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MASTER’S THESIS

SUSTAINABLE DEVELOPMENT PERFORMANCE EVALUATION OF MARITIME TRANSPORT COMPANIES

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THESIS APROVAL PAGE

DECLARATION

I hereby declare that this master’s thesis titled as “Sustainable Development Performance Evaluation of Maritime Transport Companies” has been written by myself in accordance with the academic rules and ethical conduct. I also declare that all materials benefited in this thesis consist of the mentioned resources in the reference list. I verify all these with my honor.

…./…./2021

Sacit Tekin GÜNAYDIN

ABSTRACT

Master's Thesis

Sustainability Development Performance Evaluation of Maritime Transport Companies

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Sustainable development has become a crucial concept recently and there have been many worldwide attempts to promote it. As being one of the most important actors in the world merchant trade, the maritime transport sector also has critical responsibility in terms of sustainable development. However, this responsibility can not be limited to one specific dimension. All dimensions (Economic, Environmental, Social) of sustainable development have to be considered.

This study aims to identify the performance criteria in terms of sustainable maritime transport and to weight the significance levels of the criteria. Additionally, it also aims to determine which maritime transport company is more successful in terms of sustainable development performance by years.

The Analytic Hierarchy Process (AHP) method is used to weight the significance levels of the criteria and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) method is used to find out which maritime transport company is more successful in terms of sustainable development performance by years. Accordingly, Three main and eleven sub-criteria were identified and weighted. Afterwards, the sustainable development performances of three maritime transport companies were analysed by years.

Keywords: Sustainable Development, Sustainable Maritime Transport, Sustainable Development Performance Evaluation

ÖZET

Yüksek Lisans Tezi

Deniz Taşımacılığı Firmalarının Sürdürülebilir Kalkınma Performanslarının Değerlendirilmesi

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Sürdürülebilir kalkınma son dönemlerde oldukça önemli bir kavram haline geldi ve bunu teşvik etmek amacıyla dünya çapında birçok girişimde bulunuldu. Dünya ticaretinin en önemli aktörlerinden biri olan deniz taşımacılığı sektörü, sürdürülebilir kalkınma açısından da kritik sorumluluğa sahiptir. Ancak bu sorumluluk yalnızca bir boyutla sınırlandırılmamalı ve sürdürülebilir kalkınmanın tüm boyutları (Ekonomik, Çevresel, Sosyal) dikkate alınmalıdır.

Bu çalışma deniz taşımacılığı açısından sürdürülebilir kalkınma performansı kriterlerini belirlemeyi, bu kriterlerin önem düzeylerini ağırlıklandırmayı ve yıllara göre sürdürülebilir kalkınma performansı açısından hangi deniz taşımacılığı firmasının daha başarılı olduğunu tespit etmeyi hedeflemektedir.

Bu çalışmada kriterlerin önem düzeylerinin ağırlıklandırılması için AHP yöntemi, yıllara göre sürdürülebilir kalkınma performansı açısından hangi deniz taşımacılığı şirketinin daha başarılı olduğunu bulmak için TOPSIS yöntemi kullanılmıştır. Bu doğrultuda, önce üç ana ve on bir alt kriter belirlenmiş ve daha sonra bu kriterler ağırlıklandırılmıştır. Ardından, üç deniz taşımacılığı şirketinin sürdürülebilir kalkınma performansları yıllar itibarıyla analiz edilmiştir.

Anahtar Kelimeler: Sürdürülebilir Kalkınma, Sürdürülebilir Deniz Taşımacılığı, Sürdürülebilir Kalkınma Performans Değerlendirmesi

SUSTAINABLE DEVELOPMENT PERFORMANCE EVALUATION OF MARITIME TRANSPORT COMPANIES

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ABBREVIATIONS

WCED	World Commission on Environment and Development
AHP	Analytic Hierarchy Process
TOPSIS	Technique for Order of Preference by Similarity to Ideal Solution
UNEP	United Nations Environment Program
WSSD	World Summit on Sustainable Development
WCS	World Conservation Strategy
UNCED	The United Nations Conference on Environment and Development
MDGs	Millennium Development Goals
IUCN	The International Union for Conservation of Nature
SDGs	Sustainable Development Goals
UN	United Nations
GRI	Global Reporting Initiative
UNDSD	The United Nations Division for Sustainable Development
ICS	International Chamber of Shipping
IMO	International Maritime Organization
MEPC	Marine Environment Protection Committee
MARPOL	The International Convention for the Prevention of Pollution from Ships
SOLAS	The International Convention for the Safety of Life
GHG	Greenhouse Gas
EEDI	The Energy Efficiency Design Index
SEEMP	Ship Energy Efficiency Management Plan
CO2	Carbon Dioxide
UNCTAD	United Nations Conference on Trade and Development
IGF Code	The International Code of Safety for Ships using Gases or other Low-flashpoint Fuels
SOx	Sulphur Oxides
NOx	Nitrogen Oxides
ILO	International Labour Organization
MLC	Maritime Labour Convention

CSR	Corporate Social Responsibility
ROS	Return on Sales
ROE	Return on Equity
ROA	Return on Assets
MCDM	Multi-Criteria Decision Making
CR	Consistency Ratio
CI	Consistency Index
RI	Random Index
EC	Economic Dimension Criteria
EN	Environmental Dimension Criteria
SC	Social Dimension Criteria

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INTRODUCTION

Sustainable development is a crucial concept that has been remaining on the world agenda for decades. It has been described as “The development meets the needs of the present without compromising the ability of future generations to meet their own needs” in the Brundtland Report (1987) by the World Commission on Environment and Development (WCED). As being an important actor which consists of more than four in five of world merchandise trade volume, the maritime transport has a very significant role in international trade. This role also brings along vital responsibilities as well. These responsibilities cannot be categorized only into environmental issues, it is necessary to deal with them as a whole, with economic and social issues as well. Therefore, the maritime transport sector is required to keep pace with sustainable development improvements by taking account of all dimensions and adapt itself to the current and future changes accordingly.

Despite the studies dealing with the subject of sustainable development in the literature, still there is a lack of studies on maritime transport dealing with all dimensions of sustainable development. In order to fill this gap, this study aims; a) to determine the performance criteria in terms of sustainable maritime transport; b) to weight the significance levels of the criteria by using the Analytic Hierarchy Process (AHP) method and; c) to find out which maritime transport company is more successful in terms of sustainable development performance by years using the method of the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS).

Accordingly, the rest of the study is organized as follows. The first chapter focuses on the literature review on the sustainable development concept. It includes historical background and dimensions of sustainable development, corporate sustainability, sustainability measuring, and reporting. In the second chapter, the sustainable maritime transport concept is reviewed. In the third chapter, the research methodology and results of the study are given. Last, the conclusion section summarizes the study and includes the contributions, limitations, and recommendations.

CHAPTER ONE
SUSTAINABLE DEVELOPMENT CONCEPT

1.1. DEFINITION OF SUSTAINABLE DEVELOPMENT

In the past few hundred years, our way of development has severely damaged the ecological environment of the world. The consumption rate of natural resources is so high that the earth cannot tolerate these harmful effects and recover itself. One reason is the new technologies that enabled us to reach natural resources easily and also led to the higher consumption of those resources. One of the main reasons is the exponential growth in the population as well as industrial production (Meadows, Randers, & Meadows, 2004: 17; Vanegas, Dubose, & Pearce, 1994: 1). The feature and the rate of the ecological transformation in the environment alter depending on the economic, social, and technological changes. This transformation on the planet occurs according to scientific observations although it may be difficult to notice them in an individual lifetime (Khalili, 2011: 18).

The unrestrained economic growth has affected not only eco systems but also social systems. These systems encounter significant problems such as climate change, conflicts between people, and wealth inequalities (Atila, 2018: 221). The equilibrium in ecosystems should be maintained at all costs since everyone accepts that the development of civilization and individuals depend on nature and cannot exist without it (Hull, 2008: 75). Accordingly, the question of how long more the earth can support us to continue our way of life and economic systems is always asked by different generations. The sustainable development concept may enable us to organize the responses to this critical question (Krueger, 2017: 1).

These negative trends enabled the concept of sustainable development to show up. Fundamentally, sustainable development approach deals with the environment, economy, and society together (Perdan, 2010: 5). Gillis and Vincent argue that only economic growth is not enough although it is essential because of not internalizing the cost of environmental degradation properly while taking market decisions (Gillis & Vincent, 2000: 12).

The term sustainable development put forward that economic growth is to be performed by taking account of social and environmental matters. This stands for adopting a new development thinking which does not propose that the strong economy also will bring along social and political stability (Waters, 2008: 1). In the prominent report of Our Common Future (WCED, 1987) which is also known as The Brundtland Report, it is defined as ‘’Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs‘’.

Although it has limitations, this definition includes two essential principles for achieving sustainable development. These principles can be expressed as intra-generational equity and inter-generational equity (Dalal-Clayton & Sadler, 2014: 32). Social justice and material equity are the critical standards of sustainable development to achieve intra-generational equity. This can be reached by providing all the opportunities to live better and fighting poverty (Perdan, 2010: 17). As for inter-generational equity, this concept stands for our responsibility to take account of the welfare of the next generations and the obligation to protect their interests as well. These always have been a substantial part of the sustainable development concept since the start (Perdan, 2010: 20). Since that time, there have been many publications that include a large number of interpretations of the concept and its political impacts (Dalal-Clayton & Sadler, 2014: 12).

There are numerous definitions and interpretations of sustainable development, however, specific common topics exist in all interpretations (Ramlogan, 2011: 10). Sustainable development helps people to be able to think in a different way which aims to improve welfare while dealing with the limitations of the global context (Vanegas, Dubose, & Pearce, 1994: 2). These limitations stand for the limits on the environmental resources and biosphere that are brought about by current technology and social organization (WCED, 1987).

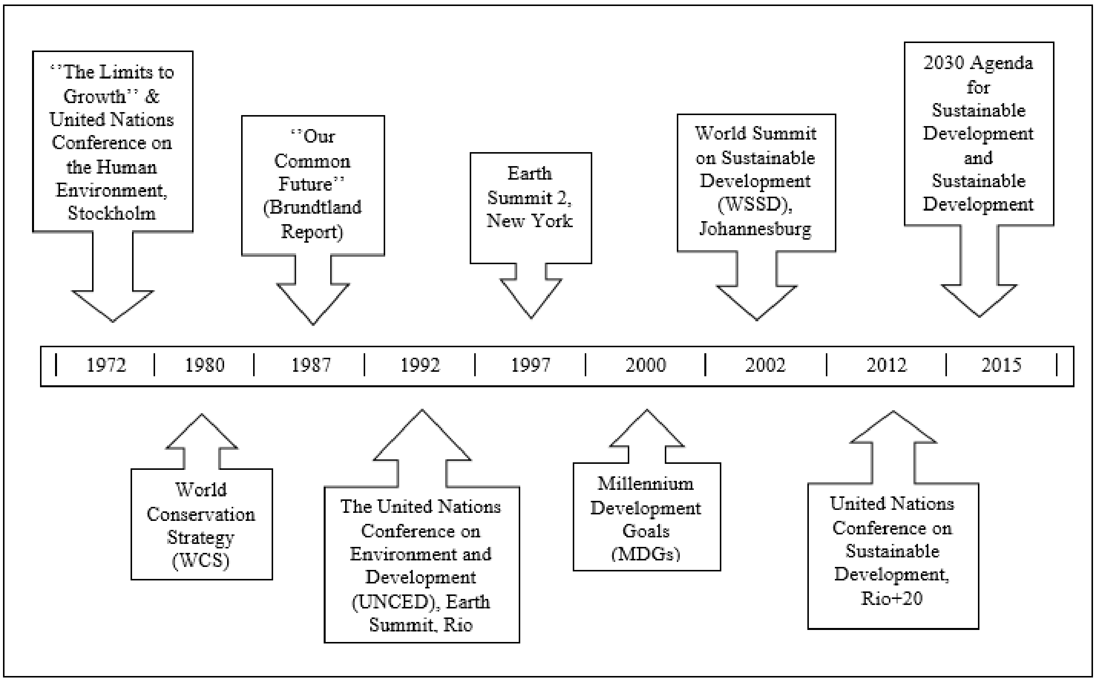
Sustainable development aims to maximize the adaptability, security, and wellbeing levels of humanity by providing improvement permanently without environmental degradation (Barrow, 2018: 3). Sustainable development is not a static concept that aims to create static fixed structures or determining fixed features for economic, political, and social life. It is an on-going process and its characteristics vary in time. It is a dynamic concept that can be promoted instead of being reached (Baker, 2015: 7-8). The concept has widely spread across political and intellectual environments thanks to its strength which is based on its basic definition of fundamental objectives (Lélé, 1991: 611-612). The ultimate objective of sustainable development is to keep to balance between economic, social, and environmental dimensions that form sustainable development (Mensah, 2019: 15).

1.2. THE HISTORICAL BACKGROUND OF SUSTAINABLE DEVELOPMENT

Throughout history, the requirement of the compatibility among the economy, social life, and the environment have acknowledged by plenty of civilizations (Ramlogan, 2011: 7). In 1798, an economist which is called Thomas Malthus (Malthus, 1798) wrote An Essay on the Principle of Population. The discussions on the limitations of Malthus have remained on the agenda for centuries and many questions have been asked about the population growth rate and sufficiency of the resources (Rogers, Jalal, & Boyd, 2008: 20). Although it has some essential shortcomings, the Malthusian ''Environmental limits'' theory may be regarded as the predecessor of the sustainable development concept (Mebratu, 1998: 499).

In 1972, the Club of Rome, a group consists of scientists, economists, and other members from relevant domains, published a groundbreaking study of ''The Limits to Growth''(Meadows et al., 1972) so that they can stimulate the people to fulfill their responsibilities for the progress of society. The Limits to Growth formed a model of a dynamic interaction among the concepts of population, consumption of limited natural resources, environmental degradation, and industrial production. Accordingly, they anticipated that the economic growth was not able to carry on permanently (Rodwell, 2007: 51). The Club of Rome with this famous publication of the Limits to Growth followed a similar view of Malthusian theory regarding population growth and its possible negative results for society (Ramlogan, 2011: 6). Nevertheless, the 'limits to growth' have been widely criticized since only dealing with the physical limits to growth and also not taking account of the possibility of the new technologies and their possible impacts for more efficient production (Baker, 2006: 18). In the same year, the United Nations Conference on the Human Environment was held in Stockholm. This conference was the first major worldwide meeting on the issue of sustainability (Drexhage & Murphy, 2010: 7). It was announced 26 principles were prepared to point out the environmental degradation and poverty stemming from unbalanced economic growth. These principles of the Stockholm Declaration with the assist of impact created by Limits to Growth became the key elements of the new concept of sustainable development which was about to appear soon (Scerri, 2017: 1). Besides the declaration, another important outcome of the conference was the creation of the permanent environmental branch of the United Nations which is called as United Nations Environment Program (UNEP) (Caradonna, 2014: 140). The argument that the environmental problems are to dealt with in the global context was legitimized and other international organizations and structures were formed thanks to the impact of the conference and its consequences (Baker, 2006: 54).

Figure 1: Milestones of Sustainable Development Concept



Source: Author

In 1980, the rate of progress was not very fast. Nevertheless, it was remarkable and its symbolic impacts were much more important than its instant impacts (Caradonna, 2014: 140). The sustainable development term was introduced by the time the International Union for Conservation of Nature (IUCN) published the World Conservation Strategy (WCS). Afterwards, the concept turned into a centerpiece of environmentalist and conservationist thinking (Reid, 1995: 38). Its objective was to carry out requirements of sustainable development by protecting natural resources. However, it mainly dealt with environmental issues instead of integrating economic and social issues (Baker, 2006: 18).

In 1987, The World Commission on Environment and Development (WCED) published a report called ‘’Our Common Future’’ which has been regarded as the origin point of the current debates on the sustainable development concept. The Our Common Future report which is also known as the Brundtland Report was a comprehensive document prepared through global collaboration. Although it was a political milestone for the sustainable development concept, it was not the exact starting point, neither was the possible final of the conceptual process of sustainable development (Mebratu, 1998: 496). The famous definition of the report on sustainable development “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” includes two critical concepts. The first one is the concept of ‘’needs’’ which priority has to be given and the other one is the idea of limitations for the maintaining capability of the environment to meet present and future needs (WCED, 1987). The Brundtland Report had an optimistic viewpoint concerning the possibility of human beings being part of the maintaining sustainable future process. It highlighted the technological development. Besides, it considered creating a common future by including the essential changes in social and economic domains as well (Baker, 2006: 22). The report also indicated the requirement of reforming laws and institutions in the frame of sustainable development to deal with the problems of the future with the aim of promoting inter-generational and intra-generational equity (Osorio, Lobato, & Del Castillo, 2005: 502).

In 1992, The United Nations Conference on Environment and Development (UNCED) which is also called the Earth Summit was held in Rio de Janeiro as one of the most important consequences of the Brundtland Commission’s work. The Earth Summit was the most extensive international conference organized up to that date. The objective was to promote the attention on global problems on development and the environment (Dresner, 2008: 41). It concentrated on two critical aspects: the first one is the connection between development and environment and the second one is the practical aspects regarding sustainable development such as new policy implementations (Baker, 2006: 55). Besides, Agenda 21 which consists of 40 chapters that explain the implementation plans in a wide range of fields was accepted. It put forward a number of plans on how to support sustainable development in practical terms and also made analyses of the reasons and signs of unsustainable ways of development (Baker, 2006: 56). The Rio Earth Summit led to the emergence of an optimistic perception of the progress of sustainable development in a global context. After the Summit, the United Nations constituted the International Commission on Sustainable Development in order to supervise the progress of Agenda 21 and to assist the accomplishment of its goals (Rodwell, 2007: 54).

Following the UNCED, the issues of sustainable development and the environment remained on the global agenda. In 1997, Earth Summit 2 took place in New York in order to revise the improvement promised by the previous meeting. However, it has to be acknowledged that there had been no significant progress in practice for the reason that Agenda 21 had not been financed well and very few of the commitments had been achieved up to that time (Dresner, 2008: 49).

In 2000, the United Nations declared Millennium Development Goals (MDGs) which are intended to be fulfilled by 2015. It was one of the most assertive efforts up to that date and all United Nations member countries accepted to comply with these 8 goals (Caradonna, 2014: 223). These goals generated a frame to be able to deal with issues such as poverty, education, health, and gender equity. Although, there had been a particular goal of 7 as ‘’ensuring environmental sustainability’’ and other goals that are related to the environment as well, the environmental basis of the MDGs remained inadequate (Dalal-Clayton & Sadler, 2014: 16).

In 2002, the third summit which is called the World Summit on Sustainable Development (WSSD) took place in Johannesburg. This summit had two main objectives: first, to evaluate the 10-year progress of the 1992 Earth Summit, and second, to promote the adherence to sustainable development in a global context. It was also was the most comprehensive event up to that date concerning its content (Baker, 2006: 64). The impacts of the concept of sustainable development had been increasing since the beginning of the millennium, especially for private firms. Besides, the concept remained on the agenda among the social and economic fields after the summit (Zaccai, 2012: 79-80).

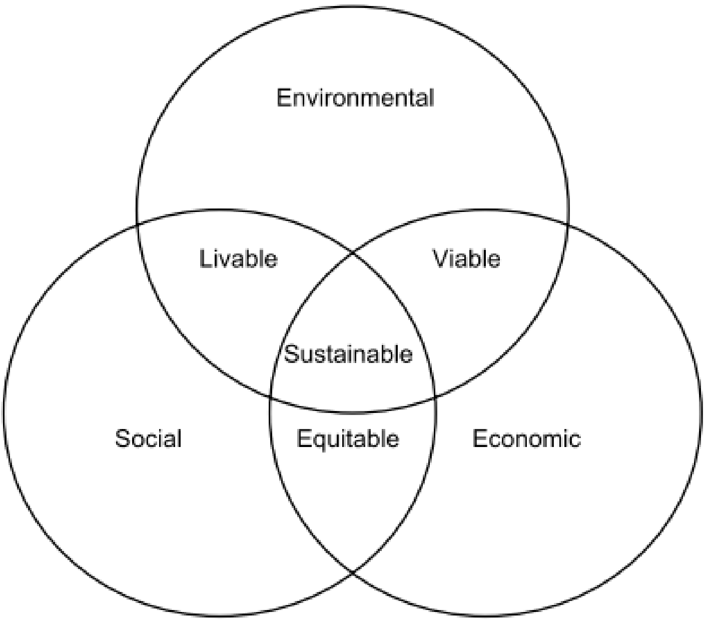
In 2012, the United Nations Conference on Sustainable Development, also known as Rio+20, took place in Rio in order to deal with the current arising global issues, to review the progress on the results of the recent summits, and to ensure political adherence (Elliott, 2013: 11).

In 2015, the 2030 Agenda for Sustainable Development and Sustainable Development Goals (SDGs) were agreed upon by United Nations members. In comparison to MDGs, SDGs transformed the conventional concept of sustainable development radically. In addition to maintaining economic growth, SDGs presented the inclusive growth concept by integrating environmental, economic, and social development (Shi, Han, Yang, & Gao, 2019: 6).

1.3. DIMENSIONS OF SUSTAINABLE DEVELOPMENT

Sustainable Development consists of three dimensions of economic, environmental, and social. These dimensions are also known as the ‘’triple bottom line’’ which is utilized to evaluate the projects or programs. All dimensions should be considered equally so that successful results could be obtained. This equilibrium yields result when each dimension is evaluated separately (Rogers et al., 2008: 42). The common pattern of sustainable development is the overlapping circles of the economic, environmental, and social dimensions. These circles depict the relation and balance between the dimensions of sustainable development (Hopwood, Mellor, & O’Brien, 2005: 48).

Figure 2: Dimensions of Sustainable Development



Source: Tanguay, Rajaonson, Lefebvre, & Lanoie, 2010: 1

These 3 dimensions have to be integrated and utilized to promote the implementation of sustainable development (R. Goodland, 1995: 4). In addition to maintaining equilibrium among these dimensions which are the fundamental components of the existence of humankind, also there is a need for a balance between the current and next generation's interests (Hull, 2008: 75-76). The Holistic method of sustainable development requires proper handling of trade-offs, collaborations, and discrepancies among these dimensions and fulfilling potentials of all dimensions synchronously. Above all, structures such as international organizations, governments of countries, and other non-governmental organizations should be involved in the management process of sustainable development issues (Mensah & Casadevall, 2019: 15).

1.3.1. The Economic Dimension of Sustainable Development

When the consequences of the previous economic crises are reviewed, it can be stated that economic development which is essential for society have to be maintained properly. Economic growth was the main objective of global policies for decades. Thus, it is quite challenging to maintain the equilibrium between economic growth and sustainable development (Moldan, Janoušková, & Hák, 2012: 5). However, the economic dimension is not only related to inflation, gross national products, or profit, it stands for a broader meaning. It is very critical for the sustainable development concept due to being a social science that clarifies consumption, production, and distribution (Vanegas et al., 1996: 4).

One of the main objectives of sustainable development is the distribution of economic welfare equally for many generations. It also aims to shift from economic growth depending on the consumption of non-renewable natural resources to more renewable ones (Robert Goodland & Ledec, 1987: 36). The economic dimension of sustainable development fundamentally includes the enhancement of the well-being of humankind. The conventional development concept had a concern with economic growth which brings economic benefit to society (Atila, 2018: 223). The sustainable development approach focuses on long-term issues and aims to modify the current perspective so that it can be noticed that the economic losses occurred because of the degradation of natural resources. In this way, it will be comprehended that in the long-term the sustainable development model is economically more favorable than previous development models (Vanegas et al., 1996: 4).

1.3.2. The Environmental Dimension of Sustainable Development

For thousands of years, human societies have had to enhance their civilizations within the framework of existing natural systems and there has been a challenging equilibrium between human beings and their surroundings. Therefore, environmental problems have always been a matter for humankind (Wheeler, 2004: 19). Humankind relies on nature for basic needs to survive like other living creatures. However, the unbalanced enormous world economy is jeopardizing the earth and leads to enormous harms that affect the survival and welfare of humanity and other kinds (Sachs, 2015: 2).

It is stated in the UN conference on the Human Environment in Stockholm that one of the most important reasons for unsustainable development is economic growth which does not take the ecological limitations into account. Besides, there is a need for a dynamic approach for the equilibrium between environmental conservation and economic growth since the growing economies inevitably lead to degradation of the environment (Strong & Hemphill, 2006: 177). The environmental development approach aims to build an ecological society that is compatible with nature. This refers to the harmonization of environmental conservation, social development, and economic activity. Thus, the enhancement of human welfare does not lead to the degradation of the earth (Baker, 2006: 5).

1.3.3. The Social Dimension of Sustainable Development

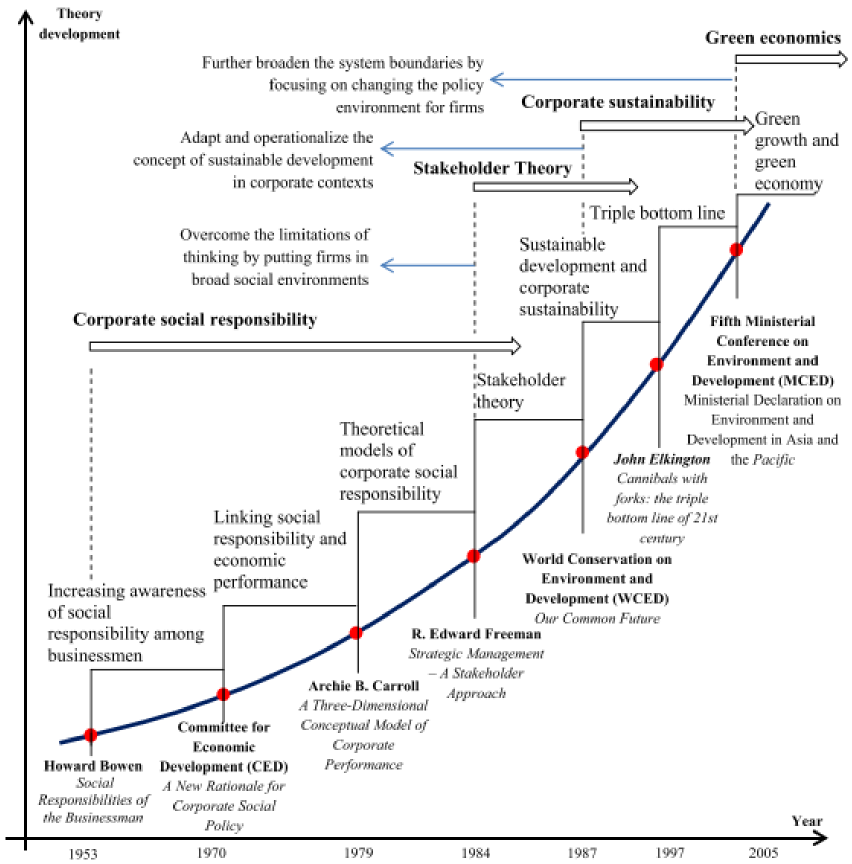
The social dimension of sustainable development deals with the questions of how do individuals and societies live together and perform their development plans by considering the limitations of the earth (Colantonio, 2009: 872). A socially sustainable development model should fulfill the requirements in the fields of education, health, gender equity, and welfare equity (Harris, 2000: 6). While the ecological economists and environmentalists of the 1970s dealt with the economic and environmental issues since the 2000s there has been more focus on social issues such as well-being, poverty, and equality. According to supporters of sustainable development, a sustainable society should fulfill these social requirements as well as conserving natural capital, eliminating waste, and establishing economic stability (Caradonna, 2014: 220). These social requirements are very critical components of the development process since they affect the feature of the development of the economy and the population (Meadows et al., 2005: 52).

It can be stated that the linkages between the dimensions of sustainable development are still a little bit vague since the concept of social sustainable development was simplified excessively and was not theorized adequately. In addition to these, there were very few attempts to define the social dimension of sustainable development as a separate dimension in the past (Colantonio, 2009: 867). However, over the past few years, there also have been more attempts in order to promote the comprehension of the social dimension. Holistic and more comprehensive approaches have been arisen in the theoretical and applied social science literature as well as policy development (Dalal-Clayton & Sadler, 2014: 259).

1.4. CORPORATE SUSTAINABILITY

Recently, various theories regarding the relationship between sustainability and companies have been put forward such as Stakeholder Theory, Corporate Sustainability, and Corporate Social Responsibility (CSR). Therefore, companies have changed their perspective remarkably. It was the result of the attempts in this area. However, still there are many unclear points related to interrelationships between the emerging theories. In this context, it is necessary to explore these interrelationships since many theories have emerged (Chang et al., 2017: 48).

Figure 3: Evolving Theories of Sustainable Development and firms



Source: Chang et al., 2017: 49

Besides, numerous approaches and definitions have been presented concerning a more ethical, more transparent, and more humanitarian way of performing business. It was a significant occasion in the development process of new business models promoting sustainable development (van Marrewijk, 2003: 95). When implementing the sustainable development approach into the business ground, the corporate sustainability concept can be adopted. Accordingly, corporate sustainability can be defined as ‘’meeting the needs of a firm’s direct and indirect stakeholders, without compromising its ability to meet the needs of future stakeholders as well’’. In this direction, companies should improve their economic, environmental, and social capital base while promoting sustainable development proactively in the political sphere (Dyllick & Hockerts, 2002: 131-132). The social pressures on the companies generate a requirement to deal with the integration of economic, environmental, and social dimensions. Sustainable development regards dealing properly with these dimensions as a critical condition for a corporation to survive sustainably. Corporate sustainability requires the ability to survive in the medium and long term while promoting the other objectives of the company such as enhancing the shareholder value (Hamilton, 2011: 184).

1.5. SUSTAINABLE DEVELOPMENT MEASUREMENT AND REPORTING

Sustainability reporting refers to the sharing of the environmental, economic, and social effects of the activities by organizations so that it can be revealed the positive and negative consequences of those activities. All organizations are very critical components to promote sustainable development since they make positive or negative changes in the progress while performing their activities (GRI, 2016: 3). Sustainability Reporting is regarded as a tool for more transparent communication by companies since they realized the significance of accountability to stakeholders and being more open. In addition to the advantages of recognization by external actors, several companies expect their market shares to increase thanks to sharing their sustainability performance (Beloff, Tanzil, & Lines, 2004: 273).

Companies have felt compelled to report their environmental performance since the former public environmental reports were released. Even though the sharing of environmental performances started in sectors that have remarkable impacts on the earth, later it was adopted by other sectors and companies which have considerably fewer impacts comparing to others. Currently, companies not only should operate their business in accordance with the requirements but also publish them accordingly. These changes have occurred since the public concern and consciousness on the concept have increased noteworthily (van den Brink & van der Woerd, 2004: 190). All three dimensions of sustainable development should be measured and reported by organizations because the long-term survival of these organizations depends on maintaining positive outcomes on each sustainable development dimensions. Later, these outcomes of the different dimensions are to be reviewed (Khalili, 2011a: 134-135).

The economist and the environmentalist John Elkington (1997) proposed the ‘’triple bottom line’’ term. Then, it became a very common reporting method that includes economic, social, and environmental issues. The triple bottom line has also been used in sustainable development arguments in a widespread manner (McKenzie, 2004: 6). Although only the reports including all dimensions can be defined as sustainability reports, one-dimensional reports still exist. One dimensional reports can only be related to sustainability reporting partly since they are focused on one specific dimension. However, some sustainability reports which are supposed to include all dimensions exclude some economic dimension related information which is usually shown in annual reports (Hahn & Kühnen, 2013: 6).

Accordingly, the organizations should detect the critical effects on the dimensions of sustainable development and reveal them in line with global frameworks (GRI, 2016: 3). One of these frameworks, adopted by the United Nations Division for Sustainable Development (UNDSD), is measurement via indicators connected to development goals. This framework categorizes the indicators first according to economic, environmental, and social dimensions, then themes and sub-themes. The other framework is the Sustainability Reporting Guidelines focused on procedures and standardization (Hutchins & Sutherland, 2008: 1691). In recent years, there have been various prospering efforts to test and review the quotients method to sustainability metrics in accordance with the ‘’sustainability context’’ attempt of the Global Reporting Initiative (GRI) in measuring and reporting sustainability (Khalili, 2011a: 135).

There had been emerged a need for integration that is compatible with recognized international reporting standards since the companies were under pressure of preparing multiple reports. In this context, the GRI which developed a consistent sustainability reporting framework on a global scale became an internationally recognized sustainability reporting standard (Beloff et al., 2004: 273). The GRI led the way in establishing the world's most common sustainability reporting framework and made a huge effort to improve and implement it in a global context. This framework enables organizations to measure and report their environmental, social, and economic performances properly by using the principles and indicators (Khalili, 2011a: 153).

CHAPTER TWO
SUSTAINABLE MARITIME TRANSPORT

2.1. DEFINITION OF SUSTAINABLE MARITIME TRANSPORT

The intercontinental transportation of manufactured products is a critical requirement for development and growth. However, this cannot be achieved without maritime transportation of energy and commodity in large amounts. Maritime transport promotes the improvement of international trade, economic growth, and societies' standards of living (ICS, 2013). Essentially, the maritime transport sector, which consists of many stakeholders, is international in all respects and critical for the global economy and sustainable development (Dragan, 2012: 257). It is at the center of sustainable development since it fosters trade, enhances market access, and helps economic growth. For this reason, maritime transport has a vital responsibility in the way to sustainable development. Energy-efficient, low-carbon, safe and rule-based maritime transport systems promote environmentally conscious, socially equitable, and economically efficient development (Benamara, Hoffmann, & Youssef, 2019: 27-28). Therefore, maritime transport has a significant effect worldwide. The responsible applications in the maritime transportation processes also affect other sectors and promote them to perform more responsibly concerning sustainability issues as well (Birwatkar, 2017: 85).

It has been broadly argued in the last decades, nonetheless, there has not been one common concept of sustainable maritime transport (Dragan, 2012: 257). In this context, Cabezas et al. (2008: 3) defined sustainable maritime transport as "a cost-effective commercial activity, in which the environmental load is not bigger than that which the environment can currently and in the future bear, and that the social community (directly and indirectly) in contact with it is not being negatively affected".

Nevertheless, it is not possible to contribute to the community while the sustainable development concept is not adopted properly. It is vital to comprehend the social and environmental issues in the maritime transport sector and put forward possible solutions to solve these problems (Martinez Marin, 2011: 59-60). The main problem regarding the maritime transport industry's negative reputation is related to the proactive structure of the industry. It is obvious that there is a necessity of effort to enhance the quality standards and safety in the maritime transport processes and diminish the negative external factors (Birwatkar, 2017: 79). Unsustainable maritime transport practices have to be detected and relevant sustainable criteria are to be integrated into maritime transport policies and planning to carry out the process more efficiently. In order to promote more efficient, environment-friendly, and more sustainable maritime transport, there will be necessary more specialized regulations and policies. It is also required that all stakeholders of the maritime transport sector have to be involved in the process of promoting sustainable maritime transport and proper coordination has to be maintained since the sector is international and many-sided which consists of many actors and stakeholders (Benamara et al., 2019:27-28).

It is obvious that all international organizations, governments, and other stakeholders in the maritime transport industry should be involved in the process of achieving sustainable maritime development and perform their activities in cooperation towards achieving all three sustainable development dimensions. (IMO, 2013). Maritime transport is regulated by international conventions since its characteristics have international features. In this context, International Maritime Organization (IMO) entered into force in 1958 in order to govern international maritime transport (Dorathy, 2017: 190-191). IMO has made various efforts to deal with this issue by adopting regulations that arrange minimum standards concerning the safety level of the services provided by the maritime transport companies. (Birwatkar, 2017: 79). Maritime transport has a huge significance to promote today's society all over the world and it increases the importance of IMO's work dramatically (Sciberras & Silva, 2019: 382). IMO conventions are approved and implemented by the member nations. They are split up into 3 main groups as maritime safety, prevention of marine pollution, liability, and compensation. In addition to these, there are also conventions coping with other issues such as tonnage measurement, salvage, unlawful acts against maritime transport (Dorathy, 2017: 190-191). For this reason, IMO has a vital part while promoting the sustainable development goals and 2030 agenda and assisting the member states by making technical cooperations and policy advices (Sciberras & Silva, 2018: 436).

In the way to sustainable development, it is essential that maritime transport companies to cope with problems that threaten their long term existence and sustainable growth. The concept of sustainable maritime transport have to be adopted not only at the societal level but also at the organizational level since unsustainable maritime transport activities may lead to a poor level of service and make challenging the objective of achieving sustainable development goals (Bhaskar, Cahoon, & Chen, 2014: 322). In practice, companies review performance indicators to assess the effects of companies' activities in the direction of sustainable maritime transport. The economic, environmental, and social impacts of sustainable maritime transport activities are shown by these indicators and the outcomes of assessments are shared with the stakeholders (Grațiela, 2019: 118).

2.2. HISTORICAL BACKGROUND OF SUSTAINABLE MARITIME TRANSPORT

Historically, maritime transport has always been a critical factor of development regarding the welfare of society and economy by promoting trade (Dragan, 2012: 258). Since ancient times, seas have been utilized for various activities such as transport in order to support society and provide its necessities. These actions have led to emerging of new regulations because of their impacts on society and the environment (Linné & Svensson, 2016: 77). However, making maritime transport more environment-friendly and sustainable development concept in maritime transport have been commenced not long ago (Thana, 2013: 938).

After 1972, the Stockholm conference and other affairs about environmental issues enabled the environmental concerns to spread worldwide and formed a basis for precautions to deal with the international issues such as pollution from ships (Linné & Svensson, 2016: 80). In 1973, Marine Environment Protection Committee (MEPC) was established by IMO. MEPC deals with air quality problems and greenhouse gas emissions from ships all over the world. Its main focus was on marine pollution by oil. Subsequently, the International Convention for the Prevention of Pollution from Ships (MARPOL) was accepted. It was the first extensive convention for pollution prevention. MARPOL convention's aim was for establishing a regulatory framework to diminish the damage on the sea and to conserve the marine environment. MARPOL convention was changed several times to extend its scope in the last decades (Popek, 2016: 3).

Another important convention adopted to maintain the safety at sea regarding the seaworthiness of ships was the International Convention for the Safety of Life (SOLAS) 1974 (Žižić, Krčum, & Šakić, 2014: 183). Subsequently, for the conservation of the marine environment, it emerged the requirement to establish a legal framework. In 1982, the United Nations Convention on the Law of the Sea (UNCLOS) which is also called as "Constitution of the Seas" was established. It was fundamentally based on the International Conventions of the United Nations and its purpose was to preserve the marine environment from pollution. This convention was adopted as a legal framework to regulate all activities on the seas and was approved by 161 parties (Thana, 2013: 937).

In 2011, Imo approved a new set of measures in order to diminish GHG (Greenhouse gas) emissions in Annex VI of the MARPOL Convention. These measures consist of operational and technical issues to enhance energy efficiency and also to decrease GHG emissions in the maritime transport industry worldwide. These changes include the Energy Efficiency Design Index (EEDI) and Ship Energy Efficiency Management Plan (SEEMP) (Žižić et al., 2014: 92). EEDI, as a first attempt to decrease GHG emissions from maritime transport, is a benchmarking tool in order to indicate the GHG emissions of ships regarding maritime transport. It compares emission rates and transport data of a ship at the design level to evaluate these rates according to IMO’s requirements (Psaraftis, 2016: 135). As for the SEEMP, it enables the maritime transport companies to control and enhance their performance with respect to several elements that lead to CO2 (Carbon dioxide) emissions (Popek, 2016:4).

By 2013, Maritime Labour Convention came into force to regulate the employment standards internationally. In this context, the Maritime transport industry became the only industry that has an extended legal framework regulating the employment standards worldwide (ICS, 2013). In 2015, the Paris agreement came into force and has been accepted by 186 nations. Therefore, relevant stakeholders have to adhere to decreasing emissions immediately in order to promote the target of “holding the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels” (UNCTAD, 2019). In the same year, IMO adopted the International

Code of safety for ships using gases or other low flashpoint fuels (IGF Code). The IGF Code aims to support eco-friendly and safe operation, construction, and design of vessels (Popek, 2016: 5-6).

After 2015, IMO started to make efforts to perform in harmony with the United Nations's sustainable development goals and has done several attempts to promote these goals in the maritime transport sector. In 2017, Ocean Conference was gathered in New York in order to assist and support the application of sustainable development goal 14 regarding to life below water (Dorathy, 2017: 191). Subsequently, IMO declared the organization's strategic goals for 2018-2023 to clarify the strategic plan for the six years of 2018-2023 (Wu, Zhang, & Feng, 2020: 2).

2.3. DIMENSIONS OF SUSTAINABLE MARITIME TRANSPORT

It is required that all areas concerning maritime transport should be reorganized properly since maritime transport is at the core of the global economy. Furthermore, all the activities regarding the adaptation of sustainable development into maritime transport processes have to be carried out by considering the economic, environmental, and social dimensions of sustainable development (Comtois & Slack, 2007: 45). This means that any activity performed in the maritime transport process should be performed in conformity with the economic, environmental, and social requirements. However, that could be quite challenging to make the maritime transport processes sustainable by implementing equitably all these activities between the parts of the process along the way to sustainable development (IMO, 2013). It is necessary to establish adequate equilibration among the economic, environmental, and social targets which are diverse and competitive in order to be able to support the sustainable development in maritime transport. The purpose is to improve the consistency of the system and creating more value-added processes by utilizing the resources at the optimal level (Benamara et al., 2019: 5).

While the aim of the economic dimension is to perform activities by considering economic efficiency, the aim of the environmental dimension is to comprehend the impacts of the industry practices on the natural environment. As for the social dimension, the aim is to make amendments regarding society's needs and come up with potential solutions for current problems led by maritime transport

(Comtois & Slack, 2007: 45). These economic, environmental, and socially sustainable development dimensions have more distinguishing features in the context of maritime transport owing to vessel sizes, emissions, and other factors such as a geographical scope. However still there are many missing points in the implementation of these dimensions and it is required to fix these problems in the maritime sector worldwide (Moreira, 2014: 7).

At the corporate level, Ji et al. emphasized that maritime transport companies should perform their activities by considering the environment and society. Thus, they have to consider the benefits of external stakeholders while obtaining profitability (Ji, Sui, & Wang, 2019: 339). It is necessary that the economic, environmental, and social dimensions of the sustainable development concept are to be comprehended properly to be able to implement and promote the sustainable development goals efficiently. In this context, it is essential to evaluate the adoption of the concept theoretically and practically within the maritime transport field (Fasoulis & Kurt, 2019: 5).

2.3.1. Economic Dimension of Sustainable Maritime Transport

Maritime trade accounts for 80% of the global trade by volume and 70% of its value (UNCTAD, 2017). The maritime transport industry is a very critical accelerator factor for the expansion of the global economy and employment as well. It also enlarges the income of the coastal countries by enhancing the relations and trade between them. Therefore, the maritime transport industry enables these countries to develop economically (Thana, 2013: 936). If maritime transport was not existed, the world would be obliged to use other ways of transport and would not make progress. This means that maritime transport is the lifeblood for global economic development (Dragan, 2012: 259). The maritime transport sector also has continuously provided reduced transport costs for commodities in global trade. Consequently, it has assisted in the improvement of global trade by maintaining the price of commodities transported fairly low (McGuire & Perivier, 2011: 73).

Table 1: Development in international maritime trade (Million tons loaded)

YEAR	TOTAL (all cargoes)
1970	2605
1980	3704
1990	4008
2000	5984
2005	7109
2006	7702
2007	8036
2008	8231
2009	7857
2010	8408
2011	8775
2012	9195
2013	9513
2014	9842
2015	10023
2016	10295
2017	10716
2018	11005

Source: UNCTAD, 2019

International Chamber of Shipping (ICS) highlighted that regulatory bodies have to put equal emphasis on all sustainable development dimensions, including the economic dimension. It has vital importance since the maritime transport industry plays a significant role in the distribution of welfare globally. However, the sector has to be commercially and economically sustainable, otherwise, the regulators can not able to invest in environmental and social improvements (ICS, 2013).

The purpose of the economic dimension of sustainable development is to provide economic development by also considering the negative impacts on environmental and social development. In this context, it enables the industry actors to adopt more cost-efficient and more environment-friendly processes (Cabezas-Basurko et al., 2008: 3). Therefore, the global maritime transport industry should make efforts to improve the environmental and social dimensions towards sustainable development, however, it also has to take into account the economic issues since it is a significant part of the sustainable development process (ICS, 2013).

2.3.2. Environmental Dimension of Sustainable Maritime Transport

Maritime transport is one of the key factors for air quality degradation and the rising amount of global trade volumes also affect these negative consequences. Hence, maritime transport became the core topic at the sustainable development arguments (Miola, Ciuffo, Marra, & Giovine, 2010: 10). The concerns about the impacts of maritime transport activities in the global trade have increased since maritime transport has expanded considerably and its volume accounts for 80 percent of the international trade. Recently, maritime transport actors have been more involved in sustainable development processes and numerous maritime transport companies have made efforts to make their activities more sustainable (Lun, Lai, Wong, & Cheng, 2014: 134).

Maritime transport issues have been conventionally analyzed concerning economic or cost-benefit criteria from the perspective of industry actors and stakeholders. These applications generally do not take the environmental issues into account or only give little attention (Psaraftis, 2016:133). Unsustainable maritime transport activities mainly cause GHG emissions, pollution, and depletion of resources, although it has been considered as a more environment-friendly way of transport in terms of tonne-miles measurement. Nevertheless, its negative impacts on the environment exceed its good implications (Benamara et al., 2019: 4).

The maritime transport industry put effort into more comprehensive and sustainable applications by adopting the more energy-efficient ways with low emissions. International Maritime Organization (IMO), as the main body to regulate this progress towards sustainable development, enables the stakeholders to get involved in the process more actively (Chatzinikolaou & Ventikos, 2011: 932). IMO put forward its “no more favourable treatment” principle in order to be able to implement all its measurements equally all over the world and to enhance the environmental processes at the maximum level. Thus, it aims to prevent the possible failures in the process of GHG emission reduction regime for global maritime transport (Popek, 2016: 3).

It was acknowledged that climate change is one of the most challenging problems of the world when the 2030 Agenda and the Paris Agreement was adopted. Furthermore, it was highlighted that climate change has serious adverse effects on the environment and it can weaken the capability of the nations to promote achieving sustainable development (IMO, 2017). Greenhouse gas (GHG) emissions such as carbon dioxide (CO2) have serious impacts on the climate, environment, and public health. Other significant emissions of sulphur oxides (SOx) and nitrogen oxides (NOx) causes the formation of other particles and acidification of sea and land areas. Furthermore, SOx and NOx also cause some health problems (Salo et al., 2016: 170). While global NOx emissions from all maritime transport activities account for 13 percent of the global SOx total, global NOx emissions account for 15 percent of the global NOx total (IMO, 2015).

Cleaner emissions require new technologies and innovations in ship design and shipbuilding. Therefore, some significant control regulations have been established (IMO, 2013). IMO commenced the EEDI to diminish carbon dioxide (CO2) emissions from maritime transport. EEDI creates a benchmark for comparison of the energy efficiency of ships by establishing a minimum required levels (Polakis, Zachariadis, & de Kat, 2019: 94). It aims to increase the utilization of less polluting and more energy-efficient engines and equipment. EEDI is not a prescriptive tool since it leaves the right for the selection of technologies that are used in the design process of the vessels. Thus, the vessel builders and designers can use any method as long as it is energy efficient at the required level (Polakis et al., 2019: 95).

Maritime transport is constantly seeking more effective ways to enhance the energy efficiency of the vessels and to diminish the consumption of fuel oil (IMO, 2013). The SEEMP is a useful instrument that enables the ship owners and operators to enhance the energy efficiency of ships during operation processes. It mainly aims to promote the increased use of various current fuel-saving applications. It is utilized for more efficient operational processes such as speed and power optimization, improved voyage planning, optimized ship handling (Cogliolo, 2015: 68-69).

2.3.3. Social Dimension of Sustainable Maritime Transport

The social dimension of the triple bottom line approach can include a broad range of organizational performance criteria. In recent years, the social performance of the companies has been assessed by measuring the overall wellbeing of the employees in terms of safety and health issues (Kitada & Langåker, 2018: 92).

Nevertheless, the social dimension has been dealt with less concerning the dimensions of sustainable development (Lam, 2015: 71).

In the maritime transport industry, the sustainable development concept is critically important in regards to diminishing maritime accidents and removing the external risks (Dragan, 2012: 258). For this reason, IMO has adopted the convention of Safety of Life at Sea (SOLAS) concerning safety issues in the maritime transport industry. It has been ratified by 164 states parties as of 31 July 2018 and it can be count as one of the most significant conventions which apply to more than 99% of the global tonnage by establishing required standards for the building, equipment, and operation of the vessels (UNCTAD, 2018a). Sustainable maritime transport has to support the safety culture by enhancing the standards and implementations all over the world. This safety culture not only should comply with the regulations but also should contribute to the process by promoting the safety (IMO, 2013). In this context, International Labour Organization's (ILO) Maritime Labour Convention (MLC) has been adopted to regulate the work-environment-related issues such as working hours, health, and safety (ICS, 2013).

Historically maritime transport sector has been dominated by men workforce. However, maritime transport companies that support the employment of women can change this situation and assist the improvement of a diversified and quality workforce as well as promoting the related sustainable development goals (UNCTAD, 2017). Although it has not been argued widely so far, all actors and stakeholders in the industry are responsible to integrate the social dimension issues such as gender equality into sustainable maritime transport processes (Kitada & Langåker, 2018: 92). In order to maintain social integrity and provide an adequate work environment for the maritime transport industry workforce, a robust collaboration among the industry actors and stakeholders is required (IMO, 2013). The workforce participation rate for women still is not at an adequate level, although there is are various attempts and progresses to maintain gender equality. Improvements in gender equality in the workforce can also promote the development of the economy and growth (UNCTAD, 2019). The United Nations has highlighted the significance of gender equality for many years by means of some tools such as MDGs and SDGs. In this context, having adopted the 2030 agenda of the United Nations for sustainable development, countries worldwide made a commitment “to achieve gender equality and empower all women and girls” (Goal 5) and “to achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value” (Goal 8, target 8.5) by 2030 (UNCTAD, 2019). These important improvements highlighted the significance of integrating sustainable development principles into maritime transport and other sectors (UNCTAD, 2018b).

CHAPTER THREE
SUSTAINABLE DEVELOPMENT PERFORMANCE EVALUATION OF MARITIME TRANSPORT COMPANIES

In the previous chapters, sustainable development and sustainable maritime transport concepts are reviewed. In this chapter, the aim and scope of the research, the significance of the research, methodology, and findings of the research are examined.

3.1. AIM AND SCOPE OF THE RESEARCH

The aim of this study is; a) to determine the performance criteria in terms of sustainable maritime transport; b) to weight the significance levels of the criteria by using the analytic hierarchy process and; c) to find out which maritime transport company is more successful in terms of sustainable development performance by years.

This study covers the performance evaluation of maritime transport companies from the container transport sector in terms of sustainable development criteria determined by conducting a literature review. The sample of the study includes three maritime transport companies that publish sustainability reports annually by providing tangible data. In this process, the sustainability and annual reports which are published between the years 2017 and 2019 were included.

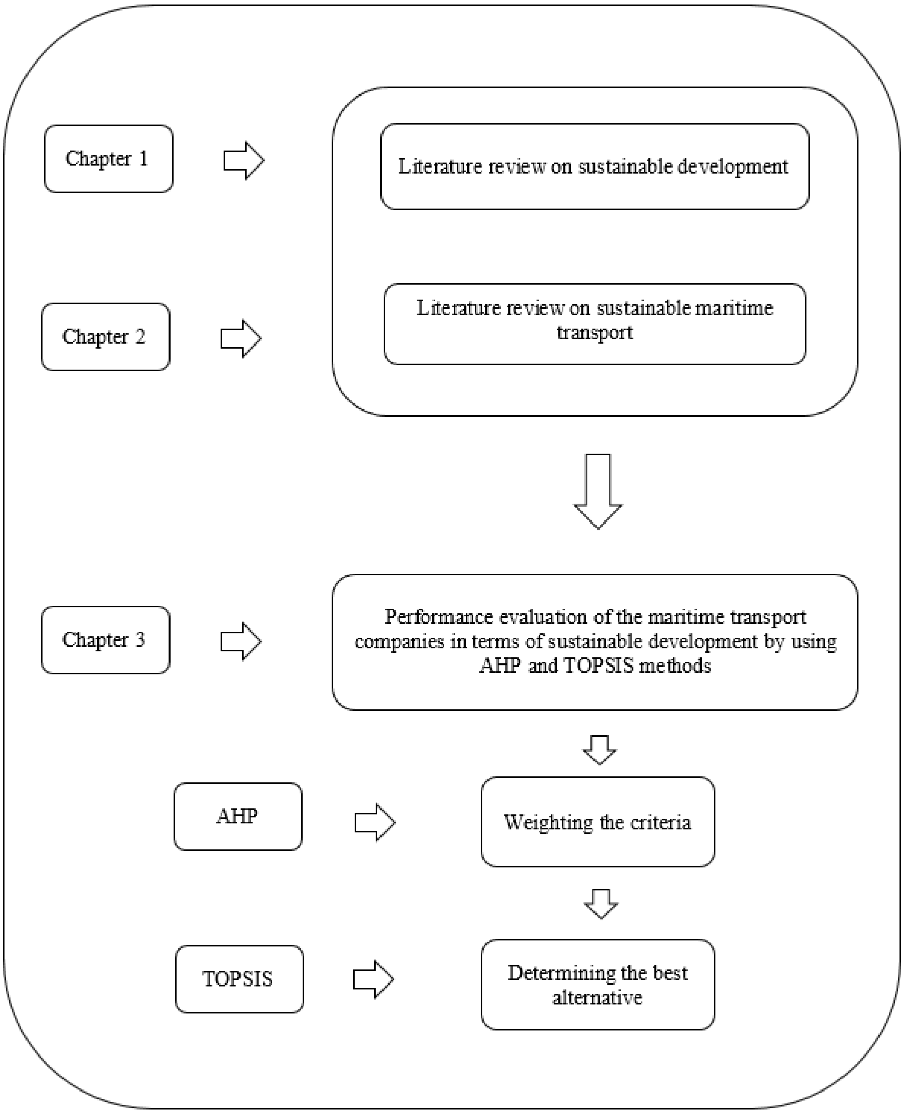
3.2. SIGNIFICANCE OF THE RESEARCH

The maritime transport sector has a very critical function in international trade and this situation brings along important responsibilities in terms of sustainable development. Although there are studies dealing with the subject of sustainable development, still there is a lack of studies about maritime transport concerning sustainable development. In this context, this study can contribute to the maritime transport sector and academic studies through its findings.

3.3. RESEARCH METHODOLOGY

In this chapter, the performances of maritime transport companies from the container transport sector are evaluated in terms of sustainable development criteria by using the AHP and TOPSIS methods.

Figure 4: Research Process of the Study



Source: Author

3.3.1 Research Data and Data Collection

In order to carry out the AHP method, three main sustainable development criteria and eleven sub-criteria have been chosen by reviewing the related literature and reports published by maritime transport companies. The economic dimension, environmental dimension, and social dimension are chosen as the main criteria. Return on sales (ROS), return on equity (ROE) and the return on assets (ROA), the consumption rate of fuel oil, the emission rate of carbon dioxides, the emission rate of sulphur oxides, the emission rate of nitrogen oxides, rate of female employees in the company, rate of female members at the management level, number of work-related fatalities and rate of injuries(lost time injury) are chosen as sub-criteria concerning main criteria.

To weight the related criteria, experts have to be chosen concerning the aim of the decision-making problem and it is supposed to be selected from the maritime transport sector or relevant academic institutions if the research is conducted within the field of maritime transport (Bulut & Duru, 2018: 41). In this context, 12 experts have been chosen from the academia and maritime transport sector to weigh the criteria and sub-criteria in the AHP. These experts have been chosen according to their relevant specialization and experience in the related field. It has been considered the experts either scholars who have related academic studies or practitioners who are at managerial positions in the related field.

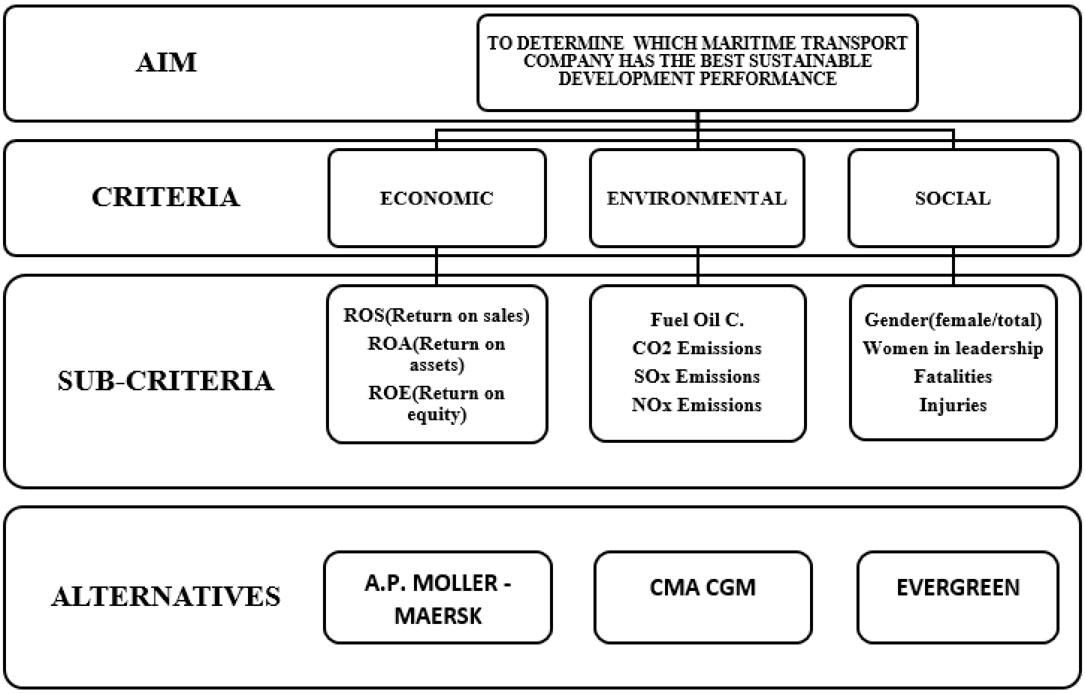
In the final part, the TOPSIS method has been used to find out which alternative is more successful in terms of sustainable development criteria. Accordingly, the three alternatives have been chosen to be evaluated between the leading liner shipping companies in the maritime transport sector. These companies have been chosen as alternatives according to their sustainability reports. The data of three years between 2017 and 2019 have been examined. In conclusion, the company which has the best performance concerning sustainable development criteria has been determined.

Table 2: The Criteria and Supporting Literature

	CRITERIA	GRI	SDGs (GRI et al., 2017)	Supporting Literature
EC	**Economic Dimension**	**GRI 200: Economic**		
EC_1	ROS	GRI 201: Economic Performance	2, 5, 7, 8, 9	(Chiang & Hwang, 2007) (Lee, Lin, & Shin, 2018)
EC_2	ROE	GRI 201: Economic Performance	2, 5, 7, 8, 9	(Chiang & Hwang, 2007) (Lee et al., 2018)
EC_3	ROA	GRI 201: Economic Performance	2, 5, 7, 8, 9	(Chiang & Hwang, 2007) (Lee et al., 2018)
EN	**Environmental Dimension**	**GRI 300: Environmental**		
EN_1	Fuel oil consumption	GRI 302: Energy	7, 8, 12, 13	(Lirn, Lin, & Shang, 2014) (Cabezas-Basurko et al., 2008)
EN_2	CO_2 emissions	GRI 305: Emissions	3, 12, 13, 14, 15	(Lirn et al., 2014) (Cabezas-Basurko et al., 2008)
EN_3	SOx emissions	GRI 305: Emissions	3, 12, 13, 14, 15	(Lirn et al., 2014) (Cabezas-Basurko et al., 2008)
EN_4	NOx emissions	GRI 305: Emissions	3, 12, 13, 14, 15	(Lirn et al., 2014) (Cabezas-Basurko et al., 2008)
SC	**Social Dimension**	**GRI 400: Social**		
SC_1	Female employee rate	GRI 405: Diversity and Equal Opportunity	5, 8, 10	(Grant & Grant, 2015)
SC_2	Women in leadership	GRI 405: Diversity and Equal Opportunity	5, 8, 10	(Pastra, Koufopoulos, & Gkliatis, 2015)
SC_3	Fatalities	GRI 403: Occupational Health and Safety	3, 8	(Lam, 2015)
SC_4	Injuries	GRI 403: Occupational Health and Safety	3, 8	(Lam, 2015)

Source: Compiled by author

Figure 5: The Model of the Study



Source: Author

3.3.2. Multi-Criteria Decision Making Methods

While considering a problem with a single criterion, the decision-making process is quite simple because only it has to be selected the alternative with the highest preference rating. However, when there is not only one criterion to be considered, the process gets more complicated, and to overcome the issues such as weighting the related criteria, there is a need to utilize more complex methods (Tzeng & Huang, 2011: 1).

To assist the decision-maker by providing useful techniques for determining the optimal solution in their particular decision-making process and placing them at the core of the decision-making process, the multi-criteria decision-making methods have been developed (Ishizaka & Nemery, 2013: 2). Multi-Criteria Decision Making (MCDM) methods mainly aim at providing consistency and compatibility between the objectives of decision-makers and the process of decision-making. In this context, to be able to keep going on the correct path while facing numerous confusing options, the tools and concepts have to be determined properly to simplify the process (Roy, 2016: 34).

Considering that MCDM methods enable decision-makers to deal with all challenges mentioned above, they are accepted as very critical tools. On the other hand, to handle complicated situations involving particular uncertainties, usually, hybrid methods are used since none of the MCDM methods are entirely suitable for all distinct scenarios (Qu, Wan, Yang, & Lee, 2018: 8). There are several MCDM methods such as AHP, PROMETHEE, ELECTRE, MAUT, UTADIS, and TOPSIS for different decision-making processes. The AHP and TOPSIS methods have been chosen to use together in this study since it has been pointed out that the TOPSIS method is a competent decision-making method for performance evaluation and it can be used with the AHP method compatibly (Jigeesh, Joseph, & Yadav, 2018: 35-36). In this context, these methods and their application steps are reviewed and explained with details in the following pages.

3.3.3. Analytic Hierarchy Process (AHP)

Analytic Hierarchy Process (AHP) was developed by Thomas Saaty (1980). It was designed in consequence of lacking comprehensible, applicable, and common methodology to be utilized to able to make complex decisions. Since that time, the capability and simpleness of AHP have brought about its broad usage in various areas all over the world (Bhushan & Rai, 2004: 15).

As an essential approach in terms of decision making, the AHP is formed in order to deal with rational factors as well as perceptive ones to choose the best from various alternatives which are assessed with respect to some criteria (Saaty & Vargas, 2012: 1). AHP enables a decision-maker to design a complex problem demonstrating the relations of the objective, criteria, sub-criteria, and alternatives in a hierarchical structure (Forman & Selly, 2001: 43). Therefore, AHP basically performs by establishing criteria to evaluate alternatives and priorities for alternatives. It allows individuals or groups to process subjective preferences by providing objective mathematics in the decision-making period (Saaty, 2001: 15-16).

In some cases, it can be challenging to make a decision between alternatives for a decision-maker while there are numerous alternatives to be assessed and various criteria are substantial for a particular problem. One of these alternatives may be predominant concerning some of the decision criteria and another alternative may be predominant concerning other different decision criteria when they are assessed with regard to various decision criteria (San Cristóbal Mateo, 2012: 11). Among these numerous criteria which are not tangible, in general, the qualitative expressions are stated quantitatively in order to be able to perform a tradeoff. In order to carry out this, it has to be made reciprocal pairwise comparisons meticulously and scientifically instead of giving a score in a simple manner from memory which cannot be confirmed properly (Saaty, 2016: 365).

As a matter of fact, in general researchers or decision-makers are more interested in relative measurements instead of certain scores of the alternatives in order to determine which alternative is the best. Furthermore, utilizing relative measurements makes the analysis less complex and it is challenging to design a measurement scale when characteristics of alternatives are not tangible (Brunelli, 2015: 1-2). The qualitative estimations obtained from experts are transformed into quantitative ones by using this technique. Comparison of criteria in pairs is simpler thus(so) the method is not difficult to be carried out. Besides, it is thoroughly based on the ground of mathematics (Podvezko, 2009: 182). It is proved that a number of techniques originating from operations research and applied mathematics are helpful conscious to make sensible decisions (Brunelli, 2015: 1).

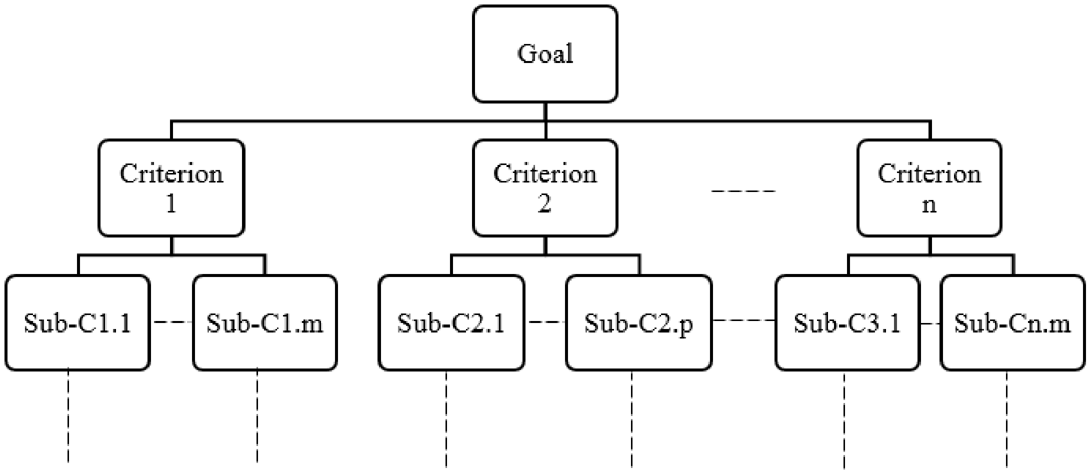
During recent years, the attention in the use of the AHP has increased remarkably and since the beginning of this century, it has also been utilizing to solve the issues of the maritime industry regularly. Since it's the ability to break down decision problems that have complex characteristics and to make the mental liability of decision-makers simpler, the method of analytic hierarchy process is a very potent tool (Bulut & Duru, 2018: 31). These characteristics of the analytic hierarchy process are remarkably applicable for a wide range of activities and it has been employed in many decision making areas such as prediction, alternative selection, re-engineering of business processes, quality management, benchmarking, healthcare, public policy decisions, resource allocation, balanced scorecard (Bhushan & Rai, 2004: 19-20).

To simplify, the application of the AHP method is indicated by 4 consecutive steps (Qu et al., 2018: 9):

Step 1: The hierarchy of criteria and alternatives.

The basis of the analytic hierarchy process is the hierarchy structure which includes objective, criteria, sub-criteria, and alternatives. It is essential that a hierarchy of precise criteria and alternatives has to be created in order to carry out the AHP technique (Qu et al., 2018: 9).

Figure 6: The Hierarchical Structure of AHP



Source: Tzeng & Huang, 2011: 16

It has to be emphasized that hierarchical structures are used in the AHP in order to deal with all decision problems. The objective for the particular decision problem is established in the first level of the hierarchy structure. In the next level, the objective is broken down into some criteria and then the specific criteria can be subdivided into sub-criteria into the lower levels (Tzeng & Huang, 2011: 16).

Step 2: Pair-wise comparison decision matrix.

For all criteria, a pair-wise comparison decision matrix is created. Where 'a' in the matrix stands for a quantified judgment on a pair of criteria.

Figure 7: The Decision Matrix of AHP

$$
\begin{array}{c}
 \\
C_1 \\
C_2 \\
C_3 \\
\vdots \\
\vdots \\
C_n
\end{array}
\begin{array}{c}
\begin{array}{cccccc} C_1 & C_2 & & & & C_n \end{array} \\
\begin{pmatrix}
a_{11} & a_{21} & \cdots & \cdots & \cdots & a_{n1} \\
a_{12} & a_{22} & \cdots & \cdots & \cdots & a_{n2} \\
a_{13} & a_{23} & \cdots & \cdots & \cdots & a_{n3} \\
\vdots & \vdots & & & & \vdots \\
\vdots & \vdots & & & & \vdots \\
a_{1n} & a_{2n} & \cdots & \cdots & \cdots & a_{nn}
\end{pmatrix}
\end{array}
$$

Source: Qu et al., 2018: 9

The fundamental scale table enables to show which factor is how many times superior over another one to be able to compare the factors (Saaty, 2008: 85).

Table 3: The Fundamental Scale of AHP

Intensity of Importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
2	Weak	
3	Moderate importance	Experience and judgment slightly favor one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgment strongly favor one activity over another
6	Strong plus	
7	Very strong importance	An activity is favored very strongly over another
8	Very, very strong	
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation

Source: Saaty & Vargas, 2012: 6

Step 3: Normalized decision matrix and the priorities

Each set of column values is summed in order to perform this calculation and afterwards each value has to be divided by a related summed value. The average of the values of the kth row is calculated to acquire the relative weight of the kth criteria (Qu et al., 2018: 9).

$$w_k = \frac{1}{n}\sum_{j=1}^{n}\frac{a_{kj}}{\sum_{i=1}^{n} a_{ij}}$$

k=(1,2…..n)

Wk stands for the weight of a particular criterion k and Aij stands for the entry row 'i' and column j in a comparison matrix of order n.

Step 4: The consistency of the judgements

A consistency test has to be done since a certain level of consistency is necessary to obtain significant weights. Consistency Ratio (CR) enables to monitor the consistency of the comparison matrices. To ensure consistency in the decision-making of the respondents, the Consistency Ratio index is utilized (Qu et al., 2018: 10).

$$CR = \frac{CI}{RI}$$

CI is the consistency index and RI is the random index.

$$CI = \frac{\lambda_{max} - n}{n - 1}$$

Table 4: Random Consistency Index

N	1	2	3	4	5	6	7	8	9	10
Random consistency index (R.I.)	0	0	0.52	0.89	1.11	1.11	1.35	1.40	1.45	1.49

Source: Saaty & Vargas, 2012: 9

The maximum eigenvalue(λmax) is calculated in the equation.

$$\lambda_{max} = \frac{\sum_{j=1}^{n} \frac{\sum_{k=1}^{n} w_k a_{jk}}{w_j}}{n}$$

j=(1,2….n),

k=(1,2…..n)

‘wj’ and ‘wk’ are the weights of criteria obtained in Step 2

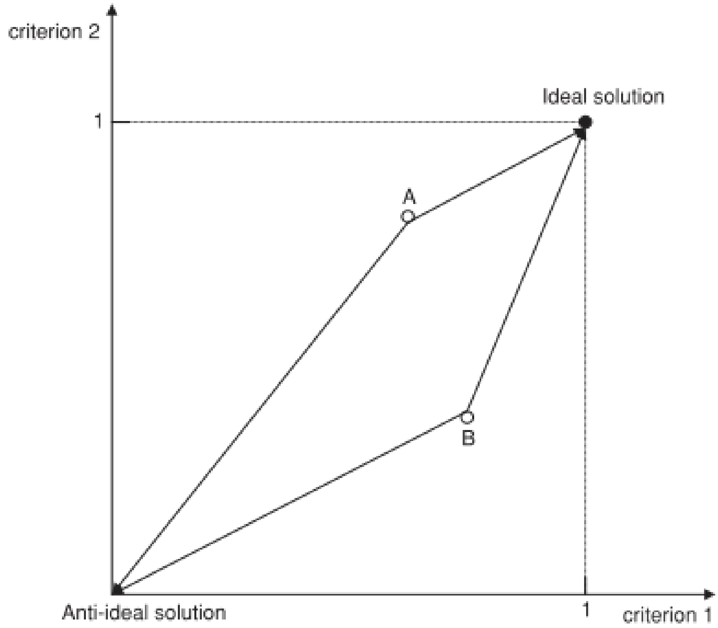
In conclusion, If the consistency ratio (CR) is equal to 10% or less, the result can be acknowledged. If not, consistency has to be enhanced (Saaty, 1990: 13).

3.3.4. The Technic for Order of Preference by Similarity to Ideal (TOPSIS)

The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method was developed by Hwang and Yoon (1981). It is designed based on the approach that the selected alternative is to have the longest distance from the negative-ideal solution and the shortest distance from the ideal solution. The ideal and the negative-ideal solutions are taken into consideration together by using the relative proximity to the ideal solution (Hwang & Yoon, 1981: 128).

It is presumed that each future has a regularly growing or diminishing utility. This simplifies to find negative-ideal and ideal solutions. Therefore, the ranking of alternatives can be obtained by measuring the Euclidean distances (San Cristóbal Mateo, 2012: 43). For instance, if the weights of the criteria are identical and both criteria should be maximized, Alternative A is a better option according to TOPSIS since it is closer to the ideal solution and further from the anti-ideal solution (Ishizaka & Nemery, 2013: 215).

Figure 8: Ideal and Anti-ideal Solutions



Source: Ishizaka & Nemery, 2013: 216

TOPSIS method is used for selection and evaluation problems and it has been used in numerous important domains such as manufacturing, finance, and banking, information technology in order to be able to evaluate the processes, suppliers, and locations (Jigeesh et al., 2018: 35-36). In some cases, TOPSIS can also be used as a substitute for AHP while ranking the alternatives. More precisely, the AHP is utilized to determine the weight of the criteria and the TOPSIS is utilized to rank the alternatives by prioritizing (Qu et al., 2018: 14). Thus, the TOPSIS method has been effectively utilized for problem-solving since its intuitive characteristics and simpleness to implement. It is a useful technique that provides the best practical solution in the decision-making matrix for each factor (Jigeesh et al., 2018: 24).

Where, A1, A2, . . . , Am are alternatives C1, C2, . . . , Cn are attributes, and ‘xij’ are original attribute values.

Figure 9: Decision Making Matrix of TOPSIS

$$\begin{array}{c|cccccc}
 & C_1 & C_2 & & & & C_n \\
\hline
A_1 & X_{11} & X_{12} & \cdots & \cdots & \cdots & X_{1n} \\
A_2 & X_{21} & X_{22} & \cdots & \cdots & \cdots & X_{2n} \\
\vdots & \vdots & \vdots & \cdots & \cdots & \cdots & \vdots \\
\vdots & \vdots & \vdots & & & & \vdots \\
\vdots & \vdots & \vdots & & & & \vdots \\
A_m & X_{m1} & X_{m2} & \cdots & \cdots & \cdots & X_{mn}
\end{array}$$

Source: Yang, 2020: 2

For simplicity, the application of the TOPSIS method is explained by 6 basic steps (Yang, 2020: 2-3):

Step 1: The normalized decision-matrix Y is computed.

$$y_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}$$

$Y=(y_{ij})_{m\times n}$,

i=(1,2,….m),

j=(1,2,….n)

Step 2: The weighted normalized decision-making matrix R is calculated.

$$r_{ij} = w_j y_{ij}$$

$R=(r_{ij})_{m\times n}$,

i=(1,2,….m),

j=(1,2,….n)

Step 3: Both the positive(r_j^+) and the negative(r_j^-) ideal solutions are determined.

If the aim is maximization:

$$\begin{cases} r_j^+ = \max_i r_{ij} \\ r_j^- = \min_i r_{ij} \end{cases}$$

i=(1,2,….m),

j=(1,2,….n)

If the aim is minimization:

$$\begin{cases} r_j^+ = \min_i r_{ij} \\ r_j^- = \max_i r_{ij} \end{cases}$$

i=(1,2,….m)

j=(1,2,….n)

Step 4: The Euclidean distances of each alternative are calculated for both the positive and negative ideal solutions.

$$S_i^+ = \sqrt{\sum_{j=1}^{n} \left(r_{ij} - r_j^+\right)^2}$$

i=(1,2,….m)

$$S_i^- = \sqrt{\sum_{j=1}^{n} \left(r_{ij} - r_j^-\right)^2}$$

i=(1,2,….m)

Step 5: The result of the evaluation(S_i) for each alternative is computed.

$$S_i = \frac{S_i^-}{S_i^+ + S_i^-}$$

i=(1,2,….m)

Step 6: The alternatives are ranked based on their evaluation results.

3.4. DATA ANALYSIS AND FINDINGS

3.4.1 Determining the Criteria Weights by Using AHP

3.4.1.1. The Sustainable Development Criteria Weights

As mentioned in the previous parts, a pair-wise comparison decision matrix has to be formed in order to weight the criteria. Accordingly, the decision matrix was created for all criteria by using the geometric mean values from the pair-wise comparisons carried out by 12 experts. Microsoft Excel was used for AHP calculations in this part. The decision matrix for comparing the main dimensions of sustainable development is given in table 5.

Table 5: Decision Matrix of Sustainable Development Dimensions

	EC	EN	SC
EC	1	1,65038235	2,52012709
EN	0,6059202	1	2,38026323
SC	0,39680538	0,4201216	1

Afterwards, each set of column values of the decision matrix were summed in order to perform to normalize the decision matrix and each value was divided by the related summed value. The normalized decision matrix is given in table 6.

Table 6: Normalized Decision Matrix of Sustainable Development Dimensions

	EC	EN	SC
EC	0,49931953	0,5374956	0,42711193
EN	0,30254779	0,32567944	0,40340776
SC	0,19813268	0,13682497	0,16948031

The average of the row values was calculated to acquire the relative weight of the criteria which is called priority vector. The priority vectors are given in table 7.

Table 7: Priority Vector of Sustainable Development Dimensions

	EC	EN	SC	PRIORITY VECTOR
EC	0,49931953	0,5374956	0,42711193	0,48797569
EN	0,30254779	0,32567944	0,40340776	0,34387833
SC	0,19813268	0,13682497	0,16948031	0,16814599

Then, row values formed by multiplying the values in the decision matrix columns and priority vector rows were summed to create all priority vectors. All priority vector is given in table 8.

Table 8: All Priority Matrix of Sustainable Development Dimensions

	EC	EN	SC	SUM
EC	0,48797569	0,56753072	0,42374926	1,47925566
EN	0,29567432	0,34387833	0,40023171	1,03978436
SC	0,19363138	0,14447071	0,16814599	0,50624808

As a final step, the consistency test has to be done since a certain level of consistency is necessary to obtain significant weights. Consistency Ratio (CR) enables to monitor the consistency of the comparison matrices.

In order to calculate CR λmax, CI and RI (Random Index) values are necessary since CR is calculated by the formula of CR = CI/RI. While CI is calculated by the formula of CI = (λmaks-n) / (n-1), the RI value is obtained by the Random Consistency Index (Table 4). For this reason, firstly λmaks value has to be calculated. All priority vector values were divided by priority vector values and the averages of the results were taken to calculate the λmax value (Table 9).

Table 9: Λmax of Sustainable Development Dimensions

ALL PRIORITY MATRIX(A)	PRIORITY VECTOR(B)	A / B
1,47925566	0,48797569	3,03141265
1,03978436	0,34387833	3,02369843
0,50624808	0,16814599	3,01076517
		Λmax = 3,02195875

Then, CR is calculated by using the given formula (CR = CI/RI). CR is shown in table 10.

Table 10: Consistency Ratio (CR) of Sustainable Development Dimensions

CI	RI	CR
0,010979375	0,52	0,021114182

In conclusion, the consistency rate is acceptable since the consistency ratio is less than 10%. The weights of the sustainable development criteria are given in table 11.

Table 11: Sustainable Development Criteria Weights

CRITERIA	WEIGHT
Economic Dimension(EC)	0,48797569
Environmental Dimension(EN)	0,34387833
Social Dimension(SC)	0,16814599

Similar mathematical procedures were used to calculate the criteria weights of economic, environmental, and social dimensions. Only final tables are given for the AHP criteria weight calculations of these dimensions. Other tables that are utilized for AHP calculations are given in Appendix 2.

3.4.1.2. The Economic Dimension Criteria Weights

All calculations were made step by step for economic dimension just as it was made in the sustainable development criteria weight calculations. First, the decision matrix was created for all economic dimensions of sustainable development criteria. Each set of column values of the decision matrix were summed in order to perform to normalize the decision matrix and each value was divided by the related summed value. The priority vectors and all priority vectors were calculated. Then, CI and RI values were calculated to find the consistency ratio. CR is shown in table 12.

Table 12: Consistency Ratio (CR) of Economic Dimension Criteria

CI	RI	CR
0,01030909	0,52	0,01982517

The consistency rate is acceptable since the consistency ratio is less than 10%. The weights of the economic dimension of sustainable development criteria are given in table 13.

Table 13: Economic Dimension Criteria Weights

CRITERIA	WEIGHT
ROS (EC_1)	0,31267894
ROE (EC_2)	0,34563943
ROA (EC_3)	0,34168164

3.4.1.3. The Environmental Dimension Criteria Weights

All calculations were made step by step for environmental dimension just as it was made in the sustainable development criteria weight calculations. First, the decision matrix was created for all environmental dimensions of sustainable development criteria. Each set of column values of the decision matrix were summed in order to perform to normalize the decision matrix and each value was divided by the related summed value. The priority vectors and all priority vectors were calculated. Then, CI and RI values were calculated to find the consistency ratio. CR is shown in table 14.

Table 14: Consistency Ratio (CR) of Environmental Dimension Criteria

CI	RI	CR
0,02080346	0,89	0,02337467

The consistency rate is acceptable since the CR is less than 10%. The weights of the economic dimension of sustainable development criteria are given in table 15.

Table 15: Environmental Dimension Criteria Weights

CRITERIA	WEIGHT
Fuel Oil Consumption Rate (EN_1)	0,17584438
CO2 Emission Rate (EN_2)	0,38757069
SOx Emission Rate (EN_3)	0,26418213
NOx Emission Rate (EN_4)	0,1724028

3.4.1.4. The Social Dimension Criteria Weights

All calculations were made step by step for the social dimension of just as it was made in the sustainable development criteria weight calculations. First, the decision matrix was created for all social dimensions of sustainable development criteria. Each set of column values of the decision matrix were summed in order to perform to normalize the decision matrix and each value was divided by the related summed value. The priority vectors and all priority vectors were calculated. Then, CI and RI values were calculated to find the consistency ratio. CR is shown in table 16.

Table 16: Consistency Ratio (CR) of Social Dimension Criteria Weights

CI	RI	CR
0,00669119	0,89	0,00751819

The consistency rate is acceptable since the consistency ratio is less than 10%. The weights of the economic dimension of sustainable development criteria are given in table 17.

Table 17: Social Dimension Criteria Weights

CRITERIA	WEIGHT
Female Employee Rate (SC_1)	0,0723506
Women in Leadership Rate (SC_2)	0,07697805
Fatalities (SC_3)	0,48911722
Lost Time Injury Rate (SC_4)	0,36155412

3.4.2. Finding the Best Alternative by Using TOPSIS

3.4.2.1. Economic Dimension Performances of the Maritime Transport Companies by Years

The formulas given in the methodology section were used in order to obtain economic dimension TOPSIS results of the year 2017. Microsoft Excel was used for TOPSIS calculations in this part. First, the decision matrix was formed as given in table 18.

Table 18: Decision Matrix of Economic Dimension (2017)

	EC_1	EC_2	EC_3
A.P MOLLER - MAERSK	0,013	-0,037	-0,018
CMA CGM	0,075	0,130	0,039
EVERGREEN	0,032	0,100	0,033

The normalized decision matrix was obtained by using the formula in step 1 of the TOPSIS methodology. The normalized decision matrix of the economic dimension for the year 2017 is shown in table 19.

Table 19: Normalized Decision Matrix of Economic Dimension (2017)

	EC_1	EC_2	EC_3
A.P MOLLER - MAERSK	0,15743992	-0,2200627	-0,3323093
CMA CGM	0,90830722	0,77319338	0,72000341
EVERGREEN	0,38754441	0,595	0,60923365

Then, the weighted normalized matrix was formed by multiplying the normalized matrix values and criteria weights (Table 20).

Table 20: Weighted Normalized Decision Matrix of Economic Dimension (2017)

	EC_1	EC_2	EC_3
A.P MOLLER - MAERSK	0,04880637	-0,077022	-0,1129852
CMA CGM	0,28157524	0,27061768	0,24480116
EVERGREEN	0,12013877	0,208	0,20713944

Both the positive and the negative ideal solutions were determined (Table 21).

Table 21: Ideal and Negative Ideal Solution Values of Economic Dimension (2017)

	EC_1	EC_2	EC_3
A^+	0,28157524	0,27061768	0,24480116
A^-	0,04880637	-0,077022	-0,1129852

The Euclidean distances of each alternative were calculated for both the positive and negative ideal solutions. The result of the evaluation for each alternative was computed. Ideal, negative ideal distances and results were given in table 22.

Table 22: Ideal, Negative ideal Distances and Results of Economic Dimension (2017)

	S_i^+	S_i^-	C_i^+
A.P MOLLER - MAERSK	0,55049587	0	0
CMA CGM	0	0,55049587	1
EVERGREEN	0,17714449	0,4346275	0,71044034

As shown in table 22, Cma Cgm has the highest (C_i^+) value according to the economic dimension of sustainable development results for the year 2017.

Similar mathematical procedures were used to calculate the TOPSIS results of economic, environmental, and social dimensions. Only final tables are given for the TOPSIS calculations of these dimensions. Other tables that are utilized for TOPSIS calculations are given in Appendix 3.

The formulas were given in the methodology section were used in order to obtain economic dimension TOPSIS results of the year 2018. First, the decision matrix was formed and the normalized decision matrix was obtained. Then, the weighted normalized matrix was formed by multiplying the normalized matrix values and criteria weights. Both the positive and the negative ideal solutions were determined (Table 23).

Table 23: Ideal and Negative Ideal Solution Values of Economic Dimension (2018)

	EC_1	EC_2	EC_3
A^+	0,29055552	0,34727871	0,33952537
A^-	0,06917989	0,00361749	0,00178698

The Euclidean distances of each alternative were calculated for both the positive and negative ideal solutions. The result of the evaluation for each alternative was computed. Ideal, negative ideal distances and results are given in table 24.

Table 24: Ideal, Negative ideal Distances and Results of Economic Dimension (2018)

	S_i^+	S_i^-	C_i^+
A.P MOLLER - MAERSK	0,20753966	0,4820391	0,69903415
CMA CGM	0,44249138	0,2254978	0,33757702
EVERGREEN	0,53026166	0	0

As shown in table 24, A.P. Moller Maersk has the highest ($\mathbf{C_i^+}$) value according to the economic dimension of sustainable development results for the year 2018.

The formulas given in the methodology section were used to obtain economic dimension TOPSIS results of the year 2019. First, the decision matrix was formed and the normalized decision matrix was obtained. Then, the weighted normalized matrix was formed by multiplying the normalized matrix values and criteria weights. Both the positive and the negative ideal solutions were determined (Table 25).

Table 25: Ideal and Negative Ideal Solution Values of Economic Dimension (2019)

	EC_1	EC_2	EC_3
A^+	0,20859098	-0,0162221	-0,0336146
A^-	0,1137769	-0,3487761	-0,3361461

The Euclidean distances of each alternative were calculated for both the positive and negative ideal solutions. The result of the evaluation for each alternative was computed. Ideal, negative ideal distances and results are given in table 26.

Table 26: Ideal, Negative ideal Distances and Results of Economic Dimension (2019)

	S_i^+	S_i^-	C_i^+
A.P MOLLER - MAERSK	0,00480209	0,45631636	0,989586
CMA CGM	0,44967468	0,08533267	0,15949813
EVERGREEN	0,09516039	0,44360847	0,82337437

As shown in table 26, A.P. Moller Maersk has the highest ($\mathbf{C_i^+}$) value according to the economic dimension of sustainable development results for the year 2019.

3.4.2.2. Environmental Dimension Performances of the Maritime Transport Companies by Years

The formulas given in the methodology section were used in order to obtain environmental dimension TOPSIS results of the year 2017. First, the decision matrix was formed and the normalized decision matrix was obtained. Then, the weighted normalized matrix was formed by multiplying the normalized matrix values and criteria weights. Both the positive and the negative ideal solutions were determined (Table 27).

Table 27: Ideal and Negative Ideal Solution Values of Environmental Dimension (2017)

	EN_1	**EN_2**	**EN_3**	**EN_4**
A^+	0,08418125	0,17572518	0,118519	0,06137344
A^-	0,11989451	0,274466	0,1777785	0,11660954

The Euclidean distances of each alternative were calculated for both the positive and negative ideal solutions. The result of the evaluation for each alternative was computed. Ideal, negative ideal distances and results are given in table 28.

Table 28: Ideal, Negative ideal Distances and Results of Environmental Dimension (2017)

	Si+	**Si-**	**Ci+**
A.P MOLLER - MAERSK	0,13261938	0	0
CMA CGM	0,0699629	0,06947542	0,49825199
EVERGREEN	0	0,13261938	1

As shown in table 28, Evergreen has the highest (**C_i^+**) value according to the environmental dimension of sustainable development results for the year 2017.

The formulas given in the methodology section were used in order to obtain environmental dimension TOPSIS results of the year 2018. First, the decision matrix was formed and the normalized decision matrix was obtained. Then, the weighted normalized matrix was formed by multiplying the normalized matrix values and criteria weights. Both the positive and the negative ideal solutions were determined (Table 29).

Table 29: Ideal and Negative Ideal Solution Values of Environmental Dimension (2018)

	EN_1	**EN_2**	**EN_3**	**EN_4**
A^+	0,08027577	0,17126167	0,11045528	0,05807801
A^-	0,12041365	0,2678241	0,18146224	0,11615601

The Euclidean distances of each alternative were calculated for both the positive and negative ideal solutions. The result of the evaluation for each alternative was computed. Ideal, negative ideal distances and results are given in table 30.

Table 30: Ideal, Negative ideal Distances and Results of Environmental Dimension (2018)

	S_i^+	**S_i^-**	**C_i^+**
A.P MOLLER - MAERSK	0,1391057	0	0
CMA CGM	0,08902144	0,05452137	0,37982655
EVERGREEN	0	0,1391057	1

As shown in table 30, Evergreen has the highest (**C_i^+**) value according to the environmental dimension of sustainable development results for the year 2018.

The formulas given in the methodology section were used in order to obtain environmental dimension TOPSIS results of the year 2019. First, the decision matrix was formed and the normalized decision matrix was obtained. Then, the weighted normalized matrix was formed by multiplying the normalized matrix values and criteria weights. Both the positive and the negative ideal solutions were determined (Table 31).

Table 31: Ideal and Negative Ideal Solution Values of Environmental Dimension (2019)

	EN_1	EN_2	EN_3	EN_4
A^+	0,07895397	0,1672452	0,10553557	0,06055095
A^-	0,12281729	0,27276895	0,18468725	0,11754009

The Euclidean distances of each alternative were calculated for both the positive and negative ideal solutions. The result of the evaluation for each alternative was computed. Ideal, negative ideal distances and results are given in table 32.

Table 32: Ideal, Negative ideal Distances and Results of Environmental Dimension (2019)

	S_i^+	S_i^-	C_i^+
A.P MOLLER - MAERSK	0,15023982	0	0
CMA CGM	0,08875916	0,06432054	0,42017682
EVERGREEN	0	0,15023982	1

As shown in table 32, Evergreen has the highest (C_i^+) value according to the environmental dimension of sustainable development results for the year 2019.

3.4.2.3. Social Dimension Performances of the Maritime Transport Companies by Years

The formulas given in the methodology section were used in order to obtain social dimension TOPSIS results of the year 2017. First, the decision matrix was formed and the normalized decision matrix was obtained. Then, the weighted normalized matrix was formed by multiplying the normalized matrix values and criteria weights. Both the positive and the negative ideal solutions were determined (Table 33).

Table 33: Ideal and Negative Ideal Solution Values of Social Dimension (2017)

	SC_1	SC_2	SC_3	SC_4
A^+	0,05526891	0,0675713	0	0,2032208
A^-	0,02699179	0,01615835	0,48507525	0,2146377

The Euclidean distances of each alternative were calculated for both the positive and negative ideal solutions. The result of the evaluation for each alternative was computed. Ideal, negative ideal distances and results are given in table 34.

Table 34: Ideal, Negative ideal Distances and Results of Social Dimension (2017)

	S_i^+	S_i^-	C_i^+
A.P MOLLER - MAERSK	0,48636859	0,02690801	0,05242399
CMA CGM	0,06933407	0,41999798	0,85830874
EVERGREEN	0,05977651	0,48507525	0,89028848

As shown in table 34, Evergreen has the highest (**C_i^+**) value according to the social dimension of sustainable development results for the year 2017.

The formulas given in the methodology section were used in order to obtain social dimension TOPSIS results of the year 2018. First, the decision matrix was formed and the normalized decision matrix was obtained. Then, the weighted normalized matrix was formed by multiplying the normalized matrix values and criteria weights. Both the positive and the negative ideal solutions were determined (Table 35).

Table 35: Ideal and Negative Ideal Solution Values of Social Dimension (2018)

	SC_1	SC_2	SC_3	SC_4
A^+	0,05608926	0,0713466	0	0,1554582
A^-	0,02492856	0,01744028	0,48507525	0,23318731

The Euclidean distances of each alternative were calculated for both the positive and negative ideal solutions. The result of the evaluation for each alternative was computed. Ideal, negative ideal distances and results are given in table 36.

Table 36: Ideal, Negative ideal Distances and Results of Social Dimension (2018)

	S_i^+	S_i^-	C_i^+
A.P MOLLER - MAERSK	0,49337031	0,0167254	0,03278875
CMA CGM	0,09885361	0,4204773	0,80965198
EVERGREEN	0,0622646	0,49126349	0,8875132

As shown in table 36, Evergreen has the highest (**C_i^+**) value according to the social dimension of sustainable development results for the year 2018.

The formulas given in the methodology section were used in order to obtain social dimension TOPSIS results of the year 2019. First, the decision matrix was formed and the normalized decision matrix was obtained. Then, the weighted normalized matrix was formed by multiplying the normalized matrix values and criteria weights. Both the positive and the negative ideal solutions were determined (Table 37).

Table 37: Ideal and Negative Ideal Solution Values of Social Dimension (2019)

	SC_1	SC_2	SC_3	SC_4
A^+	0,05429473	0,07068341	0	0,14492925
A^-	0,02591339	0,02041965	0,49	0,23488534

The Euclidean distances of each alternative were calculated for both the positive and negative ideal solutions. The result of the evaluation for each alternative was computed. Ideal, negative ideal distances and results are given in table 38.

Table 38: Ideal, Negative ideal Distances and Results of Social Dimension (2019)

	S_i^+	S_i^-	C_i^+
A.P MOLLER - MAERSK	0,49191933	0,09116164	0,15634473
CMA CGM	0,08995609	0,49338823	0,84579247
EVERGREEN	0,1037485	0,49001434	0,82526946

As shown in table 38, Cma Cgm has the highest (C_i^+) value according to the social dimension of sustainable development results for the year 2019.

CONCLUSION

The Sustainable Development concept has been on the world agenda for many decades. There have been various attempts to promote the concept worldwide. As having an important part of international transport volume, the maritime transport sector also has been making a remarkable effort to keep up with these improvements. Since the sustainable development concept has three important dimensions, it has to be dealt with all dimensions equally. However, the studies mostly have dealt with only one dimension of the sustainable development in the literature and there is a lack of studies on sustainable development performance evaluation of the maritime transport companies by considering all dimensions entirely. In order to fill this gap, this study aims to identify the performance criteria in terms of sustainable maritime transport and to weight the significance levels of the criteria. Besides, it also aims to determine which maritime transport company is more successful in terms of sustainable development performance by years.

The first research question of this study is ''What are the most important criteria for maritime transportation in terms of sustainable development performance evaluation''. To answer this question, both literature review and analytic hierarchy process method were implemented. The first chapter focused on the literature review concerning sustainable development, its historical background, and its dimensions while the second chapter focused on the literature review concerning the sustainable maritime transport concept.

In the third chapter in order to answer the first research question of the study, the sustainable development performance criteria were identified. Three main sustainable development criteria and eleven sub-criteria were chosen. The economic dimension, environmental dimension, and social dimension were chosen as the main criteria. Return on sales (ROS), return on equity (ROE) and the return on assets (ROA), the consumption rate of fuel oil, the emission rate of carbon dioxides, the emission rate of sulphur oxides, the emission rate of nitrogen oxides, rate of female employees in the company, rate of female members at the management level, number of work-related fatalities and rate of injuries(lost time injury) were chosen as sub-criteria concerning main criteria. Then, those criteria identified were weighted by using the Analytic Hierarchy Process (AHP) method.

AHP results revealed that the economic dimension of sustainable development is the most important criteria by evaluating the sustainable development performance of the maritime transport companies according to the main criteria. The environmental and social dimension was second and third important criteria respectively. AHP results also indicated that ROE was the most important criteria with respect to the economic dimension of sustainable development although there was not a remarkable difference between ROE, ROA, and ROE as sub-criteria. When it comes to environmental dimension sub-criteria, CO2 Emission Rate was the most important criteria while SOx Emission Rate was in the second most important criteria. Fuel Oil Consumption Rate and NOx Emission Rate were third and fourth respectively. Regarding the social dimension sub-criteria, the Number of Fatalities criteria was the most important criteria while Lost Time Injury Rate was the second most important criteria. The Female Employee Rate and Women in Leadership Rate were third and fourth according to AHP results.

The second research question of this study is ‘‘ How well do the maritime transport companies conduct their businesses in accordance with the sustainable development performance evaluation criteria’’. To answer this question, the TOPSIS method was employed. In the third chapter, after the sustainable development performance criteria were identified and weighted by using the AHP method, the most successful companies were identified by using the TOPSIS method with respect to sustainable development performance criteria by years between the three leading liner shipping companies (A.P. Moller Maersk, Cma Cgm, Evergreen) from the maritime transport sector.

TOPSIS results revealed that Cma Cgm was the most successful company with respect to economic dimension results in the year 2017 while A.P. Moller Maersk was the most successful company in the same dimension results in the following consecutive years of 2018 and 2019. TOPSIS results also demonstrated that Evergreen was the most successful company for all three consecutive years of 2017, 2018, and 2019 with respect to the environmental dimension of sustainable development. When it comes to the social dimension of sustainable development, Evergreen was the most successful company for the years of 2017 and 2018 while Cma Cgm was the most successful for the year 2019.

The results of this study provide a number of contributions to both literature and practice. One of the more significant contributions to emerge from this study is that the study dealt with all three dimensions of sustainable development, although the majority of the studies in the literature were more focused on one dimension. This holistic point of view contributes to a better understanding of the sustainable development concept. However, the AHP results conflicted with some of the perspectives in the literature while answering the question of which criteria are more important while evaluating the sustainable development performance. Although according to Benamara et al. (2019), all dimensions of sustainable development should be considered equally, the results of the study show that the economic dimension is considered more important. However, the social dimension is considered as the least important criteria by evaluating the sustainable development criteria in the maritime transportation sector. This may help to understand why the social dimension of the sustainable development concept is slightly neglected in the literature as highlighted by Lam (2015). It was also shown that how can be assessed the sustainable development performance of the maritime transport companies by the TOPSIS method. In this way, both the significance level of the sustainable development criteria and which maritime transport companies are more successful by years with respect to those sustainable development performance criteria were determined by using integrated AHP and TOPSIS methods.

This research, however, is subject to several limitations. For this reason, the results of the study must be interpreted with caution and several limitations should be taken into account. Lack of data required us to limit the scope of the analysis. Sustainability reporting for maritime transport companies have been becoming common in recent years, however, only a few companies have been publishing annual sustainability reports for several years. Therefore, only three companies from the maritime transport companies which are conducting business in the container transportation sector were chosen because of either lack of published reports or lack of availability of tangible data in the reports. Besides, chosen maritime transport companies' sustainable development performances were evaluated for the last three years between 2017 and 2019 because of a lack of tangible data before those years.

Based on these conclusions, practitioners should consider publishing reports regularly about sustainable development or including more tangible data into those reports in order to enable the stakeholders to determine the sustainable development performance of the company. Besides, to understand the effects of the findings of the study, more studies may help to find out which criteria are important to evaluate the sustainable development performance of the maritime companies. The focus of the study is limited to the 11 sub-criteria for sustainable development performance evaluation because of lack of tangible data therefore further research is needed to broaden the scope of the criteria and to be able to find out more comprehensive results.

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APPENDICES

APPENDIX 1. AHP Questionnaire

Dear Participant,

This study is being carried out by Sacit Tekin Günaydın, which is a master degree student at Dokuz Eylül University, Department of Maritime Business Administration, under the supervision of Prof. Dr. Durmuş Ali Deveci in order to evaluate the sustainable development performances of maritime transport companies. In this context, the Analytic Hierarchy Process(AHP) is used as a multi-criteria analysis method to weight the criteria and sub-criteria.

In the following pages, you will find the general information about the criteria, scale and examples. In the last section, we would like to obtain your opinion as an expert through a questionnaire, in which you are requested to prioritize the main criteria and sub-criteria with respect to their significance level in the sustainable development performance. Please read the information carefully and answer all questions below.

This study is carried out for only academic purposes and the personal details of the participants such as name, address, etc. will not be disclosed.

The information you provide will be of great value for this research and your participation is very much appreciated.

Sacit Tekin Günaydın

General Information about the Criteria

3 main criteria were chosen in the AHP evaluation: These are:

Economic Dimension: It refers to the economic dimension of sustainable development.(Profitability etc.)
Environmental Dimension: It refers to the environmental dimension of sustainable development.(CO_2 emissions etc)
Social Dimension: It refers to the social dimension of sustainable development. (Female employee rate etc.)

11 sub-criteria were identified. These are:

ROS(Return on Sales): Return on sales(ROS) is a ratio used to evaluate a company's operational efficiency and it provides insight into how much profit is being produced per dollar of sales.
ROA(Return on Assets): Return on assets (ROA) is a ratio that indicates how profitable a company is relative to its total assets.
ROE(Return on Equity): Return on equity(ROE) is a ratio that indicates how efficiently a company is handling the money that shareholders have contributed to it.
Fuel Oil Consumption: The consumption rate of fuel oil.
CO_2 Emissions: The emission rate of Carbon dioxide.
SO_x Emissions: The emission rate of Sulphur oxides.
NO_x Emissions: The emission rate of Nitrogen oxides.
Female Employee Rate: The rate of female employees in the company.
Women in Leadership: The rate of female members at the management level.
Fatalities: The number of work-related fatalities.
Injuries: The rate related to injuries.

The Comparison Scale and Examples

Saaty’s fundamental scale is used to express the importance of one element over another.

Intensity of Importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective.
3	Moderate importance	Experience and judgment slightly favor one activity over another.
5	Strong importance	Experience and judgment strongly favor one activity over another.
7	Very strong importance	An activity is favored very strongly over another; its dominance demonstrated in practice
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation

EXAMPLES:

Given Options A & B, you can judge their relative importance as shown below example:

if you think the option ‘Economic Dimension Criteria’ in column A is moderately more important than the option ‘Environmental Dimension Criteria’ in column B, then you mark "3" on the left-hand side.

Economic Dimension	9	7	5	3	1	3	5	7	9	Environmental Dimension
				☒						

if you think the option ‘Social Dimension Criteria' in column **B** is very strongly more important than the option ‘Economic Dimension Criteria’ in column **A**, then you mark "7" on the right-hand side.

Economic Dimension	9	7	5	3	1	3	5	7	9	Social Dimension
								☒		

Pairwise Comparison Questionnaire

With respect to Main Criteria, Using the scale from 1 to 9 (where 9 is extremely and 1 is equally important), please indicate (X) the relative importance of options A (left column) to options B (right column).										
OPTION A	**EXTREMELY**	**VERY STRONGLY**	**STRONGLY**	**MODERATELY**	**EQUALLY**	**MODERATELY**	**STRONGLY**	**VERY STRONGLY**	**EXTREMELY**	**OPTION B**
Economic Dimension	9 ☐	7 ☐	5 ☐	3 ☐	1 ☐	3 ☐	5 ☐	7 ☐	9 ☐	**Environmental Dimension**
Economic Dimension	9 ☐	7 ☐	5 ☐	3 ☐	1 ☐	3 ☐	5 ☐	7 ☐	9 ☐	**Social Dimension**
Environmental Dimension	9 ☐	7 ☐	5 ☐	3 ☐	1 ☐	3 ☐	5 ☐	7 ☐	9 ☐	**Social Dimension**

With respect to Economic Dimension Criteria, Using the scale from 1 to 9 (where 9 is extremely and 1 is equally important), please indicate (X) the relative importance of options A (left column) to options B (right column).										
OPTION A	**EXTREMELY**	**VERY STRONGLY**	**STRONGLY**	**MODERATELY**	**EQUALLY**	**MODERATELY**	**STRONGLY**	**VERY STRONGLY**	**EXTREMELY**	**OPTION B**
ROS(Return on Sales)	9 ☐	7 ☐	5 ☐	3 ☐	1 ☐	3 ☐	5 ☐	7 ☐	9 ☐	**ROE(Return on Equity)**
ROS(Return on Sales)	9 ☐	7 ☐	5 ☐	3 ☐	1 ☐	3 ☐	5 ☐	7 ☐	9 ☐	**ROA(Return on Assets)**
ROE(Return on Equity)	9 ☐	7 ☐	5 ☐	3 ☐	1 ☐	3 ☐	5 ☐	7 ☐	9 ☐	**ROA(Return on Assets)**

With respect to Environmental Dimension Criteria, Using the scale from 1 to 9 (where 9 is extremely and 1 is equally important), please indicate (X) the relative importance of options A (left column) to options B (right column).										
OPTION A	**EXTREMELY**	**VERY STRONGLY**	**STRONGLY**	**MODERATELY**	**EQUALLY**	**MODERATELY**	**STRONGLY**	**VERY STRONGLY**	**EXTREMELY**	**OPTION B**
Fuel Oil Consumption	9 ☐	7 ☐	5 ☐	3 ☐	1 ☐	3 ☐	5 ☐	7 ☐	9 ☐	**CO2 Emissions**
Fuel Oil Consumption	9 ☐	7 ☐	5 ☐	3 ☐	1 ☐	3 ☐	5 ☐	7 ☐	9 ☐	**SOx Emissions**
Fuel Oil Consumption	9 ☐	7 ☐	5 ☐	3 ☐	1 ☐	3 ☐	5 ☐	7 ☐	9 ☐	**NOx Emissions**
CO2 Emissions	9 ☐	7 ☐	5 ☐	3 ☐	1 ☐	3 ☐	5 ☐	7 ☐	9 ☐	**SOx Emissions**
CO2 Emissions	9 ☐	7 ☐	5 ☐	3 ☐	1 ☐	3 ☐	5 ☐	7 ☐	9 ☐	**NOx Emissions**
SOx Emissions	9 ☐	7 ☐	5 ☐	3 ☐	1 ☐	3 ☐	5 ☐	7 ☐	9 ☐	**NOx Emissions**

With respect to Social Dimension Criteria, Using the scale from 1 to 9 (where 9 is extremely and 1 is equally important), please indicate (X) the relative importance of options A (left column) to options B (right column).										
OPTION A	**EXTREMELY**	**VERY STRONGLY**	**STRONGLY**	**MODERATELY**	**EQUALLY**	**MODERATELY**	**STRONGLY**	**VERY STRONGLY**	**EXTREMELY**	**OPTION B**
Female Employee Rate	9 ☐	7 ☐	5 ☐	3 ☐	1 ☐	3 ☐	5 ☐	7 ☐	9 ☐	**Women in Leadership**
Female Employee Rate	9 ☐	7 ☐	5 ☐	3 ☐	1 ☐	3 ☐	5 ☐	7 ☐	9 ☐	**Fatalities**
Female Employee Rate	9 ☐	7 ☐	5 ☐	3 ☐	1 ☐	3 ☐	5 ☐	7 ☐	9 ☐	**Injuries**
Women in Leadership	9 ☐	7 ☐	5 ☐	3 ☐	1 ☐	3 ☐	5 ☐	7 ☐	9 ☐	**Fatalities**
Women in Leadership	9 ☐	7 ☐	5 ☐	3 ☐	1 ☐	3 ☐	5 ☐	7 ☐	9 ☐	**Injuries**
Fatalities	9 ☐	7 ☐	5 ☐	3 ☐	1 ☐	3 ☐	5 ☐	7 ☐	9 ☐	**Injuries**

APPENDIX 2. AHP Calculations

Decision Matrix of the Economic Dimension Criteria

	EC_1	EC_2	EC_3
EC_1	1	1,04348785	0,7923379
EC_2	0,95832453	1	1,16773117
EC_3	1,2620878	0,85636149	1

Normalized Decision Matrix of the Economic Dimension Criteria

	EC_1	EC_2	EC_3
EC_1	0,31051924	0,35984209	0,26767548
EC_2	0,29757821	0,3448455	0,39449457
EC_3	0,39190255	0,29531241	0,33782995

Priority Vector of the Economic Dimension Criteria

	EC_1	EC_2	EC_3	PRIORITY VECTOR
EC_1	0,31051924	0,35984209	0,26767548	0,31267894
EC_2	0,29757821	0,3448455	0,39449457	0,34563943
EC_3	0,39190255	0,29531241	0,33782995	0,34168164

All Priority Matrix of the Economic Dimension Criteria

	EC_1	EC_2	EC_3	SUM
EC_1	0,31267894	0,36067054	0,27072731	0,94407679
EC_2	0,2996479	0,34563943	0,3989923	1,04427962
EC_3	0,39462827	0,29599229	0,34168164	1,0323022

Λmax of the Economic Dimension Criteria

ALL PRIORITY MATRIX(A)	PRIORITY VECTOR(B)	A / B
0,94407679	0,31267894	3,01931687
1,04427962	0,34563943	3,02129775
1,0323022	0,34168164	3,02123992
		Λmax = 3,02061818

Decision Matrix of Environmental Dimension Criteria

	EN_1	EN_2	EN_3	EN_4
EN_1	1	0,58916657	0,63227036	0,81486895
EN_2	1,69731288	1	1,92720291	2,26648202
EN_3	1,58160188	0,51888672	1	1,92720291
EN_4	1,2271912	0,44121241	0,51888672	1

Normalized Decision Matrix of the Environmental Dimension Criteria

	EN_1	**EN_2**	**EN_3**	**EN_4**
EN_1	0,18161656	0,23111226	0,15503054	0,13561815
EN_2	0,30826012	0,39226982	0,4725436	0,37720924
EN_3	0,28724509	0,2035436	0,2451966	0,32074322
EN_4	0,22287824	0,17307431	0,12722926	0,1664294

Priority Vector of the Environmental Dimension Criteria

	EN_1	**EN_2**	**EN_3**	**EN_4**	**PRIORITY VECTOR**
EN_1	0,18161656	0,23111226	0,15503054	0,13561815	0,17584438
EN_2	0,30826012	0,39226982	0,4725436	0,37720924	0,38757069
EN_3	0,28724509	0,2035436	0,2451966	0,32074322	0,26418213
EN_4	0,22287824	0,17307431	0,12722926	0,1664294	0,1724028

All Priority Matrix of the Environmental Dimension Criteria

	EN_1	**EN_2**	**EN_3**	**EN_4**	SUM
EN_1	0,17584438	0,2283437	0,16703453	0,14048569	0,71170829
EN_2	0,29846293	0,38757069	0,50913256	0,39074785	1,58591403
EN_3	0,2781158	0,20110529	0,26418213	0,33225518	1,07565839
EN_4	0,21579467	0,171001	0,1370806	0,1724028	0,69627907

Λmax of the Environmental Dimension Criteria

ALL PRIORITY MATRIX(A)	PRIORITY VECTOR(B)	A / B
0,71170829	0,17584438	4,04737588
1,58591403	0,38757069	4,09193487
1,07565839	0,26418213	4,07165469
0,69627907	0,1724028	4,03867607
		Λmax = 4,06241038

Decision Matrix of the Social Dimension Criteria Weights

	SC_1	SC_2	SC_3	SC_4
SC_1	1	1,01360158	0,15772283	0,17162189
SC_2	0,98658095	1	0,1753738	0,20610707
SC_3	6,34023642	5,70210603	1	1,62657656
SC_4	5,82676244	4,85184706	0,61478815	1

Normalized Decision Matrix of the Social Dimension Criteria Weights

	SC_1	SC_2	SC_3	SC_4
SC_1	0,0706535	0,08065225	0,08097133	0,05712531
SC_2	0,0697054	0,07956997	0,09003294	0,0686039
SC_3	0,44795992	0,45371643	0,51337739	0,54141516
SC_4	0,41168118	0,38606135	0,31561834	0,33285563

Priority Vector of the Social Dimension Criteria Weights

	SC_1	SC_2	SC_3	SC_4	PRIORITY VECTOR
SC_1	0,0706535	0,08065225	0,08097133	0,05712531	0,0723506
SC_2	0,0697054	0,07956997	0,09003294	0,0686039	0,07697805
SC_3	0,44795992	0,45371643	0,51337739	0,54141516	0,48911722
SC_4	0,41168118	0,38606135	0,31561834	0,33285563	0,36155412

All Priority Matrix of the Social Dimension Criteria Weights

	SC_1	SC_2	SC_3	SC_4	SUM
SC_1	0,0723506	0,07802508	0,07714495	0,0620506	0,28957123
SC_2	0,07137972	0,07697805	0,08577835	0,07451886	0,30865499
SC_3	0,45871991	0,43893703	0,48911722	0,58809546	1,97486962
SC_4	0,42156976	0,37348575	0,30070347	0,36155412	1,4573131

Λmax of the Social Dimension Criteria Weights

ALL PRIORITY MATRIX(A)	PRIORITY VECTOR(B)	A / B
0,28957123	0,0723506	4,00233351
0,30865499	0,07697805	4,0096491
1,97486962	0,48911722	4,03762028
1,4573131	0,36155412	4,03069143
		Λmax = 4,02007358

APPENDIX 3. TOPSIS Calculations

Decision Matrix of Economic Dimension (2018)

	EC_1	EC_2	EC_3
A.P MOLLER - MAERSK	0,006	0,096	0,057
CMA CGM	0,021	0,012	0,003
EVERGREEN	0,005	0,001	0,0003

Normalized Decision Matrix of Economic Dimension (2018)

	EC_1	EC_2	EC_3
A.P MOLLER - MAERSK	0,26779311	0,99222487	0,99860404
CMA CGM	0,93727587	0,12402811	0,05255811
EVERGREEN	0,22316092	0,010	0,00525581

Weighted Normalized Decision Matrix of Economic Dimension (2018)

	EC_1	EC_2	EC_3
A.P MOLLER - MAERSK	0,08301586	0,34727871	0,33952537
CMA CGM	0,29055552	0,04340984	0,01786976
EVERGREEN	0,06917989	0,004	0,00178698

Decision Matrix of Economic Dimension (2019)

	EC_1	EC_2	EC_3
A.P MOLLER - MAERSK	0,044	-0,002	-0,0008
CMA CGM	0,042	-0,043	-0,007
EVERGREEN	0,024	-0,003	-0,0007

Normalized Decision Matrix of Economic Dimension (2019)

	EC_1	EC_2	EC_3
A.P MOLLER - MAERSK	0,67287413	-0,046349	-0,1129903
CMA CGM	0,64228894	-0,996503	-0,9886651
EVERGREEN	0,36702225	-0,070	-0,0988665

Weighted Normalized Decision Matrix of Economic Dimension (2019)

	EC_1	EC_2	EC_3
A.P MOLLER - MAERSK	0,20859098	-0,0162221	-0,0384167
CMA CGM	0,19910957	-0,3487761	-0,3361461
EVERGREEN	0,1137769	-0,024	-0,0336146

Decision Matrix of Environmental Dimension (2017)

	EN_1	EN_2	EN_3	EN_4
A.P MOLLER - MAERSK	0,47	1,64	0,024	0,038
CMA CGM	0,41	1,28	0,020	0,035
EVERGREEN	0,33	1,05	0,016	0,020

Normalized Decision Matrix of Environmental Dimension (2017)

	EN_1	EN_2	EN_3	EN_4
A.P MOLLER - MAERSK	0,66608062	0,70375896	0,68376346	0,68593846
CMA CGM	0,58104905	0,54927529	0,56980288	0,63178542
EVERGREEN	0,46767362	0,451	0,45584231	0,36102024

Weighted Normalized Decision Matrix of Environmental Dimension (2017)

	EN_1	EN_2	EN_3	EN_4
A.P MOLLER - MAERSK	0,11989451	0,274466	0,1777785	0,11660954
CMA CGM	0,10458883	0,21421736	0,14814875	0,10740352
EVERGREEN	0,08418125	0,176	0,118519	0,06137344

Decision Matrix of Environmental Dimension (2018)

	EN_1	EN_2	EN_3	EN_4
A.P MOLLER - MAERSK	0,45	1,47	0,023	0,036
CMA CGM	0,40	1,24	0,019	0,034
EVERGREEN	0,30	0,94	0,014	0,018

Normalized Decision Matrix of Environmental Dimension (2018)

	EN_1	EN_2	EN_3	EN_4
A.P MOLLER - MAERSK	0,66896473	0,68672847	0,6979317	0,68327066
CMA CGM	0,59463532	0,57928116	0,57655227	0,64531118
EVERGREEN	0,44597649	0,439	0,42482799	0,34163533

Weighted Normalized Decision Matrix of Environmental Dimension (2018)

	EN_1	EN_2	EN_3	EN_4
A.P MOLLER - MAERSK	0,12041365	0,2678241	0,18146224	0,11615601
CMA CGM	0,10703436	0,22591965	0,14990359	0,1097029
EVERGREEN	0,08027577	0,171	0,11045528	0,05807801

Decision Matrix of Environmental Dimension (2019)

	EN_1	EN_2	EN_3	EN_4
A.P MOLLER - MAERSK	0,42	1,37	0,021	0,033
CMA CGM	0,36	1,12	0,017	0,030
EVERGREEN	0,27	0,84	0,012	0,017*

* Calculated approximately by utilizing the data from 2018 and 2019.

Normalized Decision Matrix of Environmental Dimension (2019)

	EN_1	EN_2	EN_3	EN_4
A.P MOLLER - MAERSK	0,68231825	0,69940757	0,7103356	0,69141227
CMA CGM	0,58484421	0,57177845	0,57503358	0,62855661
EVERGREEN	0,43863316	0,429	0,40590605	0,35618208

Weighted Normalized Decision Matrix of Environmental Dimension (2019)

	EN_1	EN_2	EN_3	EN_4
A.P MOLLER - MAERSK	0,12281729	0,27276895	0,18468725	0,11754009
CMA CGM	0,10527196	0,2229936	0,14950873	0,10685462
EVERGREEN	0,07895397	0,167	0,10553557	0,06055095

Decision Matrix of Social Dimension (2017)

	SC_1	SC_2	SC_3	SC_4
A.P MOLLER - MAERSK	0,26	0,27	7	0,89
CMA CGM	0,43	0,46	1	0,9
EVERGREEN	0,21	0,11	0	0,94

Normalized Decision Matrix of Social Dimension (2017)

	SC_1	SC_2	SC_3	SC_4
A.P MOLLER - MAERSK	0,47740589	0,49576766	0,98994949	0,56450222
CMA CGM	0,7895559	0,84464119	0,14142136	0,57084494
EVERGREEN	0,38559707	0,202	0	0,59621582

Weighted Normalized Decision Matrix of Social Dimension (2017)

	SC_1	SC_2	SC_3	SC_4
A.P MOLLER - MAERSK	0,03341841	0,03966141	0,48507525	0,2032208
CMA CGM	0,05526891	0,0675713	0,06929646	0,20550418
EVERGREEN	0,02699179	0,016	0	0,2146377

Decision Matrix of Social Dimension (2018)

	SC_1	SC_2	SC_3	SC_4
A.P MOLLER - MAERSK	0,27	0,20	7	1,29
CMA CGM	0,45	0,45	1	1,25
EVERGREEN	0,20	0,11	0	0,86

Normalized Decision Matrix of Social Dimension (2018)

	SC_1	SC_2	SC_3	SC_4
A.P MOLLER - MAERSK	0,48076508	0,39637002	0,98994949	0,64774252
CMA CGM	0,80127514	0,89183254	0,14142136	0,62765748
EVERGREEN	0,35612228	0,218	0	0,43182835

Weighted Normalized Decision Matrix of Social Dimension (2018)

	SC_1	SC_2	SC_3	SC_4
A.P MOLLER - MAERSK	0,03365356	0,0317096	0,48507525	0,23318731
CMA CGM	0,05608926	0,0713466	0,06929646	0,22595669
EVERGREEN	0,02492856	0,017	0	0,1554582

Decision Matrix of Social Dimension (2019)

	SC_1	SC_2	SC_3	SC_4
A.P MOLLER - MAERSK	0,29	0,20	5	1,16
CMA CGM	0,44	0,45	0	1,88
EVERGREEN	0,21	0,13	0	1,85

Normalized Decision Matrix of Social Dimension (2019)

	SC_1	SC_2	SC_3	SC_4
A.P MOLLER - MAERSK	0,51121664	0,39268563	1	0,40258125
CMA CGM	0,77563903	0,88354267	0	0,65245927
EVERGREEN	0,37019136	0,255	0	0,64204769

Weighted Normalized Decision Matrix of Social Dimension (2019)

	SC_1	SC_2	SC_3	SC_4
A.P MOLLER - MAERSK	0,03578516	0,03141485	0,49	0,14492925
CMA CGM	0,05429473	0,07068341	0	0,23488534
EVERGREEN	0,02591339	0,020	0	0,23113717