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MARITIME 4.0 AND EXPECTATIONS IN MARITIME SECTOR

Dursun BALKAN *

Abstract

As the rapid development of communication and information technologies allows real-time transmission of information, the world is increasingly becoming a global society. In this context, the most developed countries are required to develop their own strategies to encourage the industrial sector to stay up to date and compete in a dynamic and volatile global market in order to maintain its competitive capacity. For this reason, since the path of competitiveness through technological differentiation in industrialization provides a wider and innovative field of research, it reveals the result of a new phase of organization and industrial technology that is beginning to change our relationship with industry, society and human interaction in the business world at present standards. The main target of this study is to reveal the effects of Industry 4.0 on the Maritime sector using with the explanation of the historical development and conceptual framework of today's high technology industry 4.0 and its expectations in maritime sector in the light of the relevant literature. The whole worldwide maritime applications and their reflections on all fields are also the scope of this study. A qualitative descriptive analysis method was conducted to determine the current situation of Maritime Sector which is including Industry 4.0 processes. The findings of this study are Marine-related organizations should be reshaped to meet the needs of the future. Measures and regulations related to the increasing environmental protection sensitivity in the world will directly affect almost every area of the sector. Also, the developing technologies, increasing customer demand and intense competition; it will make the recently introduced Industry 4.0 implementation inevitable.

Keywords: Maritime Sector, Maritime 4.0, Industry 4.0, Maritime Expectations, Maritime Development

* Dr., Sanayi ve Teknoloji Bakanlığı, ORCID: 0000-0002-4024-9498

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Denizcilik 4.0 ve Denizcilik Sektörünün Beklentileri

Öz

Bilişim teknolojileri hızlı bir biçimde ilerlemesi, verilerin anlık bir biçimde aktarılmasını sağladığından, insanlık hızlıca küresel bir toplum haline dönüşmektedir. Gelişmiş ülkelerin bile değişken pazar şartlarında, rekabet güçlerini korumak ve sanayi sektörünü güncel tutabilmeleri için tüm sektörleri birbiriyle yarıştıracak farklı yol haritaları ortaya koyması gerekmektedir. Sanayide çalışanlar, sanayinin genel yapısı ve toplumsal olarak etkileşimlerimiz değiştiğinden, rekabetçiliğin beklenenden fazla inovatif ve farklı pazarlara yönlendirebilme özelliği iş dünyasının da mevcut standartlarını ortaya koymaktadır. Bu çalışmada, günümüzün ileri teknoloji trendinin göstergesi olan Endüstri 4.0'ın tarihsel gelişimi ve kavramsal çerçevesi ele alınarak ilgili literatür ışığında denizcilik sektöründeki Endüstri 4.0 beklentileri incelenmiştir. Dünya çapındaki denizcilik uygulamaları ve bunların tüm alanlara yansımaları da bu çalışmanın kapsamı olarak ele alınmıştır. Endüstri 4.0 süreçlerini içeren denizcilik Sektörünün mevcut durumunu belirlemek için nitel bir durum analizi yöntemi uygulanmıştır. Bu çalışmanın bulguları, geleceğin ihtiyaçlarını karşılamak için denizcilikle ilgili kuruluşların yeniden şekillendirilmesi gerektiğidir. Dünyada artan çevre koruma duyarlılığına ilişkin önlemler ve düzenlemeler, sektörün neredeyse her alanını doğrudan etkileyecektir. Ayrıca gelişen teknolojiler, artan müşteri talebi ve yoğun rekabet; yakın zamanda piyasaya sürülen Endüstri 4.0 uygulamasını kaçınılmaz hale getirecektir.

Anahtar Kelimeler: Denizcilik Sektörü, Denizcilik 4.0, Sanayi 4.0, Denizcilik Beklentileri, Denizciliğin Gelişimi.

1. Introduction

Nowadays, production systems and technologies are in a rapid change. This change leads to a change in the understanding of classical production as well as physical change. Technology has been the most important issue of modern production systems, and businesses, governments and production policy makers play a major role in the development or renewal of existing production technologies. The rate of technological progress is also increasing. Currently, 1.3 billion people in the world can not use electricity, 17

percent of the total world population uses industry 2.0 technologies. Similar things can be said For Industry 3.0. There are a large number of people in the world who do not have access to the internet. However, the spread rate of the internet is quite fast compared to other technologies. For example, the spinning machine was able to spread out of Europe after 120 years, and it took 15 years for the internet to take its form. Considering the spread rate of the Internet, the rate of spread of Industry 4.0 is estimated by a similar approach (Alçın, 2016).

Traditional production systems include important advantages such as international automation, scale economy, experience-based information. In parallel with changing customer demands, mounting new developing production technologies into production systems becomes an increasingly important issue (Mehami et al., 2018).

Increase in labor costs increase in investment return period, reduced qualified labor force, disruptions in the ecosystem, shift of labor from manufacturing to service sector, labor-related bottlenecks are triggering a new industrial revolution unlike the ongoing second and third industrial revolution. The personalized demands of customers, which are increasing day by day, are one of the reasons of the new industrial revolution (Benesova & Tupa, 2017). The Fordist production model supports mass production, the focus of each machine on one job, uniform mass production. This approach is inadequate for different product demands. In order to respond to different customer demands, the functions of the machines in the production system need to be increased. Flexible production systems that adapt instantly to changes in production, enabling machines to operate in different modes and reducing line change or calibration times, need to be established (Fırat & Fırat, 2017).

The three-industrial revolution in history triggered technological advances. The discovery of water and steam powered

machines, business division and transition to mass production, the introduction of software and Programmable Logic Control (PLC) into production systems triggered the first three industrial revolutions. Today, the new industrial revolution is triggering the rapid development of the internet. The internet enables the establishment of communication between people and machines (Bartodziej, 2016). The widespread use of the internet ensures digitization in all areas. Therefore, production systems are entering the process of digitization. Digitalization is manifested not in selected sectors but in all sectors. It is impossible for businesses to think independently of the new technological developments and the digitization processes that occur after the sector is located. Digitalization is not a matter of choice for businesses, it will be a necessary step to be taken over time (Saucedo-Martínez et al., 2018).

According to more than 2000 research companies, the level of digitalization of companies is expanding quickly. Each firm can become advanced institutions after this conversion process. Digitalization process will include both physical and virtual simultaneous display of products and imaginative administrations. Also, firms which apply digitalism processes will work in accodance with their computerized environments, contain the common advances they construct with their clients and providers (Kagermann et al., 2012). With the new industrial revolution, information and communication technologies and their fields of use are developing rapidly. Major developments in automation, sensor connections, data transfers, manufacturing systems technologies are examples of information and communication technologies. All of these developments and changes in technology, including the idea and approach is introduced as Industry 4.0 (Salkın et al., 2018).

Technological systems, which have been used in production in recent years, change the industrial appearance. Beyond conventional industrial systems, smart factories and smart machines reveal the concept of Industry 4.0. The concept of Industry 4.0 is a series of

technological developments that affect and change products and processes, integrate the digital and physical world into production, and enable intelligent products to be produced. As the industrial appearance changes, product demands with smart products are rapidly changing, and more functional and comprehensive products are being demanded (Benesova & Tupa, 2017).

The reasons for the emergence of Industry 4.0 are not limited to technological developments. Developed countries have lost their competitive power against developing countries and have sought a new production strategy because of the increase in social spending along with aging populations. The Fourth Industrial Revolution, which the United States and Germany put forward the first ideas, includes the rationale for the establishment of smart factories before manpower to increase production. Thus, with smart factory installations, developed countries will be able to regain their lost competitiveness (Bartodziej, 2016).

New emerging technologies also affect the education system. The human factor plays an important role in future production systems because only the personnel who are well trained in the logic of new production systems can use these technologies. For this reason, enterprises should pay attention to human resources management and strategies and focus on the qualified development of the workforce (Lezzi et al., 2018).

With new technologies, the increasing volume of data increases demand for the cloud system. In terms of information technologies, there will also be a need for specialized personnel who will implement the cloud system in enterprises, and the experts who will enable the integration of the cloud system engineers will be working in the business cadre. In other words, after switching to the cloud system, the understanding of computing personnel will change, and they will need to be more qualified (Alçın, 2016). With Industry 4.0,

new business environments are emerging where the machine-human-product relationship between smart factories is established with the internet and where the work is carried out on the internet and the target productions are planned and executed efficiently by robots (Salkın et al., 2018).

There are differences between traditional enterprises and Industry 4.0 enterprises. The goal is to provide high quality products or services to customers at low cost in traditional enterprises. In addition, businesses are constantly aiming to increase their profits and their respectability. In this context, various data are used to understand current operational situations, to solve errors. Existing errors are corrected after they are detected. Otherwise, in Industry 4.0 enterprises, besides using existing data and accumulating new data, the system makes predictions to prevent possible production errors and sends alarms to the management to resolve any errors. Thus, the management becomes more knowledgeable about the status of production lines and can solve the problem without error. The Industry 4.0 system targets zero downtime during just-in-time maintenance and production (Motyl et al., 2017; Saucedo-Martínez et al., 2018).

According to McKinsey's research in 2015, companies don't know modern developing advances consistently. McKinsey guided an inquire about on 300 driving companies in production, 48% of these firms were prepared for Industry 4.0, 78% of participating firms were within the prepare of this unused handle (Baur & Wee, 2015; Sung, 2018). It is well known that leading companies in developed countries look positively and that new technologies are rapidly integrated into production systems.

Maritime 4.0 programs are not more advanced than Industry 4.0 organizations. The industrial enterprises have already used high levels of automation with Industry 4.0 and digitalization processes are fairly minimum phase. The life cycles are considerably longer and

more complex for industries which have more investment chance than other. Also, innovation in Maritime researches is not same with other sectors. The main difficulties that confront operations at ocean cruel there will be critical contrasts. The digitalization methodologies and the sort of specialized associations will be diverse since the boundaries to appropriation are more noteworthy. It isn't fair that any arrangement must survive the requests of a working life at ocean. The openings for imaginative arrangements to enter the item life cycle are less and the timescales more firmly.

Maritime 4.0 applications have started at first started in Germany like Industry 4.0 initiatives and nearly 12 billion euros will be contributed into the research and developments turnover of the maritime industry. The sea industry has the yearly turnover of 18 billion euros, and approximately 80% of the value is included within the maritime industry in Germany (BMWi, 2017). In Japan, the Industry 4.0 thought had reported in 2014, however it is gotten to be official in 2016, with the articulation of future German-Japanese participation (BST, 2017). But, maritime researches are beginner phase in Japan like France, Brazil, Finland, Spain, UK, Sweden, Norway.

American organizations established the Industrial Internet Consortium (IIC), and five of them begun with the expanding the advertise estimate of the internet of the things within the shipbuilding industry. The new ships are more technologically progressed and complicated than any past era, speedier and way better than ever some time recently. Moreover, the ships of the modern era will final longer and be more versatile to changing the wants all through their lives. Nowadays US shipbuilding, particularly the Naval force, confronting a tidal wave of expanded requests; the NNS (Newport News Shipyard) shipyard is on his way to the Maritime 4.0 digitization handle. It is anticipated, that this approach will produce 15 percent more taken a toll investment funds over the

conventional shipbuilding strategies. (DM, 2017)

Industry 4.0 process has started with "Manufacturing Innovation 3.0 Strategy" reports at Korea in 2015. Korea has commenced a development center within the shipbuilding capital of Ulsan in Busan in 2015 as portion of the modern alter within the industrial innovation. Samsung Heavy Industries, Daewoo Shipbuilding & Marine Engineering and Hyundai Heavy Industries which is three main shipbuilders will support all the innovation activities in this center (HHI, 2015).

The activity methodology construct "Made in China 2025" coordinate motivation from Germany Industry 4.0. is published in 2015. The arrange is making the innovation centers from 15 to 40 between 2020 to 2025. Shipbuilding 4.0 within the Chinese shipbuilding industry is called 5S, a ships operation cleverly benefit framework that highlights Sea, Ship, System, Smart and Services. The keen demo transport is highlighted need improvement in "Made in China 2025" (Yuyang, 2014; Kennedy, 2015). This implies dispatch status security appraisal, transport vitality proficiency checking, investigation, evaluation and optimization, status, appraisal and support optimization, ocean course, dispatch route and operational control, all associated through Big Data (CSSC, 2015).

The advanced change of the Maritime 4.0 period begun within the Adelaide Australian Naval force shipyard in Australia. 1.5 billion Australian dollars for the design and engineering process and almost 100 million Australian dollars in information and technologies will be invested for this digital transformation process to become the most advantages Navy shipyard in the world (Hughes, 2016).

2. A General Review of Literature on the Impact of Industrial Revolution

When we examine the general term "industrial revolution" in detail, we see that it can be divided into three parts until the present

day. The First Industrial Revolution began in the late 18th century with the use of steam-powered weaving looms (first mechanical loom, 1784). It is assumed that the Second Industrial Revolution was started with the start of mass production with the help of electrical energy (First assembly line, 1870). The third industrial revolution is carried out by the application of electronic equipment and information technologies and by the automation of production (First programmable logic control system, 1969). In addition, the Fourth Industrial Revolution (Industry 4.0) has recently been added to the industry literature, which foresees intense cooperation with data and the physical world and the internet connection between machine and human (Camarinha-Matos et al,, 2017; Salkın et al.,2018).

In 2011, Industry 4.0 emerged as a state-of-the-art strategy project, which was developed to "Maintain Germany's position as a major production force in the world". Basically, the İndustry 4.0 revolution is the concept that uses the Internet of Things (IoT), Cyber-Physical Systems (CPS), data, machinery and people together to effectively establish a fully integrated, automated and optimized production base instead of a traditional one-hand managed production system, and, in this context, aims to establish higher productivity and closer production relationships between people and machines (Motyl et al., 2017).

The world is rapidly becoming interconnected in a virtual and physical environment. Technological advances have led to the rapid development of computer and internet since the 1990s, and data management in production becomes a problem for companies and sectors. In all industries, customers demand manufacturers to produce bespoke products at the cost of mass production. They also intervene with last-minute changes to production (Wagner et al., 2017).

Considering all this, industry 4.0 briefly promises to produce

bespoke products at serial production cost, to establish a highly flexible production structure that can adapt to changes quickly, to establish closer and effective relationships between customers, contractors, subcontractors and other stakeholders in the product development process, to increase machine-human-compatible operation with large data link, fully integrated, automatic and optimized production flow (Pereira & Romero, 2017).

3. History of Industrial Revolution

The first place of industrial revolution is in England. The First Industrial Revolution spread to Western European countries and the United States immediately after Britain. With the industrial revolutions, many approaches in production have changed, new rules have been started to be applied, and the level of development of the countries has been started to be determined by looking at the levels of industrialization. Industrialization can be defined as the transformation of nature parallel to human needs (Aksoy, 2017).

Table 1: History of industrial revolution

Industrial Revolution	Description
First Industrial Revolution (1760-1830)	Discovery of machines operating with water and steam energy
Second Industrial Revolution (1840-1973)	Discovery of electricity, division of labor and formation of mass production logic
Third Industrial Revolution (1974-2011)	The establishment of automation systems, development of Information Technology
Fourth Industrial Revolution (2011-…)	Rapid transfer of cyber-physical systems and information in production

Table 1 shows the dates of the realization of the four industrial revolutions and the important events leading to the emergence of the concept of industrial revolution. Examining the four industrial revolutions that are important in the production

industry as sub-headings will provide a step-by-step overview of the revolutions in production.

The first industrial revolution (1760-1830), which was considered as the first industrialization in production, began with the emergence of the UK and the use of machines working with water and steam energy in production. In the first industrial revolution, which spread all over Europe and then the world just after the United Kingdom, it was ensured that machines made using water and steam energy were used instead of manpower. In addition, factories have started to be opened for the first time (Gabaçlı & Uzunöz, 2017; Wagner et al., 2017). The transition from classical agriculture to industrial society started in these years and with the Industrial Revolution, radical changes took place in the society. It has also increased its production capacity naturally, when it began to be used instead of manpower in production (Burritt & Christ, 2016).

The second industrial revolution (1840-1973) is also called the technology revolution. Raw materials and energy sources began to change with this revolution. The replacement of steam power with the discovery of electricity has led to the formation of new systems while developing the production industry. Together with electricity, assembly lines were established, and mass production lines were created. Henry Ford was one of the pioneers of the Second Industrial Revolution by starting to implement the type of production bands that will generate mass production in the automobile factory. The mass production lines that started in the automotive sector have rapidly spread to other sectors. Until the 1960s, mass production was called Fordism (Wang et al., 2016). Today, less developed industries and the second industrial revolution in countries are still going on in part according to the level of development of the sector and countries.

The use of electricity in factories instead of steam energy, the use of crude oil as a source of energy instead of coal, and the series production assembly lines were innovations introduced by the Second Industrial Revolution into production systems. With Fordist series production and Taylor production techniques, productivity increases were achieved with the increase in production speeds. The increase in productivity has led to the increase in revenues and the increase in income has led to the rise of the middle class (Berger, 2014; Wagner et al.,2016).

The third industrial revolution (1974-2011) is mass production enables the delivery of uniform products to the market. Since the second half of the 20th century, customer production demands have started to change, and the logic of mass production has changed. As computers, automation systems, information and communication technologies started to be used in production lines, production models were started to be produced according to personal demands instead of mass production (Gabaçlı & Uzunöz, 2014). Personalized customer demands have led to the Third Industrial Revolution. Developing technologies and the use of these technologies in production systems are the main factors that start this process.

The third industrial revolution is thought to be the foundation of satellite and wireless technology products, resulting from the development and spread of information and communication technologies. Solar, wind, underground and hydrogen energies, zero emission transportation, green economy, common relations between industries, globalization of industry and trade are the main topics of this period (Glas & Kleemann, 2016; Kabaklarlı, 2016).

Fourth industrial revolution (2011 -....); every industrial revolution has led to an increase in productivity and a great acceleration in production. By today, Cyber-Physical Systems and

Internet-based production of objects that are used in production systems have led to a new industrial revolution. The Fourth Industrial Revolution is called Industry 4.0 by most sources, and unlike the third industrial revolution, it is seen that machine and machine systems automatically perform production and manage production processes without labor (Berger, 2014).

4. Development Process of Industry 4.0

There are some elements that trigger the emergence of Industry 4.0. The high-level developments in Internet and technology after industry 3.0 paved the way for the new industrial revolution. In addition to technological developments, since the 1990s, the world's share of production has shifted from developed countries to developing countries, population has increased in developing countries, costs have increased in developed countries, leading to a new revolution in production in western developed countries (Benesova & Tupa, 2017).

The production sector is one of the main sectors of Europe's economic growth. In Europe, 75 percent of exports and 80 percent of all innovations are from industrial growth but the current growth in Europe is evaluated in two different ways. While the developing Eastern European countries and the German industry are constantly growing, advanced Western European countries, such as England and France, have been losing market share in the industry for the past 20 years. In total, Europe has lost its market share in the last 20 years, while developing countries have doubled their industrial market share to 40 percent today. Since Germany has seen that the market share in the industry is constantly shifting to developing countries, it has tried to produce strategies to protect and develop its current market share for several years and has become the leading country in the industry (Hermann et al,, 2016). When examining Europe in terms of developed countries, it is clear that

the share of the production market has fallen with globalization in recent years, like other developed countries.

In 1997, the concept of the liquidity of production factors, which was defined by Aron, was the idea that capitalists would direct their investments to lower cost countries by thinking about their production costs. In this case, the capital and information resources of developed countries were transferred to developing countries, while developing countries presented their raw materials and labor force to the use of developed countries. The decline in production costs triggered more production and began to globalize with the idea of capitalism. Developing countries such as Brazil, Argentina, Turkey, India, Indonesia, Taiwan, Thailand and China have begun to develop industries by combining the financial strength they have gained from developed countries with the knowledge they have learned in this process. In particular, countries under the leadership of China, India and Brazil compete with developed countries with this development opportunity, and even establish dominance over them (Kağnıcıoğlu & Özdemir, 2017).

As well as the level of development, the population rates of countries cause changes in production rates in the world in recent years. China and India ensure that the population of the country is far above the world average and labor costs are low. On the other hand, Germany and developed European countries are unable to compete with developing countries with aging populations. As a solution to this, instead of body power, it tries to spread high-tech automation systems (Wagner et al., 2017) Using high-tech production systems is an important step towards the transition to Industry 4.0.

All these developments show that developed countries need to enter a new trend in order to regain their lost market shares in the manufacturing industry. This trend is now Industry 4.0. (Kagermann et al., 2012), industry-strong countries such as

Germany believe that they can successfully implement Industry 4.0 applications. Because it will not be easy to implement industry 4.0 expertise issues such as the transition to automation systems, the establishment of sensor-dependent production information systems, the establishment of self-managing production systems, and efficient operation in countries where the industry is not strong.

5. Industry 4.0 and Expectations in Maritime

Today, maritime transportation is responsible for the transport of 90% of the international cargoes and is in a very important position for the functioning of the global economy. Especially in the intercontinental trade, it is not possible to realize the economic and efficient realization of large amounts of import and export of raw materials, food and other cargoes, except for maritime transport. The low cost and high efficiency in maritime transport has led to developments in the field of industry and economy, especially in the Far East countries, allowing goods produced at low costs to be consumed in the intercontinental markets, enabling them to achieve global living standards (Papers in Australian Maritime Affairs, 2002).

Bespoke products provide the basis for shipbuilding. It is normal for shipyards, shipowners, and government agencies to wish to add demands that could bring profound changes to the construction contract, even for ship designs previously made. All of this is not enough because customers expect the production of bespoke products to be produced at the cost of mass production. At the same time, returning shipyards to the 'smart factory' concept will allow them to respond quickly to last-minute changes or revisions (Motyl et al., 2017).

Ship Construction; it requires an integrated operation and planning of many processes from procurement of equipment and materials to design activities, subcontracting to class and legal

organization activities. This integration can be achieved through Product Lifecycle Management (PLM). PLM; It is a data management system that can integrate data, process, business systems and ultimately people in an organization. PLM software enables efficient and cost-effective monitoring and management of this data throughout its life cycle, from the emergence of a product idea to its design, production, service life and ultimately discard (Buhaug et al., 2002).

IT integration, which can increase machine automation in production, especially in activities that can be defined as automated jobs, such as resource processes, and which can decide independently, will reduce the error rate and make a more efficient process possible. With the use of large data structure in ship design, it is possible to produce a ship prototype quickly by iteration and design optimization of order parameters from the existing ship database, and accordingly, shipment of design documents to the shipyard by using PLM structure and a shipbuilding process can be possible as well (Lezzi et al., 2018).

Inventory and material management will enable the IoT network with various transmitters to be included in the design documents and parts lists, and material output and management can be realized more efficiently throughout the construction process. In addition, it will be possible to plan which equipment will be supplied to the shipyard without coming from any central decision-making mechanism by means of returns collected from cyber physical systems from the key products to be determined during the construction process. In both cases, the Just-Time concept will be realized and the work in process will be reduced. The main problems in the application of Industry 4.0 to shipbuilding and shipyards are given below (Endresen et al., 2010):

- IT security problems, which is the principle of accessing all kinds of personnel and machines to the data pool, which comes with

a large data concept, involves cyber risk in itself. To overcome this, robust internet security protocols and procedures must be developed.

- From design to shipyard production workshops, from material suppliers to subcontractors, from class organizations to various regulatory authorities, the shipbuilding and maritime process will require many organizations to work together and exchange data. This will be a disadvantage as well as a great advantage with the system's seating.

- Trained staff deficit,

- Probable strength of sector stakeholders to Industry 4.0.

- A large part of the workforce resource "smart factory" concept and labor surplus status (social dimension).

5.1. Reshaping The Maritime Sector

One of the most troublesome issues in the maritime sector is the fact that it faces conjunctural problems. These problems can be macroeconomic changes, such as economic crises, political crises. There is no direct action the sector can take to prevent them. All he can do is reduce risk damage by implementing risk management plans based on healthy risk assessments that are designed beforehand when these occur. Risk management is a very sensitive issue. Risk management needs to be "reshaping" of the organization as necessary. This shaping covers the following areas (Dalrosen et al., 2017):

- Management will react to different situations and have a capacity to be built according to the concept of 'strategic management.

- Flexible renewal of the organization to respond to different situations.

- Critical personnel are competent and trained to respond to different situations,

- Diversification of the fields of activity of the organization,

- Digitalization to enable the collection, storage and use of large and diverse information (data).

- In this context, the following issues can be made by companies operating in the maritime area (Balland et al., 2012):

- Formation of top management according to strategic management concept,

- Financial, budgeting, organizational structure required for crisis management,

- Maritime organizations; marina, port operation, marina, shipyard business and other areas of activity, such as logistics and similar areas of activity,

- Development of Management Information Systems, transition to digital trade, and automation with high reliability.

The usage of new 5G technologies, block-chain systems and dynamic clusters techniques are the specific applications of reshaping maritime sector. 5G technologies will be modified all sectors. The maritime industry become more safety with this technological improvement. With improved communication technology comes improved maritime communication. 5G is expected to facilitate the roll out of smart drones that can return real time monitoring of ships entering and leaving ports and improve ship shore communications for ship traffic. In addition to

providing a better connectivity for the internet of things sensors that can assist in search and rescue efforts by providing real time information and accurate positioning of downed or stuck vessels. While autonomy can be a scary buzzword when talking about industries that could be autotomized. In the shipping industry, autonomous shipping could instead potentially save thousands of lives. The oceans are not a place to make mistakes and sometimes these vessels can never be safely recovered adding further to the harmful rubbish we leave in our already suffering seas. Also, the development of autonomous ships is still at the experimental stage, 5G technologies will provide a stronger base for the manufacture of remote-controlled ships, remote-piloted ships and vessels powered by artificial intelligence. Most importantly, advanced communication technologies will improve the safety of commercial shipping for the better, saving lives, preventing accidents and putting less pollution into our already affected oceans. We are already seeing a drop in the number of spills and total losses experienced every year but considering many of the ships used today are decades old and not the cleanest. There is still more the industry can be doing to ensure an eco-friendlier method of distribution. With a blockchain enabled shipping systems each vessel has generating a highly automated, self-executable and functional transportation system. The ships brain can be precisely modified to robotize rationale-based occasions. A blockchain enabler within the shipping can create multiple contracts in numerous blockchain systems connected to a single chain and improve them with restrictive energetic information not shared inside the blockchain networks. Dynamic clustering is a vital portion of bringing any industry to life. Development cherishes company and the capacity to share encounters, thoughts and discover common objectives are basic parts of any explore for arrangements. There's a vitality and a buzz, and basic for numerous of the start-up companies looking for to develop interior a cluster to end of the sea and shipping economies.

5.2. Marine Environment and Environmental Sensitivity in The Maritime Sector

More than %70 of the earth's surface is cover by oceans and seas with give minerals and nourishment, create oxygen, retain nursery gasses and keep climate alter, decide temperatures and climate designs, and support as interstates for sea-borne universal exchange. The seas economy includes a maintainable economy for the ocean-based marine environment, species and hereditary assets, biological systems, related biodiversity and common assets at the sea (UNCTAD, 2020). Climate actions, life below water, CO_2 emissions subjects are the main development goals which is based on marine environment in United Nations environment program.

In international platforms, ongoing discussions are being held to reduce and eliminate greenhouse gas emissions and new measures are being taken. Of course, the maritime sector is also affected. Maritime transport, which is an international activity, has taken important steps in this regard and studies in this field are continuing. Those operating in this sector have to be very careful about this issue (Awoyomi et al., 2019).

Reducing carbon dioxide (CO_2) emissions and preventing dangerous climate change is one of the most important issues to reduce CO2 emissions. In fact, maritime transport is the area where carbon emissions are most efficient in commercial transportation. Fuel is the most important cost in maritime transport, so reducing CO_2 emissions is important for maritime transport, which is around 2.6% (Rehmatulla et al,, 2017).

Environmental pollution is not just CO_2 emissions. To reduce the greenhouse effect that leads to climate change, hazardous substances such as co, NMVOC, PM, CH_4, N_2, SO_x and NO_x (Nitrogen and Sulphate Derivatives) must also be controlled. This condition requires that not only ships, but all elements such as Port, shipyard,

dismantling facilities and offshore platforms connected to the sea should be constructed so as not to pollute the environment. Therefore, both ship and other marine facilities need to be considered in the planning and construction phase to meet these qualities. Additional equipment, sea connections, filtration systems, consumables to be made for the control of the emissions made to the sea constitute an important expense item and they should be considered at the beginning (Klimarx, 2019).

5.3 Traffic Density and Security of Navigation

85% of World Trade is made by sea. In 2015, the world sea trade increased by an estimated 2% on a yearly basis, reaching a total of 10.7 billion tons. The capacity of the world maritime trade fleet has increased by more than twice compared to the beginning of 2003 and reached 50 700 commercial vessels and 1.67 billion DWT by mid-2015. The growth of the world economy and, consequently, the amount of the goods transported and the number of ships in the world's oceans has increased due to the increase in traffic density, AIS, ECDIS and satellite communications systems, facilitating navigation if it provides the danger of cruising the seas still continues. Advanced navigational aids provide great convenience in recognition, promotion and evaluation, but a large number of collected information makes it difficult for users to assess. There is a need for systems that filter the most important and priority information to the user. By associating the position-route speed information collected by navigation systems (interface), it is necessary to create a digital analysis capability that will analyze them according to the current position and movements of the ship and present the most appropriate information (Lee et al., 2018).

The term of “The Road Ahead” which is about the traffic or navigation systems in maritime enter the literature with Industry 4.0 developments. Subsequently, to survey the marine activity

security precisely each nation ought to select the foremost reasonable evaluation show for their claim conduits. Because, waterways of each nation have their possess characteristics like geography, oceanography, shipping/fishing exercises and individual characteristics of seafarers. The administrative and lawful systems in the countries will be created to encourage a secure and capable new innovation technologies with the road towards associated independent shipping route frameworks to specialized cargo vessels for costal and nearby activity. After using these Industry 4.0 technologies in navigation systems at vessels, also the risk of the piracy problems at the seas will reduce.

5.4. Automation, Digitization and Internet of the Things

In order to increase production speed and efficiency in industry, reduce the use of manpower and reduce costs, automation is made. The use of automation in ships, shipyards and ports has increased greatly. However, automation requires a certain technological investment and increases the dependency of computer systems. Developments in the field of computer and electronics require the renewal of automation systems from time to time. In open end systems suitable for development and changes, these changes are cheaper and easier to make (Balland et al., 2012).

Computer support was inevitable in the operations of both the management operating systems and the machines used in the enterprise. Digitalization is essential for providing this support easily and inexpensively. Digitalization is the transfer of data or operational processes that were previously created manually to a computer or to a digital environment. With the power of the computer, the process goes faster, and data access and resource management are simplified. Information mining and Artificial Intelligence have become a necessity in today's large enterprises. Digitization is also essential for these applications (Eide et al.,

2011).

As a result of the widespread use of the Internet, "Internet of things" has emerged. This new approach can be described as a wide network of communication in which physical objects are interconnected with each other or larger systems. The purpose of the system is to connect objects to objects, and object to people. Especially in a very wide geography and 7 days 24 hours operation of the sea transportation in this new concept should be considered the benefit of absolute (Endresen et al., 2010).

In summary, in order to operate marine sector systems consisting of Huge Ships, Ports and shipyards efficiently and economically, it is now necessary to assimilate new developments such as automation-digitization-information mining-artificial intelligence-Internet of objects.

5.5. Financial Difficulties

The capacity of ports, shipyards and offshore platforms related to ships and sea has grown. Today, ship prices are between 50 and 250 million dollars. The cost of a bulk cargo fleet of 20 ships is between $ 1 and $ 2 billion. The cost of installation of a medium-sized port varies according to the region but is over $ 1 -2 billion. It is essential to have a financial source for such investments. Traditionally, the maritime sector, especially the supply of ships is carried out with loans. As a result of the growth of ships and the use of high technology, it is no longer possible to provide ships with small-scale loans. Lenders want to see at least 7-year strategic plans of the companies in the provision of large amounts of loans. In other words, in order to operate the financial system, the company that is looking for credit has to be first switched to the strategic management system. In order to switch to strategic management system, companies need to gain the following skills in the light of their recommendations at Freeman (2011):

- Strategic Orientation (Determination of the objectives of the company and management in this direction),

- Formulation of the Strategic Program (Progressively identifying programs),

- Budgeting (Use of resources in accordance with strategic plan, Accurate determination of possible income and expense table),

- Continuous Control (to ensure that the Strategic Plan is implemented correctly,

- Company Structure and Working System (Establishing a macro level organization and management system for full implementation.

Exceptional powers of alter come in the sea with the Industry 4.0 phenomenon. Inactive cooperation moves toward dynamic because of the equipment and its compounds costs are more than before 2000. Also, conventional and elective budgetary firms are getting to be progressively included within the possession and operation of intermodal resources. But it has been a result of the credibility problems with the advancement of worldwide exchange. Shipping industry, whereas generally youthful compared to standard resources, advanced out of the tall instability seen within the sea markets and are outlined to assist oversee chance. This hazard radiates from changes in cargo rates, bunker costs, vessel costs, scrap costs and the more conventional ranges of intrigued rates and outside trade rates. After all, the maritime sector don't overcome this liquidity problem.

5.6. Collaboration, Cooperation and Community Relations

In the 20th century, the concept of cooperation became very strong and many organizations achieved significant success. Later, the transfer of consortia began. Consortiums have enabled companies with a common purpose in different business areas to acquire the ability to collaborate with others, thus benefiting from much larger projects. Shipbuilding industry, especially shipyard - machine and auxiliary machine manufacturers - the company established by the manufacturers of electronic systems has reduced the cost while increasing the capacity and made the emergence of much better products (Ketchum & Pourzanjani, 2014).

In the same way, the number of professional associations bringing together spouses or similar professions has increased and they have become stronger. In the meantime, the use of the internet has introduced a concept called social media. Increasing communication among people has also strengthened non-governmental organizations. The resistance, protests and publications created by some non-governmental organizations have started to put big companies in serious trouble. Moreover, globalization has given great importance to the relations of large companies with society. Social reactions to environmental pollution have made these companies very difficult. In this respect, the maritime sector has now had to establish good relations with the non-contact community. This has made it necessary for the Public Relations Unit, which has not been active in maritime organizations before (Dalrosen et al., 2017).

The Industry 4.0 digitalization progress change the maritime industry all over the world. After that the digital and transformative cooperations become more important. Conventional shipping companies have matched up with innovation companies, and the

result of these associations are imaginative and transformative product with these relationships.

5.7. Organization

Activities outside technical and Commercial Management in maritime business are defined as policy determination, planning, strategy determination, accounting, tax affairs, finance; law, publicity and marketing (Drewery, 2006). From these activities, tax affairs, finance, law, Promotion and marketing functions were carried out in the form of consulting and outsourcing in small companies. Companies that are growing and whose financial values are increasing should now create these activities in their own bodies. In particular, in order to continuously monitor and control the financial risk, which is always one of the most important risks in a maritime company, the financial activity must be one of the most sensitive areas within the company. Today, it is common for companies that are outside the main field of activity of an organization to carry out some activities that are more economical than those that are specialized in this field to be carried out in the form of outsourcing. Maritime business advertising, agency and broker activities, electronic commerce (e-commerce), training, etc. are appropriate activities for outsourcing, but in order to carry out these activities in a healthy way, there is a need for a structure and order to control outsourcing within the company (Eide et al., 2011).

Modern maritime operations include more sophisticated part of the impact of the maritime industry. Each shipping plants serves a special combination of requests, in a special physical setting, beneath interesting commercial and organization imperatives. Accomplishing a adjust between execution, efficiency, and fetched adequacy requires a exhaustive, synchronous examination of all issues in Maritime planning process and strategic development with Industry 4.0 earnings. After using these organizational behaviors of Industry 4.0, the maritime sector become more efficient, productive

and powerful level.

5.8. Total Quality Management (TQM)

Customer satisfaction is vital for maritime transport, which is a commercial activity. A Total Quality Management System is needed to ensure customer satisfaction and ensure efficient, operational and financial effectiveness. This system needs to be supported by internal and external audit. Nowadays, it is inevitable to use ISO 18001 standards related to Occupational Safety and Health as well as ISO 9001 and ISO 14001 in the implementation of TQM. In the new TQM concept, a risk assessment is required for each process, which is necessary and necessary for making risk management plans that are vital during crisis periods (Ekinci et al., 2018).

There are many specific total quality management factors can be improved at the maritime sector with Industry 4.0 applications. Cargo demands, misplaced time occurrences due to disappointment of apparatus, detentions/deficiencies amid vetting/psc reviews will be zero with TQM methods. Also, the maritime sector will be understanding the quality information systems much better, reduced the operational costs minimum and transform the turnaround time well using with TQM techniques.

5.9. Sustainable and Quality Manpower

High-tech systems used in ships, shipyards, harbors and other marine facilities need to be equipped with the manpower to use them efficiently. Germanist Lloyd and Fraunhofer CML (2014) conducted a survey examining the problems of 100 large maritime companies and found that 88 percent of respondents had the biggest problem with staff (Sandberg, 2018). Due to the difficulties of working on ships and offshore structures, it is quite difficult to find volunteer young people, especially in developed countries. In

BIMCO / ISF's Manpower Report-2016, the deficit in the number of officers working on board was calculated as 97,000 in 2020 and 147,500 in 2025. Beyond that, modern systems in the maritime industry require high-tech personnel to employ them at full capacity. As an example, personnel using automation systems should be capable of restoring the systems they control in the event of a failure. For this purpose, in addition to the information given in classical training programs, automation systems should be subjected to additional training in order to know the working principles and limitations. There is a need for people who are able to follow the maritime developments and conduct scientific research on these issues. For this purpose, it is necessary for the universities providing maritime education to increase their research skills and to open master programs in marine technologies and applications (Han et al., 2019).

Quality manpower supply become the most vital figure driving sustainability in maritime sector with Industry 4.0 sustainable process. For producing of more useful and technical advanced ships and harbour systems to meet this expanded request for seaborne exchange, alongside modern necessities for controlling security will request with well trained and educated personnel staff. So that, it is simple to see why economic improvement needs economical sea transportation framework and why maintainable shipping needs feasible and quality labor supply.

6. Conclusions and Implications

If we define maritime trade according to economic concepts, it is an effort that has a high capacity, low profit return, but its demand is constantly increasing, indispensable and operates on a global scale. Maritime sector is an area of activity which is constantly under the influence of high technological developments and where new technologies are widely applied, which requires continuous cooperation and cooperation both in and out of Turkey.

Marine tools, facilities and organizations that are responding almost twice to the continuous growth of the world economy are in the direction of continuous growth. Considering these determinations, current trends and predictable needs of the future and the predictions regarding maritime transport will be as follows:

- Marine-related organizations should be reshaped to meet the needs of the future.

- Measures and regulations related to the increasing environmental protection sensitivity in the world will directly affect almost every area of the sector. Modification of ships and facilities in accordance with the new regulations is a very difficult and expensive task. For this reason, we should focus on the construction of environmentally friendly ships, green harbors and shipyards.

- The limited resources on land, as a new resource, increase the attempts to benefit from the sea and provide useful results. Taking advantage of high technology, it is important to attach importance to the development and dissemination of marine technologies that play a key role in such activities.

- Increasing traffic density in the seas of the world requires more comprehensive measures for navigation safety. There is a need for more excellent navigational aids that are easy to use and make it easier for users to make decisions.

- Automation, Digitization and Internet of Things are inevitable for the management and operation of growing maritime organizations. Furthermore, information mining and artificial intelligence applications will be unavoidable especially in large companies during the planning and execution phase.

- The most important problem during the establishment phase of large-scale companies is financing. Strategic planning should also

be focused on financing, restructuring according to strategic management concept and structuring of the systems accordingly. Finance is also one of the most important measures that an organization has in terms of risk management.

- In organizations, the units such as finance, budgeting, public relations and law, which were not given much importance before, should be given importance. Reducing the cost of outsourcing offers the opportunity to benefit from the organizations specialized in the fields not related to the organization's own business. However, companies need a mechanism to keep their activities under strict control.

- In order for an organization to be able to work more efficiently, to increase its operational and financial effectiveness and to ensure the satisfaction of customers that are indispensable for trade, it needs to establish a Total Quality Management System that takes advantage of internal and external audits together. In the new TQM concept, risk assessment is required for each process. Risk management is essential to reduce the effects of economic crises that our world has fallen into every 10 years. The most important input of risk management will be the risk assessments made within the scope of TQM.

- We live in an age when advanced technologies are constantly affecting maritime trade and the reaction time is very short. It must have the manpower to use these advanced systems, and to make a quick and accurate profit. Today, the number of manpower is very high. In order to create high quality manpower to be employed in maritime trade, the training system needs to be arranged in a dynamic way to meet the needs.

As a result, the industrial revolution of Maritime 4.0 is presented with developing and troublesome technologies. Also, main point of the future is digitalization in maritime sector

researches. Openings for the sea industry to gotten to be more secure and more effective whereas at the same time diminishing its natural impression. This will make an imaginative exchanging environment, connecting related angles such as the Advanced Economy, Future Cities and modern exchanging frameworks such as Blockchain. The longer-term workforce will have to be adjust to this changing work environment, with changing working demeanors and unused abilities brought approximately by unused innovative and demographical changes. New jobs and employments will be made moving the center of human assets to empower expanded proficiency and throughput. With an expanded utilize of Manufactured Insights and Mechanical frameworks comes an expanded accentuation on the part of human-machine collaboration; inquiring questions approximately how data can be nourished back to the human client and how the framework can be guaranteed to guarantee client believe within the Counterfeit Insights. Modern aptitudes will require unused shapes of preparing to keep up with the tall speed of alter. Education that can be conveyed carefully and remotely while still keeping up the association and part models of one to one training. Innovation can be astonishing, it can be game-changing, but innovations on their claim do nothing. It is the combination of individuals and innovation that produces things happen to complete in the maritime industry.

7. Research Limitations and Directions for Further Research

Developing technology, increasing customer demand and intense competition; it will make the recently introduced Industry 4.0 implementation inevitable. The high efficiency it promises, the production of bespoke products at the cost of mass production, and the low cost and error-free production attracts the producers more and more day by day. The application of the principles of Industry 4.0 to the shipbuilding sector is seen as essentially possible. It is a

foreseeable fact that the current shipyard production structure and the way of doing business with its stakeholders cannot change at once. In this respect, it is important to allocate a certain initial investment cost and consider the internet infrastructure and data processing units as the most important part of production instead of being seen as support for production. In addition, it is necessary to create an infrastructure that will ensure the management of all processes, from the idea of PLM-like product to its design and discard, to ensure internet security, to train qualified personnel in this matter.

As a last word, in a world where high competition conditions exist, the maritime transport sector must continuously follow the technological developments and reshape itself by taking into consideration the needs of the future.

References

Aksoy, S. "Değişen teknolojiler ve Endüstri 4.0: Endüstri 4.0'ı anlamaya dair bir giriş". *Sosyal Araştırma Vakfı Katkı*, 4, (2017): 34-44.

Alçın, S. 2016. "Üretim için yeni bir izlek: Sanayi 4.0". *Journal of Life Economics*, 8, (2016), 19-30.

Awoyomi, A., Patchigolla, K., & Anthony, E. J. "CO2/SO2 emission reduction in CO2 shipping infrastructure". *International Journal of Greenhouse Gas Control*, 88, (2019), 57-70.

Balland, O., Erikstad, S.O., & Fagerholt, K. "Optimised selection of air emission controls for vessels". *Maritime Policy and Management: The flagship journal of international shipping and port research*, (2012).

Bartodziej, C. J. "The concept industry 4.0: an empirical analysis of technologies and applications in production logistics". Springer, (2016).

Baur, C., & Wee, D. "Manufacturing's next act.". *McKinsey Quarterly*, June, (2015).

Benesova, A., & Tupa, J. "Requirements for Education and Qualification of People in Industry 4.0". *Procedia Manufacturing*,. (2017), 2195 – 2202.

Berger, R. "Industry 4.0. The new industrial revolution. How Europe will succeed?". (2014) downloaded 22.05.2019, https://www.rolandberger.com/publications/publication_pdf/roland_berger_tab_industry_4_0_20140403.pdf.

BMWi - The Federal Ministry for Economic Affairs and Energy of Germany. "Maritime Agenda 2025*". MKL Druck GmbH & Co.KG*, Berlin, March, (2017).

BST - Business Sweden Tokyo. "Opportunities & Barriers to implementation of Industry 4.0 in Japan", Stockholm, (2017).

Buhaug, Q. et al., "Second IMO GHG study". *International Maritime Organization (IMO)*, 20, (2009).

Burritt, R., & Christ, K. "Industry 4.0 and environmental accounting: a new revolution?". *Asian Journal of Sustainability and Social Responsibility*, 1(1), (2016), 23–38.

Camarinha-Matos, L. M., Fornasiero, R., & Afsarmanesh, H. "Collaborative networks as a core enabler of industry 4.0". *Working Conference on Virtual Enterprises,* Springer, (2017), 3-17.

CSSC - China 5 Shipbuilding Corporation. "CSSC Developing a Smart Ship for the Future". Shanghai, (2015).

Dalrosen, S., et al., "Update on emissi- ons and environmental impacts from the internati- onal fleet: The contrribution from majör ship types and ports". *Atmospheric Chemistry and Physics*, 9, (2017), 2171-2194.

Deniz, C. "Gemi makinelerinde Enerji Ekonomisi". (Yayınlanmamış Doktora Tezi), *İstanbul Üniveristesi Fen Bilimleri Enstütüsü*, İstanbul, (2000).

DM - Digital Mariner. "Shipbuilding 4.0: the digital thread in shipbuilding technology". *Siemens Enthusiast*, downloaded 18.02.2020, http:// community.plm.automation.siemens.com, (2017).

Drewery, A. "Metaphysics in science". Oxford: Blackwell, (2006).

Eide, M.S. et al., "Future Cost Scenarios for reduction of Ship CO2 Emissions". *Maritime Policy and Management*, Routledge Taylor and Francis Group, (2011).

Ekinci, Y. et al., "A segmentation-based analysis for measuring customer satisfaction in maritime transportation". *Transport,* 33(1), (2011), 104-118.

Endresen, Q. et al., "The environmental impacts of increased international maritime shipping, past trends and future perpectives". *OECD/ITF Global Forum on Transport and Environment in a Globalising World*, (2010).

Fırat, S. Ü., & Fırat, O. Z. "Sanayi 4.0 devrimi üzerine karşılaştırmalı bir inceleme: Kavramlar, küresel gelişmeler ve Türkiye". *Toprak İşveren Dergisi*, 114, (2017), 10-23.

Freeman R.E. "Strategic Management". Cambridge Press, London (2011).

Gabaçlı, N., & Uzunöz, M. "IV. Sanayi Devrimi: Endüstri 4.0 ve Otomotiv Sektörü". *Uluslararası Politik, Ekonomik ve Sosyal Araştırmalar Kongresi Bildiriler Kitabı,* 2, (2017), 149-174.

Glas, A. H., & Kleemann, F. C. "The impact of industry 4.0 on procurement and supply management: A conceptual and qualitative analysis". *International Journal of Business and Management Invention*, 5(6), (2016), 55-66.

Xiao, Y. & Wu, S. "China's high-quality marine ship and crew development environment optimization recommendations based on the fuzzy comprehensive evaluation". *2018 International Workshop on Education Reform and Social Sciences*, Atlantis Press, (2019).

Hermann, M., Pentek, T., & Otto B. "Design Principles for Industrie 4.0 Scenarios", *System Sciences*, (2016).

HHI- Hyundai Heavy Industries. "Hyundai Heavy Industries and Ulsan Metropolitan City Opens Center for Creative Economy & Innovations", Shipbuilding News, Korea, (2015).

Hughes D. "Shipping Commits to CO2 Roadmap". *The Business Times*, Singapore, (2016).

Kabaklarlı, E. "Endüstri 4.0 ve dijital ekonomisi; Dünya ve Türkiye ekonomisi için fırsatlar, etkiler ve tehditler". Nobel Bilimsel Eserler, Ankara, (2016).

Kagermann, H., Wahlster, W., & Helbig J. "Bericht der promotorengruppe kommunikation im fokus: Das zukunftsprojekt industrie 4.0". *Bericht der Promotorengruppe Kommunikation*, Forschungsunion, (2012).

Kağnıcıoğlu, C. H. & Özdemir, E. "Endüstri 4.0 bağlamında Eskişehir ilindeki KOBİ'lerin değerlendirilmesi". *PressAcademia Procedia*, 3, (2017), 900-908.

Kennedy S. "Made in China 2025". *Center for Strategic & International Studies,* downloaded 19.02.2020, http://csis.org/analsys/made-china-2025, (2015).

Ketchum C. & Pourzanjani M. "European Maritime Post Graduate Programmes for Former Seafarers". World Maritime University, Malmo, (2014).

Kilmarx, R. A. "America's Maritime Legacy: A History of the US Merchant Marine and Shipbuilding Industry Since Colonial Times". Routledge, (2019).

Lee, P. T. W., et al., "Research trends and agenda on the Belt and Road initiative with a focus on maritime transport*". Maritime Policy & Management*, 45(3), (2018), 282-300.

Lezzi, M., Lazoi, M., & Corallo, A. "Cybersecurity for Industry 4.0 in the current literature: A reference framework". *Computers in Industry*, 103, (2018), 97–110.

Mehami, J., Nawi, M., & Zhong, R. Y. "Smart automated guided vehicles for manufacturing in the context of Industry 4.0". *Procedia Manufacturing,* 26, (2018), 1077- 1086.

Motyl, B., et al., "How will change the future engineers' skills in the Industry 4.0 framework? A questionnaire survey". *Procedia Manufacturing*, 11, (2017), 1501 – 1509.

Papers in Australian Maritime Affairs, "The Strategic Importance of Seaborne Trade and Shipping". Australia, (2002).

Pereira, A.C., & Romero, F. "A review of the meanings and the imlications of the Indusrty 4.0 concept". *Procedia Manufacturing*, 13, (2017), 1206–1214.

Rehmatulla, N., Calleya, J., & Smith, T. "The implementation of technical energy efficiency and CO2 emission reduction measures in shipping". *Ocean Engineering*, 139, (2017), 184-197.

Salkın, C., et al., "Industry 4.0: Managing The Digital Transformation". Springer, (2018), 3-22.

Sandberg, E. A. "An analysis of the marine corps selection process: Does increased competition lead to increased quality". Naval Postgraduate School Monterey United States, (2018).

Santos, C. et al., "Towards Industry 4.0: an overview of European strategic roadmaps". *Procedia Manufacturing,* 13, (2017), 972– 979.

Saucedo-Martínez, J. A., ey al., "Industry 4.0 framework for management and operations: a review". *Journal of Ambient Intelligence and Humanized Computing,* (2018), 1-13.

Sung, T. K. "Industry 4.0: a Korea perspective". *Technological Forecasting and Social Change*, 132, (2018), 40-45.

UNCTAD -United Nations Conference on Trade and Development. "Oceans Economy and Fisheries" downloaded 11.03.2020, https://unctad.org/en/Pages/DITC/Trade-and-Environment/Oceans-Economy.aspx,. (2020).

Yuyang L. "Big Data herald era of smart ships", *China Economic Net*, China, (2014).

Wagner, T., Herrmann, C., & Thiede S. "Industry 4.0 impacts on lean production systems". *Procedia CIRP*, 63, (2017), 125 –131.

Wang, S., Wan, J., Li, D., & Zhang, C. "Implementing smart factory of industrie 4.0: an outlook". *International Journal of Distributed Sensor Networks*, 12(1), (2016).