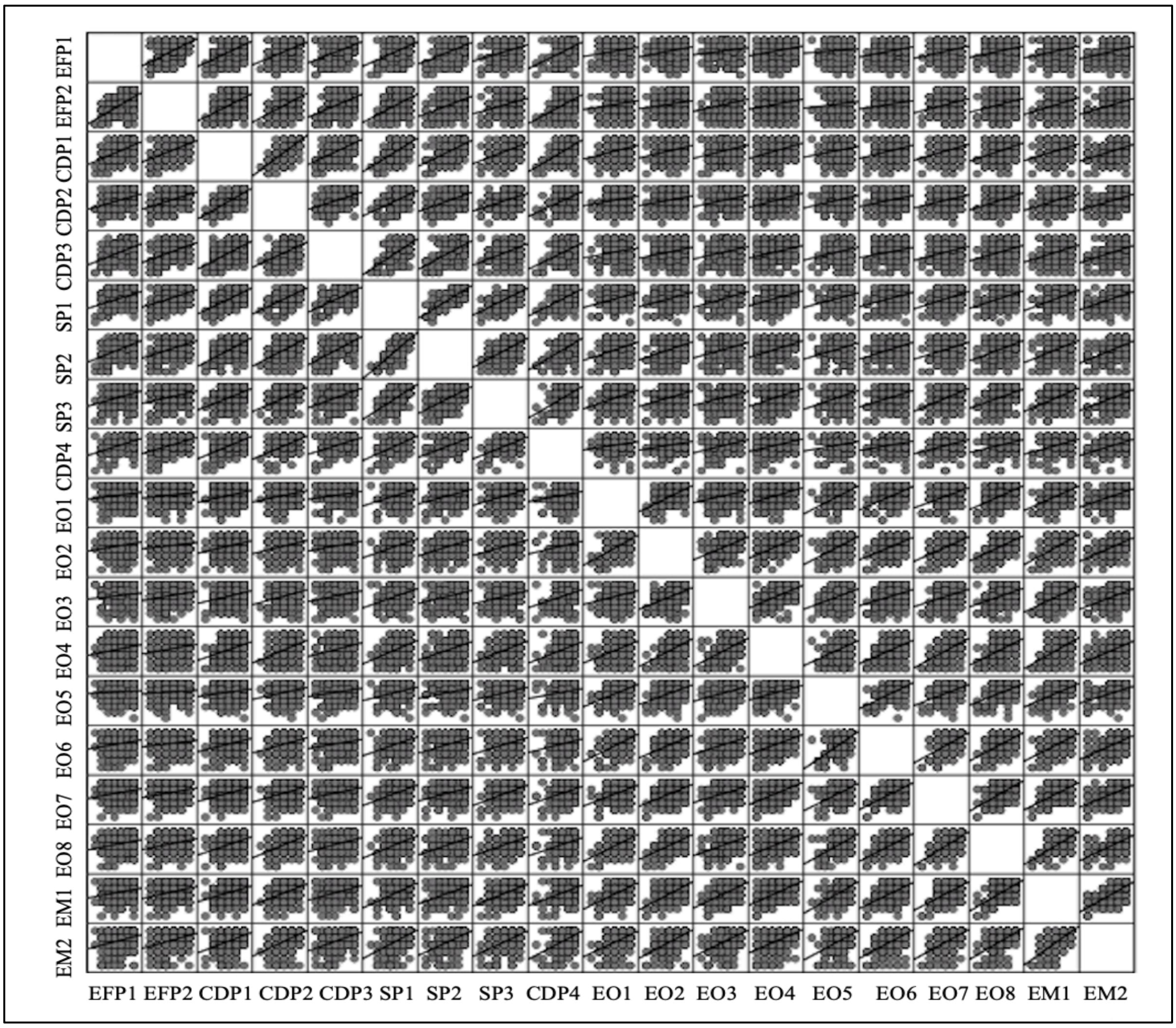

Figure 7.4 Example of bivariate scatterplot for the assumption of linearity

7.3.3 Multicollinearity

Multicollinearity refers to situations where measured variables are highly correlated with each other, indicating that they contain redundant information, and they are not necessarily all included in the same analysis (Tabachnick and Fidell 2013). Multicollinearity is a matter of degree, not a matter of presence or absence (Paul 2006). Some degree of multicollinearity is tolerated because related measures are intentionally used in factor analysis and SEM. However, a high correlation between measurement variables of the same construct might result in a poorly fit model (Weston et al. 2008). Multicollinearity can be detected by correlation coefficients. If the coefficients have magnitudes of 0.90 and above, the variables are regarded as strongly correlated, signalling a possible problem. Another practical way is to check tolerance and Variance Inflation Factor (VIF) values. As a rule of thumb, when tolerance values are greater than 0.20 and VIF values are below 5, or 10 for the more lenient cut-off, it is an indication that the associated coefficients are sufficiently estimated, concluding that there is no issue concerning multicollinearity. Table 7.4 shows the results of assessing multicollinearity. According to the results, all variables had standardised coefficients between the absolute 0.004 to 0.348, which indicated they had little correlation with each other. In terms of tolerance and VIF values, they fell into the satisfactory cut-off, with greater than 0.20 for tolerance values and less than 5 for VIF values. Consequently, the data used in this study did not violate the assumption of collinearity.

Table 7.4 Results of multicollinearity

Construct	**Item**	**Standardised coefficient**	**Collinearity statistics**	
			Tolerance	**VIF**
Competitive advantage	EFP1	0.157	0.462	2.167
	EFP2	-0.004	0.442	2.261
	CDP1	0.048	0.295	3.385
	CDP2	-0.157	0.352	2.839
	CDP3	-0.061	0.446	2.240
	CDP4	0.151	0.464	2.156
	SP1	0.100	0.210	4.764
	SP2	0.021	0.232	4.308
	SP3	0.017	0.380	2.634
Environmental sustainability	EO1	-0.090	0.468	2.136
	EO2	0.204	0.424	2.357
	EO3	-0.095	0.510	1.962
	EO4	-0.031	0.467	2.141
	EO5	0.119	0.453	2.210
	EO6	0.033	0.402	2.490
	EO7	-0.033	0.388	2.574
	EO8	-0.129	0.324	3.088
	EM1	-0.067	0.285	3.505
	EM2	-0.203	0.305	3.278
Social sustainability	IHR1	-0.103	0.437	2.286
	IHR2	0.185	0.458	2.181
	IHR3	0.093	0.335	2.990
	IHR4	-0.115	0.550	1.820
	IHR5	0.069	0.391	2.558
	EP1	-0.044	0.412	2.429
	EP2	0.078	0.380	2.629
	EP3	0.068	0.414	2.416
Economic sustainability	ES1	0.048	0.577	1.733
	ES2	0.123	0.384	2.603
	ES3	-0.149	0.537	1.861
	ES4	0.120	0.459	2.180
	ES5	-0.137	0.291	3.435
	ES6	0.136	0.473	2.116
	ES7	-0.102	0.352	2.840
	BS1	0.166	0.304	3.284
	BS2	0.192	0.277	3.615
	BS3	-0.348	0.293	3.410
	BS4	-0.019	0.427	2.344
	BS5	-0.114	0.445	2.246

7.4 Procedure to perform EFA

EFA is a multi-step process with interrelated methodological decisions to be made. The decisions at each step can lead to different conclusions about measured variables and consequently impact the quality of EFA results (Conway and Huffcutt 2003). Therefore, it is necessary for researchers to be knowledgeable regarding methodological issues and relevant criteria to undertake the optimal practice of the technique. For a more precise and clear application of EFA, many efforts have been made to provide recommendations on the important decisions and their rationales (e.g. Costello and Osborne 2005; Matsunaga 2010; Yong and Pearce 2013). They agreed that five major methodological decision points should be addressed in EFA: sample size, the number of factors to be retained, factor extraction method, type of factor rotation, and re-specification of factor matrix. However, it is emphasised that EFA is a relatively subjective statistical technique and the decisions at each step are relied on the researcher's delicate judgment (Norris and Lecavalier 2010). There may not be a perfect answer, but it has been recommended that what works best should be found depending on study design, data properties, research questions, and purpose of using EFA (Mahmoud and Kamel 2010; Matsunaga 2010). Figure 7.5 illustrates the procedure of EFA developed for the current study by adopting from Costello and Osborne (2005) and Hair et al. (2014). A total of 236 data from the questionnaire were used in the analysis of EFA and further analyses (CFA and SEM).

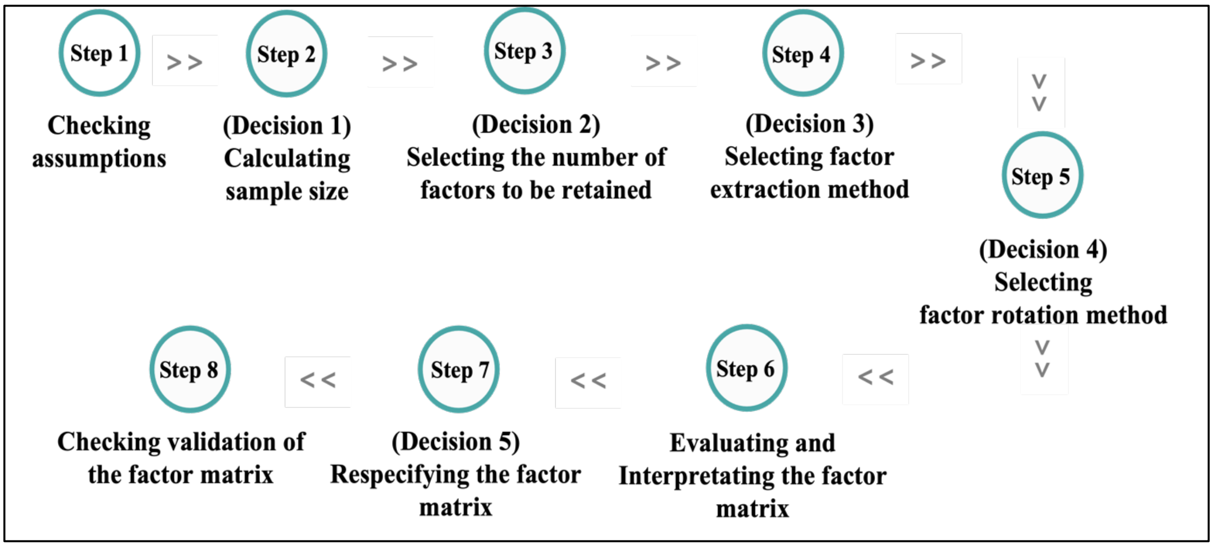

Figure 7.5 Procedure of conducting EFA, adapted from Costello and Osborne (2005) and Hair et al. (2014)

7.4.1 Checking assumptions

To perform EFA, three assumptions underlying factor analysis must be achieved: multivariate normality, outliers, and multicollinearity (Yong and Pearce 2013). That is, it is essential to confirm that (1) variables are normally distributed, (2) there are no outliers, and (3) there is a linear relationship between the factors and the variables. Outliers of the data were managed in Chapter 5 (see subsection 5.5.2), and the assumptions of multivariate normality and multicollinearity were already addressed in the previous section in this chapter (see section 7.3), confirming that no assumptions were violated. In addition to the three assumptions, the degree of interrelatedness among the variables is assessed from both overall and individual variable perspectives to confirm that the variables are conceptually valid and appropriate to conduct EFA (Hair et al. 2014). This statistical assessment helps ensure that the variables in the current study are sufficiently intercorrelated to be a representative measure of competitive advantage, environmental sustainability, social sustainability, and economic sustainability (Hair et al. 2014).

The standard statistical tests of determining the appropriateness for EFA are *Kaiser-Meyer-Olkin* (*KMO)* and *Bartlett's test of sphericity*. Those tests provide the adequacy of sampling and the degree of statistical significance regarding correlations among the variables, respectively. Greater than 0.50 of KMO and less than 0.05 of Bartlett's test of sphericity significance levels indicate that the data are appropriate in using EFA (Hair et al. 2014). As shown in Table 7.5, the KMO value was 0.927 overall, and each construct had greater than 0.80, which was classified as an outstanding sampling adequacy range (Hair et al. 2014). The Bartlett's test of sphericity had a significance level for both overall and individual constructs, providing evidence for satisfying the assumption of intercorrelation. These statistical tests for the data confirmed that EFA in this study was appropriate.

Table 7.5 KMO and Bartlett's test for both overall and each of the four constructs

KMO and Bartlett's Test		Overall	Competitive advantage	Environmental sustainability	Social sustainability	Economic sustainability
KMO		0.927	0.876	0.920	0.902	0.900
Bartlett's Test	Chi-Square	5689.571	1165.588	124.868	812.423	1433.323
	df	741	36	45	28	66
	Sig.	0.000	0.000	0.000	0.000	0.000

7.4.2 Calculating sample size

The decision of sample size for undertaking EFA is necessary to obtain a stable factor structure. However, there is no consensus regarding the ideal sample size (Norris and Lecavalier 2010). Some researchers argue that no fewer than 50 observations and preferably 100 or larger are sufficient (Hair et al. 2014), while other researchers claim that the sample size should be at least 300 participants for generalisation or replicability of results (Yong and Pearce 2013). One frequently used way to calculate the ideal sample size is the subject-to-variable ratio, determined by how many variables each subject answered (Costello and Osborne 2005). The most preferred subject-to-variable ratios for determining a priori sample size are 2:1 or 5:1 (Costello and Osborne 2005). Streiner (1994) and Hair et al. (2014) supported the 5:1 ratio, at least five times as many observations as the number of variables to be analysed, but they also offered a 10:1 ratio for the more acceptable sample size. With the general rule of 5:1 ratio, the sample size in the current study was calculated that at least 195 observations for 39 variables. Consequently, a total of 236 observations were collected, and thus, the sample size of this study was satisfied within the acceptable limit. Another acceptable way is to calculate the number of variables and the magnitude of factor loadings per factor (Guadagnoli and Velicer 1988; Stevens 2012). For example, if a factor has three or more variables with the loading of 0.80 or above, four or more variables with the loading of 0.60, and 10 or more variables with the loading of 0.40, then a sample of 150 observations are considered reasonable (Mahmoud and Kamel 2010). In the current study, more than 10 variables were loaded onto greater than 0.60 (see Table 7.7), which confirmed that the sample size of 236 in the current study was satisfactory to produce a stable factor solution. Besides, for SEM, a minimum sample size of 200 was required for reliable solutions, which was fulfilled in the current study.

7.4.3 Selecting the number of factors

It is not overstated that factor retention decision is paramount in the EFA application. According to Zwick and Velicer (1986), the decision of the number of factors had significant effects on the robustness of other methodological decisions in EFA. The total number of possible factors to extract is equal to that of the variables analysed (Matsunaga 2010). For example, there are 39 measured variables in the current study, which means the maximum number of factors that can be generated by EFA is 39. Nonetheless, not all factors extracted can represent a substantial portion of the total variance across all the variables. Thus, it is required to define the optimal number of factors that adequately represent a set of variables with a conceptual foundation and empirical evidence (Hair et al. 2014). *The eigenvalue* and *the scree test* are popular objective criteria to determine the number of factors to retain. The former represents the amount of variance of the variables accounted for by a factor, and it is recommended to retain all factors whose computed eigenvalue is greater than 1.0 (Norris and Lecavalier 2010). The latter facilitates examining the eigenvalue on the graph and identifying a breakpoint in the data where the curve has a noticeable drop or start a relatively flattens out. (Costello and Osborne 2005).

According to Hair et al. (2014), the decision on how many factors to retain should take into account additionally subjective criteria such as the percentage of variance criterion and a priori criterion. *The percentage of variance criterion* is an approach based on a cumulative percentage of total variance accounted for by the present and all preceding factors (Hair et al. 2014). Although an exact percentage of total variance explained is not consistent, most social science scholars and statisticians consider greater than 50 per cent of the variance as satisfactory (Peterson 2000a; Hair et al. 2014). *The a priori criterion* allows the extraction of as many factors as desired by simply instructing the computer to that number, which is useful in the case that the number of factors is already determined by theory or previous research (Hair et al. 2014). Based on this approach, the current study assumed at least four factors and analysed EFA for 4-factor extraction, as the measured variables were grouped into the four latent constructs (competitive advantage, environmental sustainability, social sustainability, and economic sustainability).

7.4.4 Selecting factor extraction method

This step is concerned with determining which methods to use for factor extraction and rotation. The decision of factor extraction and rotation methods can make differences in the results of factor loadings and communality, which influence the selection of factors and variables accordingly. (Floyd and Widaman 1995; Park et al. 2002). There are several methods that can be used to estimate factor models, for example, Maximum likelihood, Principal Components, Principal axis factoring, Unweighted least squares, Generalised least squares, Alpha factoring, and Image factoring. Although various factor extraction methods are available in SPSS, the most frequently used factor extraction methods can be categorised as either common factor models or components models (Conway and Huffcutt 2003). *Maximum Likelihood* (ML) method is the most popular among the common factor models, and of the components models, *Principal Components* (PC) method is well-known.

The decision to choose which methods for factor analysis depends on the purpose of EFA. The ML method is useful to understand the structure of a set of constructs (factors) that explain relationships among measured variables. Also, it allows for an evaluation of statistical significance testing for factor loadings and relationships among the variables (Fabrigar et al.1999). In this regard, the ML method is suggested using when data show normality, and EFA involves hypothesis testing and model fit (Fabrigar et al. 1999). The PC method, also called Principal components analysis, is intended to identify variables that are composites of measured variables and to sieve non-essential variables by examining whether a construct (factor) is loaded onto all of the measured variables sufficiently represented (Conway and Huffcutt 2003). Thus, it is more appropriate for reducing measured variables into a smaller set of variables while keeping as much information from the original data as possible (Park et al. 2002).

However, researchers assert that there are no marked differences in the results between the PC and ML extraction methods because most multivariate data are correlated to some degree. For example, when it comes to factor loading, it has been claimed that there is almost no difference between the ML and PC methods (Velicer and Jackson 1990; Costello and Osborne 2005). Furthermore, Mabel and Olayemi (2020) confirmed that the PC method was overall most suitable and even better than the ML method when the number of variables was 20 or more, but factor loadings from each method were fairly similar. On the other hand, some researchers raised doubts about the use of PC method in that the factor loadings tended to be too large; instead, the ML method was quite accurate (e.g. Widaman 1993). Gorsuch (1997) also pointed out that such inflation could give the false belief that the variables were sufficiently representative of the construct. Although the PC method is suitable for the primary purpose of EFA in the current study, the comparison of factor loadings by each method is considered to verify the doubts in the PC method and make more accurate decisions. Before conducting the comparison, the factor rotation method needs to be determined.

7.4.5 Selecting factor rotation method

The goal of the factor rotation is to identify theoretically meaningful factors and the simpler structure of the data for better interpretation. This process attempts to obtain an ideal structure that maximises the number of high loadings on each variable and minimises the number of factors each variable is loaded into (Fabrigar et al. 1999). The types of factor rotation are divided into oblique and orthogonal methods. The oblique rotation method yields correlated factors, while the orthogonal rotation method is assumed that the factors are independent of each other (Hair et al. 2014). Several different approaches are available for performing either oblique (e.g. Promax, Oblimin, Quartimin, etc.) or orthogonal rotations (e.g. Varimax, Equimax, Quartimax, etc.). *Varimax* is the most commonly employed approach for orthogonal rotation, and *Promax* is for oblique rotation (Costello and Osborne 2005; Hair et al. 2014). There has been a considerable controversy over which rotation method to apply. Some people argue that the orthogonal rotation is less realistic since factors in the social sciences generally have a conceptual correlation to some degree (Costello and Osborne 2005). In other words, if factors are uncorrelated, either rotation produces nearly identical results; if correlated, orthogonal rotation may produce misleading solutions (Brown 2006). It has been also claimed that oblique rotation provides a more accurate representation of clustering variables since each rotated factor is closer to the respective group of variables (Hair et al. 2014).

Notwithstanding its shortcomings, many researchers agree that orthogonal rotation approaches are more frequently utilised to generate easily interpretable factor structures in which factor loadings represent correlations between measured variables and constructs (Johnson and Wichern 2002; Brown 2006). According to Henson and Roberts (2006), 55% of the research on factor analysis adopted orthogonal rotation strategies, and 38.3% used the oblique rotation technique. Moreover, there has been an argument that the results of the two rotation methods are not significantly different (see Gerbing and Hamilton 1996; Fabrigar et al. 1999). They concluded that the orthogonal varimax rotation generally worked as fit as the oblique rotations, and when it comes to estimates, the varimax had more accuracy.

Overall, the preference of factor rotation methods can be differed by varied respects, and the suitability should be fulfilled by a logical interpretation based on the knowledge of data and research questions (Costello and Osborne 2005). Hair et al. (2014) also underlined the importance of evaluating the comparability regarding factor rotation methods. Accordingly, it is considered sensible to compare the results produced by both oblique and orthogonal rotation approaches (Fabrigar et al. 1999). This study assessed the data taking into account all possible combinations of the ML and PC methods for factor extraction and promax and varimax techniques for factor rotation, and the comparison of the results follow in the next step of EFA.

7.4.6 Evaluating and interpretating factor matrix

Initial EFA

The first EFA was performed to explore a preliminary estimate of constructs (factors). The PC extraction and varimax rotation defaulted to SPSS were employed on 39 variables with eigenvalues greater than 1. Hair et al. (2014) provided a guideline for identifying significant factor loadings based on sample size. For a sample size of 250, which is similar to the current study of 236, the factor loadings of 0.35 are considered the minimum level. By taking this guideline, all variables considered were extracted with a factor loading constrained to 0.40, and thus factor loading values lower than 0.40 were not visually shown in the output results. In the initial extraction, the original data was explained by seven components with 64.24% of the total variance. In order to determine the more accurate number of factors in the data, the scree plot was examined (Figure 7.6). The scree plot indicated that four components were sufficient to describe the data.

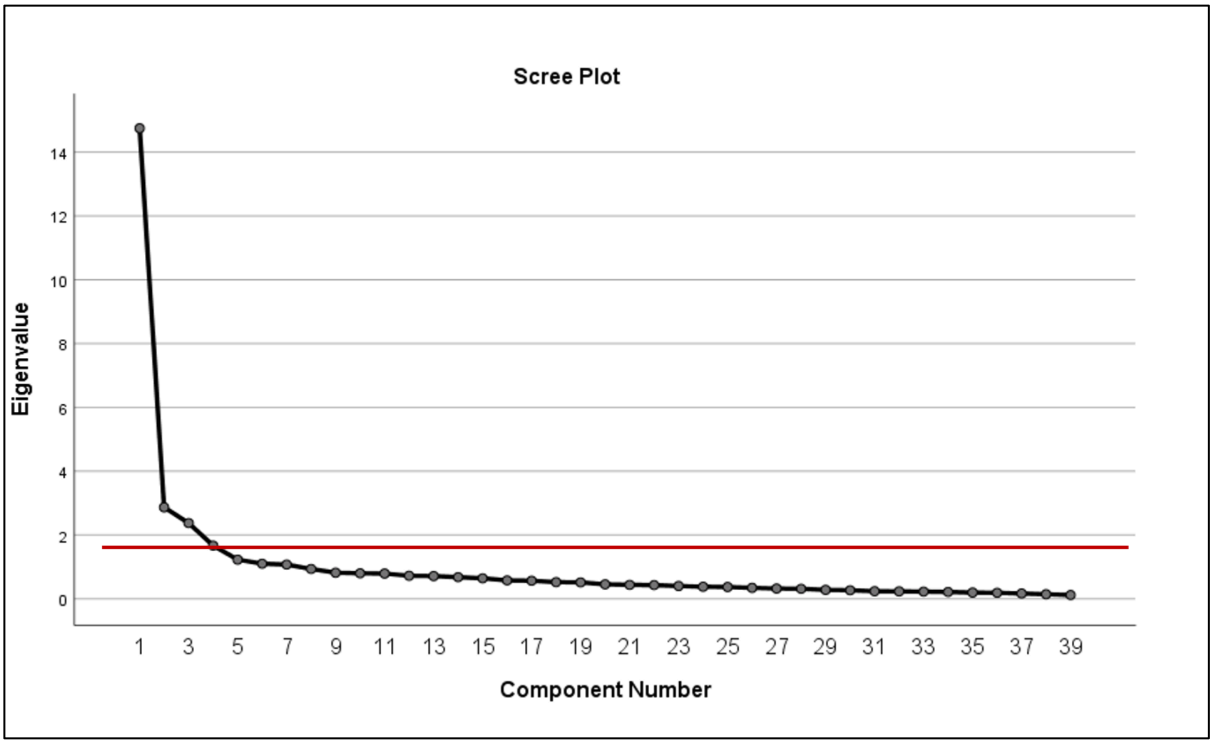

Figure 7.6 Scree plot of eigenvalue of factors

According to the indication of the scree plot, the 39 variables were rerun with a 4-factor solution and considered all possible combinations of the ML and PC extraction methods with promax and varimax rotations, respectively. Although there were slight differences in the magnitude of factor loadings, the significance for the four factors and a cross-loading pattern among the variables were similarly detected in all combinations. Table 7.6 presents the factor matrix produced with PC extraction and varimax rotation as an example of the combinations.

Table 7.6 Factor matrix with PC and varimax

Construct (Factor)	Variable	Factor loading			
		1	2	3	4
Competitive advantage	EFP1			0.722	
	EFP2			0.659	
	CDP1			0.711	
	CDP2			0.611	
	CDP3			0.688	
	CDP4			0.661	
	SP1			0.720	
	SP2			0.732	
	SP3			0.525	0.408
Environmental sustainability	EO1	0.672			
	EO2	0.722			
	EO3	0.513			
	EO4	0.626			
	EO5	0.732			
	EO6	0.754			
	EO7	0.710			
	EO8	0.717			
	EM1	0.738			
	EM2	0.596			
Social sustainability	IHR1				0.548
	IHR2				0.524
	IHR3				0.678
	IHR4				0.729
	IHR5				0.626
	EP1				0.685
	EP2				0.642
	EP3				0.683
Economic sustainability	ES1		-		
	ES2		0.676		
	ES3		-		
	ES4		0.580		
	ES5		0.735		
	ES6		0.589		
	ES7		0.653		
	BS1		0.656		
	BS2		0.697		
	BS3		0.674		
	BS4		0.492		0.411
	BS5		0.598		

The results confirmed that the four components sufficiently explained the data with 55.53% of the total variance. Except for ES1 and ES3, all variables had factor loadings of 0.492 or higher, which fell into the acceptable threshold, indicating they were satisfactory variables for the factors. Even though ES1 and ES3 showed the possibility that they were unmeaningful variables, the decision to remove them was tentatively held until each construct was analysed. Also, two variables, the SP3 of competitive advantage and the BS4 of economic sustainability, were cross-loaded with social sustainability. A cross-loading occurs when a variable has significant loadings of more than one factor, indicating that there may be a meaningful hidden construct or that the characteristics of a variable may share with other factors (Hair et al. 2014). Variables with a cross-loading are recommended to be removed in the sense that they make interpretation difficult. Before making a decision to delete them, an evaluation with loading plots of the relevant factors was undertaken to understand the properties of variables properly (Yong and Pearce 2013; Hair et al. 2014). The loading plots produced a two-dimensional space of factors where the variables with a cross-loading existed, attached in Appendix F. They were sufficiently departed from each other and confirmed that cross-loadings were not a serious issue.

A single EFA for each factor

The second EFA considered individual comparisons of the four constructs (factors), confirming whether each factor adequately contains the interrelated variables. Running a single EFA for each factor enables an exploration of whether the factors are clearly distinguishable and be represented by a single component, respectively (Papoutsi and Sodhi 2020). Hence, a single EFA for each factor is reasonable in this study since competitive advantage and the three sustainability aspects were distinct concepts, and their variables were independently established. The individual EFA for the four factors was conducted by fixing the number of factor extraction to one. In terms of the rotation method, promax and varimax approaches produced the same factor loadings, and their comparison was meaningless. Therefore, the single EFAs were carried out with varimax rotation and compared the factor loadings between the PC and ML extraction methods, respectively. The results of single EFAs for each factor are presented in Table 7.7.

Although social sustainability and economic sustainability had lower than 50% of the total variance, they were close to the acceptable proportion. Additionally, the factor loadings of the PC method had slightly higher than the ML method. Nonetheless, all variables of each factor in both extraction methods had significant factor loadings with higher than 0.50, appearing high loadings (from 0.60 to 0.80 loadings) for most of the 39 variables.

Table 7.7 Single EFAs for each construct (factor) with varimax rotation in ML and PC

Construct (Factor)	TVE*	Variable	Maximum likelihood Factor (ML)		TVE	Principle components factor (PC)	
			Communality	Loading		Communality	Loading
Competitive advantage	50.37%	EFP1	0.399	0.582	55.88%	0.444	0.666
		EFP2	0.341	0.584		0.447	0.668
		CDP1	0.583	0.764		0.664	0.815
		CDP2	0.456	0.676		0.540	0.735
		CDP3	0.493	0.702		0.542	0.736
		CDP4	0.457	0.676		0.543	0.737
		SP1	0.739	0.860		0.712	0.844
		SP2	0.682	0.826		0.662	0.813
		SP3	0.443	0.666		0.477	0.691
Environ-mental sustainability	51.14%	EO1	0.419	0.648	55.86%	0.478	0.691
		EO2	0.510	0.714		0.573	0.757
		EO3	0.326	0.571		0.381	0.617
		EO4	0.446	0.668		0.509	0.713
		EO5	0.467	0.683		0.525	0.725
		EO6	0.530	0.728		0.587	0.766
		EO7	0.524	0.724		0.569	0.754
		EO8	0.618	0.786		0.647	0.804
		EM1	0.696	0.834		0.711	0.843
		EM2	0.578	0.760		0.607	0.779
Social sustainability	48.90%	IHR1	0.412	0.642	55.12%	0.484	0.696
		IHR2	0.398	0.631		0.467	0.684
		IHR3	0.592	0.769		0.645	0.803
		IHR4	0.354	0.595		0.431	0.656
		IHR5	0.544	0.737		0.599	0.774
		EP1	0.573	0.757		0.619	0.787
		EP2	0.516	0.719		0.584	0.764
		EP3	0.524	0.724		0.581	0.762
Economic sustainability	45.20%	ES1	0.254	0.504	49.50%	0.295	0.543
		ES2	0.479	0.692		0.527	0.726
		ES3	0.238	0.488		0.308	0.555
		ES4	0.298	0.546		0.360	0.600
		ES5	0.594	0.771		0.645	0.803
		ES6	0.301	0.549		0.357	0.598
		ES7	0.487	0.698		0.528	0.726
		BS1	0.650	0.806		0.670	0.818
		BS2	0.678	0.824		0.665	0.815
		BS3	0.639	0.800		0.632	0.795
		BS4	0.420	0.648		0.488	0.698
		BS5	0.387	0.771		0.471	0.686

*: Total Variance Explained.

7.4.7 Respecifying the factor matrix

This step is concerned with evaluating the meaningfulness of defined factors and variables based on the interpretation of factor loadings and communalities. Factors and variables should have substantive meaning and conceptual relevance; if not, it should consider eliminating them (Brown 2006). For assessing the practicality of the factors, the attempt was made to compare several factor solutions with different factor extraction and rotation methods in the previous steps (see Table 7.7). The examination of several alternative solutions provided valid interpretation, enabling a final and reasonable decision on a desirable factor solution representing the structure of the variables (Hair et al. 2014).

Firstly, it was observed that the PC method tended to inflate factor loadings compared to the ML method, which was consistent with the findings of Widaman (1993). However, the difference in factor loadings was not dramatic apart. Besides, the adoption of EFA in the current study focused on confirming adequate variables for theoretically designed constructs (factors), and thus, the detected inflation did not influence any decisions as long as the factors had substantial variables. Secondly, despite detecting inflation, all variables of each factor were within the significant range of factor loadings. Lastly, it was found that there was a considerable difference in the values of communality between the ML and PC methods. Communality represents the amount of variance accounted for by the factor solution for each variable, used as a criterion for assessing whether the variables are included or not (Hair et al. 2014). A variable with a higher communality value indicates that it has more in common with the other variables included in the analysis, and variables with communalities less than 0.50 are recommended to remove from the analysis (Child 2006). The variables with communality values of less than 0.50 in the ML and PC method, respectively, are summarised in Table 7.8.

Table 7.8 Comparison of communalities less than 0.50 between ML and PC

Construct (Factor)	**Maximum likelihood factor (ML)**		**Principle components factor (PC)**	
	Variable	**Communality**	**Variable**	**Communality**
Competitive advantage	EFP1	0.399	EFP1	0.444
	EFP2	0.341	EFP2	0.447
	CDP2	0.456	SP3	0.477
	CDP3	0.493		
	CDP4	0.457		
	SP3	0.443		
Environmental Sustainability	EO1	0.419	EO1	0.478
	EO3	0.326	EO3	0.381
	EO4	0.446		
	EO5	0.467		
Social sustainability	IHR1	0.412	IHR1	0.484
	IHR2	0.398	IHR2	0.467
	IHR4	0.354	IHR4	0.431
Economic sustainability	ES1	0.254	ES1	0.295
	ES2	0.479	ES3	0.308
	ES3	0.238	ES4	0.360
	ES4	0.298	ES6	0.357
	ES6	0.301	BS4	0.488
	ES7	0.487	BS5	0.471
	BS4	0.420		
	BS5	0.387		

As the PC method had fewer variables with unacceptable communality values than the ML method, this study determined to delete variables according to the results of communality of the PC method. This decision was supported by researchers who highlighted the cautious decision about possible deletion, as eliminating too many variables might leave out influential variables representing the factor structure, threatening empirical and conceptual support of research (Hair et al. 2014). Matsunaga (2010) also strongly recommended reviewing the remaining or deleting variables and perceiving the possible impacts that such decisions might have on explaining theoretical structure. Therefore, a theoretical review was conducted to ensure a robust analytical examination, and IHR1 (Health and safety) was determined to remain, given that it represents the most essential activity of social sustainability in the maritime domain (Chintoan-Uta and Silva 2017; Lim et al. 2019). The validity of IHR1 is tested using CFA in Chapter 8. Consequently, 26 out of 39 variables were retained in the study (Table 7.9). The variables considered in the further analysis of CFA and SEM were 6 variables of competitive advantage (CDP1, CDP2, CDP3, CDP4, SP1, SP2), 8 variables of environmental sustainability (EO2, EO4, EO5, EO6, EO7, EO8, EM1, EM2), 6 variables of social sustainability (IHR1, IHR3, IHR5, EP1, EP2, EP3), and 6 variables (ES2, ES5, ES7, BS1, BS2, BS3) of economic sustainability.

Table 7.9 Final 26 variables retained through EFA

Construct (Factor)	Initial number of items	Number of items retained	Variables retained
Competitive advantage	9	6	CDP1 CDP2 CDP3 CDP4 SP1 SP2
Environmental sustainability	10	8	EO2 EO4 EO5 EO6 EO7 EO8 EM1 EM2
Social sustainability	8	6	IHR1 IHR3 IHR5 EP1 EP2 EP3
Economic sustainability	12	6	ES2 ES5 ES7 BS1 BS2 BS3
Total	39	26	

7.4.8 Checking validation of the factor matrix

The decisions made in the previous steps contributed to ensuring statistical adequacy, reliability, and validity in the outcome of the analysis by selecting factors with high factor loadings of variables, removing low communality variables, and satisfying the criteria of the total variance of 50% or more. (Hair et al. 2014). However, the procedure of removing variables might affect statistical grounds, causing adverse consequences for the content validity of construct measures (Henseler et al. 2015). In this sense, diagnostic measures of reliability and validity of the variables retained were performed in order to assess the legitimacy of the decisions and the reliability of the results (Hair et al. 2014).

The adequacy of the data was verified through KMO and Bartlett's test, presented in Table 7.10. Overall KMO index was 0.927, which suggested a high degree of adequacy of the data for the four factors. Moreover, the KMO indices of individual factors showed 0.845 for competitive advantage, 0.910 for environmental sustainability, 0.882 for social sustainability, and 0.888 for economic sustainability, indicating that the data is appropriate for CFA (Hair et al. 2014).

Table 7.10 Results of adequacy for the remained variables

KMO and Bartlett's Test	Overall		Competitive advantage	Environmental sustainability	Social sustainability	Economic sustainability
KMO	0.927		0.845	0.910	0.882	0.888
Bartlett's Test	Chi-Square	3817.544	788.365	995.937	594.403	781.441
	df	325	15	28	15	15
	Sig.	0.000	0.000	0.000	0.000	0.000

Additionally, this study evaluated the internal consistencies among the remaining variables to confirm their reliability. The reliability results for the variables that remained of each factor are provided in Table 7.11. The item-to-total and inter-item correlations in each factor exceeded the recommended level of 0.50 and 0.30, respectively. Furthermore, all factors had a high Cronbach's alpha greater than 0.800, showing 0.882 for competitive advantage, 0.903 for environmental sustainability, 0.867 for social sustainability, and 0.849 for economic sustainability. These results verified that the variables remained were reasonably consistent and measured by the same concept.

Table 7.11 Results of reliability for the remained variables

Construct (Factor)	Item-Total Statistics	Inter-Item Correlation Matrix							Cronbach's alpha	
			CDP1	CDP2	CDP3	CDP4	SP1	SP2	Before deletion	After deletion
Competitive advantage	0.740	CDP1	1.000	0.726	0.551	0.555	0.607	0.564	0.897	0.882
	0.642	CDP2	0.726	1.000	0.430	0.492	0.524	0.482		
	0.650	CDP3	0.551	0.430	1.000	0.431	0.620	0.593		
	0.615	CDP4	0.555	0.492	0.431	1.000	0.529	0.529		
	0.792	SP1	0.607	0.524	0.620	0.529	1.000	0.805		
	0.752	SP2	0.564	0.482	0.593	0.529	0.805	1.000		

Construct (Factor)	Item-Total Statistics	Inter-Item Correlation Matrix									Cronbach's alpha	
			EO2	EO4	EO5	EO6	EO7	EO8	EM1	EM2	Before deletion	After deletion
Environ-mental sustainability	0.660	EO2	1.000	0.529	0.483	0.471	0.480	0.518	0.596	0.538	0.909	0.903
	0.625	EO4	0.529	1.000	0.393	0.448	0.527	0.503	0.567	0.485		
	0.642	EO5	0.483	0.393	1.000	0.641	0.485	0.524	0.555	0.461		
	0.700	EO6	0.471	0.448	0.641	1.000	0.585	0.581	0.551	0.542		
	0.703	EO7	0.480	0.527	0.485	0.585	1.000	0.656	0.566	0.531		
	0.743	EO8	0.518	0.503	0.524	0.581	0.656	1.000	0.659	0.588		
	0.783	EM1	0.596	0.567	0.555	0.551	0.566	0.659	1.000	0.704		
	0.706	EM2	0.538	0.485	0.461	0.542	0.531	0.588	0.704	1.000		

Construct (Factor)	Item-Total Statistics	Inter-Item Correlation Matrix							Cronbach's alpha	
			IHR1	HR3	IHR5	EP1	EP2	EP3	Before deletion	After deletion
Social sustainability	0.592	IHR1	1.000	0.543	0.463	0.464	0.432	0.475	0.879	0.867
	0.685	IHR3	0.543	1.000	0.521	0.601	0.492	0.539		
	0.696	IHR5	0.463	0.521	1.000	0.551	0.544	0.630		
	0.701	EP1	0.464	0.601	0.551	1.000	0.585	0.529		
	0.650	EP2	0.432	0.492	0.544	0.585	1.000	0.500		
	0.682	EP3	0.475	0.539	0.630	0.529	0.500	1.000		

Construct (Factor)	Item-Total Statistics	Inter-Item Correlation Matrix							Cronbach's alpha	
			ES1	ES5	ES7	BS1	BS2	BS3	Before deletion	After deletion
Economic sustainability	0.464	ES1	1.000	0.440	0.605	0.538	0.584	0.566	0.893	0.849
	0.663	ES5	0.440	1.000	0.526	0.618	0.614	0.590		
	0.590	ES7	0.605	0.526	1.000	0.488	0.597	0.610		
	0.771	BS1	0.538	0.618	0.488	1.000	0.685	0.655		
	0.776	BS2	0.584	0.614	0.597	0.685	1.000	0.740		
	0.730	BS3	0.566	0.590	0.610	0.655	0.740	1.000		

Discriminant validity and nomological validity were also included for the validity test of the variables remained. One simple way to assess discriminant validity is to check whether there is cross-loading or not (Farrell 2010), and no serious cross loading was found in this analysis. Another way is to examine correlations among factors, and less than 0.70 of the correlation values is considered that the extracted factors are sufficiently distinct from each other (Hair et al. 2014). Table 7.12 shows that the correlations among the four factors were lower than 0.670, demonstrating that the factors were sufficiently different from each other and developed by dissimilar concepts. Finally, nomological validity refers to the degree that the variables remained are aligned and consistent with the underlying theory (Dunn et al. 1994). Each factor was established based on theory and a systematic literature review (see Chapters 2 and 3), and therefore, nomological validity was met in this study.

Table 7.12 Correlations among the four constructs (factors)

Construct (Factor)		**Competitive advantage**	**Economic sustainability**	**Social sustainability**	**Economic sustainability**
Competitive advantage	Pearson Correlation	1	0.529**	0.496**	0.632**
	Sig.		0.000	0.000	0.000
Economic sustainability	Pearson Correlation	0.529**	1	0.614**	0.584**
	Sig.	0.000		0.000	0.000
Social sustainability	Pearson Correlation	0.496**	0.614**	1	0.670**
	Sig.	0.000	0.000		0.000
Economic sustainability	Pearson Correlation	0.632**	0.584**	0.670**	1
	Sig.	0.000	0.000	0.000	

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

7.5 Summary

According to the pre-test of the initial theoretical model of four constructs with a total of 39 variables, the model was not suitable for the analysis of structural modelling equation by showing the insufficient overall goodness-of-fit indices and the failure in satisfying the discriminant validity. Therefore, this study determined to conduct EFA to increase the overall goodness-of-fit and ensure the discriminant validity. Before conducting EFA, key statistical assumptions were tested in terms of normality, homoscedasticity, linearity, and multicollinearity. The summary of assumptions examined in this study and their statistical results are presented in Table 7.13.

Table 7.13 Summary of the results of assumptions of factor analysis

Assumption	Requirement	Methods and criteria for confirmation	Result
Multivariate normality	The variables should follow a normal distribution.	• Skewness < 2.0 • Kurtosis < 7.0	Satisfied
Homoscedasticity	The variables should be equal levels of variance, having residuals scattered randomly around zero.	Residual scatter plots without pattern-less cloud of dots.	Satisfied
Linearity	The variables should have a straight-line relationship.	Bivariate scatterplots with linear lines among variables.	Satisfied
Multicollinearity	The variables should have a low degree of correlation.	• Correlation coefficients < 0.90 • Tolerance values > 0.20 • Variance Inflation Factor (VIF) values < 5.00	Satisfied

Multivariate normality was assessed by skewness and kurtosis, and all variables ranged from the absolute 0.220 to 1.556 of skewness, and the absolute from 0.010 to 2.172 of kurtosis, verifying no violation in multivariate normality. Homoscedasticity was confirmed by observing the residuals with an irregular distribution. Additionally, the bivariate scatterplots showed the linear relationships among the variables, satisfying the assumption of linearity. Lately, multicollinearity was examined using three methods, which were correlation coefficients, tolerance, and VIF values. The correlation coefficients of all variables were between the absolute 0.004 and 0.348, tolerance values ranged from 0.210 to 0.577, and all VIF values were between 1.733 and 4.764, confirming no problem of multicollinearity. The satisfactory assumptions tests verified the appropriateness of the data collected for factor analysis.

This study conducted the eight-step EFA suggested by Costello and Osborne (2005) and Hair et al. (2014). The EFA analysis included the five major decision points: sample size, the number of factors to be retained, factor extraction method, factor rotation method, and respecifying factor matrix. The decision makings on the criteria and methods involved in each EFA step in the current study is summarised in Table 7.14.

Table 7.14 Summary of each EFA step performed in the study

Relevant criteria and method	Requirements	Result of this study	Decision
Step 1: Checking assumptions			
Multivariate normality	Normally distributed	Normally distributed	Assumptions were confirmed.
Outliers	No outliers	No outliers	
Multicollinearity • KMO • the Bartlett's test of sphericity	Linear relationship • KMO > 0.50 • The significance of the Bartlett's test of sphericity < 0.05	Linear relationship • Greater than 0.50 of KMO and less than 0.05 of the significance levels of Bartlett's test of sphericity.	
Step 2: Calculating sample size (Decision point 1)			
Subject-to-variable ratio (5:1)	At least 195 responses for 39 variables	236 responses obtained in this study.	The sample size of this study was sufficient.
The magnitude of factor loading and the number of variables per factor	150 responses are reasonable when 3 or more variables with loading of 0.80 or above, 4 or more variables with loading of 0.60 and 10 or more variables with loading of 0.40 for 150 responses.	More than 10 variables loaded on higher than 0.60.	
Step 3: Selecting the number of factors to be retained (Decision point 2)			
The scree test	Identifying a break point in the data where the curve has a noticeable drop or start a relatively flattens out	4 components	4 factors were sufficient to explain the data.
The percentage of variance criterion	Greater than 50%	55.53% of 4 factors	
Step 4: Selecting factor extraction method (Decision point 3)			
Maximum likelihood Principal components	Depending on the characteristics of data and the research questions of the study	Inflated factor loadings in PC, but fewer numbers of variables had low communalities.	Principal components
Step 5: Selecting factor rotation method (Decision point 4)			
Orthogonal (Varimax) Oblique (Promax)	Depending on the characteristics of data and the research questions of the study	The same factor loadings produced and the comparison between them was meaningless.	Varimax defaulted to SPSS

Step 6: Interpretating the factor matrix			
The overall EFA	• The percentage of variance • Factor loadings • Cross-loadings	• 55.53% of 4 factors • ES1 and ES3 had insignificant factor loadings • Cross-loadings in SP3 and BS4	An evaluation with loading plots of factors with cross-loadings confirmed that the cross-loadings were not a serious issue.
Single EFAs for each factor	• The percentage of variance • Factor loadings	• All factors explained more than 50% of variance except economic sustainability with 49.50% of variance explained. • All variables had significant factor loadings.	49.50% of variance explained in economic sustainability was close to acceptable proportion (above 50%), confirming that it was not issue.
Step 7: Respecifying the factor matrix (Decision point 5)			
Communality	Deletion of variables with communality < 0.05	• Competitive advantage: EFP1, EFP2, SP3 • Environmental sustainability: EO1, EO3 • Social sustainability: IHR1, IHR2, IHR4 • Economic sustainability: ES1, ES3, ES4, ES6, BS4, BS5	Deletion of variables with low communalities except for IHR1 which represented the most important activity in social sustainability to maintain the robust conceptual and theoretical support of social sustainability.
Deletion or retention of variables	Based on the overall and single EFAs	• The total number of variables retained were 26 variables of 4 factors, reduced from the original 39 variables.	
Step 8: Validifying the factor matrix (After deletion of variables)			
Reliability • Item-to-total and Inter-item correlation • Cronbach's alpha	• Item-to-total correlation > 0.50 •Inter-item correlation > 0.30 • Cronbach's alpha > 0.60	• Both the item-to-total correlation and the inter-item correlation in each factor exceeded the recommended level. • All factors had high Cronbach's alpha with greater than 0.800.	Reliability was confirmed.
The adequacy of the data • KMO • the Bartlett's test of sphericity	• KMO > 0.50 • The significance of the Bartlett's test of sphericity < 0.05	Both overall and each factor had high degree of KMO (greater than 0.800) with the significant level of the Bartlett's test of sphericity (sig. 0.000).	Adequacy was confirmed.
Validity • Discriminant validity • Nomological validity	• Discriminant validity: correlations less than 0.70 among factors • Nomological validity: the factors and variables should be consistent with the underlying concept or theory.	• The correlations among the four factors were lower than 0.670. • Each factor was established based on theory and a systematic literature review.	Validity was confirmed.

The appropriate sample size was calculated using two methods: the subject-to-variable ratio (5:1) and the magnitude of factor loadings of variables per factor. The former method suggested at least 195 responses for 39 variables, and the latter method recommended 3 or more variables with the loading of 0.80 or above, 4 or more variables with the loading of 0.60 and 10 or more variables with the loading of 0.40 for 150 responses. The current study had a total of 236 responses, and more than 10 variables were loaded onto greater than the factor loading of 0.60, confirming the adequate sample size. The four factors decided to be retained based on the observation of the scree test. The number of factors was correspondent to the conceptual and theoretical support in the current study, which constituted the four constructs to test the hypothesises established. Additionally, 55.53% of the variance for the four factors verified that the number of factors was sufficient to explain the data. The factor extraction method and factor rotation method were determined by PC and Varimax, respectively, which showed the most appropriate results in communalities.

Furthermore, EFA was performed for both overall factors and a single analysis for each factor. There were two statistical problems detected: cross-loadings between the variables of SP3 and BS4; and the percentage of variance in the factor of economic sustainability (49.50%). However, the percentage was close to the acceptable proportion, which is more than 50%, and the evaluation of loading plots of factors was confirmed that the cross-loadings were not a serious problem. The decisions to delete or retain variables were taken in the step of respecifying the factor matrix based on the result of communalities where it was recommended to remove variables with a communality level of less than 0.50. The variables determined to delete were: 3 variables (EFP1, EFP3, SP3) of competitive advantage; 2 variables (EO1, EO3) of environmental sustainability; 2 variables (IHR2, IHR4) of social sustainability; and 6 variables (ES1, ES3, ES4, ES6, BS4, BS5) of economic sustainability.

Consequently, the total number of variables were 26 variables for the four factors, which were used to analyse CFA and SEM. The reliability, adequacy and validity of the factors and variables were verified in the last step of EFA, confirming that the variables remained adequately represented the factors. The EFA improved the initial theoretical model with the four constructs with more meaningful measurement variables. The analysis of CFA and SEM applying the modified model is discussed in the next Chapter.

Chapter 8. Confirmatory Factor Analysis and Structural Equation Modelling

Chapter 7 focused on conducting EFA and presented the modified four latent constructs represented by the meaningful variables. This chapter is dedicated to examining the research model modified in Chapter 7 and testing the hypotheses presented in Chapter 3. This chapter is structured into two main parts. In the first part, the research model that represents the correlation between competitive advantage, environmental, social, and economic port sustainability performance is validated through confirmatory factor analysis. The measurement validity of the research model is assessed in terms of unidimensionality, convergent and discriminant validity. Additionally, the issue of common method bias is examined using the Harman's single factor test and the unmeasured latent method factor technique. In the second part, the structural path model that illustrates the direct and indirect relationships between port sustainability performance and competitive advantage is investigated, and the nine hypotheses developed are tested through structural equation modelling.

8.1 Measurement model: Confirmatory Factor Analysis

CFA is conducted to provide statistical evidence of validating the underlying structure of the measurement variables established by the empirical analysis of EFA and to examine the validity of the measurement model. In addition, CFA is used to confirm that the measurement model plays a role in a foundation for further theory testing by specifying how the measured variables logically and systematically operationalise constructs in a theoretical model (Hair et al. 2014). That is, the focus of CFA is to examine the relationship between the measurement variables and the latent constructs. The results of CFA allow the theoretical model can eventually form a structural theory to be tested with a SEM model (Hair et al. 2014). In assessing the measurement model, the main concerns are to ensure goodness-of-fit and construct validity of the model in terms of convergent and discriminant validity. When convergent validity and discriminant validity are satisfied, the construct validity of the measurement model is regarded supported. The criteria of goodness-of-fit and validity has been discussed in Chapter 4 (see subsection 4.7.1 for validity tests and subsection 4.8.2 for goodness-of-fit indices). The results of CFA in the current study are presented in the following sections.

8.2. CFA results for individual constructs

The overall measurement model specified for the research model were developed with four constructs, which were competitive advantage, environmental sustainability, social sustainability, and economic sustainability. With the measured variables and their underlying constructs, the measurement model was assessed to ascertain the extent to which the measured variables were significantly measuring their corresponding constructs. In this section, single CFAs for each construct are discussed in terms of their parameter estimates and validity. These results are also used as a basis for constructing the overall measurement model.

8.2.1 Competitive advantage

The CFA results of the competitive advantage construct are summarised in Table 8.1. The 6 variables had high t-values ranging from 10.655 to 16.534 at the significant value with p < 0.001, and the standardised factor loadings ranged from 0.641 to 0.880. Additionally, the CR for competitive advantage was 0.884, and the AVE was 0.563, suggesting that the measured variables converged on the latent construct, and they were sufficiently reliable in capturing competitive advantage. Despite sufficient significance in the latent construct, overall goodness-of-fit indices indicated that the hypothesised model is not entirely adequate, with χ^2/df=11, CFI=0.885, IFI=0.886, TLI=0.808, and RMSEA=0.206. Only reached SRMR the recommendation level with 0.065. Literally interpreted, the hypothesised model of competitive advantage might deteriorate the construct validity of the overall measurement model, and it is suggested to modify it by adding covariances based on the results of modification indices.

However, a majority of researchers strongly recommend avoiding model modifications with covariance added if the sole intent is to improve the model (Landis et al. 2009; Hermida 2015; Flora and Flake 2017). Respecifying or modifying the model alters the substantive meaning of the established model and can compromise an actual test of a theoretical model. In this sense, the model modification should be justified on the basis of solid logic from previous research or theory as well as consistency with research aims (Brown 2006). Furthermore, Hair et al. (2017) argued that an individual CFA tends to provide partial information, preventing a complete examination of the validity of measurements, which was also supported by Cheng (2001). They suggested testing an overall CFA by including all latent constructs and variables involved in the theoretical model before deciding to modify the model using modification indices. Thus, this study decided to accept the construct of competitive advantage at this stage, but recognising that the potential statistical violations may occur.

Table 8.1 CFA results of competitive advantage

Construct	Variable	Standardised factor loading	*t*-value	Composite reliability	AVE	Cronbach's alpha
Competitive advantage	CDP1	0.744	13.027***	0.884	0.563	0.882
	CDP2	0.655	10.959***			
	CDP3	0.701	11.977***			
	CDP4	0.641	10.655***			
	SP1	0.880	16.534***			
	SP2	0.850	-			

Overall Goodness-of-Fit Indices

χ^2/df=11; SRMR=0.065; CFI=0.885; IFI=0.886; TLI=0.808; RMSEA=0.206

Figure 8.1 illustrates the first-order competitive advantage measurement model with standardised factor loadings. The 6 variables were included in the latent construct of competitive advantage, having more than the minimum threshold level of 0.50 with reference to Hair et al. (2014).

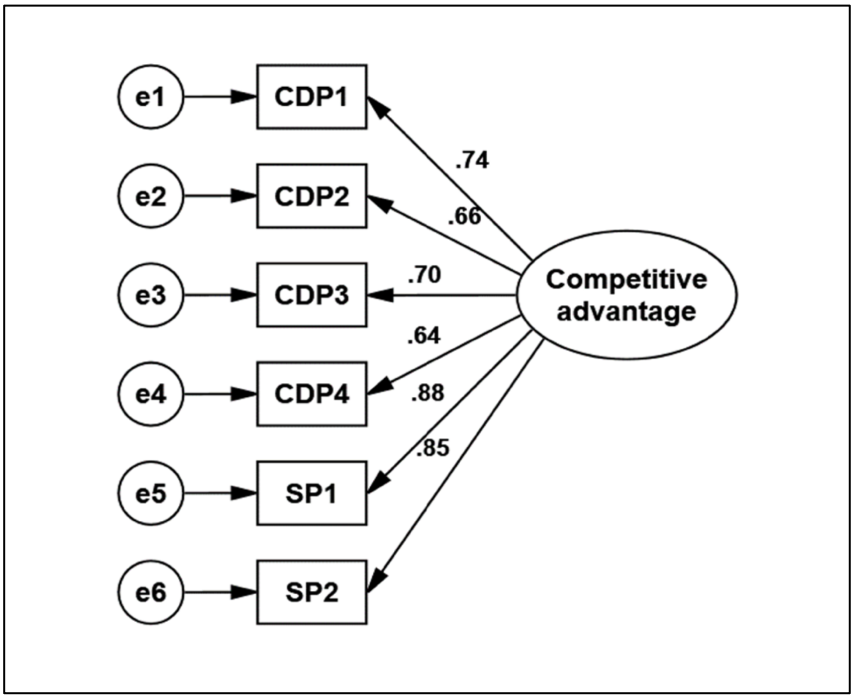

Figure 8.1 First-order competitive advantage construct

8.2.2 Environmental sustainability

Table 8.2 presents the CFA results of environmental sustainability construct. The overall model fit was acceptably good (χ^2/df=3.369, SRMR=0.0407, CFI=0.952, IFI=0.952, TLI=0.933), other than RMSEA having the value of 0.1. The normed chi-square (=3.369) met its recommendation criteria within 5, TLI was higher than 0.90, and CFI and IFI were higher than 0.95, indicating the model was a good fit. SRMR also showed a good fit with a value of less than 0.05. The standardised factor loadings of the variables ranged from 0.66 to 0.83, and the t-values were significant at p < 0.001. Although the problem of convergent validity of the latent construct was detected as the AVE was lower than 0.50, its value was 0.485, approximately reaching the cut-off level and suggesting the construct was marginally acceptable.

Table 8.2 CFA results of environmental sustainability

Construct	Variable	Standardised factor loading	t-value	Composite reliability	AVE	Cronbach's alpha
Environmental sustainability	EO2	0.692	10.746***	0.896	0.485	0.903
	EO4	0.661	10.201***			
	EO5	0.678	10.496***			
	EO6	0.730	11.400***			
	EO7	0.741	11.591***			
	EO8	0.794	12.541***			
	EM1	0.831	13.211***			
	EM2	0.762	-			

Overall Goodness-of-Fit Indices

χ^2/df=3.369; SRMR=0.0407; CFI=0.952; IFI=0.952; TLI=0.933; RMSEA=0.1

Figure 8.2 illustrates the single CFA model of environmental sustainability. The 8 measured variables with high standardised factor loadings constituted the environmental sustainability construct.

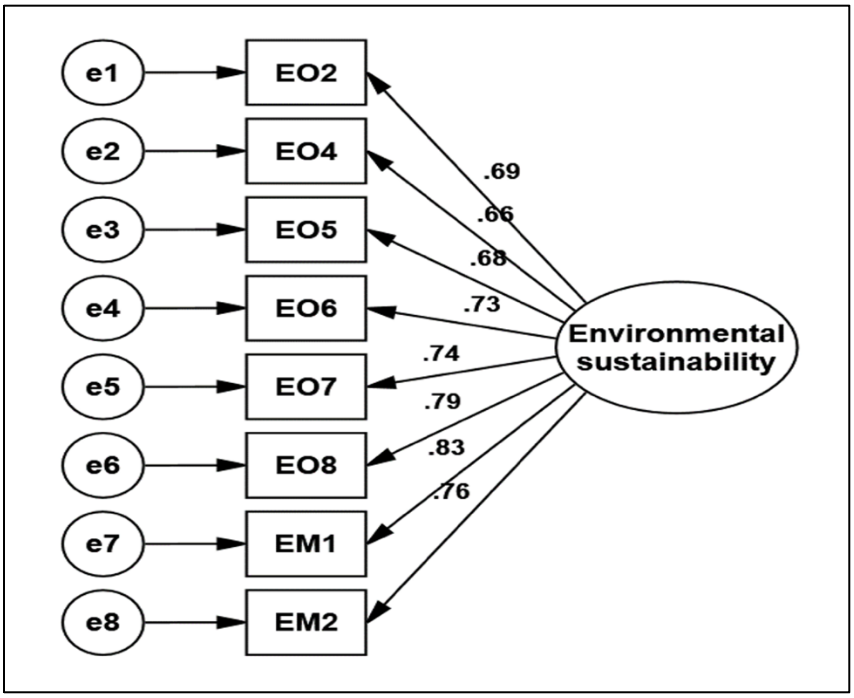

Figure 8.2 First-order environmental sustainability construct

8.2.3 Social sustainability

With regard to the CFA results of social sustainability construct, the 6 measured variables were loaded on the latent construct with acceptable factor loadings from 0.641 to 0.761. The results of the analysis provided evidence that all the measured variables were acceptable with good model fit: χ^2/df=2.343; SRMR=0.0304; CFI=0.979; IFI=0.980; TLI=0.966; RMSEA=0.076. Additionally, the convergent validity was satisfied with the AVE of 0.526, the CR of 0.869, and the Cronbach's Alpha of 0.867. Table 8.3 presents the summary of the CFA results of the social sustainability construct.

Table 8.3 CFA results of social sustainability

Construct	Variable	Standardised factor loading	t-value	Composite reliability	AVE	Cronbach's alpha
Social sustainability	IHR1	0.641	9.514***	0.869	0.526	0.867
	IHR3	0.744	11.130***			
	IHR5	0.755	11.306***			
	EP1	0.761	-			
	EP2	0.704	10.502***			
	EP3	0.743	11.122***			
Overall Goodness-of-Fit Indices						
χ^2/df=2.343; SRMR=0.0304; CFI=0.979; IFI=0.980; TLI=0.966; RMSEA=0.076						

According to the results of the EFA in Chapter 7 (see subsection 7.4.7), IHR1 was detected by a potential problematic variable in the latent construct with low communality. However, the CFA results confirmed that IHR1 was a satisfactory variable in capturing social sustainability construct. Consequently, the CFA model of social sustainability was specified, as shown in Figure 8.3.

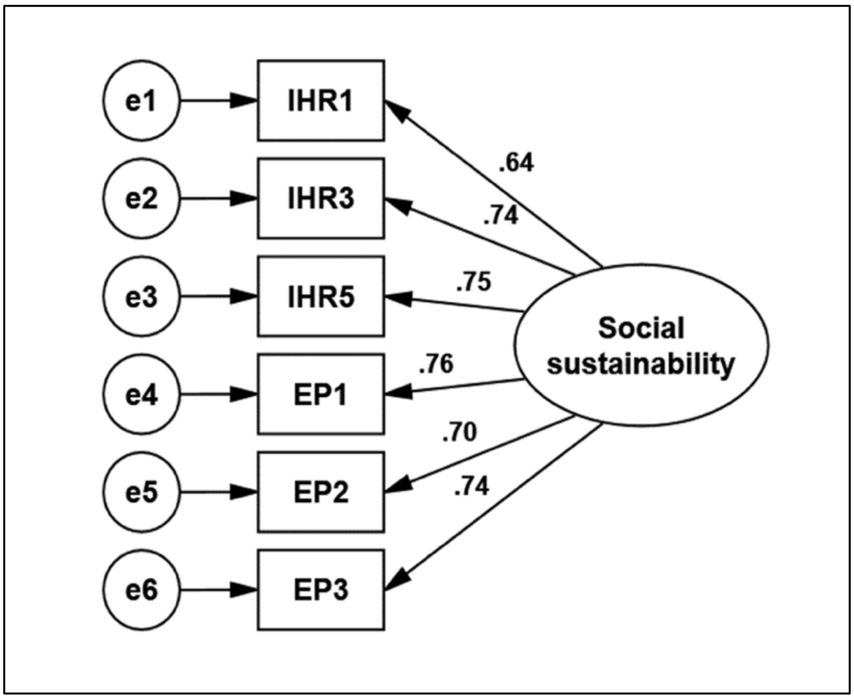

Figure 8.3 First-order social sustainability construct

8.2.4 Economic sustainability

The 6 variables were included in the latent construct of economic sustainability. Table 8.4 presented the CFA results of economic sustainability construct. The overall goodness-of-fit indices indicated an acceptable fit by satisfying the cut-off levels (χ^2/df=3.243; SRMR=0.0348; CFI=0.974; IFI=0.974; TLI=0.957; RMSEA=0.098). Additionally, all the standardised factor loadings ranged between 0.689 and 0.864, and the t-values were significant at the 0.001 significance level. The CR and Cronbach's Alpha values were higher than 0.80, and the AVE value was also higher than 0.50, indicating good scale reliability and satisfactory construct validity.

Table 8.4 CFA results of economic sustainability

Construct	Variable	Standardised factor loading	t-value	Composite reliability	AVE	Cronbach's alpha
Economic sustainability	ES2	0.689	11.909***	0.897	0.594	0.849
	ES5	0.718	12.607***			
	ES7	0.712	12.460***			
	BS1	0.782	14.328***			
	BS2	0.864	-			
	BS3	0.844	16.108***			
Overall Goodness-of-Fit Indices						
χ^2/df=3.243; SRMR=0.0348; CFI=0.974; IFI=0.974; TLI=0.957; RMSEA=0.098						

Figure 8.4 illustrates the individual CFA model of economic sustainability, which was composed of the 6 variables with adequate standardised factor loadings.

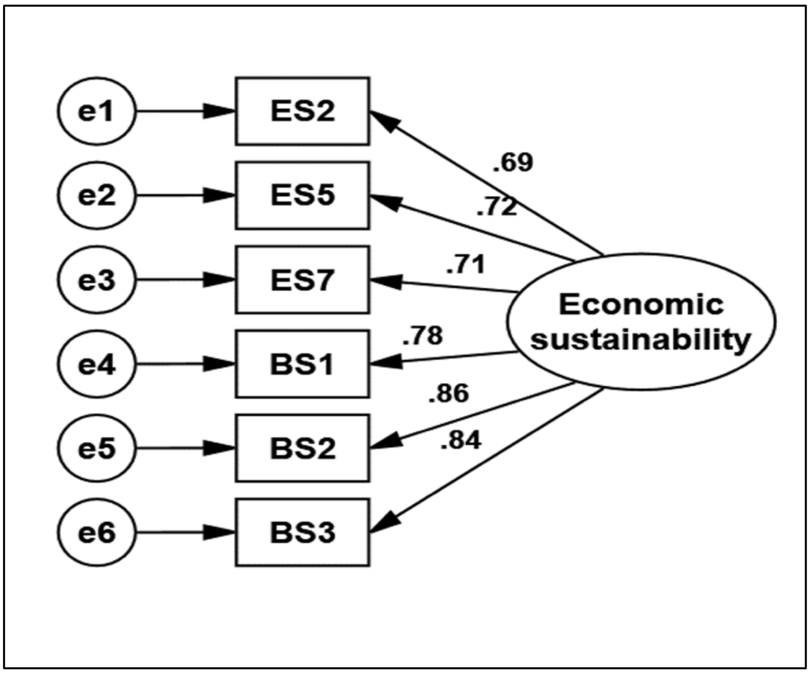

Figure 8.4 First-order economic sustainability construct

8.3 CFA results of the overall measurement model

After assessing the validity of the individual constructs, the integrated model was evaluated. Competitive advantage (6 variables), environmental sustainability (8 variables), social sustainability (6 variables), and economic sustainability (6 variables) were included to construct the overall measurement model. Figure 8.5 shows the illustration of the overall measurement model in which the four constructs were inter-correlated with two-headed arrows, and 26 measured variables were loaded on the corresponding constructs, respectively. According to Figure 8.5, all the standardised factor loadings were above 0.60, indicating that they were influential variables. All t-values of variables were also significant at $p < 0.001$. Additionally, the overall measurement model indicated a good fit to the data as all the goodness-of-fit indices satisfied the recommendation levels (χ^2/df=2.045; SRMR=0.0535; CFI=0.916; IFI=0.917; TLI=0.907; RMSEA=0.067). The CFA results also verified the unidimensionality of the study constructs, showing the correlation estimates among the constructs less than 0.80.

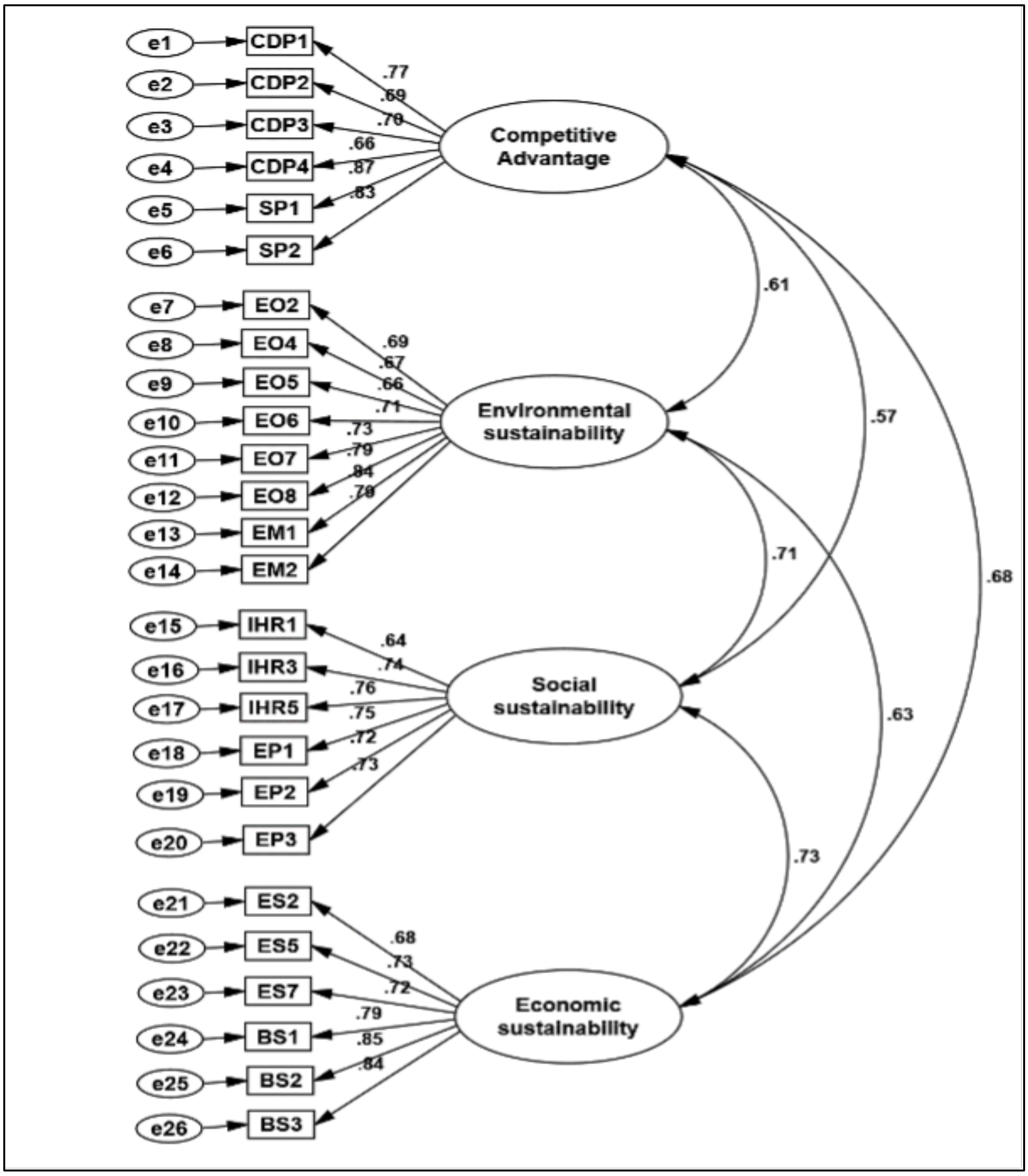

Figure 8.5 CFA results of the overall measurement model

8.4 Assessing convergent and discriminant validity

It is necessary to ensure convergent and discriminant validity, as well as reliability of the measurement model. The adequate validity of the study constructs suggests that the measured variables are credible and that the proposed measurement model can be used in testing SEM (Hair et al. 2014). In order to assess the convergent and discriminant validity of the overall measurement model, four measures were considered in this study: Composite Reliability (CR) should be greater than 0.70; Average Variance Extracted (AVE) greater than 0.50; Maximum Shared Variance (MSV) less than AVE; and the square root of AVE greater than inter-construct correlations. Table 8.5 shows the results of assessing convergent and discriminant validity of the measurement model.

Table 8.5 Results of convergent and discriminant validity

Construct	CR	AVE	MSV	Competitive advantage	Environmental sustainability	Social sustainability	Economic sustainability
Competitive advantage	0.887	0.568	0.456	**0.754**	0.608	0.573	0.675
Environmental sustainability	0.904	0.543	0.498	0.608	**0.737**	0.706	0.627
Social sustainability	0.870	0.527	0.526	0.573	0.706	**0.726**	0.725
Economic sustainability	0.898	0.595	0.526	0.675	0.627	0.725	**0.772**

Note: Diagonal entries (in bold) are the square root of AVE.

As shown in Table 8.5, the convergent validity for the measurement model of the four constructs was satisfied. The AVE values for each of the four constructs were higher than 0.50. The values of MSV for each construct were less than those of AVE. Additionally, the four constructs had the square root of the AVE higher than the correlations among the study constructs. Moreover, the correlation coefficients among the four constructs did not exceed 0.85. Thus, the overall measurement model in this study was verified that a set of measured variables represented sufficiently the corresponding constructs, respectively, and the four constructs were formulated by different concepts each other.

8.5 Common method bias

As discussed in Chapter 4 (see subsection 4.7.3), the possible effects of Common-Method Variance (CMV) for this study were recognised since dependent and independent variables were measured under the same respondents. Hence, the procedural remedies to mitigate the effects were conducted at the stage of designing the questionnaire. In this section, the two statistical tests were used to examine the presence of common methods bias. First, the Harman's single-factor test was performed with the use of EFA. The presence of CMV is indicated by the emergence of either a single factor or a general factor extracted accounting for more than 50% of the variance (Podsakoff et al. 2003; Sharma et al. 2009) All variables of the four constructs were loaded onto a single factor representing a common influence. The total number of factors were extracted based on the initial eigenvalues (eigenvalues greater than or equal to 1) with an unrotated factor solution. The generated factor matrix extracted four distinct factors accounting for 63.79% of the total variance. In addition, the first unrotated factor captured only 43.06% of the variance in data. The result suggested the absence of CMV since neither a single factor emerged, nor the first factor captured more than 50% of the variance.

Because the Harman's single factor is not without limitations, the unmeasured latent method factor technique was additionally adopted to check the magnitude of common method bias. The results showed that the model adding the common method factor had an adequate fit to the data (χ^2/df=1.964, SRMR=0.0674, CFI=0.923, IFI=0.914, TLI=0.924, RMSEA=0.0674). Although the fit of the model with the common methods factor was marginally improved (χ^2/df by 0.081, CFI by 0.007, TLI by 0.017), the difference was not considerable. Additionally, the variance extracted by this common methods factor was 0.38, falling below the 0.50 threshold that is suggested as indicating the presence of common method bias (Fornell and Larcker 1981; Cole et al. 2011). Thus, although common-method variance may be present in the data, the results of post-hoc statistical techniques confirmed that it was unlikely to be a serious problem in this study.

8.6 Testing structural model

Concerning the measurement model in this study, the results of CFA showed that the measurement model consisted of valid measured variables by providing evidence of statistically acceptable fit and validity to the data. Since the measurement model fit was confirmed, the structural model using SEM procedures was then estimated in order to clarify the interrelationships between the constructs and the relationships between the measured variables proposed in the model simultaneously. The focus of the SEM analysis shifts from the correlational relationships between the latent constructs and measured variables, which is the focus of CFA, to the nature and magnitude of each relationship between constructs by specifying which constructs are related to each other (Hair et al. 2014). In the current study, the proposed structural model was developed according to the hypotheses presented in Table 8.6.

Table 8.6 Hypotheses in the current study and their paths in the SEM

	Hypothesis	Path
H1	Port social sustainability has a positive influence on port environmental sustainability.	Social sustainability → Environmental sustainability
H2	Port social sustainability has a positive influence on port economic sustainability.	Social sustainability → Economic sustainability
H3	Port environmental sustainability has a positive influence on port economic sustainability.	Environmental sustainability → Economic sustainability
H4	The implementation of environmental sustainability has a positive influence on the achievement of a competitive advantage of ports.	Environmental sustainability → Competitive advantage
H5	The implementation of social sustainability has a positive influence on the achievement of a competitive advantage of ports.	Social sustainability → Competitive advantage
H6	The implementation of economic sustainability has a positive influence on the achievement of a competitive advantage of ports.	Economic sustainability → Competitive advantage
H7	The implementation of environmental sustainability has a positive influence on the achievement of a competitive advantage of ports through mediated by economic sustainability.	Environmental sustainability → Economic sustainability → Competitive advantage
H8	The implementation of social sustainability has a positive influence on the achievement of a competitive advantage of ports through mediated by environmental sustainability.	Social sustainability → Environmental sustainability → Competitive advantage
H9	The implementation of social sustainability has a positive influence on the achievement of a competitive advantage of ports through mediated by economic sustainability.	Social sustainability → Economic sustainability → Competitive advantage

The SEM examined the nine hypotheses representing causal relationships among the four major latent constructs, of which one was exogenous (social sustainability), and three were endogenous (environmental sustainability, economic sustainability, and competitive advantage). The structural model was transformed into a path diagram in which causal dependency relations between the four constructs were depicted, as presented in Figure 8.6. Ellipses described exogenous and endogenous variables, and 26 measured variables were depicted by rectangles, and the directional arrows showed direct relationships between all constructs.

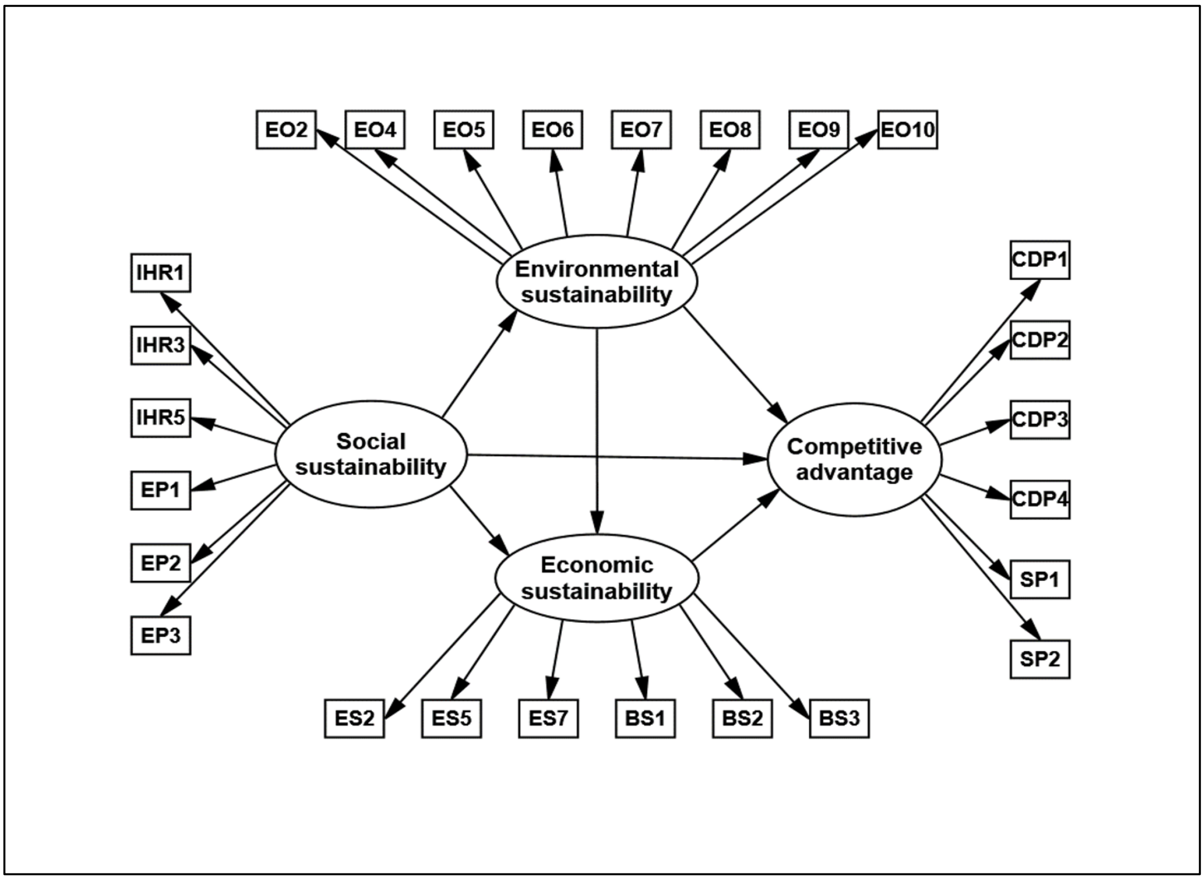

Figure 8.6 Proposed structural model of hypotheses

As discussed earlier, theory testing with the SEM is considered by examining two issues: overall model fit to confirm the acceptance of the proposed model; and statistical significance of structural parameter estimates, which identifies the path estimates and direct and indirect effects of dependence relationships (Hair et al. 2014). The same goodness-of-fit indices used to the assessment of the measurement model were applied, namely the normed Chi-square (χ^2/df), RMSEA, and SRMR as absolute fit indices, CFI, IFI, and TLI as incremental fit indices. Pursuant to the accomplishment of the goodness-of-fit measures by the overall measurement model, the proposed structural model yielded identical model fit results with the CFA model (χ^2/df=2.045, SRMR=0.0535, CFI=0.916, IFI =0.917, TLI=0.907, and RMSEA=0.067) supporting the proposed model of the study. The standardised factor loading estimates were also unchanged from the CFA model. The same results between the CFA and the SEM are reasonable unless statistically insignificant relationships or significant opposite relationships among the latent constructs (Cheng 2001).

8.7 Hypothesis testing: Direct effects

The results of testing the direct effects of the hypothesised relationships are summarised in Table 8.7, including the individual standardised path estimates (β), t-values, and their statistical significance levels (p).

Table 8.7 Hypothesis test results of the direct effects

Hypothesis	Hypothesised relationship	Standardised coefficient (β)	t-value	p	Result
H1	SO → EN	0.706	9.022	***	Supported
H2	SO → EC	0.563	5.961	***	Supported
H3	EN → EC	0.229	2.716	**	Supported
H4	EN → CA	0.296	3.363	***	Supported
H5	SO → CA	0.019	0.179	0.858	Not supported
H6	EC → CA	0.476	5.016	***	Supported

***: $p < 0.001$, **: $p < 0.01$
Note: SO = social sustainability, EN = environmental sustainability, EC = economic sustainability, and CA = competitive advantage.

- *Hypothesis 1* examined the direct relationship between social sustainability and environmental sustainability, with the assumption that social sustainability would have a positive influence on environmental sustainability. The results showed that there was significantly a positive path from social sustainability to environmental sustainability (β = 0.706, p < 0.001), supporting hypothesis 1.
- *Hypothesis 2* investigated that the direct relationship between social sustainability and economic sustainability. The results demonstrated the direct and positive relationship between social sustainability and economic sustainability (β = 0.563, p < 0.001), and this hypothesis was statistically supported.

- *Hypothesis 3* tested the direct relationship between environmental sustainability and economic sustainability, proposing that environmental sustainability would have a positive influence on economic sustainability. This relationship was statistically confirmed (β = 0.229, p < 0.01), and hypothesis 3 was supported.
- *Hypothesis 4,* which proposed the direct effect of environmental sustainability on competitive advantage, was statistically supported with the result indicating a positive and direct relationship between environmental sustainability and competitive advantage (β = 0.296, p < 0.001).
- *Hypothesis 5* investigated the direct influence of social sustainability on competitive advantage. It was hypothesised that social sustainability would positively influence enhancing the competitive advantage of ports. The results suggested that this relationship was not significant (β = 0.019, p = 0.858), and hence hypothesis 5 was statistically not supported.
- *Hypothesis 6* tested the direct relationship between economic sustainability and competitive advantage and proposed that economic sustainability would positively influence competitive advantage. The results indicated a statistically positive influence of economic sustainability on competitive advantage (β = 0.476, p < 0.001), and this hypothesis was supported.

Figure 8.7 illustrates the standardised path estimates for the hypothesised direct relationships among the constructs. Overall, all but one structural path estimate was significant in the proposed direction, presenting t-values above 2 and confirming a standard normal distribution at a 0.05 level. The exception was the path from social sustainability to competitive advantage. Its estimate had non-significance with a p-value of greater than 0.05. Therefore, although the structural path was in the hypothesised direction, it was not statistically supported. However, as the indirect relationship between social sustainability and competitive advantage has been recognised, it is necessary to further investigate the indirect effect of social sustainability on competitive advantage in order to verify the validity of the structural model.

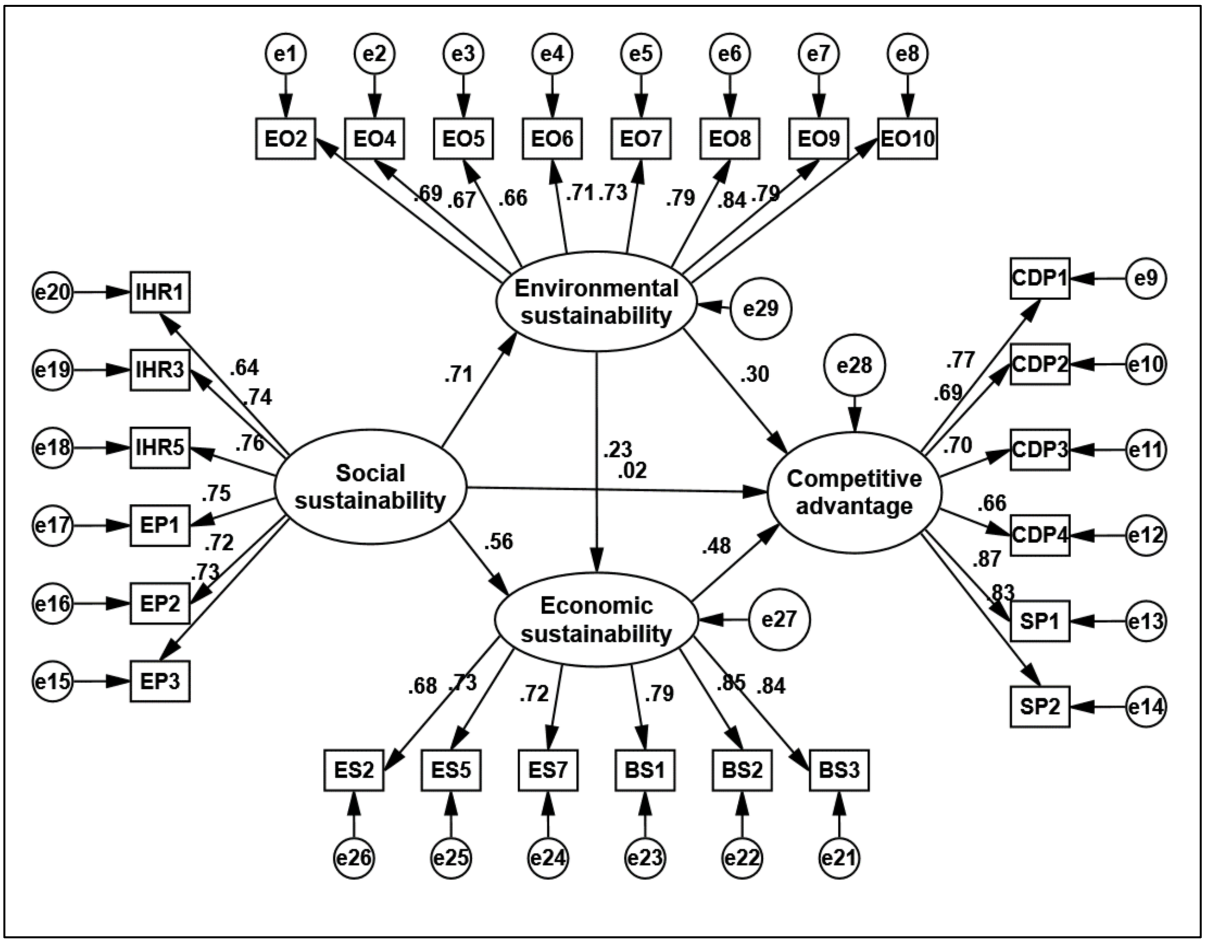

Figure 8.7 Standardised structural path estimates for the proposed relationships

8.8 Hypothesis testing: Indirect effects

Direct effects are, by definition, those that load a variable directly to another variable, while indirect effects exist when there is a third variable between a path from an independent variable to a dependent variable. In that case, the indirect effect is generated by the third variable on the relationship between the other two variables (Kalkhouran et al. 2017). It should be noted that the terms mediated effects (mediators) and indirect effects are not synonymous, although many researchers often use them interchangeably (Kline 2016). Indirect effects always accompany as part of mediation, while not all indirect effects indicate the existence of mediation. Kline (2016) emphasised that indirect effects are referred to as "mediation" when a causal relationship causes changes in the relationship between an independent variable and a presumed mediator, which in turn leads to changes in a dependent variable.

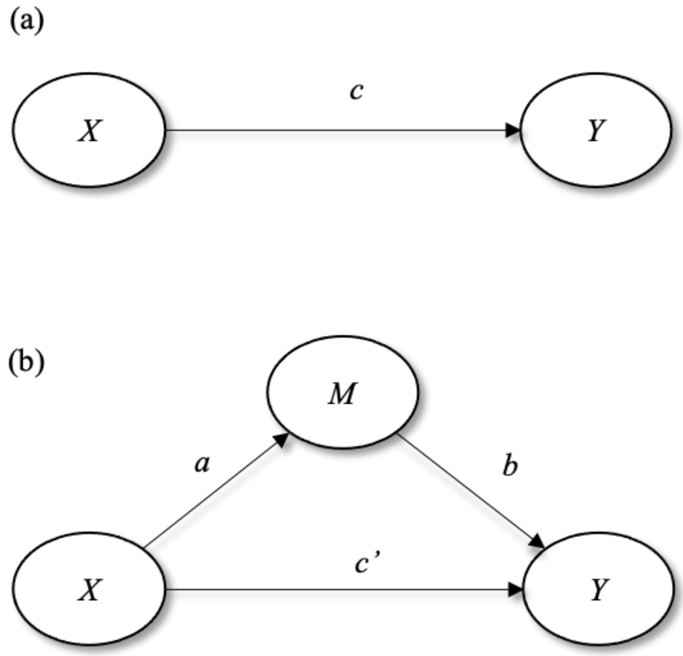

Figure 8.8 Direct effect and simple mediation model, adapted from Preacher and Hayes (2004)

Figure 8.8 depicts a direct effect and simple mediation model, where X is an independent variable, Y is a dependent variable, M is a mediator, and a, b, c, and c' are the standardised path coefficients. Figure 8.8 (a) represents the direct effect of an independent variable (X) on a dependent variable (Y), and path c refers to the simple relationship between X and Y, denoted the total effect of X on Y. Figure 8.8 (b) represents a simple mediation design, where the direct effect of X on Y is mediated by M. Path c' is the direct effect of X on Y after the addition of the effect of M. The indirect effect of X and Y is calculated by multiplying a and b (ab), and the total effect of X and Y is drawn by summing the indirect effect (ab) and the direct effect (c') (Preacher and Hayes 2004). That is, the total effect is assessed by estimating the following equation:

Total effect = Direct effect + Indirect effect

$$c = c' + ab$$

The traditional prerequisite for a mediated effect should initially occur a significant association between X and Y (i.e. path c), which is not applied to the assessment of indirect effects. In addition to that assumption, M can be considered a mediator when X is significantly associated with M, and M is significantly associated with Y (Baron and Kenny 1986). If following the traditional criteria, this study should cease to examine the indirect effect of social sustainability because the direct relationship (c) has been rejected. However, Preacher and Hayes (2004) stressed the examination of the total effect including the direct effect and the total indirect effect in order to conclude whether the indirect effect can also represent a mediation or not, because a significant indirect effect was detected even when there was no evidence for a significant total effect according to their assessments, which was also supported by Loeys et al. (2015). Zhao et al. (2010) further claimed that the strength of the mediation effect should be dependent on the size of the indirect effect, not by the lack of the direct effect, and the significant indirect effect (*ab*) is only required to establish a mediating effect. Based on more recent arguments, this study decided to examine the existence of mediating effect by investigating the total effect including direct and indirect effects among the constructs.

8.8.1 Observed indirect effects within hypothesised paths

Table 8.8 summarises the effect decomposition, which divided the total effect into the direct and indirect effects. In this model, indirect effects were observed in three pathways: from social sustainability to economic sustainability via environmental sustainability (SO → EN → EC); from social sustainability to competitive advantage via environmental sustainability and economic sustainability (SO → EN → CA and SO → EC → CA); and from environmental sustainability to competitive advantage via economic sustainability (EN → EC → CA). The total effect of the path from social sustainability to economic sustainability showed 0.725 by adding the indirect effect of 0.162. The indirect effect (0.109) also existed in the relationship between environmental sustainability and competitive advantage, and the total effect of this relationship was 0.405. Moreover, the path from social sustainability to competitive advantage became stronger (the total effect of 0.573) than when only the direct effect (0.019) was considered as the indirect effect (0.554) was added.

Table 8.8 Effect decomposition for each path in the proposed model

Path	Direct effect	Indirect effect	Total effect
SO → EN	0.706	-	0.706
SO → EC	0.563	0.162	0.725
EN → EC	0.229	-	0.229
SO→ CA	0.019	0.554	0.573
EN → CA	0.296	0.109	0.405
EC → CA	0.476	-	0.476

8.8.2 Testing statistical significance of indirect effects

To statistically examine the robustness of the indirect effects, a bootstrapping procedure was performed using 1,000 resamples with a 95% confidence level for the full model, and the path coefficients and the significance levels of these paths were obtained (Preacher and Hayes 2004). The null hypothesis for indirect effect is that the indirect effect equals zero. Therefore, if the lower bound and the upper bound values of bootstrap confidence interval include zero, then the null hypothesis would be retained, and it is concluded that the indirect effect is not statistically significant. As presented in Table 8.9, the three pathways did not include zero in the lower and upper endpoints of bootstrap confidence interval (0.019 and 0.303 for SO → EN → EC, 0.375 and 0.735 for SO → EN → EC → CA, and 0.024 and 0.221 for EN → EC → CA). Also, ρ-value of two-tailed significance inferred that the indirect effects of the paths were further confirmed statistically significant with a confidence level of 0.05. It should be pointed out that the path from social sustainability to competitive advantage, where the direct effect was not significant, was significant in the total effect after the indirect effects were added (bold in Table 8.9).

Table 8.9 Results of bootstrap for the direct, indirect, and total effects of the paths

Path	Bootstrap confidence interval		
	Lower bound	**Upper bound**	**ρ-value (Two-tailed)**
Direct effect			
SO → EN	0.584	0.819	0.002
SO → EC	0.370	0.747	0.002
SO → CA	**-0.198**	0.209	**0.862**
EN → EC	0.021	0.415	0.033
EN → CA	0.125	0.454	0.004
EC → CA	0.244	0.685	0.002
Indirect effect			
SO → EN → EC	0.019	0.303	0.026
SO → EN → EC → CA	0.375	0.735	0.002
EN → EC → CA	0.024	0.221	0.016
Total effect			
SO → EN	0.584	0.819	0.002
SO → EC	0.622	0.814	0.002
SO → CA	**0.442**	0.670	**0.003**
EN → EC	0.021	0.415	0.033
EN → CA	0.195	0.573	0.004
EC → CA	0.244	0.685	0.002

8.8.3 Individual indirect effects of social sustainability on competitive advantage

According to Kline (2016), for a model with multiple indirect effects of *X* on *Y*, which was the case for the current study, the total indirect effect should be estimated by summing the coefficients for each indirect effect. The indirect effects of social sustainability on competitive advantage (0.554, see Table 8.8) were estimated by the sum of the coefficients for the indirect effects of environmental sustainability and economic sustainability. Hence, it is ambiguous to determine to what extent each path had an indirect effect. In this sense, the individual indirect effects were further examined by testing the specific indirect effects of social sustainability on competitive advantage via user-defined estimands technique that specifies parameter names of the certain indirect paths. There were three specific pathways that constituted the indirect effects of social sustainability on competitive advantage as follows:

- Specific indirect effect 1 (SIE1): Social sustainability → Environmental sustainability → Competitive advantage
- Specific indirect effect 2 (SIE2): Social sustainability → Economic sustainability → Competitive advantage
- Specific indirect effect 3 (SIE3): Social sustainability → Environmental sustainability → Economic sustainability → Competitive advantage

The sum of those three indirect effects provided the total indirect effect of social sustainability on competitive advantage. Adding the coefficient of the direct effect of social sustainability on competitive advantage presented the total effect (TE) of social sustainability on competitive advantage. These can be expressed in simple equations as follows:

$$\text{Specific indirect effect (SIE): } a*b$$

$$\text{Total indirect effect (TIE)} = \text{SIE1} + \text{SIE2} + \text{SIE3}$$

$$\text{Total effect (TE)} = \text{TIE} + \text{Direct effect } (c')$$

Table 8.10 summarised the results of testing the individual indirect effects of social sustainability on competitive advantage. The true indirect effect was estimated: SIE1=0.209, SIE2=0.268, and SIE3=0.077. The total indirect effect was calculated at 0.554 by the sum of three indirect effects, and consequently, the total effect of social sustainability on competitive advantage was estimated at 0.573. The results of bootstrap confidence interval provided evidence that the individual indirect effects and the total effect including the total indirect effect of social sustainability on competitive advantage, were statistically significant with 95% confidence.

Table 8.10 Individual indirect effects of social sustainability on competitive advantage

Individual indirect path	True indirect effect	Bootstrap confidence interval			
		Estimate	Lower bound	Upper bound	ρ-value
SIE1	$0.706 \times 0.296 = 0.209$	0.285	0.127	0.51	0.002
SIE2	$0.563 \times 0.476 = 0.268$	0.366	0.178	0.64	0.001
SIE3	$0.706 \times 0.229 \times 0.476 = 0.077$	0.105	0.026	0.219	0.013
TIE	$0.209 + 0.268 + 0.077 = 0.554$	0.756	0.508	1.073	0.002
TE	$0.554 + 0.019 = 0.573$	0.782	0.587	1.002	0.002

8.8.4 Determining indirect effects as mediations

As discussed earlier, not all indirect effects imply the existence of mediations, and therefore the further examination carried out the magnitude of indirect effects and its type to determine indirect effects as mediation effects. First, all indirect effects in the research model were verified as statistically significant (Loeys et al. 2015), as shown in Table 8.9. Additionally, the magnitude for each indirect effect was assessed using Variance Accounted For (VAF), calculated by dividing indirect effect by total effect (Zhao et al. 2010). According to Hair et al. (2016), a VAF value greater than 80% represents full mediation, a VAF value between 20% and 80% suggests partial mediation, while a VAF value smaller than 20% indicates no mediation. The results of the magnitude of indirect effects are presented in Table 8.11. All indirect effects confirmed the presence of mediations. Specifically, the partial mediation effect was identified in two paths: social sustainability to economic sustainability; and environmental sustainability and competitive advantage. On the other hand, the indirect effects of social sustainability on competitive advantage supported a full mediation.

Table 8.11 Summary of magnitude and type of mediation

Path	Indirect effect	Total effect	VAF	Type of mediation
SO → EC	0.162	0.725	22.3%	Partial
SO→ CA	0.554	0.573	96.6%	Full
EN → CA	0.109	0.405	26.9%	Partial

8.9 Summary

After completing the EFA, the measurement model was tested using CFA to confirm the relationship between the latent constructs and the measured variables. The CFA in this study was performed regarding both individual constructs and the overall measurement model, and they were assessed using the criteria for goodness-of-fit, the standard factor loadings, and the reliability and validity tests. Although a slight problem with the model fit was detected in the individual construct of competitive advantage, it was confirmed that the issue was not serious since the overall measured model test showed the satisfactory model fit and construct validity. Consequently, the four constructs (competitive advantage, environmental sustainability, social sustainability, and economic sustainability) were verified as valid.

With the satisfactory results in model fitness, reliability and validity, the overall measurement model was accepted as the final model of the current study and used for the hypothesis testing of the structural model. The final model indices and validity tests obtained are shown in Table 8.12, which compares with the initial hypothesised model. The table indicates that the final model attained an improvement in goodness-of-fit indices (χ^2/df: 2.158 → 2.054; SRMR: 0.0620 → 0.0535; CFI: 0.848 → 0.916; IFI: 0.849 → 0.917; TLI: 0.838 → 0.907; RMSEA: 0.070 → 0.067), falling within the range of the recommended levels. Moreover, the construct validity in terms of convergent and discriminant among the constructs were satisfied. This evidence suggests that the final model serves as a better fitting model than the initial model. In addition, the result of common method bias further validated that common-method variance was not a concern in this study.

Table 8.12 Goodness-of-fit indices and validity tests for the initial and final measurement models

Fit indices	Acceptable fit	Measurement model	
		Initial	Final
χ^2/df	$2 < \chi^2/\text{df} < 5$	2.158	2.045
SRMR	$< 0.05 - 0.08$	0.0620	0.0535
CFI	> 0.90	0.848	0.916
IFI	> 0.90	0.849	0.917
TLI	> 0.90	0.838	0.907
RMSEA	< 0.08	0.070	0.067
Convergent validity		Fail	Pass
Discriminant validity		Fail	Pass

As the goodness-of-fit measures of the measurement model were achieved, the proposed structural model was also supported with the same results as the overall CFA model fit. The structural model transformed into a path diagram was involved in testing the nine established hypotheses of the study, where the causal dependencies were examined in terms of their direct and indirect effects among the four constructs. The overall hypothesis testing results are summarised in Table 8.13.

Table 8.13 Summary of hypothesis testing results of the current study

Hypothesis	Hypothesised relationship	Hypothesis test result
H1	SO → EN	Supported
H2	SO → EC	Supported
H3	EN → EC	Supported
H4	EN→ CA	Supported
H5	SO → CA	Not supported
H6	EC → CA	Supported
H7	EN → EC → CA	Supported
H8	SO→ EN →CA	Supported
H9	SO→ EC →CA	Supported

All hypotheses regarding the direct effects among the constructs were supported except for hypothesis 5 (the direct effect of social sustainability on competitive advantage). However, adding the indirect effects, the path from social sustainability to competitive advantage was statistically significant. The VAF value of 0.966 was said that 96% of social sustainability's effect on competitive advantage could be explained via environmental sustainability and economic sustainability. Since the VAF was greater than the 0.80 threshold level, it was confirmed that environmental sustainability and economic sustainability fully served as mediators of the relationship between social sustainability and competitive advantage (Zhao et al. 2010; Agyabeng-Mensah 2020).

According to the magnitude of the standardised estimates, the indirect effect of social sustainability on competitive advantage via economic sustainability (VAF of 46.7%) was relatively stronger than via environmental sustainability (VAF of 36.5%). Furthermore, it was examined that environmental sustainability had a positive influence on competitive advantage directly and indirectly. Although it suggests ignoring the indirect relationship if its magnitude is smaller than that of direct relationship of the path, and the direct relationship is significant regardless of the indirect relationship (Zhao et al. 2010), the strength of indirect effect tests (VAF of 26.9%) has been confirmed the partial mediating effect of economic sustainability on the relationship between environmental sustainability and competitive advantage. Additionally, the significance of indirect effects was tested, confirming that the indirect effects of all paths were statistically significant with a confidence level of 0.05.

Consequently, this study concluded that all hypotheses were supported except for hypothesis 5 regarding the direct impact of social sustainability on competitive advantage. The research results drawn from this study by the RII and SEM analyses will be discussed in-depth in the next chapter.

Chapter 9. Research Conclusion

This final chapter serves to provide the findings and discussion of the entire study. The chapter commences by summarising the process of the research work being done to achieve the research aim. By answering each of the research questions, the findings of the study are discussed, which leads to the development of overall conclusions, including implications and contributions of this study. As common to all scholarly research, the research limitations are also acknowledged, and these are addressed in detail accordingly. This chapter concludes with suggestions for future research directions based on the results of the research.

9.1 Summary of the study

Under the business environment where decisions are constantly being made regarding how to use the organisation's resources, it is critical to implement strategic sustainability management that improves the priority setting of organisations. This raises the need for an empirical approach to understand, evaluate, and manage sustainability performance for desirable port operations and management (Chapter 1). Hence, the initial intention of the study was as follows:

The overall aim of this study is to investigate how ports could capture competitive growth opportunities through strategic sustainability management and to provide empirical evidence of the value of sustainability performance in the port industry.

This study focused on integrating sustainable development goals into port operational and managerial activities and increasing the competitive advantage of ports. To achieve the research aim, the study had two objectives: identifying the influential sustainability activities affecting the competitive position of ports; and examining the impacts of port sustainability performance on the competitive advantage of ports.

The exhaustive literature review has been conducted to understand the concept of sustainability and competitive advantage in the context of port operations and management and clarify the research gaps of the current study. Particularly, a systematic literature review was adopted in this study to evaluate the structure and patterns of port sustainability performance and assessment that have been addressed in the existing research and to identify key indicators of sustainability performance for further analysis in the study. Through this stage of the study, the importance of empirical research has been identified in developing a strategy that embraces safe, social, and environmentally acceptable port management while increasing the capacity of economic benefits in terms of competitive advantage (Chapter 2). Based on the theoretical backgrounds on the strategy-practice approach and the Natural Resource-Based View, this research understood the theoretical principle that sustainability action can be developed into a pragmatic strategy to create a competitive advantage of ports. This research stage proposed the research model represented by the nine hypotheses for testing the relationship between sustainability practices and competitive advantage (Chapter 3).

The research methodological standpoint of the study was clarified, and the questionnaire survey was conducted to collect the data (Chapter 4). Afterwards, the data analysis was performed from the analytical and empirical perspectives. A general description of responses was provided regarding the demographic profile of survey respondents and their responses to the questions (Chapter 5). The Relative Importance Index analysis was conducted to address the first objective of the study, *identifying the influential sustainability activities affecting the competitive position of ports* (Chapter 6). Subsequently, the empirical analysis was carried out using EFA, CFA, and SEM to address the second objective of the study, *examining the impacts of port sustainability performance on the competitive advantage of ports*. The EFA enabled the improvement of the initial research model, which consisted of valid variables corresponding to each construct (Chapter 7). The refined research model through the EFA was examined in terms of its validity through the CFA, and the structural path model and hypotheses in the study were tested with the SEM (Chapter 8).

9.2 Discussion

This study advances an overall knowledge of sustainable development for the successful implementation of sustainability practices within port operations and management. By empirically demonstrating the benefits of port performance through sustainability practices, this study expands the development and applicability of port sustainability activities according to their strategic relevance. As a result, the findings have implications for both practice and research. The study findings is discussed by addressing the answers to the four research questions.

9.2.1 What are the main factors supporting strategic sustainability management in ports?

According to the analysis of publications in the field of port sustainability performance, it appears the importance of a systematic approach for managing port sustainability based on a knowledge network among port governing bodies, such as the European Seaports Organisation (ESO). From a geographical perspective, the research regarding green ports and maritime logistics have been developed to focus on the region of western Europe and the United States (Davarzani et al. 2016). The significant advances in the port sustainability management, most notably in Europe, can be ascribed to the development of the EcoPorts system for environmental management initiatives fully adopted by the ESO in 2011. The primary principle as a guide is "to raise awareness on environmental protection through cooperation and sharing of knowledge between ports, and to improve environmental management" (Darbra et al. 2020, p. 4). This system allows ports to facilitate the exchange of knowledge and experience within the network and measure their environmental performance (Lim et al. 2019). The expansion of EcoPorts management system goes beyond Europe, adopted by the ports of Kaohsiung, Keelung and Taichung in 2014 and 2015. This highlights the need for the development of a systematic network among ports in order to increase the understanding of the structure of port sustainability operationalisation and meet to standard criteria for requirements of sustainable transport policy (Liao et al. 2016; Lim et al. 2019).

Given the growing number of publications over the past few years, sustainable development has become further established within port operations and management as an organisational practice (Lim et al. 2019). For more sensible sustainability management, ports need monitoring and measuring schemes that produce substantive evidence for understanding the success or failure of their sustainability processes. Definite positive impacts of sustainability disclosure on port sustainability performance are supported by the investigation for status quo and compliance, and subsequently the strategic realignment for management and operational systems for future improvement in the port industry (Lam and Notteboom 2014). It is relevant to have a voluntary sustainability reporting standard or system that help ports comply with international laws and prove their commitment to internal sustainability initiatives. According to Hossain et al. (2021), major international container ports have actively produced their own annual sustainability reporting to show their willingness to be responsible corporate citizens. Furthermore, environmental certifications such as ISO 14001 and Port Environmental Review

System (PERS) provide the systemised planning for mandatory reporting (Ashrafi et al. 2019; Hossain et al. 2021), contributing to the basis for developing a strategic sustainable port (Lam and Notteboom 2014). However, it is observed that port sustainability management shows biased progress limited to environmental issues, which hinders the development of balanced and rational sustainability management in ports from a strategic perspective.

Additionally, the sustainability reporting practice implies recognising that cogent sustainability management requires scientific data used for strategic management decision making (Wooldridge et al. 1999). Its importance lies in understanding the role of science-based assessments for the actual impact and implementation of sustainability activities and operations in ports. A scientific approach that critically evaluates and systematises detailed information can support decision-making for reasonable and coherent sustainability actions by adding credible evidence to sustainability execution systems (Wooldridge et al. 1999; Kates et al. 2001). In this sense, the port sustainability research has predominantly contributed to developing indicators in terms of sustainability-related practices and activities in order to support measuring sustainability performance.

By analysing the most-used indicators through the systematic literature review, this study can recognise the critical issues and trends of sustainability operations and management in ports. Typical indicators for the assessment of port sustainability from an environmental perspective are related to water management, air pollution management, energy and resource use, and noise control. In terms of the social aspects, health and safety-related activities are the most-frequency indicator, followed by the activities ensuring employee job security. Regarding economic sustainability, foreign direct investment and efficient port operations are primary issues. However, the quality of indicators has a tendency to be changed by external and internal factors such as systems, themes, and goals since subject perspectives are engaged from the formulation to the measurement of indicators established (Riley 2001). For example, Darbra et al. (2020) observed fluctuations in critical activities and priorities of environmental management in ESO since 2013 and suggested potential causes of this phenomenon to port development projects, environmental accidents, and stakeholder interests. It suggests that indicators related to port sustainability need to be updated periodically to reflect current issues and rationalise sustainability performance.

9.2.2 What are the influential sustainability activities that have an impact on strengthening the competitive advantage of ports?

Under the three sustainability aspects, 30 key activities were identified from the systematic literature review: 10 activities from the environmental practice, 8 activities from the social practice, and 12 activities from the economic practice. The perceived priority of each activity for strengthening the competitive advantage of ports was examined according to its ranking. According to the comprehensive observation of the relative importance of port sustainability performance, social practice is considered the most essential to increase the port's competitive advantage, followed by the economic practice. Interestingly, the relative importance value of the economic practice has little difference from the social practice. Indeed, the overall ranking of sustainability activities showed that "Healthy and safety" of the social practice was the top, and from the second to the eighth ranking, the sustainability activities of economic practice ranked, suggesting that both social and economic practices have considerable impacts on the competitive advantage of ports. On the other hand, all environmental activities occupied the lower ranks (between 19^{th} and 29^{th}). The priority in the three sustainability aspects seems different from previous research findings within the context of the general assessment of port sustainability performance. For example, Oh et al. (2018) found that economic practice was the highest important criterion, followed by environmental and social practices in ports in South Korea. However, where the competitive standpoint is considered, container ports have perceived that the activity competency in social and economic sustainable operations and management can produce the strategic position of ports.

The top three sustainability activities in each aspect of sustainability for strengthening the competitive advantage of ports are as follows: under environmental practice, "Waste pollution management", "Green port management", "Energy and resource usage management"; under social practice, "Health and safety", "Job training", "Public relations"; and under economic practice, "Port operational efficiency", "High quality services", "Port infrastructure construction". It is noteworthy that the indicator of foreign direct investment considered the most important indicator from the economic aspect was the least important activity determining a competitive advantage of ports. Other than that, the overall activities from both social and economic practices seem to be reasonably consistent with the priorities of general port sustainability performance. For example, human resource management, such as occupational health and safety and job training, is established as the essential factor in reporting port social performance (Lim et al. 2019). Similarly, the top three economic sustainability activities are port performance measurements that rely heavily upon addressing performance issues, including port competitiveness (see Haezendonck et al. 2000; Tongzon and Sawant 2007; Divandri and Yousefi 2011; Asgari et al. 2015).

However, there were distinct differences found in the environmental sustainability activities. As mentioned above, dominant environment issues in performing successful sustainability practice in container ports were traditionally atmospheric pollution management, water pollution management, and energy consumption-related management. On the other hand, waste pollution management has failed to gain much attention, perceived as an indicator of low importance (see Asgari et al. 2015; Puig et al. 2017; Lim et al. 2019). When it comes to creating a competitive advantage, however, the priorities among these activities are opposite. While air and water pollution management are perceived as relatively low importance, waste pollution management is far more critical than others. This finding echoes the recent ESPO reporting for environmental monitoring programmes. The environmental management related to port waste and energy efficiency is the most monitored issue, showing positive trends in terms of assimilation and implementation (Darbra et al. 2020).

9.2.3 How are the influential sustainability activities specified depending on the attributes of ports?

The influential sustainability activities were examined by the characteristics of ports and respondents, namely geographical location, port size, and management level of respondents, and each result was compared with the overall relative importance priorities. The analysis suggested that the activities from the three sustainability aspects prioritised for enhancing competitive advantage are perceived similarly regardless of port size. This observation is consistent with the previous research that claimed no noticeable correlation between port size and port environmental performance (Puig et al. 2017). It can also imply that port size may not be the decisive factor considered in making a sustainability strategy to gain a competitive advantage. In terms of management levels, top and middle managers put more importance on the activities generating external advantages, such as environmental management reporting, social relations, port image, whereas frontline managers consider more importantly the activities generating internal advantages, such as quality of the working environment and job creation and security. Due to the lack of previous literature on the detailed roles of port managers in carrying out sustainability management, it was unlikely to link the present findings to support this phenomenon. Notwithstanding, in that it is similar to their decision-making scopes within the organisational structure of ports, it can be seen that their different perceptions are shaped based on the purview of managerial activities depending on their management levels.

Additionally, divergent perceptions regarding the priorities of sustainability activities affecting the competitive advantage of ports are established across the regions. This finding was expected at the beginning of the study by the previous literature that ports are developing and implementing a variety of strategies for sustainable operation and management in accordance with their own interpretations of sustainable development within local regulatory, political, social, and institutional contexts (Wooldridge et al. 1999; Stojanovic and Farmer 2013). Nonetheless, a similar pattern of the priorities to some extent is observed between Asian (particularly, East and Southeast region) and European ports, which might explain that ports in the two regions have developed some similar interest in addressing sustainability concerns and supporting their responsibility.

According to Lam and Notteboom (2014), sustainability management between Asian and European ports had the following similarities: port functional activities, high level of pricing policy, compliance with international conventions like the Prevention of Pollution from Ships (MARPOL), and adoption of Environmental Management System standards such as the ISO 14001. This view is also supported by Hossain et al. (2021), which assessed seaports' sustainability efforts in Europe, North America, and Asia, and some similarities of ports from Asia and Europe were found regarding port sustainability initiatives and port sustainability reporting. Indeed, the leading container ports in the world are concentrated in Asia and Europe regions, handling a substantial amount of shipping traffic and container throughputs and occupying an important position in the container port market (Feng et al. 2012). Hence, ports in the two regions have shared highly similar sustainability issues and have carefully considered the environmental and social responsibilities for their behaviours (Lam and Notteboom 2014). This is also reflected in research interest in port sustainability performance centred on these two regions (see Appendix A). Such similarity between these two regions also suggests that Asian and European ports can mutually benefit from actively communicating and benchmarking for strategic system development.

9.2.4 To what extent does sustainability performance contribute to gaining the competitive advantage of ports?

This research has proposed an empirical model that supports the implementation of port sustainability practices, with nine hypotheses that tested the link between port sustainability performance and competitive advantage. The proposed model is found to be feasible, making an important addition to the modelling of sustainability performance measurement in ports. The results also provide a salient overview of the status of ports with respect to the progress toward sustainability and its impact on port operational performance in terms of competitive advantage. Overall, the factor analysis indicates that port sustainability performance has a positive impact on competitive benefits by strengthening the competitive difference performance and sustainable performance. However, the financial benefits from sustainability performance are questionable because the variables representing financial performance were failed to be included in the final measurement model based on the results of validity tests. This can be possibly explained by two rationales. Firstly, the variables of financial benefits could be served as mediating between sustainability performance and competitive difference performance. This relationship is supported by the studies in the organisational discipline that have demonstrated that the enhanced financial performance accompanies sustainability performance in order to ultimately create better competitive positions of firms (Li et al. 2006; Chang 2011; Cantele and Zardini 2018). Secondly, the competitive advantage variables used in the study were adopted and developed from diverse business and organisational disciplines, due to the lack of references in the field of port sustainability related to competitive advantage research. Hence, the items selected for the study might not be sufficient to represent the characteristics of the port operation and management setting, potentially inducing statistical model specification error (Gerbing and Hamilton 1996; Tomarken and Waller 2003).

The significant effects of interconnection between the environmental, social, and economic aspects of sustainability (H1, H2, and H3) indicates that container ports are on the right track for the transition towards sustainability, in line with the intended goals of port sustainability management that seek balanced growth between environmental and social responsibility and economic benefits. Within the context of strategic sustainability management, this finding provides evidence that port sustainability operations can support the extension of strategy formulation for port sustainability in an interconnected and integrated manner (Figge et al. 2002; Whittington 2006; White 2009). The connection between environmental and social performance (standardised coefficient=0.706) is stronger than between environmental and economic (standardised coefficient=0.229) performance or social and economic performance (standardised coefficient=0.563), suggesting that there is some environmental-social interface in practice, highlighting synergetic benefits between environmental and social sustainability performance structures within port operations and management.

Furthermore, the results show significantly the direct effects of the sustainability performance from both environmental and economic aspects on strengthening the competitive positioning of ports (H4 and H6). Hence, the present study provides evidence to suggest that container ports can benefit from developing and deploying environmental and economic sustainability-related practices or activities as a source of competitive differentiation in port reputation, port services and technology, and user satisfaction. This finding empirically reinforces the previous literature in port research, which advocate that engagement in environmental commitments, not to mention economic management practice, drives more stable and efficient port activities (Lun 2011; Yap and Lam 2013; Yang et al. 2013; Acciaro et al. 2014; Pavlic et al. 2014; Anne at al. 2015).

Unlike the environmental and economic performance, the port social sustainability performance does not appear to have a direct influence on enhancing the competitive positioning of ports (H5). However, the effect of social performance on the competitive advantage of ports was supported by being fully mediated by both environmental and economic practices (H8 and H9). The indirect robustness of social sustainability performance to competitive advantage can underline the potential roles of both environmental and economic sustainability as meaningful differentiators for port competitiveness. Therefore, this finding indicates that container ports with stronger environmental and economic performance are more likely to support a greater extent of social performance, emphasising the need for intervention of support from environmental and economic sustainability to make progress in the competitive advantage of ports. The mediating effects of environmental and economic sustainability between social sustainability and competitive advantage also reaffirms that port sustainability practices are influenced by diverse factors rather than a single factor or intervention. Additionally, the indirect impact of social performance on competitive advantage through economic sustainability (VAF=46.7%) is stronger than through environmental sustainability (VAF=36.5%). Moreover, the mediating role of economic performance has been statistically significant effects on both environmental and social performance (H7). Consistent with the existing research in the sustainability business management discipline, these findings underline that sustainability structure can be developed to be more feasible based on the continued economic expansion (Ekins 1993; Doane and MacGillivray 2001; Islam et al. 2003; Jänicke 2012; Stanković 2021).

9.3 Theoretical implication

The theoretical underpinning of this research is based on the strategy-as-practice view and the NRBV. The theoretical approach of the strategy-as-practice was adopted as a means of gaining insights into the strategy formulation by understanding a practice framework for the sustainability strategy of container ports. The conceptual framework presented in this study from a strategy-as-practice view was connected with the NRBV theory, arguing that holistic port sustainability performance encompassing environmental, social, and economic sustainability is a bundle of resources and capabilities that positively and directly contribute to the competitive advantage of ports. This argument strengthened the theoretical understanding of the strategy-as-practice view in this study that port sustainability practices constituted with key sustainability activities can be a source of competitive advantage as a practical strategy. (Hengst et al. 2020; Jarzabkowski et al. 2021).

This research adds to the NRBV in the port sustainability literature by responding to the call to test the combined effect of resources on sustainability performance in order to facilitate the development of key capabilities in organisational operations (Hart and Dowell 2011). The main objectives of this study were to identify key port sustainability activities and assess the effects of sustainability performance on competitive advantage in the context of container ports. The study finds strong empirical evidence for the positive effects of environmental and economic sustainability on the strength of the port's competitive advantage. Agyabeng-Mensah et al. (2020) argued that the initial financial capacity for sustainable logistics practices ultimately resulted in financial performance by enabling the provision of low-cost services leading to higher customer attraction which has positive impacts on market size, sales, and profitability. This study also identified the similar empirical results, providing further evidence in the port research literature that sustainability management capabilities lead to competitive differentiation performance in terms of finance, market share, and sustainability performance.

The findings of the RII analysis and SEM demonstrate that ports directly can experience the benefit of competitive advantage through environmental pollution prevention from port operations and value-added port services. From the NRBV, they imply that the competitive sources of ports can include the capability of ports to provide environment-friendly port facilities, undertake feasible sustainability management plans and assessments, and handle air and waste pollution management generated from port operations. The findings also indicate that port sustainability performance mechanism can be understood from the combined perspectives from the NRBV of pollution prevention and service stewardship strategies (Hart 1995; Hart and Dowell 2011). McDonough and Braungart (2010) explained, based on the core principles of the NRBV, that designing a sustainable product, service, or process can be achieved by preventing environmental pollution and reusing resources. Container ports actively follow port activities concerned with pollution prevention practices within their day-to-day operations such as the uptake of shore power (Hua et al. 2020), electric port facilities (Molavi et al. 2020), viable organisms ballast water management systems (Hess-Erga et al. 2019). They also follow service (process) stewardship practices of reducing, recycling, reusing, disposing of services and production processes in a socially responsible manner. Those practices are often represented as a circular economy in ports (Carpenter et al. 2018), such as sewage recycling (Vaneeckhaute and Fazli 2020), energy-saving lamps in the port area, water recycle and solar powered energy systems (Tseng and Pilcher 2019). Consequently, ports have fostered their sustainability management by providing their environmentally friendly port service (service stewardship) and conserving the natural resources and ecosystem (pollution prevention), which may be expected to gain a competitive advantage for ports (Jayarathna et al. 2022).

Furthermore, the significant, positive interconnections among the port's environmental, social, and economic sustainability performance can be explained by the notion of path dependency toward a sustainable development strategy of the NRBV propositions, which views their connections as a sequential process that begins with pollution prevention (Hart 1995; Fowler and Hope 2007; Caldera et al. 2018). This is further strengthened by the SEM results of the positive mediating effects of environmental and economic sustainability on the relationship between social sustainability and the competitive advantage of ports. It implies that ports should leverage the capability to manage pollution prevention and economic development in port operations in order to drive positive social sustainability outcomes for the competitive advantage of ports. These findings particularly corroborate the existing argument in diverse disciplines—for example, Galeazzo et al. (2014) in the manufacturing, Kwon et al. (2021) in business management, and McDougall et al. (2021) in sustainable supply chain management—

that a sequential interdependency of sustainability practices generates the synergistic interaction of sustainability practices to improve both organisational performance and competitiveness. Consequently, the association between the port sustainability performance and competitive advantage are consistent with the NRBV underpinning that environmentally sustainable economic activity is a source of competitive advantage, nurturing the strong sense of social-environmental objectives that facilitate port competitive strategies (Hart 1995; Jayarathna et al. 2020; Andersson et al. 2022). From the perspective of the NRBV, this can be led to the argument that environmental and economic performance focusing on pollution reduction through low-impact technologies or systems and processes can extent the boundaries of capability in port social performance, in turn, which determine the competitive advantage of ports (Hart and Dowell 2011).

Additionally, this study made a theoretical contribution to the port studies by adopting the strategy-as-practice view. The conceptual framework of strategy practice in this study with the linkages between practice-praxis-practitioners-outcome allowed the analysis and discussion of the sustainability practices and the implications of port managers' perceptions in the relationship between sustainability performance and the competitive advantage of ports (Begkos et al. 2020). The important concern of the strategy-as-practice view is to broaden the understanding of what, who, and how of strategy practice (Jarzabkowski 2016). This study, particularly, adds to a body of knowledge of the 'what' agenda of the strategy-as-practice by clarifying which activities of sustainability practices should be focused on when forming sustainability strategies for port competitive advantage. By doing so, this study makes a theoretical contribution to the strategy-as-practice literature and port studies in terms of strategising port sustainability performance at the operational level. Furthermore, this study contributes to building a pragmatic value to theory, which has often been criticised due to its vagueness and abstract in conceptual studies (Yoshikuni et al. 2021; Jarzabkowski et al. 2022), by demonstrating that the strategy practice model (Figure 3.3) can be measured by port sustainability practices that can lead to recognised outcomes of competitive advantage. This is also answering the several authors in the strategy-as-practice literature who has called for empirical investigations on evaluating what practices are strategic to add insight into wider phenomena that might extend the understanding of strategy (Vaara and Whittington 2012; Golsorkhi et al. 2015; Kearney et al. 2019; Jarzabkowski et al. 2022).

The NRBV focuses on what an organisation has, while the strategy-as-practice view highlights something its members do within organisations. Both perspectives are concerned with the internal capability of organisations. In fact, developing and implementing a strategy make, inevitably, strategic decisions of fundamental change in operations process and resource allocation (Bryson et al. 2022). In this sense, the strategy-as-practice view scholars have offered an integrative research attempt that interprets the strategising by further applying the RBV in order to understand the social complexity and casual ambiguity that underpin the RBV and open new insights on the dynamic capabilities view for strategising (Jarzabkowski and Spee 2009; Jarzabkowski et al. 2016; Jarzabkowski et al. 2022). This harnessing the diverse theoretical lens in the strategy-as-practice view were reinforced by Kohtamäki et al (2022) that developing a strategy in nature is drawn from the collection of crossing strategies, sequential, interplay or bridging to connect research streams. Therefore, one of the meaningful contributions of this research is to add to the current attempts of this perspective in the strategy-as-practice literature by taking the integrated theoretical lenses (Karanasios and Slavova 2019; Kearney et al. 2019; Begkos et al. 2020; Netz et al. 2020). The combined theoretical lens enriches the understanding of port sustainability performance from a strategic perspective by strengthening the argument of this study that container ports should deploy their internal resources and capabilities into strategic sustainability activities generating the value-added to port competitiveness. By integrating the findings of the RII analysis and SEM with the two adopted theoretical views, this study provides practical implications with suggestions of the directions to develop strategies for port sustainability management in the next section.

9.4 Practical implication

It has been apparent that container ports face the challenge of implementing sustainability. On the one hand, they are consistently demanded to collaborate with other ports in order to achieve the common shared goal (i.e. sustainable development). On the other hand, each port needs to sustain its competitiveness to survive intense competition. Hence, this study presents opportunities for developing sustainability practice that leads to strengthening the competitive positioning of ports from a strategic perspective through an integrated analysis of the status of sustainability performance and priorities of sustainability-related operations and management activities in ports. Decision-makers or strategists in the port industry might harness the findings to develop optimal practices in port sustainability management and formulate cogent and robust port sustainability strategies that create positive outcomes for port competitiveness.

Port sustainability strategy should include socially oriented practice. It is evident that the characteristics and principles of port social sustainability practices are a blind spot with high potential for growth. The importance of social sustainability performance is identified in the sense that it simultaneously strengthens environmental management and competitiveness of port performance. Ports with a focus on developing proactive social-practice strategies can enjoy a first-mover advantage by establishing strong recognition for specialisation in social activities. The study results confirm that human resource management-related activities are perceived as best practice in container ports. This suggests that a port can gain a competitive advantage over other competitors through the pre-emption value of key resources that actively reinforce human resource management practices such as advanced tools for external and internal communication, job training programmes, and cooperation with competent authorities. By doing so, ports will attain superior results from a lead-time advantage for developing experience and capabilities and the stakeholder's engagement, positively affecting the cost-benefit structure compared to other ports (Tetrault Sirsly and Lamertz 2008).

Particularly, ports can create competitive benefits from an incorporated approach that can realise the combined effects among environmental, social, and economic sustainability management simultaneously. For example, eco-social management may include education and training employees in environmental-related initiatives, control systems and technologies, and transparent public reporting for environmental analyses on their websites. Similarly, strategic actions for eco-economic dynamics that enable a solid financial foundation can facilitate further investment in eco-social practices. For the port industry, this can be achieved by a circular economy having components with influential factors that can differentiate it from other ports and create the strategic values of port performance.

A circular economy, closely linked with waste pollution management and energy and resource usage management, gains growing attention as a strategic means to facilitate the transition towards port sustainability (Merli et al. 2018; Sassanelli et al. 2019). As an economic system of closing loops, it involves reusing, sharing, repairing, and recycling existing materials and products. Many companies and organisations are promoted to design business models for the circular economy to maximise direct profits potential and create additional value for organisational performance while pursuing sustainability (Geissdoerfer et al. 2017). The role of container ports has been emphasised as ideal places for further development in the transition towards the circular economy practices, serving as a hub for global resource flows, a complex for international logistics and manufacturing, and inter-modal connections with hinterland and urban areas (Carpenter et al. 2018; de Langen and Sornn-Friese 2019). The circular economy within the ports, with renewable energy development and waste resource reuse as its key components, enables a synergistic approach that boosts the value created by each management process and the mutual benefits between companies and communities through circular chains (Hollen et al. 2015; Carpenter et al. 2018). Furthermore, the circular economy can contribute to the adaptation for the transition to a resilient and zero-carbon economy development emphasised recently at the Conference of the Parties 26 (COP26). Thus, the integration of the circular economy into port operations and management can be a lever for a port's competitive advantage by enabling the effective reduction of resource inputs and waste generation, and thereby reconciling the economic sustainability in the port sector with the environmental impacts (Cerceau et al. 2014; Carpenter et al. 2018).

In addition, the conflicting results between the perception of the importance of social performance and the outcomes of actual social performance suggest that approaches to systematically addressing the societal issues within the port industry are lacking. Moreover, this research identified that the structure of social sustainability is characterised by a multidimensional problem intermingled with environmental and economic sustainability activities in order to create a positive outcome to a competitive advantage of ports. Such characteristic of social sustainability makes it much harder to predict in detail what and how to tackle discrete societal-related operations, and it might be challenging to be addressed by a single port. In order for both individual ports and the port industry to benefit from social sustainability performance, it is imperative to consolidate the efforts of ports through an organised network such as the EcoPorts project for environmental management to improve the management component of social sustainability. The joint action among governments, businesses, and civil society to deliver climate goals has been highlighted at the COP26, which also reinforces the need for collaborative efforts on social sustainability actions (UN 2021). Establishing a social sustainability management system among ports through joint initiatives can enable tactically more stable and consistent standards of social practice to function and develop relevant policies.

Furthermore, this research provides insights into the importance of internal capacity that nurtures a competitive advantage in port sustainability management, highlighting the roles of port managers. When it comes to strategy formation and implementation from the strategy-as-practice approach, the decision-making process is often top-down, i.e. top managers are primary practitioners, and activities and decisions are set up from the top and disseminated downward (Johnson et al. 2003; Jarzabkowski 2007; Jarzabkowski and Spee 2009; Egels-Zandén and Rosén 2015). However, this top management bias is particularly problematic within port sustainability management systems where individuals, regardless of position or role, entail great leadership competencies in adapting to closely interlinked port sustainability operations.

The findings have shown that managers recognised critical sustainability activities differently according to their managerial capacity to influence port sustainability performance, implying a potential relationship between management levels and port sustainability performance (Mantere 2008; Gond et al. 2018). Therefore, participative decision-making involving all managers at different operational and managerial levels can be an efficient tactic in designing and delivering port sustainability strategies that create differentiated sustainability performance from other competitors (Thakhathi et al. 2019). For example, the relative importance perceptions of the sustainability activities suggest that top and middle-level port managers can participate in evaluative activities in the context of institutional management, such as planning, systemising, legislating, and assessing port sustainability management. On the other hand, the opinions from frontline port managers who give more importance to the internal environment of ports, such as human resource management-oriented activities, can be helpful to develop social-oriented initiatives such as employee training programmes and work environment improvement. Such persuasive participation of managers can also assist port strategy makers in producing detailed and specific guidelines of action that define the boundaries of responsibilities and prioritise tasks according to the organisational structure of ports, thereby enabling port managers to infuse and manifest them in practice in their daily work.

9.5 Contributions

In addition to managerial and practical implications, this research makes meaningful contributions to theory and method in the port sustainability management research, providing a foundation for practitioners and researchers in the port industry to understand and utilise sustainability within the context of port operations and management.

Firstly, this investigation was the first effort to empirically assess the impact of sustainability performance on the competitive advantage of ports. This has been insufficiently examined in the literature on port sustainability performance so far. Moreover, the evaluation was covered from a comprehensive approach that includes all the three sustainability aspects, namely environmental, social, and economic, in the measurement model, which is also the first analysis attempted by this study. This study has explicitly stated and tested the path process of the impact of port sustainability on enhancing the competitive positioning of ports, which was implicitly addressed in many previous works. Additionally, it is worth pointing out that this study expands the knowledge of port sustainability management in an integrated view by considering both “perceived” results and “measured” results. Thus, the contribution made in this study has been to provide a comprehensive picture of the relationship between port sustainability performance and its benefits in strengthening port competitiveness by providing a solid theoretical foundation on the rationale of sustainability performance in the port industry.

Secondly, this research has made a contribution to the expansion of literature regarding port sustainability performance measurement by developing and validating sustainability indicators that help to monitor port sustainability activities and their impacts. With regard to measurement items, the study generated them from a synthesising approach and confirmed their validity in the measurement model. In this sense, the contribution of this study remains in the detailed elaboration of variables into the evaluation instruments that clearly express the constructs of competitive advantage, and environmental, social, and economic sustainability, although the need for the improvement of the scales of competitive advantage has been recognised. The overall measurement model with the robust and statistically validated sustainability indicators can serve as a research framework for further empirical investigations of the relationships between these four constructs by incorporating more variables.

Thirdly, this research has made theoretical contributions to the port sustainability performance research. Grounded in the NRBV, this research shed light on its concepts of sustainable development strategy for container port operations and management by illustrating how sustainability practices are interconnected and can be applied to confer better operational performance from a competitive view. This is an important contribution to the NRBV research as most previous research has focused mainly on pollution prevention and product stewardship capabilities (Hart and Dowell 2011). Furthermore, there has been little attention in the field of port sustainability research in adopting the NRBV to understand the association between sustainability management and organisational performance in the port operations and management context. In this sense, this research made a theoretical contribution to the port sustainability literature by clarifying the sustainability performance-competitive advantage linkage from the NRBV. In addition, this research has introduced the strategy-as-practice approach to the field of port research, contributing to the expansion of the theoretical knowledge of port sustainability management from a strategic perspective. The strategy practice-based view has been widely applied in a strategic organisational management discipline to provide a clear understanding of the process of sustainability work within organisations and to incorporate it into operational and managerial systems as a strategy for benefits (Vaara and Whittington 2012; Gold and Heikkurinen 2013; Egels-Zandén and Rosén 2015; Silva and Figueiredo 2017; Gond et al. 2018; Thakhathi et al. 2019). However, it has not been utilised in the port research areas. By adopting the approach, this study comprehended the logic of sustainability in the context of port operations and management. In addition, a strategy practice framework has been developed and contributed to embodying the practice of port sustainability into purposive strategic activities to produce desirable outcomes. Given the rarity of in-depth discussions on practices in port sustainability studies from a strategic perspective, this study contributes to a foundation for a further open and profound dialogue on strategic port sustainability management.

Fourthly, this study offers insight to decision-makers seeking to manage port sustainability in a more standard way by adding useful information on best practices. The priorities of sustainability activities presented in this study can be employed to set specific targets to ensure the competitive advantage of port and update a list of determinants of sustainable activities. Port managers and decision-makers can apply the identified priority information to effectively and efficiently allocate port resources to actions that lead to positive outcomes in terms of port competitiveness. Additionally, this study presented the priority of sustainability activities for the competitive advantage of ports from a holistic perspective by considering its importance concerning different conditions such as port region, port size, and port manager's role level. The classified priorities can be utilised as benchmarking information to identify areas for improvement in sustainability activities and realign and create a meaningful activity-focused strategy and supporting policies.

Fifthly, this study has made important contributions from a methodological perspective. SEM, which has been adopted to examine the direct and indirect relationships between the study constructs, has been overwhelmingly used in many research fields, including port research. However, this analytical tool has only recently been introduced in the field of port sustainability research (e.g. Lu et al. 2016a; Sislian and Jaegler 2018). Therefore, the analysis process and requirements thoroughly described and practised in this study can be practical guidance to researchers in the field of port sustainability research who are interested in applying this technique. In addition, the RII approach has been adopted, which is the first attempt using this technique in port research. Traditionally, the AHP technique has been favoured as a type of relative importance analysis. By introducing the RII technique as an alternative method for prioritising attributes, this study opens the door to an opportunity for port researchers to compare the advantages and disadvantages of diverse analytical approaches, contributing to the methodological expansion in the field of port research.

9.6 Limitations and directions for further research

Despite the essential findings and contributions, there are limitations of the study that need to be considered. This research designed a cross-sectional study, which was useful to define a snapshot of the current position of container ports. However, the conclusions of the present study cannot be used to determine causality that might exist in the research model because it is not possible to distinguish between short- and long-term effects; instead, the analysis can report levels of association only. Future studies with longitudinal data can provide insight into how port sustainability performance can reach the final goal in practice by identifying cause-and-effect relationships between the variables and leading to another image of trend and change of performance and priorities regarding port sustainability over time. Furthermore, this study from a positivist perspective could only provide an objective investigation and accordingly is unable to expound why the different or similar patterns of priorities have been perceived or how the particular relationship can be explained. In-depth follow-up interviews with respondents need to be considered in future studies to answer these questions.

The systematic literature review included articles focused on evaluating port sustainability performance using quantitative tools. Meaningful qualitative indicators uncovered in the previous studies were not reflected, and thus this study could not reveal more abstract facets and structure, for example, cross-activities interactions and linkages and connectivity of sustainability activities. Additionally, although port sustainability performance has been observed as a growing field of research that has not reached maturity, the number of articles considered for this study is limited. This may be because the systematic literature review considered only peer-reviewed journal articles, which also implies that this study is limited in acknowledging important recent aspects. Thus, in future studies, port sustainability performance should be evaluated by identifying more related articles encompassing book chapters, conference proceedings, dissertations and theses, and other grey literature such as government documents, white papers, reports and working papers.

This research relied heavily on measurements from the previous literature. Although their validity and reliability have been verified through a valid process by the researchers, the possibility of missing essential variables that might be discovered through interviews cannot be overlooked. As mentioned earlier in the discussion, the variables measuring competitive advantage were selected and adapted from diverse management disciplines. Accordingly, the variables of competitive advantage used in this study may not be fully representative to measure the competitive advantage of ports. Future research needs to consider developing the measures suitable for evaluating the competitive advantage of ports that include both aspects of sustainability performance and financial and economic performance.

Additionally, this study does not cover the technical aspects of port sustainability that have been addressed in the previous studies (e.g. Woo et al. 2011), such as equipment utilisation, terminal efficiency, and labour productivity. This also excludes digital technologies which have been recently identified as a key factor of sustainability performance and competitiveness in ports (see Tijan et al. 2021; Cammin et al. 2020; González-Cancelas et al. 2020; Philipp 2020). Hence, future research should be expanded by considering physical and technological factors of port sustainability and pursuing a more in-depth investigation of sustainability activities that affect the port's competitive advantage.

This research limited the study target to container ports, which might pose the issue of generalising the research findings to other types of ports such as dry, bulk cargo, and oil ports. Moreover, the study data was disproportionately collected across the regions, from a maximum of 22 responses to a minimum of 1 response. A large sample with a more balanced set of responses across countries would give greater confidence in the measurement model and the perceptions of priorities, increasing the level of credibility and generalisation of the findings.

In addition, this study presents various directions for future research based on the research results. The present study has identified that the relationship between social sustainability performance and competitive advantage is mediated by environmental and economic sustainability performance. The mediating effects imply that social performance is within a complex system engaged in various factors where there may be unmeasured exterior factors.

However, the studies on social sustainability performance have been overlooked in port research, contrary to its high importance recognised in the port industry. The lack of academic development and contributions to port social sustainability implementation makes it difficult to obtain data identifying various social sustainability factors and measure the impact of social sustainability on port operational performance accurately. Therefore, the focus on enlightening critical elements in determining the effectiveness of social sustainability performance in the port operations structure should be considered in future studies.

The mediating roles of environmental and economic sustainability to the relationship between social sustainability and the competitive advantage of ports also imply that there might be a unique structure among sustainability activities in port operations. Therefore, future research can focus on elucidating this hidden structure by further adding mediating effects among environmental, social, and economic practices determining port competitiveness. In a similar context, another possible future direction is to consider moderating effects, e.g. port size, as much organisational management literature has recognised firm size as a moderation or control variable to determine the impact of sustainability management on operational performance (Hernández et al. 2020; Sardana et al. 2020). Future research that considers mediating or moderating effects can provide a more definitive account of how port sustainability practices relate to competitive advantage.

Future research could also explore in more depth how multiple practitioners within the ports shape the boundaries of strategies for sustainability management and affect the effectiveness of port sustainability operations. One possible extension of this analysis points to determining a set of micro-level actions that define sustainability performance according to the role of port managers and clarify the boundaries of activities and practices for port sustainability performance in a more strategic way. This way can provide a clearer picture of sustainability performance by explaining the implementation of port sustainability in the culture and structure of the port industry and clarifying the pathways of managerial influence on port sustainability practice. Moreover, the detailed list of activities can be valuable information in developing robust and sophisticated research instruments to measure port sustainability performance and establish the priorities of sustainability activities that contribute to competitive advantage and deliberate strategy formulation.

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Appendices

Appendix A. The systematic literature review published in a journal

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Port sustainability and performance: A systematic literature review

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A B S T R A C T

Motivated by a lack of research on port sustainability performance and assessment, this paper uses a systematic literature review to identify trends, measurement methods, and mechanisms for the implementation of strategy and policy in this area. The paper provides a comprehensive and critical evaluation of port operational sustainability, focusing on ascertaining the impact of its implementation. The study analysed and synthesised established characteristics in the current literature regarding the performance of port sustainability and its evaluation in terms of operations and management. Successful performance measurement in port sustainability is driven by the dependence on establishing accurate indicators as the basis for measurement. Our clustering of analytical sustainability indicators reveals that environmental research is focused on pollution, social research is mainly focused on human resource management, while economic research is mainly on port management and borderline investment. Findings are discussed in four key areas of port sustainability performance and assessment: existing trends, implementation of measures, mechanisms for implementation, and assessment gaps and challenges. For existing trends, attempts to evaluate the applicability and practicality of green operations have improved the awareness and promotion of governmental green policies. Implementation measures relate to the utilisation of techniques that reveal optimal practices for practical sustainable operations while mechanisms largely relate to establishing indicators which increase understanding of performance. Finally, challenges in this field include achieving consistency among ports in how sustainability is measured. Future research should incentivise improvements in port operational practice and encourage self-examination in order to reprioritise activity.

1. Introduction

Maritime transport plays a pivotal role in international logistics chains, and acts as a facilitator of economic growth between regions and countries (Clark et al., 2004). Fuelled by globalisation and containerisation, international seaborne trade volumes reached 10.7 billion tons in 2017, with a growth rate of 4 per cent over the last five years. Shipping also accounted for more than 80 per cent of the world's merchandise trade transport (UNCTAD, 2018). Even though maritime transport has been regarded as an environmentally-friendly mode of transport in terms of emissions per kilometre, given the share of maritime transport in total world trade, its impacts on the environment are not negligible. Furthermore, port authorities have extended their port infrastructure in order to satisfy the growing demand for the maritime transport and logistics services, and to accommodate the wide range of container vessels size (Notteboom and Rodrigue, 2005; Yang and Chen, 2016). Thus, increased international seaborne trade and port expansion have led to significant adverse effects on the environment including increased noise, reduced air quality, biodiversity loss, and water pollution, as well as impacts on public health and safety (UNCTAD, 1993; Endersen et al., 2003; Corbett and Winebrake, 2007).

With global regulations regarding environmental issues in maritime transport being developed and enacted, for example the MARPOL regulations (Zhang, 2016) and the Kyoto Protocol (Bodansky, 2016), ports are facing greater pressures to comply with regulatory and societal requirements for operational sustainability. Ports have had to take progressive action in this area because it has become a paramount consideration when shipping companies are determining which port to use (Thai, 2016; Parola et al., 2017;

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Ding et al., 2019). A port which is operating at a high level of sustainability is more likely to attract support from the government, communities and the public, as well as potential investors in the maritime industry (UNCTAD, 2015). Ports have thus increasingly had to make costly investments to achieve regulatory compliance and improve their Corporate Social Responsibility image (Acciaro, 2015). However, given that port operators will ultimately aim to increase profits and only invest where necessary, whereas sustainable port development strategies potentially require heavy financial investment, it is still unclear if the concept of port sustainability is successful or has yielded positive outcomes.

As incompatibility between sustainable management and economic advantage continues to emerge in ports and related activities (Yang et al., 2013; Hou and Geerlings, 2016), previous literature on sustainability performance in ports has reflected understanding of global sustainable development issues in the context of ports, for example, incorporating sustainability challenges into operational practices and strategies and increasing sustainability performance capability from a management perspective. Research has delivered insights into practices and operations regarding port sustainability performance, which have mainly been addressed from three perspectives; performance measurement (Peris-Mora et al., 2005; Chiu et al., 2014; Asgari et al., 2015; Shiau and Chuang, 2015; Lu et al., 2016a); performance management (Videira et al., 2012; Hiranandani, 2014; Lam and Notteboom, 2014; Le et al., 2014; Kim and Chiang, 2017); and the relationship between the three aspects of sustainability examining the effects of environmental or social management on economic performance in the context of ports (Anne et al., 2015; Laxe et al,. 2016; Cheon, 2017; Cheon et al., 2017).

Notwithstanding significant relevant contributions and insights into port sustainability performance from the growing body of literature, further questions emerge; how does the literature on port sustainability performance and its evaluation contribute to fulfilling the goals of sustainability?, and what are the managerial implications of sustainability performance within ports? Further, reflecting on sustainability in port performance identifies a gap in the literature; a comprehensive review of port sustainability performance and assessment does not exist.

This study aims to provide a synthesised view of sustainability performance in the context of ports by understanding operational and managerial implications with a specific focus on assessing sustainability performance from both methodological and empirical perspectives. Performance evaluation plays a strategic role in all areas of business management, helping to explain to what extent they have reached their goals (Dyson, 2000). Therefore, improving understanding through a systematic analysis of the existing literature is a suitable approach to assess the current situation and provide evidence for future port sustainability approaches. However, although this study is not the first to examine the concept of port sustainability using a systematic literature review (see Hakam and Solvang, 2013; Sislian et al., 2016; Davarzani et al., 2016), it is the first to use such an approach to consider port sustainability performance and evaluation.

This study is distinct in two ways from previous systematic literature reviews in this area. First, the focus of this study is on port sustainability in terms of its performance and evaluation, which has, to date, not been covered. Second, in contrast to previous studies which focused on environmental aspects of sustainability, this study covers port sustainability performance from three perspectives; environmental, social, and economic, and categorises aspects of sustainability using clustering of sustainability analytical indicators. Another important contribution of this study is that it covers a period of significant increase in publications on this topic between 2005 and 2018, with 2017 accounting for approximately 29% of the total. Table 1 positions the contribution of this research against other studies that focus on reviewing port sustainability research.

Using a rigorous review approach, this paper provides (1) overall knowledge regarding the current state of port sustainability performance and its assessment, (2) useful evidence of key indicators to decision makers in implementing port sustainability, and (3) suggestions where academic research has the potential to make new contributions in the field of port sustainability performance. The subsequent sections cover the following: first, the definition and scope of port sustainability and a literature review on port sustainability are presented; second, the research methodology adopted for the research is addressed; third, a discussion about the research questions is conducted; and lastly, conclusions are drawn and contribution outlined.

2. Literature review

Many publications have considered sustainable management in the port industry, although many of them discuss sustainable management of ports as one part of maritime logistics, shipping, and supply chain management (e.g. Ng and Song, 2010; Berechman and Tseng, 2012; Bergqvist and Egels-Zandén, 2012; Hou and Geerlings, 2016). Therefore, in line with the research aim, this section provides a considered review aimed at addressing sustainability in the context of ports.

2.1. *Port sustainability*

The increase in volumes carried by maritime transport has led to the expansion of port facilities and resources related to port activities, often causing severe environmental pollution (e.g. Rao et al., 2000). Operational outputs in port areas including water discharge, effluent discharge, noise, dust, greenhouse gas emissions, and dredging spoil disposal, have had detrimental environmental consequences as well as creating security, safety, and health issues for employees (UNCTAD, 1993; Peris-Mora et al., 2005; Acciaro et al., 2014). These issues have increased the need for consideration of a sustainability concept in the port sector.

Port sustainability is rooted in the three pillars of sustainable development that embrace environmental, social, and economic goals (AAPA, 2007). Its main purpose is to seek a safe, socially acceptable, energy-efficient, and environmentally friendly port management approach while at the same time maximising profits (AAPA, 2007; Hakam and Solvang, 2013). Practical and multidisciplinary management techniques are required to integrate the socio-economic, legal, technical, and environmental practices, and to analyse the performance of sustainable responsibilities with appropriate data of components of sustainability (Wooldridge et al.,

Table 1
Position of this study in the context of port sustainability research.

Reference	Title of study	Period covered by the study	Scope of research	Focused aspect of sustainability
Hakam and Solvang (2013)	Container port sustainability	1985–2012	Port sustainability and related initiatives	Environmental aspects
Sislian et al. (2016)	A literature review on port sustainability and ocean carrier's network problem	1987–2013	Port sustainability and Ocean Carrier's Network Problem	Environmental aspects
Davarzani et al. (2016)	Greening ports and maritime logistics: A review	1975–2014	Green ports and maritime logistics	Environmental aspects
This study	Port sustainability performance: A systematic literature review	1990–2017	Port sustainability performance and evaluation	Environmental, social, and economic aspects

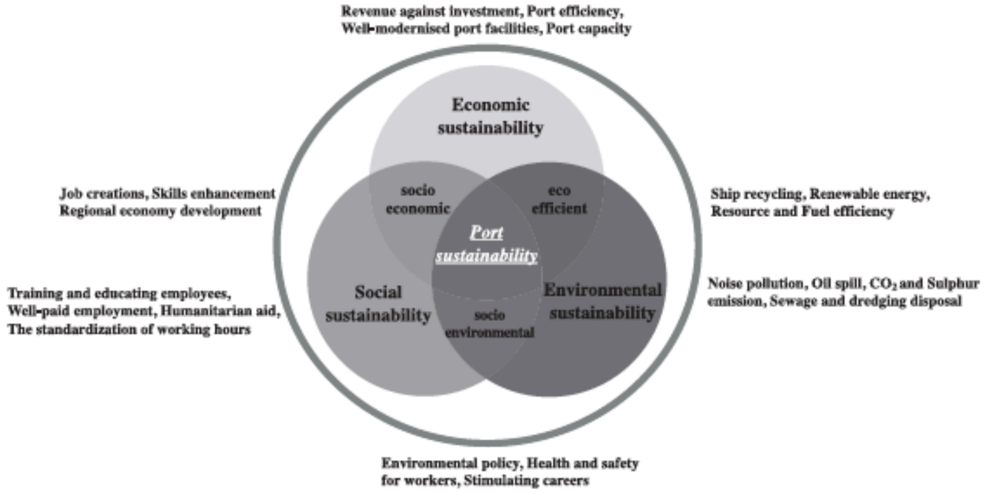

Fig. 1. The three pillars of port sustainability (Source: Authors).

1999). Fig. 1 illustrates the three pillars of port sustainability.

The goals of each of the three pillars from a port perspective can be summarised as follows:

- Environmental sustainability: minimising the negative impacts engendered by a wide range of operational and shipping activities within the vicinity of ports (Narula, 2014; Shiau and Chuang, 2015).
- Social sustainability: contributing to the enhancement of people's quality of life by supporting port activities to satisfy socio-economic priorities such as employment opportunities, education for employees and communities, and improving social stability of the area surrounding ports (Narula, 2014).
- Economic sustainability: maximising the economic performance resulting from implementing sustainable development initiatives, without adversely affecting social and environmental development (Cabezas-Basurko et al., 2008).

2.2. Port sustainability literature

Ports are inherently complex systems interlinked with numerous internal and external factors together with broader port functions such as, for example, socio-economic issues (Parola and Maugeri, 2013). Indeed, each port establishes and implements individually different operational management strategies depending on the characteristics of geographical position, size, ownership, policy, administration, and stakeholder (Abood, 2007; Li and Yang, 2010; Dinwoodie et al., 2012).

Academic interest in port sustainability has been addressed from a variety of viewpoints: the ecology of port logistics system (see Li and Yang, 2010; Martinsen and Björklund, 2012; Psaraftis, 2016); the environmental impact costs of shipping operations (see Ng and Song, 2010; Lun et al., 2016); the analysis of exhaust emissions from vessels activities (see Abrutytė et al., 2014; Winnes et al., 2015; Papaefthimiou et al., 2016); and the viability of regulatory and political frameworks in terms of environmental port management (see Wooldridge et al., 1999; Gilman, 2003).

Ports need to consider the integration of environmental concerns into their activities (Beleya et al., 2015; Roh et al., 2016). Environmental sustainability is an essential component of sustainable business strategies and operations in the port sector, in order for them to comply with sustainable development regulations, polices, and guidelines (Puig et al., 2015; Kim and Chiang, 2017; Rocha et al., 2018). This is particularly evident in port activities such as dredging, material disposal, and cargo loading and unloading. In this sense, research related to port sustainability has been focused on such daily port activities in order to promote environmental port performance including, for example, waste oil processing, exhaust emissions reduction, renewable energy generation, energy efficiency initiatives, and noise, waste, and other polluting substances reductions (e.g. Bateman, 1996; Rao et al., 2000; Joseph et al., 2009; Lashin and Shata, 2012; Beleya et al., 2015; Di Vaio et al., 2018).

Research has demonstrated sustainable port operational approaches in a number of ways. (e.g. I2S2, 2010; Homsombat et al., 2013; Shiau and Chuang, 2015). For example, Abood (2007) investigated sustainability initiatives featuring port development and operational activities, and categorised them using a green rating system. More recently, Kim and Chiang (2017) conceptualised the structures and attributes of sustainability practices related to port operations through semi-structured interviews. Regarding research on port sustainability practices, most try to understand their complexities, and in many cases the various conceptual frameworks have been presented in order to realise sustainable port development (e.g. Acciaro et al., 2014; Hou and Geerlings, 2016). More recently, there has been a surge in port sustainability research which in itself demonstrates the importance of port sustainability (e.g. Park and Yeo, 2012; Liao et al., 2016; Puig et al., 2015; Wan et al., 2018). Gonzalez-Aregall et al. (2018) address port sustainability in the context of port hinterland interactions by identifying individual green strategies and measures taken at 76 ports. The authors emphasise the importance of environmental measures taken within hinterland activities to achieve successful sustainable development approaches.

Globally, ports are operated and managed under the different forms of port administration and ownership. Some ports are controlled by central government in a way that includes all regulation and landlord functions; some are operated under mixed public and private service provision. In the western world, ports are, in many cases, private organisations being fully privatised with all regulatory and operational functions transferred from the public to the private sector and aiming to maximise profits with reduced financial investment (Van den Berg and De Langen, 2017; Baird, 2000; Cullinane and Song, 2002; Brooks, 2004). Regardless of the governance structure of ports, the ultimate aims of any port are to maximise operational productivity and efficiency, and to optimise overall direct and indirect economic benefits. The mechanics of this lie in achieving operational efficiency and financial stability, and in building sustainable revenue streams within a specific resource base and budget. (World Bank, 2007; Van den Berg and De Langen, 2017). On the one hand, the concept of sustainability has been identified as one of the key factors influencing the improvement of port competitiveness (Woo et al., 2011; Park et al., 2015; Parola et al., 2017), on the other hand sustainability is required to remove or minimise risk, abandoning short-term gains inherent in, for example, committing to additional investment, and bearing additional external costs such as environmental costs related to CO_2 emissions (EC, 2003; Tichavska and Tovar, 2015). Hence, sustainable economic growth is one of the critical agendas for port authorities, and an ongoing debate has been focused on the balance between environmental and social concerns, and economic importance (Nebot et al., 2017).

However, it is a complex task to assess sustainability performance or establish evaluation criteria in that sustainability itself is entwined with a multitude of internal and external factors (Robert et al., 2005; Magee et al., 2013). This complexity has contributed to developing diverse quantitative indicators to assess sustainability performance in the context of ports (see Lirn et al., 2013; Puig et al., 2014; Roos and Neto, 2017; Oh et al., 2018), and to weight them via tools and evaluation methods including Environmental Management Systems (EMS), Analytic Hierarchy Process (AHP), and synthetic index calculation methods (see Chiu et al., 2014; Le et al., 2014; Liao et al., 2016; Lu et al., 2016b; Laxe et al., 2017; Jiang et al., 2018). In addition, assessing port sustainability performance has had to account for complementary and multidimensional approaches with view to determining the economic effectiveness of sustainability objectives. For example, Cheon (2017) focused on the socio-economic impacts of port activities, while Asgari et al. (2015), Laxe et al. (2016), and Cheon et al. (2017) analysed the relationship between economic and environmental performance.

Although sustainable port development appears to have increased in importance, there remains only a limited amount of literature addressing sustainability issues in port operations, compared to the other modes of transport such as road and urban transport systems (Cabezas-Basurko et al., 2008). As highlighted earlier it is clear that systematic literature review papers, even up to the present time, in the area of port sustainability have not extended to cover social and economic aspects, an issue which this paper now addresses. Besides, the difficulty in understanding the structure of port sustainability performance has been highlighted because port sustainability faces complex decision-making processes (Mansouri et al., 2015). Even though a variety of aspects have been covered, and valuable insights have been provided in the literature, an integrated framework for evaluating port sustainability performance has not yet been developed.

3. Methodology

A systematic literature review methodology was used in order to gather and explore literature addressing the theme of evaluating port sustainability performance. The port sustainability research field has been regarded as being at a relatively early stage in its evolution (see, for example, Asgari et al., 2015). Petticrew and Roberts (2008) suggested that conducting exploratory research through systematic literature reviews was appropriate when a phenomenon was at the developmental stage and research questions were unclear. In this section, the application of each steps of review process is described in detail.

3.1. Systematic literature review

A systematic literature review is defined as 'a systematic, explicit and reproducible method for identifying, evaluating and synthesising the existing body of completed and recorded work produced by researchers, scholars, and practitioners' (Fink, 2013). It is a scientific method designed to investigate and classify large bodies of information, contribute to exploring the frontiers of research, and establish and expand background knowledge (Gu and Lago, 2009). A systematic literature review provides an evidence-informed approach which highlights relevant research studies and questions (Denyer and Tranfield, 2009), and identifies, appraises, and synthesises existing original data from primary research with explicit search strategies and procedures in order to answer particular questions (Petticrew and Roberts, 2008).

Nonetheless, insufficient attention has been given to the systematic literature review as a research method in the field of port sustainability research. An integrated review of the evaluation of port performance and assessment in the context of sustainability has not, to date, been undertaken. The following literature studies focused on one topic (port sustainability or the evaluation of port performance) and provided fragmentary evidence; Hakam and Solvang (2013) adopted a systematic literature review in order to understand the issues and patterns in sustainability of container ports; and Dutra et al. (2015) attempted a more methodical systematic literature review by using a bibliographic portfolio, 'ProKnow-C' (Knowledge Development Process – Constructivist) for the purpose of analysing elaborate future research streams on the evaluation of seaport performance.

The use of a systematic literature review in this study is supported by Dutra et al. (2015). They show that a critical analysis of the literature around performance evaluation in port management can support the decision-making process to establish sound policies for port development. Also, Tranfield et al. (2003) highlighted that a systematic literature review enables the identification of effective and efficient evidence based on policy and practice in many disciplines. Therefore, this study, synthesises the evidence of port sustainability performance, and contributes by providing ideas and recommendations for practice.

This study adopts a review protocol proposed by Denyer and Tranfield (2009) for conducting a systematic literature review in the field of management studies. The review protocol involves five major phases: (1) Question formulation; (2) Locating studies; (3) Study selection and evaluation; (4) Analysis and synthesis; and (5) Reporting and using the results. Each step contributes to minimising errors and bias in appraising the review. The review in this paper uses the methodological features and contributions previously defined by researchers in this field.

As pivotal players in international trade and logistics, the important roles of ports cannot be overstated. Despite periodic variations in the performance of the global economy, ports consistently handle over 80 percent of global trade, realising market access, links to industrial activities, support to supply chains, and a range of wider economic benefits (UNCTAD, 2018). Depending on location, function, and the types of ship served, ports are classified into various types such as cruise ports, inland ports, and dry ports. Globalisation and integration of transport networks in the maritime logistics industry have led to the rise of containerised cargo (Chen, 2009), and therefore container ports handing cargo containers, in particular, have become central to maritime transport activities. World seaborne container trade accounts for approximately 60 percent of the value of total world seaborne trade (Statista, 2018) which stood at 752 million TEUs in 2017 (UNCTAD, 2018). However, with the constant expansion in container trade volumes, container ports are also known to be significant contributors to environmental impact through operational activities (Lam, 2011).

The anthropogenic impact of container ports has motivated many researchers in the port industry to re-examine the role of container ports in sustainable maritime logistics beyond traditional performance levels such as operational efficiency, cost reduction, and the increase in trade volumes and to re-evaluate performance challenges for container ports in terms of environmental and social issues. In this sense, it was considered to be reasonable to delimit the scope of the research to container ports to facilitate information gathering on port sustainability and to provide an integrated analysis on a common basis. The term "ports" in this paper is henceforth taken to mean "container ports", and sustainability is bounded on port operations and management. Hence, the focus of the review is on the investigation of port sustainability performance from operational and managerial aspects regardless of the characteristics and functions of those ports.

3.2. Research question formulation

Determining the focus of research by formulating clear research questions is essential in all disciplines, but is of paramount consideration in conducting a transparent and rigorous systematic literature review. This is due to the fact that it reflects a variety of approaches, assumptions, and methodological implications from primary research. The appropriate research questions are established before starting the review because the major components of a systematic review such as eligibility criteria, and search strategies are contingent on research questions. An approach called PICO (Population, Intervention, Comparison, Outcomes) has been developed to help to establish definite research questions at an early stage of the review and to preclude inefficient effort that refines them repeatedly during the review process. Denyer and Tranfield (2009) restructured the approach into CIMO (Context, Interventions, Mechanisms, Outcomes) to accommodate the research domain of business management and organisation.

The main aspects of this study were identified by the CIMO as: performance of sustainability operations in ports (C), methods of the assessment of port sustainability performance (I), indicators and tools regarding port sustainability performance (M), and the effectiveness, efficiency, positive and negative results of implementing port sustainability (O). Based on this, the research questions were defined as following.

- *RQ1*: What are the existing trends in port sustainability performance and assessment research?
- *RQ2*: How are port sustainability performance and assessment measures implemented?
- *RQ3*: What are the mechanisms that exist for the implementation of port sustainability performance and assessment?
- *RQ4*: Which gaps and challenges in this research field can be identified?

3.3. Identifying studies

After establishing the specific research questions, the next step was to locate the existing works which were relevant to answering the research questions by identifying search databases and search strings (Smith et al., 2011). Locating studies involved three search strategies: search terms, databases for literature search, and inclusion and exclusion criteria.

3.3.1. Search terms

Based on the research questions and the main topics defined earlier by the CIMO, the initial search strings included the following key terms: "port sustainability", "performance", and "evaluation". According to an iterative process for a keyword structure presented by Davarzani et al. (2016), and previous literature review studies of port sustainability (see Gimenez and Tachizawa, 2012; Reim et al., 2015; Wong et al., 2015; Centobelli et al., 2017), the structured keywords were determined: *"port"* OR *"container port"* OR *"seaport"*; *"sustainability"* OR *"sustainable development"* OR *"green"*; *and "performance assessment"* OR *"performance evaluation"* OR *"performance measurement"* OR *"green port performance"*.[1] Fig. 2 illustrates the iterative procedure to establish keyword for effective searches.

The searches were run using all possible combinations between the three types of keywords. An asterisk was used at the end of the

[1] Based on a suggestion from an anonymous reviewer we added the key word "green port performance".

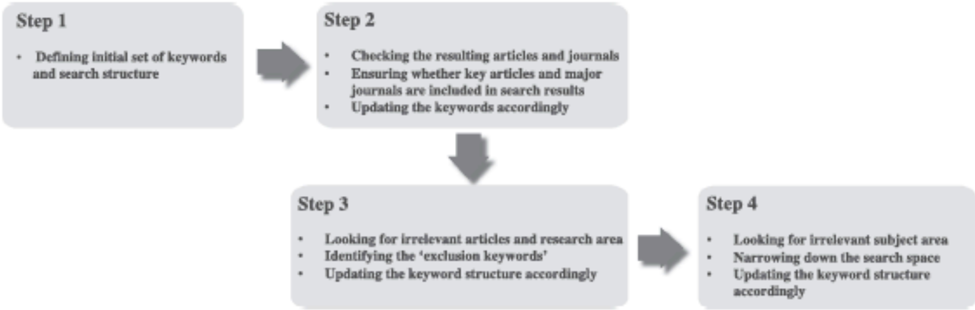

Fig. 2. Redesigned iterative procedure with the search keywords process of Davarzani et al. (2016).

keywords to expand the range of possible studies (Gimenez and Tachizawa, 2012), considering different derivatives for the same terms, e.g. "sustainable" is derived from "sustainability". Additionally, the advanced search used Boolean logic: "AND" to connect the two key terms; and "OR" to allow synonyms (Gu and Lago, 2009). In order to thoroughly explore the relevant literature, the keywords focusing on each of the three aspects of port sustainability were additionally searched, for example, *"container port"* AND *"environmental OR social OR economic"* AND *"performance assessment"*.

3.3.2. Database for literature searches

The initial online searches were conducted using the Scopus database (Elsevier). Additionally, iterative literature searches were conducted to reduce the risk of missing literature (Barnett-Page and Thomas, 2009), and enhancing the sensitivity of the review process. Thus, an exhaustive search of a wide range of databases was also conducted (Petticrew and Roberts, 2008). Various electronic international journal databases available were used including EBSCO, Emerald Insight, Google Scholar, Web of Science as well as a university library database, which provides a comprehensive and diverse database in business and management disciplines (Wong et al., 2015). In the same vain, as the published literature is to a considerable degree interlinked (Srivastava, 2007), a manual search of the reference lists of reviews was necessary in order to ensure a more comprehensive landscape of literature review that could be obtained (Schryen et al., 2015).

3.3.3. Inclusion and exclusion criteria

Only peer-reviewed articles published in academic journals were included in the study (Colicchia and Strozzi, 2012). The exclusion criteria encompassed conference articles, book chapters, dissertations and theses, and other 'grey literature' (Petticrew and Roberts, 2008) including reports, working papers, government documents, and white papers (Boland and Dickson, 2013). Often the contributions of such work can be found in the completed version in academic journals (Davarzani et al., 2016). Given that discussions on sustainability in maritime logistics have gradually developed since 1990 (Hakam and Solvang, 2013), the period of time considered by the study was therefore determined to be from 1990 to the present. Also, only articles available in full-text in English were selected in this study. Furthermore, since the focus of this study is on port sustainability performance and assessment, only articles covering the methods or measures for performance assessment were included. In other words, those focused on establishing a conceptual approach and frameworks were excluded from the study. Summaries of the inclusion and exclusion criteria are detailed in Table 2.

3.4. Study selection and evaluation

Using the keyword combinations detailed in Section 3.3.1, an initial search identified a total of 704 papers. The results of the search through individual electronic databases are illustrated in Fig. 3.

This study's inclusion and exclusion criteria were based on the recommendations of Pittaway et al. (2004) and Petticrew and

Table 2
Inclusion and exclusion criteria (Source: Authors).

Inclusion criteria	• Research published in academic journals • Full access to full-text • Peer-reviewed research articles • Research published since 1990 • Research covering port sustainability performance and assessment
Exclusion criteria	• Research not covering port managerial sustainability • Non-English • Research focusing on conceptual approach and frameworks • Gray literature, conference articles, working papers, commentaries, editorials book review articles, dissertations, and books

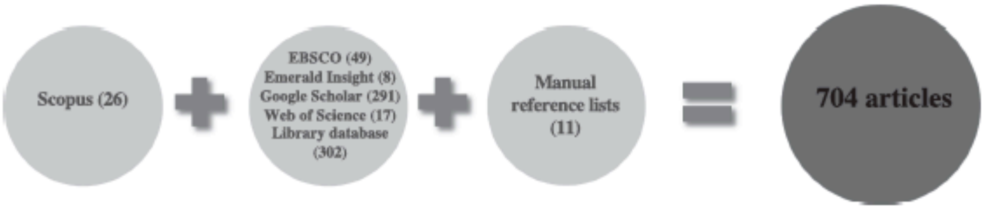

Fig. 3. Number of articles identified through initial database search (Source: Authors).

Roberts (2008). Three filtering processes were established for the purpose of increasing the reliability of article selection. First, refining based on the scope of the papers was accomplished using the context provided by the abstract together with the keywords. Since it is unlikely that the paper title adequately reflects the papers relevance to the research questions, the abstract provides a broader summary of the paper (Gu and Lago, 2009). Papers not falling within inclusion criteria such as non-accessibility to full text, articles, conference paper, book chapters, and non-English papers were filtered at this stage. The research scope was also considered in this step. Since this study was concerned on the area of ports, articles covering irrelevant subjects, for example, shipping, ship-related, supply chain management, maritime logistics, logistics, climate change, transport, marine environment, international trade, education, were excluded even if they covered the concept of sustainability. Also, a large number of duplications resulting from the repetitive search using the electronic databases were eliminated. On this basis, the number of articles was reduced to 68.

Second, the papers were categorised using the following quality criteria (Pittaway et al., 2004; Petticrew and Roberts, 2008; and Easterby-Smith et al., 2012).

- List A: Papers whose abstracts/contexts focus on both port managerial sustainability and performance assessment (32 papers).
- List B: Papers whose abstracts/contexts mainly focus on performance assessment but cover scarce or insignificant reference to port managerial sustainability (25 papers).
- List C: Papers whose abstracts/contexts mainly focus on port managerial sustainability but cover scarce or inconsistent reference to performance assessment (11 papers).

The 36 papers contained in List B (25 papers) and List C (11 papers) were determined to be extraneous to the central research and questions and excluded since this study focuses on the performance evaluation of port managerial sustainability. The 32 papers identified in List A using the second filtering process were included due to their consistency with the scope of the research.

Last, a thorough examination of the context was carried out separately with a focus on the inclusion and exclusion criteria as well as the research questions specified earlier. After assessing the full context of the papers, a further 11 articles were excluded, and consequently a total of 21 articles containing useful information for answering the research questions were selected. Through the iterative filtering process, the number of papers reduced from 704 to 21, primarily for two reasons; redundancy and duplication identified using the iterative process from the previous steps in finding studies; and a lack of literature covering empirical evidence of sustainability performance in the context of general operation and management of ports (Hakam and Solvang, 2013). The complete filtering procedure for selecting papers is shown in Fig. 4. All reviewed papers are listed in Appendix A.

The final sample size of 21 papers (a 97% reduction from the original 704 papers) is consistent with other studies of this type. Although, 13% higher than Davarzani et al.'s (2016) study on greening ports and maritime logistics, which started with an initial sample of 2,180 papers and finished with a final sample of 228 papers (84.4% reduction), this study aligns with other literature review studies in supply chain management. On average the decrease in sample size in such studies from initial to final samples is between 95% and 98% (see Miemczyk et al., 2012; Abidi et al., 2014; Gimenez and Tachizawa, 2012; Tachizawa and Wong, 2014). A further example, is a study in software engineering (Kitchenham et al., 2009) where they analysed only 18 papers a decrease from original sample size of 99.3%.

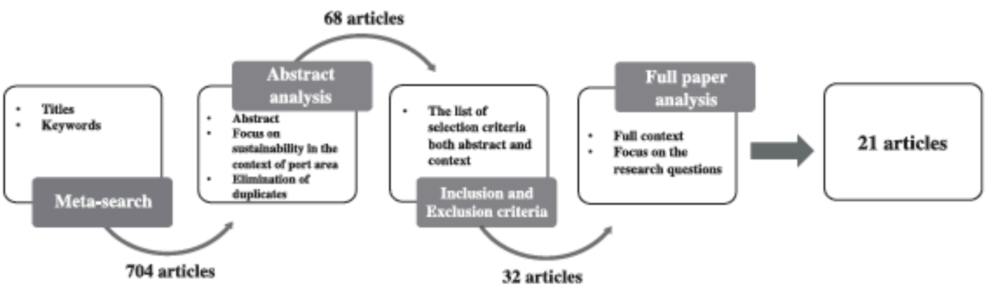

Fig. 4. The procedures of selecting and filtering of the articles (modified from Abidi et al. 2014).

Fig. 5. Distribution of the ports' geographical locations (Source: Authors).

3.5. *Analysis and synthesis*

This section provides a descriptive overview of the information obtained from the papers dealing with the research questions established in the review process. Further important evidence in relation to port sustainability was identified and synthesised.

3.5.1. *Descriptive analysis*

3.5.1.1. Number of articles. The 21 papers identified between 2005 and 2018 relate to sustainability performance and assessment in the context of port management and operations. However, there has been a significant increase in the number of published papers covering these areas in the last four years, with 6 being published in 2017, accounting for approximately 29% of the total. This suggests that evaluation studies on port sustainability performance represent an emerging field of research, showing a gradual increase in academic interest. In fact, the recent growth in the number of articles published is plausible because the concept of sustainability within the maritime and transport industry has developed, particularly since the United Nations Conference on Environment and Development (UNCED) (Earth Summit) in Rio de Janeiro in 1992, where the concept of sustainability concerning maritime transportation was reinforced, and governments agreed and adopted a comprehensive programme, the so- called "Agenda 21" (UN, 1992). This summit emphasised the need for comprehensive impact studies and assessment of sustainable development.

3.5.1.2. Geographical scope. Geographical location was analysed in order to identify the distribution of academic interest. Ports that have been the focus of the most research were in Taiwan (5 articles) and China (5 articles), followed by ports in South Korea (3 articles) and Spain (3 articles). Fig. 5 illustrates the proportion studies relating to a ports' geographical location. The greatest density was found in Asia (62% of the total): Taiwan (24%), China (24%), and Republic of Korea (14%).

Assessing green port performance in Asian ports has been growing since the region has the largest and busiest ports which handle the highest container volumes globally, and regulations addressing the environmental impact caused by their activities have been strengthened (Chen and Pak, 2017). Furthermore, increasingly studies have been conducted on the effectiveness and feasibility of port sustainability implementation in the Asian region (Asgari et al., 2015; Chen and Pak, 2017) reflecting the pervasive perception among Asian ports that the benefits of sustainable practices are not sufficient to cover the costs of their implementation (Yang et al., 2013; Acciaro, 2015).

3.5.1.3. Dimensions of sustainability. Papers on the dimensions of sustainability can generally be split into three aspects and, taking possible overlaps into account, six categories were used for this review: (1) environmental; (2) social; (3) economic; (4) environmental and social; (5) environmental and economic; and (6) social and economic. Fig. 6 shows the number of articles by category.

It is worth noting that 8 articles focused on the social aspect with environmental and economic aspects, and none of the articles only focused on social aspects. Similarly, 5 articles focused on economic aspects along with social and environmental issues, but none focused solely on economic considerations. On the other hand, 10 articles investigated the sustainable performance of ports from an environmental perspective. Including papers whose foci overlap with social and economic aspects, environmental issues in ports were addressed by a total of 19 articles.

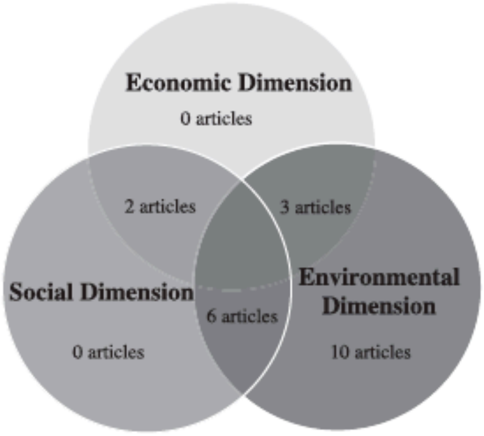

Fig. 6. Number of articles by the category of sustainability (Source: Authors).

3.5.1.4. Research methods and data analysis techniques. In order to classify the articles based on their characteristics and purposes of methods, this study adopted the categorisation provided by Wacker (1998), which has been used by researchers in operations management in order to detect certain patterns in the literature (Burgess et al., 2006; Woo et al., 2011). Wacker (1998) divided research methods into two groups: analytical research conducted using deductive methods; and empirical research using induction methods applied to external data from organisations or businesses. Further, each major classification can be divided into three sub-categories: conceptual, mathematical, and statistical for analytical approaches; and experimental, statistical, and case studies for empirical approaches. Empirical research methods (12 papers, 57%) were used more extensively than analytical research methods (9 papers, 43%). All empirical research has been undertaken using statistical approaches which analyse data gathered from external sources such as interviews, surveys, archival research, and Delphi techniques. In other words, neither empirical experimental research ('field experiments') demonstrating causal relationships under controlled environments (Meredith et al., 1989) nor empirical case studies which investigate a limited number of samples to generalise theoretical ideas, have been used. Contrary to empirical research biased towards one methodology, analytical research methods were used evenly across the three sub-categories. One paper (5%) using analytical conceptual research aimed to add new insights to traditional problems, illustrating developed concepts by case study. Four papers (19%) using mathematical research studied the relationships of concepts based on numerical examples. Finally, four papers (19%) used analytical statistical research which measures the relationship of variables and develops integrated models for empirical statistical tests (Wacker 1998). Table 3 reports the proportions of type of research methods in six categories.

Most researchers used Analytic Hierarchy Process (AHP), a Multiple Criteria Decision Making (MCDM) method, followed by the Delphi method, and Data Envelopment Analysis (DEA) in order to evaluate and measure port sustainability performance, conducting not only case studies but also survey-based research. This is primarily because each port is influenced by different characteristics such as geography, regulations, size, and the different types of cargo handled, and thus it is easy to understand certain relationships and potentials with survey-based MCDM methods. Fig. 7 illustrates the number of articles included in the data analysis techniques.

3.5.2. Synthesis of empirical evidence

The purpose of synthesising empirical evidence is to describe existing data and findings identified through the previous phase which was the process of analysing the main patterns of the articles. The focus here is on the similarities within diverse evidence in order to understand the mechanism of port sustainability evaluation and to provide a fresh understanding and direction for future research.

Based on a "Plan-Do-Check-Act" management model for environmental performance evaluation presented by Scipioni et al. (2008), the evaluation approaches in terms of port sustainability performance in the articles were sorted into five processes:

Table 3
The different types of research methods in port sustainability and performance studies.

Types of research method (proportion)	
Analytical research (43%)	Mathematical research (19%)
	Statistical research (19%)
	Conceptual research (5%)
Empirical research (57%)	Statistical research (57%)
	Experimental research (None)
	Case study (None)

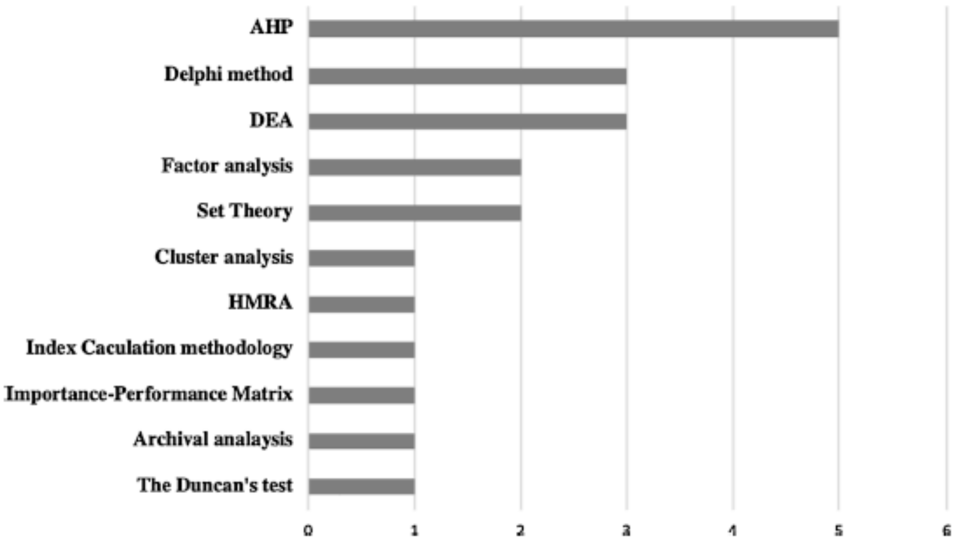

Fig. 7. Number of articles by data analysis techniques (Source: Authors).

Identification of indicators; Prioritising key indicators; Assessment of port sustainability performance; Comparison of sustainability performance among ports; and Development of a tool for assessment of port sustainability. The most common approaches for evaluating port sustainability were the 'Identification of indicators' (18 articles) and 'Assessment of port sustainability performance' (13 articles). This implies that successful performance measurement depends on establishing accurate indicators as a criterion for measurement. The study analysed the type of participants in order to explore who are regarded as major and potential stakeholders in port sustainability performance. The articles referred to in the analysis utilised the views of experts involved in port sustainability in order to establish the indicators and confirm the relative importance and weights of green port performance indicators. The experts' viewpoints were gathered through surveys and interviews. Puig et al. (2014) argued that potential users of sustainability indicators such as port authority, port users (e.g. terminal operators or shipping agencies), policy makers, and public organisations (e.g. NGOs or local communities) should be considered.

In accordance with the principle outlined above 13 different perspectives of experts were considered in the identified papers in order to collect information on establishing the indicators and their priorities: Terminal operators, Shipping companies, Academic Researchers, Ship owners, Port managers, Port Authorities, Port consultants or Supervisors, Government representatives, Legislators, Industry representatives, Employees in a port, Forwarder or Cargo owners, and Local communities and Organisations. 'Port managers' were integrated into 'Port authority' in that they mainly work for and with port authorities (van der Lugt et al., 2017). Accordingly, the surveyed experts who have played key roles in implementing port sustainability were commonly 'Researchers in academia', 'Port authorities', and 'Terminal operators'.

Identifying effective and pertinent indicators is necessary in order to analyse, assess, and control port sustainability tasks (Hughes and Bartlett, 2002) due to the fact it is a difficult task for complex and dynamic entities such as seaports to consider all variables affecting an environmental analysis (Peris-Mora et al., 2005). In the same context, the majority of the articles (18 articles) undertook the process of identifying indicators before embarking on the measurement of port sustainability performance. The accepted opinions of the experts by the articles confirmed the relative importance and weights of performance indicators regarding three dimensions of port sustainability. The purpose of prioritising indicators was to provide evidence to decision makers in establishing key indicators for the evaluation of sustainability performance as well as for green operations.

3.5.3. *Clustering of analytical sustainability indicators*

The most frequently studied environmental indicators were 'Water pollution management' (16 articles), 'Air pollution management' (14 articles), 'Energy and resource usage' (11 articles), and 'Noise pollution' (9 articles). These can be considered as key environmental indicators in measuring the environmental impacts or sustainability performance of port operations (GEMI, 1998). Most environmental indicators prioritised by experts were associated with port operational aspects, encompassing products and services resulting from port activities (Puig et al., 2014). Multiple indicators related to port operations in the articles were identified including inputs such as resource consumption, and outputs such as noise reduction, waste production rates and waste water recycling. Further, atmospheric pollution is acknowledged as a salient indicator with most experts agreeing that port operational activities should pay more attention to enhancing the quality of the atmosphere in order to meet sustainability goals.

In terms of the social aspect, there were very few articles dealing with the concept of sustainability and thus the variety of indicators established was limited. Eight indicators were consistently identified from the articles: 'Health and safety', 'Job generation

Table 4
Literature classification of aspects of sustainability using clustering of sustainability analytical indicators.

Aspect of sustainability	The most identified indicators by researchers (Number of Papers)	Dominant research (%)
Environmental (10 Indicators)	Water pollution management (16) Air pollution management (14) Energy and resource usage (11) Noise pollution (9) Green port management (8) Ecosystem and habitats (6) Soil pollution management and occupation (5) Waste pollution management (4) Green construction and facilities (3) Odour pollution management (1)	Environmental Pollution (64%)
Social (8 Indicators)	Health and safety (7) Job generation and security (5) Job training (4) Public relations (2) Gender equality (2) Social image (1) Quality of living environment (1) Social participation (1)	Human Resources Management (78%)
Economic (11 Indicators)	Foreign direct investment (4) Value generated productivity (2) Port operational efficiency (2) High quality business services (2) Benefits from external stakeholders (2) Port development funding (2) Port infrastructure construction (2) Port throughput (2) GDP (1) Operating costs/revenue (1) Cost-efficiency (1)	Port Management (38%) Investment (19%)

and security', 'Social image', 'Public relations', 'Quality of living environment', 'Social participation', 'Job training', and 'Gender equality'. 'Health and safety' (7 articles) was not only the most interesting indicator for researchers, but also a priority for experts. The scope of 'Health and safety' includes 'Employee job security and safety', 'Ensuring cargo handled safely and effectively', 'Port area safety and orders', 'Low frequency of accidents', and 'Occupational health and safety'.

The most frequently identified economic indicator was 'Foreign Direct Investment' (4 articles) which is considered as one of the key components of growth performance in that the implementation of port sustainability has positive impacts on national and international economy and prosperity by leading the creation of jobs, promoting exports, and the expansion of income and employment (OECD, 2013). Table 4 reports this study clustering of analytical sustainability indicators from the environmental, social, and economic aspects. Where 64% of environmental sustainability research is focused on pollution and 78% of social sustainability research is focused on human resources management. While 38% and 19% of economic sustainability research is focused on port management and investment, respectively.

4. Discussion

Using a systematic literature review, this study has addressed the structure and patterns of port sustainability performance and assessment in the existing research, and provided synthesis of empirical evidence. In this section, the findings from the analysis and synthesis of papers are summarised in relation to the four research questions, focusing on managerial implications.

4.1. What are the existing trends in port sustainability performance and assessment research?

According to the overall analysis of publication trends in this field, it is clear that only recently has there been serious interest in the evaluation of port sustainability performance. However, given the fact that the number of publications has been steadily increasing over the past few years, sustainable development has become more established within port industry research. Research in this field has been increasingly focused on the link between environmental or social impact and economic performance, as well as port competitiveness. Definitive positive links between environmental, social and economic issues have increasingly been highlighted, consistent with findings from a wide range of studies on sustainability performance (see Christmann, 2000; Filbeck and Gorman, 2004; Lun, 2011). Specifically, the benefits of sustainability implementation have contributed to service quality and operational efficiency enhancement. These both involve the drive for continuous improvement in the areas of port performance and port distribution network effectiveness over the longer term (Kim and Chiang, 2017).

There is, however, a clear difference between views expressed in the existing literature and the findings of this review. Taking a geographical perspective, Davarzani et al. (2016) show that many studies of green ports and maritime logistics have come from researchers in western Europe and the United States, while research into east Asian ports has been less common. There have been significant advances in the management of port sustainability, most notably in Europe, with the development of the Ecoports system for environmental management adopted by the European Seaports Organisation in 2011. This system allows ports to measure their environmental performance and compare themselves to standard criteria. The guiding principle is 'to raise awareness on environmental protection through cooperation and sharing of knowledge between ports, and to improve environmental management'. Currently the Ecoports network covers 113 ports primarily in Europe (ESPO, 2019).

Where the focus of research is on the assessment of port sustainability performance, Asian ports feature more prominently. In this context the ports of Taiwan and China, have featured regularly in studies of international environmental responsibility, auditing and compliance. In this way, the Ecoports management system has been adopted beyond Europe and the ports of Kaohsiung, Keelung and Taichung were certified as EcoPorts in 2014 and 2015. This has encouraged Asian ports to investigate their port sustainability performance more thoroughly in order to achieve the long-term goals of sustainable development for the future (Liao et al., 2016; TIPC, 2017). In China, there has been a widespread perception that the guidelines and processes of green port management promoted by the government have led to a decline in port profitability. This is seen to be due to the additional investment costs required, despite the expansion of grants and funds from the Chinese government for the participation of ports in green initiatives (Chen and Pak, 2017). In this sense, attempts to evaluate the applicability and practicality of green operations have improved the awareness and promotion of governmental green policies.

4.2. How are port sustainability performance and assessment measures implemented?

Overall, quantitative assessments of port sustainability performance are seen in the study of financial measures such as operational efficiency, container throughput, costs, and economic impact on measures such as Gross Domestic Product. Given that many ports operate as private enterprises (Brooks, 2004), performance assessment using a quantitative approach is reasonable for understanding the relationship between profits and costs. Additionally, scientific evidence through the process of quantifying actions is required for decision makers in order to validate the substantial investment required for the implementation and tracking of progress towards port sustainability.

The conflicting aims between the economic and environmental dimensions – cost-efficiency in port operations and additional investment for managing environmental impacts – seem to contribute to considerable utilisation of MCDM methods in research. Particularly, AHP has been the most preferred technique by researchers with a view to revealing the best and most optimum practices for practical sustainable operations. However, there are difficulties in measuring the performance of port sustainability. For example, the individual nature of each port in terms of their resources and unique operating environments have made the consistent assessment of port sustainability performance elusive. In this respect, there have been efforts made to reflect geographical similarities in measuring green performance through conducting case studies, focusing on ascertaining differences in the eco-friendly levels between ports in a similar geographic area.

4.3. What are the mechanisms that exist for the implementation of port sustainability performance and assessment?

It has been shown that indicators should be established for the assessment of port sustainability performance in order to understand the structure for the implementation of green port management and its evaluation. In this review, a wide diversity of indicators was identified from the environmental, social, and economic aspects of green port issues. Typical indicators for the assessment of port sustainability from an environmental perspective are related to water management, air pollution management, energy and resource use, and noise control. In terms of the social aspects health and safety is important while for economic aspects Foreign Direct Investment and efficient port operations are primary issues.

From an environmental perspective it can be seen that there is a slight difference between indicators used by researchers for assessment and those appreciated as important and prioritised by the practitioners such as port authorities, port managers, and port operators. The most frequently mentioned indicators in the reviewed studies for the assessment of port sustainability are associated with water pollution management. However atmospheric pollution management and energy consumption are regarded as more important indicators, than water quality when making decisions on successful environmental performance of ports.

From an operational perspective, the amount of energy usage within a port area, including fuel consumption, is high but unavoidable for ongoing port operations. As practitioners have recognised, and underlined, the importance of the efficiency of overall port operations and management, efficient energy management is assumed to be the most salient factor for practitioners, enabling them to comply with environmental requirements while achieving economic growth.

4.4. Which gaps and challenges in this research field can be identified?

The analysis of the surveys in the reviewed studies show that few reflect the opinions of local groups regarding port sustainability. This implies that even though the majority of reviewed studies have verified that public relations have been positively associated with port economic performance, the weak power of local stakeholders in green port planning and management has been still detected as a barrier against the achievement of port sustainability.

External cooperation with green activities is underlined by the several studies reviewed as one of the mediums for the goal of efficient port operations since port systems are engaged in various functions and relations, for example, green road systems linking to the port to its hinterland, and green actions of shipping companies (Cheon, 2017). Public participation also plays an important role in embodying a specific sustainability scheme of ports, for example, the engagement of local governments which have responsibility in enacting legislation to promote eco-friendly industries located near the port, allowing them to comprehensively control air and water quality in surrounding port areas. Thus, in order to fulfil the successful implementation of port sustainability, communities, groups, and organisations affected by port activities should be taken into consideration in the decision-making process of port sustainability operations.

Furthermore, a system of integrated performance measures is required for the purpose of supporting practical and balanced implementation of port sustainability with consistent and meaningful evidence of evaluation over time (Puig et al., 2014). However, the difficulty in establishing an integrated evaluation standard is another conundrum in measuring port sustainability performance. Ports are complex organisations which have been affected by economy, culture, policies, local communities, geographical locations, and administrations (Chiu et al., 2014), taking their own positions with regard to port sustainability operations and management. Indeed, depending on the size and type of port, organisational structure, location, the level of environmental impact from port activities may vary from port to port. Hence the criteria for performance evaluation may not be consistent among ports. The issue of sustainable development for ports is not limited to one country, nor is it easy to conduct an integrated evaluation of sustainability performance for ports due to the distinct nature of port administrations. Therefore, a model or tool which can reflect both the international evaluation criteria and the characteristics of each port should be developed in order to overcome the challenge of the conflicting claims.

5. Conclusion

The systematic literature review adopted in this study was used to understand the existing academic characteristics of port sustainability performance and assessment and to provide useful insights for future research. The main contributions of this study emanate from an overview of managerial performance of ports from the perspective of sustainable development and its assessment, being recognised in the reviewed studies.

The contributions of this study can be summarised as follows. First, it contributes to the expansion of the overall knowledge of port sustainability performance and its assessment by articulating economic effects and applicability. Second, this study clearly shows the key indicators for the assessment of port sustainability performance for each of the three dimensions of sustainability. This is useful evidence for decision makers in implementing sustainability operations and management. Last, the findings of this study provide insights for future research for the successful implementation and evaluation of sustainability in port operations and management by identifying the crucial challenges that need to be overcome.

This systematic literature review provides insights into the idea of performance management and measurement regarding port sustainability from an economic perspective, and leads to new research directions. Three future research directions are identified for the analysis of economic effects of port sustainability performance. First, this review has confirmed that sustainability performance has had a positive impact on port economic growth, and future research needs to investigate enablers and drivers which accelerate and maximise such impacts of sustainability performance as well as inhibitors which obstruct the successful implementation of sustainability performance. By exploring the dynamics of port sustainability operations and management, the mechanisms whereby environmental and social values, and economic performance are simultaneously realised, can be clear, contributing to the evaluation of more accurate port sustainability performance. Second, with the increasing awareness of social responsibility, future research should focus on developing key social indicators for ports. The lack of research on social impacts of port operations may be attributed to the ambiguous boundaries and subjective interpretations of social indicators, obscuring the measurement of the effects of port social performance. Therefore, there is an opportunity for research to establish key indicators by expanding the scope of social indicators with clear definitions in the context of green port operation. Third, future research should investigate whether the impacts of sustainability collaboration with internal and external stakeholders are positive or negative for port economic performance. The stakeholders should include different organisations, communities, companies, and carriers who are involving in port sustainability performance. In general, the collaboration with other organisations has been seen as having positive impact on the sustainability performance of ports, and the need for such cooperation has been emphasised. However, deeper investigation into the economic effects from the sustainable development collaboration is still lacking. Therefore, future research focusing on the effects of collaboration with external stakeholders can be addressed in two directions: the collaboration mechanism with intra-and inter-organisations to resolve effectively the conflicting interest; and the effect of costs and social benefits on the collaboration with external stakeholders, for example, in terms of the reduction of risks in uncertain port environments and the improvement of social legitimacy and reputation.

There are important policy implications that emerge from this review. These are in the areas of environmental management trajectories for ports, and the extent to which governments proactively determine environmental sustainability in port development. Parallel areas of potential research involve the role of academia in capturing key performance metrics in a way that best fits the practical requirements of the ports themselves, and at the same time also fits the needs of the academic world to usefully reflect the tensions between commercial and sustainability objectives as they evolve through time.

Both academic research and policy making is likely to follow two main paths. The first path is to stimulate, through both controlling legislation and incentivisation, the progressive improvement of port operational practices. Such a 'top-down' approach would lead to both immediate and long-term gains through the introduction of more efficient machinery, better space utilisation, wider use of modern technologies, and the implementation of technological improvements, especially those which themselves encourage a move towards sustainable practices. The second path is that which encourages port businesses and the wider port community to self-examine and to reorder priorities so that environmental, social and economic sustainability become a leading part of corporate behaviour and development, and employees' thinking. This is essentially a 'bottom-up' approach. This paper has identified a number of potentially valuable policy pointers especially in the areas of environmental pollution and management, occupational health and safety, social aspects of employment, and job satisfaction and training.

Finally, there are some limitations to this study. Technical aspects of port sustainability, capturing metrics such as equipment utilisation, terminal efficiency, and labour productivity, do not fall within the scope of this paper and have been addressed in previous studies (e.g. Woo et al., 2011). The analyses and contributions of this study are based only on 21 academic journal papers due to scarcity of literature covering empirical evidence of sustainability performance in the context of general operation and management of ports. This might limit evidence of the scientific relationship between the findings of the reviewed articles, because the selection of the articles included in this review and their analysis are based on subjective interpretations. Furthermore, this study focused on the performance and evaluation of sustainability in terms of general operational aspects of ports. In other words, studies which cover specific port activities, such as vessel operations or energy management, are excluded from this study, which may also limit the insights for the implementation and evaluation of port sustainability.

Appendix A. Reviewed papers

Asgari, N., Hassani, A., Jones, D., Nguye, H.H., 2015. Sustainability ranking of the UK major ports: methodology and case study. Transportation Research Part E: Logistics and Transportation Review 78, 19–39.

Chen, Z., Pak, M., 2017. A Delphi analysis on green performance evaluation indices for ports in China. Maritime Policy & Management 44(5), 1–14.

Cheon, S., 2017. The Economic–Social Performance Relationships of Ports: Roles of Stakeholders and Organizational Tension. Sustainable Development 25(1), pp.50–62.

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Appendix B. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.trd.2019.04.009.

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Appendix B. Ethical approval for data collection and survey questionnaire

B1.1 Research ethics approval

Cardiff Business School
Ysgol Busnes Caerdydd

Sewha Lim
Cardiff Business School
Cardiff University

11 December 2019

Dear Sewha,

Ethics Approval Reference: 1920009

Project Title: An evaluation of the relevance and applicability of sustainability indicators for strategic sustainable development in ports

I would like to confirm that your project has been granted ethics approval as it has met the review conditions.

Should there be a material change in the methods or circumstances of your project, you would in the first instance need to get in touch with us for re-consideration and further advice on the validity of the approval.

I wish you the best of luck on the completion of your research project.

Yours sincerely,

Electronic signature via email

Dr. Debbie Foster
Chair of the School Research Ethics Committee
Email: CARBSResearchEthics@cardiff.ac.uk

B1.2 Research ethics supplement

CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD

CARDIFF UNIVERSITY BUSINESS SCHOOL RESEARCH ETHICS COMMITTEE
APPLICATION FOR ETHICAL REVIEW

For Office Use Only	
SREC Reference: [ ]	Meeting/Review Date: [ ]

SECTION 1. GENERAL INFORMATION	
Application Type:	☐ Staff ■ PGR student ☐ PGT/Masters Student ☐ Undergraduate
Research Project Title:	An evaluation of the relevance and applicability of sustainability indicators for strategic sustainable development in ports
Short Title (where applicable):	
For Staff Projects	
Name of Chief/Principal Investigator:	
Contact details:	
Other members of research team:	
For Student Projects	
Name of Student:	Sehwa Lim
Contact details:	LimS10@cardiff.ac.uk
Name of Supervisor(s):	Stephen Pettit/Wessam Abouarghoub/Anthony Beresford
Contact details:	Pettit@cardiff.ac.uk/AbouarghoubW@cardiff.ac.uk/Beresford @cardiff.ac.uk
Other members of research team:	

SECTION 2. SCREENING QUESTIONS			
		Yes	No
2.1	Is the research project categorised as 'Research' (as defined in the Cardiff University Policy on the Ethical Conduct of Research involving Human Participants, Human Material or Human Data)? *If **no** (i.e. the research project is a Service Evaluation or Audit), the Committee is not required to conduct a review of the proposal but may choose to do so.* ***Please contact the School Ethics Officer to seek advice before proceeding with this application.***	✓	
2.2	Does the research project involve human participants, human material or human data (as defined in the Cardiff University Policy on the Ethical		

[Version 1] [Sept-2019]

	Conduct of Research involving Human Participants, Human Material or Human Data)? *If **no**, you are not required to submit the research proposal to this Committee – however, you must **please provide a brief description of the research under 3.1 below and sign and submit to the Research Office.***	✓	
2.3	Does the research project require review by an external ethics committee (refer to Appendix 1 of the Cardiff University Policy on the Ethical Conduct of Research involving Human Participants, Human Material or Human Data)? Please note that this includes all research projects involving participants who lack the capacity to consent. *If **yes**, the research project should be submitted to the relevant external ethics committee for review and does not fall within the remit of this Committee. Please contact the Research Governance Team for further advice. **Please do not continue with this application.***		✓
2.4	Has the research project been ethically reviewed by another university or research institution (for example, where the Chief/Principal Investigator for the research project is based at another institution)? *If **yes**, please provide evidence of the review conducted (such as an outcome letter or communication) and the ethical review policy of the relevant institution or committee. **Please do not continue with this application.***		✓
2.5	Does the research project only involve the use of information that is publicly and lawfully available e.g. census data, population statistics published by government departments and personal letters/diaries in public libraries. Note: research projects involving the use of Human Data obtained from social media (or similar internet forums) do not fall within this category. *If **yes**, you are not required to submit the research proposal to this Committee – however, you must **please provide a brief description of the research under 3.1 below and sign and submit to the Research Office.***		✓
2.6	Does the research project fall within the scope of the UK Policy Framework for Health and Social Care Research? This Framework broadly applies to research taking place within, or involving, the health and social care systems. *If **yes**, you will need to apply to the Research Governance Team for Sponsorship using the Advanced Project Information Proforma (APIP) (available on the Cardiff University intranet). The Research Governance Team will advise you on the approvals that are required for the research project after it has conducted a review of the APIP and supporting documentation. **Please do not continue with this application until you have sought advice from the Research Governance Team.***		✓
2.7	Does the research project involve the collection or use of Human Tissue (including, but not limited to, blood, saliva and bodily waste fluids)? *If **yes**, the research project should be submitted to the Human Tissue Act Compliance Team (HTACT) prior to submission to an ethics*		✓

	committee. ***Please do not continue with this application until you have sought advice from HTACT.***		
2.8	Does the research project fall within the scope of the University's Security-sensitive Research Policy? This Policy broadly applies to research involving terrorism, extremism or radicalisation (or access to materials of such a nature). *If **yes**, you must register the research in accordance with the Policy and comply with the IT and security arrangements contained in the Policy.*		✓
2.9	Has the research project received scientific review? (For student research projects, review by the research project supervisor is an acceptable form of scientific review) *If **no**, please obtain appropriate scientific review before submitting the application to this Committee.*	✓	

If the research project involves the use of animals, please contact the Cardiff University Biological Standards Office bso@cardiff.ac.uk to seek further advice.

SECTION 3. PROJECT SUMMARY

3.1	Summarise the research project (including the purpose and its methodology) using language that would be understood by a lay person.

This survey is the data collection phase for my PhD thesis which aims to investigate the valid adoption of evaluation indicators of port sustainability and to provide insights into assessment of influential sustainability practices ensuring strategic planning for sustainable development in the context of port management. This research also focuses on developing a holistic list of indicators that most directly contribute to the process of strategic sustainable development in port management by examining the interrelationship between sustainability indicators and port performance (efficiency, effectiveness, competitive advantage).

3.2	Describe the research question(s).

Main questions

To what degree do sustainability indicators convey realistic and reliable information of sustainable development goals in the context of port management?

Sub-questions

1. Which indicators have been identified for evaluation of sustainable development in ports?
2. To what extent are sustainability indicators relevant and applicable on decision making process for ports' sustainable development performance?
3. How are the indicators of port performance and sustainability systematically linked each other?
4. What is the potential utility for port sustainability indicators to advance and facilitate sustainable development in ports?

3.3	Estimated start date.
December 2019	
3.4	Estimated end date (usually the end of data collection).
April 2020	
3.5	Is the research project funded? *If* ***yes****, please name the funding body.*
No	
3.6	Are there any potential conflicts of interest? *If* ***yes****, please confirm the action you propose to take to address such conflicts.*
No	
3.7	Does the research project involve the use of **only** common methodology(ies) previously approved by the SREC? *If* ***yes****, please provide details in 'Section 10: Supporting Documents' below and attach the relevant documentation (e.g. protocol or stand operating procedure for the common methodology(ies)) to this application.* *In Cardiff University Business School, common methodologies include the use of interviews, questionnaires, focus groups and surveys accompanied by informed consent. Informed participant observation i.e. observation that gains the explicit consent of research participants is also a common methodology, but any covert data collection or observations (including the use of social media), may not fall within this category and further advice must be sought from SREC BEFORE submitting an application.*
Yes	

SECTION 4. FULL REVIEW CRITERIA				
Note: CM means common methodology(ies) previously approved by the SREC – as detailed above. For each response given as 'Yes-CM', please provide details of the CM in the text box below.		**Yes**	**Yes-CM**	**No**
4.1	Will the research project be performed without the participants' prior consent?			✓
4.2	Does the research design include an element of deception, including covert research?			✓
4.3	Will the research project involve children under the age of 18 or 'at risk' (vulnerable) adults or groups? *The Cardiff University Safeguarding Children and Adults at Risk: Policy and Guidance sets out examples of 'at risk' or 'vulnerable' adults.*			✓

4.4	Does the research project include topics which may be considered highly sensitive for participants? *This includes sexual behaviour, illegal activities, political, religious or spiritual beliefs, race or ethnicity, experience of violence, abuse or exploitation, and mental health.*			✓
4.5	Does the research project require access to records of a sensitive or confidential nature, including Special Category Data, for the purposes of the General Data Protection Regulation and Data Protection Act 2018?			✓
4.6	Is permission of a gatekeeper required for initial or continued access to participants? *This includes participants in custody and care settings, or research in communities where access to research participants is not possible without the permission of another adult, such as another family member or a community leader.*			✓
4.7	Does the research project involve intrusive or invasive procedures? *This includes the administration of substances, vigorous physical exercise, procedures involving pain or more than mild discomfort to participants (including the risk of psychological distress, discomfort or anxiety to participants).*			✓
4.8	Does the research project involve visual or audio recordings where participants may be identified?			✓
4.9	Does the research project involve the collection or use of human tissue?			✓
4.10	Is there a risk to the safety and wellbeing of the Researchers?			✓

For each response given as 'Yes-CM', please provide details of the CM that has been approved by the SREC.

PROCEDURE TO FOLLOW, BASED ON RESPONSES IN SECTION 4:

- If any 'Yes' box applies, the research project should follow a full ethics review.
- If all 'No' boxes apply, the research project may be considered for proportionate review.
- If a combination of only 'No' and 'Yes-CM' boxes applies, the research project may be considered for proportionate review.

SECTION 5. RECRUITMENT	
5.1	How will you recruit participants to the research project? *If appropriate, please include sampling criteria.*
The target participants will be experts who are well acquainted with port sustainability. Potential respondents' groups will be port managers, port authorities, and port terminals. The ways to identify participants for the questionnaires will be through open information of participants online, and through personal connections to people who work in port terminals or authorities.	
5.2	How many participants are you aiming to recruit? *If applicable, please include a breakdown of participants by type and number.*
The number of respondents is expected approximately 150 to 200 regardless their position, age, gender, and geographical locations.	
5.3	What is the inclusion and exclusion criteria for participants?
Their current job and position will be considered the means to gain information from the most relevant people and to ensure the adequacy of respondent groups represented as a sample. There are no gender and age discrimination concerns, hence the survey will not be asked other criterion including race, religious beliefs etc.	
5.4	How will the research project address recruitment of participants who are not fluent in the English/Welsh language?
Due to the added complexities and cost of developing a foreign language survey, non-English-speaking countries will be ignored, other than Republic of Korea where the researcher comes from.	
5.5	Will the research project involve participants that are Cardiff University staff or students or people who are likely to become students or clients of the University or the place in which you may otherwise work? *If applicable, please provide details.*
NO	
SECTION 6. CONSENT PROCEDURES	
6.1	How will informed consent be obtained? *Please include who will be taking consent, how consent will be recorded, when participants will be provided with information about the research project, and how long potential participants will be given to decide whether to take part.*
The invitation letter will inform the respondents about the purpose, nature, and process of the survey in the first page of the online questionnaire, and informed consent from respondents will be asked on the second page. There will be also an assurance of confidentiality, an academic use for the collected data, and an offer of assistance for any respondent with individual questions. Agreement to participate in the survey will be achieved by checking the box 'Yes, I Consent', ensuring the clarity of ethical considerations for	

respondents. If they do not give consent, the survey will end immediately. Participation in the survey is entirely anonymous and voluntary such that it can be withdrawn by each respondent at any time without giving a reason.	
6.2	Will participants be offered any incentives to take part in the research project?
NO	
6.3	If a questionnaire is to be used, will you give participants the option of omitting questions they do not wish to answer?
YES	
6.4	Will participants be informed that their participation is voluntary and that they may withdraw at any time and for any reason?
YES (Please refer to 6.1)	
SECTION 7. POSSIBLE HARM TO PARTICIPANTS/RESEARCHERS	
7.1	Is there is a risk of the participants experiencing physical, emotional or psychological harm or distress? *If yes, please provide details of how ethical issues will be handled and how any risks will be minimised. Please consider whether the research project includes topics which could be considered as highly sensitive for participants.*
NO	
7.2	Is there a risk of the Researcher(s) experiencing physical, emotional or psychological harm or distress? *If yes, please provide details of how ethical issues will be handled and how any risks will be minimised.*
NO	
SECTION 8. DATA MANAGEMENT, CONFIDENTIALITY AND DATA PROTECTION	
8.1	How, and by whom, will data be collected?
This PhD research will be developed from a quantitative approach with the purpose of testing hypotheses established through literature review and of examining the interrelationship between data. An online questionnaire survey will be conducted by the PhD student (Sehwa Lim) as the phase of data collection for PhD thesis, aiming to clarify the most relevant and influential indicators that support effective assessment of port sustainability performance. The questionnaire will be created by using a web-based survey tool (Qualtrics), which is supported by Cardiff University, and the survey web page link will be sent by email to experts who are involved in sustainability management and operation of ports. AMOS will be utilised in order to statistically analyse the collected data.	

8.2	Will you be accessing or collecting Personal Data (identifiable personal information) as part of the research project? *If yes, please confirm what data will be accessed and/or collected (including details of the information participants are asked to provide on a written consent form).*

NO. The questionnaire will not collect any form of personal data.

8.3	How long will you retain the Personal Data collected in connection with the research project?

Since the collected data will be used only for the purpose of research, all research relevant data relevant will be kept in a form of secure until September 2021, the expected end date of the PhD thesis that is no longer needed for data processing purposes.

8.4	What efforts will be made to anonymise the data collected (where possible)?

No name and email identifier are gained in the survey, hence any respondents' identifier with their responses will not be able to be traced. Additionally, respondents will be informed that all data collected will be used only for research purposes confidentially and anonymously. The data including their identifiers and consent forms from the respondents will remain confidential to the researcher and will not be made available to any other party, keeping them safely secured using password systems.

8.5	Are you proposing to utilise 'public task' as the lawful basis for processing Personal Data for the purposes of the research project (as recommended in the University's GDPR Guidance for Researchers)? *If no, please explain why and what alternative lawful basis you propose to use.*

YES. Basically, the research will rigorously follow the EU General Data Protection Regulation (GDPR).

8.6	Have you utilised/incorporated into the Participant Information Sheet the template GDPR privacy information for research participants? *If no, please explain why this has not been used.*

YES.

8.7	For how long will the collected anonymised data be retained?

As mentioned in 8.3, the data will be maintained anonymously and confidentially until the end of the PhD thesis which will be September in 2021. The data will be erased safely from the researcher after the completion of the research.

8.8	Who will have access to the data?

Data including identifiers of respondents will not be made available to any party. Only the researcher will have access to the data.

8.9	Will the data be shared in any way, for example through deposit in a data repository, with third parties, or a transcription service?

NO. For ensuring the confidential, the data will be only remained to the researcher.

SECTION 9. OTHER ETHICAL CONSIDERATIONS

Please outline any other ethical considerations raised by the research project and how you intend to address these. You are obliged to bring to the attention of the SREC any ethical issues not covered in this Ethics Review Application Proforma.

During the project, the main ethical considerations are primarily involved in informed consent for the respondents, together with the need to maintain confidentiality and secure storage of collected data. Any respondents will be informed at the beginning that the purpose of research, the period of data retention, voluntary participation, anonymity, and confidentiality will be guaranteed throughout the process of the survey. Respondents are able to skip the questions or withdraw from the survey at any time. Contact details for the researcher will be made available to all respondents involved in this project and invited to make contact at any stage for further information. Personal data relating to an identified or identifiable information such as a name, an identification, or special category data specific to physical, mental, or social identify of respondents are not requested. However, indirect influence might be involved such as location of country, and job position. Data will be treated in a manner that ensures appropriate security with encrypted password code.

SECTION 10. SUPPORTING DOCUMENTS

I have attached the documents, as indicated in the table below, in support of this application.

Please note that the documents listed below **MUST BE** provided where relevant to the research project, alongside any other documents relevant to recruitment, consent and participation.

		Yes	No	**Version no.** (where applicable)
1	Research Project Protocol/Proposal	✓		
2	Recruitment Adverts/Invitation Letters	✓		
3	Participant Information Sheet	✓		
4	Consent Form	✓		
5	Data Collection Tools (e.g. questionnaires)	✓		
6	Other participant communications (e.g. debrief sheets)		✓	
7	Protocol(s) or Standard Operating Procedure(s) of documented and ethically approved common methodology(ies) being used for the research project	✓		
8	[Evidence of training completion]	✓		

SECTION 11. SIGNATURES AND DECLARATIONS
General declaration I confirm that: a. The information in this form is accurate to the best of my knowledge and belief and I take full responsibility for it. b. I have the necessary skills, training and or/expertise to conduct the research project as proposed. c. I am familiar with the University's health and safety requirements and policies and that all relevant health and safety measures have been taken into account for the research project. d. I am familiar with, and will comply with, the University's Policy on the Ethical Conduct of Research involving Human Participants, Human Material or Human Data and the University's Research Integrity and Governance Code of Practice. e. The relevant equality and diversity considerations have been taken into account when designing the research project. f. If the research project is approved, I undertake to adhere to the research project protocol, the terms of the full application as approved and any conditions set out by the Committee and any other body required to review and/or approve the research project. g. I will notify the Committee and all other review bodies of substantial amendments to the protocol or the terms of the approved application, and to seek a favourable opinion from the Committee before implementing the amendment.

FOR STAFF PROJECTS
Signed: Chief/Principal Investigator
Print name:
Date:

FOR STUDENT PROJECTS	
Signed: Student [signature]	Signed: Supervisor [signature]
Print name: Sehwa Lim	Print name: S. PETTIT
Date: 08. 11. 19	Date: 8/11/19

Please submit the completed application and supporting documents to CARBS-ResearchEthics@cardiff.ac.uk
Your electronic submission should contain wet-ink or electronic signatures of all relevant parties. Please note that if any information is missing, the application may be returned to you.

[Version 1] [Sept-2019]

Cover letter for the survey

Dear Sir/Madam,

I hope this email finds you well.

I am **Sehwa Lim**, a PhD student at Cardiff Business School. For my thesis, I am currently doing a research survey in order to obtain opinions regarding port sustainability and competitive positioning from relevant executives, directors, supervisors, and managers in the port industry. This questionnaire is designed to assess your perception of the impact of port sustainability on competitive advantage and the importance of each sustainability activity.

The survey will require approximately **15-20 minutes** to complete. I am aware that it is not shore time and you are extremely busy with your work, but I will appreciate it if you could take your time and provide your valuable input in forming an important part of my final thesis. In order to participate, please click on the following link which can be accessed through your computer or mobile phone:

https://socsi.qualtrics.com/jfe/form/SV_d5Yy7XOkLD9qzUF

Your participation in this survey is completely voluntary, and your response will remain confidential. No information from the survey will be attributable to any individual. I hope that you will be able to participate in this survey, but if you are unable to, I would be grateful if you would be willing to pass it to a relevant colleague who could do so.

Thank you in advance for taking your time, and for assisting me in my academic endeavours.

Yours sincerely

Sehwa Lim
PhD student at the Logistics and Operations Management Section
Cardiff Business School
Cardiff University

Cardiff University / Prifysgol Caerdydd — Cardiff Business School / Ysgol Busnes Caerdydd

Invitation letter

An Evaluation of The Impact of Sustainability Performance on Port Competitive Advantage

I would like to invite you to participate in this research.

- This research is independent **PhD academic research** exploring the impact sustainability practice has on the competitive advantage of container ports.
- The purpose of this survey is to collect information on sustainability performance in the port industry, and to identify core activities that contribute to value creation and competitiveness of ports.
- This survey is limited to **ports/terminals that handle containers.**
- **Port sustainability** in this research refers to a port's commitment to maintaining economic development and creating long-term value while pursuing safe, socially acceptable and environmentally friendly port management as a business strategy.
- **Competitive advantage** in this research refers to ports' competence to integrate its own resources and skills into its value creating strategy and to sustain core business and services that can differentiate themselves from other ports and be more attractive to port users.
- Please provide your opinion according to your background and experience.

- Your participation in the survey is entirely voluntary and it can be withdrawn at any time without giving a reason.
- All data collected from participants will be used only for research purposes. Data will be kept safe using secured password systems.
- The questionnaire will take **15-20 minutes to complete.**
- If you think you are not the right person to answer the questionnaire, please pass it to people who you think might have the relevant knowledge.

Thank you very much for your support and participation in my research.

Sehwa Lim
PhD student, Logistics and Operations Management Section
Cardiff Business School
Cardiff University, CF10 3EU
Email: LimS10@cardiff.ac.uk

Section 1. Informed Consent Declaration for Research Participants

Consent to participate

I understand and agree with the information given above and I am giving my consent to participate in this research.

◯ Yes I Consent
◯ No I do not Consent

Section 2. Competitive advantage

To what extent do you agree the following statement?

(1=Strongly disagree; 7=Strongly agree)

1 ⟷ 7	
Strongly disagree	Strongly agree

Compared to our competitors,

	Strongly disagree 1	2	3	4	5	6	Strongly agree 7	Not known
my port/terminal has a larger market share.	○	○	○	○	○	○	○	○
my port/terminal gets a higher return.	○	○	○	○	○	○	○	○
the quality of port/terminal services is higher	○	○	○	○	○	○	○	○
port/terminal user's satisfaction is higher.	○	○	○	○	○	○	○	○
my port/terminal is technologically superior.	○	○	○	○	○	○	○	○
my port/terminal's reputation in terms of sustainability management is better.	○	○	○	○	○	○	○	○
my port/terminal is considered as a leading port/terminal in terms of sustainability management in the industry.	○	○	○	○	○	○	○	○

my port/terminal more thoroughly responds to social and ethical demands.	○	○	○	○	○	○	○	○
my port/terminal has a greater capacity to respond to port/terminal user's needs.	○	○	○	○	○	○	○	○

Introduction for Section 3

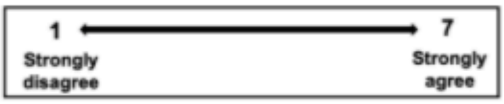
Sustainability performance

In this section, I would like to ask your perception about sustainability practices of your port/terminal. The questions are asked in three aspects of sustainability - environmental, social, and economic. Please check the option according to the best of your knowledge.

Section 3.1 Environmental sustainability performance

1. Environmental sustainability performance

To what extent do you agree the following statement in terms of environmental sustainability practices?
(1=Strongly disagree; 7=Strongly agree)



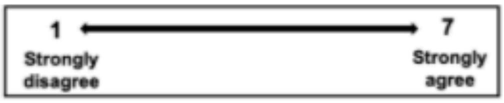
My port/terminal...

	Strongly disagree 1	2	3	4	5	6	Strongly agree 7	Not known
1.1 has reduced water pollution.	○	○	○	○	○	○	○	○
1.2 has reduced air pollutants and emissions.	○	○	○	○	○	○	○	○
1.3 has reduced energy consumption and used renewable energy or fuels.	○	○	○	○	○	○	○	○
1.4 has reduced noise and vibration generation.	○	○	○	○	○	○	○	○
1.5 has reduced soil pollutants from disposal of dredging sediment and sludge.	○	○	○	○	○	○	○	○
1.6 has reduced the impact on natural structure and habitat.	○	○	○	○	○	○	○	○
1.7 has reduced general and hazardous waste.	○	○	○	○	○	○	○	○
1.8 has reduced odours from perishable bulk solids, waste treatment, water purifiers, etc.	○	○	○	○	○	○	○	○
1.9 has used environment-friendly port/terminal facilities.	○	○	○	○	○	○	○	○
1.10 has undertook sustainability management plan and regularly conducted sustainability monitor or assessment.	○	○	○	○	○	○	○	○

2. Social sustainability performance

To what extent do you agree the following statement in terms of social sustainability practices?

(1=Strongly disagree; 7=Strongly agree)



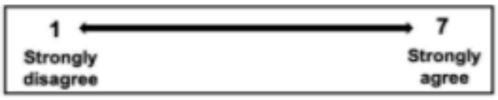
My port/terminal...

	Strongly disagree 1	2	3	4	5	6	Strongly agree 7	Not known
2.1 has implemented health and safety practices within port/terminal area	○	○	○	○	○	○	○	○
2.2 has increased employment opportunities.	○	○	○	○	○	○	○	○
2.3 has provided employee training and education.	○	○	○	○	○	○	○	○
2.4 has developed communication tools to share the social impact of port/terminal operations.	○	○	○	○	○	○	○	○
2.5 has supported gender equality.	○	○	○	○	○	○	○	○
2.6 has improved its eco-friendly and socially responsible image.	○	○	○	○	○	○	○	○
2.7 has created a safe and satisfying working and living environment around port/terminal area.	○	○	○	○	○	○	○	○
2.8 has interacted with relevant stakeholders and local communities.	○	○	○	○	○	○	○	○

Section 3.3 Economic sustainability performance

3. Economic sustainability performance

To what extent do you agree the following statement in terms of economic sustainability practices?
(1=Strongly disagree; 7=Strongly agree)



My port/terminal...

	Strongly disagree 1	2	3	4	5	6	Strongly agree 7	Not known
3.1 has created an open and direct investment environment outside the country.	○	○	○	○	○	○	○	○
3.2 has provided value-added port/terminal services.	○	○	○	○	○	○	○	○
3.3 has delivered efficient operation and management.	○	○	○	○	○	○	○	○
3.4 has provided reliable, responsive, efficient, punctual, and safe port/terminal services.	○	○	○	○	○	○	○	○
3.5 has reduced the costs of general operation and maintenance of port/terminal.	○	○	○	○	○	○	○	○
3.6 has encouraged collaboration with external stakeholders for port/terminal operations and development.	○	○	○	○	○	○	○	○
3.7 has attracted public, private and other forms of funding for port/terminal development.	○	○	○	○	○	○	○	○

3.8 has continuously upgraded port/terminal infrastructure and facilities.	○	○	○	○	○	○	○	○
3.9 has increased annual container throughput.	○	○	○	○	○	○	○	○
3.10 has contributed to total gross value added of the port industry.	○	○	○	○	○	○	○	○
3.11 has obtained revenue from the use of port/terminal facilities and services.	○	○	○	○	○	○	○	○
3.12 has deployed the current resources for maximum cost-efficiency.	○	○	○	○	○	○	○	○

Introduction for section 4

Competitive advantage and sustainability performance

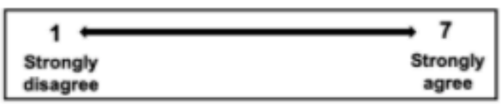
In this section, there are questions about your opinion of core activities to enhance competitive advantage of your port/terminal. The questions are asked in three aspects of sustainability - environmental, social, and economic. Please check the option according to the best of your knowledge.

Section 4.1 Competitive advantage and environmental sustainability performance

1. Competitive advantage and environmental sustainability performance

To what extent do you agree the following statement?

(1=Strongly disagree; 7=Strongly agree)



1.1 **Water pollution management*** strengthens the competitive advantage of my port/terminal.

*Controlling deterioration of water quality

Strongly disagree	2	3	4	5	6	Strongly agree	Not known
○ (1)	○	○	○	○	○	○ (7)	○

1.2 **Air pollution management*** strengthens the competitive advantage of my port/terminal.

*Reducing air pollutants and emissions of particles from general port/terminal operational activities

Strongly disagree	2	3	4	5	6	Strongly agree	Not known
○ (1)	○	○	○	○	○	○ (7)	○

1.3 **Energy and resource usage*** strengthens the competitive advantage of my port/terminal.

*Using energy efficient control systems, recyclable resources and substituting renewable energy or fuels (e.g. solar, geothermal, biomass, ethanol, biodiesel, biogas, etc.)

Strongly disagree	2	3	4	5	6	Strongly agree	Not known
○ (1)	○	○	○	○	○	○ (7)	○

1.4 **Noise pollution management*** strengthens the competitive advantage of my port/terminal.

*Reducing noise and vibration generation from port/terminal operations, transport operations and the use of machinery

Strongly disagree	2	3	4	5	6	Strongly agree	Not known
○ (1)	○	○	○	○	○	○ (7)	○

1.5 **<u>Green port management*</u>** strengthens the competitive advantage of my port/terminal.

*Implementation of sustainability management plan, system, policy and legislation including monitoring and assessment of sustainability in port/terminal area

Strongly disagree	2	3	4	5	6	Strongly agree	Not known
①	○	○	○	○	○	⑦	○

1.6 **<u>Ecosystem and habitats protection*</u>** strengthens the competitive advantage of my port/terminal.

*Minimising habitat losses and protecting aquatic life and natural structure within and around port/terminal area

Strongly disagree	2	3	4	5	6	Strongly agree	Not known
①	○	○	○	○	○	⑦	○

1.7 **<u>Soil pollution and occupation management*</u>** strengthens the competitive advantage of my port/terminal.

*Prevention soil pollutants and erosion, and disposal of dredging sediment and contaminated sludge

Strongly disagree	2	3	4	5	6	Strongly agree	Not known
①	○	○	○	○	○	⑦	○

1.8 **<u>Waste pollution management*</u>** strengthens the competitive advantage of my port/terminal.

*General and hazardous waste handing

Strongly disagree	2	3	4	5	6	Strongly agree	Not known
①	○	○	○	○	○	⑦	○

1.9 **Green construction and facilities*** strengthens the competitive advantage of my port/terminal.

*Environmentally friendly port/terminal facilities and sustainable construction plans and designs

Strongly disagree	2	3	4	5	6	Strongly agree	Not known
①	○	○	○	○	○	⑦	○

1.10 **Odour pollution management*** strengthens the competitive advantage of my port/terminal.

*Controlling odours from perishable bulk solids, waste treatment, water purifiers, etc.

Strongly disagree	2	3	4	5	6	Strongly agree	Not known
①	○	○	○	○	○	⑦	○

Section 4.2 Competitive advantage and social sustainability performance

2. Competitive advantage and social sustainability performance

To what extent do you agree the following statement?

(1=Strongly disagree; 7=Strongly agree)

1 ⟵⟶ 7
Strongly disagree — Strongly agree

2.1 **Health and safety*** strengthens the competitive advantage of my port/terminal.

*Ensuring port/terminal area safety and orders by reducing accidents and injury including occupational health and safety

Strongly disagree	2	3	4	5	6	Strongly agree	Not known
①	○	○	○	○	○	⑦	○

2.2 **Job creation and security*** strengthens the competitive advantage of my port/terminal.

*Job creation and offering internship and employment opportunities

Strongly disagree	2	3	4	5	6	Strongly agree	Not known
○	○	○	○	○	○	○	○

2.3 **Job training*** strengthens the competitive advantage of my port/terminal.

*Employee training and education by providing learning or working program

Strongly disagree	2	3	4	5	6	Strongly agree	Not known
○	○	○	○	○	○	○	○

2.4 **Public relations*** strengthens the competitive advantage of my port/terminal.

*Developing communications tools, activities, and programs to share port/terminal's plans for sustainability with relevant social groups and stakeholders

Strongly disagree	2	3	4	5	6	Strongly agree	Not known
○	○	○	○	○	○	○	○

2.5 **Gender equality*** strengthens the competitive advantage of my port/terminal.

*Supporting gender diversity and providing professional education and career development opportunities for women

Strongly disagree	2	3	4	5	6	Strongly agree	Not known
○	○	○	○	○	○	○	○

2.6 **Social image*** strengthens the competitive advantage of my port/terminal.

*Eco-friendly and socially responsible image with transparency of port/terminal operation and management

Strongly disagree	2	3	4	5	6	Strongly agree	Not known
○	○	○	○	○	○	○	○

2.7 **Quality of working and living environment*** strengthens the competitive advantage of my port/terminal.

*Creating a safe and satisfying working and living environment around port/terminal areas

Strongly disagree	2	3	4	5	6	Strongly agree	Not known
○	○	○	○	○	○	○	○

2.8 **Social participation*** strengthens the competitive advantage of my port/terminal.

*Interaction with relevant stakeholders and cooperative synergies with local communities and cities for socio-economic sustainability of ports/terminals

Strongly disagree	2	3	4	5	6	Strongly agree	Not known
○	○	○	○	○	○	○	○

Section 4.3 Competitive advantage and economic sustainability performance

3. Competitive advantage and economic sustainability performance

To what extent do you agree the following statement?

(1=Strongly disagree; 7=Strongly agree)

1 ⟵⟶ 7
Very little … Very strongly

3.1 **Foreign direct investment*** strengthens the competitive advantage of my port/terminal.

*Establishing an open and direct investment environment outside the country into assets and into equity stakes in port/terminal owners

Strongly disagree	2	3	4	5	6	Strongly agree	Not known
○	○	○	○	○	○	○	○

3.2 **Value-added productivity*** strengthens the competitive advantage of my port/terminal.

*Creating value-added port/terminal services (e.g. modern facilities, wide logistics services, trained expert staff, skills, etc.)

Strongly disagree	2	3	4	5	6	Strongly agree	Not known
①	○	○	○	○	○	⑦	○

3.3 **Port/terminal operational efficiency*** strengthens the competitive advantage of my port/terminal.

*Operational capability of ports/terminals to deliver efficient operation and management with high quality of services and support

Strongly disagree	2	3	4	5	6	Strongly agree	Not known
①	○	○	○	○	○	⑦	○

3.4 **High quality services*** strengthens the competitive advantage of my port/terminal.

*Providing reliable, responsive, efficient, punctual, and safe port/terminal services

Strongly disagree	2	3	4	5	6	Strongly agree	Not known
①	○	○	○	○	○	⑦	○

3.5 **Reducing operating costs*** strengthens the competitive advantage of my port/terminal.

*Reducing the costs of general operation and maintenance of ports/terminals (e.g. repair of facilities, cost of water, electricity, gas, consumable substances, labor costs, etc.)

Strongly disagree	2	3	4	5	6	Strongly agree	Not known
①	○	○	○	○	○	⑦	○

3.6 **Benefits from external stakeholders*** strengthens the competitive advantage of my port/terminal.

*Benefits from collaboration with external stakeholders for port/terminal operations and development (e.g. academia, employees, NGOs, financial community, local community, regulators and policy makers, etc.)

Strongly disagree	2	3	4	5	6	Strongly agree	Not known
①	○	○	○	○	○	⑦	○

3.7 **<u>Port/Terminal development funding*</u>** strengthens the competitive advantage of my port/terminal.
*Public, private and other forms of funding for port/terminal development

Strongly disagree	2	3	4	5	6	Strongly agree	Not known
○ 1	○	○	○	○	○	○ 7	○

3.8 **<u>Port/Terminal infrastructure construction*</u>** strengthens the competitive advantage of my port/terminal.
*Monitoring and upgrading port/terminal infrastructure and facilities

Strongly disagree	2	3	4	5	6	Strongly agree	Not known
○ 1	○	○	○	○	○	○ 7	○

3.9 **<u>Container throughput*</u>** strengthens the competitive advantage of my port/terminal.
*Annual throughput of container cargoes

Strongly disagree	2	3	4	5	6	Strongly agree	Not known
○ 1	○	○	○	○	○	○ 7	○

3.10 **<u>GDP*</u>** strengthens the competitive advantage of my port/terminal.
*Total gross value-added contribution to GDP supported by the port sector

Strongly disagree	2	3	4	5	6	Strongly agree	Not known
○ 1	○	○	○	○	○	○ 7	○

3.11 **<u>Operating revenue*</u>** strengthens the competitive advantage of my port/terminal.
*Revenue from the use of port/terminal facilities and services (e.g. service fees, ship and port dues, etc.)

Strongly disagree	2	3	4	5	6	Strongly agree	Not known
○ 1	○	○	○	○	○	○ 7	○

3.12 **Cost-efficiency*** strengthens the competitive advantage of my port/terminal.

*Deploying the current resources for maximum cost-efficiency with the least amount of money invested

Strongly disagree	2	3	4	5	6	Strongly agree	Not known
○	○	○	○	○	○	○	○

Section 5. Details of Respondents

Some information about you and your organisation.

Where is your organisation located in?

What is your position at the organisation?

- ○ President
- ○ Vice president
- ○ CEO
- ○ Harbour master
- ○ Senior director
- ○ Director
- ○ Supervisor
- ○ Manager
- ○ Operator
- ○ Others (please specify)

How many years of experience do you have in the industry?

- ○ Less than 1 year
- ○ 1-5 years
- ○ 6-10 years
- ○ 11-15 years
- ○ Greater than 15 years

How many containers do your organisation handle annually in terms of TEU?

- ○ under 500,000
- ○ 500,000 - 1 million
- ○ 1 - 2 million
- ○ 2 - 5 million
- ○ 5 - 10 million
- ○ over 10 million

Appendix C. Summary of non-bias test

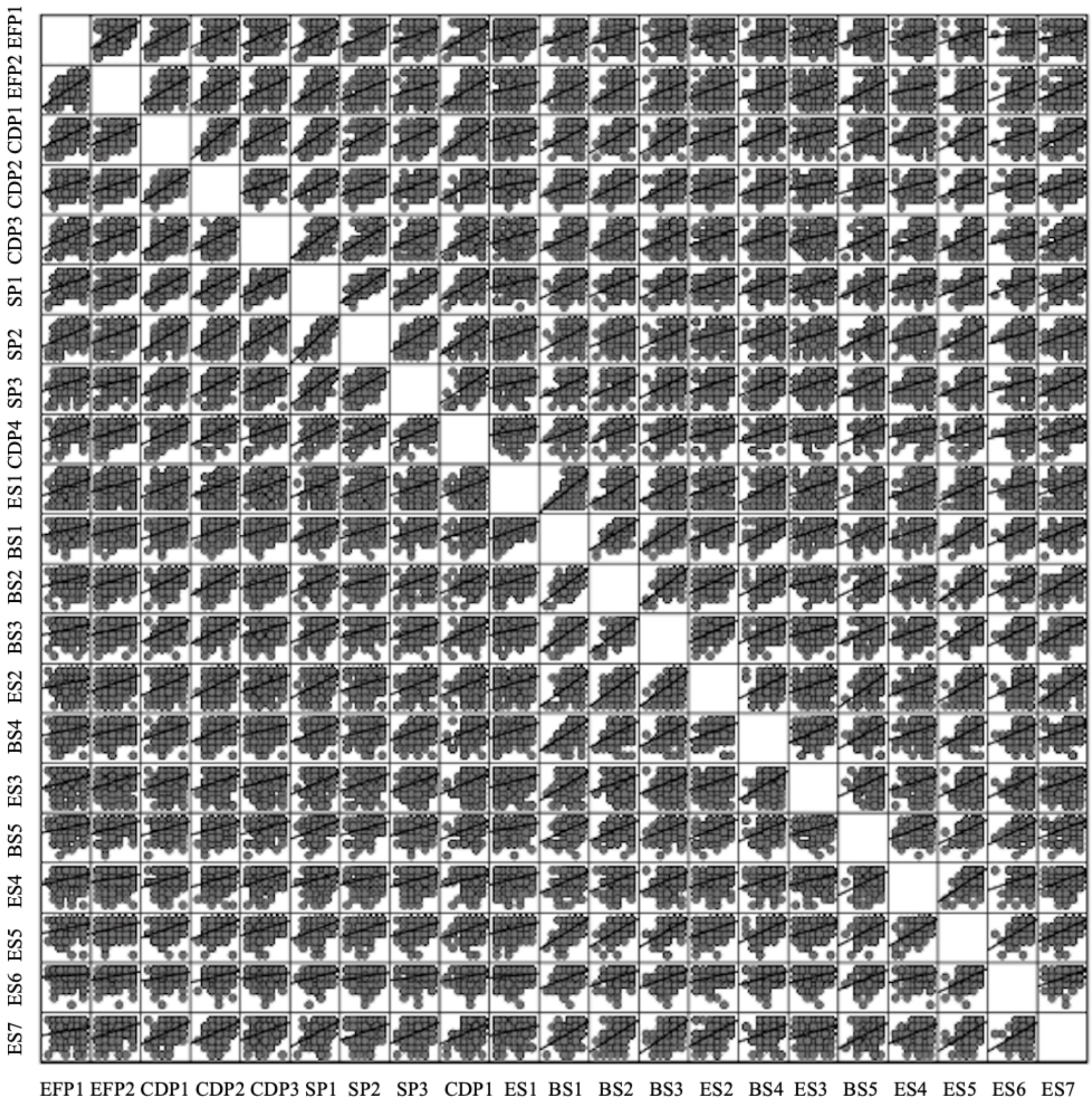
Item	Levene's test for equality of variances		t-test for equality of means			
	F	Sig.	t	Sig. (2-tailed)	Mean difference	Std. error difference
EFP1	0.015	0.904	-0.880	0.383	-0.357	0.405
EFP2	0.046	0.830	0.464	0.644	0.172	0.371
CDP1	2.205	0.144	0.431	0.669	0.128	0.298
CDP2	0.090	0.766	1.005	0.320	0.311	0.310
CDP3	0.016	0.899	0.501	0.619	0.204	0.408
CDP4	0.057	0.812	-0.099	0.922	-0.030	0.307
SP1	0.066	0.798	-0.277	0.783	-0.085	0.308
SP2	1.694	0.199	0.259	0.797	0.091	0.354
SP3	0.420	0.520	-0.355	0.724	-0.145	0.407
EO1	0.008	0.930	-0.006	0.996	-0.002	0.383
EO2	2.192	0.145	-0.790	0.434	-0.280	0.354
EO3	1.430	0.238	-0.828	0.412	-0.269	0.325
EO4	0.900	0.347	-0.754	0.454	-0.271	0.359
EO5	0.416	0.522	-1.278	0.207	-0.446	0.349
EO6	0.807	0.373	0.000	1.000	0.000	0.434
EO7	0.827	0.368	-0.652	0.517	-0.240	0.368
EO8	1.814	0.184	-0.169	0.866	-0.054	0.323
EM1	0.000	0.986	0.979	0.332	0.331	0.340
EM2	0.192	0.663	0.975	0.334	0.374	0.384
IHR1	0.181	0.672	0.529	0.599	0.122	0.230
IHR2	0.068	0.795	-2.205	0.032	-0.782	0.354
IHR3	0.477	0.493	-1.515	0.136	-0.473	0.312
IHR4	1.051	0.310	0.047	0.963	0.017	0.371
IHR5	0.888	0.351	-0.734	0.467	-0.224	0.305
EP1	1.031	0.315	-1.245	0.219	-0.401	0.322
EP2	0.360	0.551	-0.074	0.941	-0.026	0.362
EP3	0.003	0.958	-0.728	0.470	-0.248	0.340
ES1	0.246	0.622	-1.398	0.169	-0.720	0.515
ES2	3.406	0.071	-0.724	0.473	-0.261	0.361
ES3	0.014	0.908	0.730	0.469	0.225	0.308
ES4	0.988	0.325	-1.167	0.249	-0.408	0.350
ES5	0.084	0.773	-0.975	0.334	-0.322	0.330
ES6	0.395	0.533	0.571	0.570	0.212	0.372
ES7	0.012	0.914	-0.507	0.614	-0.160	0.316
BS1	0.102	0.751	-1.000	0.323	-0.394	0.394

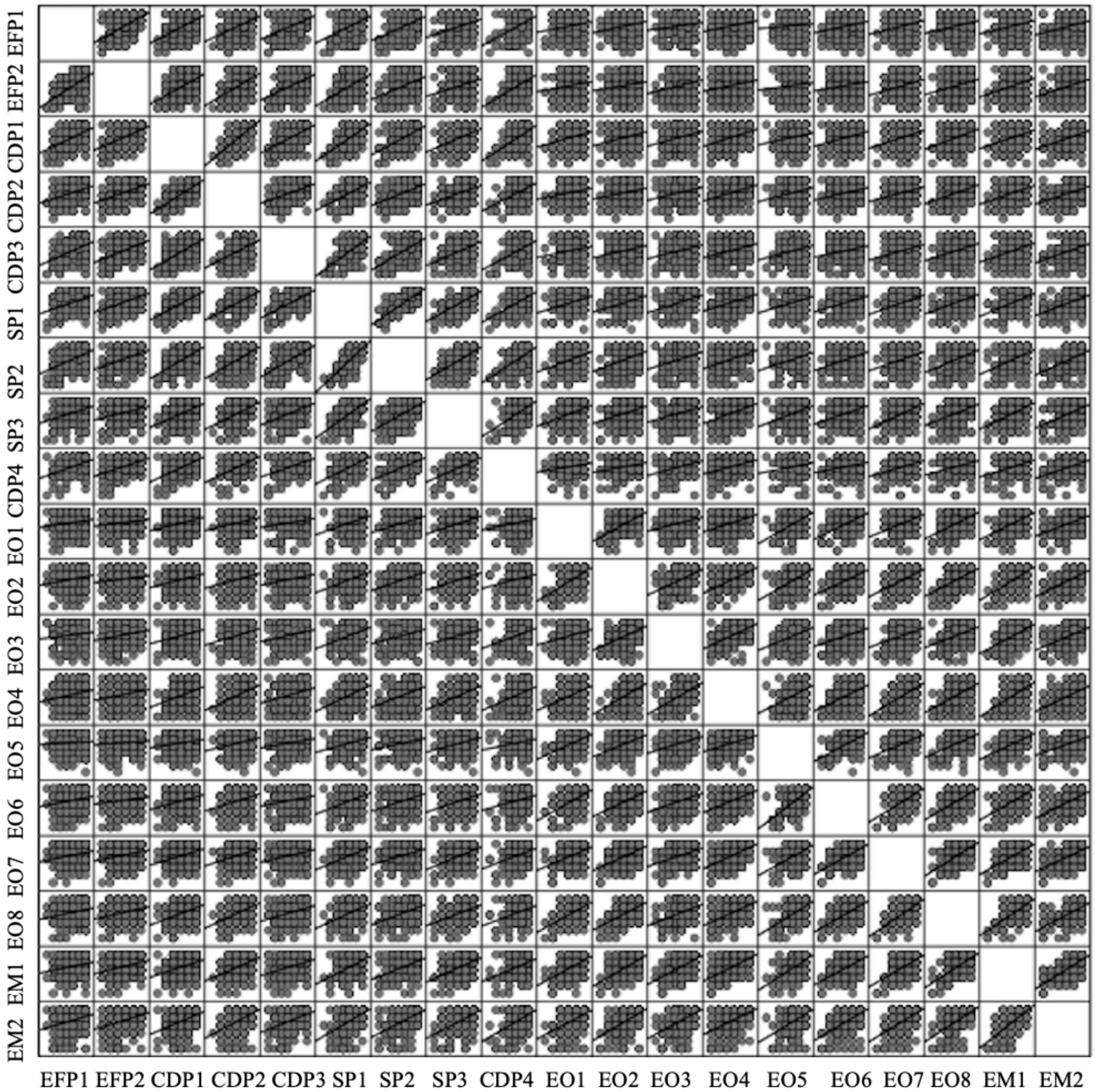
BS2	0.000	0.996	0.634	0.529	0.281	0.444
BS3	3.190	0.080	-1.156	0.253	-0.591	0.511
BS4	0.132	0.718	-0.034	0.973	-0.009	0.279
BS5	3.979	0.052	-1.973	0.054	-0.714	0.362
CAEN1	1.546	0.220	0.873	0.387	0.445	0.509
CAEN2	1.187	0.282	1.798	0.079	0.862	0.479
CAEN3	0.399	0.531	0.279	0.781	0.129	0.461
CAEN4	0.686	0.412	0.818	0.418	0.380	0.465
CAEN5	4.280	0.045	1.806	0.078	0.773	0.428
CAEN6	0.011	0.917	1.443	0.156	0.672	0.465
CAEN7	1.212	0.277	1.108	0.274	0.475	0.428
CAEN8	3.465	0.069	1.448	0.154	0.669	0.461
CAEN9	0.021	0.887	0.248	0.805	0.115	0.466
CAEN10	5.058	0.030	0.219	0.828	0.103	0.472
CASO1	0.010	0.919	-0.269	0.789	-0.080	0.297
CASO2	3.473	0.069	-1.765	0.085	-0.690	0.391
CASO3	0.027	0.871	-0.831	0.410	-0.300	0.353
CASO4	1.325	0.256	0.029	0.977	0.010	0.342
CASO5	2.462	0.124	-0.041	0.967	-0.020	0.486
CASO6	1.035	0.315	0.219	0.828	0.080	0.365
CASO7	0.066	0.798	0.297	0.768	0.110	0.370
CASO8	1.500	0.228	0.677	0.502	0.250	0.370
CAECO1	0.110	0.741	0.058	0.954	0.032	0.548
CAECO2	0.005	0.945	-0.102	0.919	-0.032	0.322
CAECO3	0.561	0.458	0.609	0.546	0.186	0.306
CAECO4	1.243	0.271	0.261	0.796	0.069	0.266
CAECO5	0.025	0.876	-0.228	0.821	-0.080	0.350
CAECO6	0.010	0.919	0.471	0.641	0.222	0.472
CAECO7	0.120	0.731	-0.901	0.373	-0.306	0.340
CAECO8	0.319	0.575	-0.380	0.706	-0.115	0.304
CAECO9	1.791	0.188	-1.260	0.215	-0.583	0.462
CAECO10	1.214	0.277	-1.228	0.226	-0.402	0.327
CAECO11	1.383	0.246	0.560	0.578	0.162	0.289
CAECO12	0.367	0.548	-0.259	0.797	-0.092	0.357

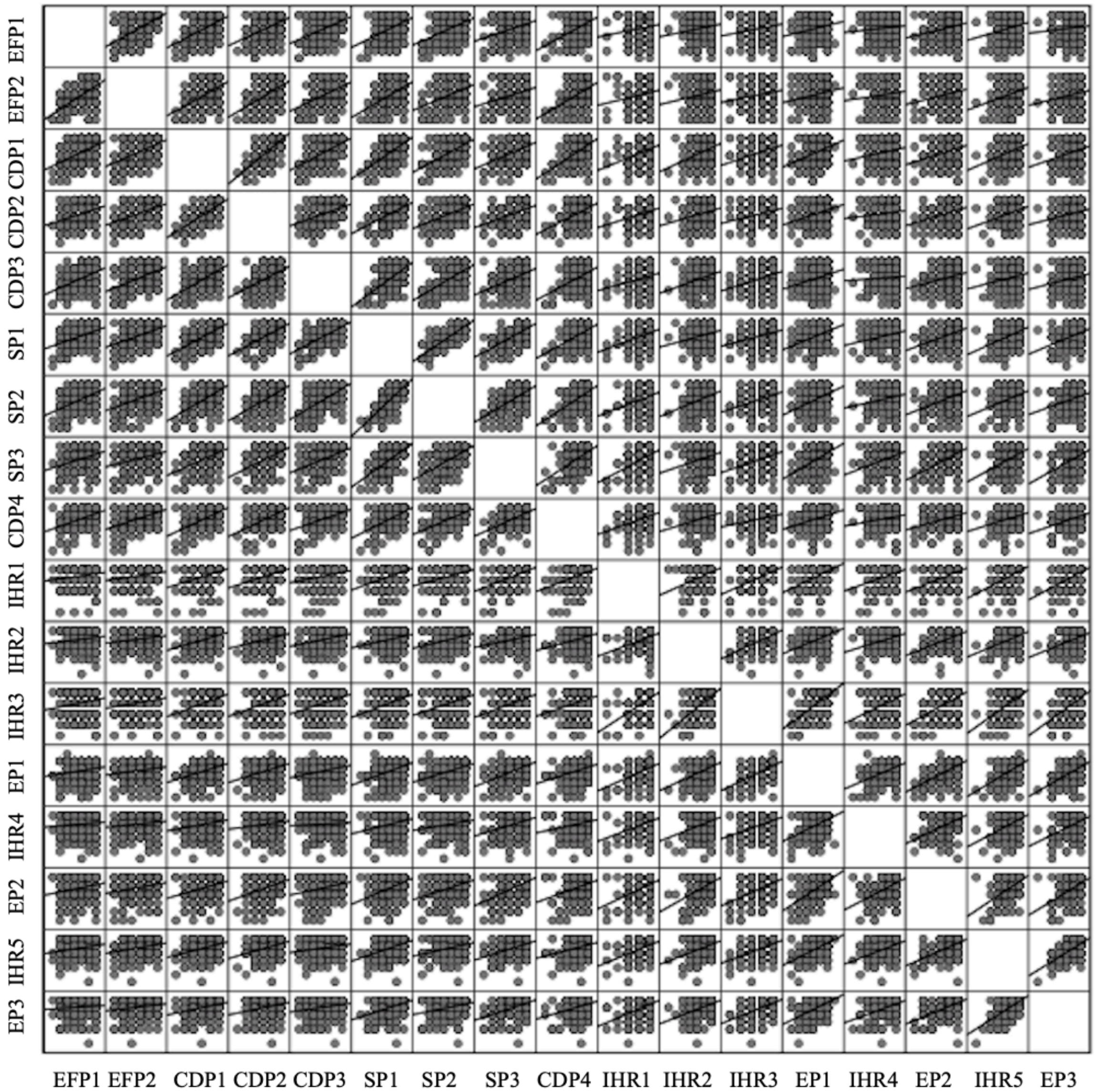
Appendix D. Outliers

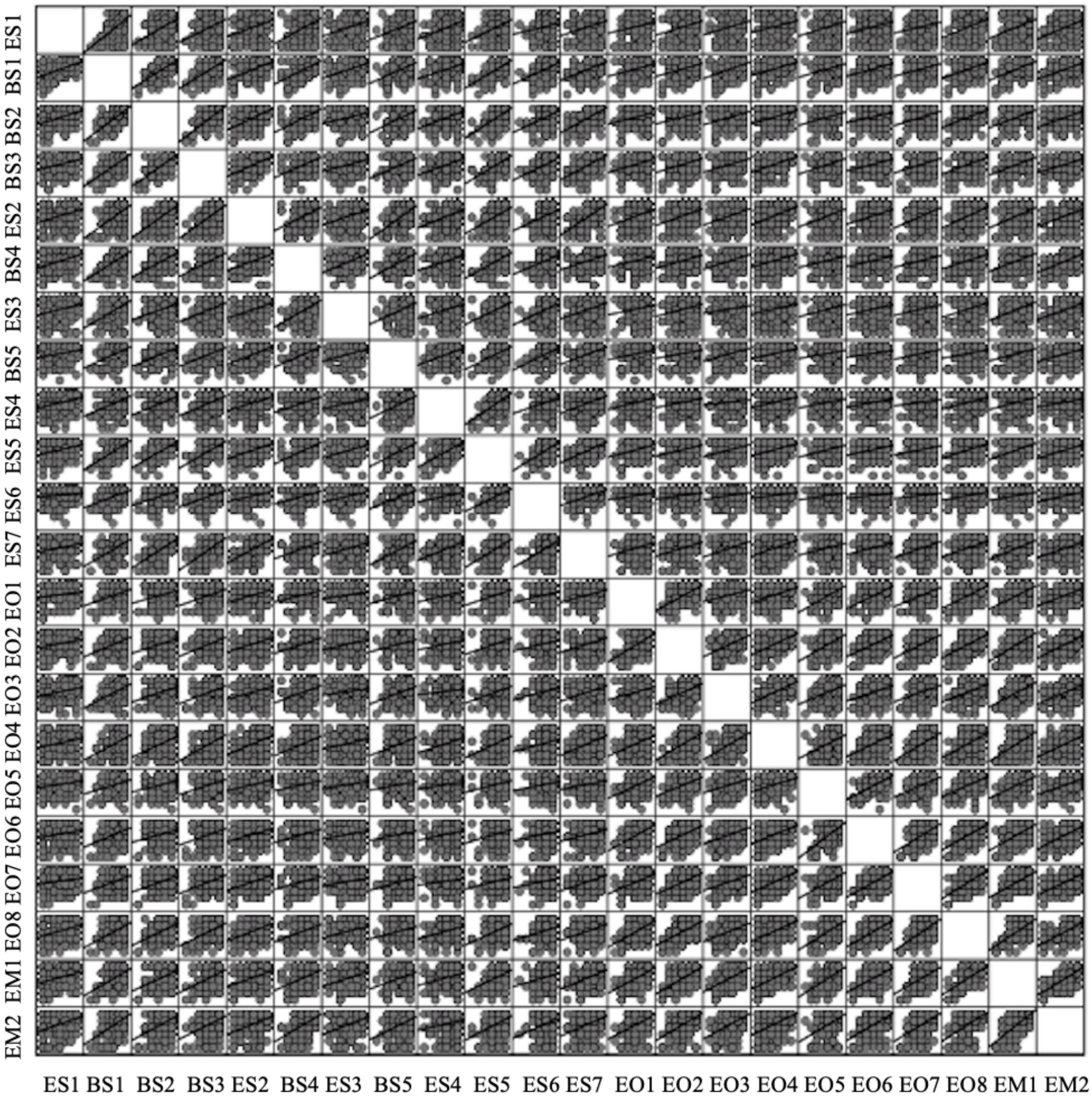
No.	Observation number	Mahalanobis D2-distance	Probability
Part A of the questionnaire			
1	41	118.8848	0.00000
2	92	117.851	0.00000
3	77	95.29165	0.00000
4	129	94.28694	0.00000
5	150	89.30219	0.00001
6	174	88.84372	0.00001
7	39	88.01918	0.00001
8	183	83.60616	0.00004
9	244	79.79469	0.00013
10	199	78.87963	0.00016
11	35	77.80938	0.00022
12	10	76.86394	0.00028
Part B of the questionnaire			
1	134	105.5495	0.00000
2	199	103.2808	0.00000
3	204	93.96676	0.00000
4	41	92.29205	0.00000
5	183	89.30862	0.00000
6	13	88.02227	0.00000
7	129	85.89997	0.00000
8	25	85.75816	0.00000
9	147	80.83829	0.00000
10	77	79.37904	0.00000
11	169	77.45573	0.00000
12	232	76.67952	0.00001
13	185	69.95999	0.00005
14	126	68.53763	0.00008
15	73	67.41944	0.00011
16	152	66.4403	0.00014
17	133	65.739	0.00018
18	148	65.71917	0.00018
19	144	63.41428	0.00035
20	228	62.10743	0.00051
21	105	61.95282	0.00053
22	186	61.54151	0.00060
23	216	60.6985	0.00076
24	19	59.73307	0.00099

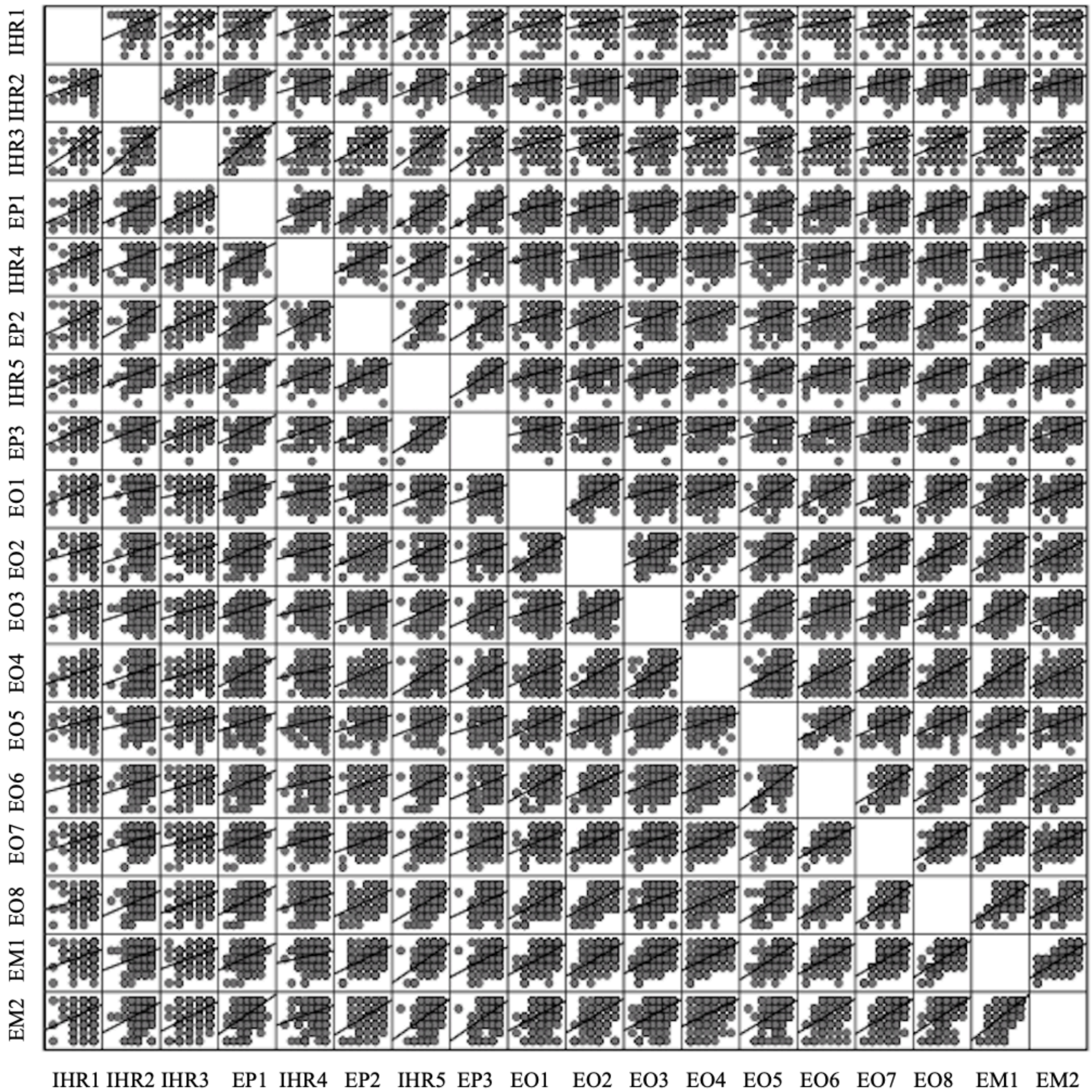
Appendix E. Bivariate scatterplots of variables for examining homoscedasticity



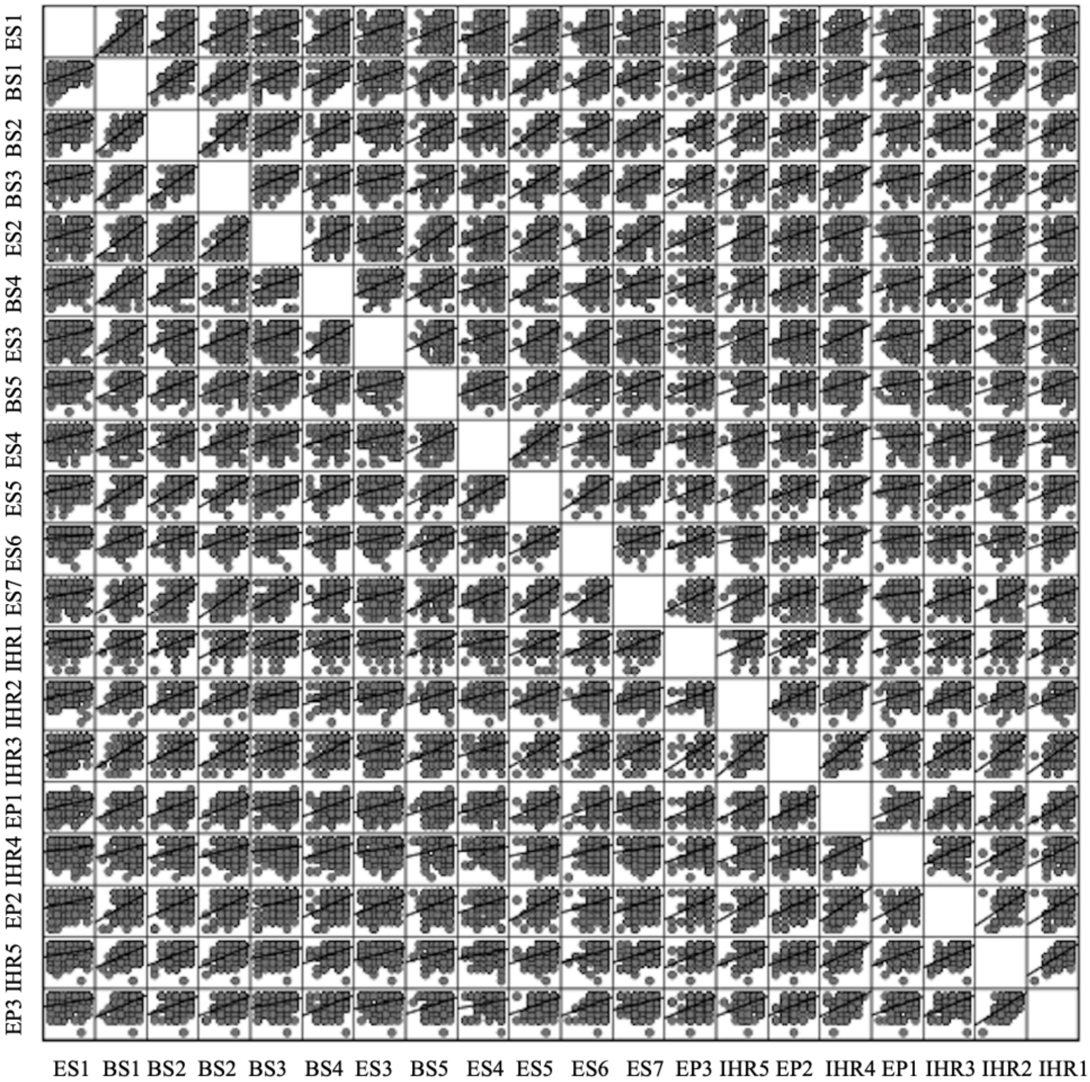

EFP1 EFP2 CDP1 CDP2 CDP3 SP1 SP2 SP3 CDP4 EO1 EO2 EO3 EO4 EO5 EO6 EO7 EO8 EM1 EM2


EFP1
EFP2
CDP1
CDP2
CDP3
SP1
SP2
SP3
CDP4
IHR1
IHR2
IHR3
EP1
IHR4
EP2
IHR5
EP3
EFP1 EFP2 CDP1 CDP2 CDP3 SP1 SP2 SP3 CDP4 IHR1 IHR2 IHR3 EP1 IHR4 EP2 IHR5 EP3


ES1 BS1 BS2 BS3 ES2 BS4 ES3 BS5 ES4 ES5 ES6 ES7 EO1 EO2 EO3 EO4 EO5 EO6 EO7 EO8 EM1 EM2

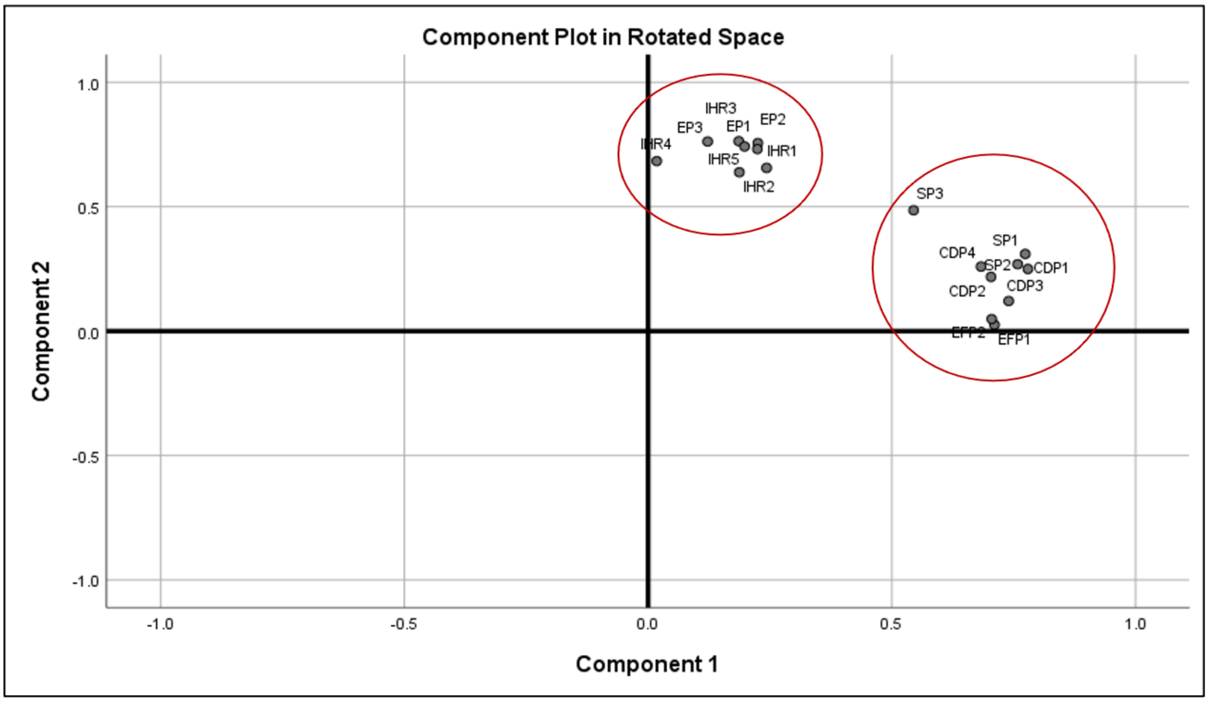


IHR1
IHR2
IHR3
EP1
IHR4
EP2
IHR5
EP3
EO1
EO2
EO3
EO4
EO5
EO6
EO7
EO8
EM1
EM2
IHR1 IHR2 IHR3 EP1 IHR4 EP2 IHR5 EP3 EO1 EO2 EO3 EO4 EO5 EO6 EO7 EO8 EM1 EM2


ES1
BS1
BS2
BS3
ES2
BS4
ES3
BS5
ES4
ES5
ES6
ES7
IHR1
IHR2
IHR3
EP1
IHR4
EP2
IHR5
EP3
ES1 BS1 BS2 BS2 BS3 BS4 ES3 BS5 ES4 ES5 ES6 ES7 EP3 IHR5 EP2 IHR4 EP1 IHR3 IHR2 IHR1

Appendix F. Loading plots between factors with potential cross-loading effects

F1.1 Competitive advantage and social sustainability factors



F2.2 Social sustainability and economic sustainability factors