DOKUZ EYLUL UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
DEPARTMENT OF MARITIME BUSINESS ADMINISTRATION
MARITIME BUSINESS ADMINISTRATION PROGRAM
MASTER'S THESIS

GREEN PERFORMANCE CRITERIA AND SUSTAINABLE PORT CONCEPT: A COMPARATIVE ANALYSIS

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ABSTRACT

Master's Thesis

Green Performance Criteria and Sustainable Port Concept: A Comparative Analysis

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Today's ports as logistic centres, have dominated world trade. High volume cargo transfers and intensive handling operations in ports, have brought along environmental pollution. At this point, '*green port*' concept as so involving the whole environmentally friendly and sustainable approaches, has risen to the surface in order to reduce environmental negative effects of the ports. Gaining '*green port*' statute of a port is possible when a port has carried out '*green port performance criteria*'. In this study, priority perception of selected two Turkish ports on '*green port performance criteria*', has been measured. This measuring has been carried out thereby implementing questionnaire study to managers of two ports constitute sample, by the help of *Analytic Hierarchy Proses.* In consequence of analyses, although some perceptual differences have been observed, essentially '*liquid pollution management*' has come into prominence among key criteria. With this study, it is revealed that this study has ability to be implemented to managers of the whole Turkish ports, thus Turkey's own '*green port policy*' may be created thereby measuring '*green port performance criteria*' perception of Turkish ports.

Keywords: Sustainable Port, Green Port, Green Port Performance Criteria, Analytic Hierarchy Process, Green Port Certificate

ÖZET

Yüksek Lisans Tezi

Yeşil Performans Göstergeleri ve Sürdürülebilir Liman Kavramı: Karşılaştırmalı Bir Analiz

Umur BUCAK

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Denizcilik İşletmeleri Yönetimi Programı

Günümüz limanları, lojistik merkezler olarak dünya ticaretine yön vermektedir. Limanlardaki yüksek hacimli yük transferleri ve yoğun elleçleme operasyonları, çevresel kirliliği de beraberinde getirmektedir. İşte bu noktada, '*yeşil liman*' kavramı çevre dostu ve sürdürülebilir tüm yaklaşımları içine alacak şekilde, limanların çevresel etkilerini azaltmak üzere ortaya çıkmıştır. Bir limanın '*yeşil liman*' statüsüne kavuşması '*yeşil liman performans kriterleri*'ni yerine getirmesiyle mümkündür. Bu çalışmada, seçilen iki Türk limanının '*yeşil liman performans kriterleri*'ne karşı öncelik algısı ölçülmüştür. Bu ölçüm, *Analitik Hiyerarşi Yöntemi* yardımıyla, örneklemi oluşturan iki limanın yöneticilerine anket çalışması uygulanarak gerçekleştirilmiştir. Yapılan analizleri sonucunda bazı algısal farklılıklar gözlenmekle birlikte, temelde '*sıvı kirliliği yönetimi*' ana kriterler arasında ön plana çıkmıştır. Bu çalışmayla, tüm Türkiye'deki liman yöneticilerine bu çalışmanın uygulanabileceği ve bu sayede Türk limanlarının '*yeşil liman performans kriterleri*'ne karşı algısı ölçülerek Türkiye için bir '*yeşil liman politikası*' oluşturulabileceği ortaya konulmuştur.

Anahtar Kelimeler: Sürdürülebilir Liman, Yeşil Liman, Yeşil Liman Performans Göstergeleri, Analitik Hiyerarşi Yöntemi, Yeşil Liman Sertifikası

GREEN PERFORMANCE CRITERIA AND SUSTAINABLE PORT CONCEPT: A COMPARATIVE ANALYSIS

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CHAPTER TWO

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ABBREVIATIONS

%	Per Cent
€	Euro
AAPA	American Association of Port Authorities
ACEC	American Council of Engineering Companies
AHP	Analytic Hierarchy Process
AIRPOL	Air Pollution
AMSPA	Amsterdam Port Authority
APA	Asean Ports Association
APWA	American Public Works Association
CAAP	Clean Air Action Plan
CCC	California Coastal Commission
CD	Compact Disk
CDC	Clean Diesel Campaign
CGH	Cruise Gate Hamburg
CH4	Methane
CHE	Cargo Handling Equipment
CI	Consistency Indicator
CKYH	Cosco, K_Line, Yang Ming and Hanjin
CM	Commercial Manager
CMAA	Construction Management Association of America
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CO2	Carbon Dioxide
CR	Consistency Rate
CSR	Corporate Social Responsibility
CST	The Centre for Sustainable Transportation
CWA	Clean Water Act
DERA	Diesel Emissions Reduction Act
DERA	Diesel Emissions Reduction Act
DERA	Diesel Emissions Reduction Act

DPM	Diesel Particulate Matter
DRTS	Demand Responsive Transportation Services
DWH	Deepwater Horizon
EC	European Commission
ECA	Emissions Control Area
ECOSLC	ECO Sustainable Logistic Chain Foundation
EEDI	Energy Efficiency Design Index
EIS	Eco Information System
EMAS	Eco-Management and Audit Scheme
EMS	Environmental Management System
ENR	Engineering News-Record
EPA	Environmental Protection Agency
EPK	Ege Ports Kuşadası
EQM	Environment and Quality Manager
E-RTG	Electric Rubber-tired Gantry
Es	Environment, Economy and Equity
ESI	Environmental Ship Index
ESPO	European Sea Ports Organization
EU	European Union
FEE	Foundation for Environmental Education
GDP	Gross Domestic Product
GHG	Green House Gas
GP	Green Port
GPC	Green Port Certificate
GPP	Green Port Project
GRI	Global Reporting Initiative
GPPC	Green Port Performance Criteria
GPPI	Green Port Performance Indicator
GRT	Gross Tonnage
HC	Hydro Carbon
HDE	Heavy-duty Equipment
HKP	Hong Kong Port

HPA	Hamburg Port Authority
IAPH	International Association of Ports and Harbours
IAVs	Intelligent Autonomous Vehicles
IMDG	International Maritime Dangerous Goods
IMS	Integrated Management System
ISO 14001	International Environmental Management Standard
ISPS	International Ship and Port Security
IT	Information Technology
JPY	Japanese Yen
KWh	Kilo Watt Hour
LEED	Leadership in Energy and Environmental Design
LIQPOL	Liquid Pollution
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
M^2	Meter Square
M^3	Meter Cubic
MARBIO	Marine Biology
MARPOL	International Convention for the Prevention of Pollution from Ships
MEU	Ministry of Environment and Urbanisation
MSM	Maritime Services Manager
MTMAC	Ministry of Transport, Maritime Affairs and Communications
MTT	Mobile Terminal Truck
MWh	Mega Watt Hour
NCP	National Contingency Plan
NCST	Centre for Sustainable Transportation
NEPA	National Environmental Policy Act
NFPA	National Fire Protection Association
NGO	Non-Governmental Organizations
nm	Nautical Mile
NOX	Nitrogen Oxide
NRC	National Research Council
OECD	The Organisation for Economic Co-operation and Development

OGV	Ocean-going Vessel
OM	Odour Management
OPA	Oil Pollution Act
PA	Port Akdeniz
PERS	Port Environmental Review System
PIANC	World Association for Waterborne Transport Infrastructure
POA	Port of Amsterdam
POAN	Port of Antwerp
POG	Port of Gothenburg
POLA	Port of Los Angeles
POLB	Port of Long Beach
POR	Port of Rotterdam
POT	Port of Toronto
POV	Port of Vancouver
PROFIT	Programme for the Promotion of Technological Research
Ps	People, Planet and Profit
PSAM	Port Services Assistant Manager
PSD	Port of San Diego
PSM	Port Services Manager
R&D	Research and Development
RI	Random Index
Ro-ro	Roll on Roll off
ROT	Republic of Turkey
RTG	Rubber-tired Gantry
SDM	Self-Diagnostic Model
SDUPD	San Diego Unified Port District
SEEMP	Ship Energy Efficiency Management Plan
SM	Security Manager
SO_2	Sulphur Dioxide
SO_x	Sulphur Oxide
STAR	Sustainable Transport Analysis and Research

STELLA	Sustainable Transport in Europe with Links and Liaisons with America
SUMA	Sustainable Urban Mobility in Asia
SW	Solid Waste
SWPOL	Solid Waste Pollution
TBL	Three Bottom Line
TCOS	Turkish Chamber of Shipping
TEU	Twenty Equivalent Unit
UK	United Kingdom
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
US	United States
US$	United States Dollar
USA	United States of America
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds
VPA	Valencia Port Authority
WACOSS	Western Australian Council of Social Service
WCED	World Commission on Environment and Development
WHO	World Health Organization
WPCC	World Ports Climate Conference
WPCD	World Ports Climate Declaration
WPCI	Worlds Ports Climate Initiative
ZAF	Republic of South Africa
ZAR	South African Rand
Λmax	Greatest Eigenvector

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INTRODUCTION

Recently, need for sustainable approaches for all markets which are technology, tourism, agriculture, transportation, etc. is obvious. At this point, ever-growing technology, scarce resources, next generation requirements and global economy, force stakeholders and shareholders of global transportation to become sustainable. Ports constitute one of the principal stand of the transportation by their handling services, bunkering services to vessels, logistic services, etc. Against ever-growing ship sizes, trade volume, and therefore ever-changing demands of the ports' stakeholders, ports should prevent deterioration in the port area, moreover, they should increase their opportunities. Sustainable port concept involves all opportunities related to ports' growing necessity, and offers solutions to provide economic, social and environmental development for ports. Research subject of this study what is green port (GP) concept, is located under the title of environmental sustainability.

GP concept involves environmentally conscious, energy saving, marine biology (MARBIO) protecting, alternative resource usage, etc. attitudes. In this study, GP concept had been evaluated by the whole aspects, green port performance criteria (GPPC) had been obtained from literature. GPPC are indicators measure ports' environmental performance. In this study, these green port performance indicators (GPPIs) had been evaluated by port practitioners of selected two ports by the help of Analytic Hierarchy Process (AHP). And this individual judgements had been clustered for determining ports' judgements. Thus, a comparison analysis of perceptual differences on GP concept between these two ports.

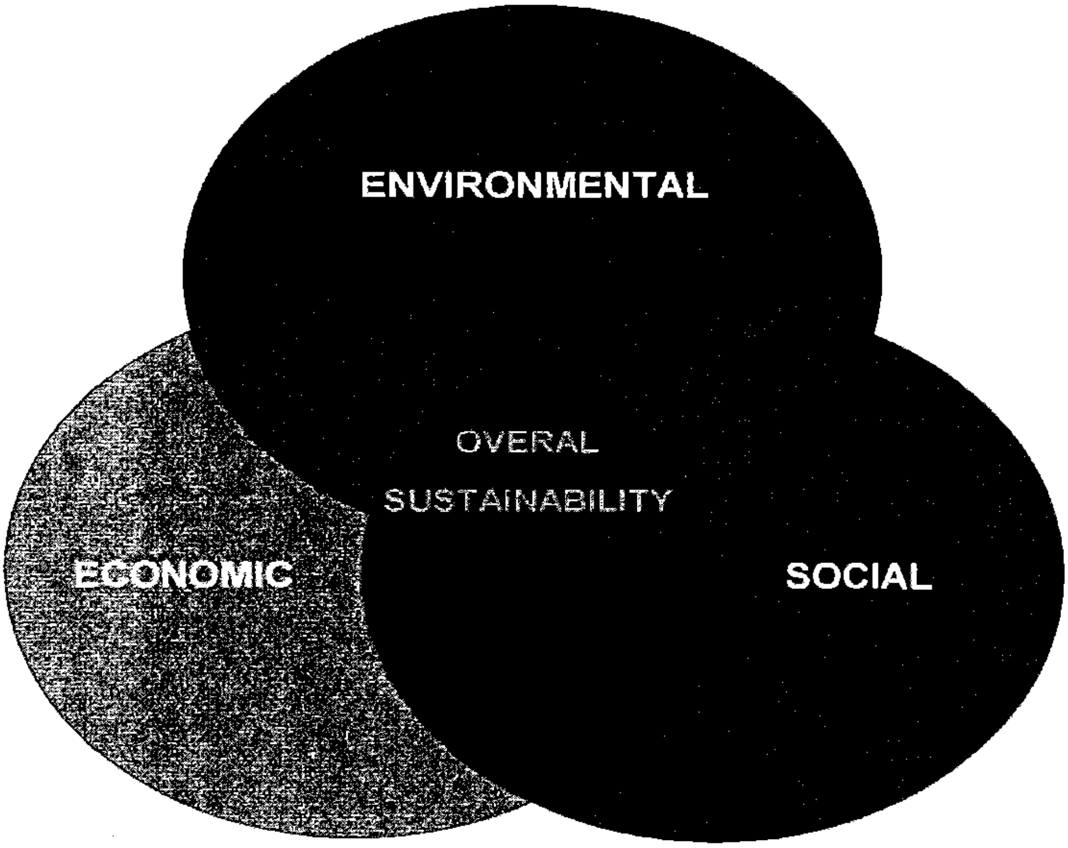
Accordingly, on the subject of preventing liquid pollution (LIQPOL), preserving MARBIO, and evaluation key criterions, certain differences had been determined. However, both of the ports had thought that LIQPOL management is key to provide environmentally friendly approaches for ports. Structural differences between both, had created these perceptual differences. Main structural difference is that one of both is serving for cruise vessels, another is serving for freighters.

CHAPTER ONE
SUSTAINABLE PORT

1.1. DEFINITION OF SUSTAINABILITY

Lexical meaning of sustainability is the vitality of community, social institutions or societal practices through quite a while. Environmental sustainability is critical to long-term growing capacity of individualities, communities and natural world itself (Olafsson et al., 2014: 935); and also as displaying sensitivity to long-term ecological balance, sustainability is the quality of being harmless toward environment and as far as less consumption the natural resources. For human population, sustainability maximize the environmental and social conditions' scope that supports human security, well-being and health (McMichael et al., 2003: 1919). Distinctly, sustainability has been defined in literature as decision making process that involves social, economic and environmental aspects (Barber et al., 2012: 119). As a sustainability process term sustainable development, has been popularized in *Our Common Future,* a report published by World Commission on Environment and Development (WCED) in 1987, and has been defined as "*development which meets the needs of the present without compromising the ability of future generations to meet their own needs*" (WCED, 1987: 47). Sustainability can be seen as interdependence of ecological, social and economic systems are three pillars of sustainability (Hutchins and Sutherland, 2008: 1688). These are also known as three *"Ps" (People, Planet and Profit)* or three *"Es" (Environment, Economy and Equity)* (Boström, 2012: 3). Generally, if social, economic and environmental requirements have been provided, overall sustainability has become acquirable. Model of the only way to reach overall sustainability has been executed in Figure 1 (Zavrl and Zeren, 2010: 2952).

Figure 1: Three-Legged Sustainability Stool



Source: Zavrl and Zeren, 2010: 2952.

1.2. SUSTAINABLE TRANSPORT

According to the Organisation for Economic Co-operation and Development (OECD) report, the environmental and health effects of the motorised transportation is in evidence, and these cause that are as follows: *global warming and depletion of the ozone layer; spread of toxic organic and inorganic substances, notably tropospheric ozone; depletion of oil and other natural resources; and damage to landscape and soil* (OECD, 1997: 10). The Centre for Sustainable Transportation (CST) had defined sustainable transportation system as follows:

- *allows the basic access needs of individuals and societies to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations.*

- *is affordable, operates efficiently, offers choice of transport mode, and supports a vibrant economy.*
- *limits emissions and waste within the planet's ability to absorb them, minimizes consumption of non-renewable resources, limits consumption of renewable resources to the sustainable yield level, reuses and recycles its components, and minimizes the use of land and the production of noise* (CST, 2002: 1).

Global warming has originated from deposit of greenhouse gases in the atmosphere. The world is adversely affected from global warming, has studied on avoiding negative effects of global warming. Therefore, main producer of greenhouse gases has been seen as transportation; and in order to sustain transportation some working groups founded are Sustainable Transport Analysis and Research (STAR) and Sustainable Transport in Europe with Links and Liaisons with America (STELLA). STAR has shown up in America, STELLA has arose in continental Europe. These contingents attached importance to create sustainable transport policy that are as follows: *Globalization, E-economy and Trade; ICT and Innovation in the Transport System; Society, Behaviour and Public Private Transport; Environment, Safety, Health, Land Use and Congestion; and, Institutions, Regulations and Markets* (Black and Sato, 2007: 86).

In Table 1 environmental effects of transportation on the basis of each transport mode has been showed by the help of study of Linster in 1990. Although this study is old dated study, transportation are still protecting its impact on these issues. As a matter of fact, these effects are on the increase and spread off other issues. Transport policies that can be used to avoid negative impact of transportation on environment, can be subsumed under three groups are *Transport technology, Transport supply and Transport demand* (Greene and Wegener, 1997: 181).

Table 1. Selected Environmental Effects of Main Modes of Transport

	Climate	Aquatic resources	Ground resources	Solid waste (SW)	Sound pollution	Accident risk
Shipping		Changing water system while remodelling in port	Ground use for port area	Ships cancelled from shipping		Handling of dangerous goods
Railway			Ground taken for right of ways	Removed rolling stocks	High sounds through railway	Derailment or collision of train carries dangerous goods
Land carriage	Atmos-pheric pollution	Pollutants caused by changed water systems due to highway repair	Ground taken for building	Removed wrecks due to highway repair; removed road tools from service	High sound caused by cars, motorcycle and trucks	Mortality, laceration due to land carriage and carriage of dangerous goods risk
Airfreight	Air pollution	Changing water table due to airport building	Ground taken for airport building	Aircraft withdrawn from service	High sound around airport	

Source: Linster, 1990 as cited in Greene and Wegener, 1997: 179.

Indicators which have been shown in Table 2, to evaluate transportation policies have differed from country to country, even continent to continent. For instance, in United Kingdom (UK) modal shares, especially, the number of passengers use public transport, are seen as indicators of sustainable transportation.

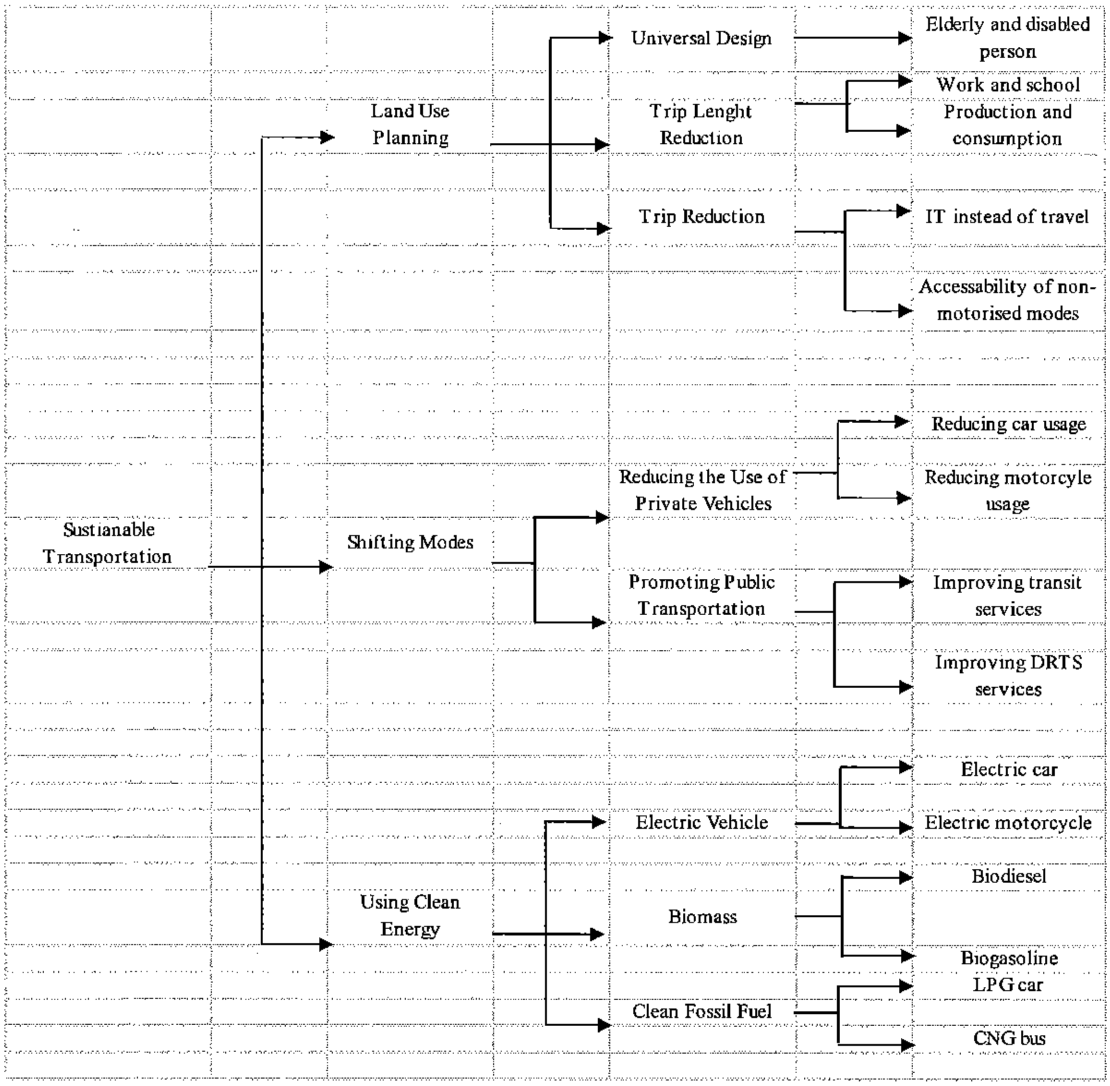
Table 2: Transportation Sustainability Meters

Purposes	**Meter**
Financial	
Honour	Fair average honoured voyage time
Transportability – Ground use	Count of job opportunities inside 30 minutes voyage distance of settlement
Transportability – Smart Development	Applications to carry out multi modal growth
Mode variety	Mode segmentation by walking, cycling, rideshare, public transport
Purchasing power	Sharing 20% of transportation costs to minimal income households
Institution cost	Expenses per capita on land ways, parking areas and service of air, railway, road, maritime traffic
Freight output	Velocity and affordability of global transport modes
Designing	Degree to applications of transportation activities against least costs and least investments
Social	
Safety	Per person handicap due to accidents and per person medical institutions
Wellness as of medical	Percentage of community that routinely walks and cycles
Public livableness	Degree to which transportation implementations raise public livableness (regional environmental standard)
Equivalent – justice	Degree to which charges represent complete costs
Equivalent – without drivers	Quality degree of transportation opportunities for not drivers
Equivalent – disabled persons	Quality degree of transportation opportunities for disabled persons (e.g., wheelchair drivers, partially sighted persons)
Transport design for engineless vehicles	Degree to which attendance of engineless vehicle into transportation design by policy makers
Inclusion national subjects	Inclusion of civis into transportation design and system
Environment	
Emissions causing climate change	Per person consumption of fossil fuel, emission CO_2
Another air pollutants	Per person issues of conventional air pollutants (CO, VOC, NO_X, particulates, etc.)
High sound pollution	Share of high volume traffic sound
Fluid contamination	Per person dehydration
Ground taken effect	Per person ground dedication for transportation institutions
Fauna and plant conservation	Conservation of non-person organisms
Resource productivity	Share of renewable resource usage while producing and using transportation system vehicles and infrastructures

Source: Bachok et al., 2015: 466.

Germany, France, Austria and Switzerland have approved the level of service, travel demand, and number of passengers use public transport, as indicators of sustainable transportation; United States of America (USA) have accepted transit accessibility and transport affordability as indicators of sustainable transportation. Japan has developed indicators in terms of Ministry of Land, Infrastructure, Transport and Tourism; other Asian nations have approved to Sustainable Urban Mobility in Asia (SUMA) project that measures evaluation of access, safety, environment/clean air, economic and social and developed as an indicators' plot to a sustainable system (Bachok et al., 2015: 465). In another study, sustainable transportation strategies that have been shown in Figure 2, had been determined by Tzay-An Shiau.

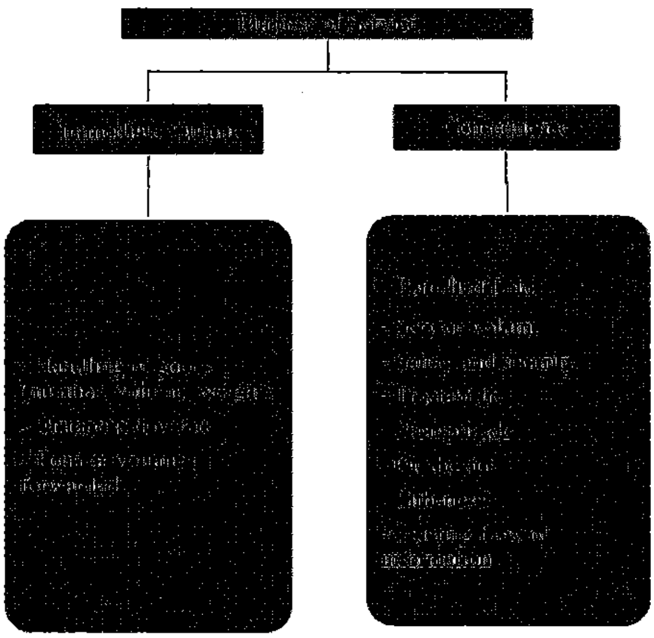
Figure 2: The Hierarchy of Sustainable Transport Strategies



Source: Shiau, 2012: 428.

According to this study, sustainable transportation can be achieved by land use planning, shifting modes and using clean energy. In order to provide land use planning, universal design, trip length reduction and trip reduction should be succeeded; in order to provide shifting the modes, reducing the use of private vehicles and promoting public transportation should be preferred; in order to provide using clean energy, electric vehicle, biomass and clean fossil fuel should be used. As a result of all that phases, indicators of sustainable transportation strategy that are Elderly and disabled person, Work and school, Production and consumption, Information Technology (IT) instead of travel, Accessibility of non-motorised modes, Reducing car usage, Reducing motorcycle usage, Improving transit services, Improving Demand Responsive Transportation Services (DRTS), Electric car, Electric motorcycle, Biodiesel, Biogasoline, Liquefied Petroleum Gas (LPG) car, Compressed Naturel Gas (CNG) bus, have been executed. After empirical study prioritization of these indicators has been executed. Hereunder, improving the accessibility of non-motorised modes has been seen as the highest priority of all. Promoting use of biodiesel and improving DRTS have chased the first place (Shiau, 2012: 432). Indicators of sustainable freight transport thereby classified as output and outcome, has been shown in Figure 3.

Figure 3: Purpose of Service Indicators in Terms of Freight Transportation



Source: Hyard, 2013: 1380.

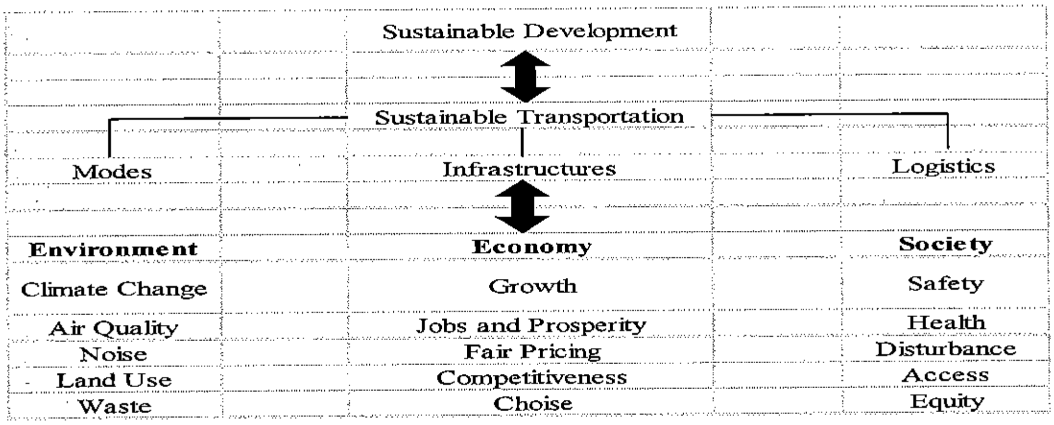
According to OECD report in 1999, transport that doesn't harm community health or ecosystem and meets requirements for access stable, can be supplied if renewable resources are used at below their rate of renewal and if non-renewable resources are used at below the rate of renewal alternative (Butcher, 1999: 5).

The environment, air quality, motor vehicle accident, congestion and long term fuel need can be counted as consideration of sustainable transportation (Black and Sato, 2007: 87). Therefore the sustainable transport concept offers the interdependency between environmental, economic and social angels each other, in order to maintain environmental protection, economic stabilization and social progress while proceeding to use transportation system.

1.3. THREE DIMENSIONS OF SUSTAINABLE TRANSPORT

According as remarked by the United Nations (UN) in its Agenda for Development, economic progress, social progress and environmental conservation constitute components of sustainable development (Kuhlman and Farrington, 2010: 3438). Sustainable transportation has also been divided into three parts are economic, social, and environmental sustainable transport (see in Figure 4). Economic sustainable transport is related with *Growth, Jobs and Prosperity, Fair Pricing, Competitiveness, Choise;* social sustainable transport is related with *Safety, Health, Disturbance, Access, Equity;* environmental sustainable transport is related with *Climate Change, Air Quality, Noise, Land Use, Waste* (Solak, 2014: 18).

Figure 4: Sustainable Transportation Concept



Source: Rodrigue et al., 2013 as cited in Solak, 2014: 18.

1.3.1. Economic Dimension

Sustainability in transportation represents continuous development on transportation systems, options and anticipations supply aim of protecting future social and economic development within the scope of environmental sustainability that protects community health (Verma, 2013: 1). In order to achieve economic development while promoting sustainable transport, cost efficiency in transportation systems is vital. Transportation costs are following: *the price of motor fuel, Congestion charging or road pricing, Toll schemes, whose main purpose is often to fund road investments, but may be regarded as a very simple form of road pricing, Schemes designed to reward car drivers for reducing their driving, complying with speed limits or avoid driving in the rush hours* (Elvik and Ramjerdi, 2014: 90).

Economic dimension of sustainable transport involves cost minimization, suitable output due to limitation of quality, profit maximization, social benefit and opportunity maximization, operational cost minimization of the transport (Daraio et al., 2016: 3). Additionally, productiveness, economic performance, cost restructurings, cost functions, subsidies, liberalization and privatization, economies of scale, economies of scope, transport infrastructure cost reduction and tracking of environmental costs which eliminate waste and reduce production costs for both operation and production, can be seen as indicators of economic dimension of sustainable transport (Yang et al., 2016: 1156).

1.3.2. Social Dimension

Sustainable transportation system should involve urban land use, envisioning, infrastructure describing, repairs and maintenance, travel demands, financial analysis, proposals and introduction, creation of career opportunities (Yang et al., 2016: 1156). Generally, social dimension of sustainable transport had seemed related with quality of life, and seems as improver of quality of life whose lives in public. Quality of life refers to well-being (Steg and Gifford, 2005: 62). In Table 3, indicators of quality of life has been presented.

Equity between present generation and future generations constitutes main component of sustainability. If protecting next generations is not an issue, climate change and scarce resources wouldn't be vital. However, most of environmental impacts of transport also have a strong social effect in terms of current generation (Greene and Wegener, 1997: 180). According to Grieco, poverty and social injustice create main problem of social sustainability in the transportation. Discrepancy of per capita income from city to city had been executed and the effects of these discrepancies on pricing policy of transportation actualises in public domain.

Table 3: Life Quality Indicators with Their Definitions

Indicator	Definition
Wellness	Having fitness.
Unity of family	Holding healthy relations between members of the family.
Social equity	Presentation equivalent rights and opportunities to citizenry.
Liberty	Giving opportunity to citizenry for making their own decision.
Safety	Safety at home and in the street thereby protecting citizenry from criminal events.
Training	Giving a well-defined training occasion to citizenry and improving knowledge of public.
Personality/Self esteem	Providing improving self-confidence opportunity to citizenry.
Private life	Giving opportunity for public members to be themselves.
Environmental growth	Avoiding pollutants in the soil, water and air in order to provide healthy life for public members.
Sociable connections	Existence of good relations between public members. And existence of meeting with new friends opportunity.
Labour	Existence of high level employment as much as possible.
Security	Sensing being considered by others.
Biological diversity	Existence of biological diversity and attendance of species.
Idle hours	Existence of reminder time from hours of labour and having a great spare times.
Earning	Having high level income as much as possible in order to buy things that give happiness to public members.
Luxury	Existence of luxurious life in public.
Aesthetic pleasure	Being happiness of public members from natures' beauty.
Dividedness	Having different lives of public members from each other and existence of opportunity to experience different things.
Enthusiasm	Experiencing exited things which can be sports.
Statute/reputation	Being respected by another members of society.
Secularism	Giving opportunity to members of society to carry out religious necessities according to their own religion.
Earthbound beauty	Having pleasing supplies into and about the houses.

Source: Steg and Gifford, 2005: 63.

1.3.3. Environmental Dimension

Environmental dimension of sustainable transport can be collected in 3 main title as follows:

(1) Reducing the volume of motorised travel;

(2) Transferring travel to modes generating less external effects, and

(3) Modifying road user behaviour in a way that will reduce external effects of transport (Elvik and Ramjerdi, 2014: 89).

In Table 4, environmental impacts of transportation have been executed with these impacts' disturbances.

Table 4: Environmental Impacts Caused by Transportation

Pollution reason	**Nuisance**
Atmospheric contamination	Greenhouse effect, acidization, eutrophication, ozone layer depletion, etc.
Atmospheric contamination in urban areas	Pollutants effect wellbeing medically
High Sound	Activities discomfort sensation level
Ground usage	Ground disintegration
Ecological overturn	Exhaustion of energy resources

Source: Olsson, 1999: 408.

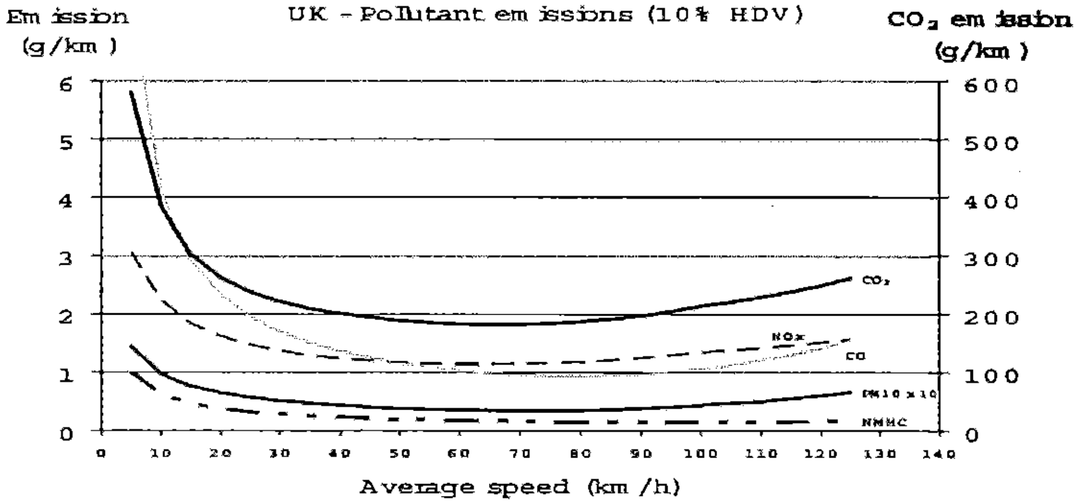
The outlays for energy are \$1.5 trillion in order to supply the demands of the whole markets. While supplying these demands, generally fossil fuels have been used as energy. However, consumption of fossil fuels contain coal, petroleum, natural gas etc., in the transport modes extends emission of contaminants. Also using fossil fuels cause health problems and environmental fate (Ahmed et al., 2016: 1370).

3 % of global CO_2 emissions are caused by shipping. Shipping is responsible for 10% CO_2 emissions within CO_2 emissions from transportation; additionally transportation by road is responsible for 73%, air traffic has share of 12%, CO_2 emissions from pipelines constitute about 3%, and transport by rail causes 2% CO_2 emissions within CO_2 emissions caused by transportation (Marquez-Ramos, 2015: 170). In order to avoid CO_2 emissions some policies have been tried to develop. One of them is decreasing speed of motor vehicles. In Figure 5, the effect of high-speed

driving motor vehicles on CO_2 emissions has been presented. Accordingly, it is seemed that emission levels are pretty much especially in initial velocity.

Generally, damage due to environmental pollution has come in view from that companies do not carry out their responsibilities in terms of community and nature. In classic view, while accounting product costs, firms calculate costs about material and employee. However, environmental resource costs were not addressed (Ding et al., 2015: 563).

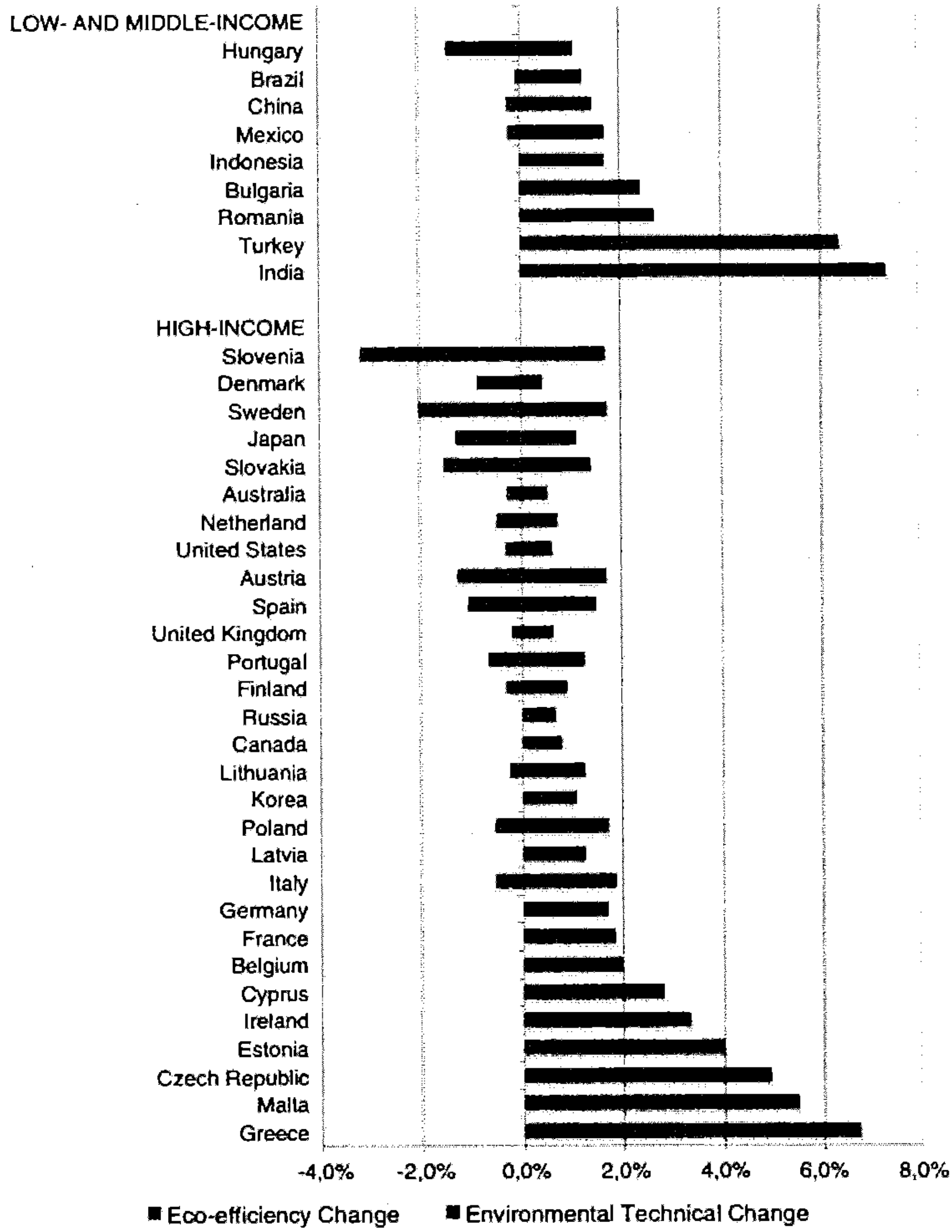
Figure 5: Gaseous Emissions as a Function of Speed



Source: OECD, 2006: 43.

Also, CO_2, CO, NO, methane gases have been released from transport industry is one of the major air pollutant; and these gases have hazardous impacts on human health and nature. Countries have policies progress transportation system, in order to protect nature and human health from these hazardous impacts. Beltran-Esteve and Picazo-Tadeo had developed a model shows countries' sustainable development in transportation sector in consequence of their policies. While this model had being fictionalized global warming factors had been considered (Beltran-Esteve and Picazo-Tadeo, 2015: 571). Accordingly, Low and Middle Income countries have emphasised on environmentally friendly approaches in sustainable transport much better than High Income countries. Social welfare also effects countries' environmental sustainable transport strategies. Effectiveness of these strategies differ from country to country in terms of level of income that has been illustrated in Figure 6. It shows that countries such as Turkey, India, Greece, Malta, have advanced in sustainable transport.

Figure 6: Countries' Sustainable Development in Transportation in Terms of Level of Income (between the years 1995–96 and 2008–09)



Source: Beltran-Esteve and Picazo-Tadeo, 2015: 576.

1.4. SUSTAINABLE PORT CONCEPT

An increase of ship number all around the world has caused great problem of the relevant air pollutants emissions produced also while they are mooring in ports (Coppola et al., 2016: 816). At first, sustainable port had been seemed as Corporate Social Responsibility (CSR) activity of ports, now this approach has been seemed as necessity in order to exist in global market competition. Concordantly port sustainability was defined by American Association of Port Authorities (AAPA) as *"business strategies and activities that meet the current and future needs of the port and its stakeholders, while protecting and sustaining human and natural resources."* (AAPA, 2008: 3). Herein, port stakeholders should have big impact on ports' policies and ports should satisfy their needs. And also Triple Bottom Line (TBL) of sustainability which are environmental, economic and social dimensions, is basic approach to develop sustainable port management policy for ports. Sustainability has objectives to progress business units likewise ports what are as follows: *"Increased Revenue / Market Share, Reduced Operational Expenses, Reduced Risk – Making for Easier (cheaper) Financing, Reduced Expenses at Commercial Sites, Increasing Employee Productivity, Higher Retention of Best Talent, Easier Hiring of Best Talent"* (AAPA, 2008: 10).

1.4.1. Historical Development of Sustainable Port

After *Our Common Future,* a report published by WCED in 1987, need for sustainability had been put into words in all spheres. Ports are also had been effected from this trend. Large vessels and ever-growing market have made ports sustainable. In 1987, an idea of giving an award to environmentally friendly marinas and beaches surfaced in France, called Blue Flag had been developed by Foundation for Environmental Education (FEE) in Europe, supported by European Commission (EC) (FEE, 2016). 17 years later, European Sea Ports Organization (ESPO) created Environmental Conduct Code for Industrial Ports which supplies guideline to port administrations when need to develop their environmental policies (Goulielmos, 2000: 190). In 1997, Eco Information System (EIS) has been developed by Amsterdam Port Authority (AMSPA)

(AMSPA, 1999: 3). Port of Rotterdam (POR) has been started to give Green Award to environmentally friendly stakeholders (Green Award, 2009). Valencia Port Authority (VPA) progressed Ecoport Project: Towards an Eco-Friendly Port Community between the years of 1998 and 2001; Ecoports Project: Information Exchange and Impact Assessment for Enhanced Environmental-Conscious Operations in European Ports and other Terminals between the years of 2002 and 2005; and INDAPORT PROJECT: System of Environmental Indicators for Ports financed by the Programme for the Promotion of Technological Research (PROFIT) of the Spanish Ministry of Science and Technology between the years of 2000 and 2003 (VPA, 2012). In order to regulate coastal regions and promote sustainable development in these areas EC approved a directive framework for area planning in terms of maritime and littoral management on the 12th of March 2013. Previously EC had studied on this subject named as Integrated Coastal Zone Management of 2002, and Barcelona Convention on Integrated Coastal Zone Management has been approved by European Union (EU) in 2010 (EC, 2016). Environmental Management System (EMS), Environmental Risk Analysis and Environmental Land Use Plans had been reformed by EC, have been used by first European ports, then global ports in the later years. In 2008, in order to determine a policy for integration of environmental sustainability requirements within the San Diego Unified Port District's (SDUPD) jurisdiction, Port of San Diego (PSD) developed GP Policy (SDUPD, 2008: 2).

1.4.2. Sustainable Development in Ports

Sustainable development has been seen as answering current requirements without vandalising the capability of meeting needs of next generations, as mentioned in a report published by WCED in 1987. Although Environment Ministers of OECD member countries inferred after their studies that struggle with climate change is essential to succeed sustainable development (OECD, 2008: 9), corporates have duties towards third parties. Accordingly, corporate sustainability had been defined as, considering environmental and social worries in commercial activities and interactive relations with stakeholders, by (Marrewijk, 2003: 96). This corporate sustainability description is valid for ports too, they also should consider their stakeholders' requirements, just as cost efficiency, profit etc., while operating environmentally and socially friendly. At the same time these aspects, environmental, economic and social cares, can be evaluated as an interwoven structure. For instance, in the study of Yang and Chang, a comparison between Rubber-tired Gantries (RTGs) and Electric Rubber-tired Gantries (E-RTGs) in terms of saving energy and reduction in CO_2 emissions, has been evaluated as follows: E-RTGs can save 86.60 % of energy and reduce 67.79 % of CO_2 emissions in comparison to RTGs; and also investment return of E-RTGs are starting after 2.2 years (Yang and Chang, 2013: 67).

Sustainable development approach aims to achieve environmental integrity, economic efficiency and quality of life (UNCTAD, 1996: 29).Using energy efficiently provides either environmentally friendly approach or social contribution and economic benefit. Energy efficiency in ports can be supplied thereby investing new equipment are new RTG cranes, reach stackers, yard tractors, wheel loaders and forklifts etc. and this creates need of information technology in ports (Pavlic and others, 2014: 936). Sustainable port management lays emphasis on five main issue are energy management, waste management, equipment management, social environment relation management and work safety (Fedai and Madran , 2015: 4). While science and technology are vital for sustainable development, other factors such as institutions, governance, and political economy are also critical for sustainable development (Balisacan et al., 2015: 6).

1.4.3. Need For Sustainable Port

According to National Association of Counties (NACO), economic development is related to existence of sustainable ports. Because ports create thousands job opportunities; handle millions of dollars while operating and this handle support countries' economic dynamism (NACO, 2014: 1). Behind these economic and social positive effect of ports, a heavy environmental pollution comes, many ports today are main producer of air pollution of the cities (Vujicic et al., 2013:

547). In addition to this, port investments are expensive, risky and long term investments; therefore ports should use current resources efficiently for productive operations (Çağlar, 2016: 143). Being sustainable for ports will progress economic benefit, social equity and environmental persistence in ports' region.

Initially, global climate change crisis based on CO_2 emission, global warming, bio-diversity loss, sea pollution, energy crisis, rapidly increasing population, inequality of income, soil and river pollution based on waste, civil liberties infringement, increasing environmental disasters and unexpected natural disasters are burning problems of humanity (Fedai and Madran, 2015: 2). Ports have important mission in order to avoid many of these problems. On the other hand ports create environmental problems due to their operations. Their operations are harmful to water, air, nature, human health when out of controlled (Darbra et al., 2005: 866). Despite the adoption of sustainable development, increased demand for resources and greater environmental pollution have propagated environmental disasters including the BP Horizon oil spill with an estimated $8.7 billion economic impact on the Gulf of Mexico's economy and loss of 22,000 jobs (Kuznetsov, 2014: 34).

Depending growing global trade, progress of the ports will continue by reason of handling goods are matter of trade via ports (Bailey and Solomon, 2004: 749). Recently, this global trade volume progress has brought with need of adopting technology, employing qualified employees, enabling quay draft suitable for mega ships, supplying the needs of electric and internet for ships have come alongside the quay, operating large-scale mobile cranes suitable for mega ships, etc.

1.4.4. Three Dimensions of Sustainable Port

Ports have responsibilities toward social life, ecological environment and stakeholders and shareholders economically. For this reason, ports should complete social, environmental and economic process for being sustainable port.

1.4.4.1. Economic Perspective

In recent years ports have become production, consumption and trade area and become logistic centre associated with globalization fulfilment. This have laid economic concern at ports' door. Ever-growing global trade and their requirements force ports to become economically sustainable in order to be elastic when needed investing new equipment or profit making integration.

In order to meet economic sustainability for the corporates, transparency is a key factor. Transparency about the sustainability of organizational activities supplies information about operations have been carried out by related company, for stakeholders are commercial organizations, labour organizations, non-governmental organizations, financiers etc. (GRI, 2011: 2). Ports as a corporate have responsibilities to groups and individuals internal and external to the organization, including shareholders, employees, and the community (Rebstock, 2014: 7).

In order to realise the sustainability in ports, some strategies involving reducing pollution, by all means and in all fields, recycling everything, from plastic (bottles) and paper (newspapers, magazines) to tyres and computers in port area, using alternative energy such as solar energy or hydroelectric power, or by replacing the port vehicles with alternative fuel vehicles, have to be actualised (Anastasopoulos et al., 2011: 79). These strategies create value added service and opportunity for asset gathering to ports.

Some activities exist in ports, add costs but no value are: *production of goods not yet ordered, waiting, rectification of mistakes, excess processing, excess movement, excess transport, and excess stock.* Lean supply chain strategies concentrate on this no value activities and aim to zero in these activities' costs (Esmer et al., 2010: 279). Port sustainability strategies involve these lean strategies in ports to increase ports' cost efficiency.

1.4.4.2. Social Perspective

Social sustainability definition had been identified by Stephen McKenzie as *"a life-enhancing condition within communities, and a process within communities that can achieve that condition"* (McKenzie, 2004: 12). According to Western Australian Council of Social Service (WACOSS), social sustainability is based on five principles as follows: Equity, Diversity, Life Quality, Inter-connectedness, Democracy and Governance (Cattalini, I., 2013: 1). Despite lack of concurrence on meaning of social sustainability, here are some components accepted exist as follows:

- *meeting basic needs;*
- *overcoming disadvantage attributable to personal disability;*
- *fostering personal responsibility, including social responsibility and regard for the needs of future generations;*
- *maintaining and developing the stock of social capital, in order to foster trusting, harmonious and co-operative behaviour needed to underpin civil society;*
- *attention to the equitable distribution of opportunities in development, in the present and in the future;*
- *acknowledging cultural and community diversity, and fostering tolerance; and*
- *empowering people to participate on mutually agreeable terms in influencing choices for development and in decision-making* (Baines and Morgan, 2004: 97).

Despite increasing care on social factors within business operations, social aspects of sustainable port have not been well identified (Denktas and Karataş, 2012: 302). A great majority of global ports have increased corporate social responsibility projects and attach importance to trainings for their employees and students of surrounding schools. The most important precondition of being sustainable port is the ability to contact well relations with their stakeholders (Denktas and Karataş, 2012: 313).

1.4.4.3. Environmental Perspective

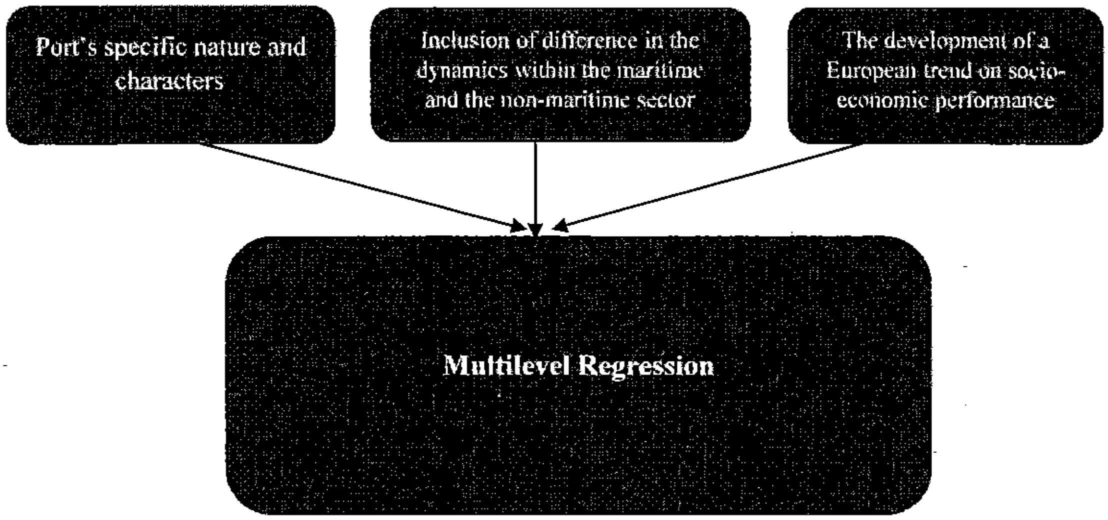
Environmental sustainability is the ability to sustain things or qualities that are valued in the physical environment includes natural and biological environment (Sutton, 2016: 1). This physical environment has been suffered by port operations. In recent years, in order to create environmentally friendly operations in ports, Eco Port and GP approaches have been progressed. Accordingly, the overall idea of the construction of an ecological port is based on few resource usage, low environmental effect, continuous growth method, powerful scale effect (Anastasopoulos et al., 2011: 76). At present, the control of greenhouse gas emissions is a key tool for measuring the environmental impact of organisations and freight (Carballo et al., 2012: 765). Importance of electrical equipment in the port area is gradually increasing. Environmental port sustainability involves not only air pollution (AIRPOL) management, but also liquid contamination preservation, precaution against SW and the other contaminants, aesthetic and excess noise detention and protecting MARBIO (Lirn et al., 2013: 447). Dust, noise, gas, sewage, daily garbage have been composed in port area by ships, operation vehicles and other operational activities in port area, create hazardous environmental pollution and this pollution threatens sustainable development of ports and their surrounding public (Sheu et al., 2013: 755).

As a precaution for environmental disasters, using electric power while handling operations, using alternative fuels in ports' superstructures, maintaining equipment regularly, using renewable energy resources, dredging activities without prejudice to marine environment and the life in the sea, providing electric power to vessels from shore, controlling port sediment, making provision against liquid leaks while loading and discharging, separation and segregation of dangerous goods in port area, managing discharges of solid and liquid waste, getting under control of discharging ballast water, trying to prevent exceeding odour sill, are extremely important.

1.4.5. Sustainable Port Examples

From the socio-economic perspective employment and value added services are important criteria to show the economic contribution of port development to local communities as well as different levels of government. For this reason ESPO has built Portopia project that its model has been demonstrated in Figure 7. Accordingly, Portopia project provides a direct employment and direct gross added value estimation tool to European ports, and this project involves scientifically valid method that based on proxy indicators related to the amount of cargo (for maritime related employment) and the land use (for non-maritime related employment) (ESPO, 2016: 40).

Figure 7: Portopia's Model for Socio-Economic Indicators



Source: ESPO, 2016: 41.

ESPO had been carried out a research in order to determine indicators of professional well-being, safety, and security in the port area. Two techniques had been used that are: a bottom-up method, involves thorough analysis for identifying symptoms implemented by ports, and a top-down approach, contains analysis of subjects under discussion and feedback from stakeholders of port and from maritime sector(ESPO, 2016: 43).

Environmental issues are key elements of port organizations to sustain their development. In February 1996 ESPO had implemented a survey for constituting advices to the ESPO Environmental Code of Practice. Then, ESPO had made another survey in 2009, and this generated priorities of European port market in terms of environmental care (ESPO, 2009: 2).

European ports have proceeded their environmental development by the help of their applications on environmental care, after every researches on determining priorities on environmental care of their region ports which executed in Table 5. In order to make up a shortage ESPO has EMS based on Self-Diagnostic Model (SDM).

Table 5: Variances of Environmental Indicators' Priorities of European Ports by Years

Remark	Years		
	1996	**2004**	**2009**
1	Seaward growth	Port trash	High sound
2	Water standard	Dredging: activities	Atmospheric standard
3	Dredging collocation	Dredging collocation	Port trash
4	Dredging: activities	Powder	Dredging: activities
5	Powder	High sound	Dredging collocation
6	Landside growth	Atmospheric standard	Stakeholder management
7	Polluted ground	Dangerous good	Power depletion
8	Habitat missing	Fuel delivery	Powder
9	Density of traffic	Landside growth)	Seaward growth
10	Industrial waste water	Bilge water management	Landside growth

Source: ESPO, 2009: 4.

EMS provides an independent evaluation by the ESPO, AAPA, ECO Sustainable Logistic Chain Foundation (ECOSLC), Eco ports collaborating experts for each port applied. EMS supplies ports some benefits that are as follows:

- *Cost saving and improved management control*
- *Compliance with legislation and good relations with stakeholders*
- *Meeting customer expectations*
- *Demonstration of commitment*
- *Improved environmental performance*
- *Motivating the port authority towards environmental management*
- *Integrated environmental management and effective integration with safety, health and quality systems*
- *Environmental monitoring which promotes the application of performance indicators to track the efficiency of the management system in actual quality of the physical environment* (Cardiff University, 2012).

According to AAPA, the Diesel Emissions Reduction Act (DERA) grants, authorized by Congress in 2005 as part of the Energy Policy Act, are part of the Environmental Protection Agency's (EPA) Clean Diesel Campaign (CDC). These grants had been donated in order to be made improve on controlling emissions, usage of alternative fuel, substituting vehicles. Ports should use alternative fuels, such as electricity, fuel cells, solar power, wind energy, and more recently, Liquefied Natural Gas (LNG), in order to develop and sustain air quality (AAPA, 2007: 26).

1.4.5.1. Port of Antwerp

The port of Antwerp handles second highest volume cargo between European ports and employing 150,000 people directly and indirectly. The Port of Antwerp (POAN) has expended energy on sustainability issues what are employment generation, education and training for workers, protecting nature in and around the port, increasing air and sediment quality, avoiding soil, noise, waste disposal in the port area, creating added value and labour productivity, decreasing energy consumption and usage of alternative and renewable energy. In return, the Port of Antwerp was selected as Port of the Year in 2014 by the International Seafarers' Welfare Awards; also Bronze IAPH Environment Award in 2013, Environmental World Ports Award in 2013, Best Belgian Sustainability Report Award in 2012, East Flanders Heritage Award in 2012, Lloyd's List Global Award in 2010, Security Award in 2009, Shipping Star Award in 2009, Best Dry Bulk Port in 2009 had been gained by the port of Antwerp (POAN, 2015: 13).

1.4.5.2. Port of Hamburg

Hamburg Port Authority (HPA) has determined some sustainable goals that are:

- *Follow sustainable guidelines and principles of resource preservation, successfully position the port to compete internationally.*
- *Positioning of the HPA as an attractive employer in the core area of expertise of Hamburg's economy,*
- *Development of the Cruise Gate Hamburg (CGH) as a new business and operational area for all three cruise ship terminals in Hamburg,*
- *Climate targets – reduction of CO_2 emissions by 40% to 1990 – must be met,*
- *Continuous dialogue with relevant stakeholders of the port, as long term (by 2025) and midterm (by 2020) strategies of Hamburg Port* (HPA, 2015: 7).

And the Authority has determined indicators of being sustainable port according to their stakeholders involve employees, customers, consumers, capital market, political and administrative authorities, suppliers, associations and non-governmental organisations (NGOs). These determined indicators are Stakeholder communication, Sediment management, Energy transition, Allocation of space, Prevention of corruption, Availability of infrastructure, Occupational health and safety, Energy efficiency in facilities, Human rights, Water quality, Air quality, Employment, Social commitment (HPA, 2015: 10).

HPA is working on the system related to environmental care by the help of the International Environmental Management Standard (ISO 14001). In order to reach goal of decreasing 40% CO_2 emissions until 2020, the HPA has being integrated its power supply into the pool agreement of the Free and Hanseatic City of Hamburg, which it will use to obtain power from renewable energy sources, thus compensating for about 50% of the overall CO_2 emissions of the company, since total energy consumption accounts for about 33% (HPA, 2015: 28). In return, the Port of Hamburg generated 13.4% of the added value, at a total of €11.7 billion; in 2013, the "Kreetsand" project what involves planning and execution of basic river-engineering measures, received an award for "Best Practice in Working with Nature" from the World Association for Waterborne Transport Infrastructure (PIANC) (HPA, 2015: 39). In POR, some services that are shore based power, inland links, clean inland shipping, we-nose system determines dangerous gases, environmental ship index, using bio fuels while operating, biomass, capturing CO_2 (POR, 2014).

1.4.5.3. Port of Gothenburg

The Port of Gothenburg (POG) set their environmental responsibility over three main areas: minimising carbon footprint, reducing the environmental impact locally, and reducing the use and consumption of resources (Karestedt, 2014: 14). Environmental overview of POG has been inferred in Table 6.

Table 6: Environmental Overview of the POG

	2012	2013	2014
Cold Ironing			
Percentage of ship would like to use cold ironing, %	34	30	37
Percentage of lay time when cold ironing might be implemented, %	18	12	16
Amount consumed MWh	10,340	10,520	10,710
Environmental Utilities:			
Sulphur dioxide in tonnes	10	10	10
Nitric oxide in tonnes	130	140	140
Particulates in tonnes	4	4	4
Carbon dioxide in tonnes	6,300	6,400	6,500
Promotive Port Tariff for Ships			
Amount of ships join sulphur programme	43	49	51
Contribution of the Sulphur Programme to the Nature:			
Sulphur dioxide in tonnes	110	120	110
Nitric oxide in tonnes	15	16	15
Particulates in tonnes	12	13	12
Emissions Caused by Maritime Activities in Gothenburg Town			
Sulphur dioxide in tonnes	700	800	700
Nitric oxide in tonnes	2,600	2,600	2,800
Particulates in tonnes	110	120	100
CO_2 in tonnes	160,000	160,000	142,000
Hydrocarbons in tonnes	58	56	43
Power Consumption and Causing Climate Change			
Green House Gases (GHGs) emissions of GPA – direct in tonnes of CO_2 reserves	480	460	380
GHGs emissions of GPA – indirect energy in tonnes of CO_2 reserves	330	330	200
GHGs' total emissions – other indirect in tonnes of CO_2 reserves	190,000	190,000	160,000
Ships powered by diesel in litres	28,000	35,000	35,000
Diesel production vehicles in litres	18,000	21,000	12,000
Petrol production vehicles in litres	8,900	5,700	3,200
Vehicle gas, Nm^3, production vehicles	5,400	9,300	9,900
Buildings consume natural gas in MWh	1,600	1,400	1,000
Pump consumes diesel in litres	2,400	0	1,800
Electricity in MWh	7,000	7,300	6,600
Heating of pipes MWh	2,000	2,000	2,000
Electrical Efficiency in KWh/m^2:			
Energy Port's workshop/building	120	110	120
Amerikaskjulet, HK/building	150	130	130
Galeren building	75	82	83
Building 642	33	36	32

Source: Karestedt, 2014: 29.

In this context, POG has implemented Stena line for onshore power supply in 1989 which transformed to unique power supply in 2000, has implemented environmentally driven tariffs to vessels since 1998, has enhanced onshore power supply service since 2011, has used electric rail trucks since 2004 and vapour recovery system since 2001, green bunkering has been implemented to minimize the risk of spillage since 2000 and founded pool for wildfowl in 2013 (Karestedt, 2014: 12-13). The port of Gothenburg's financial responsibility can be collected in three components: progress of the freight centre, financial power, and concentrate on stakeholders (Karestedt, 2014: 18). And also Financial Overview of POG between the years 2012 and 2014 has been screened in Table 7.

Table 7: Financial Overview of the POG

	2012	2013	2014
Net sales Port of Gothenburg Group, MSEK	645	628	661
Operating profit Port of Gothenburg Group, MSEK	216	452	150
Profit/loss for items affecting comparability, MSEK	174	131	150
Customer satisfaction Index	65	59	No info
Equity assets ratio, Port of Gothenburg Group	41.4	41.5	47.5
Cash flow from operating activities, Port of Gothenburg Group, MSEK	129	286	230
Costs in investment activities, Port of Gothenburg Group, MSEK	177	554	392
Services			
How many seaways are compounded by POG?	136	138	127
How many direct ship lines are calling to the other part of the world?	8	7	6
How many shipping lines are calling at the POG? (except tanker ships)	23	19	18
How many train operators are exist in Railport Scandinavia?	10	10	8
How many cruise vessels are calling?	69	39	73
Production			
Planned maintenance, MSEK	101	140	104
Volumes			
Container, TEU	900,000	858,000	837,000
Million tonnes of cargo in total	41.7	38.9	37.1
Ro-ro goods, units	538,000	557,000	549,000
New cars, numbers	163,000	163,000	166,000
Energy, million tonnes	22.2	20.4	19.2
Passengers, millions	1.67	1.69	1.82
Containers by rail, TEU	411,000	393,000	406,000
Goods by rail, million tonnes	5.3	4.9	4.9
Containers by rail in container terminal (APM Terminals), %	46	51	53
Gothenburg Ro-ro by rail, %	20	20	20
Total import/export, full containers, %	46/54	46/54	47/53
Handling containers share in Swedish market, %	60	59	57
Handling Ro-ro share in Swedish market, %	20	21	21

Source: Karestedt, 2014: 28.

The POG's social responsibility that has been shown in Table 8, is based on three main areas: generating employment, contributing to employees' training and welfare, and contributing to solving public problems. And this port creates directly 8,000, indirectly 14,000, totally 22,000 job opportunity (Karestedt, 2014: 24-25).

Table 8: Social Overview of the POG

	2012	2013	2014
In terms of Employment			
Amount of persistent employees	118	123	124
Distribution of Age, %:			
20 – 29	8	10	13
30 – 39	25	27	33
40 - 49	24	28	34
50 – 59	29	21	28
60 -	14	14	17
Mean age	46.8	45.4	44
Absence due to illness, %	3.2	3.8	4.1
Salaried Employees / Labour Agreement Employees:			
- Dockers	20	22	20
- Office attendants/directors/superiors	98	101	104
Number of females ratio to males in total	35/83	39/84	41/83
Number of females ratio to males in managers	7/15	9/13	10/15
Number of females ratio to males in management team	3/5	4/5	4/5
Number of females ratio to males on board of directors	5/10	6/9	6/10
Staff turnover, %	11.4	8	9.4
Occupational injuries	3	4	6
Fatalities	0	0	0
Number of employees applying for cycling allowance	-	6	1
Number of employees checked up	59	59	53
Number of employees using public transport	-	50	51
Number of employees applying health and fitness allowance	41	69	41
Corporate Accountability			
Number of employees directly employed by POG	8,000	8,000	8,000
Number of employees indirectly employed by POG	14,000	14,000	14,000
Number of persons are travelled by guided sighting boat trips	1,300	2,800	1,500
External visitors / groups / delegations, number of persons	3,000	2,000	1,800
Number of thesis students / interns / labour market programmes	4	11	16

Source: Karestedt, 2014: 30.

1.4.5.4. Port of Los Angeles

Port of Los Angeles (POLA) has progressed plans to sustain their operations and port area use. Within this framework, *Los Angeles Waterfront Project, Community Mitigation Trust Fund, Community Aesthetics Mitigation Program, Capital Improvement Program, Land Use Planning, Climate Adaptation, Southern*

California International Gateway, Clean Air Action Plan (CAAP) that its big impact on emission in POLA has been revealed in Table 9, *Environmental Ship Index (ESI), Vessel Speed Reduction Program, Alternative Maritime Power, Marina Engine Exchange Program, Clean Truck Program, Rail Locomotives, Pacific Ports Clean Air, Collaborative Climate Change Mitigation, Climate Leadership Award, World Ports Climate Initiative, Mitigation Monitoring and Reporting Program, Water Resources Action Plan, Tenant Storm Water Outreach Program, Energy Management Action Plan, Renewable Energy Program, Zero Emissions Roadmap* that its supplying a reduction in SO_2 between the years 2005 and 2011 has been shown in Figure 8, *Technology Advancement Program, Green Building Policy, Waste Diversion, Trade Connect Program, Strategic Sourcing Policies, Employee Training* has been used as sustainability projects in order to develop port's sustainability (POLA, 2013: 10-11).

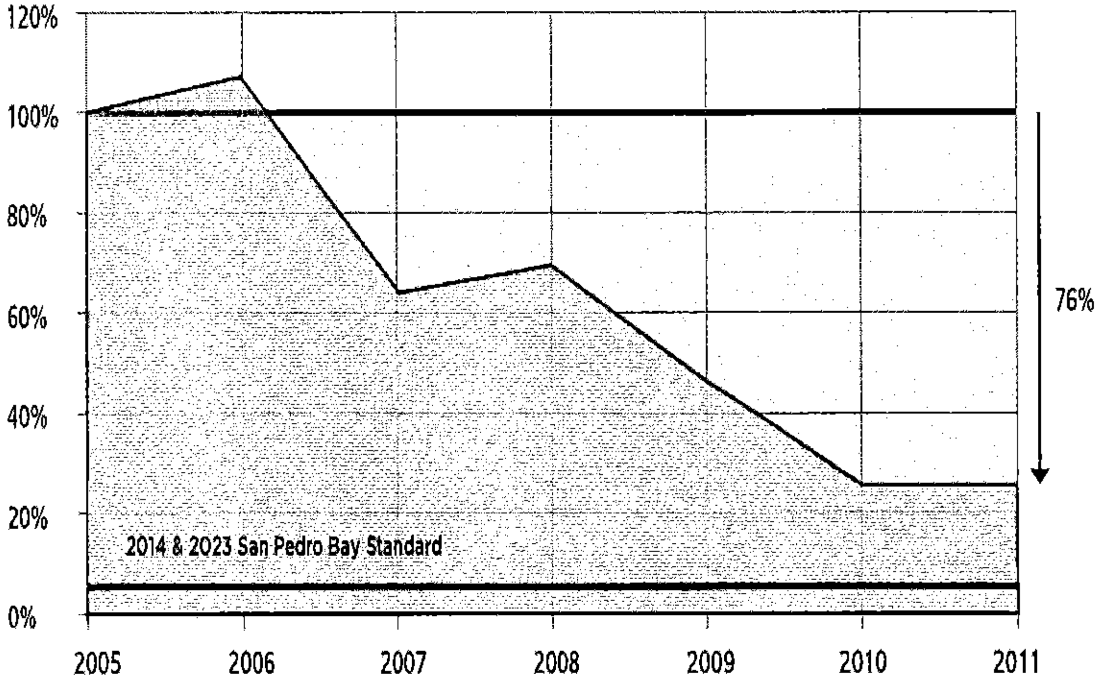
Table 9: CAAP Impact on Emissions in POLA

Year	**PM_{10}**	**$PM_{2.5}$**	**DPM**	**NO_x**	**SO_x**	**CO**	**HC**
2011	287	258	258	7,989	1,287	2,037	482
2010	304	272	276	8,212	1,319	1,995	276
2009	491	425	447	10,864	2,435	2,622	560
2008	763	655	693	15,024	3,802	3,461	719
2007	723	634	627	16,383	3,400	3,659	778
2006	1,047	896	947	18,526	5,725	4,185	866
2005	980	836	891	16,381	5,325	3,666	770
2010-2011 Period Percentages	-6%	-5%	-7%	-3%	-2%	2%	1%
CAAP Effect by Percentages (2005-2011)	-71%	-69%	-71%	-51%	-76%	-44%	-37%

Source: POLA, 2013: 31.

Thank to these projects, POLA created new non-profit organization Harbour Community Benefit Foundation to distribute fairly $350,000 for medical service. Additionally, another $450,000 had been granted for public organizations. Thank to these grants and projects, %71 DPM reduction, receiving 556 ship calls into ESI have, decreasing 500 metric tonnes GHG emissions been achieved. Compliance rate has been increased by a 94% compliance rate within 20nm of the port and a 79% compliance rate within 40nm of the port (POLA, 2013: 10-11).

Figure 8: SO_2 Reduction per year (2005-2011) in POLA

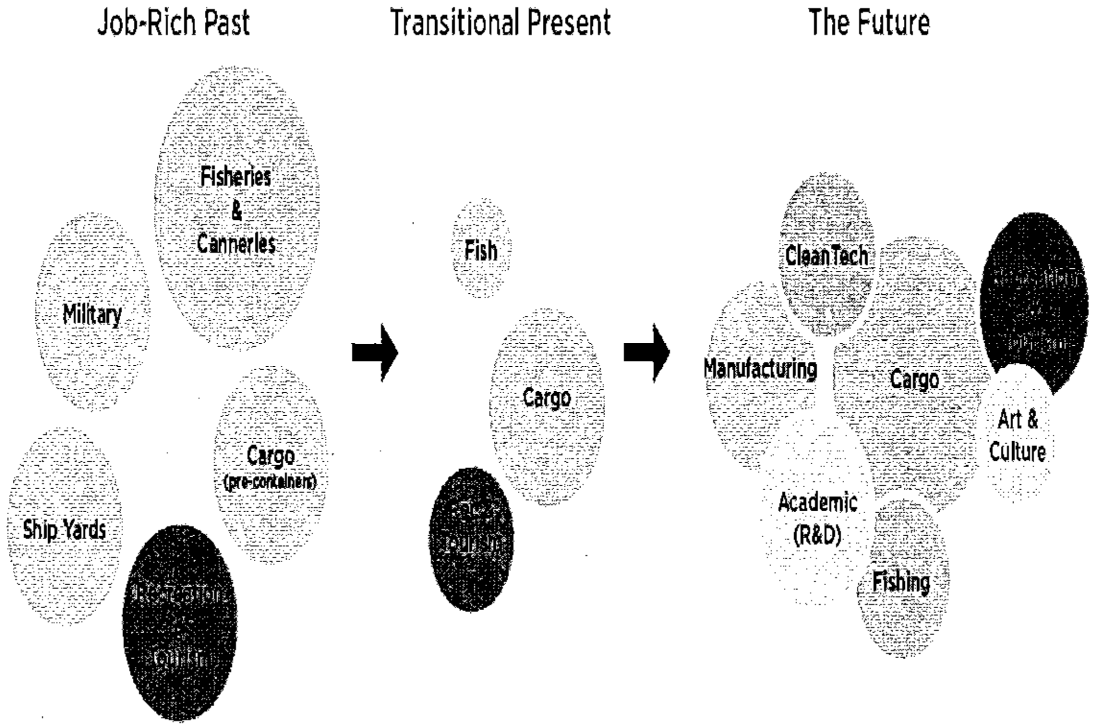


Source: POLA, 2013: 34.

POLA has created added job opportunities within the context of social responsibility to the public. Job creation diagram of POLA has been demonstrated in Figure 9.

Consequently, POLA has gained *2012 Containerisation International Environmental Award, 2012 Lloyd's List Global Award in Environment Category, 2012 Ocean Award for "Excellence in Solutions", 2012 Construction Management Association of America (CMAA) Project of the Year Award, 2011 United States Environmental Protection Agency (USEPA) Climate Leadership Award, 2011 American Public Works Association (APWA), Southern California Chapter Project of the Year Award, 2011 Engineering News-Record (ENR) California Magazine Best Project Award, 2011 American Council of Engineering Companies (ACEC) Merit Award, 2011 U.S. Green Building Council Leadership in Energy and Environmental Design*, etc. (POLA, 2013: 13).

Figure 9: Job Creation in Port Area of POLA

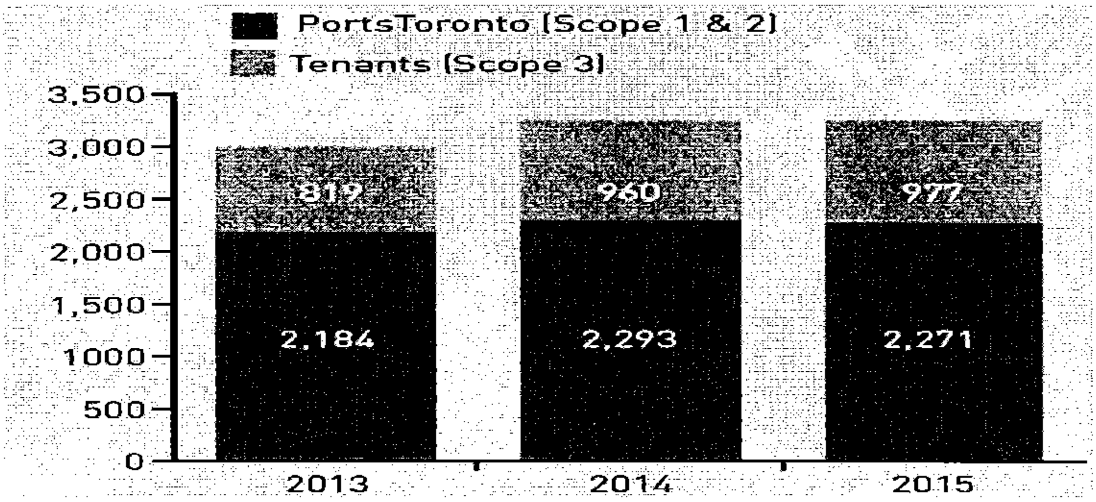


Source: POLA, 2013: 60.

1.4.5.5. Port of Vancouver and Port of Toronto

Port of Vancouver (POV) has initiated '*We Can Project*' since 2008; and through this project, the port determined previous sustainable efforts and achievement, and began working on measurable, consistent changes to identify opportunities for future growth (POV, 2013: 6). As a part of sustainability process in port area, Port of Toronto (POT) has concerned beside that the reduction of emissions that its development has been shown in Figure 10, also increasing biodiversity, dredging and wetland creation, Evergreen school ground greening program, energy efficiency, improving fleet efficiency, respecting environmental law and regulations, pursuing environmental and safety excellence in management systems, employees health and safety, continuing education and awareness, sustainable site design and construction, waste management, noise management, traffic management, stakeholder and community engagement, financial selfsufficiency, city building and investing in public infrastructure, supporting local job creation (POT, 2015: 19).

Figure 10: Annual GHG Emissions by Scope for POT and Tenants



Source: POT, 2013: 19.

1.4.5.6. Sustainable Port Concept in Turkey

According to *Doing Business 2014* report of World Bank, 189 countries have been arrayed based on 10 criteria in respect to their ports' 'ease of business'. Criteria are employment starting, ability to get construction license, ability to get electricity service connected, ability to enter for estate register, ease of loan contracted, protection of enterpriser, duties, opportunities of trade to cross border, practicability of labour agreements, and solutions of problems due to bankrupt. Accordingly, Singapore is in the first place in the line listing, respectively Hong Kong, New Zealand, USA, Denmark, Malaysia, South Korea, Georgia, Norway and UK chased Singapore. Turkey, have been ranked number 69, thereby rising 3 number year-on-year. In Table 10, Turkey's detailed ranking in the line listing based on each criterion, have been executed (World Bank, 2014: 22).

Table 10: Turkey's Rank in 189 Countries for 'Ease of Business' Criterion

Criterion	Turkey's Ranking	Best Ranking Country
Employment Starting	93	New Zealand
Ability to Get Construction License	148	Hong Kong
Ability to Get Electricity Service Connected	49	Iceland
Ability to Enter for Estate Register	50	Georgia
Ease of Loan Contracted	86	Malaysia
Protection of Enterpriser	34	New Zealand
Duties	71	United Arab Emirates
Opportunities of Trade to Cross Border	86	Singapore
Practicability of Labour Agreements	38	Luxemburg
Solutions of Problems Due to Bankrupt	130	Japan

Source: World Bank, 2014: 231.

According to the report once again published by World Bank, and named as Logistic Performance Index 2014, 160 countries have been sorted based on 6 indicators in terms of logistic performance of countries. In this report, Turkey have taken 30th place, and top ten rank is respectively sorted as Germany, Netherland, Belgium, UK, Singapore, Sweden, Norway, Luxemburg, USA, Japan (Arvis and Ojala, 2014: 15). In Table 11, situation of Turkey in logistic performance index and its rank for every indicator has been executed.

Table 11: Turkey' Situation in Logistic Performance Index 2014 Report

Indicators	Rank	Score	Best Country
Customs	34	3.23	Norway
Infrastructure	27	3.53	Germany
Shipping Coordinating	48	3.18	Luxemburg
Quality and Perfection	22	3.64	Norway
Track and Trace	19	3.77	Germany
Timing	41	3.68	Luxemburg

Source: Arvis and Ojala, 2014: 22.

Above-mentioned criteria and indexes can be seen as international indicators of being sustainable port. Turkey's situation between other countries are competitors of own, has been revealed. Thus, it is executed that Turkish ports have a long way to become sustainable, but have also opportunities. In this context, Turkish ports are keeping to invest for being sustainable and exist in the ever-growing trade market. In Table 12, some Turkish ports' investments to increase capacity of terminals, have been revealed by the help of Turkish Chamber of Shipping (TCOS) data.

Table 12: Turkish Ports' Investments to Increase Capacity

Port	Cargo Type	Current Capacity	As-built Capacity
Borusan Port	Container	400,000 TEU	650,000 TEU
	General Cargo	5,000,000 tonnes	6,500,000 tonnes
Port of Ege Gubre	Container	400,000 TEU	600,000 TEU
Evyap Port	Container	600,000 TEU	1,200,000 TEU
Limak İskenderun	Container	400,000 TEU	3,000,000 TEU
Toros Tarım	Dry Bulk/General Cargo	3,300,000 tonnes	8,500,000 tonnes
Yılport	Container	450,000 TEU	2,500,000 TEU
	General Cargo	2,500,000 tonnes	4,000,000 tonnes
	Liquid Cargo	500,000 m^3	1,000,000 m^3
Aksa	General Cargo	-	4,000,000 tonnes
Dubai Port World	Container	-	1,300,000 TEU
Batıçim	Container	-	300,000 TEU
	General Cargo	6,000,000 tonnes	7,500,000 tonnes
İgsaş	General Cargo	2,000,000 tonnes	2,500,000 tonnes
Altıntel	General Cargo	1,000,000 tonnes	5,000,000 tonnes
	Liquid Cargo	1,500,000 m^3	6,000,000 m^3
Koruma Klor	General Cargo	-	300,000 tonnes
	Liquid Cargo	2,200,000 m^3	3,200,000 m^3
Martaş	General Cargo	3,000,000 tonnes	5,000,000 tonnes
Petlim	Container	-	1,100,000 TEU

Source: TCOS, 2015: 124.

Limak Port has published a sustainability report in the year of 2014. According to this report, Limak Port's direct energy consuming has increased 4,015 to 14,749 giga calorie in 2013 than the year of 2012. Limak Port's energy consuming due to purchased electric has increased 1,990,347 to 5,058,343 kwh in 2013 than the year of 2012. Limak Port's GHGs emissions have increased 1,202 to 3,517 tCO_2e in 2013 than the year of 2012. This report has hooked these consuming raises into operational raises. On the other hand, Limak Port has invested to purchase E-RTGs, to use time adjusted lighting engineering, to use screening off and shielding to avoid dust pollution, to separate fuel based wastes, to practice sensor in electric and water usage, to practice sewage quality and noise tests (Erverdi, 2014: 75). İçdaş Port has carried out sustainability requirements are employment, occupational health and safety, emission management, biodiversity, energy and waste management. Global Ports Holding has 3 port investments in Turkey, has invested to use electrically driven equipment in their port areas. Petlim Port located in Aegean region of Turkey, has developed employee codes of conduct in order to carry out social sustainability requirements.

Generally, sustainable port concept has been evaluated under the titles of social, economic and environmental dimensions. Green port concept as to, has been evaluated under the title of environmental dimension of sustainable ports. Although, environmental protection issues have been viewed in green port concept, being green port provides also economic benefits and social equity. In chapter 2, green port concept and this concept's performance indicators will be evaluated thereby analysing in social, economic and environmental frames.

CHAPTER TWO

GREEN PORT PERFORMANCE CRITERIA

2.1. GREEN PORT CONCEPT

Seaports serve globalization thereby connecting sea routes, supporting global trade and propping countries' economic progress (Chiu et al., 2014: 1). Ports play a key role as transhipment hubs in order to be carried out the global supply chain logistics (Bergqvist and Zanden, 2012: 85). Recently, ports drive global trade competitiveness how being intermodal nodes in international supply chain networks (Esmer et al., 2010: 279). Ports' competitiveness and efficiency are vital elements for ports according to well-accepted port management studies (Lirn et al., 2013: 428). However the growth of trade volumes and need for competitiveness on the world-wide market are forcing ports around the world to sistematically and continously evaluate all possibilities for the optimisation and related costs reduction (Pavlic et al., 2014: 936).

Ports promote employment, variability of price, and related industries; and these promotions supply economic growth. Additionally close relationship between ports and their stakeholder, governments, NGOs contributes to provide added value, financial revenue, and to gain social recognition (Dooms et al., 2015: 171). Ports offer their region social and economic benefits, but also must fulfil environmental requirements (Rodrigue and Schulman, 2013). Ports have observable impact on economy, community and environment. Thus ports need to be sustainable in terms of economic, social and environmental perspectives. At this point GP is the approach what supports and contributes sustainable development of ports. GP should be comprehensive and structural combined ports which are integrated social, economic, cultural, environmental and other factors; also GP defends an opinion that are social stability and civilization rapid economic development and harmonious environment (Ying and Yijun, 2011: 467).

Both domestic and foreign ports are accord with in terms of "eco-ports", "GPs", "environment-friendly ports" and other concepts of GPs (Ying and Yijun, 2011: 468); "GP" is the most common usage when academia needs to describe or mention these all notions which are have same meaning with "GP". The GP is defined as "*a product of the long-term strategy for the sustainable and climate friendly development of port's infrastructure*" (Pavlic et al., 2014: 936). He Jing and Ji Yijun defined the GP inclusively as "*the GP had to take the economic and environmental benefits into considerate, instead of taking environmental protection as a cost, it paid attention on environmental protection, the friendly development of ecology, saving resources and energy, strengthen environmental management, and constructing ecology ports, etc., also promoting harmonious relationship between the nature, economic and society in sustainable development, this meant the GP need to reach a balance of the impact on environment and economic benefits, and the sustainable port will not cause fatal impact on environment*" (Sheu et al., 2013: 756). In GP concept economic, social and environmental awareness are seen as precipitating factors for each other.

2.2. GREEN ASPECTS

Ernst Haeckel who uses *ecology* term, derives this from *oikos* word what is meaning as house in Greek and *logos* word what means rational statement (Yardımcı, 2006: 1). According to Odum's definition, ecology is seeking nature's structure and process as system(ecosystem) that is supporter of life. On the other hand, industry and business are researching new ways that would allow for further economic growth and ecological adaptation of industrial productions at the same time (Huber, 2000: 269). Environmentalism which is namely environmental protection opinion, perceives inside stream ecological disruption what is called environmental problems of current period and environmentalism is in a struggle for solution seeking within the scope of current business (Yalçın, 2010: 3). Either port operations should be adapted to ecology as an industrial production. Therefore, materials usage, refers for ports: handling and transporting equipments, energy usage should be improved and thus resource, capital and labour productivity will be increased. Growth of the global corporations, trade volume, investment, travel, and technological development contributing a lot to the deterioration of the environment. For instance, tariffs on forest products are reduced to a minimum (Yussupova, 2014: 2).

Seaports are located in nodal point of international transport thereby contributing global commerce and countries' economic expansion. And also seaports in the line of their duty on international trade, are being the checkpoint for human made inputs which are environmental pollutant. At this point GP concept offers solutions and requirements in order to prevent environmental pollutants are caused by the vehicles and handling activities of seaports. The GP approach implements three aspects what are low energy consumption, environmental guard, and attention to ecology (Chiu et al., 2014: 2).

As well as energy use is controversial issue in modern world, energy is irreplaceable factor for continuous development and economic growth (Sadeghifam, 2013). Nowadays decreasing energy resources cause to turn onto alternative energy and idle energy recovery which is the best way for energy conservation. According to the study, implementation readily of new technologies can bring to successful conclusion in energy savings of nearly 30% (Shen et al., 2015: 322). This study shows that technological developments and their usages are not single-handed enough. Social behaviour should gather round the GP concept for being more environmentally friendly. For example, all the most successful and sustainable energy conservation programs in Asia have two features: state aid and continuing financial investment (Yang and Rumsey, 1997: 520). If energy development of Asian countries within years is considered, this program can be implemented in Turkey. Therefore Energy Conservation Centres should be founded in just the same way as Asian practice coupled with government investments.

In order to increase environmental protection governmental regulations have strong impact. When administrative sanctions and audits resolutely applied; when demotic environmental consciousness is enhanced; when informing about administrative fines is raised, the effect of administrative level is increased and real solutions are revealed because of its relations on environmental law (Hatipoğlu, 2013: 2). Within the scope of public susceptibility against environmental problems, worries just as nature protection, life quality protection and environmental conditions protection, constitute content of environmentalism. Environmentalism appeared in the middle of nineteenth century as Sierra Club, Audubon Society in the USA

(Yalçın, 2010: 2). Discount rates play vital role for environmental protection. Lower discount rates can recess for environmental friendly investments.

Darbra et al. have revealed eleven green aspects that are as follows (Darbra et al., 2005: 867):

- *Emissions to air (including gases, solid particles and energy; dust is a significant contribution).*
- *Discharges to water (e.g. waste waters, accidental releases during loading/unloading operations).*
- *Releases to soil due essentially to industrial activities.*
- *Releases to marine sediments and activities affecting the seabed (such as dredging).*
- *Noise, with its potential impact on population and fauna.*
- *Waste generation and dredging disposal.*
- *Loss/degradation of terrestrial habitats.*
- *Changes in marine ecosystems.*
- *Odours.*
- *Resource consumption.*
- *Land and sea occupation.*

2.3. GREEN PORT PERFORMANCE CRITERIA

Despite the most of port management studies have centered issues related with competitive edge and loss minimization of ports, currently studies on the issues that are port sustainability and trainings accord with sustainability of port workers have found place in literature and courses in the universities provide training for maritime subjects (Lirn et al., 2013: 428). According to the UK's Department of the Environment, Transport and the Regions, has confirmed the following eight objectives of a sustainable distribution system which containes port system as cited in (Gilman, 2003: 276):

- *Improve the efficiency of distribution*
- *Minimise congestion*
- *Reduce the road freight intensity of economic growth*

- *Make better use of transport infrastructure*
- *Minimise pollution and reduce greenhouse gas emissions*
- *Reduce noise and disturbance from freight movements*
- *Manage development pressures on the landscape – both natural and man made*
- *Reduce the number of accidents, injuries and cases of ill health associated with freight movement.*

In distribution system several transport modes are exists. All of them are serving for globalization. Damages to the environment of shipping are less than other freight transport modes. Hence, shipping is the most sustainable mode. So, in order to hand down the next generations the globalization, maritime mode has a tight role in distribution system all around the world. At this point, ports are fundamental point for interconnecting the whole modes each other. Due to these reasons, Green Performance of ports is vital for actualization of globalization in the strictest sense, for productivity of distribution system, for next generations by implication.

Frankel proposed Port Planning and Development that contains requirements from plan related with port lay out and improvement. These subjects what are cited from Lirn et al. Study, are listed below (Lirn et al., 2013: 429):

- *sediment of port entrance and coast erosion;*
- *MARBIO protection;*
- *oil spill;*
- *waste dumping in the water;*
- *cargo spilling from chemical carriers and tanker;*
- *air pollution from bulkers' cargo handling;*
- *aesthetic interference with local community;*
- *oil spillage during disconnection of cargo pipeline;*
- *noise and vibration from cargo handling;*
- *impact on marine fauna during vessel sailing, operation, and anchoring;*
- *impact of ballast water on plankton;*
- *decreasing number of marine fauna near the port (because of the concentration of marine fauna and flora by the port infrastructures);*
- *separation effect during the dredging of the navigation channel;*

- *collision and stranding of vessels;*
- *interference with recreation boats and fishing boats;*
- *pipeline network and its impact on the real estate value of the local community; and*
- *interference during construction or renovation of the port facility.*

According to study of Gupta et al., ports have been set up coast or riverfront, cause to release natural and human related contaminants to the sea or environment by means of port operations which are dredging operations, disposal of materials, coastal area enlargement. Environmental pollution problems by means of port operations can be collected as follows (Gupta et al., 2005: 134):

- *Coastal habitats can be ruined and navigational channels silted caused by causeway construction and land reclamation.*
- *Unrestrained mariculture activities in the port and harbour areas can impend shipping safety.*
- *During construction and operation phases in the port, deterioration of surface water quality can be occurred.*
- *Port operations may generate sewage, bilge wastes, SW and leakage of harmful materials both from shore and ships.*
- *Human and fish health may be influenced by contamination of coastal water due to urban effluence discharge.*
- *Oil pollution is one of the major environmental problem as a consequence of port and shipping operations.*
- *Air pollutant emissions caused by ship emissions, loading and discharging operations and construction emissions due to vehicular movement.*

Nowadays ports play critical role for global trade, and they become logistic centres thus they create value added services for their region. Despite all, ports have negative impact on their region's environment. Ports' environmental impact can be demonstrated as excess noise caused by ships and handling equipment in port area, CO_2, NO_X, and SO_2 emissions caused by ships and vehicles in port area, dust caused after handling operation of goods are grain, coal, sand, and creating added road and rail traffic. These negative impacts can be classified as below (Chiu et al., 2014: 3):

- *Problems caused by port activity itself;*

- *Problems caused at sea by ships calling at the port; and*
- *Emissions from intermodal transport networks serving the port hinterland.*

In order to reduce or minimize environmental negative impact of ports, to fulfil GPPC is vital. According to AAPA's report published in the year 1998, seaports' environmental concerns are sorted below (Bailey and Solomon, 2004: 751):

- *Air pollution from port operations, including smog and particulate pollution.*
- *Loss or degradation of wetlands.*
- *Destruction of fisheries and endangered species.*
- *Wastewater and storm water discharges.*
- *Severe traffic congestion.*
- *Noise and light pollution.*
- *Loss of cultural resources.*
- *Contamination of soil and water from leaking storage tanks.*
- *Air releases from chemical storage or fumigation activities.*
- *Solid and hazardous waste generation.*
- *Soil runoff and erosion.*

In the study of Klopott has focused on Polish ports' environmental requirements, Klopott has determined top ten priorities in order to carry out environmentally friendly attitudes for Polish ports. In Table 13 these priorities has been showed.

Table 13. Top ten environmental priorities of European and Baltic ports in 2009 and three Polish ports in 2012

			Polish Ports	
No	**European Ports**	**Baltic Ports**	**Gdynia/Gdansk**	**Szczecin/Swinoujscie**
1	High Sound	High Sound	Sewage	Dredging disposal
2	Atmospheric standard	Dredging collocation	Noise	
3	Port trash	Atmospheric standard	Dust	Dredging operations
4	Dredging activities	Stakeholder management	Dredging disposal	Conservation areas
5	Dredging collocation	Powder	Landside growth	Ship exhaust emissions
6	Stakeholder management	Dredging activities	Conservation areas	Noise
7	Power depletion	Power depletion	Ballast water	Energy consumption
8	Powder	Vessel stack emissions	Ship exhaust emissions	Ballast water
9	Seaward growth	Climate change	Energy consumption	Landside growth
10	Landside growth	Landside growth	Stakeholder management	Stakeholder management

Source: Klopott, 2013: 441.

Chiu et al. in their study, had evaluated GPPC by AHP Fuzzy method in order to determine the order of priority. 79 GPPC had been taken under review. These 79 GPPC for ports are collected under the 13 title are *Hazardous waste handling, Water pollution, Air pollution, Port greenery, Habitat quality maintenance, Energy usage, Water consumption, Port staff training, Materials selection, Land and sediments pollution, Community promotion and education, Noise pollution, and General waste handling.*

2.3.1. Air Pollution Management

Air pollution caused by ports constitutes one of the biggest negative impact to the nature. In Table 14 the place of CO_2 produced by shipping activities in the global CO_2 emission, has been showed by the help of Third International Maritime Organization (IMO) GHGs Study. In addition to CO_2, negative effecting gases such as SO_2, NO_X, PM_{10}, HC, CO and VOC, are exist in the port area (Lam and Voorde, 2012: 3). These GHGs have caused many health problems are phthisic and other respiratory illnesses, coronary and vascular illnesses, bellows cancer and preterm death for local community (Bailey and Solomon, 2004: 752).

Table 14: The Place of Shipping Welded CO_2 Emissions in Global CO_2 Emissions

Year	Global CO_2	Total shipping	% of global	International shipping	% of whole world
2007	31,409	1,100	3.5%	885	2.8%
2008	32,204	1,135	3.5%	921	2.9%
2009	32,047	978	3.1%	855	2.7%
2010	33,612	915	2.7%	771	2.3%
2011	34,723	1,022	2.9%	850	2.4%
2012	35,640	938	2.6%	796	2.2%
Mean	**33,273**	**1,015**	**3.1%**	**846**	**2.6%**

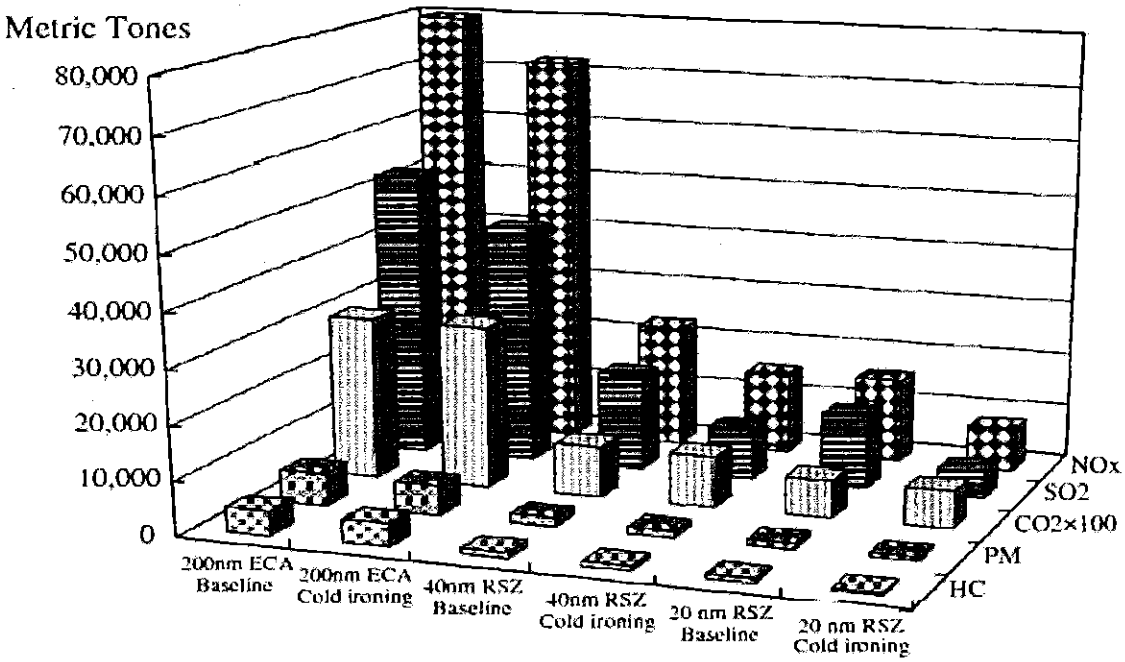
Source: IMO, 2014: 1.

ESPO encourages measurement of emissions to reduce CO_2 caused by port operation and use alternative energy, sustainable nautical service thereby using hybrid tugboats, self-propelled barges, etc. This support contains energy efficient equipment in port superstructures (ESPO, 2009: 3). Also ESPO has included these recommendations in its latest statements which are related to GHG emissions, these policy statements provide to be implemented toward accepted recommendation in World Ports Climate Declaration (WPCD) and other projects of the Worlds Ports Climate Initiative (WPCI), that are following projects to WPCD. The recommendations made by the ESPO on this issue are as follows (ESPO, 2009):

- *Calculation of a ports' CO_2 footprint;*
- *Reduction of CO_2 emissions from port operations and development;*
- *Reduction of CO_2 emissions by promoting the usage of renewable energy;*
- *Reduction of CO_2 emissions of hinterland transport;*
- *Reduction of CO_2 emissions of ocean going shipping.*

While calculating berthing emissions of vessels, lay time per call, how many vessels are handled per year, and emissions factor of auxiliary engines are used. According to the study implemented in Kaohsiung Port, after using cold ironing what is supplying electric energy needs of ships from land side, reduction had been observed on emissions of NO_x by 49.2%, SO_2 by 63.2%, PM by 39.4%, CO_2 by 57.2% and Hydrocarbons (HC) by 29.2% (Chang and Wang, 2012: 189). Positive effect of cold ironing on GHG emissions has been shown in Figure 11.

Figure 11: Effects of Cold Ironing on the Emissions Inventory in Kaohsiung Port



Source: Chang and Wang, 2012: 188.

On April, 2008, Board of Directors of the IAPH added up officials of The Large Ports Climate Leadership Group, also known as C40 World Ports, by the meeting has been named as C40 World Ports Climate Conference (WPCC). After this meeting, a declaration is named as the WPCD has been published. Pursuant thereto, advisor opinions has been executed in order to reduce green gas emissions produced by shipping sector. These opinions are as follows (ESPO, 2009):

- *Support the development of clean shipping (fuel / engine / ship design).*
- *Promote and accommodate the further development and standardisation of shore-side supplied (renewable) electricity.*
- *Consider speed reductions were effective and possible with regard to nautical safety.*
- *Develop transparent incentives based on a shared system of environmental indexing of ships.*
- *Urge the IMO to accelerate incorporating best practices in reducing* CO_2 *in IMO treaties and to accelerate adoption of the current proposals to amend International Convention for the Prevention of Pollution from Ships (MARPOL) Annex VI.*

- *Promote CO_2 reduction measures for terminal operations and cargo handling (e.g. in lease contracts).*
- *Promote co-siting and shared utilities to capture energy efficiencies and use waste energy.*
- *Develop sustainable nautical services, such as those represented by tugs and other harbour craft.*
- *Encourage shore-side supply of (renewable) electricity for inland navigation, e.g. inland vessels, tugs and self-propelled barges.*
- *Improve the energy efficiency of buildings, cargo handling, transportation and other elements of public and private port operations.*
- *Use efficient and innovative logistics to reduce the need for hinterland transport.*
- *Institute, facilitate and program the modal shift towards clean and energy efficient modes of transport.*
- *Stimulate the environmental performance of all transport modes (e.g. by environmental zoning).*
- *Promote and enable generation of renewable energy (e.g. wind, solar, geo-thermal) in public and private domains.*
- *Use renewable energy where possible for port authority operations and advocate the use of renewable energy for port operations more broadly* (IAPH, 2008: 3-4).
- *Promote the transport and processing of certified biomass for the production of renewable energy.*
- *Begin a process of quantification and managing of CO_2 footprints by creating carbon inventories for their own activities, for port operations as a whole, and for the relevant part of the supply chain.*
- *Create structures and reporting mechanisms to internalize CO_2 self-assessment and control.*
- *Develop the methodology to determine and reduce the footprint of the port area (per unit of activity/cargo) and distinguish between cargo handling and port industrial activities.*

- *Develop their own (proportional) targets for CO_2 emission reductions in the port and industrial area in conjunction with relevant parties.*
- *Create institutional mechanisms and responsibilities within their ports to drive continuous emission reductions and innovation.*
- *Monitor and evaluate the implementation of the afore-mentioned initiatives.*
- *Advocate the agreed initiatives through an active leadership role throughout their regions and networks.*
- *Organize and facilitate technology transfer, education, outreach and exchange of best practices and cost benefit examples.*

According to Port of Long Beach report on emissions inventory, air pollutants and their producers in port area has been revealed in Table 15. *Particulate Matter* (PM) which divided as *PM less than 10 microns in diameter (PM_{10}) and PM less than 2.5 microns in diameter ($PM_{2.5}$), Diesel Particulate Matter (DPM), NO_x, SO_x, (HC), CO, GHGs* which are CO_2, CH_4, N_2O, are main air pollutants produced by *Ocean-going vessels (OGV), Harbour craft, Cargo handling equipment (CHE), Locomotives, Heavy-duty vehicles (HDV)* (POLB, 2014: 2-3). PM emissions from ships cause 60,000 premature death annually. The IMO has adopted regulations in order to reduce air emissions produced by maritime activities, in specific areas around the world is called Emission Control Area (ECA) (Chatzinikolaou et al., 2015: 155).

Table 15: Port Related Emissions in POLB by Category, tons

Type	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
OGV	126	114	99	4,258	655	462	219
Harbour craft	27	25	27	667	1	313	56
CHE	11	10	10	546	1	617	36
Locomotives	25	23	25	695	1	156	39
HDV	16	14	14	1,045	3	318	52
TOTAL	**205**	**186**	**175**	**7,211**	**650**	**1,866**	**402**

Source: POLB, 2014: 114.

2.3.2. Liquid Pollution Prevention

The successful GP fulfils the regulations of IMO for management of dumping of wastes to the sea related to avoiding oil pollution, avoiding sewage pollution, repression garbage of vessel (Sheu et al., 2013: 764). Oil pollution from port operations is very important and regulations on this issue have been determined in MARPOL Annex I. According to MARPOL Annex I oily water separator should be used while discharging bilge water or separating oily waters from the cargo stores in vessels. This separations supply great decrease in the pollution of the seas. Human health and nektons' health are in danger against sewage is discharged by vessels. For this reason, discharging sewage into the sea nearby ports as near as 12 nautical miles (nm), has been forbidden by IMO in terms of MARPOL Annex IV. This rule has gone for vessels have 400 gross tonnage (GRT) and above weight and allowance to transport more than 15 passenger or crew. The United Nations Convention on the Law of the Sea (UNCLOS) in Article 196, have called countries to take joint action against the whole pollutants are caused by shipping operations, caused by ships' liquid discharging, caused by uncontrolled SW reception (IMO, 2016a).

Oil spill in the ocean threats MARBIO and inhesion of ecosystem in the water. If we need to cite example, the most recent event is Deepwater Horizon (DWH) oil spill in the northern Gulf of Mexico, after burst and foundering of the DWH on 20 April 2010. The oil spill had become stopped a result of capping with about 3.19 million barrels of crude oil on 15 July 2010. This crude oil release into the ocean had surfaced of the ocean (Sun et al., 2016: 276). Ports should have urgent action plan against all kinds of spill which can be caused by oil, chemical or waste. In order to constitute urgent action plan against this kind of pollutants, procedures of territorial and international laws can be guide for ports. Also ports should employ responsible personnel for constituting action plan to take precaution against spills (Sislian et al., 2016: 24).

Liquid form of chemicals are dangerous if they fall into the sea occurred after collision, sinking of ships, operation problem in the port area, etc. In MARPOL Annex II, categorized liquid form of bulks involved chemicals is as follows (IMO, 2016b):

- *Category X: Noxious Liquid Substances which, if discharged into the sea from tank cleaning or deballasting operations, are deemed to present a major hazard to either marine resources or human health and, therefore, justify the prohibition of the discharge into the marine environment;*
- *Category Y: Noxious Liquid Substances which, if discharged into the sea from tank cleaning or deballasting operations, are deemed to present a hazard to either marine resources or human health or cause harm to amenities or other legitimate uses of the sea and therefore justify a limitation on the quality and quantity of the discharge into the marine environment;*
- *Category Z: Noxious Liquid Substances which, if discharged into the sea from tank cleaning or deballasting operations, are deemed to present a minor hazard to either marine resources or human health and therefore justify less stringent restrictions on the quality and quantity of the discharge into the marine environment; and*
- *Other Substances: substances which have been evaluated and found to fall outside Category X, Y or Z because they are considered to present no harm to marine resources, human health, amenities or other legitimate uses of the sea when discharged into the sea from tank cleaning of deballasting operations. The discharge of bilge or ballast water or other residues or mixtures containing these substances are not subject to any requirements of MARPOL Annex II.*

LIQPOL around port is caused by ships thereby spillage after sinking or discharging sewage, ballast water illegally, or caused by port operations are loading and discharging or bunkering. Nearly 80% oil spills all around the world are happened in ports' area of responsibility, especially spillage from port operations rather than tanker accidents, constitutes the most of oil spill problems. Oil spills' potential risks on marine environment are listed below (UKMSAC, 2001a):

- *Marine animals and plants tend to be tolerant of low level concentrations of oil in sediments from chronic or small discharges, however this is not always the case.*

- *Exposure to major and minor oil spills can lead to the mass mortality of benthic communities, fish, marine mammals and birds, and the severe damage of saltmarsh.*
- *Conversely, the effects of major oil spills on marine habitats and species can often be temporary and non-fatal (for example Zostera beds were exposed to oil after the Sea Empress incident with little or no observable effects).*
- *Saltmarsh vegetation often recovers well after a single spill, however chronic pollution may cause the long-term loss of saltmarsh vegetation. Different saltmarsh species show different tolerance to oil, with the result that repeated spillages may alter the community structure and allow tolerant species to become dominant.*
- *Contamination of sediments with oil may modify chemical, physical and biological processes. Contaminants can be trapped in the sediments and later released as a result of disturbance, such as erosion.*
- *In sediments, as it is organic, oil will be broken-down relatively quickly by micro-organisms which may result in the localised removal of oxygen from the sediments and surrounding water with possible effects on marine life.*
- *The persistent toxic constituents of oil, such as heavy metals, can become stored in the sediments and taken up into the food chain. Therefore, following large oil spills, even where animals recover in diversity and density, they may continue to suffer physiological and behavioural disorders which can result in reduction of growth and reproduction, and in the worse cases, death. For example, liver lesions in flatfish are associated with high concentrations of oil in sediments.*
- *The breakdown of oil tends to be slowest in intertidal areas, which leads to the highest concentrations and longest residence times.*

Petrol spilt on the water floats on surface because of density of petrol spilt is 0.75, and petrol spilt evaporates quickly around 75 to 85% of a petrol slick evaporates from the first hour after the spill. Petrol spilt causes exist of toxic molecules with large quantities in the water column (Kremer, 2007: 18). In 1967 the world's first major oil spillage event had been happened with unleashing 37 million gallons of crude oil inside the sea of oil tanker Torrey Canyon; in 1969, unleashing of 200,000 gallons of crude oil spill into the sea had been occurred in Santa Barbara Channel; 11 million gallons of oil spillage inside the Alaska's Prince William Sound had been occurred after Exxon Valdez distress in 1989. After each disaster, regulations have been developed by authorities. For instance, National Oil and Hazardous Substances Pollution Contingency Plan (National Contingency Plan, or NCP) in 1968, National Environmental Policy Act (NEPA) in 1970, Clean Water Act (CWA) in 1972, and Oil Pollution Act (OPA) in 1990, have come into force (Meux et al., 2015: 6).

In the study of California Coastal Commission (CCC) preventing oil spill measures contains *schedules, methods, and procedures for testing, maintaining, and inspecting pipelines and other structures that contain or handle oil that may impact the coastal zone; methods to reduce spills during transfer and storage operations, including overfill prevention and immediate spill containment provisions; and procedures to assure clear communication during oil transfer operations* (CCC, 2013: 11). According to report of CCC on Oil Spill Prevention categories of the oil spill are as follows (Tejedor and Spinosa, 2005: 10):

- *Vessel spills (including accidental spills and operational discharges from all vessels).*
- *Oil and gas production (including accidental spills from offshore platforms, operational discharges from platforms, spills from marine and land-based pipelines and spills and discharges from land-based production facilities).*
- *Land-based sources including point sources (spills and discharges from industrial facilities and municipal treatment plants) and non-point sources (coastal and urban runoff).*
- *Natural sources of oil pollution.*
- *Air emissions.*

Ballast water that is threat for water ecosystem, and also creates health problems for the human. The National Research Council (NRC) has prepared guide for managing ballast water spillage. This guide involves some rules that are as follows (UKMSAC, 2001b):

- *On departure or before control is based on preventing or minimising the intake of organisms during the loading of ballast water at the port of origin,*
- *During the voyage control is based on the removal of viable organisms prior to the discharge of ballast water at the destination port either by treatment or by open ocean ballast water change. Shipboard treatment could commence immediately upon departure and continue throughout the voyage.*
- *On arrival control at the port of arrival begins when the vessel's master intends to discharge all or some of the ballast water on board. Control strategies are aimed at preventing the discharge of unwanted organisms that could survive in the target environment.*

The IMO regulations generally include rules are listed below (IMO, 2016c):

- *Inform local agents and/or ships of areas and situations where uptake of ballast water should be avoided, such as near sewage outfalls, areas known to be contaminated with harmful organisms or in very shallow water where there is a risk of sediment being introduced to the ballast tanks,*
- *Encourage the exchange of ballast water at sea (where it is safe to do so), and*
- *Discourage unnecessary discharge of ballast water.*

2.3.3. Solid Waste Pollution Management

The main purpose of the SWPOL management plans is reducing and preventing ships' dumping wastes illegally. As a result of analysis by tackling existing samples, it has been seen that commercial vessels cause 15-35% of total waste, fishing vessels contribute to this waste by constituting 65% of total commercial ships' waste. MARPOL regulations on what types of wastes can be collected by reception facilities located in ports have been showed in Table 16. Port waste management plans involve the elements that are as follows (Palabıyık and Altunbaş, 2004: 276):

- *A summary of relevant legislation and official regulations for delivery;*
- *Identification of a person who responsible for the implementation of the port waste management plan;*
- *An assessment of the need for port reception facilities meeting the need of the ships normally visiting the port;*
- *Examining the types and amounts of waste and cargo residues delivered in the port;*
- *A description of the treatment equipment and processes in the port;*
- *A description of the type and capacity of port reception facilities;*
- *A detailed description of the procedures for the reception and collection of ship generated waste and cargo residues;*
- *A description of how the ship generated waste and cargo residues are disposed of;*
- *A description of methods of recording use of the port reception facilities;*
- *A description of methods of recording amounts of ship generated waste and cargo residues received in the reception facilities;*
- *Description of the charging system;*
- *Procedures for reporting inadequacies of port reception facilities;*
- *Procedures for consulting with port users, waste contractors, terminal operators and other interested parties in the city management context;*
- *Reference to proper delivery of ship generated waste and cargo residues;*
- *Location of port reception facilities shown on the diagram, and map of the port;*
- *A description of the waste sorting system;*
- *List of ship generated waste and cargo residues dealt with in the port;*
- *List of contact persons, the operators and the services offered;*
- *Description of procedures for waste delivery;*
- *Description of charging system;*
- *Procedures for reporting inadequacies of port reception facilities.*

Founding integrated SWPOL system in the port management is key to reducing negative environmental effect of SWs produced by ships or operation in port area. SW management hierarchy can be collected as below *(UNEP, 2005: 9):*

- *Prevent the production of waste, or reduce the amount generated.*
- *Reduce the toxicity or negative impacts of the waste that is generated.*
- *Reuse in their current forms the materials recovered from the waste stream.*
- *Recycle, compost, or recover materials for use as direct or indirect inputs to new products.*
- *Recover energy by incineration, anaerobic digestion, or similar processes.*
- *Reduce the volume of waste prior to disposal.*
- *Dispose of residual SW in an environmentally sound manner, generally in landfills.*

Table 16: MARPOL Regulations on Reception Facilities

Annex	Waste sort	Necessity for reception facility	Waste types for reception
I	Crude oil	+	Involves all types of waste from transporting of crude oil
II	Poisoned fluid materials of bulk	+	Chemical sludge caused by chemical bulk carriage
III	Harmful substances carried by sea in packaged form	-	-
IV	Sewage from ships	+	Retained sewage in tanks of vessels after removal in ports or out of 12nm away
V	Garbage from ships	+	Garbage involves traditional (eat and wrapping) and operational (overhaul, shipload and dangerous wastes).
VI	Atmospheric pollutants caused by vessels	-	-

Source: Palabıyık and Altunbaş, 2004: 274.

Storage of sludge in vessel is a necessity to prevent pollution until giving to waste reception facilities located in land side or disposal on the deep sea. Also bins take garbage in, should be covered strictly and guarded against the heeling and the access of gnawers and insects. As opposed to defection of rodents and insects in containers, inside of the containers must be cleaned after handling operations (WHO, 2016). SW reception is the best way to manage any pollution from SWs produced by ships. Directive on port waste reception facilities is exist regulated in MARPOL 73/78. The basis characteristics of this instruction are as follows (Georgakellos, 2007: 510):

- *Each community port shall have a waste management and handling plan.*
- *Each community port shall ensure that there are adequate waste reception facilities for vessels normally calling at a port.*
- *All ships calling at a port must land their ship-generated waste unless they have enough storage capacity for the waste to be delivered at a subsequent port.*
- *The cost of the port reception facilities shall be covered through the collection of fees from ships. The amount and the basis on which the fees have been calculated should be made clear for the port users. The fees should be fair, transparent, non-discriminatory and reflect the costs of the facilities and services made available.*

2.3.4. Marine Biology Protection

Marine Conservation Biology is an approach has been arisen to prevent disappear of biological diversity in the seas thereby supplying data. Marine Conservation Biology has interacted with other sciences that are MARBIO, ecology, ichthyology, oceanography, biological oceanography, and others. MARBIO has exercised on life existence in the ocean. Also salt water environments such as estuaries and wetlands penetrate the field of MARBIO's study. Differently, biological oceanography has studied on same issues but studied in oceans as a field of its study, despite two different discipline are used as interchangeable notions. MARBIO has interacted with other sciences that are astronomy, biological oceanography, cellular biology, chemistry, ecology, geology, meteorology, molecular biology, physical oceanography and zoology and the new science of marine conservation biology draws on many longstanding scientific disciplines such as marine ecology, biogeography, zoology, botany, genetics, fisheries biology, anthropology, economics and law (Marine Bio, 2015).

Recently increase in tonnages of vessels, has obliged ports to supply deeper draft. Dredging operation may be caused problem or harmful damages to surrounding structures and marine ecosystem. The principal components of dredging are excavation, removal and transport, and disposal of earth material. Dredging sometimes creates unwanted effects which are ground vibration, air blasts, shock wave pressure, etc. are enough to damage to the surrounding structures and environment (Tripathy and Shirke, 2015: 249).

2.3.5. Operational Risk and Odour Management

Port sediments are largest depository of metals, dust contamination in marine environment. Determining polluted sediments in port area is still quite difficult. Methods named "threshold value" or "geochemical background concentration range" are unequal to distinguish polluted sediments from unpolluted sediments (Mali et al., 2015: 709). *Mud, talcum, red soil, fly-ash, sand, calcium carbonate, silica and test dust* constitute dust pollutant (Darvish et al., 2015: 737).

Storage of dangerous goods in port area creates great risk. A historical analysis shows that 17% of all chemistry accidents has been occurred while storing. According to report of the National Fire Protection Association (NFPA), fire accidents caused by storage facilities that actualized in USA, constitute 13% of all accidents. And fire accidents caused by storage facilities are costed $69,980,000 (Bernechea and Viger, 2013: 49).

Ports should make the necessary studies to manage contaminations produced by port operations. This planned studies should become guide to manage superstructures in port area sustainably and to determine dangerous wastes to get under control. Another environmental problem that disturbs community and ecological balance is noise pollution produced by port operation, the vehicle and ship traffic. Ports should determine effective their own noise measurement standard in order to regulate noises from activation of whistles, klaxons, equipment alarms, and others. Usage of diesel or diesel-electric powered equipment, usage of trees as barrier thereby planting around the port, using water cooled systems rather than using air cooled systems, laying on ground with lighter asphalt, etc. are countable as efficient methods to reduce noise pollution (Anastasopoulos, 2011: 78).

2.4. CURRENT GREEN PORT POLICIES

2.4.1. IMO Regulations

IMO forces maritime industry to obey regulations on emissions from ships especially NO_X, PM_X, and SO_X levels of emission caused by ships. Also, IMO restricts sulphur volumes of fuels fire marine engines up; and interacts with countries have a coast on, and request them tight control in their continental shelf (AECOM, 2012: 2). IMO also has adopted mandatory measurements of energy consumption with Energy Efficiency Design Index (EEDI) and Ship Energy Efficiency Management Plan (SEEMP) in order to provide observable decrease on CO_2 emissions caused by maritime operations. MARPOL is main regulation for reducing pollutants produced by maritime operation and accidents. MARPOL includes Annex I involves rules for preservation of oil pollution; Annex II contains regulations for transporting of hazardous liquid bulks; Annex III comprises adjustments in order to prevent pollutants produced by harmful packaged goods; Annex IV is related to avoiding vessel sewage pollutants; Annex V applies rules related with prevention of vessel garbage pollutants; Annex VI embodies orders for repression of air pollution produced by vessels (IMO, 2016d). Ports have responsibilities these pollutions from ships if ships sailing or anchoring or berthing in area of responsibility of ports. Thus ports must implement IMO's MARPOL regulations in their area that they are responsible. On April, 2008, Board of Directors of the IAPH added up C40 World Ports' officials by the meeting has been named as C40 WPCC. After this conference, WPCD contains requirement for reduction of harmful GHG emissions for nature produced by ocean going freight transport, handling activities in ports, port development, logistic of goods after handling in ports. Also this declaration reveals needs for CO_2 inventories and activities for usage of renewable energy (IAPH, 2008: 2).

2.4.2. ESPO Practices

ESPO fictionalized surveys periodically for European ports in order to assess priorities of GPPC from the perspective of each port. First survey went under the name of Environmental Code of Practice in 1994, second one implemented in 2004 named as Environmental Survey, and in 2009 Eco Ports Port Environmental Review System (PERS) has been carried out by ESPO. As I mentioned before, after each one of all surveys, European ports have fulfilled their deficiency on pollution produced by their port operations. European port sector had monitored themselves periodically by the help of these surveys and as a result had made progress on environmentally friendly approaches in port areas. GP indicators have been monitored by the help of surveys implemented to European ports since 1996. Collecting perspectives of port managers and taking precaution against these indicators have been aimed. In Table 17, progress of European ports on becoming GP, has been showed. One after the other surveys implemented in the years of 1996, 2004, 2009, 2012 and 2016 have been arisen as a result of SDM (ESPO, 2012: 13). SDM is the best practice in order to determine problems related with environment and in order to prioritize environmental indicators in the port areas. SDM gives an opportunity to port managers an ability to assess their own ports' environmental programme. Otherwise, PERS has been progressed to constitute positive environmental port management system and its practice might be certified by Lloyd's Register of itself. The project's objective had been supplied by ESPO policy makers in accordance with common purpose.

ISO 14001 standards bring some regulatory implementations that firms should carry out. ISO 14001 also supplies to progress environmental management system for ports. In order to gain ISO 14001 certificate, ports should fulfil followings (ESPO, 2012: 14):

- *Making a self-determination and self-declaration, or*
- *Seeking confirmation of its conformance by parties having an interest in the organisation, such as customers, or*
- *Seeking confirmation of its self-declaration by a party external to the organisation, or*
- *Seeking certification/registration of its environmental management system by an external organisation.*

Table 17: Progress on Selected Environmental Performance Indicators by European Ports

Environmental Management Component	Year of 1996 (%)	Year of 2004 (%)	Year of 2009 (%)	Year of 2012 (%)	Percentage Change (2004-2012)
Existence of green policy implemented by port	45	58	72	91	+33
Public availability of policy	-	59	62	85	+26
Green quality growth capacity of this policy	32	49	58	73	+24
Existence of annual green review or report published by port authority	-	31	43	65	+31
Existence of personnel concerned on green growth employed by port authority	55	67	69	95	+28
Existence of environmental management system in the port	-	21	48	62	+41
Existence of environmental monitoring carried out by port	53	65	77	80	+15
Existence of identification on environmental indicators in order to monitor in ports	-	48	60	71	+23

Source: ESPO, 2012: 13.

The EU Eco-Management and Audit Scheme (EMAS) is a measurement device for firms and administration bodies that offers reports to determine and develop their performance respecting environmentally friendly. This scheme based on measurement had been published on 22 December 2009 and had become obligatory on 11 January 2010 (ESPO, 2012: 18).

Monitoring activities of European ports are continuing still. Table 18 shows that number of monitored ports in the sense of environmental issues, have been increased.

Table 18: Components of Port Environmental Monitoring Programmes in European Sea Ports

Environmental issues being monitored by European ports	**Year of 2012 (%)**	**Year of 2016 (%)**	**% change 2012-2016**
Waste	67	79	+12
Energy consumption	65	73	+8
Water quality	56	70	+14
Air quality	52	65	+13
Sediment quality	56	63	+7
Water consumption	58	62	+4
Noise	52	57	+5
Carbon footprint	48	47	-1
Soil quality	42	44	+2
Marine ecosystems	35	36	+1
Terrestrial habitats	38	30	-8

Source: ESPO, 2016: 5.

Table 19 shows that the big majority of European ports have implemented an Environmental Policy (92%), maintain actual inventories of applicable environmental legislation (90%) and of their significant environmental aspects (89%), define objectives and targets for environmental improvement (89%), have documented environmental responsibilities of key personnel (85%) and monitor their environmental impact (82%). Ports are now using EMS, have showed increase by 16 spot in between the years of 2012 and 2016. Number of ports have environmental policy, has increased by 2 spot; number of ports determined environmental targets and objectives, has increased by 5 spot in between the years of 2012 and 2016. While number of ports documented environmental responsibilities of key personnel, has being showed one of the most increase by 14 spot; number of ports have environmental training program for employees, has showed one of the most decrease by 11 spot in between the years of 2012 and 2016.

Table 19: Percentages of Positive Answers on Key Environmental Management Indicators in European Ports

Key Environmental Management Indicators		Year of 2012 (%)	Year of 2016 (%)	Changes 2012-2016
A	Certified EMS	54	70	+16
B	Entity of a Green Policy	90	92	+2
C	Environmental Policy making reference to ESPO's policy documents	38	34	-4
D	Entity of document of relating to green regulations	90	90	-
E	Entity of document of Significant Green Aspects	84	89	+5
F	Identification of purposes and goals of green growth	84	89	+5
G	Percentage of ports providing environmental training to their employees	66	55	-11
H	Percentage of ports have environmental monitoring	79	82	+3
I	Percentage of ports documented key personnel related to environmental responsibilities	71	85	+14
J	Publicly available environmental report	62	66	+4

Source: ESPO, 2016: 3.

2.4.3. AAPA Practices

AAPA is regulatory on American ports and harbours. Recently a Memorandum of Understanding which is related to improving port sustainability, has been signed by AAPA and this signing obligatory for ports located in America. Green Marine is a venture works on maritime affairs and aims to improve environmental performance in maritime sector, and this venture has become joint for AAPA in terms of implementing this memorandum. Within the USA, a great number of conservations, adjustments and enterprises have been exhibited. These acts are as follows (AECOM, 2012: 2):

- *Clean Air Act: Requires the US EPA to regulate emissions of hazardous air pollutants such as* SO_X *and PM; sets emission standards for new diesel* *engines and boilers on vessels, as well as other engine types generally used on ports (on-road, non-road, and locomotive).*

- *Clean Ports USA: Incentive-based program to encourage ports to reduce emissions from diesel equipment on ports; funds a variety of project types, such as gate automation systems, shore power for vessels, and alternative fuel vehicles.*
- *Diesel Emissions Reduction Act (DERA): provides funds to federal and state programs to retrofit or rebuild diesel engines with proven, cost-effective technologies.*
- *AAPA Strategic Initiative – Sustainability: Implemented a task force to examine port sustainability issues and encourages ports to implement the concept of sustainability as part of their standard business practices for both near and long-term planning.*

2.4.4. Asean Ports Association (APA) Practices

Asian ports regard green approaches as method of staying leader in the global market. In Asia, environmental progress is tried with alliances of shipping lines. First example for this application is CKTH alliance (Cosco, K_Line, Yang Ming and Hanjin) which aims green transportation. Accordingly, assignment of ports is yielding this kind of enterprises contribute to constituting environmental culture. According to report of Hong Kong Port (HKP) on creating green culture, HKP has environmental potential to reduce pollutions in port area. The issues are as follows (Wines, 2010: 36):

- *The use of both berth side and portable cold ironing facilities to support in the use of electrical power generation to vessels as opposed to bunker fuel burn to run vessel APU systems.*
- *The incorporation of hydrocarbon and bio-fuel based processes to assist on the running of vehicles on the port side as well as on the vessels themselves.*
- *Incentive programmes to reduce the cost of berthing for companies with ISO 14001 certifications or for vessel operators who exceed the Marpol VI*

guidelines for the use of lighter bunker fuels, leading to the reduction of sulphur content within Hong Kong's waters.

- *Agreement to develop globally recognized certification programmes such as ISO 14001 which are designed to audit and monitor the process for continual improvement within the Environmental process.*
- *The creation of an alliance programme with the ports of Yantian and South China ports to agree the standards of environmental best practice within the region*
- *Governmental intervention to respond to the growing issues of air quality in Hong Kong and to support create necessary compliance benchmark and legislation to lead in battling pollution in Hong Kong.*

2.4.5. Countries' Own Practices

In UK, green investment bank has been launched in 2012 to fund projects aim reducing GHG emissions which are hazardous. Long term returns have been taken into account while putting these projects into practice. Producing own energy thereby collecting and using renewable energy is the preferred purpose of the China until 2020. Five year plan between the years of 2009 and 2013 of Republic of Korea contains green growth strategies. As part of this plan South Korean government thinks of investing 2% of annual Gross Domestic Product (GDP) for projects in terms of environmental growth. National projects on environmental innovation of Japan means to found Japanese Yen (JPY) 50 trillion market based on environmental innovations and to constitute 1.4 million job opportunity related with environmental innovations. In 2011, Republic of South Africa (ZAF) has planned to invest South African Rand (ZAR) 25 billion in order to progress green growth project according to announcement of the Industrial Development Corporation is reporting to the Economic Development Ministry (OECD, 2011: 13).

2.4.6. Green Port Developments in Turkey

In Turkey, ports generally have located either in city centres or round the city. Within the context of "Clean Seas and Water Front Accession" that is strategy of

Ministry of Transport, Maritime Affairs and Communications (MTMAC) of Republic of Turkey (ROT), GP Project (GPP) has been developed for Turkish ports in order to harmonise with EU's climate change and environmental protection policies. Accordingly, Turkish ports which fulfill indicators of being GP determined by Ministry, will gain right to obtain GP Certificate (GPC) and to use specially designed logo (MTMAC, 2014: 348).

2.4.6.1. Being Green Port Phases in Turkey

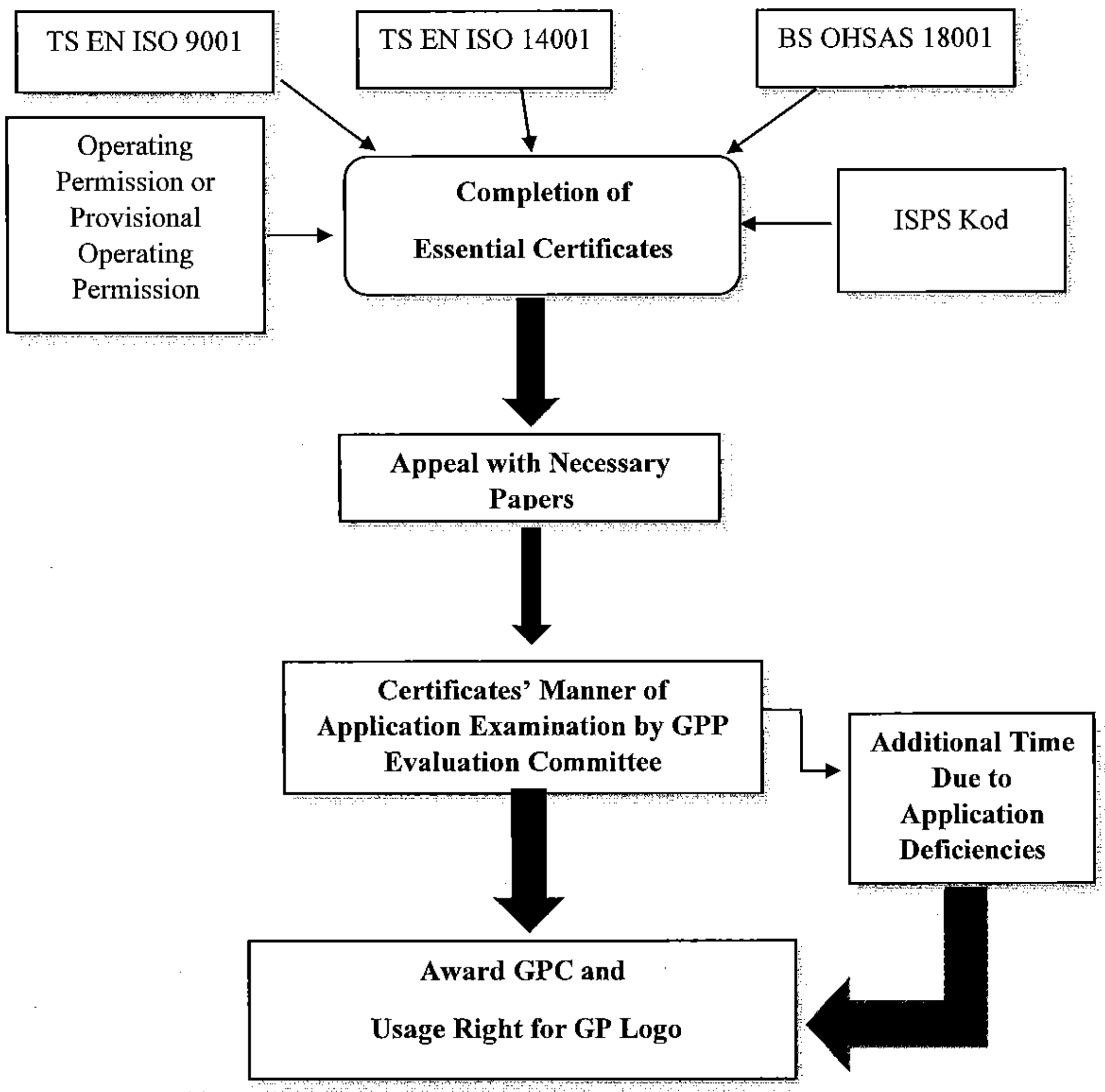
GP policy in Turkey can be collected under 7 titles that are natural life policy, air policy, water policy, soil and sediment policy, education policy, sustainability policy, and energy policy (Ateş and Akın, 2014: 174). Turkish ports should chase phases have been regulated by MTMAC. Phases in order to be awarded GPC have been submitted in Figure 12.

First of all, in Turkey GPC is based on voluntariness process and ports do not have any legal obligation. To be awarded GPC, Turkish ports should complete essential certificates that are TS EN ISO 9001 Quality Management System Certificate, TS EN ISO 14001 Environmental Management System Certificate, and BS OHSAS 18001 Occupational Health and Safety Certificate granted by Turkish Standards Institution, Operating Permission or Provisional Operating Permission Certificate from Turkish government, and International Ship and Port Security (ISPS) Code. Afterwards, awarding GPC requires appeal with necessity papers that are as follows (Ateş and Akın, 2014: 176, 177):

- Detailed publicity of port facility includes layout plan,
- Owned international certification systems' one each sample,
- Environmental Management System guide book (in the setting of Compact Disk (CD)),
- Waste Management Plan (in the setting of CD),
- Integrated Management System (IMS) (in the setting of CD) and explanatory information related running of IMS,
- Emergency Response Plan (in the setting of CD),
- Legislative harmonisation monitoring table,

- Explanatory information about environment officer,
- Precautions taken against wastes occur in port area,
- Actualised or planned to actualise practices on contamination from handling equipment,
- Actualised or planned to actualise practices on contamination from ships in port area,
- One each sample of exemption, permission and licence from Ministry of Environment and Urbanisation (MEU),

Figure 12: GP/Eco Port Certificate Acquisition Phase Diagram in Turkey



Source: Prepared by author.

- Waste oil declaration form and sample of waste oil analysis report,
- National waste hauling form,
- Waste hauling agreement samples and hauled institution's licensee samples from MEU,
- Information on waste disposal and disposed institution's licensee samples from MEU,
- Wastes from ships transfer form samples,
- Document on emission measurement of vehicles do not move out of port area and conformity report samples,
- List and content of trainings from competent authorities of port workers against wastes,
- Hazardous wastes management agreement sample,
- Obligatory dangerous goods and hazardous wastes liability insurance sample,
- Medical waste agreement and samples of pursuit forms,
- Bilge water and sludge reception agreement sample,
- Samples of permissions and analysis of water pollution control code,
- Wastewater treatment facility project approval sample,
- Waste management table sample,
- If the port is within the context of International Maritime Dangerous Goods (IMDG) Code, information about practices and regulations on subject,
- Environmental Impact Assessment permissions list and samples of documents,
- Within the context of Environmental Noise Assessment and Management Regulations assessment document sample,
- Environmental technician service agreement sample,
- If the port is member of any NGO on especially maritime pollution prevention, information on this subject should be presented,
- If the port has any CSR project on in the fields of maritime and environment, information on this subject should be presented,

- If the port has any penalty, warning, sanction in the fields of environmental pollution from any agency or institute, samples of information and documents related the process; and in information about practices regard to overcoming deficiencies caused environmental pollution.

Additionally, GHGs Verification Report and GHGs Verification Document can be presented while appealing by ports. Now these documents are not necessity to gain GPC, but will be obligated for this project.

After appeal to Directorate General of Merchant Marine, appeals have been evaluated by GPP Evaluation Committee. Appealed ports have been investigated on site by this committee. Accordingly, ports made their certifications' application on environment, sustainable have been awarded GPC and had right to use GP logo; extension of time has been granted to ports which had deficiencies on certifications' application. After overcoming deficiencies, ports have right to be awarded GPC and to use GP logo.

2.4.6.2. Green Port Certificated Ports in Turkey

After MTMAC of ROT started to implement ports GPC in terms of GPP, only Marport have been awarded GPC; and 8 ports have been awarded GP Project Sectorial Criteria Certificate and they have had right to gain GPC. These ports are Evyap Port, Petlim, Ford-Otosan Port, Kumport, Solventaş Port, Bodrum Cruise, Ege Ports Kuşadası, Borusan Port. Conducting certification ceremony for these 8 ports has been planned in the upcoming dates. Furthermore, 14 ports now have accomplished application process and have started to wait investigation date arrangement of GPP Evaluation Committee. In Table 20, profile data and date of having right to gain GPC of GPC awarded only Turkish port Marport and other port which have right to gain GPC, have been executed.

Table 20: Profile Information of Ports Have Right to Gain GPC

Port Name	Founding Date	Terminals	Annual Performance	Number of Employees	Status	Date of Having Right
Marport	1996-2001	Container	1,585,450 TEU	900	GP	13.07.2015
Evyap Port	2004	Container / Liquid Bulk	605,385 TEU / 482,240 tonnes	550	-	05.10.2015
Petkim Port	1965	Container / Ro-ro, Bulk, Project	*	*	-	15.10.2015
Ford-Otosan	2000	Ro-ro	* / 400000 cars	*	-	04.11.2015
Solventaş	1967	Liquid Bulk	1,519,661 tonnes	*	-	26.01.2016
Bodrum Cruise	2008	Passenger	1,295,048 GRT / 29,551 passenger	*	-	26.01.2016
Ege Ports Kuşadası	2004	Passenger	21,354,569 GRT / 673,617 passenger	35	-	26.01.2016
Kumport	1994	Container / Ro-ro, Bulk, Project	1,415,000 TEU /	610	-	03.02.2016
Borusan Port	1974	Container / Ro-ro, Project	230,075 TEU / 3,200,414 tonnes	490	-	17.05.2016

Source: Prepared by author.

*: Not Available.

CHAPTER THREE

ANALYTIC HIERARCHY PROCESS STUDY TO PRIORITIZE GREEN PORT PERFORMANCE CRITERIA: A COMPARATIVE ANALYSIS

3.1. AIM AND SCOPE OF THE RESEARCH

Under today's economic conditions, ports have a place in global trade. Such that, ports meet the whole logistic requirements involve transportation, packaging, stocking, storage, handling etc., besides that ships' defection and loading/discharging requirements. Scarce resources and ever-growing technology force ports to be sustainable in the case of all markets. Being sustainable for ports can come true by meeting economic, social and environmental needs in the port area. These three dimensions of sustainability have been mingled and effect each other either positively or negatively. At this point, the aim of the research is presenting importance of the GP concept which has been suggested under the title of environmental dimension of sustainable port; and executing perception of port practitioners that work in Turkey, in relation to GP.

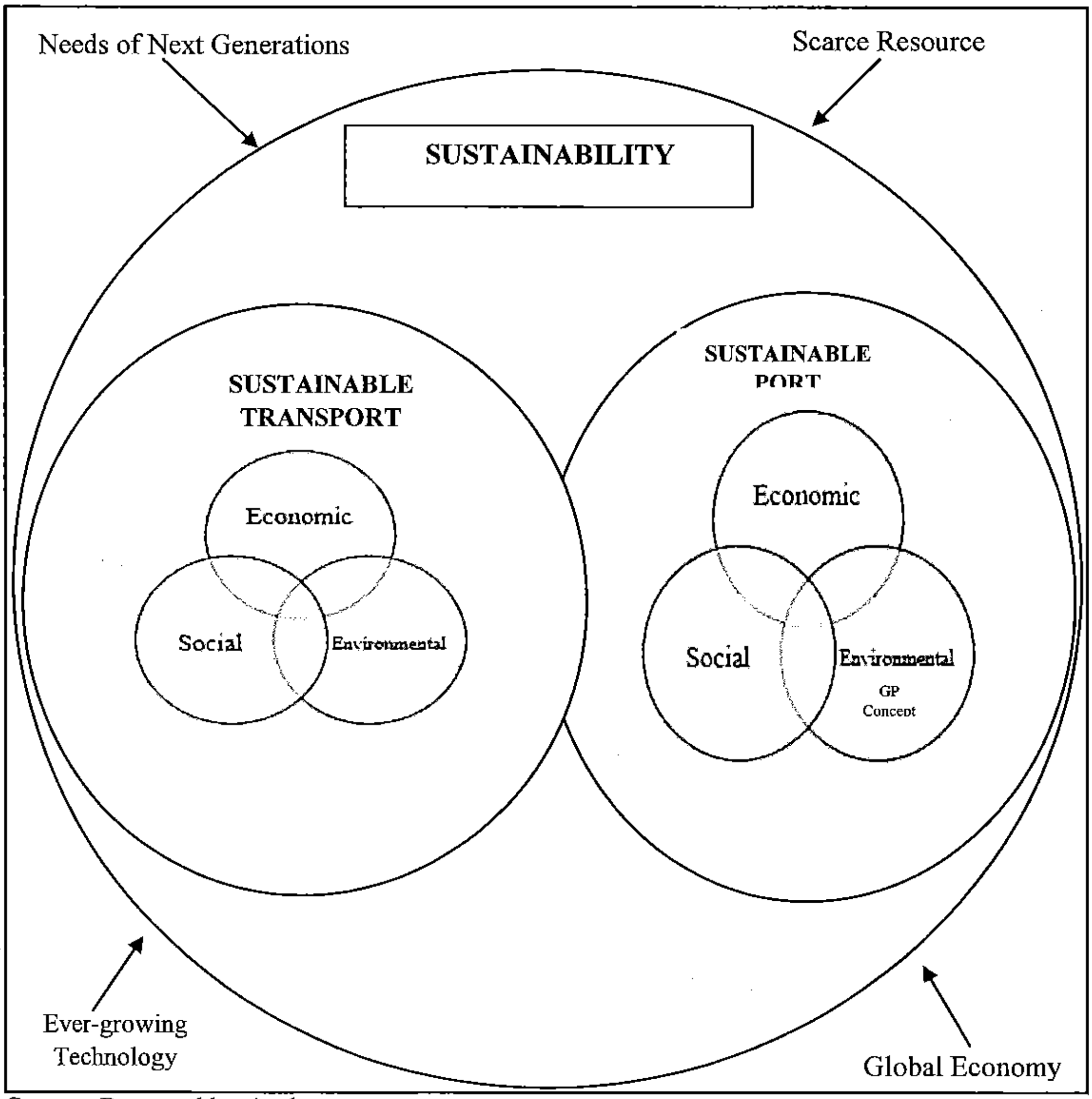
In accordance with this aim, sustainable port concept has been evaluated under the umbrella of sustainability notion. After three dimensions of sustainable port are economic, social and environmental dimensions have been revealed, GP approach has been analysed under the title of environmental dimension of sustainable port. GPPC what is requirements from ports in order to be GP, has been found out by the help of literature review. Besides that requirements and phases to award GP certificate in Turkey have been executed; perception of port practitioner work in Turkey in relation to GPPC, has been evaluated. While research phases had being chased, the study named GPPC for Sustainable Ports in Asia, had been taken as an example study (Lim et al., 2013).

Primarily, GPPC has taken a part in literature, has been turned into questionnaire form and this form was implemented to academicians studied on sustainable ports or GPs, in order to determine their priority perception. Accordingly, some criteria has been unable to retort 4.00 spot in frequency table, eliminated after the results of questionnaire. Afterwards, AHP questionnaire form has been fulfilled with GPPC above 4.00 spot in frequency table, in order to implement to port practitioners. Therefore, every GP criteria was evaluated and was collected under the 5 major titles. Every GPPC's priority analysis under their own title and major titles' priority analysis in terms of each other has been analysed, after AHP questionnaire form implemented to port practitioners. This AHP questionnaire form implemented 2 ports give service in Turkey, also expert opinion of 12 academicians has been asked by the questionnaire form was prepared in terms of likert scale. Port practitioners' perceptions have been collected in order to determine each ports' perception. By this means, perceptual difference of the 2 ports each other, has been analysed.

3.2. RESEARCH MODEL

Literature related with *sustainable transport, sustainable port, and GP,* have been reviewed deeply. After this detailed review, model of this research has been formed and revealed in Figure 13. Scarce resources, ever-growing technology and in parallel with demands, and request to protect resources for future generations, force all markets to become sustainable. In this study, sustainable transport and sustainable port as a component of sustainable transport, has been discussed under the umbrella of sustainability notion. Accordingly TBL approach brings forward an idea that sustainability has economic, social and environmental dimensions. Economic, social and environmental dimensions of sustainable port has been evaluated. Therefore, the effects of each dimension to each other has been executed in this study. While making these evaluation for sustainable ports, regulations and practices of international organizations on shipping and ports had been taken into consideration. After evaluation of sustainable port policies of international organizations on this subject, representative countries and ports, GP concept has been discussed under the title of environmental dimension of sustainable port.

Figure 13: Research Model



Source: Prepared by Author.

Under the title of environmental dimension of sustainable port, GP concept has been reached. In all aspects of GP approach has been evaluated in this study. At the same time, GP concept has been identified by the help of literature has been constituted by academicians and regulations of international organizations in terms of maritime transportation and ports. Then, green performance measures that are requirements in order to become GP, has been defined, classified and evaluated. By the help of literature, too many criteria has been determined, but after evaluation with essentials, for attaining objective basic needs for ports in order to become GP has been revealed. Accordingly, green performance measures has been collected under 5 titles that are AIRPOL management, LIQPOL prevention, SWPOL management, MARBIO protection and operational risk control and OM. Under these titles, measures which are aimed at reducing CO_2 in port area, harmonization of trucks, handling equipment, harbour vehicles, port infrastructures and superstructures to environmentally friendly approaches, protecting MARBIO from pollutants caused by ships, protecting port area and around of port from dangerous chemical goods, crude oil spillage, excessive dust and noise, etc. have been discussed.

Organizations related with maritime transportation, ports and countries have prepared policy frameworks in order to fulfil the requirements of to become GP. In this direction, IMO statutory regulations related to environmentally friendly shipping activities, have been evaluated as an example of MARPOL Appendix towards reducing pollutants in port area and around of port. ESPO practices which are SDM, Eco Ports, PERS, EMAS, and surveys have been named as Environmental Code of Practice, Environmental Survey, have been talked over. In this framework, these surveys progresses self-knowledge for ports have been showed and contribution of these surveys to progress constituting GP approach in Continental Europe, has been discussed. Otherwise, AAPA applications contribute environmentally friendly approaches in ports, have been investigated and some policies are *Clean Air Act, Clean Ports USA, DERA, AAPA Strategic Initiative – Sustainability* have been detected. Additionally, APA practices and policies of some countries have been executed. And, currently ongoing project by Turkish government named as GPC has been explained. Accordingly, phases to gain GPC have been clarified and discussed.

3.3. RESEARCH METHODOLOGY

In this study which aims executing importance of sustainable approaches for ports and determining order of priority of green performance measures according to practitioners in selected Turkish ports, literature review and content analysis in respect of GP has been analysed. After these analysis, GP measures have been revealed. In order that these measures' order of priority are purposed, AHP method has been used as a method determines order of priorities.

3.3.1. Literature Review on Green Port-Related Articles

GP-related literature executed by reviewing academic articles issued in academic journals which are available at the "mass browsing of databases" of Dokuz Eylul University Central Library. After detailed reviewing, previously reached 41 articles have been decreased to 18 articles are related mainly GP concept. Literature review of these GP-related articles is as follows:

Esmer et al. (2010), in their study, has aimed to evaluate Turkish container terminals as dimensions of lean capability and green concept. A simulation model has been created to specify ideal handling equipment number of container terminals, in order to raise Turkish ports' lean capabilities by taking into consideration of green care. In this study ideal MTT (Mobile Terminal Truck) number has been found as 2, when 1 SSG and 2 RTG are has been used in operations. Authors have been considered not to exceed optimum number of MTT significant for GP concept. Ying and Yijun (2011) aimed to realize Tianjin Port's GP planning and development thereby executing their constructions' actualities and problems. According to Chang and Wang (2012), decelaration vessel velocity to 12 knots, providing cold ironing, founding reducing velocity zone for vessels somewhere in the region of 20 nautical miles to shore, are effective strategies in order to develop GP policy and increase air quality. Carballo-Penela et al. (2012), in their study, have executed that superstructure materials, supplies, operations, forest and geoponic resources, contaminations and electric power in ports are leading composing parts of corporate carbon footprint in the port of Gijon. Fan et al. (2012) have analysed the petroleum port enterprise and other enterprises (carriage by road enterprise, stowage enterprise and maritime transportation enterprise) in order to execute the connection of solidarity and co-ordination between one another. And oil port and related enterprises' solidarity-coordination game model which has been retained to provide healthy decision making, has been fictionalized. In the study of Sheu et al. (2013) GP factors had been collected from literature and implemented to Taiwan Ports by means of questionnaire and these ports compared with the successful GPs are port of Los Angeles and port of Long Beach. Consequently, Taiwan ports have focused on energy efficiency and Taiwan ports' biggest gaps between successful GPs are tax incentives and rewards. On the study of Yang and Chang (2013), a comparison between RTGs and E-RTGs by the vista of energy saving and CO_2 emission reduction, has been evaluated. Accordingly, these are detected: E-RTGs can save 86.60% energy and can reduce 67.79% CO_2 emissions in comparison to RTGs; and also investment return of E-RTGs is starting after 2.2 years. According to Pavlic et al. (2014) trainings about environmental care are helpful to boost the confidence of employees and management vane; and establishing environmental and energy management departments and developing environmental and energy management system or adapting implemented system are helpful to constitute corporate environmental culture. This research has aimed to present approach accords port infrastructures to GP concept thereby not jeopardizing economic benefits. Chang and Jhang (2016) had fictionalised model on scenarios that decreasing ship velocity to 12 knots 20 nm away from shore and decreasing ship velocity to 12 knots and operating bunkering 20 nm away from shore. According to scenario one, about 41% and 14% more CO_2 emission had been supplied; and according to scenario two, SO_2 emission had been reduced about 48% and 43% in proportion of current applications. And, according to this research, mega ships are environmentalist than smaller ones. Also, Container carriers gain more economic and environmental favour than bulk carriers from the policy of Green Flag Program. Anastasopoulos et al. (2011), in their study, two Greek ports have been compared vis-à-vis green view of international legislation, European practices and Greece national policies. In consequence of comparison fundamental standards of GP which are preventing atmospheric pollutants, reducing soil and sediment pollutants, improving sea quality, improving wildlife life and MARBIO, reducing extra consumption of energy, reducing high sound pollution, improving weather forecasting, has been executed. Hou et al. (2011) have offered a new routing plan and built a cost efficiency and energy consumption minimization model for ports. This developed algorithm supplies an option to prefer ideal waveband integration strategy. Bergqvist and Egels-Zanden (2012) have highlighted GP due system for decreasing ports' external costs which involve contamination, traffic jam, excessive high sound, land usage in port area in order to raise productivity of ports. Dooms et al. (2013) executed that there is no effect of environmental performance on economic performance for the individual inland port level. This judgement has been put forward by the help of authors' green portfolio analysis constituted thereby analysing BCG-matrix and traffic volumes. And also industry cantilevered inland ports demonstrate greater economic and environmental performance in comparison to inland ports located in metropolitan bishop cities. On the study of Kavakeb et al. (2015), a discrete-event simulation model has been executed in order to identify impacts of new technology vehicles which are IAVs (Intelligent Autonomous Vehicles) decreases carbon footprint in port area, on ports' performance. Also, they have executed that IAVs are more efficient than trucks for now, in spite of the fact that IAVs are working slower than trucks. In other respects this efficiency difference can be enhanced thereby increasing IAVs' speed. Szili and Rofe (2007) had worked on Port Adelaide's redevelopment while urban development had been occurring by the help of the analysis of several formative materials and by the help of interviews performed with key stakeholders. Authors had established that implementations in Port Adelaide had seemed as colorable, in spite of environmentally friendly claims of Port managers exist. Morales-Caselles et al. (2008) had revealed that the metals (Cd, Cr, Hg, and Zn) and organic contaminants (PAHs and PCBs) are involved in the sediments that block green alga's usual progress, therefore, contamination level of ports are higher than the level have had by usual environment, according to study which has been implemented in Spanish ports. After detailed literature review 33 green port performance criteria have been determined (see in Appendix 5).

3.3.2. Content Analysis on Green Port-Related Articles

GP-related literature executed by reviewing academic articles issued in academic journals which are available at the "mass browsing of databases" of Dokuz Eylul University Central Library. After detailed reviewing, previously reached 41 articles have been decreased to 18 articles are related mainly GP concept. These articles had been revealed by methodologies different from each other. This methodologies are differential by articles have been collected in Table 21. Table 21 shows that GP-related articles have struggled to create a literature and statistical data is insufficient to establish a model on GP concept.

Table 21: Methodologies of GP-Related Articles

No	Year	Author	Name of The Article	Subtopic	Methodology
1	2007	Szili, Rofe	Greening Port Misery: Marketing the Green Face of Waterfront Redevelopment in Port Adelaide, South Australia	Aesthetic and Noise Pollution Management	In this article, the marketing of urban regeneration and green washing literatures have been linked via case study of the Port Adelaide revitalization.
2	2008	Morales-Caselles, Rico, Abbondanzi, Campisi, Iacondini, Riba, DelValls	Assessing Sediment Quality in Spanish Ports Using a Green Alga Bioassay	MARBIO Prevention	Probit Analysis Program has been used in order to determine toxicity of sediments received as sample from 7 Spanish city ports.
3	2010	Esmer, Çetin, Tuna	A Simulation for Optimum Terminal Truck Number in a Turkish Port Based on Lean and Green Concept	AIRPOL Management	A simulation model has been used to determine the optimum number of container handling equipment to increase the lean capabilities of a Turkish port. Arena 12.0 Simulation Software has been used.
4	2011	Ying, Yijun	Discussion on GP Construction of Tianjin Port	AIRPOL Management	Literature Review
5	2011	Anastasopoulos, Kolios, Stylios	How will Greek ports become GPs?	Environmental Economy	This study is based on a bibliography survey, examining two Greek ports as case studies and investigating the integration and adaptation of the environmental legislation, national, international and European.
6	2011	Hou, Guo, Wang, Wei	Joint Port-cost and Power-consumption Savings in Hybrid Hierarchical Optical Networks	Environmental Economy	In this study, Integer Linear Programming (ILP) model and heuristics has been proposed to determine optimum port-cost and power-consumption.
7	2012	Bergqvist, Egels-Zanden	GP Dues- The Case of Hinterland Transport	Environmental Economy	GP Fees and Marginal Costs have been evaluated in one table.
8	2012	Chang, Wang	Evaluating the Effects of GP Policy: Case Study of Kaohsiung Harbor in Taiwan	AIRPOL Management	Calculation related to ship emissions by using equation model of Corbettt et al.
9	2012	Carballo-Penela, Mateo-Mantecon, Domenech, Coto-Millan	From the Motorways of the Sea to the Green Corridors' Carbon Footprint: the Case of a Port in Spain	AIRPOL Management	This paper describes the method which is composed of financial accounts (MC3) used to estimate the Carbon Footprint of a port.

10	2012	Fan, Dong, Zhang, Li, Liang	The Research on the Cooperation and Coordination Game in Constructing Low-Carbon Green Oil Port	AIRPOL Management	This paper adopted the static game model under the asymmetric circumstance to research cooperative relations of low-carbon green oil port between the oil port enterprises and other enterprises and achieved good research achievements.
11	2013	Dooms, Haezendonck, Valaert	Dynamic Green Portfolio analysis for inland ports: An empirical analysis on Western Europe	Environmental Economy	This paper offers a dynamic Green Portfolio analysis of a range of European inland ports, based on an adapted model of the BCG-matrix and traffic volumes generated in the period 1999–2010. Strategic Positioning Analysis (SPA) has been used while evaluating.
12	2013	Sheu, Hu, Lin	The Key Factors of GP in Sustainable Development	AIRPOL Management	This study uses the questionnaire survey procedure for scholars, shipping companies, and port operators. This paper extracted five key factors by principle component analysis. Then, indicating the characteristic of the successful GPs and the gap between four ports in Taiwan and the successful GPs based on five key factors. (Cronbach alfa)
13	2013	Lirn, Wu, Chen	GPPC for Sustainable Ports in Asia	GPPC	The purpose of this paper is to measure a port's green performance. AHP was used for this article.
14	2013	Yang, Chang	Impacts of Electric Rubber-Tyred Gantries on GP Performance	AIRPOL Management	This study compared RTGs and E-RTGs from the perspective of energy savings and CO_2 reduction. Kaohsiung Port has been selected for being Case Study scope.
15	2014	Pavlic, Cepak, Sucic, Peckaj, Kandus	Sustainable Port Infrastructure, Practical Implementation of The GP Concept	AIRPOL Management	This paper presents a methodological approach for the implementation of the GP concept. Presented research work provides a methodological approach for finding realistic solutions to the problem of the future development challenges of seaports. This study has involved case study.
16	2014	Chiu, Lin, Ting	Evaluation of GP Factors and Performance: A Fuzzy AHP Analysis	GPPC	A Fuzzy AHP Analysis has been used to be forged a greener port operation.

17	2015	Kavakeb, Nguyen, McGinley, Yang, Jenkinson, Murray	Green Vehicle Technology to Enhance the Performance of a European Port: A Simulation Model With a Cost-Benefit Approach	Environmental Economy	In this paper, to identify the most economical fleet size for each type vehicle in order to satisfy the port's performance target, and to compare their impact on the performance of container terminals, a discrete-event simulation model has been developed.
18	2016	Chang, Jhang	Reducing Speed and Fuel Transfer of the Green Flag Incentive Program in Kaohsiung Port Taiwan	AIRPOL Management	This research applied Green Flag Program to investigate benefits of reducing speed and fuel transfer for large vessels entering Kaohsiung Port. For this purpose fuel consumption has been calculated.

Source: Prepared by Author.

On this study, viewed academic articles had been classified by their subtopics are as follows: Aesthetic and Noise Pollution Management, MARBIO Prevention, AIRPOL Management, Environmental Economy, and GPPC. Accordingly, 9 articles studied on AIRPOL Management, and this constitutes half of all articles; 5 articles studied on Environmental Economy, this constitutes 28% of all articles; 2 articles studied on GPPC, this constitutes 11% of all articles; subtopics are Aesthetic and Noise Pollution Management and MARBIO Prevention are handled in one for each article, these constitute 11% of all articles.

Until the year 2012, six GP-related articles have been determined; since the year 2012, 12 articles have been specified. Most of the articles had been studied in between the years of 2012-2013 which involve eight articles, and this constitutes nearly 44% of all years studied. In order that GP-related articles have struggled to create a literature, keywords of the articles are different from each other and had been regulated immethodically. Academic journals which published these articles differ from each other. Hardly, academic journals are "Transportation Research" and "Research in Transportation Business and Management" had published three for each GP-related article; both of them have published nearly 33% articles of all.

3.3.3. AHP Method

AHP is a mathematical model has been used for measure and decision making, has been invented by Thomas L. Saaty in the middle of 1970s (Saaty and

Niemira, 2006: 1). According to Saaty's definition, AHP is a multi-criteria measuring theory producing values from paired comparisons and scorings, definitive, using qualitative values, and AHP is a tool for knowledge's communication and meaning (Saaty and Özdemir, 2003: 1063). AHP model is an approach is the object of evaluable and discrete measures, and AHP place these measures in hierarchical structure and after utilize them (Vargas, 1990: 2). AHP model is a quantification method has been used generally in decision making processes, and has considered interconflictive, measurable and/or intangible criteria (Saat, 2000: 150). Firstly purpose of AHP is determined and then, questionnaire study may be implemented to specialists in their field, while determining factors effect on purpose (Dağdeviren et al., 2004: 132). However, AHP implementers does not reach absolute accuracy of their judgements, AHP is just helper while making best decision for implementers (Forman and Sally, 2001: 14). Vital characteristic of AHP is including decision-makers' either objective thinking or subjective thinking into deciding process, that is to say, AHP is a method compounds knowledges, experiments, opinions and foresights of panel into deciding process (Triantaphyllou, 1995:2). In AHP method criteria's superiority to each other is sorted from 1 point to 9 point, and is shown in creating table (Civir, 2015: 8). Primarily, problem has been designated in applications of AHP method, and criteria, sub criteria and alternatives related to problem have been revealed in a way to constitute hierarchical structure. Comparison matrix has been obtained from pairwise comparison, and significance level of these criteria has been determined from that matrix. After the application of the AHP method, the whole criteria have been evaluated together and criteria's order of priority has been found (Turgut, 2015: 62).

3.3.3.1. Axioms of AHP

AHP method has 4 different axioms that are: *the reciprocal axiom, the homogeneity axiom, the synthesis axiom, and the expectation axiom.* In the following parts, these axioms have been investigated.

3.3.3.1.1. The Reciprocal Axiom

This axiom states that in the comparison matrix constituted by criteria, data is double-faced or each data has reverse under multiplication (Kuruüzüm and Atsan, 2001: 85). For instance, if criteria A is 3 times more prior than criteria B, as it is criteria B is 3 times less prior than criteria A. This crosschecking takes part into the comparison matrix. This axiom has been used for constituting comparison matrix, and accordingly, if one of matrix is *aij*; another one is *aji* (Ünal, 2012: 40). If it is necessary to formulate this axiom, it can be shown as:

$$a_{ij} = x \equiv a_{ji} = 1/x. \quad (3.1)$$

3.3.3.1.2. The Homogeneity Axiom

AHP compares homogeneous indicators in terms of characteristic, it is necessary that indicators should be homogeneous or should be close notions in terms of a common trait for pairwise comparison (Garker and Vargas, 1987: 1386). Additionally, number of indicators under one title has to be less than 9 in order to provide coherency (Forman and Gass, 2001: 472). Also, no criteria can be infinite value times more prior than any criteria. Accordingly, AHP uses significant scale and this scale involves scale interval between 1 point and 9 point, for this reason preferences can be between the range of 1/7, 1/8, 1/9,...,7, 8, 9 (Yetim, 2004: 461). In order to provide homogeneous criteria comparison, clustering can be useful (Saaty, 2008a: 269).

3.3.3.1.3. The Synthesis Axiom

The synthesis axiom is that judgements or priorities related with element is at the one level of AHP hierarchy are independent from elements different from oneself (Ünal, 2012: 40; Forman and Gass, 2001: 476; Forman and Selly, 2001: 53). Priority of criteria in higher order, should not change based on adding or dropping new alternative (Kuruüzüm and Atsan, 2001: 85).

3.3.3.1.4. The Expectation Axiom

Expectation axiom presents two ideas related with AHP method that first of the ideas is that humans have expectations of being reflected their justified opinions; and another one is that order of alternatives based on either decision makers' decision or decision problem's nature (Saaty, 2008a: 271). This axiom prevents AHP from unsuitable usage.

3.3.3.2. Application Areas of the AHP

AHP has been studied commonly in literature and nearly all of studies in terms of decision making have been studied by the help of AHP method (Ho, 2008: 211). AHP is a method gathers round to necessity of decision making when problem occurred in economy or management, in politics, in social life, in technology, etc. (Golden et al., 1989: 141-142). However, especially recent years, AHP method has been used in order to prioritize criteria. Kou and Lin in their study of *A Cosine Maximization Method for the Priority Vector Derivation in AHP,* Lin et al. in their study of *A Heuristic Approach for Deriving the Priority Vector in AHP,* Kim et al. in their study of *Application of Delphi-AHP Methods to Select the Priorities of WEEE for Recycling in a Waste Management Decision-Making Tool,* Pourebrahim et al. in their study of *Application of VIKOR and Fuzzy AHP for Conservation Priority Assessment in Coastal Areas: Case of Khuzestan District, Iran,* Kutut et al. in their study of *Assessment of Priority Alternatives for Preservation of Historic Buildings Using Model Based on ARAS and AHP Methods,* J. Lee and H. Lee in their study of *Deriving Strategic Priority of Policies for Creative Tourism Industry in Korea Using AHP,* Li et al. in their study of *Estimating the Final Priority Ratings of Engineering Characteristics in Mature Period Product Improvement by MDBA and AHP,* Yağmur in his study of *Multi-Criteria Evaluation and Priority Analysis for Localization Equipment in a Thermal Power Plant Using the AHP,* Saaty and Özdemir in their study of *Negative Priorities in the AHP,* Ohnishi and Yamanoi in their study of *On Fuzzy Priority Weights of AHP for Double Inner Dependence Structure,* Duru et al. in their study of *Regime Switching Fuzzy AHP Model for*

Choice-Varying Priorities Problem and Expert Consistency Prioritization: A Cubic Fuzzy-Priority Matrix Design, B. Srdjevic and Z. Srdjevic in their study of *Synthesis of Individual Best Local Priority Vectors in AHP-Group Decision Making,* Lee et al. in their study of *Using AHP to Determine Intangible Priority Factors for Technology Transfer Adoption,* all of them have used AHP method to determine priorities of criteria they analysed.

In this study, toward the goal which is analysing perception differences of port practitioners employed in Turkish ports on GP concept, AHP has been used to determine priorities of GPPIs.

3.3.4. Research Sample

In accordance with the purpose of this study, GPPC for implementing samples, have been determined by the help of articles taken part in literature. The articles are available at the mass browsing of databases, and also articles which have included in their keywords such notions as "*port* + *green*", all of which have been passed through refereeing steps, have been reviewed. After this review, 33 criteria have been specified.

These criteria have been implemented to selected port managers in order to prioritize in themselves. However, firstly unrealistic criteria of all should be eliminated by the help of likert scaled survey. For this purpose, expert opinion of academicians which have studied on issues of "*sustainable port*", "*green port*", and "*sustainable transport*", has been received. For this, refereed journals have been reviewed; and 32 academicians that are worked in Turkish universities and had studied on fore-mentioned issues, have been determined. Likert scaled survey has been sent to 32 academicians via electronic mail, and 12 academicians have participated in a survey. 3 Prof. Dr., 3 Assoc. Prof. Dr., and 6 Asst. Prof. Dr. have created this committee.

As a consequence of the survey implemented to academicians, criteria prized under 4.00 spot in frequency table, have been eliminated. Hierarchical structure of this study has been fictionalized with remaining criteria after elimination phase to constitute AHP questionnaire form. This fictionalized structure has been presented to expert opinion of 4 of abovementioned 12 academicians. 2 Prof. Dr. and 2 Assoc. Prof. Dr. have given their opinions on this structure; in this direction, necessary corrections have been made. Thus, ultimate hierarchical structure of this study and AHP questionnaire form have been constituted.

Data collection tool (see in Appendix 4) has been implemented to managers of selected ports are Port Akdeniz (PA) and Ege Ports Kuşadası (EPK), in order to determine these ports' priority perception on GPPC. These selected ports are PA and EPK, have applied to gain GPC from MTMAC of Turkey. Automatically, these ports have TS EN ISO 9001 Quality Management System Certificate, TS EN ISO 14001 Environmental Management System Certificate, and TS EN 18001 Occupational Health and Safety Certificate granted by Turkish Standards Institution, Operating Permission or Provisional Operating Permission Certificate from Turkish government, and they fulfilled necessities of ISPS Code. EPK has biggest cruise terminal and is keeping on growing; PA handles almost whole cargoes are subject to maritime transport. Therefore these two ports have been selected as sample of this study. These ports are located in Mediterranean region. PA has served for either container cargo, general cargo, breakbulk cargo, project cargo, tanker cargo ships or cruise ships and military ships; EPK has served for only cruise ships and ferryboats. Both of these ports are large ports for hosting multiplexed ships at the same time. PA has 12 piers, EPK has 8 piers.

Commercial Manager (CM), Security Manager (SM), Maritime Services Manager (MSM), and Environment and Quality Manager (EQM) of PA, and Port Services Manager (PSM) and Port Services Assistant Manager (PSAM) of EPK, have attended this survey. Thus, this study's sample has been constituted with 6 managers, and this number has been seen sufficient for this method. Firstly, AHP method has been implemented to 30 experts simultaneously by Thomas Saaty, and a single answer has been created from 30 experts' remarks. However, in the later studies of Saaty, AHP more than one AHP survey form has been used. Nonetheless, minimum number of sample has not been specified by reason of the fact that AHP is not statistical method. In the literature, Kou and Lin (2014) have used 3 experts, Li et. al. (2011) have used 5 experts, Lirn et. al. (2013) have used 3 experts, in their studies while prioritizing criteria they studied on. Each manager is selected as a sample, had been assigned while these ports had being applied to relevant ministry in order to gain GPC. AHP survey based upon interviews, has been implemented to these managers in each of these ports' official building. Profile information of these managers and interview durations have been presented in Table 22.

Table 22: Profile of Managers Attended Questionnaire and Time stampings

Company Name	Managerial Role	Management Experience	Practice Format	Date	Interview Duration
Port Akdeniz	Commercial Manager	4 Years	Interview	16.05.2016	1.5 hours
Port Akdeniz	Security Manager	2 Years	Interview	16.05.2016	1.5 hours
Port Akdeniz	Maritime Services Manager	30 Years	Interview	16.05.2016	1.5 hours
Port Akdeniz	Environment and Quality Manager	A year	Interview	16.05.2016	1.5 hours
Ege Ports	Port Services Manager	14 Years	Interview	30.05.2016	1.5 hours
Ege Ports	Port Services Assistant Manager	4 Years	Interview	30.05.2016	1.5 hours

Source: Prepared by Author.

3.3.5. Stages of the Research

Thomas L. Saaty, inventor of the AHP, has offered to chase the following steps in order to implement AHP method for constituting study. These steps have been presented below (Saaty, 2008b: 85):

- *Define the problem and determine the kind of knowledge sought.*
- *Structure the decision hierarchy from the top with the goal of the decision, then the objectives from a broad perspective, through the intermediate levels (criteria on which subsequent elements depend) to the lowest level (which usually is a set of the alternatives).*

- *Construct a set of pairwise comparison matrices. Each element in an upper level is used to compare the elements in the level immediately below with respect to it.*
- *Use the priorities obtained from the comparisons to weigh the priorities in the level immediately below. Do this for every element. Then for each element in the level below add its weighed values and obtain its overall or global priority. Continue this process of weighing and adding until the final priorities of the alternatives in the bottom most level are obtained.*

According to Forman and Sally, 7 steps should be pursued to implement AHP method. These steps are as follows (Forman and Sally, 2001: 109):

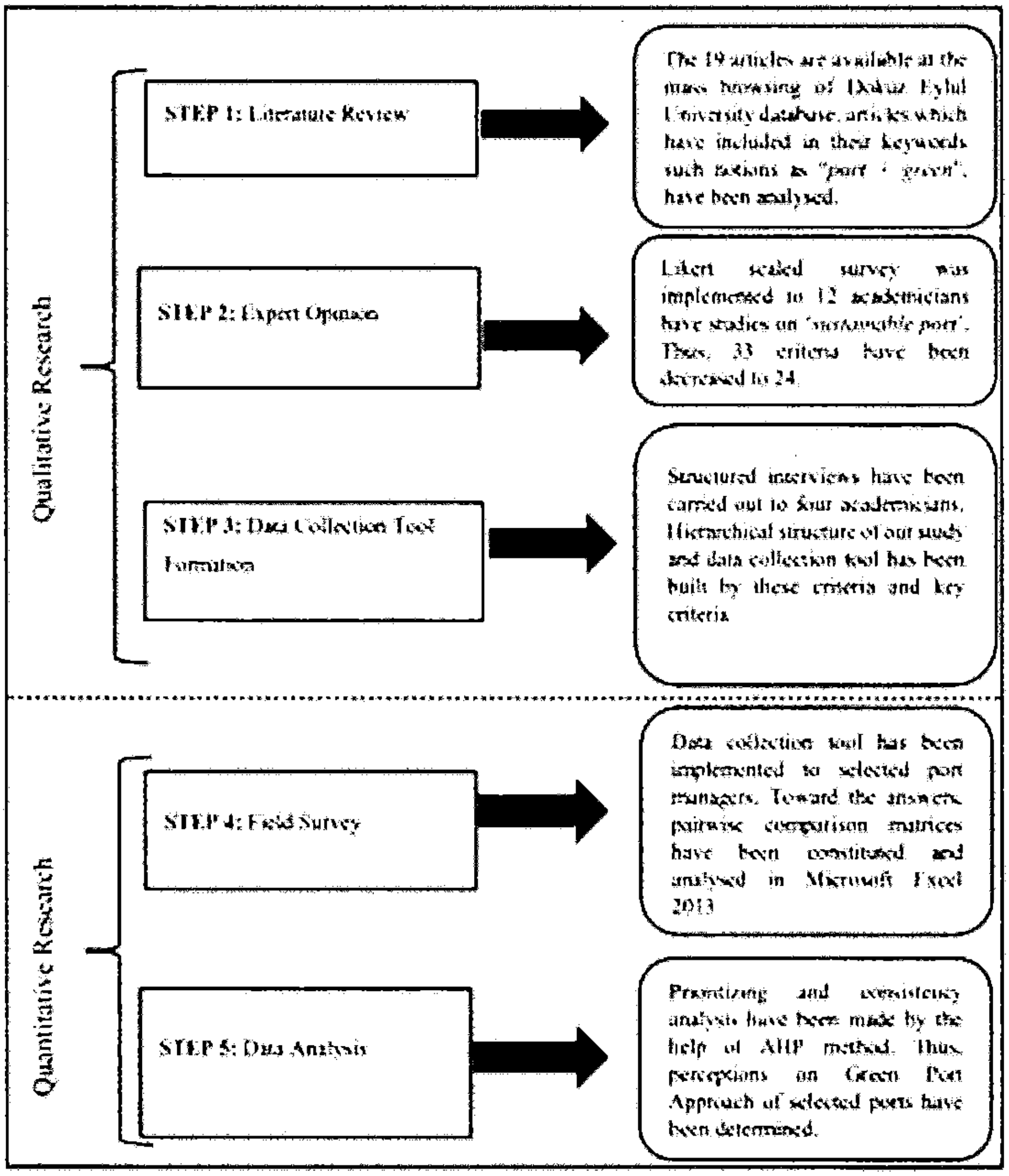
- Step 1: Identifying and researching the problem.
- Step 2: Eliminating unrealistic criteria.
- Step 3: Forming hierarchical structure which involves purpose, goals, sub goals and alternatives.
- Step 4: Evaluating factors in the model by the help of pairwise comparisons.
- Step 5: Synthesizing in order to determine the best alternative.
- Step 6: Verifying final judgement, in case of necessity iterating study.
- Step 7: Actualization and documentation of judgement.

Generally, optimum type of AHP phases have been listed below and these steps have been used while implementing this study. These phases are as follows:

- Constituting hierarchical structure.
- Making pairwise comparisons.
- Determining relative importance vector (eigenvector).
- Carrying out consistency analysis.
- Determining the best alternative.

In Figure 14, phases of this study step by step and samples of each phase have been executed.

Figure 14: Stages of the Research



Source: Prepared by Author.

3.3.5.1. Expert Opinion

33 criteria obtained from literature, are crucial to minimize environmental risks around port area. However, due to need of validation, expert opinion to prioritize these criteria, has been taken by the help of likert scaled questionnaire form. Expert team has been chosen from Turkish academicians who studied on issues of "sustainable port", "green port", and "sustainable transport" before. For this,

refereed journals have been reviewed; and 32 academicians who worked in Turkish universities and had studied on fore-mentioned issues, have been determined. Likert scaled survey has been sent to 32 academicians via electronic mail on the date of 9th September 2015, and 12 academicians have participated in the survey. Profile information of these academicians have been presented in Table 23.

Table 23: Profile Information of Specialists

Academic Title	University	Name of Publication related to *'Sustainable Port'*, *'Green Port'* or *'Sustainable Transport'*
Prof	Dokuz Eylül Üniversitesi	A Study
Prof	Dokuz Eylül Üniversitesi	Two Studies
Prof	İstanbul Kültür Üniversitesi	A Study
Assoc. Prof	Dokuz Eylül University	A study
Assoc. Prof	Pamukkale Üniversitesi	A study
Assoc. Prof	Dokuz Eylül Üniversitesi	Two Studies
Asst. Prof	Dokuz Eylül Üniversitesi	Two Studies
Asst. Prof	Dokuz Eylül Üniversitesi	A Study
Asst. Prof	Ağrı Üniversitesi	A study
Asst. Prof	Dokuz Eylül Üniversitesi	A Study
Asst. Prof	Akdeniz Üniversitesi	A Study
Asst. Prof	Piri Reis Üniversitesi	Three Studies

Source: Prepared by Author.

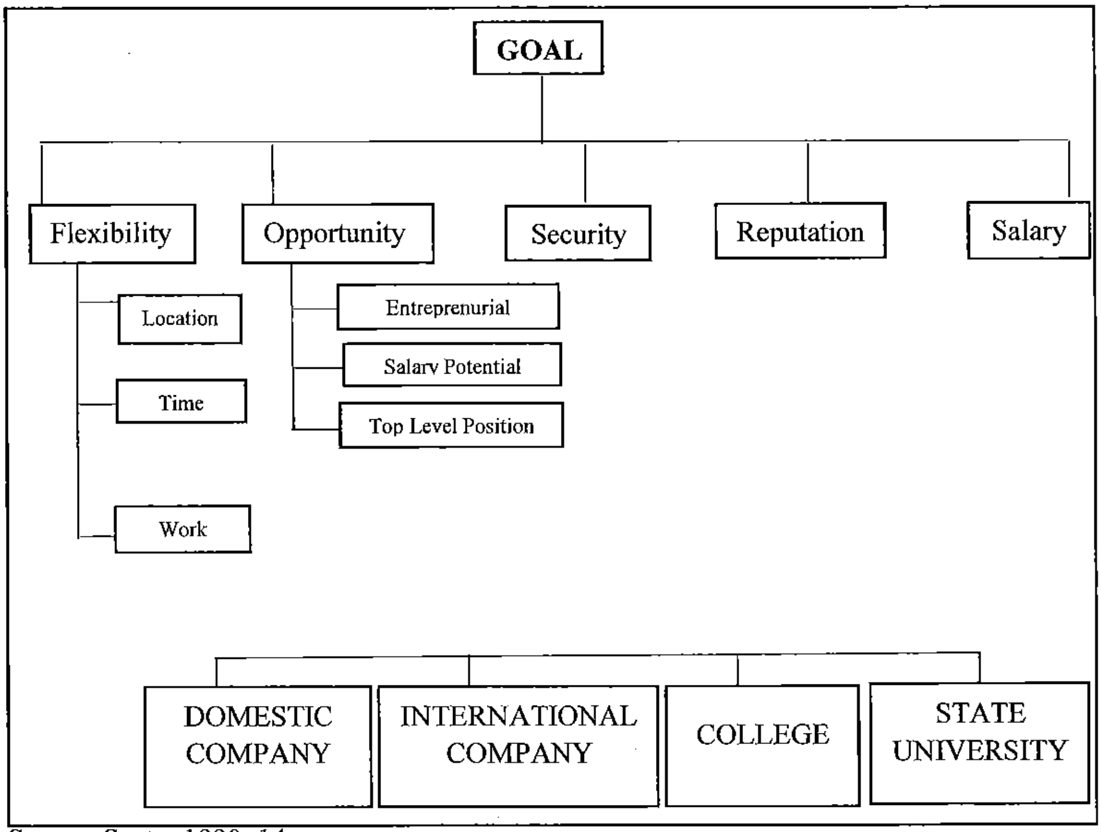
This survey form has been presented in Appendix 1. In a consequence of survey implemented to selected academicians, criteria are under 4.00 frequency level, has been seen as unrealistic criteria and they have not taken a part in hierarchical structure. Frequency table results of this survey has been presented in Appendix 2. Thus, criteria are *flood effect and pacification, increasing volunteerism on reuse convertible resources, harm on society avoidance during infrastructure constructing, avoidance of infrastructure effect, encouragement of public transport modes usage, port dredging sediments overcome, bilge water dumping management, dangerous goods segregation, usage of convertible resources, odour management*, have been glossed over while constituting data collection tool. Accordingly, '*low sulphur fuel consumption encouragement*' has been perceived as the highest priority criteria; *avoidance of oil spill, marine biology preservation, avoiding air pollution, alternative energy usage, energy smart kit usage*, have been accompanied in prioritizing analysis as far as the perceptions of selected academicians.

3.3.5.2. Data Collection Tool Formation

The first step of the AHP is separating the main decision problem to sub problems into the hierarchical structure in order to explain more clearly. Main goal places at the top of the structure, criteria are in the lower position of the structure, and alternatives rank as under the criteria (Kuruüzüm and Atsan, 86). Saaty's example study has been shown in Figure 15 for citing to hierarchical structure of AHP.

In this study, the goal is that executing perception of port practitioners employed in Turkish ports, in terms of GP approach. In accordance with this goal, revealing order of priority of green performance indictors obtained from literature has been aimed by the help of application of AHP questionnaire form to selected Turkish ports' managers. Accordingly, many previous studies have been revealed indicators are necessary for ports to become GP. However, the most of these indicators cross in the same cluster. For this reason, almost all indicators inclusive study named *GPPC for Sustainable Ports in Asia* is written by Lirn et al. (2013), has been taken as a guide study. And, GPPC taken part in study of Lirn et al. (2013), have been used while constituting hierarchical structure of this study. Hierarchical structure of this study has been fictionalized with remaining criteria after elimination phase to constitute data collection tool. For this purpose, structured interview has been had with four of the above mentioned 12 academicians on the date of 18th April 2016. Experts have given their opinions on this structure; in this direction, necessary corrections have been made. Thus, ultimate hierarchical structure of this study and data collection tool have been constituted.

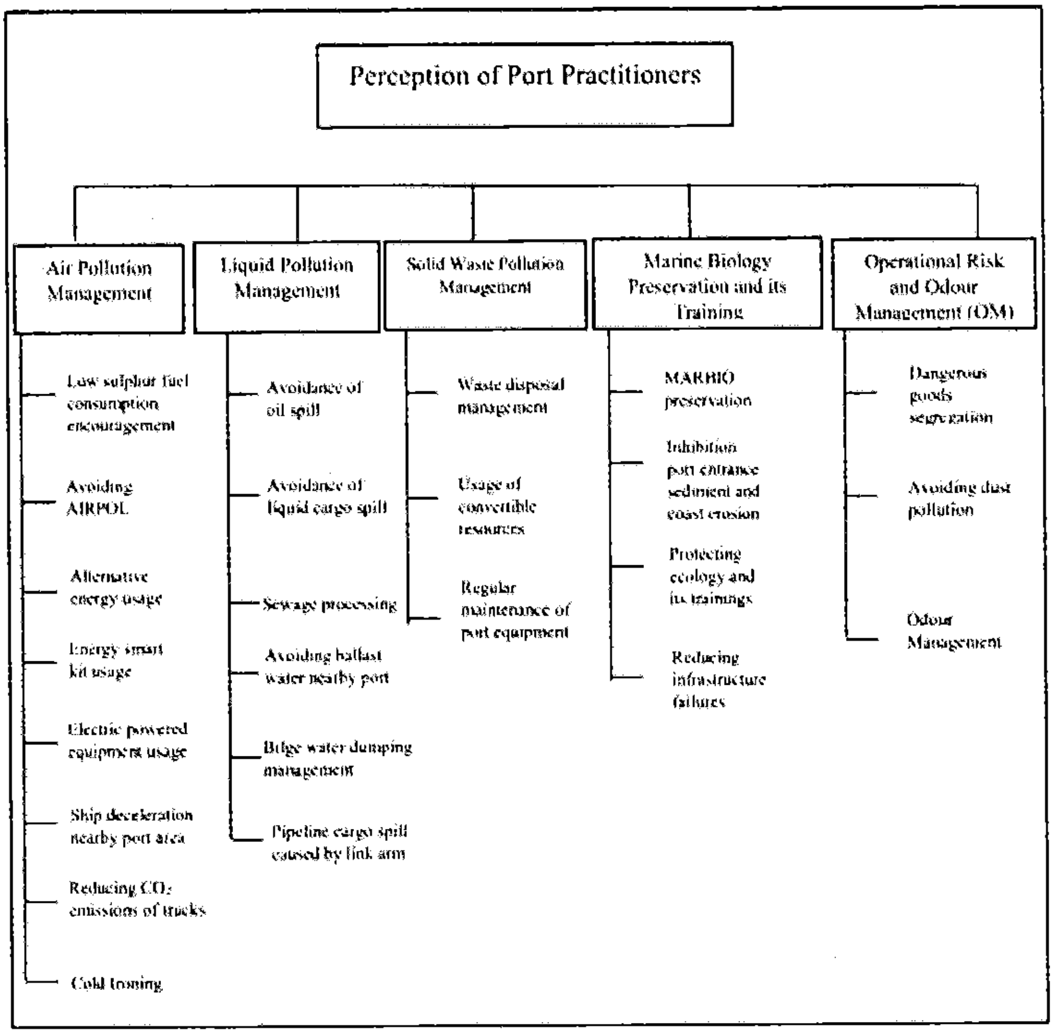
Figure 15: Example of Saaty for Hierarchical Structure of AHP



Source: Saaty, 1990: 14.

Homogeneity of criteria which will be compared each other, is vital. So, for providing homogeneity, generally, clustering method should be used (Saaty, 2008a: 258). In this study, to provide homogeneity, homogeneous indicators have been gathered under same cluster. Thus, AIRPOL management, LIQPOL management, SWPOL management, MARBIO preservation and its training, and operational risk & OM, have constituted clusters. These key criteria have been placed in hierarchical structure of AHP study as clusters. This AHP study's hierarchical structure with goal, clusters, and criteria of this study, has been executed in Figure 16.

Figure 16: Hierarchical Structure of This Study



Source: Prepared by Author.

3.3.5.3. Field Survey

After the hierarchical structure has been constituted toward the main goal, pairwise comparison matrices have been formed in order to compare criteria each other under their clusters and to compare clusters each other (Dağdeviren and Eren, 2001: 43). While this matrix is constituting, priority scale (see with weights in Table 24) between the range of 1 and 9, has been offered by Saaty.

Table 24: Priority Scale of Comparison Matrix

Significance Level	Description
1	Equally important
3	One is adequate important over another
5	One is strongly important over another
7	One is crucial over another
9	One is extremely important over another
2, 4, 6, 8	Adequate values between two close judgements

Source: Saaty, 1990: 15.

Pairwise comparisons of the whole criteria should be taken part in AHP questionnaire form. Comparison matrices are constituted with significance level of each criteria over another criteria. Comparison matrix is vital and constitutes basic of AHP method. So it should be carried out considering logic diagram. For instance, if criterion A is 3 times important over criterion B and criterion B is 3 times important over criterion C; criterion C cannot be more important than criterion A. In this study, as a result of implementing AHP survey to selected ports' managers, comparison matrices has been formed. One of them has been executed in Table 25. Also, every pairwise comparison matrices of each participant has been presented in Appendix 3.

Table 25: Pairwise Comparison Matrix to AIRPOL Management Judgements of CM of PA

	Low sulphur fuel consumption encouragement	Alternative energy usage	Electric powered equipment usage	Ship deceleration nearby port area	Cold Ironing	Reducing CO_2 emissions of trucks	Avoiding AIRPOL	Energy smart kit usage
Low sulphur fuel consumption encouragement	1	1/3	1/3	3	1/5	1	3	5
Alternative energy usage	3	1	1	7	1/3	3	7	9
Electric powered equipment usage	3	1	1	7	1/3	3	7	9
Ship deceleration nearby port area	1/3	1/7	1/7	1	1/9	1/3	1	3
Cold Ironing	5	3	3	9	1	5	9	9
Reducing CO_2 emissions of trucks	1	1/3	1/3	3	1/5	1	3	5
Avoiding AIRPOL	1/3	1/7	1/7	1	1/9	1/3	1	3
Energy smart kit usage	1/5	1/9	1/9	1/3	1/9	1/5	1/3	1

Source: Prepared by Author.

3.3.5.4. Data Analysis

To calculate eigenvector, 4 different methods have been executed that are the simplest method, much better method, well method, and optimal method. These methods and their explanations have been presented below (Karakaşoğlu, 2008: 31-32):

- The simplest method: Each row of the pairwise comparison matrix is sum up and each sum of row is normalized thereby being divided by total sum of the whole rows.
- Much better method: While this method is being implemented, elements in each column of pairwise comparison matrix are totalized. Conjugates of totalized columns (1/column totals) are found. For normalization counting, each conjugate is divided by this conjugates' total.
- Well method: This method is constituted 3 steps are: 1) sum of each column in the pairwise comparison matrix is calculated, 2) each matrix element is divided by this sum and this result matrix is pairwise comparison matric which is normalized, 3) Mean of the row elements of this normalized matrix is calculated. Accordingly, priorities of pairwise compared criteria can be forecasted by the help of this means.
- Optimal method: 'n' amount elements of each row in the pairwise comparison matrix are multiplied by each other and then 'n'th root is found. After that, received values are normalized.

In this study, optimal method has been used in order to determine eigenvector of the matrix. While calculating eigenvector, after n extraction as mentioned before when optimal method had been defined, single columned matrix is constituted. Sum of this single column is taken, and each column element is divided by sum of column elements. Obtained values as a result of previous operations constitute our eigenvectors. These vectors mean determine criteria's order of priority in percentage sense (Yaralıoğlu, 2001: 133).

Consistency rate is calculated for every matrix and this rate should be under 0,10 value. While calculating this rate, firstly, greatest eigenvector (λ_{max}) of each matrix should be calculated. Therefore, each eigenvector is multiplied by every element of own column in the pairwise comparison matrix, in this way, new matrix is formed. Elements of every row in the new matrix are sum up, and each sum is divided by each eigenvector which is corresponding to same row. After this calculation, new column is obtained, the arithmetic mean of new column becomes the greatest eigenvector (λ_{max}) of the new matrix. Finally, consistency indicator (CI) is calculated thereby implementing following formulate which is taken part in (3.2) (Gemici, 2009: 41-42):

$$\text{Consistency indicator (CI)} = \frac{\lambda max - n}{n-1} \quad (3.2)$$

Consistency rate can be found thereby dividing consistency indicator with random index (RI) which is corresponded to n number (Supçiller and Çapraz, 2011: 8-9).

$$CR = \frac{CI}{RI} \quad (3.3)$$

Additionally, random index table that shows which number of criteria correspond to which value is in the Table 26.

Table 26: Random Indicators Table

n	1	2	3	4	5	6	7	8	9
RI	0	0	0,58	0,9	1,12	1,24	1,32	1,41	1,45

Source: Donagan and Dodd, 136.

In this study, fore mentioned formulates and steps have been implemented for every matrix, and consistency rate of any and every matrix has never exceeded 0,10 value.

3.3.5.5. Determining Best Alternative

In this phase, priority values of criteria is calculated. Criteria have maximum value, should be preferred (Gemici, 2009: 42). Problem is that, how individual judgements can reflect group decision. According to Saaty, the only way to combine individual judgements, is using geometric mean while constituting new pairwise comparison matrix (Saaty, 2008b: 95).

In this study, while combining port practitioners' individual judgements in order to create each port's own judgement about GP approach, geometric mean of each judgement has been calculated. For instance, AIRPOL management pairwise matrix has been constituted with the participation of PA managers, has been executed in Table 27.

Table 27: Pairwise Comparison Matrix to Judgements on AIRPOL Management of PA Managers

	Low sulphur fuel consumption encouragement	Alternative energy usage	Electric powered equipment usage	Ship deceleration nearby port area	Cold Ironing	Reducing CO_2 emissions of trucks	Avoiding AIRPOL	Energy smart kit usage
Low sulphur fuel consumption encouragement	1	5/4	1/5	8/3	1/4	2/5	16/7	2/3
Alternative energy usage	4/5	1	4/9	15/7	1/4	3/5	5/4	3/4
Electric powered equipment usage	26/5	16/7	1	45/7	5/4	13/8	45/7	7/4
Ship deceleration nearby port area	3/8	1/2	1/6	1	1/5	1/5	3/4	2/5
Cold Ironing	31/8	26/7	4/5	26/5	1	3/2	9/2	3/2
Reducing CO_2 emissions of trucks	13/5	13/8	3/5	26/5	2/3	1	9/2	3/2
Avoiding AIRPOL	4/9	4/5	1/6	4/3	2/9	2/9	1	4/7
Energy smart kit usage	3/2	4/3	4/7	13/5	4/7	2/3	7/4	1

Source: Prepared by Author.

3.4. FINDINGS OF THE RESEARCH

AHP questionnaire form has been implemented managers of the selected ports. After that, above-mentioned AHP phases have been followed. Thus, perceptions of managers on GPPC and perceptual differences have been analysed. These analyses for each key criterion's sub-criteria and analysis between key criteria have been executed by the help of tables.

3.4.1. Findings Related to Air Pollution Management

In consequence of implementing AHP method's phases on results of AHP surveys, findings related to AIRPOL management which are priority values named eigenvectors of each criteria, and CR of each judgements, have been executed in Table 28.

Table 28: Findings Related to AIRPOL Management

	CM	SM	EQM	MSM	PA	PSM	PSAM	EPK
Eigenvector of Low sulphur fuel consumption encouragement	0.08	0.04	0.03	0.14	0.08	0.04	0.06	0.06
Eigenvector of Alternative energy usage	0.20	0.24	0.01	0.02	0.08	0.11	0.02	0.06
Eigenvector of Electric powered equipment usage	0.20	0.11	0.17	0.46	0.26	0.20	0.24	0.25
Eigenvector of Ship deceleration nearby port area	0.03	0.02	0.09	0.02	0.04	0.02	0.01	0.02
Eigenvector of Cold Ironing	0.36	0.24	0.09	0.14	0.23	0.32	0.15	0.26
Eigenvector of Reducing CO_2 emissions of trucks	0.08	0.11	0.26	0.14	0.17	0.11	0.33	0.22
Eigenvector of Avoiding AIRPOL	0.03	0.02	0.09	0.04	0.05	0.02	0.15	0.06
Eigenvector of Energy smart kit usage	0.02	0.24	0.26	0.05	0.11	0.20	0.02	0.08
CR	0.03	0.09	0.08	0.07	0.02	0.05	0.09	0.03

Source: Prepared by Author.

Accordingly, the whole judgements' consistency rates are under 0.10 value, therefore the whole judgements are consistent. PA managers have seen indicators that are electric powered equipment usage by 26%, cold ironing by 23%, and reducing CO_2 emissions of trucks by 17%, as more prior than other indicators of AIRPOL management. On the other hand, EPK managers have seen indicators that are cold ironing by 26%, electric powered equipment usage by 25%, and reducing CO_2 emissions of trucks by 22%, as more prior than other indicators of AIRPOL management. Hereunder, appreciably perceptual differences have not been observed between two selected ports' perception to AIRPOL management.

3.4.2. Findings Related to Liquid Pollution Management

In Table 29, results of selected two ports' managers' judgements about LIQPOL management criteria, have been executed.

Table 29: Findings Related to LIQPOL Management

	CM	SM	EQM	MSM	PA	PSM	PSAM	EPK
Eigenvector of Avoidance of oil spill	0.03	0.03	0.21	0.49	0.13	0.59	0.36	0.52
Eigenvector of Avoidance of liquid cargo spill	0.34	0.11	0.21	0.20	0.27	0.17	0.06	0.11
Eigenvector of Sewage processing	0.03	0.31	0.03	0.06	0.09	0.06	0.03	0.05
Eigenvector of Avoiding ballast water nearby port	0.13	0.31	0.03	0.13	0.15	0.06	0.03	0.05
Eigenvector of Bilge water dumping management	0.13	0.11	0.07	0.06	0.12	0.06	0.36	0.17
Eigenvector of Pipeline cargo spill caused by link arm	0.34	0.11	0.44	0.06	0.24	0.06	0.17	0.11
CR	0.01	0.01	0.03	0.03	0.01	0.00	0.04	0.01

Source: Prepared by Author.

Pursuant thereto, all of judgements' consistency rates are under 0.10 value, therefore the whole judgements are consistent. Managers of EPK have seen criteria that are avoidance of oil spill by 52%, bilge water dumping management by 17%, avoidance of liquid cargo spill, and pipeline cargo spill caused by link arm by 11% more prior than other criteria. Distinctly, managers of PA have seen criteria that are avoidance of liquid cargo spill by 27%, pipeline cargo spill caused by link arm by 24%, and avoiding ballast water nearby port by 15% more prior than other criteria. Therefore, the perceptual differences between two selected ports' perception on LIQPOL management, have been sought.

3.4.3. Findings Related to Solid Waste Pollution Management

In Table 30, results of selected two ports' managers' judgements on SW management indicators, have been executed.

Table 30: Findings Related to SWPOL Management

	CM	SM	EQM	MSM	PA	PSM	PSAM	EPK
Eigenvector of Waste disposal management	0.71	0.23	0.23	0.33	0.43	0.75	0.60	0.69
Eigenvector of Usage of convertible resources	0.14	0.08	0.69	0.33	0.29	0.18	0.20	0.19
Eigenvector of Regular maintenance of port equipment	0.14	0.69	0.08	0.33	0.29	0.07	0.20	0.12
CR	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.01

Source: Prepared by Author.

Results above, show that, the whole judgements' consistency rates are under 0.10 value. So, the whole judgements are consistent. Managers of PA have made judgement that waste disposal management by 43%, is more prior than other criteria related to SWPOL management. In a similar manner, managers of EPK have executed that waste disposal management by 69%, is more prior than others. Thus, appreciably perceptual differences between two selected ports' perception on SWPOL management, have not been observed.

3.4.4. Findings Related to Marine Biology Preservation and Its Training

According to judgements on MARBIO preservation and its training, of managers of selected two ports, Table 31 has been constituted. All of the answers' consistency rates are under 0.10 value. This has expressed to us that the whole answers are consistent.

Table 31: Findings Related to MARBIO Preservation and Its Training

	CM	SM	EQM	MSM	PA	PSM	PSAM	EPK
Eigenvector of MARBIO preservation	0.10	0.07	0.32	0.38	0.22	0.08	0.15	0.12
Eigenvector of Inhibition port entrance sediment and coast erosion	0.25	0.07	0.32	0.38	0.28	0.20	0.04	0.09
Eigenvector of Protecting ecology and its training	0.10	0.28	0.32	0.13	0.24	0.52	0.40	0.49
Eigenvector of Reducing infrastructure failures	0.56	0.58	0.04	0.13	0.26	0.20	0.40	0.30
CR	0.02	0.03	0.00	0.00	0.00	0.02	0.01	0.00

Source: Prepared by Author.

According to judgements of port managers, PA managers have seen that inhibition port entrance sediment and coast erosion by 28%, as more prior than other indicators of MARBIO preservation and its training; diversely, managers of EPK have seen that protecting ecology and its training by 49%, as more prior than others. For this reason, the perceptual differences exist between two selected ports' perception on MARBIO preservation and its training.

3.4.5. Findings Related to Operational Risk and Odour Management

Table 32 has been constituted with the selected port managers' judgements related to operational risk and OM.

Table 32: Findings Related to Operational Risk and OM

	CM	SM	EQM	MSM	PA	PSM	PSAM	EPK
Eigenvector of Dangerous goods segregation	0.09	0.75	0.27	0.73	0.46	0.78	0.75	0.77
Eigenvector of Avoiding dust pollution	0.45	0.07	0.67	0.19	0.34	0.11	0.18	0.14
Eigenvector of OM	0.45	0.18	0.06	0.08	0.19	0.11	0.07	0.09
CR	0.00	0.03	0.03	0.06	0.00	0.00	0.03	0.01

Source: Prepared by Author.

Consistency rate of all of managers' judgements are under 0.10 value. This means that all of judgements are consistent. According to PA managers, dangerous goods segregation is more prior by 46% than other indicators which are related to operational risk and OM. Likewise, according to managers of EPK, dangerous goods segregation is more prior than others. Hereby, appreciably perceptual differences do not exist between two selected ports' perception on operational risk and OM.

3.4.6. Findings Obtained After Pairwise Comparisons of Key Criteria

Clusters' eigenvectors of each, consistency rates of each based on individual judgements, have been shown in Table 33.

At first, consistency rates of the whole judgements are under 0.10 value. This means, judgements are consistent and suitable to analyse. According to PA managers, LIQPOL management has the highest priority by 43% among key criteria; MARBIO preservation and its training is first runner-up by 22%, and AIRPOL management has third place by 14% in order of priority among the key criteria.

Table 33: Findings Related to Key Criteria

	CM	SM	EQM	MSM	PA	PSM	PSAM	EPK
Eigenvector of AIRPOL Management	0.27	0.11	0.10	0.06	0.14	0.20	0.21	0.21
Eigenvector of LIQPOL Management	0.27	0.03	0.03	0.16	0.43	0.04	0.04	0.62
Eigenvector of SWPOL Management	0.27	0.57	0.67	0.16	0.09	0.61	0.62	0.04
Eigenvector of MARBIO Preservation and its Training	0.09	0.23	0.10	0.46	0.22	0.10	0.07	0.08
Eigenvector of Operational Risk and OM	0.09	0.06	0.10	0.16	0.12	0.04	0.07	0.06
CR	0.00	0.07	0.07	0.00	0.02	0.05	0.09	0.05

Source: Prepared by Author.

In other respects, according to managers of EPK, LIQPOL management has the highest priority by 62% among key criteria; AIRPOL management has second place by 21%, and MARBIO preservation and its training has third place by 8% in order of priority among the key criteria. Thus, the perceptual differences exist between two selected ports' perception on key criteria of GP concept.

3.5. DISCUSSION

ESPO has implemented surveys periodically for European ports in order to assess priorities of GPPC from the perspective of each port. These surveys went under the names of respectively Environmental Code of Practice, Environmental Survey, Eco PERS (ESPO, 2012: 13). Changes in perceptual priority of criteria by years have been shown in Table 34 with reference to ESPO studies on prioritizing GPPC. Pursuant thereto, it is seen that European ports have focused on prominent indicators which have been determined by the help of each survey result. Thus, each criterion has lost height in ranking table in comparison with previous survey result.

On the other hand, criteria which are *air quality* and *energy consumption,* have taken primacy. Accordingly, in recent years imposed bottleneck in maritime industry makes supplying environmental conscious difficult. So, especially regulations on ships have been of secondary importance.

Table 34: Results of ESPO Surveys on Prioritizing GPPC by Years

Remark	Years				
	1996	**2004**	**2009**	**2013**	**2016**
1	Port development (water)	Garbage / Port waste	Noise	Air quality	Air quality
2	Water quality	Dredging: operations	Air quality	Garbage / Port waste	Energy consumption
3	Dredging disposal	Dredging disposal	Garbage / Port waste	Energy consumption	Noise
4	Dredging: operations	Dust	Dredging: operations	Noise	Relationship with local community
5	Dust	Noise	Dredging disposal	Ship waste	Garbage / Port waste
6	Port Development (land)	Air quality	Relationship with local community	Relationship with local community	Ship waste
7	Contaminated land	Hazardous cargo	Energy consumption	Dredging: operations	Port Development (land)
8	Habitat loss / degradation	Bunkering	Dust	Dust	Water quality
9	Traffic volume	Port Development (land)	Port Development (water)	Port Development (land)	Dust
10	Industrial effluent	Ship discharge (bilge)	Port Development (land)	Water quality	Dredging: operations

Source: ESPO, 2016:7.

Prescriptive institutions in Turkey can carry out a study similar to ESPO's. After that, they might centre their supports upon prominent criteria. AHP method is very useful method to analyse such data through its property of forming group decision from individual judgements by taking geometric mean. Taking into account all of these, if this study is implemented to all Turkish ports or major ones, GP policy of Turkey can be constituted. And a synergy or an interaction between port managers and rule maker on GP concept may be actualised.

CONCLUSION

Research findings have been obtained from prioritizing GPPIs obtained from literature review, and content analysis by the help of analysing surveys are based on principle of on-site interview which implemented to selected Turkish ports' managers, by AHP method.

In this study, when we consider AIRPOL management indicators' order of priority, we can see that indicators are electric powered equipment usage, cold ironing, and reducing CO_2 emissions of trucks, have been shone out between indicators related to AIRPOL management by perception of both selected ports. Hereunder, CO_2 emissions maintain their effect on port area, and in return for this, using electric power has been seen as the best precaution by port practitioners. When we analyse individual judgements in deep, we can see some order of priority judgement differences. For instance, in contradistinction to group shift, security manager and environment and quality manager of PA have seen that indicators that are alternative energy usage and energy smart kit usage, have one of the highest priority among AIRPOL management indicators. As an added precaution, renewable energy usage and looking for new ways to supply energy doesn't harm nature, can be methods to reduce emissions.

Two selected ports have been clashed over while prioritizing LIQPOL management indicators. Accordingly, PA has considered indicators that are avoidance of liquid cargo spill and pipeline cargo spill caused by link arm; EPK has considered indicators that are avoidance of oil spill and bilge water dumping management, in order to prevent LIQPOL. In PA, handling operations have been carried out potently. For this reason, PA managers have cared LIQPOL while handling cargo. Distinctly, managers of EPK have cared LIQPOL caused by external factors such as ship disposals and collision.

In order of priority of indicators related to solid waste pollution management, PA and EPK managers have considered the indicator is waste disposal management, as the best precaution against pollution caused by solid waste. When we look individual judgements, in contradistinction to group shift, security manager of PA has considered regular maintenance of port equipment, and environment and quality manager of PA has considered usage of convertible resources. From different aspects, the whole indicators of solid waste pollution management are prior.

While analysing MARBIO preservation and its training indicators' order of priority, we can see that PA managers have sorted indicators by minor differences; on the other hand, according to managers of EPK, protecting ecology and its training by 49% has great priority in order to preserve MARBIO and train port employees. At this point, naturally, managers of EPK have not cared sediments because of lack of cargo handling.

Selected ports have made similar judgements, while prioritizing indicators of operational risk and odour management. Both of ports have thought that dangerous goods segregation is the highest priority among others. Hardly, avoiding dust pollution is non-ignorable in order to sweep operational risk. Such that, PA's commercial manager by 45%, and environment and quality manager by 67% have made judgements in this direction.

After analysing key criteria's pairwise comparison, perceptual differences have remarked. Although, both of selected ports have thought that LIQPOL management has great importance to carry out GP concept, PA managers have thought that MARBIO preservation and its training has second highest priority, EPK managers have thought that AIRPOL management has second highest priority. Facilities of both ports and implementation time have effect on perceptions of ports. PA has served for cargoes, EPK has served for passengers. This maybe explains perceptual difference is exist, while prioritizing key criterions. Namely, if MARBIO is damaged, in the short term, infrastructure failures or sediments cause this damage, return to ports as decrease of draught limitation of port. Edgeways, decrease of draught limitation is potential threat especially container operating ports due to late built mega ships are serving container cargoes. So, PA's care on MARBIO preservation can be explained in this manner. Variously, AIRPOL directly effects human health comparing to other key criterions. For this reason, AIRPOL is visible and passengers can see and feel this kind of pollution immediately. More particularly, EPK should take in consideration of passengers' complaints.

In this study, data collection tool to analyse priority perception on green port performance indicators, has been generated and validation for this tool has been gained. Under favour of this tool it is thought that evaluations on prominent indicators will form a conceptual frame for decision support system in terms of especially port managers and other stakeholders that are government, port states, non-governmental organizations and associations who carried out port-oriented business in Turkey.

Consequently, within the frame of the whole findings, in spite of the fact that general perceptual differences to GPPIs are exist between two ports which are serving different cargo types, necessity of carrying out GPPIs has been revealed in this study. With this study, it has been executed that protection from negative impacts of pollution around port area, protecting marine fauna around port area are vital for providing cost efficiency in ports and vital for long term serviceability of ports. ESPO had periodically implemented questionnaires to European ports in order to determine the order of priority of green port performance indicators according to port managers. Thus, prior indicators had been specified, and works had centred on these indicators to sweep deficiencies or environmental worries. With this study, it has been revealed that similar study with ESPO's can be implemented to Turkish port managers by this method; and after analysing phase, the highest priority criteria according to perception of Turkish ports, can be determined. In the light of idea exchanges with ministry representatives, ministry plans to give governmental incentive to Turkish ports in order to reduce environmental concerns. While determining incentive issues, this study can be implemented to all Turkish ports' managers. Thus, prior criteria for reducing environmental worries caused by ports, can be determined; and incentives can be provided towards initially sweeping environmental concerns on these determined criteria. By this means, relation within green port concept can be associated between rule maker and practitioners across the Turkey. If this study will be implemented periodically, effectuality of incentives may be quantified.

In short, with this study, data collection tool for prioritizing GGPC has been formed. By this means, it is revealed that AHP is valid and reliable method while analysing perceptual priorities of GGPC. As a managerial implication, it is though that evaluations on prominent indicators will form a conceptual frame for decision support system in terms of especially port managers and other stakeholders are ministry, port states, non-governmental organizations and associations carried out port-oriented business in Turkey.

In the first phase, literature review study has been performed with GPPI-related articles. So, eighteen GPPC-related articles have been established in the literature. GPPC-related literature executed by reviewing academic articles issued in academic journals which are available at the "mass browsing of databases" of Dokuz Eylül University Central Library. After in depth analysis, 33 GPPC have been revealed. Although, there more criteria exist in literature, similar and reiterated criteria have been determined and not given a place in this study. Also, lack of academicians specialised on ports can be seen as a limitation of expert opinion phase of this study. Number of academicians reached for taking expert opinion, has been remained amount of twelve academicians. In field research phase, AHP questionnaire form has been implemented to port practitioners. In this phase, two selected Turkish ports' perceptions have been compared thereby collecting their managers' individual judgements. At this juncture, it is limitation that judgements are then-current which is date of questionnaire to be implemented. Judgements in this study, are valid between the dates of 11th September 2015 and 6th June 2016. The study remained limited with two Turkish ports, due to lack of returns to our permission requests, this is because implementing AHP form have taken long time and intensity in ports. And this is necessary that implementing AHP questionnaire form by interview to provide consistency. So, on account of the fact that safety is vital in the port area, access difficulty to ports has been arisen. As suggestion for future studies on this issue, perception analysis of each terminal separately can be carried out throughout Turkey thereby increasing number of sample; perception comparison between public ports and public-private-partnership ports or academicians and port practitioners can be analysed. In this study, port sustainability has been evaluated on the basis of environmental dimension, similar study that concentrates on economic and social dimensions of port sustainability, can be fictionalized. Additionally, an environmental review index for ports might be formed thereby building fuzzy logic with prominent indicators.

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APPENDICES

APPENDIX 1 Questionnaire Form to Receive Expert Opinion of Academicians

Dear Madam/Sir,

Please specify significance level of below mentioned '*green port performance criteria*' as so fit to your opinion.

Note: ***[1] Very Few Important, [2Few Important, [3] Neither, [4] Important, [5] Very Important***

Critical Note: Only check box should be marked for each criterion.

Criterion No.	Criterion Name	1	2	3	4	5
1	Inhibition Port Entrance Sediment and Coast Erosion	☐	☐	☐	☐	☐
2	Marine Biology Preservation	☐	☐	☐	☐	☐
3	Avoidance of Oil Spill	☐	☐	☐	☐	☐
4	Waste Disposal Management	☐	☐	☐	☐	☐
5	Avoidance of Liquid Cargo Spill	☐	☐	☐	☐	☐
6	Pipeline Cargo Spill Caused by Link Arm	☐	☐	☐	☐	☐
7	Noise Pollution and Quake Caused by Discharging Equipment	☐	☐	☐	☐	☐
8	Detention of Decreasing Real Estate Value Caused by Pipeline Cargo	☐	☐	☐	☐	☐
9	Avoiding Ballast Water Nearby Port	☐	☐	☐	☐	☐
10	Sewage Processing	☐	☐	☐	☐	☐
11	Avoiding Air Pollution	☐	☐	☐	☐	☐
12	Ship Deceleration Nearby Port Area	☐	☐	☐	☐	☐
13	Cold Ironing	☐	☐	☐	☐	☐
14	Electric Powered Equipment Usage	☐	☐	☐	☐	☐
15	Low Sulphur Fuel Consumption Encouragement	☐	☐	☐	☐	☐
16	Alternative Energy Usage	☐	☐	☐	☐	☐
17	Protecting Aesthetic Townscape from Port Operations	☐	☐	☐	☐	☐
18	Avoiding Dust Pollution	☐	☐	☐	☐	☐
19	Reducing Infrastructure Failures	☐	☐	☐	☐	☐
20	Reducing CO_2 Emissions of Trucks	☐	☐	☐	☐	☐
21	Protecting Ecology and Its Trainings	☐	☐	☐	☐	☐
22	Regular Maintenance of Port Equipment	☐	☐	☐	☐	☐
23	Energy Smart Kit Usage	☐	☐	☐	☐	☐
24	Flood Effect and Pacification	☐	☐	☐	☐	☐
25	Increasing Volunteerism on Reuse Convertible Resources	☐	☐	☐	☐	☐
26	Harm on Society Avoidance During Infrastructure Constructing	☐	☐	☐	☐	☐
27	Avoidance of Infrastructure Effect	☐	☐	☐	☐	☐
28	Encouragement of Public Transport Modes Usage	☐	☐	☐	☐	☐
29	Port Dredging Sediments Overcome	☐	☐	☐	☐	☐
30	Bilge Water Dumping Management	☐	☐	☐	☐	☐
31	Dangerous Goods Segregation	☐	☐	☐	☐	☐
32	Usage of Convertible Resources	☐	☐	☐	☐	☐
33	Odour Management	☐	☐	☐	☐	☐

THANKS FOR YOUR CONCERN.

APPENDIX 2 Frequency Table of Expert Opinions on Green Performance Criteria

App. 1: Frequency Table of Expert Opinions on Green Performance Criteria

Criteria Name	Frequency Value	Turnout
Inhibition Port Entrance Sediment and Coast Erosion	4.50	12
Marine Biology Preservation	4.75	12
Avoidance of Oil Spill	4.81	11
Waste Disposal Management	4.50	12
Avoidance of Liquid Cargo Spill	4.72	11
Pipeline Cargo Spill Caused by Link Arm	4.33	12
Noise Pollution and Quake Caused by Discharging Equipment	3.91	12
Detention of Decreasing Real Estate Value Caused by Pipeline Cargo	3.00	12
Avoiding Ballast Water Nearby Port	4.50	12
Sewage Processing	4.58	12
Avoiding Air Pollution	4.75	12
Ship Deceleration Nearby Port Area	4.33	9
Cold Ironing	4.25	12
Electric Powered Equipment Usage	4.41	12
Low Sulphur Fuel Consumption Encouragement	4.83	12
Alternative Energy Usage	4.75	12
Protecting Aesthetic Townscape from Port Operations	3.91	12
Avoiding Dust Pollution	4.25	12
Reducing Infrastructure Failures	4.50	12
Reducing CO_2 Emissions of Trucks	4.33	12
Protecting Ecology and Its Trainings	4.58	12
Regular Maintenance of Port Equipment	4.41	12
Energy Smart Kit Usage	4.75	12
Flood Effect and Pacification	4.00	12
Increasing Volunteerism on Reuse Convertible Resources	4.00	11
Harm on Society Avoidance During Infrastructure Constructing	4.00	12
Avoidance of Infrastructure Effect	3.72	11
Encouragement of Public Transport Modes Usage	4.00	12
Port Dredging Sediments Overcome	3.91	12
Bilge Water Dumping Management	4.50	12
Dangerous Goods Segregation	4.58	12
Usage of Convertible Resources	4.50	12
Odour Management	4.25	12

Source: Prepared by Author.

APPENDIX 3 Pairwise Comparison Matrices Consisting of Port Managers' Judgements

App. 2: Pairwise Comparison Matrix to Air Pollution Management Judgements of Security Manager of Port Akdeniz

	Low sulphur fuel consumption encouragement	Alternative energy usage	Electric powered equipment usage	Ship deceleration nearby port area	Cold Ironing	Reducing CO_2 emissions of trucks	Avoiding air pollution	Energy smart kit usage
Low sulphur fuel consumption encouragement	1	1/9	1/5	9	1/9	1/5	9	1/9
Alternative energy usage	9	1	3	9	1	3	9	1
Electric powered equipment usage	5	1/3	1	9	1/3	1	9	1/3
Ship deceleration nearby port area	1/9	1/9	1/9	1	1/9	1/9	1	1/9
Cold Ironing	9	1	3	9	1	3	9	1
Reducing CO_2 emissions of trucks	5	1/3	1	9	1/3	1	9	1/3
Avoiding air pollution	1/9	1/9	1/9	1	1/9	1/9	1	1/9
Energy smart kit usage	9	1	3	9	1	3	9	1

Source: Prepared by Author.

App. 3: Pairwise Comparison Matrix to Air Pollution Management Judgements of Environment and Quality Manager of Port Akdeniz

	Low sulphur fuel consumption encouragement	Alternative energy usage	Electric powered equipment usage	Ship deceleration nearby port area	Cold Ironing	Reducing CO_2 emissions of trucks	Avoiding air pollution	Energy smart kit usage
Low sulphur fuel consumption encouragement	1	9	1/7	1/5	1/5	1/9	1/5	1/9
Alternative energy usage	1/9	1	1/9	1/9	1/9	1/9	1/9	1/9
Electric powered equipment usage	7	9	1	3	3	1/3	3	1/3
Ship deceleration nearby port area	5	9	1/3	1	1	1/3	1	1/3
Cold Ironing	5	9	1/3	1	1	1/3	1	1/3
Reducing CO_2 emissions of trucks	9	9	3	3	3	1	3	1
Avoiding air pollution	5	9	1/3	1	1	1/3	1	1/3
Energy smart kit usage	9	9	3	3	3	1	3	1

Source: Prepared by Author.

App. 4: Pairwise Comparison Matrix to Air Pollution Management Judgements of Maritime Services Manager of Port Akdeniz

	Low sulphur fuel consumption encouragement	Alternative energy usage	Electric powered equipment usage	Ship deceleration nearby port area	Cold Ironing	Reducing CO_2 emissions of trucks	Avoiding air pollution	Energy smart kit usage
Low sulphur fuel consumption encouragement	1	7	1/7	9	1	1	5	3
Alternative energy usage	1/7	1	1/9	3	1/7	1/7	1/3	1/3
Electric powered equipment usage	7	9	1	9	7	7	9	9
Ship deceleration nearby port area	1/9	1/3	1/9	1	1/9	1/9	1/3	1/5
Cold Ironing	1	7	1/7	9	1	1	5	3
Reducing CO_2 emissions of trucks	1	7	1/7	9	1	1	5	3
Avoiding air pollution	1/5	3	1/9	3	1/5	1/5	1	1
Energy smart kit usage	1/3	3	1/9	5	1/3	1/3	1	1

Source: Prepared by Author.

App. 5: Pairwise Comparison Matrix to Liquid Pollution Management Judgements of Commercial Manager of Port Akdeniz

	Avoidance of oil spill	Avoidance of liquid cargo spill	Sewage processing	Avoiding ballast water nearby port	Bilge water dumping management	Pipeline cargo spill caused by link arm
Avoidance of oil spill	1	1/9	1	1/5	1/5	1/9
Avoidance of liquid cargo spill	9	1	9	3	3	1
Sewage processing	1	1/9	1	1/5	1/5	1/9
Avoiding ballast water nearby port	5	1/3	5	1	1	1/3
Bilge water dumping management	5	1/3	5	1	1	1/3
Pipeline cargo spill caused by link arm	9	1	9	3	3	1

Source: Prepared by Author.

App. 6: Pairwise Comparison Matrix to Liquid Pollution Management Judgements of Security Manager of Port Akdeniz

	Avoidance of oil spill	Avoidance of liquid cargo spill	Sewage processing	Avoiding ballast water nearby port	Bilge water dumping management	Pipeline cargo spill caused by link arm
Avoidance of oil spill	1	1/5	1/9	1/9	1/5	1/5
Avoidance of liquid cargo spill	5	1	1/3	1/3	1	1
Sewage processing	9	3	1	1	3	3
Avoiding ballast water nearby port	9	3	1	1	3	3
Bilge water dumping management	5	1	1/3	1/3	1	1
Pipeline cargo spill caused by link arm	5	1	1/3	1/3	1	1

Source: Prepared by Author.

App. 7: Pairwise Comparison Matrix to Liquid Pollution Management Judgements of Environment and Quality Manager of Port Akdeniz

	Avoidance of oil spill	Avoidance of liquid cargo spill	Sewage processing	Avoiding ballast water nearby port	Bilge water dumping management	Pipeline cargo spill caused by link arm
Avoidance of oil spill	1	1	9	9	3	1/3
Avoidance of liquid cargo spill	1	1	9	9	3	1/3
Sewage processing	1/9	1/9	1	1	1/3	1/9
Avoiding ballast water nearby port	1/9	1/9	1	1	1/3	1/9
Bilge water dumping management	1/3	1/3	3	3	1	1/9
Pipeline cargo spill caused by link arm	3	3	9	9	9	1

Source: Prepared by Author.

App. 8: Pairwise Comparison Matrix to Liquid Pollution Management Judgements of Maritime Services Manager of Port Akdeniz

	Avoidance of oil spill	Avoidance of liquid cargo spill	Sewage processing	Avoiding ballast water nearby port	Bilge water dumping management	Pipeline cargo spill caused by link arm
Avoidance of oil spill	1	3	7	5	7	7
Avoidance of liquid cargo spill	1/3	1	3	3	3	3
Sewage processing	1/7	1/3	1	1/3	1	1
Avoiding ballast water nearby port	1/5	1/3	3	1	3	3
Bilge water dumping management	1/7	1/3	1	1/3	1	1
Pipeline cargo spill caused by link arm	1/7	1/3	1	1/3	1	1

Source: Prepared by Author.

App. 9: Pairwise Comparison Matrix to Solid Waste Pollution Management Judgements of Commercial Manager of Port Akdeniz

	Waste disposal management	Usage of convertible resources	Regular maintenance of port equipment
Waste disposal management	1	5	5
Usage of convertible resources	1/5	1	1
Regular maintenance of port equipment	1/5	1	1

Source: Prepared by Author.

App. 10: Pairwise Comparison Matrix to Solid Waste Pollution Management Judgements of Security Manager of Port Akdeniz

	Waste disposal management	Usage of convertible resources	Regular maintenance of port equipment
Waste disposal management	1	3	1/3
Usage of convertible resources	1/3	1	1/9
Regular maintenance of port equipment	3	9	1

Source: Prepared by Author.

App. 11: Pairwise Comparison Matrix to Solid Waste Pollution Management Judgements of Environment and Quality Manager of Port Akdeniz

	Waste disposal management	Usage of convertible resources	Regular maintenance of port equipment
Waste disposal management	1	1/3	3
Usage of convertible resources	3	1	9
Regular maintenance of port equipment	1/3	1/9	1

Source: Prepared by Author.

App. 12: Pairwise Comparison Matrix to Solid Waste Pollution Management Judgements of Maritime Services Manager of Port Akdeniz

	Waste disposal management	Usage of convertible resources	Regular maintenance of port equipment
Waste disposal management	1	1	1
Usage of convertible resources	1	1	1
Regular maintenance of port equipment	1	1	1

Source: Prepared by Author.

App. 13: Pairwise Comparison Matrix to Marine Biology Preservation and Its Training Judgements of Commercial Manager of Port Akdeniz

	Marine biology preservation	Inhibition port entrance sediment and coast erosion	Protecting ecology and its training	Reducing infrastructure failures
Marine biology preservation	1	1/3	1	1/5
Inhibition port entrance sediment and coast erosion	3	1	3	1/3
Protecting ecology and its training	1	1/3	1	1/5
Reducing infrastructure failures	5	3	5	1

Source: Prepared by Author.

App. 14: Pairwise Comparison Matrix to Marine Biology Preservation and Its Training Judgements of Security Manager of Port Akdeniz

	Marine biology preservation	Inhibition port entrance sediment and coast erosion	Protecting ecology and its training	Reducing infrastructure failures
Marine biology preservation	1	1	1/5	1/7
Inhibition port entrance sediment and coast erosion	1	1	1/5	1/7
Protecting ecology and its training	5	5	1	1/3
Reducing infrastructure failures	7	7	3	1

Source: Prepared by Author.

App. 15: Pairwise Comparison Matrix to Marine Biology Preservation and Its Training Judgements of Environment and Quality Manager of Port Akdeniz

	Marine biology preservation	Inhibition port entrance sediment and coast erosion	Protecting ecology and its training	Reducing infrastructure failures
Marine biology preservation	1	1	1	9
Inhibition port entrance sediment and coast erosion	1	1	1	9
Protecting ecology and its training	1	1	1	9
Reducing infrastructure failures	1/9	1/9	1/9	1

Source: Prepared by Author.

App. 16: Pairwise Comparison Matrix to Marine Biology Preservation and Its Training Judgements of Maritime Services Manager of Port Akdeniz

	Marine biology preservation	Inhibition port entrance sediment and coast erosion	Protecting ecology and its training	Reducing infrastructure failures
Marine biology preservation	1	1	3	3
Inhibition port entrance sediment and coast erosion	1	1	3	3
Protecting ecology and its training	1/3	1/3	1	1
Reducing infrastructure failures	1/3	1/3	1	1

Source: Prepared by Author.

App. 17: Pairwise Comparison Matrix to Operational Risk and Odour Management Judgements of Commercial Manager of Port Akdeniz

	Dangerous goods segregation	Avoiding dust pollution	Odour management
Dangerous goods segregation	1	1/5	1/5
Avoiding dust pollution	5	1	1
Odour management	5	1	1

Source: Prepared by Author.

App. 18: Pairwise Comparison Matrix to Operational Risk and Odour Management Judgements of Security Manager of Port Akdeniz

	Dangerous goods segregation	Avoiding dust pollution	Odour management
Dangerous goods segregation	1	9	5
Avoiding dust pollution	1/9	1	1/3
Odour management	1/5	3	1

Source: Prepared by Author.

App. 19: Pairwise Comparison Matrix to Operational Risk and Odour Management Judgements of Environment and Quality Manager of Port Akdeniz

	Dangerous goods segregation	Avoiding dust pollution	Odour management
Dangerous goods segregation	1	1/3	5
Avoiding dust pollution	3	1	9
Odour management	1/5	1/9	1

Source: Prepared by Author.

App. 20: Pairwise Comparison Matrix to Operational Risk and Odour Management Judgements of Maritime Services Manager of Port Akdeniz

	Dangerous goods segregation	Avoiding dust pollution	Odour management
Dangerous goods segregation	1	5	7
Avoiding dust pollution	1/5	1	3
Odour management	1/7	1/3	1

Source: Prepared by Author.

App. 21: Pairwise Comparison Matrix to Key Criteria Judgements of Commercial Manager of Port Akdeniz

	Air Pollution Management	Solid Waste Pollution Management	Liquid Pollution Management	Marine Biology Preservation and its Training	Dangerous goods segregation and odour management
Air Pollution Management	1	1	1	3	3
Solid Waste Pollution Management	1	1	1	3	3
Liquid Pollution Management	1	1	1	3	3
Marine Biology Preservation and its Training	1/3	1/3	1/3	1	1
Dangerous goods segregation and odour management	1/3	1/3	1/3	1	1

Source: Prepared by Author.

App. 22: Pairwise Comparison Matrix to Key Criterion Judgements of Security Manager of Port Akdeniz

	Air Pollution Management	Solid Waste Pollution Management	Liquid Pollution Management	Marine Biology Preservation and its Training	Dangerous goods segregation and odour management
Air Pollution Management	1	5	1/9	1/3	3
Solid Waste Pollution Management	1/5	1	1/9	1/9	1/3
Liquid Pollution Management	9	9	1	3	9
Marine Biology Preservation and its Training	3	9	1/3	1	3
Dangerous goods segregation and odour management	1/3	3	1/9	1/3	1

Source: Prepared by Author.

App. 23: Pairwise Comparison Matrix to Key Criterion Judgements of Environment and Quality Manager of Port Akdeniz

	Air Pollution Management	Solid Waste Pollution Management	Liquid Pollution Management	Marine Biology Preservation and its Training	Dangerous goods segregation and odour management
Air Pollution Management	1	5	1/9	1	1
Solid Waste Pollution Management	1/5	1	1/9	1/5	1/5
Liquid Pollution Management	9	9	1	9	9
Marine Biology Preservation and its Training	1	5	1/9	1	1
Dangerous goods segregation and odour management	1	5	1/9	1	1

Source: Prepared by Author.

App. 24: Pairwise Comparison Matrix to Key Criterion Judgements of Maritime Services Manager of Port Akdeniz

	Air Pollution Management	Solid Waste Pollution Management	Liquid Pollution Management	Marine Biology Preservation and its Training	Dangerous goods segregation and odour management
Air Pollution Management	1	1/3	1/3	1/7	1/3
Solid Waste Pollution Management	3	1	1	1/3	1
Liquid Pollution Management	3	1	1	1/3	1
Marine Biology Preservation and its Training	7	3	3	1	3
Dangerous goods segregation and odour management	3	1	1	1/3	1

Source: Prepared by Author.

App. 25: Pairwise Comparison Matrix to Air Pollution Management Judgements of Port Services Manager of Ege Ports Kuşadası

	Low sulphur fuel consumption encouragement	Alternative energy usage	Electric powered equipment usage	Ship deceleration nearby port area	Cold Ironing	Reducing CO_2 emissions of trucks	Avoiding air pollution	Energy smart kit usage
Low sulphur fuel consumption encouragement	1	1/3	1/5	3	1/9	1/3	3	1/5
Alternative energy usage	3	1	1/3	9	1/3	1	9	1/3
Electric powered equipment usage	5	3	1	9	1/3	3	9	1
Ship deceleration nearby port area	1/3	1/9	1/9	1	1/9	1/9	1	1/9
Cold Ironing	9	3	3	9	1	3	9	3
Reducing CO_2 emissions of trucks	3	1	1/3	9	1/3	1	9	1/3
Avoiding air pollution	1/3	1/9	1/9	1	1/9	1/9	1	1/9
Energy smart kit usage	5	3	1	9	1/3	3	9	1

Source: Prepared by Author.

App. 26: Pairwise Comparison Matrix to Air Pollution Management Judgements of Port Services Assistant Manager of Ege Ports Kuşadası

	Low sulphur fuel consumption encouragement	Alternative energy usage	Electric powered equipment usage	Ship deceleration nearby port area	Cold Ironing	Reducing CO_2 emissions of trucks	Avoiding air pollution	Energy smart kit usage
Low sulphur fuel consumption encouragement	1	5	1/7	7	1/5	1/9	1/5	5
Alternative energy usage	1/5	1	1/9	3	1/9	1/9	1/9	1
Electric powered equipment usage	7	9	1	9	3	1/3	3	9
Ship deceleration nearby port area	1/7	1/3	1/9	1	1/9	1/9	1/9	1/3
Cold Ironing	5	9	1/3	9	1	1/3	1	9
Reducing CO_2 emissions of trucks	9	9	3	9	3	1	3	9
Avoiding air pollution	5	9	1/3	9	1	1/3	1	9
Energy smart kit usage	1/5	1	1/9	3	1/9	1/9	1/9	1

Source: Prepared by Author.

App. 27: Pairwise Comparison Matrix to Liquid Pollution Management Judgements of Port Services Manager of Ege Ports Kuşadası

	Avoidance of oil spill	Avoidance of liquid cargo spill	Sewage processing	Avoiding ballast water nearby port	Bilge water dumping management	Pipeline cargo spill caused by link arm
Avoidance of oil spill	1	5	9	9	9	9
Avoidance of liquid cargo spill	1/5	1	3	3	3	3
Sewage processing	1/9	1/3	1	1	1	1
Avoiding ballast water nearby port	1/9	1/3	1	1	1	1
Bilge water dumping management	1/9	1/3	1	1	1	1
Pipeline cargo spill caused by link arm	1/9	1/3	1	1	1	1

Source: Prepared by Author.

App. 28: Pairwise Comparison Matrix to Liquid Pollution Management Judgements of Port Services Assistant Manager of Ege Ports Kuşadası

	Avoidance of oil spill	Avoidance of liquid cargo spill	Sewage processing	Avoiding ballast water nearby port	Bilge water dumping management	Pipeline cargo spill caused by link arm
Avoidance of oil spill	1	9	9	9	1	3
Avoidance of liquid cargo spill	1/9	1	3	3	1/9	1/3
Sewage processing	1/9	1/3	1	1	1/9	1/9
Avoiding ballast water nearby port	1/9	1/3	1	1	1/9	1/9
Bilge water dumping management	1	9	9	9	1	3
Pipeline cargo spill caused by link arm	1/3	3	9	9	1/3	1

Source: Prepared by Author.

App. 29: Pairwise Comparison Matrix to Solid Waste Pollution Management Judgements of Port Services Manager of Ege Ports Kuşadası

	Waste disposal management	Usage of convertible resources	Regular maintenance of port equipment
Waste disposal management	1	5	9
Usage of convertible resources	1/5	1	3
Regular maintenance of port equipment	1/9	1/3	1

Source: Prepared by Author.

App. 30: Pairwise Comparison Matrix to Solid Waste Pollution Management Judgements of Port Services Assistant Manager of Ege Ports Kuşadası

	Waste disposal management	Usage of convertible resources	Regular maintenance of port equipment
Waste disposal management	1	3	3
Usage of convertible resources	1/3	1	1
Regular maintenance of port equipment	1/3	1	1

Source: Prepared by Author.

App. 31: Pairwise Comparison Matrix to Marine Biology Preservation and Its Training Judgements of Port Services Manager of Ege Ports Kuşadası

	Marine biology preservation	Inhibition port entrance sediment and coast erosion	Protecting ecology and its training	Reducing infrastructure failures
Marine biology preservation	1	1/3	1/5	1/3
Inhibition port entrance sediment and coast erosion	3	1	1/3	1
Protecting ecology and its training	5	3	1	3
Reducing infrastructure failures	3	1	1/3	1

Source: Prepared by Author.

App. 32: Pairwise Comparison Matrix to Marine Biology Preservation and Its Training Judgements of Port Services Assistant Manager of Ege Ports Kuşadası

	Marine biology preservation	Inhibition port entrance sediment and coast erosion	Protecting ecology and its training	Reducing infrastructure failures
Marine biology preservation	1	5	1/3	1/3
Inhibition port entrance sediment and coast erosion	1/5	1	1/9	1/9
Protecting ecology and its training	3	9	1	1
Reducing infrastructure failures	3	9	1	1

Source: Prepared by Author.

App. 33: Pairwise Comparison Matrix to Operational Risk and Odour Management Judgements of Port Services Manager of Ege Ports Kuşadası

	Dangerous goods segregation	Avoiding dust pollution	Odour management
Dangerous goods segregation	1	7	7
Avoiding dust pollution	1/7	1	1
Odour management	1/7	1	1

Source: Prepared by Author.

App. 34: Pairwise Comparison Matrix to Operational Risk and Odour Management Judgements of Port Services Assistant Manager of Ege Ports Kuşadası

	Dangerous goods segregation	Avoiding dust pollution	Odour management
Dangerous goods segregation	1	5	9
Avoiding dust pollution	1/5	1	3
Odour management	1/9	1/3	1

Source: Prepared by Author.

App. 35: Pairwise Comparison Matrix to Key Criteria Judgements of Port Services Manager of Ege Ports Kuşadası

	Air Pollution Management	Solid Waste Pollution Management	Liquid Pollution Management	Marine Biology Preservation and its Training	Dangerous goods segregation and odour management
Air Pollution Management	1	5	1/5	3	5
Solid Waste Pollution Management	1/5	1	1/9	1/3	1
Liquid Pollution Management	5	9	1	9	9
Marine Biology Preservation and its Training	1/3	3	1/9	1	3
Dangerous goods segregation and odour management	1/5	1	1/9	1/3	1

Source: Prepared by Author.

App. 36: Pairwise Comparison Matrix to Key Criteria Judgements of Port Services Assistant Manager of Ege Ports Kuşadası

	Air Pollution Management	Solid Waste Pollution Management	Liquid Pollution Management	Marine Biology Preservation and its Training	Dangerous goods segregation and odour management
Air Pollution Management	1	3	1/5	5	5
Solid Waste Pollution Management	1/3	1	1/9	1/3	1/3
Liquid Pollution Management	5	9	1	9	9
Marine Biology Preservation and its Training	1/5	3	1/9	1	1
Dangerous goods segregation and odour management	1/5	3	1/9	1	1

Source: Prepared by Author.

APPENDIX 4 Data Collection Tool

EXPERT PROFILE

Age :

Educational Status : ☐ Lise ☐ Lisans

☐ Ön Lisans ☐ Lisansüstü

Position Held :

Job Experience in this Position (by Years):

Which terminal are you responsible? : ☐ Container ☐ Tanker

☐ Passenger ☐ Dry Bulk

Which port do you work for? :

COMPARISONS OF AIR POLLUTION MANAGEMENT CRITERIA

Survey Question Number	Very Strongly More Important	Strongly More Important	More Important	Slightly More Important	CRITERIA	Equally Important	CRITERIA	Slightly More Important	More Important	Strongly More Important	Very Strongly More Important
1					Low Sulphur Fuel Consumption Encouragement		Alternative Energy Usage				
2					Low Sulphur Fuel Consumption Encouragement		Electric Powered Equipment Usage				
3					Low Sulphur Fuel Consumption Encouragement		Ship Deceleration Nearby Port Area				
4					Low Sulphur Fuel Consumption Encouragement		Cold Ironing				
5					Low Sulphur Fuel Consumption Encouragement		Reducing CO_2 Emissions of Trucks				
6					Low Sulphur Fuel Consumption Encouragement		Avoiding Air Pollution				
7					Low Sulphur Fuel Consumption Encouragement		Energy Smart Kit Usage				
8					Alternative Energy Usage		Electric Powered Equipment Usage				

9					Alternative Energy Usage		Ship Deceleration Nearby Port Area				
10					Alternative Energy Usage		Cold Ironing				
11					Alternative Energy Usage		Reducing CO_2 Emissions of Trucks				
12					Alternative Energy Usage		Avoiding Air Pollution				
13					Alternative Energy Usage		Energy Smart Kit Usage				
14					Electric Powered Equipment Usage		Ship Deceleration Nearby Port Area				
15					Electric Powered Equipment Usage		Cold Ironing				
16					Electric Powered Equipment Usage		Reducing CO_2 Emissions of Trucks				
17					Electric Powered Equipment Usage		Avoiding Air Pollution				
18					Electric Powered Equipment Usage		Energy Smart Kit Usage				
19					Ship Deceleration Nearby Port Area		Cold Ironing				
20					Ship Deceleration Nearby Port Area		Reducing CO_2 Emissions of Trucks				
21					Ship Deceleration Nearby Port Area		Avoiding Air Pollution				
22					Ship Deceleration Nearby Port Area		Energy Smart Kit Usage				
23					Cold Ironing		Reducing CO_2 Emissions of Trucks				
24					Cold Ironing		Avoiding Air Pollution				

25					Cold Ironing		Energy Smart Kit Usage				
26					Reducing CO_2 Emissions of Trucks		Avoiding Air Pollution				
27					Reducing CO_2 Emissions of Trucks		Energy Smart Kit Usage				
28					Avoiding Air Pollution		Energy Smart Kit Usage				

COMPARISONS OF LIQUID POLLUTION MANAGEMENT CRITERIA

Survey Question Number	Very Strongly More Important	Strongly More Important	More Important	Slightly More Important	**CRITERIA**	Equally Important	**CRITERIA**	Slightly More Important	More Important	Strongly More Important	Very Strongly More Important
1					Avoidance of Oil Spill		Avoidance of Liquid Cargo Spill				
2					Avoidance of Oil Spill		Sewage Processing				
3					Avoidance of Oil Spill		Avoiding Ballast Water Nearby Port				
4					Avoidance of Oil Spill		Bilge Water Dumping Management				
5					Avoidance of Oil Spill		Pipeline cargo spill caused by link arm				
6					Avoidance of Liquid Cargo Spill		Sewage Processing				
7					Avoidance of Liquid Cargo		Avoiding Ballast Water				

					Spill		Nearby Port				
8					Avoidance of Liquid Cargo Spill		Bilge Water Dumping Management				
9					Avoidance of Liquid Cargo Spill		Pipeline cargo spill caused by link arm				
10					Sewage Processing		Avoiding Ballast Water Nearby Port				
11					Sewage Processing		Bilge Water Dumping Management				
12					Sewage Processing		Pipeline cargo spill caused by link arm				
13					Avoiding Ballast Water Nearby Port		Bilge Water Dumping Management				
14					Avoiding Ballast Water Nearby Port		Pipeline cargo spill caused by link arm				
15					Bilge Water Dumping Management		Pipeline cargo spill caused by link arm				

COMPARISONS OF SOLID WASTE MANAGEMENT CRITERIA											
Survey Question Number	Very Strongly More Important	Strongly More Important	More Important	Slightly More Important	**CRITERIA**	Equally Important	**CRITERIA**	Slightly More Important	More Important	Strongly More Important	Very Strongly More Important
1					Waste Disposal Management		Usage of Convertible Resources				
2					Waste Disposal Management		Regular Maintenance of Port Equipment				
3					Usage of Convertible Resources		Regular Maintenance of Port Equipment				

COMPARISONS OF MARINE BIOLOG PRESERVATION AND ITS TRAINING CRITERIA											
Survey Question Number	Very Strongly More Important	Strongly More Important	More Important	Slightly More Important	**CRITERIA**	Equally Important	**CRITERIA**	Slightly More Important	More Important	Strongly More Important	Very Strongly More Important
1					Marine Biology Preservation		Inhibition Port Entrance Sediment and Coast Erosion				
2					Marine Biology Preservation		Protecting Ecology and Its Training				
3					Marine Biology Preservation		Reducing Infrastructure Failures				
4					Inhibition Port Entrance Sediment and Coast Erosion		Protecting Ecology and Its Training				
5					Inhibition Port Entrance Sediment and Coast Erosion		Reducing Infrastructure Failures				
6					Protecting Ecology and Its Training		Reducing Infrastructure Failures				

COMPARISONS OF OPERATIONAL RISK AND ODOUR MANAGEMENT CRITERIA											
Survey Question Number	Very Strongly More Important	Strongly More Important	More Important	Slightly More Important	**CRITERIA**	Equally Important	**CRITERIA**	Slightly More Important	More Important	Strongly More Important	Very Strongly More Important
1					Dangerous Goods Segregation		Avoiding Dust Pollution				
2					Dangerous Goods Segregation		Odour Management				
3					Avoiding Dust Pollution		Odour Management				

COMPARISONS OF KEY CRITERIA											
Survey Question Number	Very Strongly More Important	Strongly More Important	More Important	Slightly More Important	**CRITERIA**	Equally Important	**CRITERIA**	Slightly More Important	More Important	Strongly More Important	Very Strongly More Important
1					Air Pollution Management		Solid Waste Pollution Management				
2					Air Pollution Management		Liquid Pollution Management				
3					Air Pollution Management		Marine Biology Preservation and Its Training				

4					Air Pollution Management		Operational Risk and Odour Management				
5					Liquid Pollution Management		Solid Waste Pollution Management				
6					Liquid Pollution Management		Marine Biology Preservation and Its Training				
7					Liquid Pollution Management		Operational Risk and Odour Management				
8					Solid Waste Pollution Management		Marine Biology Preservation and Its Training				
9					Solid Waste Pollution Management		Operational Risk and Odour Management				
10					Marine Biology Preservation and Its Training		Operational Risk and Odour Management				

APPENDIX 5 Determining Criteria by Literature Review

	Indicators \ Academicians	*Esmer et al. (2010)*	*Morales-Caselles et al. (2008)*	*Heng and Yijun (2011)*	*Dooms et al. (2013)*	*Chang and Wang (22012)*	*Chiu et al. (2014)*	*Carballo-Penela et al. (2012)*	*Lirn et al. (2013)*	*Bergqvist and Zanden (2012)*	*Odindi and Mhangara (2012)*	*Kavakeb et al. (2015)*	*Szili and Rofe (2007)*	*Anastasopoulos et al. (2011)*	*Yang and Chang (2013)*	*Chang and Jhang (2016)*	*Pavlic et al. (2013)*	*Sheu et al. (2013)*	*Hartman and Colt (2012)*	*Park and Yeo (2012)*
1	Inhibition Port Entrance Sediment and Coast Erosion		✓				✓		✓					✓		✓		✓		✓
2	Marine Biology Preservation	✓	✓				✓		✓				✓	✓				✓		
3	Avoidance of Oil Spill			✓			✓		✓					✓				✓		✓
4	Waste Disposal Management	✓	✓	✓	✓		✓	✓	✓					✓				✓		
5	Avoidance of Liquid Cargo Spill						✓		✓					✓				✓		
6	Pipeline Cargo Spill Caused by Link Arm						✓		✓					✓						
7	Noise Pollution and Quake Caused by Discharging Equipment						✓		✓	✓				✓				✓		✓
8	Detention of Decreasing Real Estate Value Caused by Pipeline Cargo						✓		✓					✓						
9	Avoiding Ballast Water Nearby Port		✓	✓	✓		✓		✓					✓				✓		✓
10	Sewage Processing		✓	✓	✓		✓		✓					✓				✓		✓
11	Avoiding Air Pollution	✓		✓	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓
12	Ship Deceleration Nearby Port Area					✓	✓		✓					✓		✓		✓		
13	Cold Ironing					✓	✓		✓					✓						

14	Electric Powered Equipment Usage	✓		✓			✓	✓	✓			✓			✓		✓	✓		
15	Low Sulphur Fuel Consumption Encouragement	✓		✓			✓		✓	✓				✓	✓	✓	✓	✓		
16	Alternative Energy Usage					✓	✓		✓			✓		✓	✓		✓	✓		
17	Protecting Aesthetic Townscape from Port Operations			✓			✓		✓	✓	✓							✓		
18	Avoiding Dust Pollution			✓			✓		✓										✓	
19	Reducing Infrastructure Failures			✓			✓		✓		✓		✓					✓		
20	Reducing CO_2 Emissions of Trucks	✓		✓	✓		✓	✓	✓	✓		✓		✓		✓		✓	✓	
21	Protecting Ecology and Its Trainings						✓		✓								✓	✓		
22	Regular Maintenance of Port Equipment			✓			✓		✓		✓			✓						
23	Energy Smart Kit Usage			✓			✓		✓						✓		✓	✓		✓
24	Flood Effect and Pacification						✓		✓											
25	Increasing Volunteerism on Reuse Convertible Resources	✓					✓		✓	✓				✓	✓			✓		✓
26	Harm on Society Avoidance During Infrastructure Constructing						✓		✓		✓		✓					✓		
27	Avoidance of Infrastructure Effect						✓		✓		✓		✓	✓				✓		
28	Encouragement of Public Transport Modes Usage				✓		✓		✓											
29	Port Dredging Sediments Overcome		✓				✓		✓									✓		✓
30	Bilge Water Dumping Management		✓	✓	✓		✓		✓					✓				✓		
31	Dangerous Goods Segregation						✓		✓					✓						
32	Usage of Convertible Resources	✓					✓		✓					✓				✓		✓
33	Odour Management						✓		✓											