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MASTER'S THESIS

SUSTAINABILITY PERFORMANCE MEASUREMENT IN PORTS BY USING AHP AND TOPSIS METHODOLOGY

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İZMİR-2017

TEZ ONAY SAYFASI

DECLARATION

I hereby declare that this master's thesis titled as "Sustainability Performance Measurement in Ports by Using AHP and TOPSIS Methodology" has been written by me in accordance with the academic rules and ethical conduct. I also declare that all materials benefited in this thesis consist of the mentioned resources in the reference list. I verify all these with my honor.

…./…./…….

Nergis ÖZİSPA

ABSTRACT

Master's Thesis

Sustainability Performance Measurement in Ports by Using AHP and TOPSIS Methodology

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Ports located at the center of world trade have vital importance in delivering the needs of the daily life from one point to another. Sustainability for the port industry has become a growing source of fear and concern for port authorities, policy makers, port users and local communities. Ports composed of different businesses dealing with different activities and offering a wide range of services are among the most harmful to the environment due to their characteristics such as the amount of waste they produce, harmful emissions and noise pollution they cause. To reduce this harm, sustainability is one of the important concepts for port industry and it was thought that more detailed examination of measuring port performance would be useful. Thus, the purpose of this study is to determine the prevalently used port sustainability indicators in the sustainability reporting process and to compare ports' sustainability performance via the ports sustainability indicators (PSIs).

The relevant literature includes many publications on port and sustainability concepts, yet, no study has so far examined the efficiency of existing port sustainability reports according to three fundamental dimensions of sustainability. This indicates that a gap exists in the literature, which has been the main motivation of this study.

A detailed literature review was conducted to determine the outline of the study and to find common port sustainability indicators that are recommended for use in all ports' sustainability reports. In addition, starting with 1987, when concept of sustainability entered the literature, all the publications which have the keywords "port" and "sustainability" in the title were scanned and a content analysis was conducted on relevant publications. The usage frequency of these indicators was analyzed through the N-Vivo 8 package program. No useful result could be obtained in analyzes made with the N-vivo program regarding the commonly used indicators so 16 different PSI's were identified that are contained within the sustainability reports of four international ports. An evaluation form was created for the AHP weights of the port sustainability indicators obtained. This evaluation form has been answered by 10 experts from different industries. In the last part, the indicators of these four ports were analyzed using AHP and TOPSİS methods with Microsoft Office Excel program. The AHP results reveals that, the most important sustainability dimension is financial, followed by environmental and social dimensions respectively. Additionally, the most important financial indicator determined is operating profits, the environmental indicator is water consumption and the social indicator is fatalities. According to results of the TOPSIS, two of the above mentioned ports (Port of Coruna and APM Terminals) have had successful results in financial dimension and the other two (Port of Coruna and Port of Gothenburg) have had successful results in environmental dimension. APM Terminals have also been identified as the most successful port in the social dimension of sustainability.

Keywords: Sustainability, Performance Measurement, Multi-Criteria Decision Analysis, Port Sustainability

ÖZET

Yüksek Lisans Tezi

Limanlarda Sürdürülebilir Performansın AHP ve TOPSİS Yöntemleri Kullanılarak Ölçülmesi

Dokuz Eylül Üniversitesi
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Dünya ticaretinin merkezinde yer alan limanlar, gündelik hayatın devamlılığını sağlayan ihtiyaçların farklı noktalara ulaştırılabilmesi adına hayati öneme sahiptir. Liman sektörü için sürdürülebilirlik konusu; liman otoriteleri, politika yapıcılar, liman kullanıcıları ve yerel topluluklar için artan bir korku ve endişe kaynağı haline gelmiştir. Farklı faaliyetlerle uğraşan ve geniş bir hizmet yelpazesi sunan farklı işletmelerden oluşan limanlar, ürettikleri atık miktarı, zararlı salınımlar ve gürültü kirliği gibi özellikleri sebebiyle çevreye en çok zarar veren sektörler arasında gösterilmektedir. Bu zararın büyük ölçüde azaltılması adına, sürdürülebilirlik, liman sanayi için önemli kavramlardan biridir ve liman performans ölçümünün daha ayrıntılı incelenmesinin gerekli olduğu düşünülmektedir. Böylece, söz konusu çalışmanın amacı, sürdürülebilirlik raporlarında esas olarak kullanılan liman sürdürülebilirlik göstergelerine karar vermek ve Liman Sürdürülebilirlik Göstergeleri (PSIs) değerleriyle limanların sürdürülebilirlik performansını karşılaştırmak olarak belirlenmiştir.

Yazında liman ve sürdürülebilirlik kavramları üzerine çok sayıda yayın olmasına karşın, mevcut liman sürdürülebilirlik raporlarının etkinliğini sürdürülebilirliğin üç temel boyutu kapsamında inceleyen bir çalışmaya ulaşılamamıştır. Bu durum, konu hakkında bir boşluk olduğunu ortaya koymuş ve çalışmanın ana motivasyon kaynağını oluşturmuştur.

Çalışmanın ana hatlarını belirlemek ve tüm limanların sürdürülebilirlik raporlarında kullanılması önerilen ortak liman sürdürülebilirlik göstergeleri bulmak amacıyla detaylı bir yazın taraması yapılmıştır. Bunun yanında çeşitli veri tabanlarında, sürdürülebilirlik kavramının yazında ilk kez kullanılmaya başlandığı 1987 yılından günümüze, "liman" ve "sürdürülebilirlik" anahtar kelimeleri kullanılarak yayın taraması yapılmış ve konu ile ilgili olduğu saptanan yayınlara içerik analizi yapılmıştır. Yazın taraması sonucu elde edilen bu değişkenlerin mevcut liman sürdürülebilirlik raporlarındaki kullanım sıklıkları N-Vivo 8 paket programı aracılığıyla analiz edilmiştir. N-Vivo programı ile yapılan analizlerde kullanılabilir bir sonuç elde edilemediğinden, dört uluslararası limanın sürdürülebilirlik raporlarında yer verilen 16 farklı liman sürdürülebilirlik göstergesi tespit edilmiştir. Bu şekilde elde edilen liman sürdürülebilirlik göstergelerinin AHP ağırlıklandırmaları için bir değerlendirme formu oluşturulmuştur. Oluşturulan bu form farklı sektörlerden 10 uzman tarafından cevaplandırılmıştır. Son kısımda ise elde edilen bu dört limana ait göstergeler AHP ve TOPSİS yöntemleri ile Microsoft Office Excel programı kullanılarak analiz edilmiştir. Çalışmanın AHP sonuçlarına göre; sürdürülebilirliğin en önemli boyutu finansal boyut olarak belirlenirken, çevresel ve sosyal boyutlar onu takip etmiştir. Buna ek olarak; en önemli finansal gösterge işletme karı, çevresel gösterge su tüketim miktarı, sosyal gösterge ölümlü kaza olarak belirlenmiştir. Çalışmanın TOPSIS sonuçlarına göre ise; Coruna Limanı ve APM Terminalleri finansal sürdürülebilirlikte, Coruna Limanı ve Gothenburg Limanı çevresel sürdürülebilirlikte başarılı sonuçlar elde etmişlerdir. Sürdürülebilirliğin sosyal boyutunda ise yine APM Terminalleri en başarılı liman olarak belirlenmiştir.

Anahtar Kelimeler: Sürdürülebilirlik, Performans Ölçümü, Çok Kriterli Karar Verme, Limanlarda Sürdürülebilirlik

SUSTAINABILITY PERFORMANCE MEASUREMENT IN PORTS BY USING AHP AND TOPSIS METHODOLOGY

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ABBREVIATIONS

AA100	Account Ability 1000
AHP	Analytical Hierarchical Process
CAAP	Clean Air Action Program
CDP	Carbon Disclosure Project
CGSDI	Consultative Group on Sustainable Development Indicators
CHE	Cargo Handling Equipment
COP	Communication on Progress
CSR	Corporate Social Responsibility
DEA	Data Envelopment Analysis
DS	Dimensions of Sustainability
E	Environmental Dimension of Sustainability
F	Financial Dimension of Sustainability
GRI	Global Reporting Initiative
IUCN	International Union for the Conservation of Nature and Natural Resources
MCA	Multi Criteria Analysis
MCDA	Multi Criteria Decision Analysis
OCNP	Ocean's Carrier Network Problem

PDE	Panel Data Estimation
PPP	Port Project Planning
PSI	Port Sustainability Indicator
RST	Rough Sets Theory
S	Social Dimension of Sustainability
SD	Sustainable Development
TIPC	Taiwan International Ports Corporation
TOPSIS	Technique for Order Preference by Similarity to Ideal Solution
UN	United Nations
UNCED	UN Conference on Environment and Development
UNCHS	United Nations Conference on Human Settlements
UNEP	United Nations Environment Program
WCED	World Commission on Environment and Development
WCS	The World Conservation Strategy
WWF	World Wildlife Fund

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INTRODUCTION

Ports are very complicated because of their nature, various services and a wide range of environmental issues such as water releases (limber water), harmful emissions, waste and noise production and pollution (Hakam, 2015; Darbra et al, 2005). They are composed of different companies, dealing with different activities and offering a wide range of services. Seaports are notorious to be serious polluting industry, however, they have many opportunities for reducing emissions and pollutions (Broesterhuizen et al., 2012). Sustainability in the port industry is of growing source of fear for port authorities, policy makers, port users and local communities (Acciaro et al., 2014). Therefore, sustainability is one of the important concepts for port industry and it was thought that more detailed examination and comparison of port performance measurement would be useful. For all these reasons the purpose of this study is to decide prevalently used port sustainability indicators in the sustainability reporting process, to compare ports' sustainability performance via the ports sustainability indicators (PSIs).

In the first chapter of the study, the concept of sustainability and the historical background of sustainability are explained in detail. Along with that, the concept of sustainable development, the summit and meetings for the development of the concept and three main dimensions of sustainability which are; financial, environmental and social are examined. The last section of chapter one focuses on the concepts of measurement and reporting of sustainability.

In the second chapter, a detailed literature survey was conducted to find the common port sustainability indicators (PSIs) to be used to measure port sustainability. In addition, to obtain an overview of the increase of writings on the topic, an online search was made in the following electronic databases: Google Scholar, Ebscohost, Proquest, Science Direct and Scopus. The search terms "port sustainability", "sustainable port", "environmental management in ports", "green port", "sustainable supply chain management", "corporate social responsibility in ports" and "port sustainable

development” are used on all databases in English and Turkish from the period of 1987 to 2017 April.

In the third chapter of the study, a "Port Sustainability Indicators Set" was composed by compiling the port sustainability indicators obtained in the second chapter. Indicators in this set were subjected to usage frequency analysis using the N-Vivo program, within the sustainability reports of the seven ports. With the frequency analysis conducted, it was determined that there are very few or no common indicators in the existing port sustainability reports. Along with that four ports with common indicators were identified. In the last part of this chapter, the obtained indicators were analyzed using AHP and TOPSİS methods with Office Excel Program. In addition, mathematical background and formulas of AHP and TOPSIS methods are given in this chapter.

In the conclusion, the results obtained from analyses are explained. In addition, the limitations of the study and suggestions for future studies are also included in this section.

CHAPTER 1
SUSTAINABILITY

1.1. SUSTAINABILITY

Sustainability which has environmental and social dimensions as well as economic dimension and it has the power to solve problems such as poverty and hunger in the world when applied successfully is a phenomenon that has been used extensively in recent times (Sürücü, 2015: 37). Özmehmet (2008) generalized the sustainability as the least understood and applied concept from global scale to local scale.

Sustainability is a policy concept that born in the Brundtland Report of 1987 (Kuhlman and Farrington, 2010: 3436). The term of sustainability formed over time and become widely used term to refer simply to practices that are noted to be more environmentally sound than others (Heinberg and Lerch, 2010: 1). In addition to that, nowadays, the sustainability concept becomes more popular because it attracts attention from the media, the industry and the research community (Hakam and Solvang, 2013: 803).

Even if former organizations applied methods and tools, adopted several approaches and policies to apply new concepts to transform into information organizations, today's information age, one of the biggest challenges that the organizations should pay attention is the sustainability factor (Nazlı, 2016: 339). Basically sustainability concept is the management of all sorts of resources with a view to continue at least quality of life for current generation and the generations to come (Kuş, 2012: 1).

According to Taşçıoğlu (2014), sustainability concept has been defined in diverse fields, like management and social science, environmental science or technical science. Maybe because of that reason, there are various definitions of sustainability in current literature. Some of these definitions are;

"Meeting the needs of the present without compromising the ability of future generations to meet their own needs" (Bruntland Report for the World Commission on Environment and Development, 1987).

"A process of change in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations" (Brundtland Report for the World Commission on Environment and Development, 1987).

"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (Brundtland Report for the World Commission on Environment and Development, 1992).

"Any state of a business in which it meets the needs of its stakeholders without compromising its ability also to meet their needs in the future" (Hockerts, 1999: 30).

"Consumption of natural resources at a rate that can be naturally replenished and the emission of waste at a rate that can be absorbed by nature" (Dyllick and Hockerts, 2002: 132).

"Securing long-term economic performance by avoiding short-term socially detrimental and environmentally wasteful behaviour" (Porter and Kramer, 2006: 80).

"Achievement of an organization's social, environmental and economic goals" (Carter and Rogers, 2008: 362).

"Activities that attempt to improve the environmental performance of purchased inputs, or of the suppliers that provide them" (Walker et al., 2008: 70).

"Performing well on not only traditional measures of profit but also in social and natural dimensions" (Pagell and Wu, 2009: 38).

"An effort to conserve natural resources and avoid waste in operations" (Pfeffer, 2010: 36).

"A way of doing business that creates profit while avoiding harm to people and the planet" (The Center for Sustainable Enterprise, 2010).

"Intersection of economic, environmental and societal superiority" (Paulraj, 2011: 20).

1.2. HISTORICAL BACKGROUND OF SUSTAINABILITY

The etymological root of the sustainability term is based on the word "sustenere" (sustain) in Latin. Conceptually, it is based on forestry, fisheries and soil science and was first used in these branches of science. At the end of the 18th century the German miner Carlowitz used it the mining industry's masts to mean that timber plantations would be utilized in a way that would increase the productivity and sustainability (Aksoy, 2013: 10). After that, the concept of sustainability has been associated with the concept of productivity in the fields of renewable sources like agriculture ecology and fishery (Bozlağan, 2005: 1013) it has been described as "ability to maintain productivity despite obstacles" (Aksoy, 2013: 10).

According to Warde (2011: 153), Justus Freiherr von Liebig (12 May 1803 – 18 April 1873) who was a German chemist firstly talked about a concept of sustainability in 1840's. Liebig defended that simple recycling of organic matter was insufficient to maintain soil fertility. Moreover, he gave ecological substance and historical traction to

the emerging model of sustainability. In 2011 Warde found that the modern conception of sustainability in Liebig's study: "a society's development is beholden to fundamental biological and chemical processes, but also that this was a complex dynamic system with feedback effects" (Warde, 2011: 153).

After that in the 1950's, Hannah Arendt, a political theorist, warned the humanity that (Pantelic et al., 2016: 37) "advances in technology and the increase in free time were providing humankind with the opportunity to consume the whole world" (Csikszentmihalyi, 2000: 267).

Then, in 1983 main policy making and representative agency of the United Nations, created the "World Commission on Environment and Development" (WCED) commission (Ugbaja, 2016: 12). WCED publishes yearly reports to discuss and highlight the sustainability and in the 1987 Our Common Future report, WCED released the most accepted sustainability definition, which is "Meeting the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). The creation of this definition is accepted as a starting point of sustainability concept by many sources. A number of definitions of sustainability have been made in various studies in various branches from 1987 to the present day. Some of these definitions are given above title in chronological order.

1.2.1. 1972 Stockholm Environment and Human Rights Conference

At the "United Nations Conference on the Human Environment" (Stockholm Conference) held in Stockholm on 5-6, June 1972, 113 country representatives (Eş, 2008: 5) with different socio-economic structures and development levels came together for the first time to discuss environmental issues (T.C. Dışişleri Bakanlığı, 2017a). In this conference, relations between environment and development are discussed and it is emphasized that these terms support each other not contradictory to each other (Eş, 2008: 5). In this conference, it is stated that all countries are responsible for establishing an appropriate environmental policy within the framework of their authority and boundaries and that these countries should help developing countries to fulfill their

responsibilities and that international cooperation should be done in this regard (Aksoy, 2013: 10). At the end of the conference, the "Declaration of the United Nations Conference on the Human Environment" was accepted (T.C. Dışişleri Bakanlığı, 2017a).

The most important result of the conference was the establishment of the UN (United Nations) Environment Program (UNEP). This program is designed to focus on environmental actions within the UN system and to create an environmental fund that finances environmental programs that taking place within the UN (Eş, 2008: 5).

1.2.2. 1976 HABITAT I Conference

Following the recommendation of a United Nations (UN) conference on human settlements in the United Nations Conference on Human Environment in Stockholm in 1972, Habitat-I Conference was held in Vancouver in 1976. After that conference in 1978 the United Nations Conference on Human Settlements (UNCHS) was established. At the time of its foundation, low level support was provided to UN-HABITAT, because two out of thirds of the world's population lives in rural areas, and therefore problems related to urbanization have not yet been reached the present importance (T.C. Dışişleri Bakanlığı, 2017b).

1.2.3. 1980 The World Conservation Strategy (WCS)

The World Conservation Strategy is undoubtedly one of the most important studies that should be considered in the historical development of the concept of Sustainable Development (Eş, 2008: 5). The concept of sustainable development was first used in the World Conservation Strategy (Bozlağan, 2005: 1018). Created by International Union for the Conservation of Nature and Natural Resources (IUCN) , World Wildlife Fund (WWF) and United Nations Environment Programme (UNEP), World Conservation Strategy (WCS) was published in 1980 and it emphasizes the need to combine conservation and development thinking to achieve a sustainable society (Eş, 2008: 6). The first paragraph of the report as a summary of the purpose and the importance of the study is given below;

"Human beings, in their quest for economic development and enjoyment of the riches of nature, must come to terms with the reality of resource limitation and the carrying capacities of ecosystems, and must take account of the needs of future generations. This is the message of conservation. For if the object of development is to provide for social and economic welfare, the object of conservation is to ensure Earth's capacity to sustain development and to support all life." (WCS, 1980).

1.2.4. 1987 Brundtland Report

The Brundtland Report, prepared by the World Commission on Environment and Development (WCED), which composed of participants from twenty countries headed by Norwegian Prime Minister Gro Harlem Brundtland, in 1987 and presented to the United Nations General Assembly upon the request and proposal of the Secretary General of the United Nations in 1983 (Bozlağan, 2005: 1019). In the report it was stated that firstly to establish a link and relationship between environmental and economic development and this relationship should be "sustainable" (Aksoy, 2013: 11). Also first, the most accepted and most used, even today, sustainability definition was created in this report in 1987.

This report emphasizes the importance of international cooperation in resolving global environmental problems and emphasizes that economic and ecological activities support each other and these considerations should be supported politically (Eş, 2008: 6). The vision of the sustainable development concept in the Brundtland Report can be described as a policy invitation aimed at maximizing growth and at the same time taking into account the need for economic growth (Bozlağan, 2005: 1020).

1.2.5. 1992 UN Conference on Environment and Development (UNCED)

Based on the saving provided by the Stockholm Declaration and the Brundtland Report, the "United Nations Conference on Environment and Development" held in Rio de Janeiro in 1992 is, in the adoption of a number of initiatives to co-ordinate

international environmental and economic activities, an important step in the internationalization of Sustainable Development (Sürücü, 2015: 41).

UNCED has been a meeting without an example in the past because that summit brought together the most heads of state among the meetings made up to that date (Başarır, 2008: 36). The conference was attended by 117 heads of state, including our country, 1,500 civilian organizations and over 5,000 reporters (Eş, 2008: 6).

In the Conference a declaration was published that consist of 27 principles (Aksoy, 2013: 11), also an action plan called "Agenda 21" has been put forward (Çamur ve Vaizoğlu, 2007: 299).

1.2.5.1. Rio Declaration

In the conference in Rio, known as the world summit, attended by 117 Heads of State from 179 countries were held a declaration that consists of 27 principles (Erdem et al., 2015: 2). Those 27 principles describe the rights and responsibilities of countries in the works that done for human development and prosperity (Başarır, 2008: 37).

1.2.5.2. Agenda 21

Agenda 21, adopted at the conference, is a plan on how development can be sustainable from the social, economic and environmental perspectives (Başarır, 2008: 37). Agenda 21 focuses on concepts and issues such as sustainable human settlement, sustainable mountain development, sustainable agriculture and rural development, and sustainable forest development in addition to the notion of sustainable development (Bozlağan, 2005: 1020).

1.2.5.3. Convention on Climate Change

The aim of this contract is to stop the accumulation of greenhouse gases in the atmosphere and on the climate system at a level that will prevent dangerous human induced effects. Also achieve this level with a natural adaptation of the ecosystem to climate change, within a time frame that will allow food production to remain intact and

allow economic development to continue in a sustainable manner. However, in the conference, countries experienced a disagreement on this convention. In particular, the United States and some countries did not sign the contract, arguing that this restriction could lead to economic inaccuracies (Eş, 2008: 10).

1.2.5.4. Convention on Forest Principles

It is a non-binding guidance from the legal point of view regarding the economic development and management, conservation and sustainability of all forests that is necessary for all living beings to have their lives resigned (Başarır, 2008: 37).

1.2.5.5. Convention on Desertification

The aim of the convention is to struggle desertification and to reduce the effects of drought, especially in Africa and Latin America. For this reason, the contract has been shaped in the form of national and regional action programs (Eş, 2008: 11).

1.2.5.6. Convention on Biological Diversity

Convention aimed at ensuring the protection of biological resources at national, regional and international levels, preventing threats to these sources, introducing preventive precautions against unauthorized use of biological and genetic resources, providing new and additional sources of funding and technological transfer for the countries under development for measures to be taken for this purpose (Başarır, 2008: 37).

1.2.6. 1996 The United Nations Conference on Human Settlements - HABITAT II Summit

Within the historical course of the Sustainable Development concept, the United Nations Conference Human Settlements (Habitat II Summit) held in Istanbul by the

United Nations in 1996 has an important place (Bozlağan, 2005: 1022). The difference of the meeting from other conferences held to that date is the change of the interstate character, the non-governmental organizations' active role and contribution to the conference (Çamur ve Vaizoğlu, 2007: 300).

At the United Nations Conference on Environment and Development (Rio de Janeiro 1992), the concept of sustainable development has been expanded to include the relationship of the concept to various disciplines and the concept of sustainable development has been linked to economy till management. At the Habitat II Conference, the concept of the sustainable development is adapted to the field of human settlements (Bozlağan, 2005: 1022).

1.2.7. 1997 Rio+5 Summit

It is a follow-up meeting in New York in 1997, five years after the Rio Conference (Çamur and Vaizoğlu, 2007: 300). The vision of the Forum was set to bring together a large group of participants to pass the sustainable development from the "agenda" to the "implementation". Forum focuses on strategy and management systems that will benefit to implement the sustainable development at local, national and global levels. It is aimed that each participant will transfer their cultural, historical and spiritual knowledge and experience to the Forum (Bozlağan, 2005: 1023). The meeting encouraged and revitalized the efforts of countries to develop their own sustainable development approaches in line with their different priorities, shortcomings and needs (Çamur and Vaizoğlu, 2007: 301).

1.2.8. 2000 Millennium Summit

"Leaders Summit" took place in the Headquarters of the United Nations in New York in 6-8 September 2000, with the participation of heads of state and heads of government of 189 countries including Turkey. In the summit United Nations Millennium Declaration signed, which is considered today's one of the most powerful and priority global commitments. The Declaration sets out the "Millennium

Development Goals" for the development and reduction of poverty until 2015 (Başarır, 2008: 38). Addition to elimination of poverty and hunger, these targets included the basic education for all individuals, ensuring gender equality, increasing maternal child health and struggle with epidemic diseases (Sürücü, 2015: 46).

1.2.9. 2002 Johannesburg Summit

The World Summit on Sustainable Development was held in Johannesburg in South Africa at the date of August 26 to September 4 in 2002, to examine current developments since the 1992 Rio Earth Summit and to reinforce multilateral sustainable development (Eş, 2008: 13). The 1992 Rio Conference influenced all segments of society, the agenda of all major United Nations meetings on environmental and development issues. The most important feature of the conference is active participation of all segments of the society both during the preparation process and during the meeting (Çamur and Vaizoğlu, 2007: 301). The Johannesburg Conference has become a global event, in which concrete projects have been discussed and developed, beyond abstract and generic promises (Bozlağan, 2005: 1024).

At the Johannesburg summit the commitments made in Rio, 10 years ago, were reiterated and the Johannesburg declaration was published which is an implementation and action plan that facilitated reaching Agenda 21 and sustainable development goals, in the framework of international cooperation. The implementation plan included topics such as fighting poverty, conservation of natural resources, sustainable development for the globalized world, health and sustainable development, sustainable development and implementation tools for Africa (Eş, 2008: 13).

1.2.9.1.2012 Rio +20 Summit

Rio+20 Summit held in Rio on 20-22 June 2012. Green economy, how to value natural resources, sustainability of the private sector and its role in financing, sustainability measurement for companies were the subjects that discussed in that summit (Sürücü, 2015: 47).

To reiterate the conference on sustainable development, to support the economic, social and environmentally sustainable future, to support the world, the present and future generations the highest level of participation was attained such as heads of state and government representatives and the conclusion of the conference titled "The Future We Want" was accepted (Aksoy, 2013: 12). In the report published in the summit “The Future We Want” is said to have been assessed in the context of sustainable development and the removal of poverty (Sürücü, 2015: 47).

1.3. SUSTAINABLE DEVELOPMENT

Sustainable development is mainly a policy concept and perhaps it is the most challenging one ever developed. Because it is main aim is to provide everybody in everywhere and at any time. In short it gives opportunity to lead a dignified life in his or her respective society (Omann and Spangenberg, 2002: 2).

Sustainable development is a process that meets the needs of current generation and future generations as well without consuming limited resources by establishing a balance between human and nature (Sürücü, 2015: 47). According to Sislian et al., (2016) sustainable development is one of the greatest challenges faced by humanity nowadays. In 21st century sustainable development plays an important role both for environmental and competition perspectives of business and industry environment (Kranjc and Glavic, 2005b: 190).

Even though in the 1980s, some proclaimed that sustainable development is just a catch phrase that will eventually disappear just like the 1970s concept of appropriate technology (Mebratu, 1998: 494), as the Brundtland Report has been published in 1987, sustainable development (SD) concept has become the privileged aim and one of the crucial objective of policy makers (Singh et al., 2009: 191) and scientific communities (Krajnc and Glavic, 2005a: 552). The influence of the sustainable development concept has increased since then both national and international policy developing process, this situation resulted in a wide range of definitions (Mebratu, 1998: 494).

On this subject just like the pure sustainability there is no single definition, but the most commonly agreed definition is provided by the Brundtland Commission in 1987 which is “to provide for the needs of the present generation without compromising the abilities of future generations to meet their needs” (Sislian et al., 2016). Even if sustainable development has been included into many levels of society and industry in recent years, that specific definition is accepted as a starting point for most set out to define the sustainable development concept (Ness et al., 2006: 498). Addition to that in 2009 Hakam and Solvang claimed that the concept of sustainable development should contain three dimensions, which are economical profitability, environment friendliness and social benefits. Despite variety of sources named these dimensions close terms, some sources named them differently. Those differences will be explained detailed in next section of this chapter.

> *"Sustainable development is a dynamic process which enables people to realize their potential and improve their quality of life in ways which simultaneously protect and enhance the earth's life support systems" (Forum for the Future, 1996).*

> *"In essence sustainable development is about five key principles: quality of life; fairness and equity; participation and partnership; care for our environment and respect for ecological constraints - recognizing there are 'environmental limits'; and thought for the future and the precautionary principle" (Forum for the Future, 1996).*

> *“Sustainable development is a process of change in which the exploitation of resources, the direction of investment, the orientation of technological development, and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations” (WCED, 1987).*

1.4. DIMENSIONS OF SUSTAINABLE DEVELOPMENT

Sustainability must be taken into account and be found a balance between environmental, financial and social factors that are also referred as the triple bottom line of sustainability (Sislian et al., 2016) or called three dimensions of sustainable development (Tanzil and Beloff, 2006: 41). That triple bottom line is defined as 3P in several papers, which are People, Planet and Profit. In 3P classification, *People* stands for the social criteria as corporate social responsibility, *Planet* consists the criteria for the environment, and the *Profit* criterion will be formulated as the financial Net Present Value (Broesterhuizen et al, 2012: 5). Similar to triple bottom line of sustainability, three dimensions of sustainable development are separated as economic growth, social progress, and stewardship of the environment (Tanzil and Beloff, 2006: 41). In (1999) The U.S. National Research Council argues that there are three important components of sustainable development: what is to be sustained, to be developed, and the intergenerational component. They also create three areas and named, nature, life support systems and community then developer these names as; people, society and economy (Ness et al, 2006: 498). Consequently, three value driven dimensions are visualized and help monitor the port sustainability performance (Hakam, 2015: 15).

Similar to these approaches, in (2014) Litman also summarize sustainability dimensions as economical, environmental and social. Litman also add some sub-dimensions to those three main dimensions. Three main dimensions and their sub-dimensions are given below Table 1. Litman claims that a system must contain all those sub-dimensions to be sustainable (Kolak, 2015: 1).

Table 1: Sustainability System Dimensions

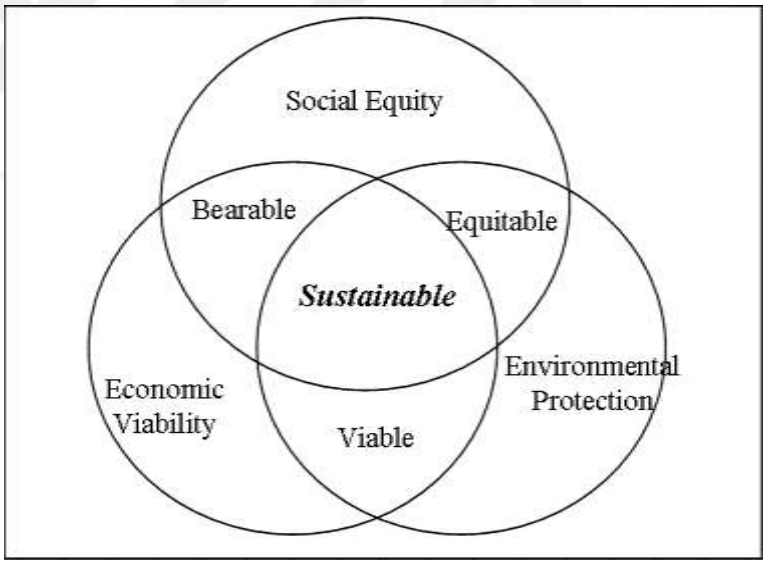
Economic	Social	Environmental
*Economic Productivity *Economic Development *Resources Efficiency *Affordability	*Equity / Fairness *Human safety, security and health *Community development	*Climate change prevention *Air, noise and water pollution prevention *Non-renewable resources

*Operational efficiency	*Cultural heritage preservation	conservation *Openspace conservation *Biodiversity preservation

Source: Kolak, 2015: 1.

In (1997) Elkington, argued that the preservation of three main "pillars", which are economic, environmental and social systems, for the benefit of future generations, of sustainability represents the "triple bottom line" concept of sustainability (Elkington, 1997). According to Ahlberg (2014), giving equal consideration that each dimension is crucial to ensure a sustainable outcome.

Figure 1: Pillars of Sustainability



Source: Ugbaja, 2016:13.

Find a balance between these three dimensions is a key to receive sustainable results as given in Figure 1. The outcome is going to be unsustainable, if one of these dimensions overwhelms the others and unbalanced (Ugbaja, 2016:13).

1.4.1. Environmental Dimension of Sustainable Development

To evaluate the environmental sustainability performance of a system is highly complex (Olaffson et al., 2014: 934) but it is unquestionably significant concept in policy making area (Dias, 2017: 589). The environmental sustainability term was presumably invented by the World Bank scientists. In the beginning, the term "environmentally sensitive development" was used (Moldan et al., 2012: 6). According to Serageldin and Streeter (1993) after that “environmentally sustainable development” term was employed. Finally, the concept of environmental sustainability, which is being used today, has been improved (Moldan et al., 2012: 6).

The environmental dimension of sustainability includes the reduction of people's negative impacts on environment and the protection of nature and ecosystems. Rapid developments in science and technology causes the giant steps that are taking place in the industry, increasing and diversified production facilities and makes human life easier along with some aspects but unfortunately it also causes of increasing environmental degradation, global warming, acid rain, increasing greenhouse gases, increasing chemical wastes, soil pollution, decrease of forest areas and desertification. This jeopardizes the future of the world. Environmental sustainability basically emphasizes that there are renewable and non-renewable resources in our world and humans must act sensitively in the use of all resources. As noted in the Brundtland Report, environmental sustainability does not mean that resources are not used, it means that the use of resources as much as needed and if they not stocked, future generations can also use them (Eş, 2008: 18).

Sustainable development is often characterized as social and economic dimensions’ development but it should also be environmentally sustainable too. In recent years’ environmental sustainability finally finds its own merits as a concept of importance and there has been growing recognition of that concept (Cook et al., 2017: 463). According to Moldan et al., (2012) by focusing on environmental sustainability’s bio-geophysical aspects, namely preserving or improving the integrity of the Earth’s life supporting systems, it can correctly have defined (Moldan et al., 2012: 4). The

environmental dimension of sustainability mainly focuses on preservation of natural resources (Ugbaja, 2016: 11). In (1995) Goodland described environmental sustainability as "improve human welfare by protecting the sources of raw materials used for human needs and ensuring that the sinks for human wastes are not exceeded, in order to prevent harm to humans" (Goodland, 1995: 3; Olaffson et al., 2014: 934).

1.4.2. Economic/Financial Dimension of Sustainable Development

The concept of sustainability along with multidimensionality is defined by three basic structures, which are economical, environmental and social in general. Even though each one of them being an indispensable place, it is necessary to acknowledge that the problems arising from the compulsive relation of the economy with nature plays much larger role than others in the emergence of the concept. The ability of maintenance of economic systems depends on the establishment of the relationship between the environment and the economy at an acceptable point. To develop the economy, it is not enough to use only human talents, it is also necessary to use natural resources (Kılıç, 2012: 207).

According to Harris (2000), an economically sustainable system should be able to produce goods and services based on ongoing principles, manage governmental and external debts and should be avoided from sectoral imbalances that harm agricultural and industrial production. But as a result, the economic dimension of sustainability centers on value creation and financial impact of a firm's sustainability activities (Bansal, 2005: 198). Economic sustainability concerns the cost-benefit analysis of an industry that aims to be profitable while producing products and services that contribute to society. This approach aims to create long-term value for stakeholders by assessing opportunities and risks arising from economic, environmental and social developments (Nemli, 2004: 81). Some economists simplify the definition of economic sustainability concept as "maximization of the benefit from consumption and the increase of wealth" (Harris, 2000: 7).

In recent years the importance of economic sustainability is increasingly recognized especially by top political representatives. It's because of the economic crisis that shows maintaining economic growth is crucial and universally accepted objective. In parallel economic growth has been the most important policy objective for the fifty years and for this reason to find the balance between sustainability and the economic growth has been difficult for countries and industries (Moldan et al, 2012: 5). But again for this reason it has been more crucial to find balance between sustainability and the economic growth.

1.4.3. Social Dimension of Sustainable Development

The different dimensions of sustainability which are; social, economic and environmental have not been equally prioritized by policy makers (Colantonio, 2011: 36). But advocates of sustainable development have recognized that the social dimension is an important component of sustainability and also they have acknowledged that this dimension has existed for a long time (Eş, 2008: 23). Social dimension of sustainability primarily focuses on human development addition to that it deals with cultural and social necessities like; permanent establishment of basic requirements such as food and shelter, security, equality, health, freedom, education and employment (Eş, 2008: 24).

When policy makers developing future scenarios the social dimension is generally been the one which is neglected. However, considering the long-standing balance between social and environmental improvements in the market economy, environmental and social dimensions should be developed equally and from the very beginning of the process (Omann and Spangenberg, 2002: 1).

In today social dimension of sustainability is widely accepted but unfortunately there is not an only and clear definition of social sustainability (Bramley et al., 2006: 1). There have been attempts to define criteria or perspectives, to define social sustainability but each author or policy maker created their unique definitions according to their perspectives on their own disciplines (Colantonio, 2007: 4).

According to Moldan et al. (2012), because of the diversity of economic, social and cultural conditions and differences in individual industries, it is very difficult to define social sustainability but in (2000) Polese and Stren defined it as "development (and/or growth) that is compatible with harmonious evolution of civil society, fostering an environment conductive to the compatible cohabitation of culturally and socially diverse groups while at the same time encouraging social integration, with improvements in the quality of life for all segments of the population" (Bramley et al., 2006: 3) , in (2003: 6) Barr et al., observed it as "I see a future of continuing change and restructuring of our rural landscapes. Not all of this is bad. Not all of it is good. But not much of it is easily avoidable. Each of us contributes in our small way to this change through the decisions we make in shopping, travelling, leisure and voting. I do not believe there is much to be achieved by using a definition of social sustainability in which the structure of our rural landscapes is fixed in time. Rural social landscapes of the Western World have been in constant change since the collapse of the feudal system. Society cannot be sustained without the capacity to adapt to change" (Baines and Morgan, 2004: 100) and in (2004) Black defined it as "the extent to which social values, social identities, social relationships and social institutions can continue into the future".

The social dimension of sustainability deals with qualitative data rather than numerical data. Even if the impact of social dimension on economic sustainability couldn't be seen at first sight, it obviously will create significant differences in the productivity of the motivated workers who works suitable and satisfactory work environment, also these satisfied employees will also be the reason of reduce costs of human resources departments. In this way, the brand image and the attractiveness of the foreign market of the business or industry is going to increase (Eş, 2008: 24).

There are some other topics related with social sustainability in the current literature. These are including corporate social responsibility (CSR) and community involvement, as well as the company's position on issues involving women, ethnic minorities, gays and lesbians, and disabled individuals (Ugbaja, 2016: 11).

1.5. CORPORATE SUSTAINABILITY

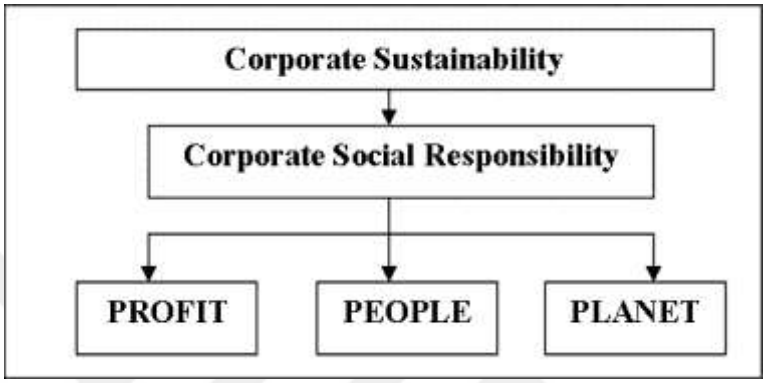
Corporate sustainability is a concept that refers firms' engagement with social and environmental activities in addition to economic activities (Linnenluecke and Griffiths, 2013, Santos et al., 2016: 2935). According to Yavuz (2010: 64), corporate sustainability is the long term strategies and approaches that firms make in order to prevent damage to the environment in the production process. According to Kuşat (2012: 229), corporate sustainability is a management approach aimed at transferring industries that had economic purpose to the healthier future while minimizing every possible material and moral risk. In (2002: 132) Dyllick and Hockerts defined corporate sustainability as a combine of environmental and social sustainability and add that institutions should focus on long-term benefits rather than short-term gains. According to Schaltegger et al., (2003) corporate sustainability is a business approach that is designed to shape the environmental, social, and economic effects of a company to provide a crucial contribution toward the sustainable development of the economy and society. In general, corporate sustainability refers to company's sustainability activities that show the inclusion of social, financial and environmental concerns and interactions with stakeholders (Marrewijk, 2003: 102).

Corporate sustainability related articles and publications number shows exponential increase in recent decades (Santos et al., 2016: 2935). Especially "business case" notion for corporate sustainability has increasingly been used by the environmental organizations and corporate sectors to find justification in sustainability strategies within organizations (Salzmann et al., 2004: 27). Corporate sustainability applications tend to be more comprehensive in sectors with large impact on stakeholders, because those kinds of sectors are more visible (Santos et al., 2016: 2936).

The economic, environmental, and social (profit, planet, people) aspects of sustainability can be translated into a corporate sustainability approach that companies have to be concerned with (Marrewijk, 2003:101). As figure 2 shows, corporate sustainability is the foundation and result of all three sustainability dimensions which are financial, environmental and social. Same figure also demonstrates the relationship

between three aspects of sustainability, corporate social responsibility and corporate sustainability.

Figure 2: Corporate Sustainability



Source: Marrewijk, 2003:101.

For many industry leaders and corporations' corporate sustainability has become a valuable tool for discovering new ways to reduce costs, manage risks and create new products (Azapagic, 2003: 303). It is observed that at the firm's level corporate sustainability is related to competition, innovation and marketing components highly in this manner any company has a competitive advantage over corporate sustainability (Balteiro et al., 2011: 763). But integrating sustainability thinking and practice into company's organizational structure requires a vision, commitment, leadership and suitable system approach (Azapagic, 2003: 303). In (2012: 230) Kuşat defined nine internal elements to facilitate the integration of corporate sustainability practices into companies. These elements are; Corporate Information Management and Transfer, Corporate Learning, Corporate Value, Corporate Welfare, Corporate Citizenship, Corporate Reputation, Corporate Social Responsibility, Corporate Management and Corporate Social Capital.

1.6. SUSTAINABILITY MEASUREMENT

The purpose of establishing an enterprise is to secure its existence by ensuring compliance with environmental conditions and to ensure its continuity. In order to ensure continuity, it is necessary to reach targets such as increasing liquidity and profitability. Businesses should be able to efficiently utilize existing opportunities taking into consideration environmental conditions and take precautions against risks that may arise. In order to ensure long-term value creation and to secure business continuity, it is necessary, to determine sustainability strategies, to define industrial and general sustainability criteria, to analyze business stakeholders' expectations and to measure sustainability performances of enterprises (Sarı, 2014: 38).

Measuring sustainability and considering progress is a complicated task and has often led to comparative evaluations of ranking lists and policy targets (Cook et al., 2017: 463). While measure sustainability the use of indicators has become standard method after the publication of the Brundtland Commission Report in 1987 and the Earth Summit in 1992 (Milman and Short, 2008: 759). Sustainability performance measurement aims to address the environmental, social and economic aspects of corporate sustainability (Öztel et al., 2012: 32). During the measurement process sustainability must be taken into account and be found a balance between environmental, financial and social factors that are also referred as the triple bottom line of sustainability (Sislian et al., 2016: 19) or called three dimensions of sustainable development (Tanzil and Beloff, 2006: 41). Consequently, three value driven dimensions are visualized and help monitor the port sustainability performance (Hakam, 2015: 15). Sustainability indicators are differentiated from other indicators by their need to measure the system ability to adapt, change and continue to function over a long time of span (Milman and Short, 2008: 759). "Indicators" and "metrics" are interchangeably words used for referring to measurement of sustainability, yet somehow term of "indicators" used more broadly in current literature (Tanzil and Beloff, 2006: 41). Turcu (2013: 16) declares that sustainability indicators are not universal and "not only useful for measuring progress, but also for identifying problems, setting sustainability goals

and suitable management solutions at the local level". Addition to those measuring the sustainability becomes even more substantial as the business adage of "only what gets measured gets managed" suggests (Tanzil and Beloff, 2006: 41).

Tools that used to obtain performance datum and measure sustainability may depend on the size, time and measurement type of desired result. The first part of sustainability assessment tools consists of indicators and indices. Indicators generally represent the dimensions of a company (environmental, social and economic) in a simple and specific area. Indices are formed by combining these indicators in any way (Eş, 2008: 44).

To measure sustainability various indicators have been created by a number of commissions since the United Nations Commission on Sustainable Development in 1992. That commission created an initial list of 134 indicators that cover social, environmental, economic, and institutional aspects of sustainable development. After that in 1996 the Consultative Group on Sustainable Development Indicators (CGSDI) were created. Then Wellbeing Index with 88 indicators, Environmental sustainability Index with 68 indicators, Global Scenario Group with 65 indicators, Ecological Footprint with a new perspective as a genuine progress indicator, U.S. Interagency Working Group on Sustainable Development Indicators with 40 indicators, Boston Indicators Project with 159 indicators followed them. At the end Global Reporting Initiative established globally applicable guidelines for reporting on the economic, environmental, and social performance initially for corporations and eventually for any business, governmental, or nongovernmental organizations (Parris and Kates, 2003: 562-566).

In addition to these various indicators, they are also differing from differences in the activities of the companies and due to the level difference in performance measurement. In these circumstances there can be countless indicators that can be used to measure a firm's performance (Eş, 2008: 48). Thus, every industry or company should have created their field-specific sustainability measurement tools.

1.7. SUSTAINABILITY REPORTING

Sustainability reporting is such an implementation of measuring and being accountable to internal and external stakeholders for organizational performance to the aim of sustainable development (Yadava and Sinha, 2014: 549). According to KPMG international survey of corporate responsibility report (2008) %79 of the leading 250 companies of Fortune 500 published sustainability report in 2008 while %52 of them published sustainability report in 2005. Therefore, Yadava and Sinha (2014: 550) stated that there is a continuous growing in the numbers of organizations that publishes sustainability report. The number of businesses reporting sustainability activities around the world is increasing steadily. Some of the businesses have put their sustainability related activities in a separate heading on their internet sites to their stakeholders; some of them have been included in the activity reports, and in the last few years the increasing numbers have started to prepare the separate sustainability report (Onay, 2015: 104).

In addition to starting to demand of social and environmental reports besides financial reports, sustainability reporting has found meaning in "Triple Bottom Line Reporting" and businesses have started to offer economic, social and environmental achievements together. Sustainable reporting includes not only the economic, but also the environmental and social success of business operations (Yanık ve Türker, 2012: 298). Sustainability reporting, a natural extension of financial reporting, broadens the scope of business reporting by explaining the business's social, economic and environmental activities (Onay, 2015: 111). These reports also provide the social stakeholders with an assessment of whether their business considers their anticipation, as well as the ability to see the results of their activities and, if necessary, produce new policies (Yanık ve Türker, 2012: 298).

Businesses have globally accepted reporting frameworks that guide them in providing clear, comprehensible and transparent sustainability reporting. These frameworks are constantly being revised and updated in accordance with evolving needs

and stakeholder demands. Consulting businesses that provide consulting services on such reporting frameworks will provide support so that businesses can provide better-quality reports (Onay, 2015: 102).

Meanwhile in 1997 Global Reporting Initiative (GRI) provided a systematic approach for the companies to report their performance on social, environmental, and economic dimensions of sustainability and developed sustainability reporting guidelines (Yadava and Sinha, 2014: 549). After that sustainability reporting has become an institutionalized way of communicating a company's sustainability performance on financial, environmental and social issues (Bergmans et al., 2014: 109). In addition to GRI, according to Onay (2015, 112-113), AA1000 (Account Ability 1000) in 1999, UNGC Global Compact in 2000, Communication on Progress (COP) in 2000, The OECD Guidelines for Multinational Enterprises in 2000, IFC Performance Standards in 2006, Carbon Disclosure Project (CDP) in 2008 and ISO 26000 in 2010 are other sustainability reporting frameworks that used around the world.

1.8. PORT SUSTAINABILITY

Because of their nature ports are known as one of the most polluting sectors so they present an opportunity to reduce different types of emissions highly and until now in sustainability concept the main attention has been given to reduction of emissions in transport, shipping and port industry (Broesterhuizen et al, 2012).

To reduce emissions many ports started different sustainability programs and invested in large amounts over the years. In 2006, the port of Los Angeles started a Clean Air Action Program (CAAP) which led to emission reductions of %50 to %75 in five years and it was the most ambitious program in the world for cleaner ports (Broesterhuizen et al, 2012). Bremenports converted electricity supply into green electricity in 2011 (Bremenports Sustainability Report, 2014). Port of Cork has installed High Mast Lighting Voltage Control Units in 2010 and 2011. Systems cost €1,400 to install and energy savings of 30% have been achieved (Port of Cork Environmental

Report, 2014). In 2015, the Port of Gothenburg became a climate-neutral company. By investing in solar cells, biogas and district heating and other environmental measures, emissions have been reduced to a minimum (Sustainability Report of Gothenburg Port Authority, 2015).

CHAPTER 2
LITERATURE REVIEW OF PORT SUSTAINABILITY STUDIES'

2.1. LITERATURE SURVEY

In this second part of study, literature reviews will be carried out by examining the studies on sustainability in the ports. Hakam and Solvang (2013) define the aim of the literature review as to summarize existing researches by identifying patterns and issues. To reach that specific literature review aim, first studies/papers are collected regarding their main subjects. To obtain an overview of the increase of writings on the topic, an online search was made in the following electronic databases: Google Scholar, Ebscohost, Proquest, Science Direct and Scopus. The search terms "port sustainability", "sustainable port", "environmental management in ports", "green port", "sustainable supply chain management", "corporate social responsibility in ports" and "port sustainable development" are used on all databases in English and Turkish from the period of 1987 to 2017 April. These seven keywords are shown in below Table 2.

Table 2: The Search Keywords

Number	Corresponding Keyword(s)
1	Sustainable Port (*Sürdürülebilir Liman*)
2	Port Sustainability (*Limanlarda Sürdürülebilirlik*)
3	Environmental Management in Ports (*Limanlarda Çevresel Yönetim Uygulamaları*)
4	Green Port (*Yeşil Liman*)
5	Sustainable Supply Chain Management (*Sürdürülebilir Tedarik Zinciri Yönetimi*)
6	Corporate Social Responsibility in Ports (*Limanlarda Kurumsal Sosyal Sorumluluk*)
7	Port Sustainable Development (*Limanlarda Sürdürülebilir Gelişme*)

Source: Created by Author.

While conducting the scan, search was limited with some criteria. As a source, articles and conference proceedings are included. There also has a time limit in the search criteria. As mentioned in the first part of the study, sustainability concept was born in the Brundtland Report of 1987 (Kuhlman and Farrington, 2010: 3436), so the literature between 1987 and 2017 was screened. 5 databases were used that free access provided by Dokuz Eylül University. All scans were carried out in the title of paper, with "containing all of the words" condition. Each keywords and their relevant paper count are given in Table 3 for each database.

2.1.1. Distribution of Publications to Databases

As shown in Table 3, the number of studies on port sustainability issues is quite limited by the number of studies on issues like "sustainable supply chain management" and "green port". Considering this gap in the literature, in current study a detailed analysis was carried out with the keywords "sustainable port" and "port sustainability" in databases shown in Table 3. In addition, content analysis was conducted in order to determine the research methods used in the paper and aims and the results obtained from paper.

Table 3: Number of Studies Available in Port Sustainability Related Publications from Different Electronic Databases

Keyword(s)/Databases	Google Scholar	Ebscohost	Proquest	Science Direct	Scopus
Sustainable Port	58	8	7	21	15
Port Sustainability	74	11	5	28	44
Environmental Management in Ports	17	6	3	11	0
Green Port	125	5	6	20	20
Sustainable Supply Chain Management	1.245	362	167	216	321

Corporate Social Responsibility in Ports	4	0	0	1	0
Port Sustainable Development	77	5	7	7	1

Source: Created by Author.

In accordance with the above criteria, each paper group under the "port sustainability" and "sustainable port" headings in Table 3 has been examined separately and the papers that scanned in more than one database have been separated. In this instance studies that are not completely suitable for the scope of this study according to their subjects have been excluded to ensure the reliability and internal validity of the research. 53 papers selected at the end of the scanning period, which are appropriate for the criteria determined, and they were examined in terms of "research subject, type of research, data analysis methods, purposes and findings of the studies".

The detailed scanning of the databases includes articles and conference proceedings which include the whole words of "sustainable port" and "port sustainability" in the title of the study and published between 1987 and 2017, the year in which sustainability came into being.

2.1.2. Distribution of Publications to Subject and Years

The distribution of studies in terms of their subjects and years that included in the content analysis is shown in Table 4. According to Table 4, although the concept of sustainability emerged in 1987, no studies were conducted in the scope of sustainability in the ports between 1987 and 1997. The first study on port sustainability issues was published in 1998 and after that eight more studies published between the years of 1998 and 2007 which were examined in the scope of this study. After 2008, the importance given to the sustainability issue has increased, and a number of studies have been conducted on a variety of topics, primarily sustainable development, sustainability performance, and sustainable management concepts. 45 of these studies have been found directly related to the subject and examined within the scope of the study.

Table 4: Distribution of Research Subjects by Years

Subject	1987 to 1997	1998 to 2007	2008 to 2017	Frequency	Percent
Sustainable Development	-	2	9	11	20,75
Sustainability Performance	-	-	9	9	16,98
Sustainable Management	-	-	8	8	15,09
Port Construction	-	1	6	7	13,21
Environmental Sustainability	-	1	4	5	9,43
Sustainability Indicators	-	1	3	4	7,55
Sustainability Policy	-	1	1	2	3,77
Sustainable Coastal Development	-	1	1	2	3,77
Economic and Environmental Sustainability	-	-	1	1	1,89
Ecological Footprint	-	-	1	1	1,89
Social Sustainability	-	1	-	1	1,89
Sustainability Reporting	-	-	1	1	1,89
Sustainability Measurement	-	-	1	1	1,89
Total	**-**	**8**	**45**	**53**	**100**

Source: Created by Author.

Table 5: Content Analysis of Port Sustainability Subjects in the Literature

	Sustainable Development	Sustainability Performance	Sustainable Management	Port Construction	Environmental Sustainability	Sustainability Indicators	Sustainability Policy	Sustainable Coastal Development	Economic and Environmental Sustainability	Ecological Footprint	Social Sustainability	Sustainability Reporting	Sustainability Measurement
Turner et al. (1998)								√					
Tindall (1999)											√		
Hoyle (1999)					√								
Gilman (2003)							√						
Dooms and Macharis (2003)				√									
Peris-Mora et al. (2005)						√							
Abood (2007)	√												
Daamen (2007)	√												
Soler et al. (2009)												√	
Hakam and Solvang (2009)		√											
Girard (2010)				√									
Wahab et al. (2011)				√									
Denktaş-Şakar and Karataş-Çetin (2012)			√										

	Sustainable Development	Sustainability Performance	Sustainable Management	Port Construction	Environmental Sustainability	Sustainability Indicators	Sustainability Policy	Sustainable Coastal Development	Economic and Environmental Sustainability	Ecological Footprint	Social Sustainability	Sustainability Reporting	Sustainability Measurement
Broesterhuisen et al. (2012)			√										
Vujicic et al. (2012)					√								
Lam and Van de Voorde (2012)	√												
Dinwoodie et al. (2013)					√								
Lirn et al. (2013)		√											
Hakam and Solvang (2013)		√											
Borriello et al. (2013)					√								
Yap and Lam (2013)								√					
Kim and Chiang (2014)			√										
Pavlic et al. (2014)				√									
Elzarka and Elgazzar (2014)		√											
Puig et al. (2014)						√							
Megahead (2014)				√									
Bergmans et al. (2014)						√							
Kutkaitis et al. (2014)	√												

	Sustainable Development	Sustainability Performance	Sustainable Management	Port Construction	Environmental Sustainability	Sustainability Indicators	Sustainability Policy	Sustainable Coastal Development	Economic and Environmental Sustainability	Ecological Footprint	Social Sustainability	Sustainability Reporting	Sustainability Measurement
Jonathan et al. (2014)	√												
Lam and Van de Voorde (2014)	√												
Martino (2014)	√												
Hakam (2015)		√											
Fedai and Madran (2015)			√										
Boulos(2015)	√												
Wang et al. (2015)	√												
Beskovnik and Bajec (2015)					√								
Guo et al. (2015)										√			
Kuznetsov et al. (2015)			√										
Asgari et al. (2015)		√											
Shiau and Chuang (2015)						√							
Laxe et al. (2016)									√				
Hou and Geerlings (2016)			√										
Sislian et al. (2016)			√										

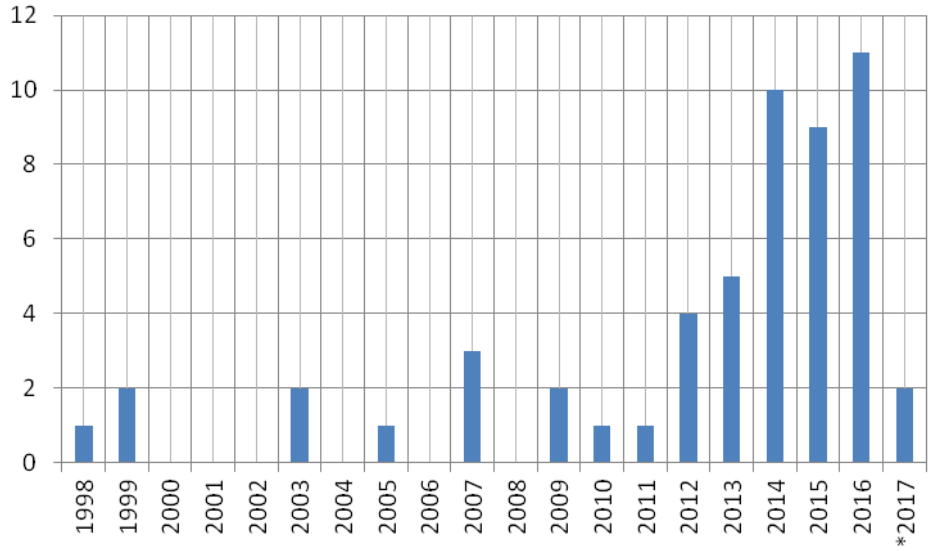
	Sustainable Development	Sustainability Performance	Sustainable Management	Port Construction	Environmental Sustainability	Sustainability Indicators	Sustainability Policy	Sustainable Coastal Development	Economic and Environmental Sustainability	Ecological Footprint	Social Sustainability	Sustainability Reporting	Sustainability Measurement
Lu et al. (2016)		√											
Çağlar (2016)		√											
Laxe et al. (2016)	√												
Awad-Nunez et al. (2016)				√									
Awad-Nunez et al. (2016)				√									
Wang et al. (2016)		√											
Roh et al. (2016)	√												
Kotowska (2016)							√						
Wang et al. (2017)			√										
Xiao and Lam (2017)													√
TOTAL	11	9	8	7	5	4	2	2	1	1	1	1	1

Source: Created by Author.

According to 53 studies' content analysis regarding to port sustainability subjects, the most common five subjects are sustainable development, sustainability performance, sustainable management, sustainable port construction and environmental sustainability respectively. The most common factor which is related to the sustainable development is stated in 11 studies. Details of other studies and subjects are given above Table 5.

The distributions of the examined papers in terms of publishing years are shown in below Figure 3.

Figure 3: Number of Articles and Conference Proceedings Published per year between 1998 and 2017



* Values for 2017 include publications issued until April.

Source: Created by Author.

It should also be noted that, in the situation of that the examined study involves more than one subject listed in Table 4 the keyword rankings specified by the authors of the studies were taken into account. Hence studies included the subject with respect to their keywords.

2.1.3. Distribution of Publications to Journals

Table 6 demonstrates the lists and the distributions of the journals in which the studies published in the scope of content analysis. According to Table 6, 22,64% of the papers consist of various conference proceedings. In accordance 77,36% of total papers consist of articles that published various journals. 4 articles that have 7,55% of total papers published in Marine Pollution Bulletin. Its followed by Transportation Research Procedia, Maritime Policy and Management, Research in Transportation Business & Management, The Asian Journal of Shipping and Logistics, Marine Policy and Sustainability journals respectively. 20 articles' diverse journal names also listed in Table 6.

Table 6: Distribution of Studies to Journals

Name of Journal	Frequency	Percent
Conference Proceedings	12	22,64%
Marine Pollution Bulletin	4	7,55%
Transportation Research Procedia	3	5,66%
Maritime Policy & Management	3	5,66%
Research in Transportation Business & Management	2	3,77%
The Asian Journal of Shipping and Logistics	2	3,77%
Marine Policy	2	3,77%
Sustainability	2	3,77%
Thermal Science	1	1,89%
Open Journal of Social Sciences	1	1,89%
Problems of Sustainable Development	1	1,89%
Advanced Engineering Forum	1	1,89%
European Online Journal of Natural and Social Sciences	1	1,89%
Procedia Social and Behavioral Sciences	1	1,89%
Ocean & Coastal Management	1	1,89%

The Geographical Journal	1	1,89%
Journal of Korea Port Economic Association	1	1,89%
Journal of Transport Geography	1	1,89%
Journal of Service Science and Management	1	1,89%
Journal of Cleaner Production	1	1,89%
International Journal of Architectural Research	1	1,89%
Journal for Communication Studies	1	1,89%
Journal of Mechanical Engineering	1	1,89%
Journal of Black Sea Studies	1	1,89%
International Journal of Sustainable Development	1	1,89%
Transportation Research Part E	1	1,89%
International Journal of Physical Distribution & Logistics Management	1	1,89%
Scientific Papers of the University of Pardubice Series D	1	1,89%
Others (No info)	3	5,66%
Total	53	100,00%

Source: Created by Author.

2.1.4. Distribution of Publications to Research Methods

Papers analyzed according to their research methods in the scope of the study. According to Table 7, 50,94% of papers used quantitative research methods, 37,74% of them used qualitative research methods as a research method. In addition, 11,32% of total paper used both qualitative and quantitative research methods to reach their aims.

Table 7: Distribution of Studies to Research Methods

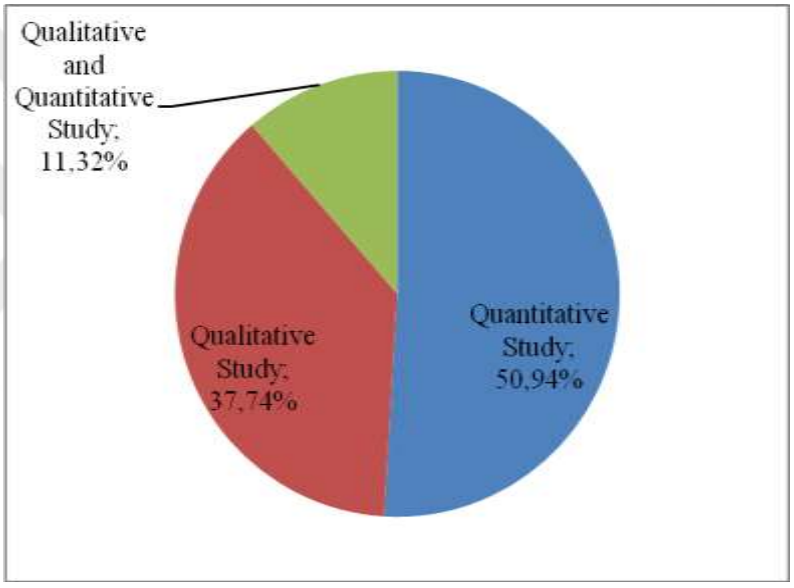
Research Methods of Study	Frequency	Percent
Quantitative Study	27	50,94%
Qualitative Study	20	37,74%

Qualitative and Quantitative	6	11,32%
Total	53	100,00%

Source: Created by Author.

Distribution percent of papers according to their research methods also demonstrated in below Figure 4.

Figure 4: Percent Distribution of Studies Research Methods



Source: Created by Author.

2.1.5. Distribution of Publications According to Methods Used for Analysis

Data analysis methods of the papers were also analyzed in the scope of the study. Results are given in below Table 8. Case Study is the most frequent data analysis method in examined port sustainability studies with the ratio of %29,85. Literature review method was also used quite a lot, generally with the help of sustainability reports and annual reports of ports and current literature. Interview, MCDM (Multi Criteria Decision Making), Survey and Statistical Methods like SPSS, DEA, PDE and PSIR followed them respectively. In addition, just one paper found in literature that used Focus Group and Workshop methods.

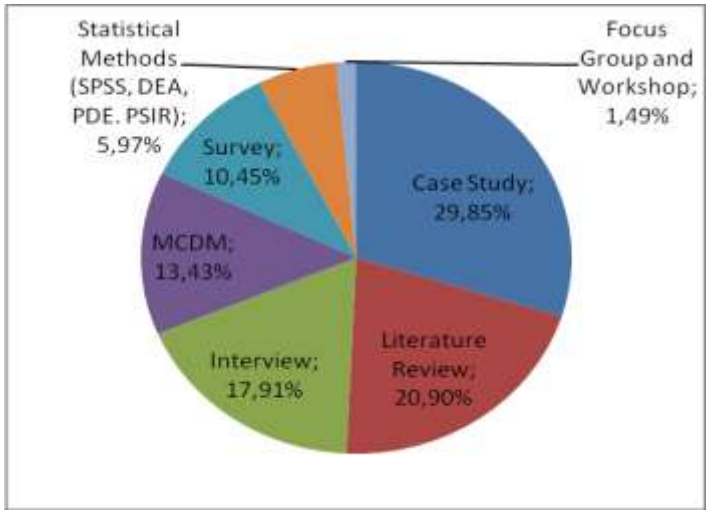
Table 8: Distribution of Studies According to Methods Used for Analysis

Methods Used for Analysis	Frequency	Percent
Case Study	20	29,85%
Literature Review	14	20,90%
Interview	12	17,91%
MCDM (Multi Criteria Decision Making)	9	13,43%
Survey	7	10,45%
Statistical Methods (SPSS, DEA, PDE, PSIR)	4	5,97%
Focus Group and Workshop	1	1,49%
Total	67	100,00%

Source: Created by Author.

In addition, it is also identified that, 41 papers used just one method listed in Table 7, 9 studies used two different methods and 3 studies used three methods to reach their findings. Distribution percent of papers according to their methods used for analysis also demonstrated in below Figure 5.

Figure 5: Percent Distribution of Studies According to Methods Used for Analysis



Source: Created by Author

2.2. ARTICLE REVIEWS

In this part of the study, the papers examined in the study were demonstrated in detail according to their subjects. The aims, findings and data analysis methods of the studies on port sustainability issue in the period 1998-2017 have been analyzed.

2.2.1. Sustainable Development

There are 11 papers about sustainable development in ports in current literature. 20,75 percent of total papers are included in sustainable development and it's the most popular subject to this date in port sustainability concept.

In (2007) Abood and Daamen investigated port sustainable development in two different geographies which USA and Europe. Daamen (2007) took Rotterdam and Hamburg ports and these cities as sample with the aim to find a new typology and new interpretation of the contemporary port-city interface. At the end of the study author demonstrated the Hamburg and Rotterdam cities port-city interface situations and found two goals of them. These are to attain general public support for the overall plans and find out what the realization of those plans could look like on the local level (Dameen, 2007: 19). Same year Abood made a case study at New York port and demonstrate several examples to show how to fit more advanced programmes into a sustainability framework. To limit sustainability subject, Abood used eight port operational topics which are; dredging, ballast water, habitat restoration, air quality, water conservation, energy conservation, material conservation and waste handling, and used them as sustainability perspective. At the end of the study Abood proposed a more quantitative sustainability rating system specifically designed to deal with port activities.

In (2012) Lam and Van de Voorde made a case study with 4 ports that the port of Los Angeles, Long Beach, Antwerp and Hong Kong. The aim of that study is to fill the gap in the concept of green and sustainable port strategy by formulating a new

framework. Hence an original framework and propositions have been developed in green and sustainable port strategy as findings of the study.

Jonathan et al. (2014) made a literature review to propose a sustainable port project planning model while adding specific components to the basics of sustainability. Their model collected all individual components of sustainability concept into one roof for port project planning (PPP). As a result they developed a thorough generic proposition model with quantifiable achieving benchmark for each component and created an integrated green and sustainable port project planning framework with consolidated conceptual approaches and theoretical methods.

Lam and Van de Voorde conducted survey to 381 people at Torkaman city to acquire relatively exact description of condition of urban sustainable development from citizens' rights point of view in 2014. At the end of the study they determined most and least effected identifiers on sustainable development of Torkaman port city which is respectively civil rights and political identifiers.

Kutkaitis et al. (2014) conducted interviews with specialists and consultants of port and logistics sector practitioners to identify the criteria of port sustainable development. They also used interview results as secondary data to be compared with the primary data of the author 's research. As a result, they designed seven steps that determine sustainability of Port of Klaipeda's logistics activity. Hence they prepared a set of indicators that determine different levels of sustainability of ports. In addition, in 2014 Martino created an alternative managerial perspective in the decision making process of port authority using the literature review method.

In the year of 2015 Wang et al. investigated energy efficiency of port operations in their case study in China. They aimed to improve energy efficiency with financial success, to report the effectiveness of sustainable development policy and to highlight the workable plans for ports in China. Finally, they reported a framework of assessing energy efficiency of port operations in China based on the data from public domain by using the combination of DEA (Data Envelopment Analysis) and PDE (Panel Data Estimation) methods.

Case study method was also conducted by Boulos in 2015 in Port Said to propose a model framework for sustainable city-port connectivity. In order to develop that model framework, they investigated the development of port-city relationship. As a result of study Boulos emphasized the importance of the balance of both port and city growths. While port expand and modernize, its impacts of the origin settlements (port cities) should be studied for each unique region as well.

In 2016 two different studies were published in the subject of port sustainable development. First of them belongs to Laxe et al. With the aim of using the Synthetic Indexes of sustainability in the analysis of port sustainability they examined 16 Spanish port authorities' datum with literature review method. Thus they demonstrated how the ports that have higher Synthetic Indexes on Sustainability move more goods at their facilities than the rest. According to their findings ports that have higher Synthetic Indexes pay more attention to a global and integrated management while being very attentive to both demands of users and permanently adapt themselves to new conditions of international competition.

In (2016) Roh et al. published the last study of this subject. They conducted in-depth interviews with Asian port authorities to determine the main factors that shaping sustainable port development. As a result, they identified key elements of sustainable port development from port authorities' perspective.

2.2.2. Sustainability Performance

In the scope of this study 9 publishing about sustainability performance were examined. Sustainability performance of ports is another important subject in current literature and 16,98 percent of total studies are including sustainability performance issues of ports. Even the sustainability concept was born in 1987, the papers about sustainability performance of ports written between the years of 2008 and 2017.

Hakam and Solvang used case study method on Narvik container port in 2009 to link flexibility and sustainable advantages together in the context of container ports. According to Hakam and Solvang to increase the container port's flexibility one should increase the port's economical and environmental sustainability. Hence to make this happen flexibility metrics should have adapted to the container port context and they should have integrated in some performance measurements to be useful to port decision makers.

Hakam and Solvang also conducted a literature review study about container ports sustainability in 2013. They examined 334 papers to look at port-related initiatives and gain a better insight on market trends about container ports sustainability. Their results demonstrated that sustainability performance and port sustainability has domination on literature between 1985 and 2012. With this study they revealed that the environmental dimension of sustainability seen as an opportunity to improve performance not as an expense anymore.

In 2013 Lirn et al. used multi-criteria decisions making methods to measure a port's green performance and choose three major container ports from China as sample. As a finding of study they determined three most critical sustainability indicators chosen by respondents in two of three ports investigated, chosen indicators are respectively; avoiding pollutants during cargo handling and port maintenance, noise control, and sewage treatment.

Elzarka and Elgazzar (2014) used three methods which are multi-criteria decisions making, survey and literature review with the purpose to propose a performance measurement system to evaluate and improve green performance of ports. As a result of the study they designed a green port performance index using a weighted averaging aggregation method. With this single index a port can compare its overall performance with other competitive ports.

In 2015 Hakam published a study about Nordic container ports sustainability performance. The aim of that study is to propose a conceptual sustainability performance management framework for container ports. Hence as a result of the study Hakam

developed a prototype based on hypothetical data and suggested a list of key port sustainability performance indicators list.

Asgari et al. (2015) also used multi-criteria decisions making methods to measure sustainability performance of UK major ports. The main aim of that study is to investigate 5 largest ports in UK sustainability performance according to environmental and economic aspects of sustainability. Asgari et al. gathered data from port managers and industry experts to rank the largest ports in the UK and verified the result using sensitivity analysis. As a result, London Port has always the highest ranking in terms of environmental aspect. Furthermore, London Port saved its place when results examined in combination of both aspects, environmental and economic.

In 2016 Lu et al. aimed to research examined the effects of sustainable supply chain management on sustainability performance in the port context. To achieve this purpose, they conducted survey with 132 respondents who is supervisor or above in three major international port authorities in Taiwan. Studies results demonstrated that external sustainable collaboration is positively associated with internal sustainable management, and internal sustainable management positively influences sustainability performance.

Çağlar (2016) used three methods which are interview, survey and literature review in Turkey and USA aiming to demonstrate sustainable advancements and challenges in efficient and sustainable container terminal operations. As a result Çağlar emphasized the importance of connectivity of seaports from railroads and gate technologies to approach channel depth and even customs regulations. Study also mentioned advance technology in container terminal equipments as a crucial point of value creation in terms of sustainability of ports.

In (2016) Wang et al. published the last study of port sustainability performance subject. They selected five of the most important adjacent ports in China which is Dalian–Yingkou, Qingdao–Yantai, Shanghai–Ningbo, Xiamen–Quanzhou, and Shenzhen–Guangzhou to reveal the recent trend of China unique port system development and analyzed China statistical yearbook, China transportation yearbook,

Province statistical yearbook and China ports yearbook that published in the years between 2004 and 2013. As a result, study identified functional differentiations in adjacent ports in terms of sustainability focus point. For instance, while some big ports focus on foreign trade in order to achieve sustainability, some other smaller ports focus on domestic trade.

2.2.3. Sustainable Management

Port sustainability issues are also worked in management subjects. In this study 8 publishing, 15,09 percent of total papers in the concept of sustainable management, are examined according to their aims, methods and findings chronologically. Like sustainability performance, all papers about sustainability management concept written between the years of 2008 and 2017.

Denktaş Şakar and Karataş Çetin integrated the organizational relationships between supply chain and port stakeholders with the aim of providing a conceptual framework based on the socially responsible marketing in 2012. Due to the publishing date study gained fundamental role and mainly served to the interests of academic. Managerial implications and port authorities' roles in different dimensions of sustainability and framework that demonstrate supply chain stakeholder's influences on port sustainability are obtained as two important outcomes of study.

Broesterhuisen et al. (2012) aimed to make a procurement process at ports as sustainable as possible. To reach that aim and to develop a tool, method or model that used by all stakeholder easily interview method was conducted. As a result of study, even they found consensus about some topic, they also found disagreement so many topics. For instance, while air quality is the number one topic in the several sustainable initiatives of international ports, most respondents did not mention air quality as an important criterion for sustainability. Hence they suggested that more research needs to be done about this subject to obtain some reliable and valid results.

In 2014 Kim and Chang conducted interviews in Busan Port to guide ports to implant sustainability practices into operations of ports. As a result of study identified four important work processes that would improve sustainability performance of ports if conducted better. These processes are listed as; container traffic growth, low environmental impacts and corporate responsible image making, operational efficiency, efficiency use of the port area. They also proposed the simultaneous implementation of those business processes that improved sustainability.

Fedai and Madran conducted both case study and interview methods to two different marinas in Turkey in Antalya in 2015. Sustainability issues of ports are examined and sustainable management strategies are mentioned in this comprehensive study. At the end of the study Fedai and Madran found lack of sustainable management perspective in ports and marinas as a mainstream management approach in studied marinas in Turkey, Antalya.

Dynamics in sustainable port and hinterland operations was examined by Hou and Geerlings in 2016 with the combination of literature survey, interview and case study methods. They aimed to present a conceptual framework and simulation of sustainability measures and its effectiveness. In that study they considered sustainable port related hinterland transport as an organizational issue and they conclude that the greatest challenge for a port to reach sustainable management standards is not to develop new technology but to develop new management regulations.

In 2016 Sislian et al. aimed to review review the maritime literature of two interrelated concepts which are Port Sustainability and Ocean's Carrier Network Problem (OCNP), then reviewed the port sustainability concept and then to relate it to the OCNP to integrate port sustainability indicators in the OCNP as a conceptual framework. Findings of this study revealed that the most common sustainable development measures focus on environmental measures hence they suggested that the future researches should focus triple bottom line of sustainability also.

The last study of sustainable port management subject is published by Wang et al. in 2017. The main aim of that study was to develop a conceptual model for the Chinese oil ports in the sustainability policy framework. At the end of the study they contribute current literature with two outcomes. First they developed specific measures to assess oil port sustainability and a holistic oil port sustainability framework.

2.2.4. Port Construction

Papers about port construction are another important subject in port sustainability literature. In this study 7 publishing, 13,21 percent of total papers in the concept of port construction, are examined according to their aims, methods and findings chronologically. Between the years of 2003 and 2016 several papers published about sustainable port construction.

Dooms and Macharis conducted in-depth interviews and multi criteria decision making methods in 2003 to present a conceptual framework for inland port planning which takes into account stakeholder preferences and objectives, in order to realize sustainable port development. As a result, they proposed a framework to develop a strategic Master plan with the port authority of the Port of Brussels.

Girard aimed to discuss under what conditions port areas can become an opportunity for the whole city development and how could it be possible in 2010. Girard used and suggested strategic implementation and management planning in order to combine tangible (hard) and intangible (soft) values in this study.

Wahab et al. (2011) used multi criteria decision making, survey and case study methods to ensure a set of standards and technical criteria during construction, design and operation processes of maritime and harbor structures. With developing an integrated sustainable port construction model Wahab introduced a new methodology to assess constructability and operability of port building designs.

In (2014) Megahead aimed to outline an approach for exploring the architectural styles of Port Said and proposed the challenges and opportunities for sustainable development in his/her study. Interviews with 63 residents, 18 planners and architects were conducted in the scope of the study. As a conclusion of the study the importance of building heritage together with environmental, economical and social aspects of sustainability as a main concern on any sustainable development emphasized.

A case study conducted on Port of Koper in (2014) by Pavlic et al. and they aimed to provide a methodological approach to solve the problems of future development challenges of seaports like implementing the green port concept in current infrastructures of ports. As a finding of the study they demonstrated the importance of state-of-the-art technologies, developing pilot initiatives based on modern energy solutions, improve efficiency in fuel consumption and emissions reduction in rubber tired gantry cranes and improve the overall energy efficiency improvement based on testing based on the case studied port.

Awad-Nunez et al. published two interrelated study in 2016. Multi criteria decision analysis (MCDA) and case study methods conducted both studies samples that consist of 10 different dry ports. They aimed to research different variables that influence sustainability of dry port location. Consequently, they found the most significant variables effect sustainability which is related to environmental protection.

2.2.5. Environmental Sustainability

Even though environmental sustainability is just one feature of triple bottom line concept of sustainability, it is the most studied one in the current literature. In this study 5 publishing, 9,43 percent of total papers in the concept of environmental sustainability, are examined according to their aims, methods and findings chronologically.

In (1999) Hoyle has examined some projects designed to measure urban coastal change processes and models in Canadian port cities, the influence of process and modals on the community groups. Hoyle conducted interviews with some community

groups in selected Canadian port cities in the scope of this study. Study revealed that there is a clear distinction between geographical, area-based or neighborhood groups.

Vujicic et al. worked on zero emission cargo handling equipments in 2012. Presenting and evaluating the up-to-date trends in the cargo handling equipment (CHE) industry was the main aim of their study. Reducing the environmental impact of container terminal operations and contributing to the sustainability of ports was another aim of this study. As a result of the study they concluded that electrification system of cargo handling equipments is a step forward to reduce the environmental impacts of ports and it is found as feasible and sustainable solution by the authors of the study. In addition, they also found that zero emission objective in cargo handling equipments are impossible to achieve yet.

In (2013) interviews with 5 ports and 2 local government-based harbor authorities are conducted by Dinwoodie et al. to analyze the smaller port authorities' ways to manage environmental sustainability in Southwest England. Dealing with smaller ports became their motivation unlike the current literature and as an outcome they provided a different perspective on environmental management in ports. They revealed that larger ports offer much more revenues compared to smaller ports as a matter of course for that reason it is impossible to transfer application of current environmental management systems that prepared to large ports to smaller ports. At the end of the study necessity of preparing new environmental management systems for smaller ports are emphasized.

Borriello et al. (2013). conducted a case study on Valencia port as an successful sample on environmental port management issues and aimed to adapt its management strategies in other port cities and port areas especially in the Southern ports of the Mediterranean. As a result of the study necessity of new integrated evaluation tools for managing the conflict between the port areas and the port cities emphasized.

A case study conducted on Port of Koper in (2015) by Beskovnik and Bajec with the aimed to identify environmental initiatives and measures that affect sustainability of ports. Paper introduced a new six pillar environmental sustainability model that could be

used environmental measuring in the region. The outcomes of the study intend to help port management for faster implementation of environmental and social objectives and measures in order to follow sustainable development.

2.2.6. Sustainability Indicators

Port sustainability indicators used to measure port sustainability and sustainable development of an industry, in addition it is important to mention that “Indicators” and “metrics” are interchangeably words used for referring to measurement of sustainability, yet somehow term of “indicators” used more broadly in current literature (Tanzil et al., 2006). Hence term of “indicators” used in this study instead of “metrics” and 4 publishing, 7,55 percent of total papers in the concept of sustainability indicators, are examined according to their aims, methods and findings chronologically.

Peris-Mora et al. (2005) published first article in this subject and they developed system of indicators for sustainable port management with the combined use of multi criteria decision making and case study methods. Port of Valencia was chosen for case study, other Spanish and European ports are chosen for Multi Criteria Analysis (MCA) in the scope of the study. Aim of the study was to propose a system of sustainable environmental management indicators that can be used by any port authorities finally they proposed 17 system indicators as an outcome of the study.

In 2014 Puig et al. aimed to develop a new methodology which is user-friendly to encourage port authorities to adopt the selected indicators within their environmental programme. To reach this aim they conducted focus groups, survey, literature review methods, conferences and workshops. As an outcome to assist port authorities in reporting and calculating the proposed indicators, a user friendly tool has been developed. List of indicators grouped in two categories. First qualitative indicators category consists of nine components of environmental management that measure the Port Authority’s ability to deliver compliance and effective environmental protection, second quantitative indicators category designed to measure of the actual impact related

to specific aspects, namely Carbon Footprint, Waste Management and Water Consumption.

Bergmans et al. (2014) conducted a case study method to Port of Antwerp and aimed to examine the port of Antwerp's sustainability reporting initiatives, sustainability reporting performance of the harbour community and process. According to Bergmans et al that kind of initiatives helps to create new discursive spaces, new practices and new reporting standards but also they contribute to the creation of community identity. Hence it is found that discussing and negotiating sustainability indicators is the way of reaching desired futures of an ideal harbour community.

The last study of sustainability indicators subject is published by Shiau and Chuang in 2017. The main aim of that study was to develop an indicator generator to generate initial port sustainability indicators (PSIs). After conducting case study and interview methods in Keelung Port it is suggested that 34 expert based PSIs for the scientific, operational, public relations and non-professional frame in the scope of this study.

2.2.7. Sustainability Policy and Coastal Development

Two publishing in sustainability policy and two publishing in sustainable coastal development concept has been found in this study's scope. Total 4 papers current ratio composed 7,54 percent of all paper examined in this study.

First Gilman studied in port sustainable policy concept in 2003. The main aim of the study was to decide in which Government's strategic objectives could be achieved in the scope of a private port system for the infrastructure, economy and environment. At the end of the study as the workability of the development approval process, the impact of the new approaches, the principle of clear need and particular problems of integration with in inland modes four main issues have emerged.

The other study in the concept of port sustainable policy conducted as multi case study with European and American port authorities by Kotowska in 2016. The article aimed to demonstrate port authorities' roles in creating sustainable growth. As an outcome of the study the actions taken by ports to improve the port environment and promote the modal shift have been grouped by author.

In 1998 Turner et al. studied first time in the concept of sustainable coastal development to decide main forces that influence the development of coastal areas. Consequently, they revealed the need for more open flexible, integrated and participatory approach to coastal science and management to reduce the inevitable uncertainties.

The other study in the concept of sustainable coastal development was conducted by Yap and Liam in 2013. Research aimed to examine ports growth paths and sustainability issues in coastal development. Hence the study contributed to current literature by addressing the need for a balanced approach in sustainability for port and coastal development both policy and research subjects.

2.2.8. Economic and Environmental Sustainability, Ecological Footprint, Social Sustainability, Sustainability Reporting and Sustainability Measurement

In the subjects of economic and environmental sustainability, ecological footprint, social sustainability, sustainability reporting and sustainability measurement there has been found just one study for each. They composed 9,45 percent of total studies examined in the scope of this study.

In 1999 Tindall published an article in social sustainability subject, with the survey method, aimed to examine the attitudes, opinions, and perceptions of Port Alberni residents and Anti-Environmentalism Movement organization members. After several analyses it is found that the general public is more likely to acknowledge ecological limits, and to be more open to change than members of Anti-Environmentalism Movement organization.

Soler et al. studied about port sustainability reporting subject in 2009. Study aimed to developed sustainability reporting guide standards for the Spanish port sector to satisfy the requirements of stakeholder groups. Study also considered indicators that defined in the Spanish Port System Balanced Scorecard and defined a set of information including ecological, financial and social variables as non-financial indicators and financial indicators.

A case study conducted on a Port in Northern China that has four container berths in (2015) by Guo et al. in ecological footprint subject with the aimed to build a port ecological footprint model, considering biological resource, energy and construction land ecological footprint while transferring resources and energy consumed in port production and operation to four ecological productive lands. Consequently, the model could demonstrate port ecological carrying capacity and provide a basis for evaluating the ecologically sustainable development of port but also because of nature of ports waters are accepted as the main sources of port ecological carrying capacity, hence study suggested strengthen the protection of waters to ensure sustainable development of ports.

Laxe et al. studied on economic and environmental dimensions of sustainability in 2015. Statistical analyses conducted on 16 Spanish ports sustainability reports to enable the existence of links between ports economic and environmental indicators. After analyzing data, it is found that not all Port Authorities fulfill the requirement specified in the Port Law, just four ports sustainability reports having a series of indicators of sustainability. According to study results to carry out the establishment of penalties to those entities not fulfilling the requirement or showing a negative evolution in these indicators have suggested.

A case study conducted on Singapore Port in (2017) by Xiao and Lam in sustainability measurement subject with the aimed to narrow the gap between adopting the systems theory and to develop a systems framework for sustainable development using three aspects of sustainability. According to analysis results study demonstrates that there is a positive relationship between the port and the city, hence study arrived the

result of Singapore port could keep on developing by reducing the negative relationships environmentally while increasing the positive relationships economically and socially.

2.3. DETAILS OF THE REVIEWED STUDIES

To contribute to current literature, details of examined 53 papers like, name of papers, authors of papers, publishing years of papers, research methods and data analyses methods of the papers are given in below Table 9.

Table 9: Details of the Reviewed Studies

No	Name of Study	Author	Year	Research Method	Method	Subject
1	Coastal Management for Sustainable Development: Analyzing Environmental and Socio-Economic Changes on the UK Coast	Turner et al.	1998	Quantitative	Statistical Methods	Sustainable Coastal Development
2	Anti-Environmentalist Thinking About Change and Sustainability in Port Alberni	Tindall	1999	Quantitative	Survey	Social Sustainability
3	Scale And Sustainability: The Role of Community Groups in Canadian Port-City Waterfront Change	Hoyle	1999	Qualitative	Interview	Environmental Sustainability
4	Sustainability and National Policy in UK Port Development	Gilman	2003	Qualitative	Literature Review	Sustainability Policy
5	A Framework for Sustainable Port Planning in Inland Ports: A Multi Stakeholder Approach	Dooms and Macharis	2003	Quantitative and Qualitative	MCDM/ Interview	Port Construction
6	Development of a System of Indicators for Sustainable Port Management	Peris-Mora et al.	2005	Quantitative	MCDM/ Case Study	Sustainability Indicators

7	Sustainable and Green Ports: Application of Sustainability Principles to Port Development and Operation	Abood	2007	Quantitative	Case Study	Sustainable Development
8	Sustainable Development of The European Port-City Interface	Daamen	2007	Qualitative	Literature Review	Sustainable Development
9	Sustainability Reports as a Key Tool for Communication Improvement in the Spanish Port System	Soler et al.	2009	Qualitative	Literature Review	Sustainability Reporting
10	On Flexibility and Sustainability in Container Ports	Hakam and Solvang	2009	Quantitative	Case Study	Sustainability Performance
11	Sustainability, Creativity, Resilience: Toward New Development Strategies of Port Areas Through Evaluation Processes	Girard	2010	Quantitative	MCDM	Port Construction
12	Sustainability and Maintainability of Port Infrastructure Using BIM/4D CAD Simulation Model	Wahab et al.	2011	Quantitative	MCDM/ Survey/ Case Study	Port Construction
13	Port Sustainability and Stakeholder Management in Supply Chains: A Framework on Resource Dependence Theory	Denktaş-Şakar and Karataş-Çetin	2012	Qualitative	Literature Review	Sustainable Management
14	Sustainability as a Procurement Criterion for Port Investments	Broesterhuisen et al.	2012	Qualitative	Interview	Sustainable Management
15	Ports Sustainability: A Life Cycle Assessment of Zero Emission Cargo Handling Equipment	Vujicic et al.	2012	Quantitative	Case Study	Environmental Sustainability

16	Green Port Strategy for Sustainable Growth and Development	Lam and Van de Voorde	2012	Quantitative	Case Study	Sustainable Development
17	Towards a Port Sustainability Management System for Smaller Ports	Dinwoodie et al.	2013	Qualitative	Interview	Environmental Sustainability
18	Green Performance Criteria for Sustainable Ports in Asia	Lirn et al.	2013	Quantitative	MCDM	Sustainability Performance
19	Container Ports Sustainability: A Literature Review	Hakam and Solvang	2013	Qualitative	Literature Review	Sustainability Performance
20	The Sustainability of Mediterranean Port Areas: Environmental Management for Local Regeneration in Valencia	Borriello et al.	2013	Quantitative	Case Study	Environmental Sustainability
21	80 Million-Twenty-Foot-Equivalent-Unit Container Port? Sustainability Issues in Port and Coastal Development	Yap and Lam	2013	Qualitative	Literature Review	Sustainable Coastal Development
22	Sustainability Practices to Achieve Sustainability in International Port Operations	Kim and Chiang	2014	Qualitative	Interview	Sustainable Management
23	Sustainable Port Infrastructure, Practical Implementation of the Green Port Concept	Pavlic et al.	2014	Quantitative	Case Study	Port Construction
24	Green Port Performance Index For Sustainable Ports in Egypt: A Fuzzy AHP Approach	Elzarka and Elgazzar	2014	Quantitative	MDCM/ Survey	Sustainability Performance
25	Identification and Selection of Environmental Performance Indicators for Sustainable Port Development	Puig et al.	2014	Quantitative and Qualitative	Survey/ Focus Group/ Workshop	Sustainability Indicators
26	Heritage-Based Sustainability in Port Said: Classification of Styles and Future Development	Megahead	2014	Qualitative	Interview	Port Construction

27	Co-Producing Sustainability Indicators for the Port of Antwerp: How Sustainability Reporting Creates New Discursive Spaces for Concern and Mobilization	Bergmans et al.	2014	Quantitative	Case Study	Sustainability Indicators
28	Assessment of Sustainability of Logistic Activity of Port of Klaipeda	Kutkaitis et al.	2014	Qualitative	Interview	Sustainable Development
29	Green and Sustainable Port Project Planning: Paradigm Shift for an Integrated Container Handling System Expansion	Jonathan et al.	2014	Qualitative	Literature Review	Sustainable Development
30	Planning of Sustainable Development Based on Civil Rights in Torkaman Port	Lam and Van de Voorde	2014	Quantitative	Survey	Sustainable Development
31	Sustainable Development Strategies of the Port Authority: The Network Approach	Martino	2014	Qualitative	Literature Review	Sustainable Development
32	Nordic Container Port Sustainability Performance: A Conceptual Intelligent Framework	Hakam	2015	Qualitative	Literature Review	Sustainability Performance
33	Sürdürülebilir Liman Yönetimi ve Antalya'da İki Yat Limaninda Vaka İncelemesi	Fedai and Madran	2015	Quantitative	Case Study	Sustainable Management
34	Sustainable Development of Coastal Cities-Proposal of a Modelling Framework to Achieve Sustainable City-Port Connectivity	Boulos	2015	Quantitative	Case Study	Sustainable Development
35	Assessing Energy Efficiency of Port Operations in China: A Case Study on Sustainable Development of Green Ports	Wang et al.	2015	Quantitative	Statistical Methods	Sustainable Development

36	Application of Environmental and Social Sustainable Measures by Port of Koper: The Basis for the Regional Approach	Beskovnik and Bajec	2015	Quantitative	Case Study	Environmental Sustainability
37	Using Ecological Footprint Model for Port Ecosystem Sustainability Assessment	Guo et al.	2015	Qualitative	Case Study	Ecological Footprint
38	Towards a Sustainability Management System for Smaller Ports	Kuznetsov et al.	2015	Qualitative and Quantitative	Interview /Case Study	Sustainable Management
39	Sustainability Ranking of the UK Major Ports: Methodology and Case Study	Asgari et al.	2015	Quantitative	MCDM	Sustainability Performance
40	Social Construction of Port Sustainability Indicators: A Case Study of Keelung Port	Shiau and Chuang	2015	Quantitative and Qualitative	Interview / Case Study	Sustainability Indicators
41	Sustainability and the Spanish Port System. Analysis of the Relationship Between Economic and Environmental Indicators	Laxe et al.	2016	Quantitative	Statistical Methods	Economic and Environmental Sustainability
42	Dynamics in Sustainable Port and Hinterland Operations: A Conceptual Framework and Simulation of Sustainability Measures and Their Effectiveness, Based on an Application to the Port of Shanghai	Hou and Geerlings	2016	Quantitative and Qualitative	Literature Review/ Interview / Case Study	Sustainable Management
43	A Literature Review on Port Sustainability and Ocean's Carrier Network Problem	Sislian et al.	2016	Qualitative	Literature Review	Sustainable Management
44	Examining Sustainability Performance at Ports: Port Managers' Perspectives on Developing Sustainable Supply	Lu et al.	2016	Quantitative	Survey	Sustainability Performance

	Chains					
45	Sustainable Container Terminal Operations: Challenges and Enhancements	Çağlar	2016	Quantitative and Qualitative	Interview / Survey	Sustainability Performance
46	Assessment of Port Sustainability Through Synthetic Indexes: An Application to the Spanish Case	Laxe et al.	2016	Quantitative	Statistical Methods	Sustainable Development
47	A Methodology for Measuring Sustainability of Dry Ports Location Based on Bayesian Networks and Multi-Criteria Decision Analysis	Awad-Nunez et al.	2016	Quantitative	MCDM/ Case Study	Port Construction
48	How Should the Sustainability of the Location of Dry Ports Be Measured?	Awad-Nunez et al.	2016	Quantitative	MCDM/ Case Study	Port Construction
49	Functional Differentiation and Sustainability: A New Stage of Development in the Chinese Container Port System	Wang et al.	2016	Qualitative	Literature Review	Sustainability Performance
50	Towards Sustainable ASEAN Port Development: Challenges and Opportunities for Vietnamese Ports	Roh et al.	2016	Qualitative	Interview / Literature Review	Sustainable Development
51	Policies Applied by Seaport Authorities to Create Sustainable Development in Port Cities	Kotowska	2016	Quantitative	Case Study	Sustainability Policy
52	A Conceptual Model for Oil Port Sustainability Policy Research: A Case Study of Chinese Ports	Wang et al.	2017	Qualitative	Literature Review	Sustainable Management
53	A Systems Framework for the Sustainable Development of a Port City: A Case Study of	Xiao and Lam	2017	Quantitative	Case Study	Sustainability Measurement

	Singapore's Policies					

Source: Created by Author.

According to Table 9 MCDM methods used intensively in studies that examined sustainability measurement and sustainability indicators. Multi-Criteria Decision Making Methods defined as the whole set of procedures that try to help the decision-maker to reach the solution wanted by addressing complex decision problems in a scientific and analytical framework by Çınar in 2004. Also it is extensively used to solve the problems of multiple and conflicting goals (Zionts, 1979: 94). For all those reasons, it is decided to use MCDM methods in the next chapter of this study.

CHAPTER 3
SUSTAINABILITY PERFORMANCE MEASUREMENT IN PORTS

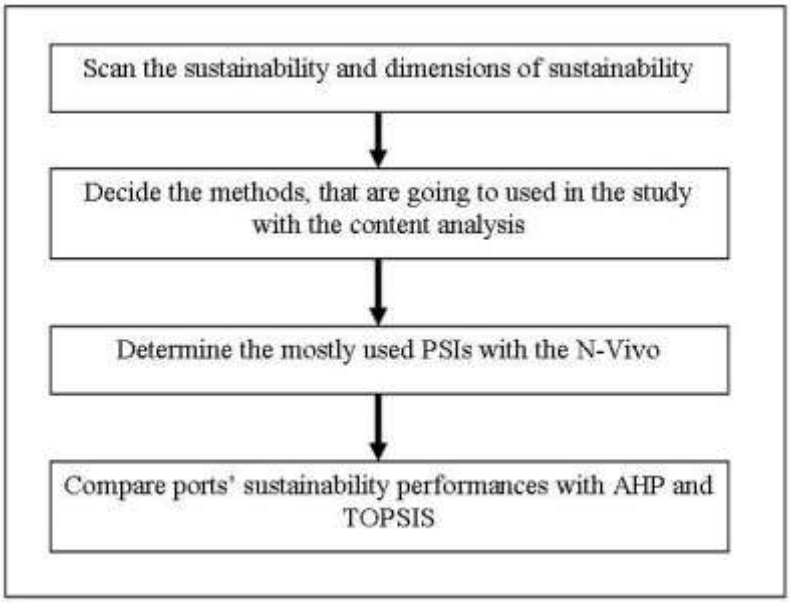
3.1. PURPOSE OF THE STUDY

The purpose of this study is ; a) to decide prevalently used port sustainability indicators in the sustainability reporting process by measuring their usage frequency; b) to suggest PSIs set to the ports for future sustainability reports and c) to compare ports' sustainability performance via the ports sustainability indicators (PSIs) values obtained in the sustainability reports and annual reports of the ports.

3.2. MODEL OF THE STUDY

Study's research model aims to discover and describe. For this reason, exploratory and descriptive research methods are used in the study that used to acquire, identify, and discover information (Nas and Cerit, 2006: 179). In exploratory research, external conditions are not controlled, and the subject or group being investigated is examined and depicted in its natural state without being affected by the researcher in any way. The advantage of exploratory research is that the examined subject is examined in a completely natural environment (Tenekecioğlu et al., 2005: 37).

Figure 6: The Research Process of the Study



Source: Created by Author

3.3. SCOPE OF THE STUDY

According to the purposes of the study, firstly 7 different ports sustainability reports published in 2014 chosen for deciding prevalently used port sustainability indicators in the sustainability reporting process. As sustainability issues are relatively new concept, it has been seen that most ports do not publish a regular sustainability report especially Turkish ports. Fortunately, Port of Los Angeles, Port of Vancouver, Port of Gothenburg, Port of Coruna, Port of Hamburg, Port of Dublin and Port of Valencia published their sustainability reports that belong to the year of 2014, so these ports sustainability reports chosen as a sample.

The other purpose of the study is to compare ports' sustainability performance via the ports sustainability indicators (PSIs). Because of the lack of published sustainability and annual reports materials just 4 different ports sustainability reports and annual reports which published between 2012 and 2015 chosen for analyze. Hence, Port of Coruna, Port of Los Angeles, Maersk Group APM Terminals and Port of

Gothenburg's sustainability reports and annual reports composed the second parts sample of this study.

3.4. METHODOLOGY OF THE STUDY

As it can be seen the purposes of the study, study consist of two main analyses parts. To reach first aim of the study which is, to decide mainly used port sustainability indicators in the sustainability reporting process by measuring their usage frequency, firstly port sustainability indicators that focused on port sustainability measurement in current literature will be gathered together to obtain sub-dimensions of sustainability, then 7 different ports sustainability reports which published in 2014 will be analyzed via the NVivo 8 software programme according to the 3 dimensions of sustainability and their sub-dimensions obtained. At the end, the most used and unused port sustainability indicators (PSIs) in the sustainability reporting process will be identified under the three main dimensions of sustainability; environmental, financial and social.

In the second part, AHP (Analytical Hierarchy Process) and TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) methods from MCDM (Multi-Criteria Decision Making) are chosen according to literature review results, to reach the aim of comparing ports' sustainability performance via the ports sustainability indicators (PSIs) values obtained in the sustainability reports and annual reports of the ports. First, the AHP method is used to determine the weights of sustainability dimensions and sub-dimensions, then the reduction of multidimensional data to a single dimension is ensured. After AHP process, with the TOPSIS method, the most successful selection between the alternatives is achieved.

3.5. ANALYSIS OF RESEARCH DATUM

Findings of the study analyzed in two groups. In the first part of findings, prevalently used PSIs detected in the current sustainability reports of ports. In the second

part of findings, sustainability performances of chosen ports are compared according to three dimensions of sustainability.

3.5.1. Selecting Prevalently Used PSIs with NVivo

Because of their specific characteristics, sea ports are very complex systems (Hakam, 2015) with a wide range of environmental issues: releases to water, air and soil, waste production and noise (Darbra et al, 2005). They are composed of different companies, dealing with different activities and offering a wide range of services (Hakam, 2015). Also they known to be one of the most polluting sectors, and therefore provide an opportunity to reduce emission significantly (Broesterhuizen et al, 2012). For all these reasons sustainability is one of the important concepts for port sector. Even though the sustainability concept is a relatively recent approach in the maritime literature, and still a gap exists in this field (Sislian et al., 2016).

To select the prevalently used PSIs firstly port sustainability indicators that focused on port sustainability measurement in current literature will be gathered together to obtain sub-dimensions. Than 7 different ports sustainability reports which are Port of Coruna, Port of Los Angeles, Port of Vancouver, Port of Hamburg, Port of Dublin, Port of Valencia and Port of Gothenburg that published in 2014 will be analyzed via the NVivo 8 software programme.

3.5.1.1. Port Sustainability Indicators

Similar to sustainability indicators, Port sustainability indicators (PSIs) are also ensure a foundation to measure, monitor, and improve the sustainable development of ports (Shiau and Chuang, 2015). Key port sustainability indicators used to measure port sustainability and sustainable development of an industry (Tanzil et al., 2006). A smooth running port sustainability measurement system shout not only describe the current state of the port system but should also provide an early warning of different problems (Milman and Short, 2008). Because of their nature, ports are known as one of the most

polluting sectors so they present an opportunity to reduce different types of emissions highly and until now in sustainability concept the main attention has been given to reduction of emissions in transport, shipping and port industry (Broesterhuizen et al, 2012).

To reduce emissions many ports started different sustainability programmes and invested in large amounts over the years. In 2006, the port of Los Angeles started a Clean Air Action Program (CAAP) which led to emission reductions of %50 to %75 in five years time and it was the most ambitious program in the world for cleaner ports (Broesterhuizen et al, 2012). Bremenports converted electricity supply into green electricity in 2011 (Bremenports Sustainability Report, 2014). Port of Cork has installed High Mast Lighting Voltage Control Units in 2010 and 2011. Systems cost €1,400 to install and energy savings of 30% have been achieved (Port of Cork Environmental Report, 2014). In 2015, the Port of Gothenburg became a climate-neutral company. By investing in solar cells, biogas and district heating and other environmental measu-res, emissions have been reduced to a minimum (Sustainability Report of Gothenburg Port Authority, 2015).

Port Sustainability Indicators to be used in measuring the using frequency in ports sustainability reports are gathered together in several sources in current literature and in this study they will be named after sub-dimensions of ports sustainability indicators. To gather these sub-dimensions, firstly 34 expert based PSIs taken directly from the study of Shiau and Chuang, (2015). In that study Shiau and Chuang, used rough sets theory (RST) to evaluate and simplify 110 initial PSIs and that 34 expert based PSIs were selected by a group of people that consist of the Taiwan International Ports Corporation (TIPC), academic researchers, and industry representatives. In current study, dimensions, that are in the form of formulas have been simplified with the aim of adapted to the suitable format. After that process 24 sub-dimensions obtained. 15 sub-dimensions are taken from Hakam (2015). In that study Hakam used a sustainability index that created for the given port and we took the dimensions which suit current study. Additionally, 8 sub-dimensions are taken from Tanzil et al., (2006). Tanzil gives a

list consists of important aspects of sustainability used for starting point and used to develop sustainability indicators. In (2005) Peris-Mora et al., found 17 indicators to develop an environmental sustainability measuring system. In current study we used 5 of those indicators to use as sub-dimension. At the end of this process 52 sub-dimensions are gathered, 27 of them are environmental sub-dimensions, 16 of them are financial sub-dimensions and 9 of them are social sub-dimensions. All 52 sub-dimensions are shown below Table 10.

Table 10: Port Sustainability Indicators

Ports Sustainability Indicators	
Environmental Indicators	Emissions of GHGs Emissions of air pollutants Noise Renewable/alternative energy usage Recycling of ships Recycling of hazardous wastes Recycling of equipment Emissions of GHGs/area of warehouse Emissions of GHGs/average service time for ships Emissions of GHGs/number of import and export containers Emissions of GHGs/annual revenues Fuel consumption Electric consumption Water consumption Air quality Atmospheric contaminant emissions: CO, NOx, SOx, PM10 particles Greenhouse effect (Carbon footprint):CO2, CH4, N2O Water quality Waste creation Waste disposal Eco-efficiency

	Wasted resources Material recycling Inner port water quality High risk areas for soil pollution Creation of sludge from dredging Efficient electric energy consumption
Financial Indicators	Annual capital investments Floor space of passenger service areas Annual ship visits Annual revenues Annual passenger visits Annual revenues/capacity of annual container throughput Annual revenues/area of container yard Annual revenues/handling efficiency of gantry cranes Annual passenger visits/annual capital investments Capacity of annual bulk and general cargo throughput/annual capital investments Capacity of annual container throughput/annual capital investments Dwell time Rate of return on turnover: Cargo handling revenue per ton of cargo Capital equipment expenditure per ton of cargo Labor expenditure
Social Indicators	Annual accident rate in port area Annual fatalities in port area Annual number of injured in port area Employee training Social impacts of operations Stakeholder engagements Human rights Workplace conditions

	Security

Source: Created by the Author

After creating Table 10, indicators shown into it, analyzed with NVivo 8 package programme to calculate usage ratio of each of them in chosen ports sustainability reports.

3.5.1.2. Analyses of Environmental Indicators with NVivo

Chosen 27 Environmental PSIs analyzed with Nvivo Package programme and findings demonstrated below in Table 11. according to their using frequency, relevance ratios and the coverage ratios.

In order to make a comparison between obtained frequencies and ratios, the word "port" is used as an indicator at the bottom of the table, because it is the most used word in all reports. Also, since some of the variables in Table 11 have more than one variable to be queried, these variables are divided and listed separately during the analysis (e.g. atmospheric contaminant emissions: CO, NOx, SOx, PM10 particles).

As a result of the analyses, not-available (N/A) indicator can be found that commonly used in the sustainability reports of all ports. In addition, it is observed that, 18 of 32 environmental indicators were not used in any port's sustainability report. Those 18 environmental sustainability indicators are listed as; Emissions of GHGs, Emissions of air pollutants, Renewable energy usage, Alternative energy usage, Recycling of ships, Recycling of hazardous wastes, Recycling of equipment, Area of warehouse, Waste creation, Wasted resources, Material recycling, Inner port water quality, High risk areas for soil pollution, Creation of sludge from dredging, Efficient electric energy consumption, CH4 Emissions, N2O Emissions, Atmospheric contaminant emissions and PM10 Particles Emissions.

Table 11: Analysis of Environmental PSIs

	Los Angeles			Vancouver			Gothenburg			Coruna			Hamburg			Dublin			Valencia		
	Relevance Ratio (%)	Frequency	Coverage (%)	Relevance Ratio (%)	Frequency	Coverage (%)	Relevance Ratio (%)	Frequency	Coverage (%)	Relevance Ratio (%)	Frequency	Coverage (%)	Relevance Ratio (%)	Frequency	Coverage (%)	Relevance Ratio (%)	Frequency	Coverage (%)	Relevance Ratio (%)	Frequency	Coverage (%)
Emissions of GHG's	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Emissions of Air Pollutants	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Noise (Including Stemmed Words)	2,6	2	0,01	9,3	34	0,16	N/A	N/A	N/A	5,9	32	0,06	3,5	3	0,02	2,7	1	0,01	4,5	12	0,02
Renewable Energy Use	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Alternative Energy Use	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Recycling of Ships	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Recycling of hazardous wastes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Recycling of equipment	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Area of warehouse	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fuel consumption	4,8	1	0,01	6,3	2	0,03	N/A	N/A	N/A	5,1	3	0,02	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Electric consumption	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3,4	1	0,01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Water consumption	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7,9	4	0,02	N/A	N/A	N/A	13,2	3	0,07	N/A	N/A	N/A	N/A
Air quality	28,4	19	0,15	31,2	23	0,24	N/A	N/A	N/A	15,5	14	0,06	8,6	1	0,01	20,1	6	0,09	10,2	4	0,02	
Water quality	13,5	9	0,09	6,7	2	0,02	N/A	N/A	N/A	10,7	14	0,07	6	1	0,01	N/A	N/A	N/A	N/A	N/A	N/A	
Waste creation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Waste disposal	N/A	N/A	N/A	7,5	1	0,01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Eco-efficiency	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	15	12	0,06	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Wasted resources	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Material recycling	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Inner port water quality	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
High risk areas for soil pollution	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Creation of sludge from dredging	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Efficient electric energy consumption	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CO2 Emissions	7,3	1	0,01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	24,2	8	0,11	N/A	N/A	N/A	N/A	N/A	N/A
CH4 Emissions	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
N2O Emissions	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Carbon	7,1	1	0,01	N/A	N/A	N/A	17,3	3	0,09	12	8	0,05	8,7	1	0,02	12	2	0,05	N/A	N/A	N/A

Footprint																					
Atmospheric contaminant emissions	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
NOx Emissions	9,3	2	0,02	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SOx Emissions	15,8	6	0,06	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PM10 Particles Emissions	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Port	30,3	652	1,97	22,1	218	0,84	30,7	220	1,60	28,9	1057	1,55	22	215	0,95	25,8	208	1,21	28,1	732	1,26

Source: Created by the Author

In addition to that, Noise, Fuel consumption, Electric consumption, Water consumption, Air quality, Water quality, Waste disposal, Eco-efficiency, CO2 emissions, NOx emissions, SOx emissions and Carbon footprint indicators are listed as the indicators used in the sustainability reports of the selected 7 ports. Information of how many ports used these indicators and usage frequency of these indicators are summarized and given in below Table 12.

Table 12: Summary of Environmental PSIs Using Frequency

Environmental Indicators	Frequency (References)	Sources
Noise	84	6
Air Quality	67	6
Carbon Footprint	15	5
Water Quality	26	4
Fuel Consumption	6	3
CO2 Emissions	9	2
Water Consumption	7	2
Eco-efficiency	12	1
SOx Emissions	6	1
NOx Emissions	2	1
Waste Disposal	1	1
Electric Consumption	1	1
Port	3302	7

Source: Created by Author

According to Table 12, Noise and Air quality indicators are the most used indicators found in 6 different port sustainability reports. Carbon footprint used 5 port sustainability reports. Water quality followed them with 4 port sustainability reports, Fuel consumption with 3 port sustainability reports and CO2 emissions and Water consumption indicators with two port sustainability reports. Eco-efficiency, SOx

Emissions, NOx Emissions, Waste Disposal and Electric Consumption are used one port sustainability report only. Total using frequencies of those indicators are shown Table 12 also. The “port” word is used as an indicator at the bottom of the table in order to make a comparison between obtained numbers.

3.5.1.3. Analyses of Financial Indicators with NVivo

Table 13 shows the ports financial sustainability indicators using frequency, relevance ratios and the coverage ratios that obtained from the literature survey, in ports sustainability reports.

As a result of the analyses, just one variable, which is Revenue, found that commonly used in the sustainability reports of all ports. In addition, it is observed that, 14 of 17 financial indicators were not used in any port’s sustainability report. Those 14 financial sustainability indicators are listed as; Floor space of passenger service areas, Annual ship visits, Annual passenger visits, Capacity of annual container throughput, Area of container yard, Handling efficiency of gantry cranes, Capacity of annual bulk and general cargo throughput, Rate of return on turnover, Cargo handling revenue, Capital equipment expenditure, Labor expenditure, Average service time for ships, Number of import and export containers and Annual revenues.

Today, however, many businesses including ports are publishing an annual financial report in addition to the sustainability report. But since the scope of this study is designated as sustainability reports, these financial reports have not been reviewed. Even if the data of such indicators are included in the financial reports of ports, it is expected to be included in the sustainability report also in accordance with GRI standards.

Table 13: Analysis of Financial PSIs

	Los Angeles			Vancouver			Gothenburg			Coruna			Hamburg			Dublin			Valencia		
	Relevance Ratio (%)	References	Coverage (%)	Relevance Ratio (%)	References	Coverage (%)	Relevance Ratio (%)	References	Coverage (%)	Relevance Ratio (%)	References	Coverage (%)	Relevance Ratio (%)	References	Coverage (%)	Relevance Ratio (%)	References	Coverage (%)	Relevance Ratio (%)	References	Coverage (%)
Capital investments	4,2	1	0,01	4,2	1	0,02	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Floor space of passenger service areas	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Annual ship visits	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Revenue (Including stemmed words)	1,8	4	0,02	1,6	1	0,01	2,1	3	0,04	1,8	8	0,02	2	4	0,03	1,7	1	0,01	2,2	13	0,04
Annual passenger visits	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Capacity of annual	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

container throughput																						
Area of container yard	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Handling efficiency of gantry cranes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Capacity of annual bulk and general cargo throughput	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dwell time	N/A	N/A	N/A	3,8	4	0,04	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Rate of return on turnover	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cargo handling revenue per ton of cargo	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Capital equipment expenditure per ton of cargo	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Labor expenditure	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Average service time for ships	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Number of import and export containers	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Annual revenues	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

At the end of the analysis of financial indicators, only three common indicators were found in current port sustainability reports. Details of these indicators are summarized and given in Table 14.

Table 14: Summary of Financial PSIs Using Frequency

Financial Indicators	Frequency (References)	Sources
Revenue	34	7
Capital Investments	2	2
Dwell Time	4	1

Source: Created by Author

According to Table 14, Revenue indicator is used all seven port sustainability reports 34 times. Capital investments used 2 port sustainability reports and Dwell time used just one port sustainability report.

3.5.1.4. Analyses of Social Indicators with NVivo

As a result of the analyses, just two social indicators were not used in any port's sustainability report which are; Accident rate and Social impacts of operations indicators. As a bright side of the study, Indicators of Security, Safety and Training that can be named as vital indicators are found all seven sustainability reports. Other 6 indicators also found ports sustainability reports which are; Fatalities, Injury, Employee training, Stakeholder engagements, Human rights and Workplace conditions. The "Safety" indicator has not been found in literature survey but because of it is used extensively in all port sustainability reports, it has been included the analysis by the authors.

Table 15: Analysis of Social PSIs

	Los Angeles			Vancouver			Gothenburg			Coruna			Hamburg			Dublin			Valencia		
	Relevance Ratio (%)	References	Coverage (%)	Relevance Ratio (%)	References	Coverage (%)	Relevance Ratio (%)	References	Coverage (%)	Relevance Ratio (%)	References	Coverage (%)	Relevance Ratio (%)	References	Coverage (%)	Relevance Ratio (%)	References	Coverage (%)	Relevance Ratio (%)	References	Coverage (%)
Accident Rate	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fatalities	N/A	N/A	N/A	N/A	N/A	N/A	2,3	1	0,01	N/A	N/A	N/A	N/A	N/A	N/A	2,2	1	0,01	2,1	2	0,01
Injury (including stemmed words)	N/A	N/A	N/A	2,3	1	0,01	2,5	1	0,01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2,5	5	0,02
Employee training	3,1	2	0,03	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2,4	1	0,01
Training	1,4	7	0,04	1,4	8	0,06	1,4	4	0,06	1,5	53	0,15	1,5	12	0,11	1,4	7	0,08	1,6	54	0,18
Social impacts of operations	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Stakeholder engagements	N/A	N/A	N/A	7,6	3	0,06	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Human rights	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5,6	1	0,01	N/A	N/A	N/A	4,9	2	0,01
Workplace	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3,6	1	0,01

conditions																					
Security (Including stemmed words)	2,9	4	0,02	6,9	26	0,19	2,7	1	0,01	3,1	8	0,02	5,5	15	0,12	3,1	2	0,02	5,7	33	0,11
Safety (Including stemmed words)	2,1	1	0,00	8,4	33	0,19	5,1	5	0,05	6,6	52	0,11	6	15	0,10	4,8	6	0,05	10,6	113	0,28

Details of social indicators used in port sustainability reports are summarized given in Table 16.

Table 16: Summary of Social PSIs Using Frequency

Social Indicators	Frequency (References)	Sources
Safety	225	7
Training	145	7
Security	89	7
Injuries	7	3
Fatalities	4	3
Employee Training	3	2
Human Rights	3	2
Stakeholder Engagements	3	1
Workplace Conditions	1	1

Source: Created by Author

According to Table 16; Safety, Training and Security indicators are the most used indicators found in all seven port sustainability reports 459 times. This means ports are really care of these vital issues gladly. After that 3 ports gave place to injuries and fatalities in their sustainability reports. Employee Training and Human Rights followed them with 2 port sustainability reports. Finally, Stakeholder Engagements and Workplace Conditions took place only one port sustainability report.

At the end of the findings, results of Table 11, Table 12, Table 13, Table 14, Table 15 and Table 16 summarized in Table 17, the usage ratios of selected indicators for each port are calculated as environmental, financial, social and total, and general picture of the current situation of port sustainability reporting has been established.

3.5.2. Findings of Prevalently Used PSIs

Table 17: General Summary of Findings

	Los Angeles		Vancouver		Gothenburg		Coruna		Hamburg		Dublin		Valencia	
	Indicator Frequency	Reference	Indicator Frequency	Reference	Indicator Frequency	Reference	Indicator Frequency	Reference	Indicator Frequency	Reference	Indicator Frequency	Reference	Indicator Frequency	Reference
Environmental Indicators	8/32	42	5/32	62	1/32	3	9/32	91	5/32	14	4/32	12	2/32	16
Financial Indicators	2/17	5	3/17	6	1/17	3	1/17	8	1/17	4	1/17	1	1/17	13
Social Indicators	4/11	14	5/11	71	5/11	12	3/11	113	4/11	43	4/11	16	8/11	211
Total	14/60	61	13/60	139	7/60	18	13/60	212	10/60	61	9/60	29	11/60	240
Total Ratio (%)	%23,3		%21,6		%11,6		%21,6		%16,6		%15		%18,3	

Source: Created by Author.

Given in Table 17, at the end of the all analysis, Port of Los Angeles used %23,3 of all chosen indicators, and it is the biggest ratio of all. After Port of Los Angeles, Port of Vancouver and Port of Coruna used %21,6 of indicators. Port of Valencia followed them with the %18,3 using rate, Port of Hamburg with %16,6, Port of Dublin with %15. With the %11,6 indicators using rate Port of Gothenburg took the last place.

As a result, when analyzed environmental dimension of sustainability n ports sustainability reports, it is seen that Port of Coruna gave place 9 chosen environmental indicators in its sustainability report. Unfortunately, it is the biggest number of all 32 chosen environmental indicators. Also any common indicator can be found in all seven ports sustainability reports and this makes impossible to make comparison between ports environmental sustainability performances. As we mentioned literature part of this study, ports known as one of the most polluting sectors, and therefore they provide an opportunity to reduce emissions significantly (Broesterhuizen et al., 2012). However, to start reduce emissions first we can measure and compare them indeed.

Unfortunately, financial dimension of sustainability is barely analyzed in this study. It's because of the chosen indicators are too specific or financial dimension of sustainability in ports sustainability reports are too narrow. Of course many businesses including ports are publishing an annual financial report in addition to the sustainability report in today and they add their financial situation in annual financial reports in spite of sustainability reports. However, even if the data of such indicators are included in the financial reports of ports, it is expected to be included in the sustainability report also in accordance with GRI standards. At the end three chosen financial indicators found and just one of them used for all seven ports, which is "Revenue".

When analyzed social dimension of sustainability in port sustainability reports, vital indicators like Security, Safety and Training are found all seven sustainability reports as a bright side of the study. In addition to that general frequencies of chosen social indicators are better than other two dimensions of sustainability in ports sustainability reports. Nearly all indicators are used by half of ports. That makes comparatively possible to compare ports social dimensions of sustainability with each

other. In that point our expectation from the at least half of sector practitioners that to use deficient indicators in their port sustainability reports to demonstrate exact situation of the ports social sustainability. Also it has been noticed that the “accident rate” indicator has never been used by any port in their sustainability reports. Because of its nature this indicator has vital importance and it should be included all sustainability reports.

3.5.3. Comparing Ports Sustainability Performances with AHP and TOPSIS

Ports all over the world are growing at a remarkable rate, and a port’s performance takes into account not only its output and efficiency, but also its green performance and sustainability rate (Lirn et al., 2012: 428). To measure the sustainability performance of a company indicators are developed and used predominantly (Puig, 2014: 125). However, the development of technology and its intense use in ports and companies could lead to more extensive performance measurement and still performance measurement is a complex subject and needs for research intended to better structure (Melnyk, 2014: 215). Consequently, these huge amounts of datum still need to be transformed into meaningful way (Bishou, 2007: 580). Institutional sustainability performance measurement aims to address the environmental, social and economic aspects of corporate sustainability. Problems arise when these three dimensions are reduced to a single dimension. However, multi-criteria decision-making methods provide a useful framework for the evaluation of these variables together (Öztel, 2012: 32).

3.5.3.1. Multi-Criteria Decision Making Methods

The MDCM was developed in 1950's. It is used to bring a probing solution in situations where multiple and often inconsistent criteria exist (Bülbül and Köse, 2011:72). The decision maker has to consider more than one criterion when looking for

a solution that can lead to a problem and at the same time satisfies the constraints (Ofluoğlu et al., 2016: 116). In this case, it is necessary to use the MDCM method, which has a structure that can produce a solution at the same time by bringing the alternative with many criteria (Bülbül and Köse, 2011:72). MDCM is examined in 6 different titles in the literature. These are; ELECTRE (Elimination and Choice Translating Reality), PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluation), MAUT (Multi Attribute Utility Theory), UTADIS (Utilities Additives Discriminants), AHP (Analytical Hierarchical Process) and TOPSIS (Technique for Order Preference by Similarity to Ideal Solution). Detailed information about the AHP and TOPSIS methods to be used in the study will be given below.

3.5.3.1.1. AHP- Analytical Hierarchical Process

In complicated decision making problems, it is a decision making process based on the principle of operating the managerial decision mechanism by giving relative importance values to decision alternatives and criteria (Timor,2014:29). Able to make binary comparisons between criteria using AHP eigen value approach; Is a multi-criteria decision making method that calibrates the quantitative scale used in measuring quantitative and qualitative performance (Vaidya and Kumar, 2006:2).

3.5.3.1.2. TOPSIS - Technique for Order Preference by Similarity to Ideal Solution

It was developed by Yoon and Hwang in 1981 and uses the basic approach of the Electre method (Sürücü, 2015: 72). The ELECTRE method is based on a comparison of binary superiority among alternatives within the criteria. With this method, many quantitative and qualitative criteria can be used together, these criteria can be weighted according to importance, and weights can be selected and the most suitable alternative can be selected (Şahin, 2014:156). Decision points are based on the principle of the ideal

solution approximation and TOPSIS solution process is shorter than Electre. Consequently, it is a technique that allows the best selection to be made among alternatives (Sürücü, 2015: 72).

3.5.3.2. Methodology

Methodological steps of the study are given following parts of the study.

3.5.3.2.1. Application Steps of AHP Method

AHP can be described as a decision-making and forecasting method that gives the percentage distributions of decision points in terms of the factors affecting the decision, which can be used if the decision hierarchy can be defined. The AHP was developed by Thoman L. Saaty in the 1970s at the Wharton School of Business for solving multi-criteria decision making problems. In this method, which requires expert opinion for rating on criteria, expert opinion is needed to determine importance ratings. The decision makers compare the criterion and the sub-criteria in the assessment form prepared using Saaty's 1-9 scale. All criteria are compared and priorities of decision alternatives are listed (Saaty, 1999: 98).

The AHP is determined by the priority vectors which form the order for determining the best of the possible outcomes by reducing the significance levels of the criteria and sub criteria to one dimension. The AHP is an effective method of establishing a common judgment and establishing a common judgment by specifying the opinions and opinions of the expert in a particular subject.

In order to calculate the priority values of the criteria in each level of the hierarchy following the creation of the hierarchical structure of the decision problem, it is necessary to make binary comparisons of the elements in the relevant level. The following steps are taken to solve the decision making problem using the AHP technique (Sürücü, 2014; Timor, 2011; Esen, 2008):

i. Identification of the decision making problem and to decide main purpose,

ii. List of decision criteria required to reach the purpose,
iii. Determination of possible decision alternatives,
iv. The creation of the hierarchical structure of the decision problem,
v. Binary comparison of the criteria for each level of the hierarchy and determination of the importance of the criteria by taking advantage of the eigenvectors,
vi. Binary comparison of alternatives according to the criteria and calculation of priorities,
vii. Calculation of compliance rate,
viii. Sorting alternatives according to their relative priority values and choosing the alternative with the highest priority value,
ix. Sensitivity analysis.

3.5.3.2.2. Mathematical Infrastructure of AHP Method

Weights of the criteria (w) obtained in binary comparisons. Decision makers do not have to make numerical comparisons; they can make a comparison with the words (Ishizaka and Nemery, 2013: 4). Binary comparisons usually use the 1-9 scale of Saaty shown in below Table 18.

Table 18: Importance Rating Table Used in Comparisons

Importance Rating	Definition	Statement
1	Equally Important	Both factors have the same precaution
3	Important in Middle Grade (Less Superior)	According to experience and judgment a factor is more important than the other.
5	Important in Strong Grade (Superior State)	One factor is strongly more important than the other.

7	Important in Very High Grade (Very Superior State)	One factor is strongly more important at a higher level than the other.
9	Important in Absolute Grade (Absolute Superiority)	One of the factors is very important to the other.
2,4,6,8	Intermediate Values	The preference between the two factors is the intermediate values of the ratios found in the above explanations.
Mutual Values	If factor i has one of the above numbers assigned to it when compared to factor j (x), then j has the reciprocal value when compared with i (1/x).	

Source: Vaidya and Kumar, 2006:2; Saaty, 1977: 99.

When the AHP is analyzed, the upper limit is set at 9, as seen in Table 3.9. Reasons of it are (Saaty, 1999:99):

i. This method gives good results especially for n <10 criteria. In other words, when solving multi-criteria decision making problems with AHP method, when the number of criteria exceeds 9, big inconsistencies can occur.

ii. If the elements of a matrix are made up of very large numbers, greater inconsistencies can occur.

In comparison matrix all comparison values are positive. In the comparison matrix, diagonal elements take the value 1 because it is compare with the criterion itself. The general structure of the binary comparison matrix is as follows if a binary comparison is required according to the relative importance weights of the n criteria so that the criterions a1, a2, ..., an, and their weights w1, w2,…, wn (Tzeng and Huang, 2011: 8).

$$A = \begin{bmatrix} a11 & a12 & \dots & a1n \\ a21 & a22 & \dots & a2n \\ . & . & . & . \\ . & . & . & . \\ . & . & . & . \\ am1 & am2 & \dots & amn \end{bmatrix} \quad (1)$$

Here $a_{ij} = \frac{1}{aji}$ (according to mutual property) and $a_{ij} = \frac{aik}{ajk}$. In real problems, $\frac{wi}{wj}$ is usually not known. That is why the value of a_{ij} is to be found in AHP as $a_{ij} \approx \frac{wi}{wj}$ (Tzeng and Huang, 2011:10). The general form of the weight matrix is shown below.

$$W = \begin{array}{c} \\ w1 \\ \vdots \\ wi \\ \vdots \\ wn \end{array} \begin{array}{c} \begin{array}{ccccc} w1 & \cdots & wj & \cdots & wn \end{array} \\ \begin{bmatrix} w1/w1 & \cdots & w1/wj & \cdots & w1/wn \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ wi/w1 & \cdots & wi/wj & \cdots & wi/wn \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ wn/w1 & \cdots & wn/wj & \cdots & wn/wn \end{bmatrix} \end{array} \quad (2)$$

W and w values are multiplied,

$$W.w = \begin{array}{c} \\ w1 \\ \vdots \\ wi \\ \vdots \\ wn \end{array} \begin{bmatrix} w1/w1 & \cdots & w1/wj & \cdots & w1/wn \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ wi/w1 & \cdots & wi/wj & \cdots & wi/wn \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ wn/w1 & \cdots & wn/wj & \cdots & wn/wn \end{bmatrix} \begin{bmatrix} w1 \\ \vdots \\ wi \\ \vdots \\ wn \end{bmatrix} = n \begin{bmatrix} w1 \\ \vdots \\ wi \\ \vdots \\ wn \end{bmatrix} \quad (3)$$

or is shown below.

$$(W\text{-}nI)\, w = 0 \quad (4)$$

The solution of the above equation is the problem of finding eigenvalues. Relative weights are calculated by using the w eigenvector that found with on the basis

of λmaks and provides the equation of Aw = λmaks. Here the largest eigenvalue of the matrix A is λmaks and *(A–λmaksI)*w=0 equation obtained depending on the w eigenvector λmaks.

In addition, two coefficients are used, consistency index (CI) and consistency ratio (CR), to ensure the consistency of subjective perceptions and the relative weights. The following formula is used to calculate the Consistency Index (CI).

$$CI = \frac{(\lambda maks - n)}{(n-1)} \quad (5)$$

Here λmaks is the greatest eigenvalue and n is the total number of properties (criterion). To obtain a reliable result, the CI value must not exceed 0,1 (Tzeng and Huang, 2011:10).

In the calculation of the consistency ratio, the following formula is used:

$$CR = \frac{CI}{RI} \quad (6)$$

RI stands for "Random Value Index". It was obtained from a large sample of randomly generated reciprocal comparison matrix. The scale used is 1/9, 1/8, ..., 1, ..., 8,9. The RI values for different element numbers *(n)* are shown in Table 19.

Table 19: Random Value Index

N	RI
1	0
2	0
3	0,58
4	0,90

5	1,12
6	1,24
7	1,32
8	1,41
9	1,45
10	1,49

Source: Tzeng and Huang, 2011: 11.

For reliable and realistic results, it is expected that the consistency ratio (CR) is below 0.1. Some researchers indicate a maximum number of 0.2 as the maximum acceptable value for this boundary value (Tzeng and Huang, 2011: 11).

3.5.3.2.3. Application Steps of TOPSIS Method

The steps to be used in the TOPSIS method are described below (Yurdakul and İç, 2003: 11-13).

Step 1: Creating the Decision Matrix

This matrix is created by the decision maker. Decision maker demonstrates decision points in rows and column show the factors. This matrix shown as;

Factors

$$\mathbf{Aij} = \begin{bmatrix} a11 & a12 & \dots & a1p \\ a21 & a22 & \dots & a2p \\ . & . & . & . \\ . & . & . & . \\ . & . & . & . \\ . & . & . & . \\ am1 & am2 & \dots & amp \end{bmatrix} \textbf{Decision Criteria}$$

Step 2: Obtaining Normalized Matrix

After the decision matrix is formed, the squares of each aij value (a11, a21, a31, ..., am1) are obtained and the column sums consisting of the sum of these values are obtained and the normalization process is performed by dividing each aij value by the square root of the column sum.

$$n_{ij} = \frac{aij}{\sqrt{\sum_{i=1}^{m} aij^2}} \quad (i = 1,\ldots,m \text{ and } j = 1,\ldots,p) \qquad (7)$$

Normalize matrix is obtained as follows;

$$N = \begin{bmatrix} n11 & n12 & \ldots & n1p \\ n21 & n22 & \ldots & n2p \\ \ldots & \ldots & \ldots & \ldots \\ \ldots & \ldots & \ldots & \ldots \\ \ldots & \ldots & \ldots & \ldots \\ nm1 & nm2 & \ldots & nmp \end{bmatrix} \qquad (8)$$

Step 3: Obtaining Weighted Normalized Matrix

Each value of the normalized matrix is weighted with a value such as w_i. The weighting process reveals the subjective direction of the TOPSIS method. The weighting process is based on the importance of the factors. The only subjective parameter of the TOPSIS method is the weight. The point to note here is that the total of wi values is equal to 1. That is, $\sum_{i=1}^{n} wi = 1$. The weighted normalized matrix (V matrix) is obtained by multiplying the n_{ij} values obtained with the normalized matrix by the weights w_i.

$$V = \begin{bmatrix} W1N11 & W2N12 & \ldots & WnN1p \\ W1N21 & W2N22 & \ldots & WnN2p \\ . & . & . & . \\ . & . & . & . \\ . & . & . & . \\ W1Nm1 & W2Nm2 & \ldots & WnNmp \end{bmatrix} = \begin{bmatrix} V11 & V12 & \ldots & V1p \\ V21 & V22 & \ldots & V2p \\ . & . & . & . \\ . & . & . & . \\ . & . & . & . \\ Vm1 & Vm2 & \ldots & Vmp \end{bmatrix} \qquad (9)$$

Step 4: Obtaining Ideal and Negative Ideal Solution Values

Once the weighted normalized matrix (V matrix) has been obtained, the maximum values for each column are determined, provided that we adhere to the structure of the problem if our main goal is maximization. These maximum values are the ideal solution value. Then minimum values for each column are obtained. This is the negative ideal solution value. If our goal is minimization, the values obtained will be the exact opposite. The notation for obtaining ideal and negative ideal solution values is as follows;

Ideal solution values:

$$A^* = \{maxVij \mid j = 1, \ldots, p \; ; \; i = 1, \ldots, m\} \qquad (10)$$

$\Rightarrow$ $A^* = \{V1*, V2*, \ldots\ldots, Vn*\}$ *the maximum values for each column,*

Negative ideal solution values:

$$A^- = \{\min V\ ij\} \qquad (11)$$

$\Rightarrow$ $A^- = \{v1-, v2-, \ldots, vn-\}$ are the minimum values for each column.

Step 5: Obtaining Ideal and Negative Ideal Distance Value

Euclidean distance is used when calculating ideal and non-ideal point distance values. In the coordinate plane, the distance between the two known x and y coordinates is found with calculating Euclidean distance;

$$d_{ij} = \sqrt{\sum_{k=1}^{p} (Xik - Xjk)^{\,2}} \qquad (12)$$

formula is used. Here;

X_{ik}: observation (k) variable value

X_{jk}: observation (k) variable value

P: variable number.

It is attempted to determine the negative ideal solving farthest distance with the ideal solving nearest euclidean distance. If this formula is generalized in order to calculate the ideal and non-ideal point distance, the following calculation method is followed;

Ideal distance:

$$S_i^* = \sqrt{\sum_{j=1}^{n}(Vij - Vj*)^2} \quad (13)$$

Negative ideal distance:

$$S_i^- = \sqrt{\sum_{j=1}^{n}(Vij - Vj-)^2} \quad (14)$$

Here the number of decision points will be $S_i^*$and S_i^-.

Step 6: Calculation of Ideal Solving Relative Proximity

Ideal and non-ideal point spacing is used to calculate the ideal resolving relative proximity of each decision point. According to the ideal solution the relative closeness is symbolized by C_i^*. Here, C_i^* value takes a value in the range 0 <C_i^* <1. C_i^* = 1 indicates the ideal resolving of absolute solution approximation of the corresponding decision point, while C_i^* = 0 indicates the negative ideal resolving absolute approximation of the corresponding decision point.

$$C_i^* = \frac{Si-}{(Si-)+(Si+)} \quad (15)$$

3.5.3.3. An Application of Ports

3.5.3.3.1. Definition of Problem and Limitations

In this study, sustainability performance measurements of four different ports (Port of Coruna, Port of Valencia, APM Terminals and Port of Gothenburg) were made. In the context of sustainability performance measurement, the financial, environmental and social dimensions of sustainability are examined. In order to measure these dimensions, sixteen indicators in total were used as measurement values, including five financial, six environmental and five social dimensions.

The reason why Turkish ports can not be included in the study is that the ports in Turkey are very new in sustainability reporting activities. Limak Port has been reporting sustainability that operating in Turkey, but the report has been found to consist mostly of qualitative data for this reason; it is not included in the study. APM Terminals, another operational port in Turkey, has been included in the scope of the study with datum from all APM Terminals around the world.

It was aimed that the PSIs used in this part of the study consisted of the PSIs most commonly used by all the ports obtained by Nvivo method in the first part of the study. Unfortunately, as it can be seen in Table 11, Table 13 and Table 15, there could not been found enough numbered common indicators used by ports in their sustainability reports. For that reason, chosen 4 ports (Port of Coruna, Port of Valencia, APM Terminals and Port of Gothenburg) sustainability and annual reports are examined detailed again and found common indicators used by all 4 ports and supported by the literature. The main dimensions of sustainability and the indicators used for each of these main dimensions are given in Table 20, Table 21, Table 22 and Table 23.

3.5.3.3.2. Data Collection

There is great difficulty in collecting data on sustainability because of new challenges of sustainability, difficulties in measuring sub-factors of sustainability, and difficulties in the implementation of sustainability reporting principles. In addition, the lack of understanding of sustainability and the fact that any reporting activity is seen as an extra expense makes it more difficult to gather data on sustainability (Sürücü, 2015: 81).

The data used in this study were obtained from the sustainability and annual reports for 2012-2015 of four ports, which are; Port of Coruna, Port of Valencia, APM Terminals and Port of Gothenburg.

Table 20: Dimensions of Sustainability to be used in Performance Measurement

Dimensions of Sustainability
DS_1: Financial Dimension
DS_2: Environmental Dimension
DS_3: Social Dimension

Table 21: Financial Indicators to be used for Sustainability Performance Measurement

Financial Indicators
F_1: Revenue
F_2: Profit for the year
F_3: Tax for the year
F_4: Operating Profit
F_5: Total Assets

Table 22: Environmental Indicators to be used for Sustainability Performance Measurement

Environmental Indicators
E_1: Greenhouse Gas Emissions (GHG)
E_2: Sulphur Oxides Emissions (SOx)
E_3: Nitrogen Oxides Emissions (NOx)
E_4: Water Consumption
E_5: Electricity Consumption
E_6: Fuel Consumption

Table 23: Social Indicators to be used for Sustainability Performance Measurement

Social Indicators
S_1:Number of Employees
S_2: Ratio of Women Employees to Total Number of Employees
S_3: Ratio of Women Employed in Senior Management to Total Number of Employees
S_4: Fatalities
S_5: Lost-time Injury and Sick Leave Accidents

With these indicators, the sustainability performances of the ports will be measured between 2012 and 2015 and first changes in the ports themselves will be evaluated according to years then ports will be compared with each other. Unfortunately, Port of Gothenburg does not publish annual financial reports, so because of the lack of financial information of port, that port's financial sustainability performance will not compared with others.

In MCDM problems, the judgments about the subject are learned by discussing with the persons concerned about the subject with evaluation forms. In order to obtain consistent outcomes, the interviewees need to be expert or moderately expert about the subject. Consequently, the results of the AHP are based entirely on the judgment of these persons (Saaty, 2000; Harker ve Vargas, 1987). Once the dimensions of sustainability have been identified, an evaluation form has been prepared containing three dimensions of sustainability for consultation. The evaluation form used is given in Appendix 1. These forms have been filled by industry experts and academicians. Within the scope of the study, 10 experts were interviewed. The experts who complete the assessment form consist of academicians experienced in sustainability and port subjects, finance and banking sector employees, environmental and chemical engineers who interested in sustainability and job security. Detailed information about these experts who are helped in the AHP weighting process of the study is given in Table 24.

Table 24: Detailed Information about the Experts

Expert Area	Sustainability Dimensions (DS)	Financial Dimension (F)	Environmental Dimension (E)	Social Dimension (S)	Information
Port Sustainability	√	√	√	√	Department of Industrial Engineering, Narvik University College, Narvik, Norway
Sustainability	√	√	√	√	Department of Maritime Business Administration, Dokuz Eylul University, Izmir, Turkey
Port	√	√	√	√	Department of Maritime Business Administration, Dokuz Eylul University, Izmir, Turkey
Environment and Job Security	√		√	√	Environmental Engineer and Job Security Specialist in Borusan Mannesmann, Bursa, Turkey.
Environmental Sustainability	√		√	√	Chemical Engineer, 4K Kimya Sanayi, İzmir, Turkey
Finance	√	√			QNB Finansbank, İzmir Branch Manager, İzmir, Turkey
Finance	√	√			T.C. Ziraat Bank, Individual Customer Relationship Authority, Bursa, Turkey
Finance	√	√			QNB Finansbank, Authorized Assistant, İzmir, Turkey
Finance	√	√			Vakıfbank, Controller, İstanbul, Turkey
Finance	√	√			Vakıfbank, Bank Inspector, Kütahya, Turkey

Source: Created by Author

3.5.3.4. Determination of Dimensions Weights with AHP

3.5.3.4.1. Weighing the Dimensions of Sustainability (DS)

As described in the mathematical structure of the AHP method, first the decision matrix was established in comparing the dimensions of sustainability. The decision matrix for assessing the fundamental dimensions of sustainability is given in Table 25.

Table 25: Sustainability Dimensions Comparison Matrix

	DS_1	DS_2	DS_3
DS_1	**1**	1,2871	2,0859
DS_2	0,7769	**1**	2,5811
DS_3	0,4794	0,3874	**1**

$$A = \begin{bmatrix} 1 & 1,2871 & 2,0859 \\ 0,7769 & 1 & 2,5811 \\ 0,4794 & 0,3874 & 1 \end{bmatrix}$$

The values in the decision matrix are the geometric mean results of the comparisons of the binary evaluations of ten experts. The geometric average evaluation form results are entered into the area above the diagonal. Diagonal have 1 value because each criterion is compared with itself and $a_{ij} = 1/a_{ji}$ formula has been applied to the area below the diagonal.

The decision matrix values were normalized by using the formula (2) in the methodology section. The normalized matrix is shown in Table 26.

Table 26: Normalized Matrix of Sustainability Dimensions

	DS_1	DS_2	DS_3
DS_1	0,4432	0,4812	0,3680
DS_2	0,3443	0,3739	0,4554
DS_3	0,2124	0,1448	0,1764

$$W = \begin{bmatrix} 0,4432 & 0,4812 & 0,3680 \\ 0,3443 & 0,3739 & 0,4554 \\ 0,2124 & 0,1448 & 0,1764 \end{bmatrix}$$

In the next step, the priority vector was created. To obtain the priority vector, the averages of the line elements in the normalized matrices are calculated. The priority vector is shown in Table 27.

Table 27: Priority Vector of Sustainability Dimensions

	DS_1	DS_2	DS_3	**Priority Vector (mean)**
DS_1	0,4432	0,4812	0,3680	**0,4308**
DS_2	0,3443	0,3739	0,4554	**0,3912**
DS_3	0,2124	0,1448	0,1764	**0,1779**

$$\begin{bmatrix} 0,4432 & 0,4812 & 0,3680 & 0,4308 \\ 0,3443 & 0,3739 & 0,4554 & 0,3912 \\ 0,2124 & 0,1448 & 0,1764 & 0,1779 \end{bmatrix}$$

Using the formula (3), which is included in the methodology, "All Priority Matrix" is obtained. The all priority matrix is shown in Table 28.

Table 28: All Priority Matrix of Sustainability Dimensions

	DS_1	DS_2	DS_3	**Total**
DS_1	0,4308	0,5035	0,3710	1,3053
DS_2	0,3346	0,3912	0,4591	1,1849
DS_3	0,2065	0,1515	0,1779	0,5359

$$W.\ w = \begin{bmatrix} 1 & 1,2871 & 2,0859 \\ 0,7769 & 1 & 2,5811 \\ 0,4794 & 0,3874 & 1 \end{bmatrix} x \begin{bmatrix} 0,4308 \\ 0,3912 \\ 0,1779 \end{bmatrix} = \begin{bmatrix} 1,3053 \\ 1,1849 \\ 0,5359 \end{bmatrix}$$

Consistency Ratio (CR) is required for the reliability of the results after achieving weighting the dimensions of sustainability. The λmax, RI and CI values are required to obtain the consistency ratio.

In order to obtain the λmax value that required for the calculation of the consistency ratio, the results obtained from the all priority matrix are divided by the priority vector then the averages of the obtained values are taken. Table 29 shows the results obtained from the division of all priorities matrix into priority vectors.

Table 29: Division of All Priority Matrix into Priority Vectors of Sustainability Dimensions

All Priority Matrix (A)	**Priority Vector (B)**	**A/B**
1,3053	0,4308	3,0299
1,1849	0,3912	3,0288
0,5359	0,1779	3,0123

The final λmax value was obtained by taking the average of the A / B values for the three sub-dimensions of sustainability.

$$\lambda max = \frac{3,0299 + 3,0288 + 3,0123}{3} = 3,0237$$

In the calculation of the consistency index (CI), the formula (5) in the methodology section is utilized. Accordingly, Consistency Index (CI);

$$CI = \frac{3,0237 - 3}{2} = 0,0118$$

The Random Index (RI) value must be selected from Table 19 to be able to calculate the Consistency Ratio (CR). There are three dimensions of sustainability which are; financial, environmental and social. So (n) takes 3 as a value. According to Table 19 it appears that the RI value is 0.58.

The consistency ratio will be calculated using the formula (6) described in the methodology. Accordingly;

$$CR = \frac{0,0118}{0,58} = \mathbf{0,0203}$$

Since the consistency ratio is 0.0203 < 0.1, the result is considered within the compliance limits. Since the inconsistency is acceptable, the weights of the criteria values of the priority vector can be interpreted.

The weight of sustainability dimensions, according to the judges of the experts are given in Table 30 according to the order of importance.

Table 30: Sustainability Dimensions Criterion Weighing

Criteria	Weight
Financial Dimension	0,4308
Environmental Dimension	0,3912
Social Dimension	0,1779

Similar mathematical procedures have been used to weight the criteria for each sustainability dimension which are financial, environmental and social. Here, the financial sustainability dimension shown as (F), the environmental sustainability dimension shown as (E) and the social sustainability dimension shown as (S). Tables related to mathematical procedures used in calculation are included in Appendix - 2.

3.5.3.4.2. Weighting the Indicators of Financial Sustainability Dimension (F)

All mathematical procedures are calculated step by step just like in the three dimensions of sustainability for the sub-factors of financial dimension (F). In order to obtain the λmax value that required for the calculation of the consistency ratio, the results obtained from the all priority matrix are divided by the priority vector then the averages of the obtained values are taken. Table 31 demonstrates the results obtained from the division of all priorities matrix into priority vectors.

Table 31: Division of All Priority Matrix into Priority Vectors of Financial Dimension

All Priority Matrix (A)	Priority Vector (B)	A/B
1,0222	0,1908	5,3562
1,3478	0,2543	5,2996
0,5817	0,1128	5,1577
1,6645	0,3112	5,3477
0,6753	0,1308	5,1633

The final λmax value was obtained by taking the average of the A / B values for the five financial dimensions of sustainability.

$$\lambda max = \frac{5,3562+5,2996+5,1577+5,3477+5,1633}{5} = 5,2649$$

In the calculation of the consistency index (CI), the formula (5) in the methodology section is utilized. Accordingly, Consistency Index (CI);

$$CI = \frac{5,2649-5}{4} = 0,0662$$

The Random Index (RI) value must be selected from Table 3.10 to be able to calculate the Consistency Ratio (CR). There are five sub-dimensions of financial sustainability which are; revenue, profit for the year, tax for the year, operating profit and total assets. So (n) takes 5 as a value. According to Table 3.10 it appears that the RI value is 1.12.

The consistency ratio will be calculated using the formula (6) described in the methodology. Accordingly;

$$CR = \frac{0,0662}{1,12} = \mathbf{0,0591}$$

Since the consistency ratio is 0.0591 < 0.1, the result is considered within the compliance limits. Since the inconsistency is acceptable, the weights of the criteria values of the priority vector can be interpreted.

The weights of financial sub-dimensions of sustainability, according to the judges of the experts are given in Table 32 according to the order of importance.

Table 32: Financial Dimensions Criterion Weighing

Criteria	Weight
Operating Profit	0,3112
Profit for the Year	0,2543
Revenue	0,1908
Total Assets	0,1308
Tax for the Year	0,1128

3.5.3.4.3. Weighting the Indicators of Environmental Sustainability Dimension (E)

All mathematical procedures are calculated step by step just like in the three dimensions of sustainability for the sub-factors of environmental dimension (E). In order to obtain the λmax value that required for the calculation of the consistency ratio, the results obtained from the all priority matrix are divided by the priority vector then the averages of the obtained values are taken. Table 33 demonstrates the results obtained from the division of all priorities matrix into priority vectors.

Table 33: Division of All Priority Matrix into Priority Vectors of Environmental Dimension

All Priority Matrix (A)	Priority Vector (B)	A/B
1,2165	0,1961	6,2023
1,2258	0,1974	6,2091
0,9306	0,1496	6,2190
1,3228	0,2126	6,2217
0,7625	0,1236	6,1692
0,7478	0,1206	6,2017

The final λmax value was obtained by taking the average of the A / B values for the six environmental dimensions of sustainability.

$$\lambda max = \frac{6,2023+6,2091+6,2190+6,2217+6,1692+6,2017}{6} = 6,2041$$

In the calculation of the consistency index (CI), the formula (5) in the methodology section is utilized. Accordingly, Consistency Index (CI);

$$CI = \frac{6,2041-6}{5} = 0,0408$$

The Random Index (RI) value must be selected from Table 19 to be able to calculate the Consistency Ratio (CR). There are six sub-dimensions of environmental sustainability which are; greenhouse gas emissions, sulphur oxides emissions, nitrogen oxides emissions, water consumption, electricity consumption and fuel consumption. So (n) takes 6 as a value. According to Table 19 it appears that the RI value is 1.24.

The consistency ratio will be calculated using the formula (6) described in the methodology. Accordingly;

$$CR = \frac{0,0408}{1,24} = \mathbf{0,0329}$$

Since the consistency ratio is 0.0329 < 0.1, the result is considered within the compliance limits. Since the inconsistency is acceptable, the weights of the criteria values of the priority vector can be interpreted.

The weights of environmental sub-dimensions of sustainability, according to the judges of the experts are given in Table 34 according to the order of importance.

Table 34: Environmental Dimensions Criterion Weighing

Criteria	Weight
Water Consumption	0,2126
Sulphur Oxides Emissions (SOx)	0,1974
Greenhouse Gas Emissions (GHG)	0,1961
Nitrogen Oxides Emissions (NOx)	0,1496
Electricity Consumption	0,1236
Fuel Consumption	0,1206

3.5.3.4.4. Weighting the Indicators of Social Sustainability Dimension (S)

All mathematical procedures are calculated step by step just like in the three dimensions of sustainability for the sub-factors of social dimension (S). In order to

obtain the λmax value that required for the calculation of the consistency ratio, the results obtained from the all priority matrix are divided by the priority vector then the averages of the obtained values are taken. Table 35 demonstrates the results obtained from the division of all priorities matrix into priority vectors.

Table 35: Division of All Priority Matrix into Priority Vectors of Social Dimension

All Priority Matrix (A)	Priority Vector (B)	A/B
0,3305	0,0645	5,1216
0,4003	0,0824	4,8551
0,5485	0,1064	5,1540
2,4400	0,4348	5,6120
1,6982	0,3118	5,4461

The final λmax value was obtained by taking the average of the A / B values for the five social dimensions of sustainability.

$$\lambda max = \frac{5,1216+4,8551+5,1540+5,6120+5,4461}{5} = 5,2377$$

In the calculation of the consistency index (CI), the formula (5) in the methodology section is utilized. Accordingly, Consistency Index (CI);

$$CI = \frac{5,2377-5}{4} = 0,0594$$

The Random Index (RI) value must be selected from Table 19 to be able to calculate the Consistency Ratio (CR). There are five sub-dimensions of social sustainability which are; number of employees, ratio of women employees to total number of employees, ratio of women employed in senior management to total number of employees, fatalities and lost-time injury and sick leave accidents. So (n) takes 5 as a value. According to Table 19 it appears that the RI value is 1.12.

The consistency ratio will be calculated using the formula (6) described in the methodology. Accordingly;

$$CR = \frac{0,0594}{1,12} = \mathbf{0,0530}$$

Since the consistency ratio is 0.0530 < 0.1, the result is considered within the compliance limits. Since the inconsistency is acceptable, the weights of the criteria values of the priority vector can be interpreted.

The weights of social sub-dimensions of sustainability, according to the judges of the experts are given in Table 36 according to the order of importance.

Table 36: Social Dimensions Criterion Weighing

Criteria	Weight
Fatalities	0,4348
Lost-Time Injury and Sick Leave Accidents	0,3118
Ratio of Women Employed in Senior Management to Total Number of Employees	0,1064
Ratio of Women Employees to Total Number of Employees	0,0824
Number of Employees	0,0645

3.5.3.5. Hierarchical Structure of Sustainability Performance Evaluation Criteria

As shown in Figure 7, according to the evaluation form responses the experts responded to the most weighted dimension is the financial dimension. The financial dimension was found to be more significant than other dimensions with 0.4308 weight points according to experts who filled the assessment form. The financial dimension is

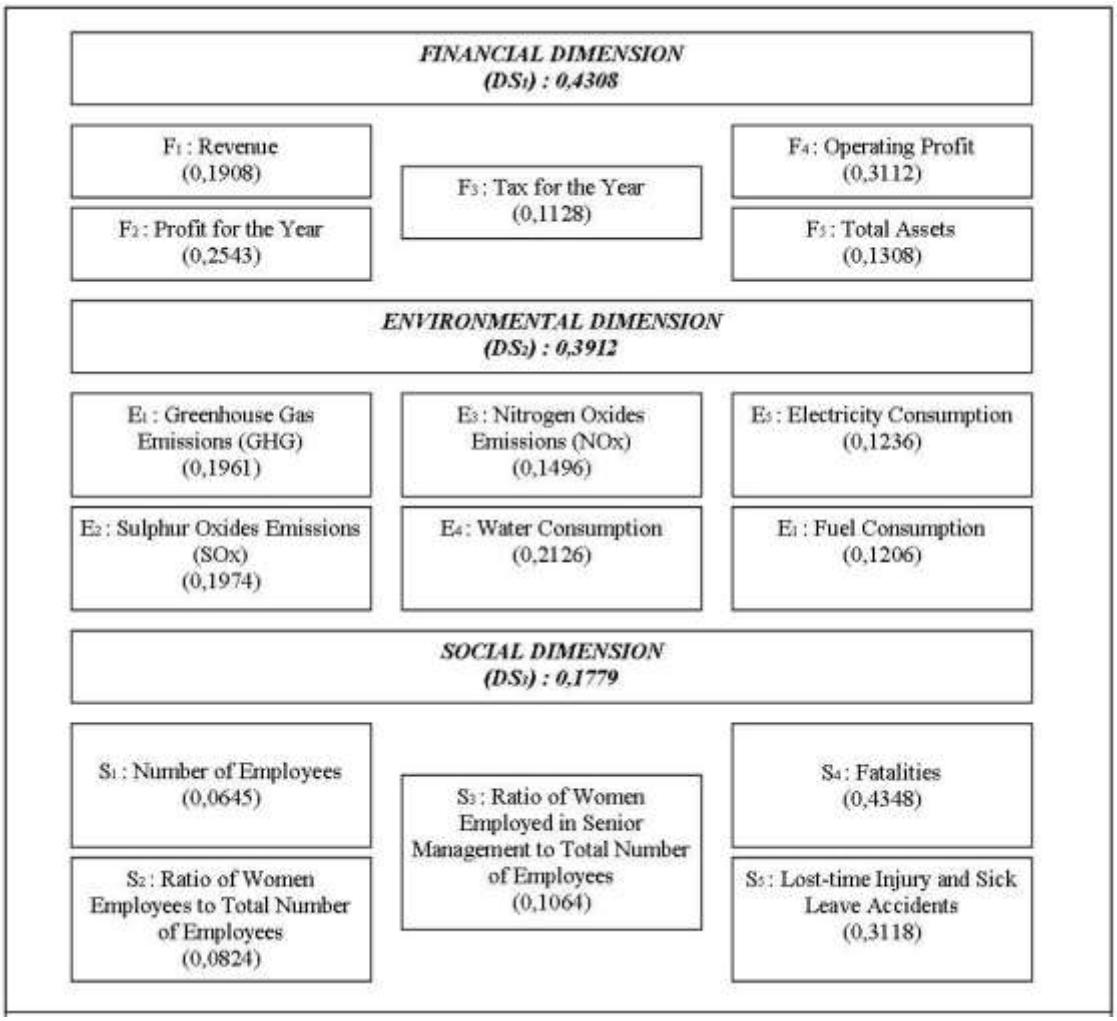
followed by the environmental dimension with a weight of 0.3912. The social dimension is determined to be the least important dimension with a weight of 0.1779.

According to the experts who responded to the evaluation form, the most important sub-factor of the economic dimension, which is the most important dimension, is operating profit (F_4) with 0,3112 weight points. The second one is the profit for the year (F_2) with 0, 2543 weight points. It is followed by revenue (F_1) with 0.1908 weight points, total assets (F_5) with 0.1308 weight points and tax for the year (F_3) with 0.1128 weight points respectively.

The most important factor in sub-factors of environmental dimension which is secondarily important is water consumption (E_4) with 0, 2126 weight points according to the experts who responded to the evaluation form. It is followed by sulphur oxides emissions (SOx) (E_2) with 0,1974 weight points, greenhouse gas emissions (GHG) (E_1) with 0,1961 weight points, nitrogen oxides emissions (NOx) (E_3) with 0,1496 weight points, electricity consumption (E_5) with 0,1236 weight points and fuel consumption (E_6) with 0,1206 weight points respectively.

According to the experts who responded to the evaluation form, the most important sub-factor of the social dimension is fatalities (S_4) with 0, 4348 weight points. It is followed by lost-time injury and sick leave accidents (S_5) with 0,3118 weight points, ratio of women employed in senior management to total number of employees (S_3) with 0,1064 weight points, ratio of women employees to total number of employees (S_2) with 0,0824 weight points and number of employees (S_1) with 0,0645 weight points respectively.

Figure 7: Hierarchical Structure of Sustainability Performance Evaluation Criteria



Source: Created by Author

3.5.3.6. Finding the Ideal Solution with TOPSIS

3.5.3.6.1. Change of Financial Sustainability Dimension of Ports According to Years

Within the scope of the study ports that analyzed used different currencies in their reports those are; Port of Valencia and Ports of Coruna used Euro, APM Terminals used USD Dollar and Port of Gothenburg used SEK as currency. USD Dollar was

accepted as the base currency since the comparison would be made using a single currency; the currency conversion of the other currencies was made using the year-end rates of the other currencies (http://www.x-rates.com).

The data used to make comparisons with the topsis method were taken from the sustainability and annual reports of the ports. However, since the port of Gothenburg did not publish its annual report on a regular basis, the necessary data could not be obtained. For this reason, the port of Gothenburg was not included in the financial dimension of the study; port of Valencia, port of Coruna and APM Terminals were compared at the financial level.

In financial comparisons with the Topsis method, ratios were used to minimize the differences caused by values such as port size or the importance of port location. In other words, it is aimed to minimize the effect of the difference between the income of the port serving 1 ship and the port serving 10 ships annually. To obtain these ratios, the table of Basic Sustainability Metrics Bridges used by Tanzil et al. (2006) was adapted to work. The basic sustainability metrics bridges table given below Figure 8.

Figure 8: Bridges' Basic Sustainability Metrics

Output: *Mass of Product* or *Sales Revenue* or *Value-Added*	**Material Intensity:**	Mass of raw materials – Mass of products / Output
	Water Intensity:	Volume of fresh water used / Output
	Energy Intensity:	Net energy used as primary fuel equivalent / Output
	Toxic Release:	Total mass of recognized toxics released / Output
	Solid Wastes:	Total mass of solid wastes / Output
	Pollutant Effects	

Source: Tanzil et al., 2006: 48.

Tanzil et al. (2006) explains the bridges of basic sustainability metrics as "The metrics were chosen as ratios. Impacts are placed in the numerators and a measure of output is in the denominator. The denominator can be mass or other unit of product, functional unit, sales revenue, monetary value-added, or a certain measure of societal benefits. Expressing the metrics as ratios allows them to be compared and used in weighing decision alternatives and comparing operational units. Defined in this manner, the lower metrics are better as they reflect lower impacts per unit of value generation." On this basis "amount of annual container handled (TEU)" of each port taken as an output. All five sub-dimensions of financial dimension were divided this output for each port and each year. Obtained ratios for each sub-dimension were used in Topsis process. While obtaining financial dimension decision matrix of 2012, the formulas given in the methodology are applied one by one. In the first step, the decision matrix is established. The decision matrix that generated is given in Table 37.

Table 37: Decision Matrix of 2012 Financial Dimension

	F_1	F_2	F_3	F_4	F_5
Port of Coruna	7080,0900	570,3700	74,0400	1574,3700	230488,4700
Port of Valencia	34,1000	6,0300	0,7300	10,6800	467,5500
APM Terminals	118,8100	19,8000	4,6000	20,9200	266,3500

A normalized matrix was obtained according to the formula (7) in the methodology. This obtained matrix is shown in Table 38.

Table 38: Normalized Matrix of 2012 Financial Dimension

	F_1	F_2	F_3	F_4	F_5
Port of Coruna	0,9998	0,9993	0,9980	0,9999	1,0000
Port of Valencia	0,0048	0,0106	0,0098	0,0068	0,0020
APM Terminals	0,0168	0,0347	0,0620	0,0133	0,0012

Once the normalized matrix is obtained, the weighting normalized matrix is obtained by the formula (9) in the methodology. The weighting normalized matrix is shown in Table 39.

Table 39: Weighting Normalized Matrix of 2012 Financial Dimension

Weight	***0,1908***	***0,2543***	***0,1128***	***0,3112***	***0,1308***
	F_1	F_2	F_3	F_4	F_5
Port of Coruna	0,1908	0,2541	0,1126	0,3112	0,1308
Port of Valencia	0,0009	0,0027	0,0011	0,0021	0,0003
APM Terminals	0,0032	0,0088	0,0070	0,0041	0,0002

While the ideal and negative ideal solution values are calculated, it is important to note that since each decision criterion is considered as a return component, the maximum values for each column are taken into account for the ideal solution values while the minimum values for each column are taken into account for the negative ideal solution values.

Accordingly, the formulas (10) and (11) in the methodology are used to obtain ideal and negative ideal solutions. Table 40 contains the ideal solution and the negative ideal solution values.

Table 40: Ideal and Negative Ideal Solution Values

	F_1	F_2	F_3	F_4	F_5
Ideal Solution	0,1908	0,2541	0,1126	0,3112	0,1308
Negative Ideal Solution	0,0009	0,0027	0,0011	0,0021	0,0002

The ideal solution values are A^+ = {0,1908, 0,2541, 0,1126, 0,3112, 0,1308}.

The negative ideal solution values are A^- = {0,0009, 0,0027, 0,0011, 0,0021. 0,0002}.

The formula (13) in methodology is used in the calculation of ideal distances. Accordingly, the calculation of the ideal distances of the 2012 financial dimension is given in Table 41.

Table 41: Calculation of Ideal Distances

	F_1	F_2	F_3	F_4	F_5	**Total**	S_i^*
Port of Coruna	0,000	0,000	0,0000	0,0000	0,0000	0,0000	0,000000
Port of Valencia	0,036	0,063	0,0124	0,0955	0,0170	0,2242	0,473548
APM Terminals	0,035	0,060	0,0111	0,0943	0,0171	0,2178	0,466738

In the calculation of negative ideal distances, formula (14) in methodology is used. Accordingly, the calculation of the negative ideal distances of the 2012 financial dimension is given in Table 42.

Table 42: Calculation of Negative Ideal Distances

	F_1	F_2	F_3	F_4	F_5	**Total**	S_i^-
Port of Coruna	0,0360	0,0632	0,0124	0,0955	0,0171	0,2243	0,473580
Port of Valencia	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,000114
APM Terminals	0,0000	0,0000	0,0000	0,0000	0,0000	0,0001	0,009032

The formula (15) in the methodology is used in the calculation of the ideal solution approximation. The conclusion of 2012 financial dimension is given Table 43.

Table 43: Results Table of 2012 Financial Dimension

	S_i^*	S_i^-	C_i^*
Port of Coruna	0,000000	0,473580	1,000000
Port of Valencia	0,473548	0,000114	0,000241
APM Terminals	0,466738	0,009032	***0,018984***

It is seen that the highest (C_i^*) value is in Port of Coruna when the order values in TOPSIS given in Table 43 are compared. This means that the best sustainable performance in terms of financial dimension in 2012 was achieved by Port of Coruna.

However, when examining the financial data of Port of Coruna it was seen that there was a high amount of cruise revenue besides the container revenue. It seems that Port of Coruna has earned more revenue by handling fewer containers compared to other ports, as "amount of annual container handled (TEU)" is used as the output in ratios used in Topsis. The reliability of the results is open to debate as the port's financial data obtained from cruise ships can not be decomposed. For this reason, it is more accurate to say that APM Terminals' 2012 financial sustainable performance is more successful than Port of Valencia when it is explained in Table 43.

The mathematical processes for the financial dimension of the year 2012 have been repeated throughout the years of the financial dimension, the environmental dimension and the social dimension. Only results tables are given in this part of the study, transactions and other tables for the year of 2013, 2014 and 2015 for financial dimension are given in Appendix 3, tables related to environmental dimension are given in Appendix 4 and tables related to social dimension are given in Appendix 5.

Table 44: Results Table of 2013 Financial Dimension

	S_i^*	S_i^-	C_i^*
Port of Coruna	0,000000	0,472810	1,000000
Port of Valencia	0,472731	0,000284	0,000601
APM Terminals	0,454779	0,025824	***0,053732***

It is seen that the highest (C_i^*) value is in Port of Coruna when the order values in TOPSIS given in Table 44 are compared. This means that the best sustainable performance in terms of financial dimension in 2013 was achieved by Port of Coruna.

However, because of the reasons explained above it is more accurate to say that APM Terminals' 2013 financial sustainable performance is more successful than Port of Valencia.

Table 45: Results Table of 2014 Financial Dimension

	S_i^*	S_i^-	C_i^*
Port of Coruna	0,000000	0,471846	1,000000
Port of Valencia	0,471818	0,000103	0,000219
APM Terminals	0,460411	0,012794	***0,027036***

It is seen that the highest (C_i^*) value is in Port of Coruna when the order values in TOPSIS given in Table 45 are compared. This means that the best sustainable performance in terms of financial dimension in 2014 was achieved by Port of Coruna.

However, because of the reasons explained above it is more accurate to say that APM Terminals' 2014 financial sustainable performance is more successful than Port of Valencia.

Table 46: Results Table of 2015 Financial Dimension

	S_i^*	S_i^-	C_i^*
Port of Coruna	0,000000	0,477157	1,000000
Port of Valencia	0,477155	0,000007	0,000015
APM Terminals	0,476741	0,000522	***0,001095***

It is seen that the highest (C_i^*) value is in Port of Coruna when the order values in TOPSIS given in Table 46 are compared. This means that the best sustainable performance in terms of financial dimension in 2015 was achieved by Port of Coruna.

However, because of the reasons explained above it is more accurate to say that APM Terminals' 2015 financial sustainable performance is more successful than Port of Valencia.

3.5.3.6.2. Change of Environmental Sustainability Dimension of Ports According to Years

The mathematical methods described in the methodology and applied in the financial dimension of 2012 have been made in the same way for the environmental dimension and these tables are given in Appendix 4. In this chapter of the study, interpretation was made by giving place to results tables according to years.

Table 47: Results Table of 2012 Environmental Dimension

	S_i^*	S_i^-	C_i^*
Port of Coruna	0,235613	0,258042	***0,522717***
Port of Valencia	0,267129	0,242847	0,476193
APM Terminals	0,311673	0,132609	0,298479
Port of Gothenburg	0,333163	0,109928	0,248094

It is seen that the highest (C_i^*) value is in Port of Coruna when the order values in TOPSIS given in Table 47 are compared. This means that the best sustainable performance in terms of environmental dimension in 2012 was achieved by Port of Coruna.

Table 48: Results Table of 2013 Environmental Dimension

	S_i^*	S_i^-	C_i^*
Port of Coruna	0,236123	0,268055	***0,531667***
Port of Valencia	0,276799	0,229188	0,452952

APM Terminals	0,322904	0,136189	0,296647
Port of Gothenburg	0,341693	0,110927	0,245078

It is seen that the highest (C_i^*) value is in Port of Coruna when the order values in TOPSIS given in Table 48 are compared. This means that the best sustainable performance in terms of environmental dimension in 2013 was achieved by Port of Coruna.

Table 49: Results Table of 2014 Environmental Dimension

	S_i^*	S_i^-	C_i^*
Port of Coruna	0,287850	0,191168	0,399084
Port of Valencia	0,279173	0,177755	0,389021
APM Terminals	0,277480	0,174661	0,386298
Port of Gothenburg	0,224454	0,255086	***0,531938***

It is seen that the highest (C_i^*) value is in Port of Gothenburg when the order values in TOPSIS given in Table 49 are compared. This means that the best sustainable performance in terms of environmental dimension in 2014 was achieved by Port of Gothenburg.

Table 50: Results Table of 2015 Environmental Dimension

	S_i^*	S_i^-	C_i^*
Port of Coruna	0,302769	0,175782	0,367322
Port of Valencia	0,265119	0,216340	0,449343
APM Terminals	0,300927	0,150340	0,333151
Port of Gothenburg	0,225539	0,230269	***0,505189***

It is seen that the highest (C_i^*) value is in Port of Gothenburg when the order values in TOPSIS given in Table 50 are compared. This means that the best sustainable performance in terms of environmental dimension in 2015 was achieved by Port of Gothenburg.

3.5.3.6.3. Change of Social Sustainability Dimension of Ports According to Years

The mathematical methods described in the methodology and applied in the financial dimension of 2012 have been made in the same way for the social dimension and these tables are given in Appendix 5. In this chapter of the study, interpretation was made by giving place to results tables according to years.

Table 51: Results Table of 2012 Social Dimension

	S_i^*	S_i^-	C_i^*
Port of Coruna	0,478524	0,045533	0,086885
Port of Valencia	0,442278	0,214962	0,327068
APM Terminals	0,220023	0,440151	***0,666720***
Port of Gothenburg	0,482774	0,082262	0,145587

It is seen that the highest (C_i^*) value is in APM Terminals when the order values in TOPSIS given in Table 51 are compared. This means that the best sustainable performance in terms of social dimension in 2012 was achieved by APM Terminals.

Table 52: Results Table of 2013 Social Dimension

	S_i^*	S_i^-	C_i^*
Port of Coruna	0,526506	0,031346	0,056190
Port of Valencia	0,444239	0,279206	0,385939

APM Terminals	0,271863	0,440264	***0,618238***
Port of Gothenburg	0,490210	0,110130	0,183447

It is seen that the highest (C_i^*) value is in APM Terminals when the order values in TOPSIS given in Table 52 are compared. This means that the best sustainable performance in terms of social dimension in 2013 was achieved by APM Terminals.

Table 53: Results Table of 2014 Social Dimension

	S_i^*	S_i^-	C_i^*
Port of Coruna	0,471633	0,060243	0,113266
Port of Valencia	0,443467	0,207504	0,318761
APM Terminals	0,216661	0,440052	***0,670083***
Port of Gothenburg	0,442110	0,180412	0,289809

It is seen that the highest (C_i^*) value is in APM Terminals when the order values in TOPSIS given in Table 53 are compared. This means that the best sustainable performance in terms of social dimension in 2014 was achieved by APM Terminals.

Table 54: Results Table of 2015 Social Dimension

	S_i^*	S_i^-	C_i^*
Port of Coruna	0,474404	0,038183	0,074491
Port of Valencia	0,444358	0,187273	0,296491
APM Terminals	0,201748	0,439766	***0,685513***
Port of Gothenburg	0,442724	0,161594	0,267398

It is seen that the highest (C_i^*) value is in APM Terminals when the order values in TOPSIS given in Table 54 are compared. This means that the best sustainable performance in terms of social dimension in 2015 was achieved by APM Terminals.

CONCLUSION

The mechanization process, started with the industrial revolution, and the global warming, one of the most crucial problems of these days, have increased the importance of sustainability at a dramatic level. Besides, ports are seen as one of the serious polluting industries according to literature. As also mentioned in previous chapters of the study, it means that many opportunities are also left to reduce harmful effects of ports to the nature. Hence, sustainability becomes one of the most important concepts for port industry, and it was thought that more detailed examination and comparison of port performance measurement is necessary.

The sustainability reporting system has become widespread in Turkey recently. Although a number of different sectors have published reports in line with GRI standards, the majority of ports in Turkey do not publish reports in this respect. In the process of this study, it has been determined that only Limak Port has a sustainability report in Turkey. Additionally, in spite of quantitative data, qualitative data were used in these sustainability reports. Thus, the ports operating in Turkey could not include in the scope of the study. To reach the goals of the study, ports that published sustainability and annual reports over the years were examined.

In order to realize the first aim of the study, a detailed literature survey was conducted in the second chapter of the thesis. In this way, port sustainability indicators (PSIs), which were obtained using various methods and proposed by different authors, have been compiled in Table 10. At the end of this process 52 sub-dimensions are gathered, 27 of them are environmental sub-dimensions, 16 of them are financial sub-dimensions and 9 of them are social sub-dimensions. The N-Vivo program was used to measure the usage frequency of these sub-dimensions that proposed by various authors for sustainability measurement. As a result of these analyses, no environmental indicator can be found that commonly used in the sustainability reports of all ports. Also it is observed that, 18 of 32 environmental indicators were not used in any port's sustainability report. Just one financial indicator, which is revenue, found that

commonly used in the sustainability reports of all ports. Additionally, it is observed that, 14 of 17 financial indicators were not used in any port's sustainability report. When analyzed social indicators, as a bright side of the study, indicators like security, safety and training that can be named as vital indicators are found all sustainability reports. Also other 6 social indicators were found in some ports sustainability reports. Unfortunately, these findings made impossible to make comparison between ports sustainability performances with PSIs obtained from the relevant literature. However, according to knowledge of the author, no study used N-Vivo program and frequency analysis so far in port sustainability studies. Even if, it couldn't reach any usable finding with this method, this feature makes this study unique. The results of frequency analysis demonstrate the differences between all port sustainability reports.

The second aim of the study is to suggest new PSIs to set up the ports for future sustainability reports, which is created after the result of the first purposes analyzes. As mentioned in the literature of the study, ports known as one of the most polluting sectors, and therefore they provide an opportunity to reduce emissions significantly. However, to start reducing emissions first, we can measure and compare them indeed. The Port Sustainability Indicators Set that shown in Table 10 is recommended for use in future sustainability reporting process to ports. Suggested indicators are important both in terms of comparing the variables that is directly interested with the sustainability of ports, and comparing them with uniform data from all ports, and simplified seeing the sustainability performance of each port. If the ports sustainability performance becomes more transparent, the ports that more successful at sustainability issues will became a good example for other ports. In this manner in the long term it will increase the sustainability performance of all ports.

The third and final aim of the study was to identify the port with the highest sustainability performance, which can be shown as an example to all other ports. To this end, the sustainability and annual reports of the ports between the years of 2012 and 2015 were reviewed again. Four ports were identified with 5 social and 6 environmental indicators. Also three ports were identified with 5 social, 6 environmental and 5

financial indicators. Evaluation form was established in the direction of the obtained data. This evaluation form was answered by the sector experts. The different results obtained from the evaluation form were transformed into a single result by taking a geometric mean and it was aimed to evaluate with TOPSİS method after weighting by AHP method. For this reason, firstly the indicators are weighted with the AHP method and determined the importance level. As a result of this weighting process, as parallel with the study of Sürücü (2015), which compared the sustainability performance of logistics companies results, the highest weight was given to the financial dimension of sustainability; it's followed by environmental and social dimensions respectively. Additionally, operating profit chosen as the most important PSI in the financial dimension. In 2013 Lirn et al. also used AHP method, to measure a port's green performance, however they selected the indicators according to their green-relatedness. Between their 17 green indicators, avoiding pollutants during cargo handling is chosen as the most important indicator. Unlike Lirn et al, in this study water consumption is determined as the most important environmental sustainability indicator. In 2015 Asgari et al. ranked the sustainability ports according to financial and environmental dimensions for the first time in the literature. Until Asgari's study in 2015 main portion of port sustainability studies only concerned with the environmental dimension of sustainability. Yet this study examined social dimension of port sustainability also. In this first analyze fatalities chosen as the most important PSI in the social dimension according to sector experts. In that study Asgari et al., also suggested AHP-TOPSIS methods for port sustainability studies as a new weighting method. In this direction, this study is also unique as a first port sustainability study that used AHP and TOPSIS methods together in the literature.

After all PSI's weights were obtained by the AHP method, the 4-year sustainability performances of the ports were compared with the TOPSIS method. In financial comparison ratios were used to minimize the differences caused by values such as port size or the importance of port location. In other words, it is aimed to minimize the effect of the difference between the income of the port serving 1 ship and the port

serving 10 ships annually. To obtain these ratios all five sub-dimensions of financial dimension were divided “amount of annual container handled (TEU)” for each port and each year. Unfortunately, when examining the financial data of Port of Coruna it was seen that there was a high amount of cruise revenue besides the container revenue. It seems that Port of Coruna has earned more revenue by handling fewer containers compared to other ports, as "amount of annual container handled (TEU)" is used as the output in ratios used in TOPSIS. The reliability of the results is open to debate as the port's financial data obtained from cruise ships can not be decomposed. At the end of the financial analyses with TOPSIS, the best sustainability performance was achieved by Port of Coruna however it is more accurate to say that APM Terminals' financial sustainability performance is more successful than Port of Valencia. Port of Coruna also found as the best sustainable port in terms of environmental dimension in 2012 and 2013. However, environmental sustainability performance of Port of Gothenburg was better than all other ports in 2014 and 2015. At the end of the TOPSIS results, the best sustainable performance in terms of social dimension was achieved by APM Terminals during 4 years.

In conclusion, according to study results; applications about social sustainability of APM Terminals, applications about environmental sustainability of Port of Gothenburg can be taken as an example to increase the sustainability performance of other ports. Along with that, Port of Coruna should investigate differences between its previous environmental sustainability application and new ones because it has experience a sharp decline for last two years. Additionally, Port of Valencia needs to do some alterations in their sustainability applications in all dimensions of sustainability.

The fact that no Turkish port was included in the study due to the fact that ports operating in Turkey do not publish regular sustainability report have been the first limitation of the study. A further limitation of the study was the fact that the comparison of the port of Coruna with the container ports because of the port was largely driven by cruise operations, which reduced the credibility of the results in financial size comparisons. The third and last limitation of this study is, due to the lack of uniform

sustainability report format, any useful result can not be obtained from the N-vivo program in the second chapter.

Hence; it is recommended to compare the ports that are suitable each other for the cargo types in the following studies. It is also considered that the ports with successful sustainability performances will increase the sustainability performance of other ports if they examined detailed and report their implemented successful innovative systems.

REFERENCES

Abood, K. A. (2007). Sustainable and Green Ports: Application of Sustainability Principles to Port Development and Operation. In *Ports 2007: 30 Years of Sharing Ideas: 1977-2007*, 1-10.

Ahlberg, M. (2014). *The Sustainability Movement: The Institutionalization of Sustainability in Organizations.* (Unpublished Bachelor Thesis). Sweden: University of Gothenburg.

Aksoy, Ç. (2013). *Sürdürülebilirlik Performansının Değerlendirilmesine Yönelik Ölçek Önerisi ve Türkiye'deki İşletmelerde Uygulaması.* (Unpublished Doctoral Dissertation). İstanbul: Marmara University Institute of Social Sciences.

Asgari, N., Hassani, A., Jones, D., and 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.

Awad-Núñez, S., González-Cancelas, N., Soler-Flores, F., and Camarero-Orive, A. (2016). A Methodology for Measuring Sustainability of Dry Ports Location Based on Bayesian Networks and Multi-Criteria Decision Analysis. *Transportation Research Procedia*, *13*, 124-133.

Awad-Núñez, S., Soler-Flores, F., González-Cancelas, N., and Camarero-Orive, A. (2016). How Should the Sustainability of the Location of Dry Ports Be Measured. *Transportation Research Procedia*, *14*, 936-944.

Azapagic, A. (2003). Systems Approach to Corporate Sustainability: A General Management Framework. *Process Safety and Environmental Protection*, 81(5), 303-316.

Baines, J. and Morgan, B. (2004). Sustainability Appraisal: A Social Perspective. Sustainability Appraisal: A Review of International Experience and Practice (ss.95-112). London: Dalal-Clayton and Sadler, International Institute for Environment and Development.

Bansal, P. (2005). Evolving Sustainability: A Longitudinal Study of Corporate Sustainable Development. *Strategic Management Journal*, 26(3): 197–218.

Barr, C. S., Newman, T. K., Becker, M. L., Parker, C. C., Champoux, M., Lesch, K. P. and Higley, J. D. (2003). The Utility of the Non-Human Primate Model for Studying Gene by Environment Interactions in Behavioral Research. *Genes, Brain and Behavior*, *2*(6), 336-340.

Başarır, E.P. (2008). *Türkiye'nin Avrupa Birliği'ne Uyum Sürecinde Çevre Odaklı Kırsal Kalkınma Politikaları.* (Published European Union Development Thesis). Ankara: T.C. Ministry of Agriculture and Welfare.

Bergmans, A., Vandermoere, F., and Loots, I. (2014). Co-Producing Sustainability Indicators for the Port of Antwerp: How Sustainability Reporting Creates New Discursive Spaces for Concern and Mobilization. *ESSACHESS-Journal for Communication Studies*, 7(1), 107-123.

Beškovnik, B., and Bajec, P. (2015). Application of Environmental and Social Sustainable Measures by Port of Koper: The Basis for the Regional Approach. *Problemy Ekorozwoju – Problems of Sustainable Development*, 10(1), 99-106.

Bichou, K. (2007) Review of Port Performance Approaches and a Supply Chain Framework to Port Performance Benchmarking. In: Cullinane, K., Ed., *Devolution, Port*

Governance and Port Performance, Research in Transportation Economics, Elsevier, 17, 567-598.

Black, A. (2004). The Quest for Sustainable, Healthy Communities, *Presented to Effective Sustainability Education Conference,* NSW Council on Environmental Education, UNSW, Sydney, 18–20 February, 2004.

Borriello, F. (2013). The Sustainability of Mediterranean Port Areas: Environmental Management for Local Regeneration in Valencia. *Sustainability*, *5*(10), 4288-4311.

Boulos, J. (2016). Sustainable Development of Coastal Cities-Proposal of a Modelling Framework to Achieve Sustainable City-Port Connectivity. *Procedia-Social and Behavioral Sciences*, (216), 974-985.

Bozlağan, R. (2005). Sürdürülebilir Gelişme Düşüncesinin Tarihsel Arka Planı. *Sosyal Siyaset Konferansları Dergisi*, (50), 1011-1028.

Bramley, G., Dempsey, N., Power, S., and Brown, C. (2006). What is 'Social Sustainability', and How Do Our Existing Urban Forms Perform in Nurturing It. *In Sustainable Communities and Green Futures' Conference,* Bartlett School of Planning, London University College, London. April 2006.

Broesterhuizen, E. F. M., Vellinga, T., Docters van Leeuwen, L., Zwakhals, J. W., Taneja, P., and Nijdam, M. (2012). Sustainability as a Procurement Criterion for Port Investments. *CESUN2012, Delft*.

Brundtland, G. H. (1987). *Report of the World Commission on Environment and Development: "Our Common Future."*. United Nations.

Carter, C. R., and Rogers, D. S. (2008). A Framework of Sustainable Supply Chain Management: Moving Toward New Theory. *International Journal of Physical Distribution & Logistics Management*, *38*(5), 360–387.

Center for Sustainable Enterprise. (2010). http://www.kenan-flagler.unc.edu/cse/cse-overview.cfm. 14.03.2017.

Colantonio, A. (2007). Social sustainability: An Exploratory Analysis of its Definition, Assessment Methods Metrics and Tools. *Oxford Brooks University, Oxford Institute for Sustainable Development (OISD)* - International Land Markets Group. 1-37.

Colantonio, A. (2011). Social Sustainability: Exploring the Linkages Between Research, Policy and Practice. *In European Research on Sustainable Development.* Springer Berlin Heidelberg, 35-57.

Cook, D., Saviolidis, N. M., Davíðsdóttir, B., Jóhannsdóttir, L., and Ólafsson, S. (2017). Measuring Countries' Environmental Sustainability Performance: The Development of a Nation-Specific Indicator Set. *Ecological Indicators*, 74, 463-478.

Csikszentmihalyi, M. (2000). The Costs and Benefits of Consuming. *Journal of Consumer Research,* 27(2): 267-272.

Çaglar, V. (2016). Sustainable Container Terminal Operations: Challenges and Enhancements. *Karadeniz Araştırmaları*, (49), 141.

Çamur, D., and Vaizoğlu, S. A. (2007). Çevreye Ilişkin Önemli Toplantı ve Belgeler. *TSK Koruyucu Hekimlik Bülteni*, 6(4), 297-306.

Çınar, Y. (2004). *Çok Nitelikli Karar Verme ve Bankaların Mali Performanslarının Değerlendirilmesi Örneği.* Published Master Thesis. Ankara: Ankara University, Institude of Social Sciences.

Daamen, T. (2007). Sustainable Development of the European Port-City Interface. In *ENHR-conference*, 25-28.

Denktas-Sakar, G., and Karatas-Cetin, C. (2012). Port Sustainability and Stakeholder Management in Supply Chains: A Framework on Resource Dependence Theory. *The Asian Journal of Shipping and Logistics*, *28*(3), 301-319.

De Martino , M. (2014). Sustainable Development Strategies of the Port Authority: the Network Approach. *In Advanced Engineering Forum Trans Tech Publications*,(11), 87-95.

Dias, J. G. (2017). Environmental Sustainability Measurement in the Travel & Tourism Competitiveness Index: An Empirical Analysis of its Reliability. *Ecological Indicators*, 73, 589-596.

Diaz, B. L., Voces, G. R., and Romero, C. (2011). Making Sustainability Rankings Using Compromise Programming. An Application to European Paper Industry. *Silva Fennica*, *45*(4), 761-773.

Dooms, M., and Macharis, C. (2003). *A Framework for Sustainable Port Planning in Inland Ports: A Multi-Stakeholder Approach.* 43rd Congress of the European Regional Science Association: "Peripheries, Centres, and Spatial Development in the New Europe", 27th - 30th August 2003, Jyväskylä, Finland.

Dyllick, T., and Hockerts, K. (2002). Beyond the Business Case for Corporate Sustainability. *Business Strategy and the Environment*, *11*(2), 130–141.

Ee, J. Y. C. (2014). *Green and Sustainable Port Project Planning: Paradigm Shift For An Integrated Container Handling System Expansion.* International Conference on Science, Engineering and Built Environment, Bali.

Elkington, J. (1997). Cannibals with Forks: The Triple Bottom Line of 21st Century Business. *Capstone*, Oxford.

Elzarka, S., and Elgazzar, S. (2014). Green Port Performance Index for Sustainable Ports in Egypt: a Fuzzy AHP Approach. In *International Forum on Shipping, Ports and Airports (IFSPA) 2014: Sustainable Development in Shipping and Transport Logistics*.

Erdem, D., Yanmaz, M., Ertem, M. E., and Karakaya, G. B. (2015). *Sürdürülebilir Kalkınma ve Demir Çelik Sektörü*. Zonguldak: Ereğli Demir ve Çelik Fabrikaları T.A.Ş.

Eş, A. (2008). *Sürdürülebilirlik ve Firma Düzeyinde Sürdürülebilirlik Performans Ölçümü.* (Unpublished Master's Thesis). Bolu: Abant İzzet Baysal University Institute of Social Sciences.

Fedai, A., and Madran, C. (2015). *Sürdürülebilir Liman Yönetimi ve Antalya'da İki Yat Limaninda Vaka İncelemesi.* II. Ulusal Liman Kongresi, İzmir.

Forum for the Future. (1996). https://www.forumforthefuture.org. 14.03.2017.

Gilman, S. (2003). Sustainability and National Policy in UK Port Development. *Maritime Policy & Management*, 30(4), 275-291.

Girard, L. F. (2010). Sustainability, Creativity, Resilience: Toward New Development Strategies of Port Areas through Evaluation Processes. *International Journal of Sustainable Development*, *13*(1-2), 161-184.

Goodland, R. (1995). The Concept of Environmental Sustainability. *Annual Review of Ecological Systems.* 26 (1), 1–24.

Guo, Z. J., Zhang, Q., Wang, W. Y., and Wang, C. (2015). Using Ecological Footprint Model for Port Ecosystem Sustainability Assessment. In *Proceedings of the Eastern Asia Society for Transportation Studies* (Vol. 10).

Hakam, M. H. and Solvang, W. D. (2009). On Flexibility and Sustainability in Container Ports. *In Service Operations, Logistics and Informatics, 2009. SOLI'09. IEEE/INFORMS International Conference on* (pp. 417-422). IEEE. July 2009.

Hakam, M. H. and Solvang, W. D. (2013). Container Ports Sustainability: A Literature Review. *In Cognitive Infocommunications (CogInfoCom), 2013 IEEE 4th International Conference on* (pp. 803-810). IEEE. December 2013.

Hakam, M. H. (2015). Nordic Container Port Sustainability Performance: A Conceptual Intelligent Framework. *Journal of Service Science and Management*, 8(01), 14-23.

Harris, J. M. (2000). Basic Principles of Sustainable Development. *Global Development and Environment Institute Working Paper*: 00-04, Tufts University, USA.

Heinberg, R. and Lerch, D. (2010). *The Post Carbon Reader: Managing the 21st Century's Sustainability Crises*. Watershed Media.

Hockerts, K. (1999). The Sustainability Radar. *Greener Management International*. (25): 29-49.

Hou, L., and Geerlings, H. (2016). Dynamics in Sustainable Port and Hinterland Operations: A Conceptual Framework and Simulation of Sustainability Measures and Their Effectiveness, Based on an Application to the Port of Shanghai. *Journal of Cleaner Production*, *135*, 449-456.

Hosseini, S. A., Amozad, H., and Mafi, M. K. (2014). Planning of Sustainable Development Based on Civil Rights in Torkaman Port. *European Online Journal of Natural and Social Sciences*, 3(3), 810.

Hoyle, B. (1999). Scale and Sustainability: The Role of Community Groups in Canadian Port-City Waterfront Change. *Journal of Transport Geography*, *7*(1), 65-78.

Kılıç, S. (2012). Sürdürülebilir Kalkınma Anlayışının Ekonomik Boyutuna Ekolojik Bir Yaklaşım. *İstanbul Üniversitesi Siyasal Bilgiler Fakültesi Dergisi*, (47).

Kim, S., and Chiang, B. (2014). Sustainability Practices to Achieve Sustainability in International Port Operations. *Journal of Korea Port Economic Association*, *30*(03), 15-37.

Kolak, O. İ. (2015). *Design and Assessment of Transportation Systems with the Sustainability Perspective.* (Unpublished Doctoral Dissertation). İstanbul: Galatasaray University Institute of Sciences and Engineering.

Kotowska, I. (2016). Policies Applied by Seaport Authorities to Create Sustainable Development in Port Cities. *Transportation Research Procedia*, *16*, 236-243.

Krajnc, D. and Glavič, P. (2005a). How to Compare Companies on Relevant Dimensions of Sustainability. *Ecological Economics*, *55*(4), 551-563.

Krajnc, D. and Glavič, P. (2005b). A Model for Integrated Assessment of Sustainable Development. *Resources, Conservation and Recycling*, *43*(2), 189-208.

Kuhlman, T., and Farrington, J. (2010). What is sustainability? *Sustainability*, *2*(11), 3436-3448.

Kuş, H. D. (2012). *Sustainable Supply Chain Management Application to Turkish Construction Industry.* (Unpublished Master's Thesis). İstanbul: Fatih University Institute of Sciences and Engineering.

Kuşat, N. (2012). Sürdürülebilir Işletmeler için Kurumsal Sürdürülebilirlik ve Içsel Unsurları. *Afyon Kocatepe Üniversitesi İİBF Dergisi*, *14*(2), 227-242.

Kutkaitis, A., Šimanskienė, L., and Burgis, D. (2014). Assessment of Sustainability of Logistics Activity of Port of Klaipeda. *Scientific papers of the University of Pardubice. Series D, Faculty of Economics and Administration.* 30 (1/2014).

Lam, J. S. L., and Van de Voorde, E. (2012). Green Port Strategy for Sustainable Growth and Development. In *Transport Logistics for Sustainable Growth at a New Level, International Forum on Shipping, Ports and Airports (IFSPA)*, 27-30.

Laxe, F. G., Bermúdez, F. M., Palmero, F. M., and Novo-Corti, I. (2016). Sustainability and the Spanish Port System. Analysis of the Relationship between Economic and Environmental Indicators. *Marine Pollution Bulletin*, *113*(1), 232-239.

Laxe, F. G., Bermúdez, F. M., Palmero, F. M., and Novo-Corti, I. (2017). Assessment of Port Sustainability through Synthetic Indexes. Application to the Spanish Case. *Marine Pollution Bulletin*.

Lirn, T. C., Jim Wu, Y. C., and Chen, Y. J. (2013). Green Performance Criteria for Sustainable Ports in Asia. *International Journal of Physical Distribution & Logistics Management*, *43*(5/6), 427-451.

Litman, T. (2011). Well Measured: Developing Indicators for Sustainable and Livable Transport Planning. *Victoria Transport Policy Institute.*

Linnenluecke, M. K. and Griffiths, A. (2013). Firms and Sustainability: Mapping the Intellectual Origins and Structure of the Corporate Sustainability Field. *Global Environmental Change*, *23*(1), 382-391.

Lu, C. S., Shang, K. C., and Lin, C. C. (2016). Examining Sustainability Performance at Ports: Port Managers' Perspectives on Developing Sustainable Supply Chains. *Maritime Policy & Management*, *43*(8), 909-927.

Marrewijk, V. M. (2003). Concepts and Definitions of CSR and Corporate Sustainability: Between Agency and Communion. *Journal of Business Ethics*, *44*(2), 95-105.

Mebratu, D. (1998). Sustainability and Sustainable Development: Historical and Conceptual Review. *Environmental Impact Assessment Review*, *18*(6), 493-520.

Megahed, N. (2014). Heritage-Based Sustainability in Port Said: Classification of Styles and Future Development. *International Journal of Architectural Research: ArchNet-IJAR*, *8*(1), 94-107.

Milman, A. and Short, A. (2008). Incorporating Resilience into Sustainability Indicators: An Example for the Urban Water Sector. *Global Environmental Change*, *18*(4), 758-767.

Moldan, B., Janoušková, S. and Hák, T. (2012). How to Understand and Measure Environmental Sustainability: Indicators and Targets. *Ecological Indicators*, *17*, 4-13.

Nas, S. and Cerit, A. G. (2006). *Gemi Operasyonlarinin Yönetiminde Kaptanin Bireysel Karar Verme Süreci Analizi ve Bütünleşik Bir Model Uygulamasi.* (Unpublished Doctoral Dissertation). İzmir: Dokuz Eylul University Institute of Social Sciences.

Nazlı, M. (2016). Does Sustainability Matter? A Qualitative Study in Tourism Industry in Turkey. *Journal of Yaşar University*, *11*(44), 339-350.

Nemli, E. (2004) "Sürdürülebilir Kalkınma: Şirketlerin Çevresel ve Sosyal Yaklaşımları" Filiz Kitabevi.

Ness, B., Urbel-Piirsalu, E., Anderberg, S. and Olsson, L. (2007). Categorising Tools for Sustainability Assessment. *Ecological Economics*, *60*(3), 498-508.

Olafsson, S., Cook, D., Davidsdottir, B. and Johannsdottir, L. (2014). Measuring Countries′ Environmental Sustainability Performance: A Review and Case Study of Iceland. *Renewable and Sustainable Energy Reviews*, *39*, 934-948.

Omann, I. and Spangenberg, J. H. (2002). Assessing Social Sustainability. *In Biennial Conference of the International Society for Ecological Economics* (Vol. 7). March 2002.

Onay, A. (2015). Sürdürülebilir Kalkınma, Kurumsal Sürdürülebilirlik ve Sürdürülebilirlik Raporlaması. *EJOIR December 2015*, (3): 104-118.

Özmehmet, E. (2008). Dünyada ve Türkiye Sürdürülebilir Kalkınma Yaklaşımları. *Journal of Yaşar University,* 3(12), 1853-1876.

Öztel, A., Köse, M. S. and Aytekin, İ. (2012). Kurumsal Sürdürülebilirlik Performansının Ölçümü için Çok Kriterli Bir Çerçeve: Henkel Örneği. *Journal of History Culture and Art Research*, *1*(4), 32-44.

Pagell, M., and Wu, Z. (2009). Building a More Complete Theory of Sustainable Supply Chain Management Using Case Studies of 10 Exemplars. *Journal of Supply Chain Management, 45*(2), 37–56.

Pantelic, D., M. Sakal and A. Zehetner. (2016). Marketing and Sustainability from the Perspective of Future Decision Makers. *South African Journal of Business Management*, 47(1): 37-47.

Pavlic, B., Cepak, F., Sucic, B., Peckaj, M., and Kandus, B. (2014). Sustainable Port Infrastructure, Practical Implementation of the Green Port Concept. *Thermal Science*, *18*(3), 935-948.

Parris, T. M. and Kates, R. W. (2003). Characterizing and Measuring Sustainable Development. *Annual Review of Environment and Resources*, *28*(1), 559-586.

Paulraj, A. (2011). Understanding the Relationships between Internal Resources and Capabilities, Sustainable Supply Management and Organizational Sustainability. *Journal of Supply Chain Management*, 47(1), 19-37.

Peris-Mora, E., Orejas, J. D., Subirats, A., Ibáñez, S., and Alvarez, P. (2005). Development of a System of Indicators for Sustainable Port Management. *Marine Pollution Bulletin*, *50*(12), 1649-1660.

Pfeffer, J. (2010). Building Sustainable Organizations: The Human Factor. *The Academy of Management Perspectives (formerly The Academy of Management Executive)(AMP)*, *24*(1): 34–45.

Polèse, M. and Stren, R. E. (2000). *The Social Sustainability of Cities: Diversity and the Management of Change*. University of Toronto Press.

Porter, M. E., and Kramer, M. R. (2006). Strategy and Society: The Link Between Competitive Advantage and Corporate Social Responsibility. *Harvard Business Review*, 84(12), 78-92.

Puig, M., Wooldridge, C., and Darbra, R. M. (2014). Identification and Selection of Environmental Performance Indicators for Sustainable Port Development. *Marine pollution bulletin*, *81*(1), 124-130.

Roh, S., Thai, V. V., and Wong, Y. D. (2016). Towards Sustainable ASEAN Port Development: Challenges and Opportunities for Vietnamese Ports. *The Asian Journal of Shipping and Logistics*, *32*(2), 107-118.

Salzmann, O., Ionescu-Somers, A. and Steger, U. (2005). The Business Case for Corporate Sustainability: Literature Review and Research Options. *European Management Journal*, *23*(1): 27-36.

Santos, S., Rodrigues, L. L. and Branco, M. C. (2016). Online Sustainability Communication Practices of European Seaports. *Journal of Cleaner Production*, *112*: 2935-2942.

Sarı, A. D. (2014). A Measure of Sustainability with Sustainable Value Added Model. *Uluslararası Akademik Yönetim Bilimleri Dergisi*, 1(1): 38-49.

Schaltegger, S., Burritt, R. and Petersen, H. (2003). An Introduction to Corporate Environmental Management: Striving for Sustainability. *Management of Environmental Quality: An International Journal*, 14(4): 541 – 542.

Serageldin, I. and Streeter, A. (1993). Valuing the Environment: Proceedings of the First Annual Conference on Environmentally Sustainable Development. In *Environmentally Sustainable Development Proceedings Series* (No. 2).

Shiau, T. A., and Chuang, C. C. (2015). Social Construction of Port Sustainability Indicators: A Case Study of Keelung Port. *Maritime Policy & Management*, *42*(1), 26-42.

Singh, R. K., Murty, H. R., Gupta, S. K. and Dikshit, A. K. (2009). An Overview of Sustainability Assessment Methodologies. *Ecological indicators*, *9*(2): 189-212.

Sislian, L., Jaegler, A. and Cariou, P. (2016). A Literature Review on Port Sustainability and Ocean's Carrier Network Problem. *Research in Transportation Business & Management*, *19*, 19-26.

Soler, C. C., Orejas, J. M. D., Fillol, A. G., and Feliu, V. R. (2009). Sustainability Reports as a Key Tool for Communication Improvement in the Spanish Port System. *Revue Sciences de Gestion*, (70).

Sürücü, E. (2015). *Lojistik Sektöründe Sürdürülebilir Performans Ölçümü İçin AHP ve TOPSİS Yöntemlerinin Kullanılması: Lojistik Firmaları Üzerine Bir Uygulama.* (Unpublished Master's Thesis). Manisa: Celal Bayar University Institute of Social Sciences.

Taih-cherng L., Yen-Chun J. and Yenming J. C., (2013). Green performance criteria for sustainable ports in Asia, *International Journal of Physical Distribution and Logistics Management*, 43(5), 427-451.

Tanzil, D. and Beloff, B. R. (2006). Assessing Impacts: Overview on Sustainability Indicators and Metrics. *Environmental Quality Management*, *15*(4), 41-56.

Taşçıoğlu, M. (2014). *Consumers' Perceptions towards Sustainability: A Cross-Cultural Analysis.* (Unpublished Doctoral Dissertation). Statesboro, Georgia: Georgia Southern University.

T.C. Dışişleri Bakanlığı. (2017a). "Uluslararası Çevre Konuları" http://www.mfa.gov.tr/uluslararasi-cevre-konulari.tr.mfa, 24.02.2017.

T.C. Dışişleri Bakanlığı. (2017b). "Birleşmiş Milerler İnsan Yerleşimleri Programı" http://www.mfa.gov.tr/birlesmis-milletler-insan-yerlesimleri-programi.tr.mfa, 24.02.2017.

Tenekecioğlu B., Tokol T., Çalık N., Karalar R., Timur N. and Öztürk S. (2005). *Pazarlama Yönetimi*. Eskişehir: Anadolu Üniversitesi.

Turcu, C. (2013). Re-thinking Sustainability Indicators: Local Perspectives of Urban Sustainability. *Journal of Environmental Planning and Management*, 56(5), 695-719.

Turner, R. K., Lorenzoni, I., Beaumont, N., Bateman, I. J., Langford, I. H., and McDonald, A. L. (1998). Coastal Management for Sustainable Development: Analysing Environmental and Socio-Economic Changes on the UK Coast. *Geographical Journal*, 269-281.

Ugbaja, S.C. (2016). *Sustainability Practices in the Top Universities of the UI Greenmetric Sustainable Ranking Index.* (Unpublished Master's Thesis). İstanbul: Okan University Institute of Social Sciences.

Yadava, R. N. and Sinha, B. (2016). Scoring Sustainability Reports Using GRI 2011 Guidelines for Assessing Environmental, Economic, and Social Dimensions of Leading Public and Private Indian Companies. *Journal of Business Ethics*, *138*(3), 549-558.

Yanık, S. and Türker, İ. (2012). Sürdürülebilirlik ve Sosyal Sorumluluk Raporlamasındaki Gelişmeler (Tümleşik Raporlama). *İstanbul Üniversitesi Siyasal Bilgiler Fakültesi Dergisi*, (47): 291-309.

Yap, W. Y., and Lam, J. S. L. (2013). 80 Million-Twenty-Foot-Equivalent-Unit Container Port? Sustainability issues in port and coastal development. *Ocean & coastal management*, (71), 13-25.

Yavuz, V. A. (2010). Sürdürülebilirlik Kavramı ve İşletmeler Açısından Sürdürülebilir Üretim Stratejileri. *Mustafa Kemal Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, 7(14): 63-86.

Vujicic, A. M., Zrnić, N., and Jerman, B. (2013). Ports Sustainability: A Life Cycle Assessment of Zero Emission Cargo Handling Equipment. *Strojniški vestnik-Journal of Mechanical Engineering*, 59(9), 547-555.

Wahab, R., Zayed, T., Goh, T., and Wang, C. M. (2011). Sustainability and Maintainability of Port Infrastructure Using BIM/4D CAD Simulation Model. *Proceedings of MTEC 2011, 13*, 15.

Walker, H., Di Sisto, L. and McBain, D. (2008). Drivers and Barriers to Environmental Supply Chain Management Practices: Lessons From the Public and Private Sectors. *Journal of Purchasing and Supply Management*, *14*(1), 69-85.

Wang, H., Huo, D., and Ortiz, J. (2015). Assessing Energy Efficiency of Port Operations in China—A Case Study on Sustainable Development of Green Ports. *Open Journal of Social Sciences*, *3*(05), 28.

Wang, L., Notteboom, T., Lau, Y. Y., and Ng, A. K. (2017). Functional Differentiation and Sustainability: A New Stage of Development in the Chinese Container Port System. *Sustainability*, *9*(3), 328.

Wang, X. (2017). A Conceptual Model for Oil Port Sustainability Policy Research–A case of Chinese ports. *Plymouth University Marine Institude.*

Warde, P. (2011). The Invention of Sustainability: Modern Intellectual History. *Cambridge University Press*, 8(1): 153–170.

WCED, U. (1987). Our Common Future. *World Commission on Environment and Development Oxford University Press*.

WCS. (1980). World Conservation Strategy: 1980. http://www.culturalecology.info/cons_hist/WorldConservationStrategy.1980, 14.03.2017.

Xiao, Z., and Lam, J. S. L. (2017). A Systems Framework for the Sustainable Development of a Port City: A Case Study of Singapore's Policies. *Research in Transportation Business & Management*, *22*, 255-262.

Zionts, S. (1979). MCDM-If Not A Roman Numeral Then What? *Interfaces.* 9(4), 94-101.

APPENDICES

Appendix 1: Evaluation Form

Dear Participant,

This study is designed by Nergis ÖZISPA, a master program student and a research assistant at Dokuz Eylul University, Department of Maritime Business Administration, to measure the sustainability performance of ports with the consultancy of Asst. Prof. Dr. Gamze ARABELEN. In this direction, first of all, it is requested to compare the sustainability dimensions which are economic, environmental and social. Subsequently, it is required to compare the sub-factors of each (economic, environmental and social) dimension in a binary way. In terms of the reliability of the study, all questions must be answered. Study is carried out for only academic purposes. Thank you for your time and valuable contributions to study.

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General information and examples about the scoring scale to be used when making the assessment;

VALUE	DEFINITION
1	**Equally Important**
3	**Important in Middle Grade (Less Superior)**
5	**Important in Strong Grade (Superior State)**
7	**Important in Very High Grade (Very Superior State)**
9	**Important in Absolute Grade (Absolute Superiority)**

Example 1:

If you think that the X and Y criteria are equally important in the two criteria, you have to mark the number 1 in the middle.

Criterion X	9	7	5	3	1	3	5	7	9	Criterion Y

Example 2:

If you think that the criterion on the left side (Criteria X) is very important in comparison with the criterion on the right side (Criteria Y), you have to mark the number 7 on the left side.

Criterion X	9	7	5	3	1	3	5	7	9	Criterion Y

Criterion X	9	7	5	3	1	3	5	7	9	Criterion Y

Binary Comparison of Sustainability Dimensions:

Economic	9	7	5	3	1	3	5	7	9	Environmental
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Economic	9	7	5	3	1	3	5	7	9	Social
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Environmental	9	7	5	3	1	3	5	7	9	Social
	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Binary Comparison of the Sub-Factors of Economic Dimension:

Revenue	9	7	5	3	1	3	5	7	9	Profit for the year
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Revenue	9	7	5	3	1	3	5	7	9	Tax for the year
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Revenue	9	7	5	3	1	3	5	7	9	Operating Profit
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Revenue	9	7	5	3	1	3	5	7	9	Total Assets
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Profit for the year	9	7	5	3	1	3	5	7	9	Tax for the year
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Profit for the year	9	7	5	3	1	3	5	7	9	Operating Profit
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Profit for the year	9	7	5	3	1	3	5	7	9	Total Assets
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Tax for the year	9	7	5	3	1	3	5	7	9	Operating Profit
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Tax for the year	9	7	5	3	1	3	5	7	9	Total Assets
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Operating Profit	9	7	5	3	1	3	5	7	9	Total Assets
	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Binary Comparison of the Sub-Factors of Environmental Dimension:

Greenhouse Gas Emissions (GHG)	9	7	5	3	1	3	5	7	9	Sulphur Oxides Emissions (SOx)
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Greenhouse Gas Emissions (GHG)	9	7	5	3	1	3	5	7	9	Nitrogen Oxides Emissions (NOx)
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Greenhouse Gas Emissions (GHG)	9	7	5	3	1	3	5	7	9	Water Consumption
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Greenhouse Gas Emissions (GHG)	9	7	5	3	1	3	5	7	9	Electricity Consumption
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Greenhouse Gas Emissions (GHG)	9	7	5	3	1	3	5	7	9	Fuel Consumption
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Sulphur Oxides Emissions (SOx)	9	7	5	3	1	3	5	7	9	Nitrogen Oxides Emissions (NOx)
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Sulphur Oxides Emissions (SOx)	9	7	5	3	1	3	5	7	9	Water Consumption
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Sulphur Oxides Emissions (SOx)	9	7	5	3	1	3	5	7	9	Electricity Consumption
	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Sulphur Oxides Emissions (SOx)	9	7	5	3	1	3	5	7	9	Fuel Consumption
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Nitrogen Oxides Emissions (NOx)	9	7	5	3	1	3	5	7	9	Water Consumption
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Nitrogen Oxides Emissions (NOx)	9	7	5	3	1	3	5	7	9	Electricity Consumption
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Nitrogen Oxides Emissions (NOx)	9	7	5	3	1	3	5	7	9	Fuel Consumption
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Water Consumption	9	7	5	3	1	3	5	7	9	Electricity Consumption
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Water Consumption	9	7	5	3	1	3	5	7	9	Fuel Consumption
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Electricity Consumption	9	7	5	3	1	3	5	7	9	Fuel Consumption
	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Binary Comparison of the Sub-Factors of Social Dimension:

Number of Employees	9	7	5	3	1	3	5	7	9	Ratio of Women Employees to Total Number of Employees
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Number of Employees	9	7	5	3	1	3	5	7	9	Ratio of Women Employed in Senior Management to Total Number of Employees
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Number of Employees	9	7	5	3	1	3	5	7	9	Fatalities
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Number of Employees	9	7	5	3	1	3	5	7	9	Lost-time Injury and Sick Leave Accidents
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Ratio of Women Employees to Total Number of Employees	9	7	5	3	1	3	5	7	9	Ratio of Women Employed in Senior Management to Total Number of Employees
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Ratio of Women Employees to Total Number of Employees	9	7	5	3	1	3	5	7	9	Fatalities
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Ratio of Women Employees to Total Number of Employees	9	7	5	3	1	3	5	7	9	Lost-time Injury and Sick Leave Accidents
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Ratio of Women Employed in Senior Management to Total Number of Employees	9	7	5	3	1	3	5	7	9	Fatalities
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Ratio of Women Employed in Senior Management to Total Number of Employees	9	7	5	3	1	3	5	7	9	Lost-time Injury and Sick Leave Accidents
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Fatalities	9	7	5	3	1	3	5	7	9	Lost-time Injury and Sick Leave Accidents
	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Appendix 2: AHP Weighting of Financial, Environmental and Social Dimensions of Sustainability

Table 1: Binary Comparison of Financial Dimension Sub-factors

	F_1	F_2	F_3	F_4	F_5
F_1	1,0000	0,6792	1,8263	0,3557	2,6145
F_2	1,4723	1,0000	2,1823	0,7551	2,5336
F_3	0,5476	0,4582	1,0000	0,5905	0,4899
F_4	2,8114	1,3243	1,6935	1,0000	2,2085
F_5	0,3825	0,3947	2,0412	0,4528	1,0000

$$A = \begin{bmatrix} 1 & 0,6792 & 1,8263 & 0,3557 & 2,6145 \\ 1,4723 & 1 & 2,1823 & 0,7551 & 2,5336 \\ 0,5476 & 0,4582 & 1 & 0,5905 & 0,4899 \\ 2,8114 & 1,3243 & 1,6935 & 1 & 2,2085 \\ 0,3825 & 0,3947 & 2,0412 & 0,4528 & 1 \end{bmatrix}$$

Table 2: Normalized Matrix and Priority Vector of Financial Dimension Sub-factors

	F_1	F_2	F_3	F_4	F_5	**Priority Vector (mean)**
F_1	0,1609	0,1761	0,2089	0,1128	0,2955	**0,1908**
F_2	0,2369	0,2593	0,2496	0,2394	0,2864	**0,2543**
F_3	0,0881	0,1188	0,1144	0,1872	0,0554	**0,1128**
F_4	0,4524	0,3434	0,1937	0,3170	0,2496	**0,3112**
F_5	0,0616	0,1023	0,2335	0,1436	0,1130	**0,1308**

$$A = \begin{bmatrix} 0,1609 & 0,1761 & 0,2089 & 0,1128 & 0,2955 & 0,1908 \\ 0,2369 & 0,2593 & 0,2496 & 0,2394 & 0,2864 & 0,2543 \\ 0,0881 & 0,1188 & 0,1144 & 0,1872 & 0,0554 & 0,1128 \\ 0,4524 & 0,3434 & 0,1937 & 0,3170 & 0,2496 & 0,3112 \\ 0,0616 & 0,1023 & 0,2335 & 0,1436 & 0,1130 & 0,1308 \end{bmatrix}$$

Table 3: All Priority Matrix of Financial Dimension Sub-factors

	F_1	F_2	F_3	F_4	F_5	**Total**
F_1	0,1908	0,1727	0,2060	0,1107	0,3420	1,0222
F_2	0,2810	0,2543	0,2461	0,2350	0,3314	1,3478
F_3	0,1045	0,1165	0,1128	0,1838	0,0641	0,5817
F_4	0,5365	0,3368	0,1910	0,3112	0,2889	1,6645
F_5	0,0730	0,1004	0,2302	0,1409	0,1308	0,6753

$$W.w = \begin{bmatrix} 1 & 0,6792 & 1,8263 & 0,3557 & 2,6145 \\ 1,4723 & 1 & 2,1823 & 0,7551 & 2,5336 \\ 0,5476 & 0,4582 & 1 & 0,5905 & 0,4899 \\ 2,8114 & 1,3243 & 1,6935 & 1 & 2,2085 \\ 0,3825 & 0,3947 & 2,0412 & 0,4528 & 1 \end{bmatrix} x \begin{bmatrix} 0,1908 \\ 0,2543 \\ 0,1128 \\ 0,3112 \\ 0,1308 \end{bmatrix} = \begin{bmatrix} 1,0222 \\ 1,3478 \\ 0,5817 \\ 1,6645 \\ 0,6753 \end{bmatrix}$$

Table 4: Binary Comparison of Environmental Dimension Sub-factors

	$\mathbf{E_1}$	$\mathbf{E_2}$	$\mathbf{E_3}$	$\mathbf{E_4}$	$\mathbf{E_5}$	$\mathbf{E_6}$
$\mathbf{E_1}$	1,0000	0,7916	1,6225	1,3410	1,2328	1,5244
$\mathbf{E_2}$	1,2633	1,0000	1,7321	0,7579	0,9950	1,9680
$\mathbf{E_3}$	0,6163	0,5773	1,0000	0,6671	1,8120	1,4953
$\mathbf{E_4}$	0,7457	1,3194	1,4990	1,0000	1,6948	2,2361
$\mathbf{E_5}$	0,8112	1,0050	0,5519	0,5900	1,0000	0,6086
$\mathbf{E_6}$	0,6560	0,5081	0,6688	0,4472	1,6431	1,0000

$$A = \begin{bmatrix} 1 & 0,7916 & 1,6225 & 1,3410 & 1,2328 & 1,5244 \\ 1,2633 & 1 & 1,7321 & 0,7579 & 0,9950 & 1,9680 \\ 0,6163 & 0,5773 & 1 & 0,6671 & 1,8120 & 1,4953 \\ 0,7457 & 1,3194 & 1,4990 & 1 & 1,6948 & 2,2361 \\ 0,8112 & 1,0050 & 0,5519 & 0,5900 & 1 & 0,6086 \\ 0,6560 & 0,5081 & 0,6688 & 0,4472 & 1,6431 & 1 \end{bmatrix}$$

Table 5: Normalized Matrix and Priority Vector of Environmental Dimension Sub-factors

	$\mathbf{E_1}$	$\mathbf{E_2}$	$\mathbf{E_3}$	$\mathbf{E_4}$	$\mathbf{E_5}$	$\mathbf{E_6}$	**Priority Vector (mean)**
$\mathbf{E_1}$	0,1964	0,1522	0,2294	0,2792	0,1472	0,1726	**0,1961**
$\mathbf{E_2}$	0,2481	0,1923	0,2448	0,1578	0,1188	0,2228	**0,1974**
$\mathbf{E_3}$	0,1210	0,1110	0,1414	0,1389	0,2163	0,1693	**0,1496**
$\mathbf{E_4}$	0,1464	0,2537	0,2119	0,2082	0,2023	0,2532	**0,2126**
$\mathbf{E_5}$	0,1593	0,1932	0,0780	0,1228	0,1194	0,0689	**0,1236**
$\mathbf{E_6}$	0,1288	0,0977	0,0945	0,0931	0,1961	0,1132	**0,1206**

$$A = \begin{bmatrix} 0,1964 & 0,1522 & 0,2294 & 0,2792 & 0,1472 & 0,1726 & 0,1961 \\ 0,2481 & 0,1923 & 0,2448 & 0,1578 & 0,1188 & 0,2228 & 0,1974 \\ 0,1210 & 0,1110 & 0,1414 & 0,1389 & 0,2163 & 0,1693 & 0,1496 \\ 0,1464 & 0,2537 & 0,2119 & 0,2082 & 0,2023 & 0,2532 & 0,2126 \\ 0,1593 & 0,1932 & 0,0780 & 0,1228 & 0,1194 & 0,0689 & 0,1236 \\ 0,1288 & 0,0977 & 0,0945 & 0,0931 & 0,1961 & 0,1132 & 0,1206 \end{bmatrix}$$

Table 6: All Priority Matrix of Environmental Dimension Sub-factors

	E_1	E_2	E_3	E_4	E_5	E_6	Total
E_1	0,1961	0,1563	0,2428	0,2851	0,1524	0,1838	1,2165
E_2	0,2478	0,1974	0,2592	0,1611	0,1230	0,2373	1,2258
E_3	0,1209	0,1140	0,1496	0,1418	0,2240	0,1803	0,9306
E_4	0,1463	0,2605	0,2243	0,2126	0,2095	0,2696	1,3228
E_5	0,1591	0,1984	0,0826	0,1254	0,1236	0,0734	0,7625
E_6	0,1287	0,1003	0,1001	0,0951	0,2031	0,1206	0,7478

$$W.w = \begin{bmatrix} 1 & 0{,}7916 & 1{,}6225 & 1{,}3410 & 1{,}2328 & 1{,}5244 \\ 1{,}2633 & 1 & 1{,}7321 & 0{,}7579 & 0{,}9950 & 1{,}9680 \\ 0{,}6163 & 0{,}5773 & 1 & 0{,}6671 & 1{,}8120 & 1{,}4953 \\ 0{,}7457 & 1{,}3194 & 1{,}4990 & 1 & 1{,}6948 & 2{,}2361 \\ 0{,}8112 & 1{,}0050 & 0{,}5519 & 0{,}5900 & 1 & 0{,}6086 \\ 0{,}6560 & 0{,}5081 & 0{,}6688 & 0{,}4472 & 1{,}6431 & 1 \end{bmatrix} x \begin{bmatrix} 0{,}1961 \\ 0{,}1974 \\ 0{,}1496 \\ 0{,}2126 \\ 0{,}1236 \\ 0{,}1206 \end{bmatrix} = \begin{bmatrix} 1{,}2165 \\ 1{,}2258 \\ 0{,}9306 \\ 1{,}3228 \\ 0{,}7625 \\ 0{,}7478 \end{bmatrix}$$

Table 7: Binary Comparison of Social Dimension Sub-factors

	S_1	S_2	S_3	S_4	S_5
S_1	1,0000	0,4882	0,4882	0,2520	0,2058
S_2	2,0483	1,0000	0,6418	0,1791	0,1973
S_3	2,0483	1,5581	1,0000	0,2654	0,2119
S_4	3,9683	5,5835	3,7679	1,0000	2,8472
S_5	4,8591	5,0684	4,7192	0,3512	1,0000

$$A = \begin{bmatrix} 1 & 0{,}4882 & 0{,}4882 & 0{,}2520 & 0{,}2058 \\ 2{,}0483 & 1 & 0{,}6418 & 0{,}1791 & 0{,}1973 \\ 2{,}0483 & 1{,}5581 & 1 & 0{,}2654 & 0{,}2119 \\ 3{,}9683 & 5{,}5835 & 3{,}7679 & 1 & 2{,}8472 \\ 4{,}8591 & 5{,}0684 & 4{,}7192 & 0{,}3512 & 1 \end{bmatrix}$$

Table 8: Normalized Matrix and Priority Vector of Social Dimension Sub-factors

	S_1	S_2	S_3	S_4	S_5	Priority Vector (mean)
S_1	0,0718	0,0356	0,0460	0,1231	0,0461	0,0645
S_2	0,1471	0,0730	0,0604	0,0875	0,0442	0,0824
S_3	0,1471	0,1137	0,0942	0,1296	0,0475	0,1064
S_4	0,2850	0,4076	0,3549	0,4883	0,6381	0,4348
S_5	0,3490	0,3700	0,4445	0,1715	0,2241	0,3118

$$A = \begin{bmatrix} 0{,}0718 & 0{,}0356 & 0{,}0460 & 0{,}1231 & 0{,}0461 & 0{,}0645 \\ 0{,}1471 & 0{,}0730 & 0{,}0604 & 0{,}0875 & 0{,}0442 & 0{,}0824 \\ 0{,}1471 & 0{,}1137 & 0{,}0942 & 0{,}1296 & 0{,}0475 & 0{,}1064 \\ 0{,}2850 & 0{,}4076 & 0{,}3549 & 0{,}4883 & 0{,}6381 & 0{,}4348 \\ 0{,}3490 & 0{,}3700 & 0{,}4445 & 0{,}1715 & 0{,}2241 & 0{,}3118 \end{bmatrix}$$

Table 9: All Priority Matrix of Social Dimension Sub-factors

	S_1	S_2	S_3	S_4	S_5	**Total**
S_1	0,0645	0,0403	0,0520	0,1096	0,0642	0,3305
S_2	0,1322	0,0824	0,0683	0,0558	0,0615	0,4003
S_3	0,1322	0,1285	0,1064	0,1154	0,0661	0,5485
S_4	0,2561	0,4603	0,4010	0,4348	0,8878	2,4400
S_5	0,3135	0,4179	0,5023	0,1527	0,3118	1,6982

$$W.w = \begin{bmatrix} 1 & 0{,}4882 & 0{,}4882 & 0{,}2520 & 0{,}2058 \\ 2{,}0483 & 1 & 0{,}6418 & 0{,}1791 & 0{,}1973 \\ 2{,}0483 & 1{,}5581 & 1 & 0{,}2654 & 0{,}2119 \\ 3{,}9683 & 5{,}5835 & 3{,}7679 & 1 & 2{,}8472 \\ 4{,}8591 & 5{,}0684 & 4{,}7192 & 0{,}3512 & 1 \end{bmatrix} x \begin{bmatrix} 0{,}0645 \\ 0{,}0824 \\ 0{,}1064 \\ 0{,}4348 \\ 0{,}3118 \end{bmatrix} = \begin{bmatrix} 0{,}3305 \\ 0{,}4003 \\ 0{,}5485 \\ 2{,}4400 \\ 1{,}6982 \end{bmatrix}$$

Appendix 3: Finding the Ideal Solution in Financial Dimension with TOPSIS between the 2013-2015

Table 1: Decision Matrix of 2013 Financial Dimension

	F_1	F_2	F_3	F_4	F_5
Port of Coruna	6587,8100	192,4500	70,4600	859,5800	221836,670
Port of Valencia	37,2300	2,1900	0,0860	6,4300	482,4300
APM Terminals	119,3400	21,2100	1,5400	22,0100	0,2000

Table 2: Normalized Matrix of 2013 Financial Dimension

	F_1	F_2	F_3	F_4	F_5
Port of Coruna	0,9998	0,9939	0,9998	0,9996	1,0000
Port of Valencia	0,0057	0,0113	0,0012	0,0075	0,0022
APM Terminals	0,0181	0,1095	0,0219	0,0256	0,0000

Table 3: Weighting Normalized Matrix of 2013 Financial Dimension

Weight	**0,1908**	**0,2543**	**0,1128**	**0,3112**	**0,1308**
	F_1	F_2	F_3	F_4	F_5
Port of Coruna	0,1908	0,2528	0,1128	0,3111	0,1308
Port of Valencia	0,0011	0,0029	0,0001	0,0023	0,0003
APM Terminals	0,0035	0,0279	0,0025	0,0080	0,0000

Table 4: Ideal and Negative Ideal Solution Values (Financial Dimension 2013)

	F_1	F_2	F_3	F_4	F_5
Ideal Solution	0,1908	0,2528	0,1128	0,3111	0,1308
Negative Ideal Solution	0,0011	0,0029	0,0001	0,0023	0,0000

Table 5: Calculation of Ideal Distances (Financial Dimension 2013)

	F_1	F_2	F_3	F_4	F_5	**Total**	S_i^*
Port of Coruna	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,000000
Port of Valencia	0,0360	0,0624	0,0127	0,0953	0,0170	0,2235	0,472731
APM Terminals	0,0351	0,0506	0,0122	0,0919	0,0171	0,2068	0,454779

Table 6: Calculation of Negative Ideal Distances (Financial Dimension 2013)

	F_1	F_2	F_3	F_4	F_5	**Total**	S_i^-
Port of Coruna	0,0360	0,0624	0,0127	0,0953	0,0171	0,2235	0,472810
Port of Valencia	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,000284
APM Terminals	0,0000	0,0006	0,0000	0,0000	0,0000	0,0007	0,025824

Table 7: Decision Matrix of 2014 Financial Dimension

	F_1	F_2	F_3	F_4	F_5
Port of Coruna	14588,270	617,8000	233,4800	473,7500	506565,8600
Port of Valencia	32,9400	6,8200	0,6700	7,6200	400,7800
APM Terminals	116,3200	23,5000	6,1100	23,5000	0,1800

Table 8: Normalized Matrix of 2014 Financial Dimension

	F_1	F_2	F_3	F_4	F_5
Port of Coruna	1,0000	0,9992	0,9997	0,9986	1,0000
Port of Valencia	0,0023	0,0110	0,0029	0,0161	0,0008
APM Terminals	0,0080	0,0380	0,0262	0,0495	0,0000

Table 9: Weighting Normalized Matrix of 2014 Financial Dimension

Weight	**0,1908**	**0,2543**	**0,1128**	**0,3112**	**0,1308**
	F_1	F_2	F_3	F_4	F_5
Port of Coruna	0,1908	0,2541	0,1128	0,3108	0,1308
Port of Valencia	0,0004	0,0028	0,0003	0,0050	0,0001
APM Terminals	0,0015	0,0097	0,0030	0,0154	0,0000

Table 10: Ideal and Negative Ideal Solution Values (Financial Dimension 2014)

	F_1	F_2	F_3	F_4	F_5
Ideal Solution	0,1908	0,2541	0,1128	0,3108	0,1308
Negative Ideal Solution	0,0004	0,0028	0,0003	0,0050	0,0000

Table 11: Calculation of Ideal Distances (Financial Dimension 2014)

	F_1	F_2	F_3	F_4	F_5	**Total**	S_i^*
Port of Coruna	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,000000
Port of Valencia	0,0362	0,0631	0,0126	0,0935	0,0171	0,2226	0,471818
APM Terminals	0,0358	0,0597	0,0121	0,0872	0,0171	0,2120	0,460411

Table 12: Calculation of Negative Ideal Distances (Financial Dimension 2014)

	F_1	F_2	F_3	F_4	F_5	**Total**	S_i^-
Port of Coruna	0,0362	0,0631	0,0126	0,0935	0,0171	0,2226	0,471846
Port of Valencia	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,000103
APM Terminals	0,0000	0,0000	0,0000	0,0001	0,0000	0,0002	0,012794

Table 13: Decision Matrix of 2015 Financial Dimension

	F_1	F_2	F_3	F_4	F_5
Port of Coruna	201237,940	8720,8400	2398,8600	28063,7700	6280872,11
Port of Valencia	30,0600	1,7200	0,6300	4,1500	341,8400
APM Terminals	117,7800	18,1700	2,9400	18,1700	0,2000

Table 14: Normalized Matrix of 2015 Financial Dimension

	F_1	F_2	F_3	F_4	F_5
Port of Coruna	1,0000	1,0000	1,0000	1,0000	1,0000
Port of Valencia	0,0001	0,0002	0,0003	0,0001	0,0001
APM Terminals	0,0006	0,0021	0,0012	0,0006	0,0000

Table 15: Weighting Normalized Matrix of 2015 Financial Dimension

Weight	**0,1908**	**0,2543**	**0,1128**	**0,3112**	**0,1308**
	F_1	F_2	F_3	F_4	F_5
Port of Coruna	0,1908	0,2543	0,1128	0,3112	0,1308
Port of Valencia	0,0000	0,0001	0,0000	0,0000	0,0000
APM Terminals	0,0001	0,0005	0,0001	0,0002	0,0000

Table 16: Ideal and Negative Ideal Solution Values (Financial Dimension 2015)

	F_1	F_2	F_3	F_4	F_5
Ideal Solution	0,1908	0,2543	0,1128	0,3112	0,1308
Negative Ideal Solution	0,0000	0,0001	0,0000	0,0000	0,0000

Table 17: Calculation of Ideal Distances (Financial Dimension 2015)

	F_1	F_2	F_3	F_4	F_5	**Total**	S_i^*
Port of Coruna	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,000000
Port of Valencia	0,0364	0,0646	0,0127	0,0968	0,0171	0,2277	0,477155
APM Terminals	0,0364	0,0644	0,0127	0,0967	0,0171	0,2273	0,476741

Table 18: Calculation of Negative Ideal Distances (Financial Dimension 2015)

	F_1	F_2	F_3	F_4	F_5	Total	S_i^-
Port of Coruna	0,0364	0,0646	0,0127	0,0968	0,0171	0,2277	0,477157
Port of Valencia	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,000007
APM Terminals	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,000522

Appendix 4: Finding the Ideal Solution in Environmental Dimension with TOPSIS between the 2012-2015

Table 1: Decision Matrix of 2012 Environmental Dimension

	E_1	E_2	E_3	E_4	E_5	E_6
Port of Coruna	826,0000	0,0000	66,0000	24777,0000	2,2500	43467,0000
Port of Valencia	207,4000	12,4000	63,4000	8,2500	4,1000	82213,0000
APM Terminals	514,0000	2,0000	5,0000	21,0000	425,0000	100,0000
Port of Gothenburg	970,0000	0,7000	2,8000	34,0000	70,0000	573,0000

Table 2: Normalized Matrix of 2012 Environmental Dimension

	E_1	E_2	E_3	E_4	E_5	E_6
Port of Coruna	0,5945	0,0000	0,7198	1,0000	0,0052	0,4674
Port of Valencia	0,1493	0,9857	0,6914	0,0003	0,0095	0,8840
APM Terminals	0,3699	0,1590	0,0545	0,0008	0,9866	0,0011
Port of Gothenburg	0,6982	0,0556	0,0305	0,0014	0,1625	0,0062

Table 3: Weighting Normalized Matrix of 2012 Environmental Dimension

Weight	**0,1961**	**0,1974**	**0,1496**	**0,2126**	**0,1236**	**0,1206**
	E_1	E_2	E_3	E_4	E_5	E_6
Port of Coruna	0,1166	0,0000	0,1077	0,2126	0,0006	0,0564
Port of Valencia	0,0293	0,1946	0,1034	0,0001	0,0012	0,1066
APM Terminals	0,0725	0,0314	0,0082	0,0002	0,1219	0,0001
Port of Gothenburg	0,1369	0,0110	0,0046	0,0003	0,0201	0,0007

Table 4: Ideal and Negative Ideal Solution Values (Environmental Dimension 2012)

	E_1	E_2	E_3	E_4	E_5	E_6
Ideal Solution	0,1369	0,1946	0,1077	0,2126	0,1219	0,1066
Negative Ideal Solution	0,0293	0,0000	0,0046	0,0001	0,0006	0,0001

Table 5: Calculation of Ideal Distances (Environmental Dimension 2012)

	E_1	E_2	E_3	E_4	E_5	E_6	Total	S_i^*
Port of Coruna	0,0004	0,0379	0,0000	0,0000	0,0147	0,0025	0,0555	0,235613
Port of Valencia	0,0116	0,0000	0,0000	0,0452	0,0146	0,0000	0,0714	0,267129
APM Terminals	0,0041	0,0266	0,0099	0,0451	0,0000	0,0113	0,0971	0,311673
Port of Gothenburg	0,0000	0,0337	0,0106	0,0451	0,0104	0,0112	0,1110	0,333163

Table 6: Calculation of Negative Ideal Distances (Environmental Dimension 2012)

	E_1	E_2	E_3	E_4	E_5	E_6	Total	S_i^-
Port of Coruna	0,0076	0,0000	0,0106	0,0452	0,0000	0,0032	0,0666	0,258042
Port of Valencia	0,0000	0,0379	0,0098	0,0000	0,0000	0,0113	0,0590	0,242847
APM Terminals	0,0019	0,0010	0,0000	0,0000	0,0147	0,0000	0,0176	0,132609
Port of Gothenburg	0,0116	0,0001	0,0000	0,0000	0,0004	0,0000	0,0121	0,109928

Table 7: Decision Matrix of 2013 Environmental Dimension

	E_1	E_2	E_3	E_4	E_5	E_6
Port of Coruna	691,0000	0,0000	61,0000	13960,00	2,3000	42637,00
Port of Valencia	188,0000	14,7000	28,5000	15,9300	3,8000	74458,00
APM Terminals	553,0000	2,0000	2,0000	28,0000	418,0000	108,0000
Port of Gothenburg	890,0000	0,8000	2,6000	34,0000	73,0000	617,0000

Table 8: Normalized Matrix of 2013 Environmental Dimension

	E_1	E_2	E_3	E_4	E_5	E_6
Port of Coruna	0,5445	0,0000	0,9049	1,0000	0,0054	0,4969
Port of Valencia	0,1481	0,9894	0,4228	0,0011	0,0090	0,8678
APM Terminals	0,4357	0,1346	0,0297	0,0020	0,9850	0,0013
Port of Gothenburg	0,7013	0,0538	0,0386	0,0024	0,1720	0,0072

Table 9: Weighting Normalized Matrix of 2013 Environmental Dimension

Weight	**0,1961**	**0,1974**	**0,1496**	**0,2126**	**0,1236**	**0,1206**
	E_1	E_2	E_3	E_4	E_5	E_6
Port of Coruna	0,1068	0,0000	0,1354	0,2126	0,0007	0,0599
Port of Valencia	0,0290	0,1953	0,0632	0,0002	0,0011	0,1047
APM Terminals	0,0854	0,0266	0,0044	0,0004	0,1218	0,0002
Port of Gothenburg	0,1375	0,0106	0,0058	0,0005	0,0213	0,0009

Table 10: Ideal and Negative Ideal Solution Values (Environmental Dimension 2013)

	E_1	E_2	E_3	E_4	E_5	E_6
Ideal Solution	0,1375	0,1953	0,1354	0,2126	0,1218	0,1047
Negative Ideal Solution	0,0290	0,0000	0,0044	0,0002	0,0007	0,0002

Table 11: Calculation of Ideal Distances (Environmental Dimension 2013)

	E_1	E_2	E_3	E_4	E_5	E_6	**Total**	S_i^*
Port of Coruna	0,0009	0,0381	0,0000	0,0000	0,0147	0,0020	0,0558	0,236123
Port of Valencia	0,0118	0,0000	0,0052	0,0451	0,0146	0,0000	0,0766	0,276799
APM Terminals	0,0027	0,0285	0,0171	0,0450	0,0000	0,0109	0,1043	0,322904
Port of Gothenburg	0,0000	0,0341	0,0168	0,0450	0,0101	0,0108	0,1168	0,341693

Table 12: Calculation of Negative Ideal Distances (Environmental Dimension 2013)

	E_1	E_2	E_3	E_4	E_5	E_6	**Total**	S_i^-
Port of Coruna	0,0060	0,0000	0,0171	0,0451	0,0000	0,0036	0,0719	0,268055
Port of Valencia	0,0000	0,0381	0,0035	0,0000	0,0000	0,0109	0,0525	0,229188
APM Terminals	0,0032	0,0007	0,0000	0,0000	0,0147	0,0000	0,0185	0,136189
Port of Gothenburg	0,0118	0,0001	0,0000	0,0000	0,0004	0,0000	0,0123	0,110927

Table 13: Decision Matrix of 2014 Environmental Dimension

	E_1	E_2	E_3	E_4	E_5	E_6
Port of Coruna	68,0000	0,0000	67,0000	1,7710	2517,000	38674,00
Port of Valencia	163,7700	2,0000	25,0000	12,3200	4,2000	64207,00
APM Terminals	574,0000	2,0000	3,0000	34,0000	468,0000	121,0000
Port of Gothenburg	710,0000	0,7000	2,8000	420,0000	66,0000	61,0000

Table 14: Normalized Matrix of 2014 Environmental Dimension

	E_1	E_2	E_3	E_4	E_5	E_6
Port of Coruna	0,0731	0,0000	0,9354	0,0042	0,9828	0,5160
Port of Valencia	0,1761	0,6864	0,3490	0,0292	0,0016	0,8566
APM Terminals	0,6172	0,6864	0,0419	0,0807	0,1827	0,0016
Port of Gothenburg	0,7634	0,2402	0,0391	0,9963	0,0258	0,0008

Table 15: Weighting Normalized Matrix of 2014 Environmental Dimension

Weight	**0,1961**	**0,1974**	**0,1496**	**0,2126**	**0,1236**	**0,1206**
	E_1	E_2	E_3	E_4	E_5	E_6
Port of Coruna	0,0143	0,0000	0,1399	0,0009	0,1215	0,0622
Port of Valencia	0,0345	0,1355	0,0522	0,0062	0,0002	0,1033
APM Terminals	0,1210	0,1355	0,0063	0,0171	0,0226	0,0002
Port of Gothenburg	0,1497	0,0474	0,0058	0,2118	0,0032	0,0001

Table 16: Ideal and Negative Ideal Solution Values (Environmental Dimension 2014)

	E_1	E_2	E_3	E_4	E_5	E_6
Ideal Solution	0,1497	0,1355	0,1399	0,2118	0,1215	0,1033
Negative Ideal Solution	0,0143	0,0000	0,0058	0,0009	0,0002	0,0001

Table 17: Calculation of Ideal Distances (Environmental Dimension 2014)

	E_1	E_2	E_3	E_4	E_5	E_6	Total	S_i^*
Port of Coruna	0,0183	0,0184	0,0000	0,0445	0,0000	0,0017	0,0829	0,287850
Port of Valencia	0,0133	0,0000	0,0077	0,0423	0,0147	0,0000	0,0779	0,279173
APM Terminals	0,0008	0,0000	0,0179	0,0379	0,0098	0,0106	0,0770	0,277480
Port of Gothenburg	0,0000	0,0078	0,0180	0,0000	0,0140	0,0107	0,0504	0,224454

Table 18: Calculation of Negative Ideal Distances (Environmental Dimension 2014)

	E_1	E_2	E_3	E_4	E_5	E_6	Total	S_i^-
Port of Coruna	0,0000	0,0000	0,0180	0,0000	0,0147	0,0039	0,0365	0,191168
Port of Valencia	0,0004	0,0184	0,0021	0,0000	0,0000	0,0107	0,0316	0,177755
APM Terminals	0,0114	0,0184	0,0000	0,0003	0,0005	0,0000	0,0305	0,174661
Port of Gothenburg	0,0183	0,0022	0,0000	0,0445	0,0000	0,0000	0,0651	0,255086

Table 19: Decision Matrix of 2015 Environmental Dimension

	E_1	E_2	E_3	E_4	E_5	E_6
Port of Coruna	672,0000	0,0000	76,0000	6,0690	1,8850	35463,00
Port of Valencia	156,6900	2,0000	35,0000	15,2700	4,9000	61783,00
APM Terminals	576,0000	0,0000	2,0000	70,0000	481,0000	122,0000
Port of Gothenburg	480,0000	0,9000	2,0000	390,0000	61,0000	529,0000

Table 20: Normalized Matrix of 2015 Environmental Dimension

	E_1	E_2	E_3	E_4	E_5	E_6
Port of Coruna	0,6595	0,0000	0,9078	0,0153	0,0039	0,4978
Port of Valencia	0,1538	0,9119	0,4181	0,0385	0,0101	0,8673
APM Terminals	0,5653	0,0000	0,0239	0,1765	0,9920	0,0017
Port of Gothenburg	0,4711	0,4104	0,0239	0,9834	0,1258	0,0074

Table 21: Weighting Normalized Matrix of 2015 Environmental Dimension

Weight	**0,1961**	**0,1974**	**0,1496**	**0,2126**	**0,1236**	**0,1206**
	E_1	E_2	E_3	E_4	E_5	E_6
Port of Coruna	0,1293	0,0000	0,1358	0,0033	0,0005	0,0600
Port of Valencia	0,0302	0,1800	0,0625	0,0082	0,0012	0,1046
APM Terminals	0,1109	0,0000	0,0036	0,0375	0,1226	0,0002
Port of Gothenburg	0,0924	0,0810	0,0036	0,2091	0,0155	0,0009

Table 22: Ideal and Negative Ideal Solution Values (Environmental Dimension 2015)

	E_1	E_2	E_3	E_4	E_5	E_6
Ideal Solution	0,1293	0,1800	0,1358	0,2091	0,1226	0,1046
Negative Ideal Solution	0,0302	0,0000	0,0036	0,0033	0,0005	0,0002

Table 23: Calculation of Ideal Distances (Environmental Dimension 2015)

	E_1	E_2	E_3	E_4	E_5	E_6	**Total**	S_i^*
Port of Coruna	0,0000	0,0324	0,0000	0,0424	0,0149	0,0020	0,0917	0,302769
Port of Valencia	0,0098	0,0000	0,0054	0,0404	0,0147	0,0000	0,0703	0,265119
APM Terminals	0,0003	0,0324	0,0175	0,0294	0,0000	0,0109	0,0906	0,300927
Port of Gothenburg	0,0014	0,0098	0,0175	0,0000	0,0115	0,0108	0,0509	0,225539

Table 24: Calculation of Negative Ideal Distances (Environmental Dimension 2015)

	E_1	E_2	E_3	E_4	E_5	E_6	**Total**	S_i^-
Port of Coruna	0,0098	0,0000	0,0175	0,0000	0,0000	0,0036	0,0309	0,175782
Port of Valencia	0,0000	0,0324	0,0035	0,0000	0,0000	0,0109	0,0468	0,216340
APM Terminals	0,0065	0,0000	0,0000	0,0012	0,0149	0,0000	0,0226	0,150340
Port of Gothenburg	0,0039	0,0066	0,0000	0,0424	0,0002	0,0000	0,0530	0,230269

Appendix 5: Finding the Ideal Solution in Social Dimension with TOPSIS between the 2012-2015

Table 1: Decision Matrix of 2012 Social Dimension

	S_1	S_2	S_3	S_4	S_5
Port of Coruna	186,0000	25,2700	4,8000	0,0000	4,0000
Port of Valencia	393,0000	11,9900	18,9100	0,0000	10,7900
APM Terminals	20685,0000	13,0000	14,0000	5,0000	2,5300
Port of Gothenburg	121,0000	29,7500	33,3000	0,0000	3,0000

Table 2: Normalized Matrix of 2012 Social Dimension

	S_1	S_2	S_3	S_4	S_5
Port of Coruna	0,0090	0,5897	0,1169	0,0000	0,3290
Port of Valencia	0,0190	0,2798	0,4606	0,0000	0,8875
APM Terminals	0,9998	0,3034	0,3410	1,0000	0,2081
Port of Gothenburg	0,0058	0,6942	0,8111	0,0000	0,2467

Table 3: Weighting Normalized Matrix of 2012 Social Dimension

Weight	**0,0645**	**0,0824**	**0,1064**	**0,4348**	**0,3118**
	S_1	S_2	S_3	S_4	S_5
Port of Coruna	0,0006	0,0486	0,0124	0,0000	0,1026
Port of Valencia	0,0012	0,0231	0,0490	0,0000	0,2767
APM Terminals	0,0645	0,0250	0,0363	0,4348	0,0649
Port of Gothenburg	0,0004	0,0572	0,0863	0,0000	0,0769

Table 4: Ideal and Negative Ideal Solution Values (Social Dimension 2012)

	S_1	S_2	S_3	S_4	S_5
Ideal Solution	0,0645	0,0572	0,0863	0,4348	0,2767
Negative Ideal Solution	0,0004	0,0231	0,0124	0,0000	0,0649

Table 5: Calculation of Ideal Distances (Social Dimension 2012)

	S_1	S_2	S_3	S_4	S_5	Total	S_i^*
Port of Coruna	0,0041	0,0001	0,0055	0,1891	0,0303	0,2290	0,478524
Port of Valencia	0,0040	0,0012	0,0014	0,1891	0,0000	0,1956	0,442278
APM Terminals	0,0000	0,0010	0,0025	0,0000	0,0449	0,0484	0,220023
Port of Gothenburg	0,0041	0,0000	0,0000	0,1891	0,0399	0,2331	0,482774

Table 6: Calculation of Negative Ideal Distances (Social Dimension 2012)

	S_1	S_2	S_3	S_4	S_5	Total	S_i^-
Port of Coruna	0,0000	0,0007	0,0000	0,0000	0,0014	0,0021	0,045533
Port of Valencia	0,0000	0,0000	0,0013	0,0000	0,0449	0,0462	0,214962
APM Terminals	0,0041	0,0000	0,0006	0,1891	0,0000	0,1937	0,440151
Port of Gothenburg	0,0000	0,0012	0,0055	0,0000	0,0001	0,0068	0,082262

Table 7: Decision Matrix of 2013 Social Dimension

	S_1	S_2	S_3	S_4	S_5
Port of Coruna	176,0000	25,0000	5,1000	0,0000	1,0000
Port of Valencia	407,0000	12,7700	16,5000	0,0000	14,7200
APM Terminals	20270,0000	9,0000	14,0000	3,0000	1,8100
Port of Gothenburg	130,0000	30,0000	41,3000	0,0000	4,0000

Table 8: Normalized Matrix of 2013 Social Dimension

	S_1	S_2	S_3	S_4	S_5
Port of Coruna	0,0087	0,5944	0,1087	0,0000	0,0650
Port of Valencia	0,0201	0,3036	0,3518	0,0000	0,9563
APM Terminals	0,9997	0,2140	0,2985	1,0000	0,1176
Port of Gothenburg	0,0064	0,7133	0,8805	0,0000	0,2599

Table 9: Weighting Normalized Matrix of 2013 Social Dimension

Weight	**0,0645**	**0,0824**	**0,1064**	**0,4348**	**0,3118**
	S_1	S_2	S_3	S_4	S_5
Port of Coruna	0,0006	0,0490	0,0116	0,0000	0,0203
Port of Valencia	0,0013	0,0250	0,0374	0,0000	0,2982
APM Terminals	0,0645	0,0176	0,0318	0,4348	0,0367
Port of Gothenburg	0,0004	0,0588	0,0937	0,0000	0,0810

Table 10: Ideal and Negative Ideal Solution Values (Social Dimension 2013)

	S_1	S_2	S_3	S_4	S_5
Ideal Solution	0,0645	0,0588	0,0937	0,4348	0,2982
Negative Ideal Solution	0,0004	0,0176	0,0116	0,0000	0,0203

Table 11: Calculation of Ideal Distances (Social Dimension 2013)

	S_1	S_2	S_3	S_4	S_5	**Total**	S_i^*
Port of Coruna	0,0041	0,0001	0,0067	0,1891	0,0772	0,2772	0,526506
Port of Valencia	0,0040	0,0011	0,0032	0,1891	0,0000	0,1973	0,444239
APM Terminals	0,0000	0,0017	0,0038	0,0000	0,0684	0,0739	0,271863
Port of Gothenburg	0,0041	0,0000	0,0000	0,1891	0,0471	0,2403	0,490210

Table 12: Calculation of Negative Ideal Distances (Social Dimension 2013)

	S_1	S_2	S_3	S_4	S_5	**Total**	S_i^-
Port of Coruna	0,0000	0,0010	0,0000	0,0000	0,0000	0,0010	0,031346
Port of Valencia	0,0000	0,0001	0,0007	0,0000	0,0772	0,0780	0,279206
APM Terminals	0,0041	0,0000	0,0004	0,1891	0,0003	0,1938	0,440264
Port of Gothenburg	0,0000	0,0017	0,0067	0,0000	0,0037	0,0121	0,110130

Table 13: Decision Matrix of 2014 Social Dimension

	S_1	S_2	S_3	S_4	S_5
Port of Coruna	173,0000	24,2800	5,2000	0,0000	4,0000
Port of Valencia	403,0000	11,9600	19,2600	0,0000	11,3200
APM Terminals	20639,0000	10,0000	15,0000	10,0000	1,4100
Port of Gothenburg	130,0000	31,5300	40,0000	0,0000	9,0000

Table 14: Normalized Matrix of 2014 Social Dimension

	S_1	S_2	S_3	S_4	S_5
Port of Coruna	0,0084	0,5681	0,1103	0,0000	0,2654
Port of Valencia	0,0195	0,2798	0,4085	0,0000	0,7511
APM Terminals	0,9998	0,2340	0,3181	1,0000	0,0936
Port of Gothenburg	0,0063	0,7377	0,8484	0,0000	0,5972

Table 15: Weighting Normalized Matrix of 2014 Social Dimension

Weight	**0,0645**	**0,0824**	**0,1064**	**0,4348**	**0,3118**
	S_1	S_2	S_3	S_4	S_5
Port of Coruna	0,0005	0,0468	0,0117	0,0000	0,0828
Port of Valencia	0,0013	0,0231	0,0435	0,0000	0,2342
APM Terminals	0,0645	0,0193	0,0339	0,4348	0,0292
Port of Gothenburg	0,0004	0,0608	0,0903	0,0000	0,1862

Table 16: Ideal and Negative Ideal Solution Values (Social Dimension 2014)

	S_1	S_2	S_3	S_4	S_5
Ideal Solution	0,0645	0,0608	0,0903	0,4348	0,2342
Negative Ideal Solution	0,0004	0,0193	0,0117	0,0000	0,0292

Table 17: Calculation of Ideal Distances (Social Dimension 2014)

	S_1	S_2	S_3	S_4	S_5	**Total**	S_i^*
Port of Coruna	0,0041	0,0002	0,0062	0,1891	0,0229	0,2224	0,471633
Port of Valencia	0,0040	0,0014	0,0022	0,1891	0,0000	0,1967	0,443467
APM Terminals	0,0000	0,0017	0,0032	0,0000	0,0420	0,0469	0,216661
Port of Gothenburg	0,0041	0,0000	0,0000	0,1891	0,0023	0,1955	0,442110

Table 18: Calculation of Negative Ideal Distances (Social Dimension 2014)

	S_1	S_2	S_3	S_4	S_5	**Total**	S_i^-
Port of Coruna	0,0000	0,0008	0,0000	0,0000	0,0029	0,0036	0,060243
Port of Valencia	0,0000	0,0000	0,0010	0,0000	0,0420	0,0431	0,207504
APM Terminals	0,0041	0,0000	0,0005	0,1891	0,0000	0,1936	0,440052
Port of Gothenburg	0,0000	0,0017	0,0062	0,0000	0,0247	0,0325	0,180412

Table 19: Decision Matrix of 2015 Social Dimension

	S_1	S_2	S_3	S_4	S_5
Port of Coruna	180,0000	24,4400	5,5600	0,0000	3,0000
Port of Valencia	409,0000	12,9100	19,6200	0,0000	9,0500
APM Terminals	21171,0000	10,0000	13,0000	4,0000	1,9400
Port of Gothenburg	123,0000	34,1400	45,8300	0,0000	7,0000

Table 20: Normalized Matrix of 2015 Social Dimension

	S_1	S_2	S_3	S_4	S_5
Port of Coruna	0,0085	0,5425	0,1073	0,0000	0,2503
Port of Valencia	0,0193	0,2866	0,3786	0,0000	0,7550
APM Terminals	0,9998	0,2220	0,2509	1,0000	0,1619
Port of Gothenburg	0,0058	0,7578	0,8844	0,0000	0,5840

Table 21: Weighting Normalized Matrix of 2015 Social Dimension

Weight	**0,0645**	**0,0824**	**0,1064**	**0,4348**	**0,3118**
	S_1	S_2	S_3	S_4	S_5
Port of Coruna	0,0005	0,0447	0,0114	0,0000	0,0780
Port of Valencia	0,0012	0,0236	0,0403	0,0000	0,2354
APM Terminals	0,0645	0,0183	0,0267	0,4348	0,0505
Port of Gothenburg	0,0004	0,0624	0,0941	0,0000	0,1821

Table 22: Ideal and Negative Ideal Solution Values (Social Dimension 2015)

	S_1	S_2	S_3	S_4	S_5
Ideal Solution	0,0645	0,0624	0,0941	0,4348	0,2354
Negative Ideal Solution	0,0004	0,0183	0,0114	0,0000	0,0505

Table 23: Calculation of Ideal Distances (Social Dimension 2015)

	S_1	S_2	S_3	S_4	S_5	**Total**	S_i^*
Port of Coruna	0,0041	0,0003	0,0068	0,1891	0,0248	0,2251	0,474404
Port of Valencia	0,0040	0,0015	0,0029	0,1891	0,0000	0,1975	0,444358
APM Terminals	0,0000	0,0019	0,0045	0,0000	0,0342	0,0407	0,201748
Port of Gothenburg	0,0041	0,0000	0,0000	0,1891	0,0028	0,1960	0,442724

Table 24: Calculation of Negative Ideal Distances (Social Dimension 2015)

	S_1	S_2	S_3	S_4	S_5	**Total**	S_i^-
Port of Coruna	0,0000	0,0007	0,0000	0,0000	0,0008	0,0015	0,038183
Port of Valencia	0,0000	0,0000	0,0008	0,0000	0,0342	0,0351	0,187273
APM Terminals	0,0041	0,0000	0,0002	0,1891	0,0000	0,1934	0,439766
Port of Gothenburg	0,0000	0,0019	0,0068	0,0000	0,0173	0,0261	0,161594