

социально-экономической деятельности, что в конечном счете увеличит интегрированность электронного документооборота в транспортной сфере.

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LOGISTICS 4.0 IN MARITIME SECTOR

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The current business environment is characterized by constant fluctuations due to the rapid technological advances of our time. The era that we are traversing through has been called the 4th Industrial Revolution, which, as it entered the world of logistics, provided new possibilities in the distribution of goods and especially contributed in the evolution of the maritime supply chain. Companies are called upon to follow these new developments in order to be able to increase their future productivity and be competitive relative to their environment. The aforementioned changes have posed a challenge to corporations of such sectors, since what is needed is the transformation of a sufficient number of their procedures, constant training of the staff and the adoption of a different corporate ethos, which in turn leads to high investment costs.

Key-Words: logistics 4.0, maritime supply chain, digital transformation, digital shipping

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Текущая бизнес-среда характеризуется постоянными колебаниями из-за быстрого технического прогресса нашего времени. Эпоха, через которую мы проходим, называется 4-й промышленной революцией, которая, войдя в мир логистики, открыла новые возможности в распределении товаров и внесла особый вклад в развитие морской цепочки поставок. Компании призваны следить за этими новыми разработками, чтобы иметь возможность повысить свою производительность в будущем и быть конкурентоспособными по сравнению с окружающей средой. Вышеупомянутые изменения поставили перед кор-

порациями таких секторов вызов, поскольку требуется трансформация достаточного количества их процедур, постоянное обучение персонала и принятие иного корпоративного этиоса, что, в свою очередь, приводит к высоким инвестиционные затраты.

Ключевые слова: логистика 4.0, морская цепочка поставок, цифровая трансформация, цифровое судостроение.

1 Introduction

In the last thirty years the supply chain has undergone great changes in its operational functions. The main functions of the supply chain begin from the production line, the safekeeping of the supply, the sales and the final delivery to the clients. As time passed and as technology advanced, these main functions were supported by more and more advanced tools. The introduction of new technologies hasn't only defined the world of logistics but entire eras as well, which have been categorized in four Industrial Revolutions [1].

In the last decade that we are traversing through, an increasing acceleration in the production of all sorts of products has been observed. The reason for this change can be pinpointed to the new production systems that have been created to make use of the internet, a feature which helps in the intercommunication of the machines and the automatic execution of all the different production procedures [1]. 2011 was a landmark year for all the impending changes because in a trade exhibition hosted in Germany, the term "Industry 4.0" was used for the first time and ever since it has been used to talk about our era. This Industry includes the development of management and production systems, of logistics, of storage systems and factories by being based on the new applications of the internet [2]. This didn't leave the maritime supply chain untouched and as a result it entered the new Industrial Revolution by experiencing changes towards digitalization and automation. Digitalization and Logistics 4.0 provide great business

gains in maritime companies, as they provide a broad range of new applications and new technologies.

Some of the business gains are operational efficiency, cost reduction, the strengthening of the relationship of the parties involved and better decision-making. So, digital innovation shapes the architecture of maritime supply chains by giving special importance to terminal stations by turning them into logistical centers and thus ensuring an efficient storing of manufactured goods and cargo [3].

Many of the new technological terms that have been inserted in the sector of shipping seem to be quite promising. Of them, the most important are Big Data Analytics (BDA), Cloud Computing (CC), Internet of the Things (IoT), artificial intelligence, drones and robotics.

2 Applications in maritime logistics

2.1. Internet of the Things (IoT)

The term Internet of the Things refers to the interconnection of different devices, buildings and vehicles that have integrated software or sensors that, using their connection to the internet, allow the collection and the trade of data. The field has evolved due to the convergence of multiple advanced technologies, including ubiquitous computing, commodity sensors, increasingly powerful embedded systems, and machine learning etc.(Fig.1) [4]. The Internet of The Things is a useful tool for the sector of shipping which helps in the acquisition of data. These data contribute to the decision-making and they allow the distribution of information both in real time and throughout the entire supply chain.

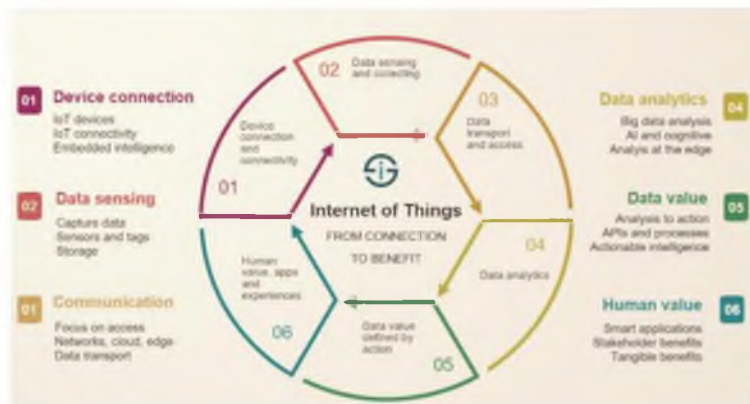


Figure 1. – IoT Concept (source: <http://www.pdhse.com/internet-of-things>)

A good example of an application of the Internet of the Things is the communication between the ships and the mainland. This interconnection also includes the recording of huge chunks of data between

the ships and the ports where the time of transit and the time lost during the stay in the port are noted as it also detects locations of high traffic. This record keeping aims at contributing to the avoidance of port

congestion and to alerting the parties involved in any situation. In other words, the Internet of the Things aims, with the help of artificial intelligence, at forecasting the “footfall” and at a smart coordination of the ships [5].

2.2. Big Data Analytics

With the term Big Data Analytics we mean “the act of collecting and evaluating data that are registered by different sources in order to support the decision-making in real time and to optimize production”(Fig. 2) [6]. Essentially it is used to describe big sums of data that are drawn and analyzed with 4.0 technologies from different sources through an entity or outside of it [7].

In the previously mentioned example, BDA can be utilized for the prognosis and the analysis of

weather conditions through the use of sensors. On one hand we have the technology of IoT, which helps, for example, in the interconnection of these sensors with the company server, which is located several nautical miles away and on the other, we have the drawing of data, which helps the server and the sensors to mine huge chunks of data. What comes next is the analysis, which is done automatically. Thus, through the analysis of these data we are drawn to conclusions that lead to the avoidance of ship delays. It is worth pointing out that in shipping industries, the monitoring of the cargo is imperative and the same goes for its proper delivery in order to enhance the trust and the feeling of safety of the client for his product. For this reason the accurate prediction of delays decreases the cost of an impending compensation for the client.



Figure 2 – Big Data Analytics Concept (source: <https://knowitinfo.com/what-is-big-data-analytics/>)

2.3. Cloud Computing

With the term cloud computing we mean the different computer services which are used through the internet (Fig. 3). Large clouds often have functions distributed over multiple locations, each location being a data center. The main features of the CC is that this service providing is done after the demand of a user who has wide access to the net. Every user, that is connected, can use a computer when and however he needs. This gives each user mutual use of resources and flexibility in his access because the CC can support a big influx of users from different devices. The advantages are numerous considering it permits fast and efficient access in informatics services and thus providing innovative solutions in supply services [8].

2.4. Robotics

Robots are closely connected with the technologies of artificial intelligence. Instances in which it is common to use robots is the loading and unloading of containers from ships, trains, trucks and other means of transportation (Fig. 4). Examples of such use can be found in the port of Rotterdam which shows considerable development in new technologies, making it one of the most powerful ports in the world [10]. When a truck arrives at the dock, a self-powered robot can unload it and categorize the parcels depending on their content by checking their label. Furthermore, it can stack them in such a way that the capacity of the container will be fully utilized. Another example where robots are used is that of dangerous cargo, where they can classify them separately and safely in special containers [11].

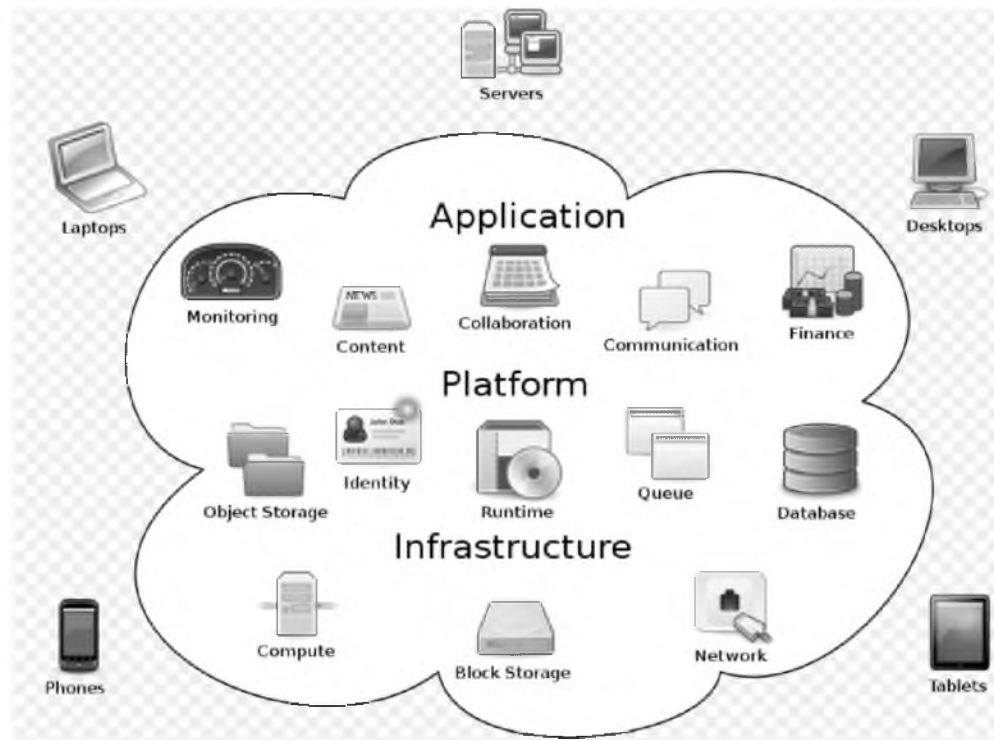


Figure 3.– Cloud computing metaphor: the group of networked elements providing services need not be individually addressed or managed by users; instead, the entire provider-managed suite of hardware and software can be thought of as an amorphous cloud (source: Wikipedia)

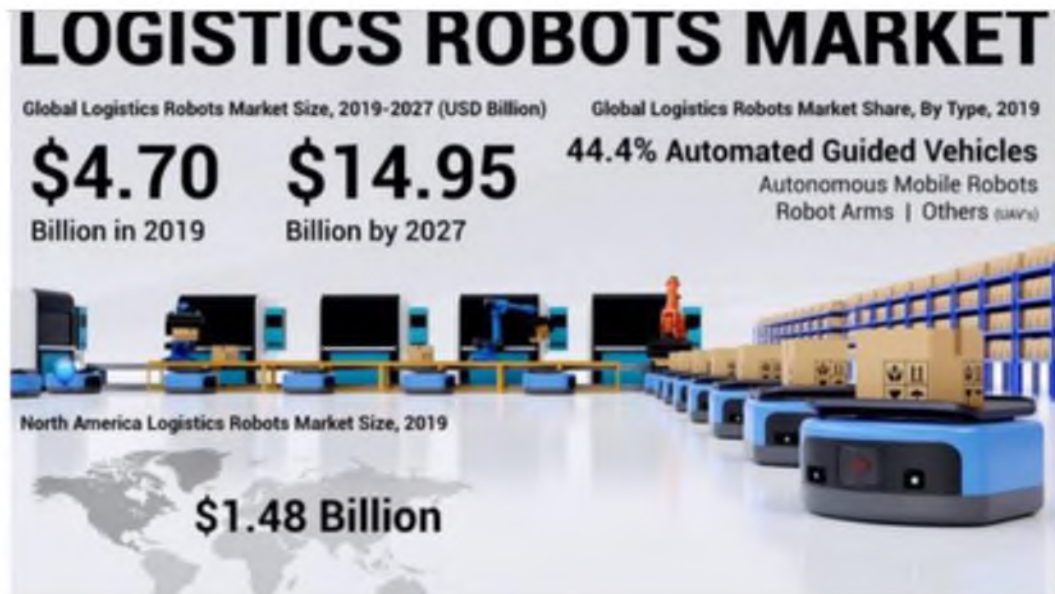


Figure 4. – Logistics Robots Market Analysis, Insights and Forecast, 2016-2027 (source: <https://www.pnews-wire.com/news-releases/logistics-robots-market-to-reach-usd-14-95-billion-by-2027-rising-demand-for-complex-supply-chain-operations-will-add-impetus-to-market-says-fortune-business-insights-301073608.html>)

2.5. Drones

Drones can be considered part of Logistics 4.0 technologies as well and their use is still in the initial phase. Drones are unmanned flying vehicles which are controlled by a remote controller or by an integrated software to function automatically. They are separated in three categories where the first revolves around drones that operate in land, called UGVs (unmanned ground vehicles). The second category is

about drones that operate at sea, called UMVs (unmanned marine vehicles) and finally, in the aerial UAVs (unmanned aerial vehicles) [12]. Some sources report that drones are gaining ground and their usage is expanded in different maritime operations. Some examples of that is their extended usage for the monitoring of cranes in docks, like in the tracking of basic equipment and the monitoring of ship deliveries in-land and from the land to the ships, to maintain safety [10].



Figure 5. – Drones have the potential to revolutionize supply chains and shape the future of unmanned aerial vehicles in logistics (source: <https://lot.dhl.com/the-future-of-logistics-takes-flight/>)

3 Business Analysis of maritime Logistics 4.0

3.1. Macro-environmental Analysis by PESTEL Analysis method

Every business is created, developed and evolved through its business environment. It influences it and it creates new conditions under which it can operate and grow. More specifically, the basic factors that shape the environment of the business are its available resources and its productive elements. A new addition to these is the factor of technology that makes up for an important business investment. Many businesses are expanding their production activities with the help of technology and they implement new ways, converting the currently in use methods into specialized ones. Outside of the internally available resources, a business is influenced from its external environment. The various informal moral norms of the society, the institutional framework of a country and even the political and financial factors tend to shape the course of a business [13].

In this chapter, we will use the PESTEL Analysis, a strategic tool that considers the events that take place in the business's environment and immediately influence its operation (Fig.6). Specifically, in globally:

- **Political Environment.** When we refer to the political environment we mean the Government of a state and the stance it takes in matters of private and state-owned businesses. The concern of maritime players is great since investments in new technologies are characterized by great costs. Many banks don't support such ventures anymore and as a result, the

modernization of fleets and the implementation of other similar works of the same scale are being proven difficult to attempt. Now it's very important for the states themselves and their governments to focus their gaze in their shipping since it's going through severe crises. They should contemplate and factor the maritime economy and research through the funding programs that they receive [14].

- **Economic Environment.** When it comes to the economic environment, the factors that were deliberated are those that have an immediate relation with the conditions that prevail based on taxation, loans, inflation, interest rates etc. Economists report that the industrial sector is the lever of economic growth. The countries that have reorganized themselves according to the global trends, meaning the digital transformation, developed their economies and avoided economic decline. Consequently, shipping, being the foundation of the transport market and transporting 90% of the global cargo, as it passes through this transformation, it creates added value in the services it offers. [15]. The adoption of the new technologies develops the economic power of shipping, contributing to the global economy. If it implements such models, it will enhance its services based on demand and it will increase its total earnings, all the while decreasing its operational costs [16].

- **Social Environment.** Another issue that is touched upon along with the New Industrial Revolution is the replacement of man with automatic machines and the loss in job positions. Through digitalization and automation, maritime logistics need to combat the problem of creating and developing new

skills and searching for new talents. The use of new technologies creates new and appealing job positions in land for the remote monitoring of ships [17]. However, at the same time a need for workers with the proper technical know-how is created. The experience, the willingness to integrate and the technical know-how are some of the most important issues that need to be accounted for. Therefore, the need for constant job training in the immediate future is to be expected [16]. According to the review 2018 of UNCTAD, even though the digitalization and the automation of the ships offers much, it is still unclear whether it will be accepted by the world's governments. The reduced role of seamen and the loss in job positions result in their corollary negative attitude. It also mentions that governments should have a supporting role by encouraging businesses to train their staff in order to develop their knowledge and skills. However, the adoption of technology in shipping leads to other advantages. New occupations give a special dynamic to women by creating new, in person, job positions that don't need that much muscle power but skill and knowledge [18].

- **Technological Environment.** With the introduction of the prototype Industry 4.0, the shipping industry is now changing form and it's getting digitalized. Therefore, what is needed is the existence of proper systems for the collection of data, their transfer, their storage and their analysis in real time. This technological reorganization brings an immediate accomplishment of certain goals between businesses in a fully interconnected environment. Shipping businesses are developing their equipment based on the Internet of the things, Big Data, cloud-based services, mobile & augmented reality etc. They are creating interconnection infrastructures in order to get a better understanding of the system and to appreciate the system's performance by collecting data from the selection devices of the ship, like VDR, ARPA, AIS etc. The use of Big Data has many possibilities but at the same time, many dangers. In these possibilities we find processes of business planning and control that can make maritime logistics better. The analysis of data in real time is done with extensive mathematic algorithms from the moment of the ship's arrival. In the future, the involved parties will be capable of predicting possible delays with greater precision [15]. Furthermore, the significant increase in the quantity of container transport will not be a challenge anymore because it will become qualitatively better with the existence of proper software, which will create models out of the existent processes. Another example of development is the creation of simulation models meant to predict methods for the optimization of terminal station processes. Finally, RFID technologies

will monitor the course of a container in order to track it at any time, from the sender to the recipient [16]. The results of the digital transformation are thought to bring, in the long term, a hyper connected system of supply that makes the distribution of material assets easier and the unification of the flows. From a technological standpoint, digitalization seems to change maritime logistics through the connection and the automation of the processes and thus contributing in its effective management. The monitoring of a cargo's course and the monitoring of ship systems through a cloud system, is not a plan that will be put in future use anymore. Some new models and processes that will drastically change the future of maritime logistics are the remote-controlled or the fully automated operation of the ship [19]. For this reason the parties involved in maritime logistics will need to invest in these new activities [16].

- **Environment and Ecology.** The transport sector and shipping especially are progressively aware when it comes to matters that concern the society. In the last years, maritime logistics has been called on quite a few times to conform to strict environmental demands from international agents that are responsible for the safety of human life in the sea and for the safety of marine life. The maritime supply chain is predicted to drastically change as a result of the accumulation of strict environmental guides that keep increasing year by year. An important matter that it tries to solve is pollution, for which actions are already taken from the IMO. For example, the environmental guide to reduce the content of sulfur in oil fuel from 3,5 % to 0,5 %, was implemented in January 2020. Respectively, the rate of 0,1% in areas of high danger was implemented in 2015 [20]. Digital transformation is predicted to contribute in the future reorganization of maritime logistics with the aim of preserving the ecosystem that surrounds it. Ships that have new design criteria bring in the picture construction advantages that comply with the new regulations (IMO) that govern modern shipping and that replace traditional ships with the so called "smart" ships. These ships "of the future" have equipment that record and analyze the daily ship emissions and thus supporting the viability of marine life [16].

- **Legal Framework.** Business executives are found to be quite anxious in matters of cyberspace safety. In 2017, the IMO set some guiding principles for the avoidance of attacks in the maritime cyberspace. These guiding principles offer recommendations that can be incorporated in the subordinate management processes that have been voted on and implemented by the IMO. At the same period, the Maritime Safety Commission voted the MSC428(98) which encourages administrations to make sure that

cyberspace dangers are properly dealt with in already existing systems of safety management, as the ISM code dictates. According to these rules, governments should create “bridges” between businesses and legislate regulatory arrangements that reduce factors that endanger the safety of shipping [21]. Big mobility in the collection of huge chunks of data in the sector of supply poses a challenge because the increasing size of data creates the need for data safety. The fear of sensitive data leaking especially involves shipping companies and the companies that are active in the sector of maritime logistics. The different data protection models that currently have existed are now reaching their limits. The danger gets greater with the use of cloud services because the greatest management of devices, ships and sensitive company data happens through it and non-authorized access or data interception pose financial danger to the shipping company. The maritime logistics companies have to

create proper investments for the safety of their data and to give proper attention to the new informatics trends [14]. There are many other examples similar to the automatic recording of personal data (RFID). AIS technology is used for the rebroadcast of the ship’s course and it also uses statistics relevant to the active travels. Consequently, it shares important data from the ship’s control center with the shore. Also, with their use, personal data from the captain are transferred, since in times of cyber threats, there is great concern for the safety of both the ship and the crew. Meaning, if the ship is sailing in areas struck by pirates or other criminal activities and they have similar threat receivers, there’s great danger in that. For this reason alone, before any implementation of the new technologies, the legal and moral rules of the matter should be reexamined. Other than the protection of private life, guiding principles could create a state of healthy competition and growth opportunities [16].

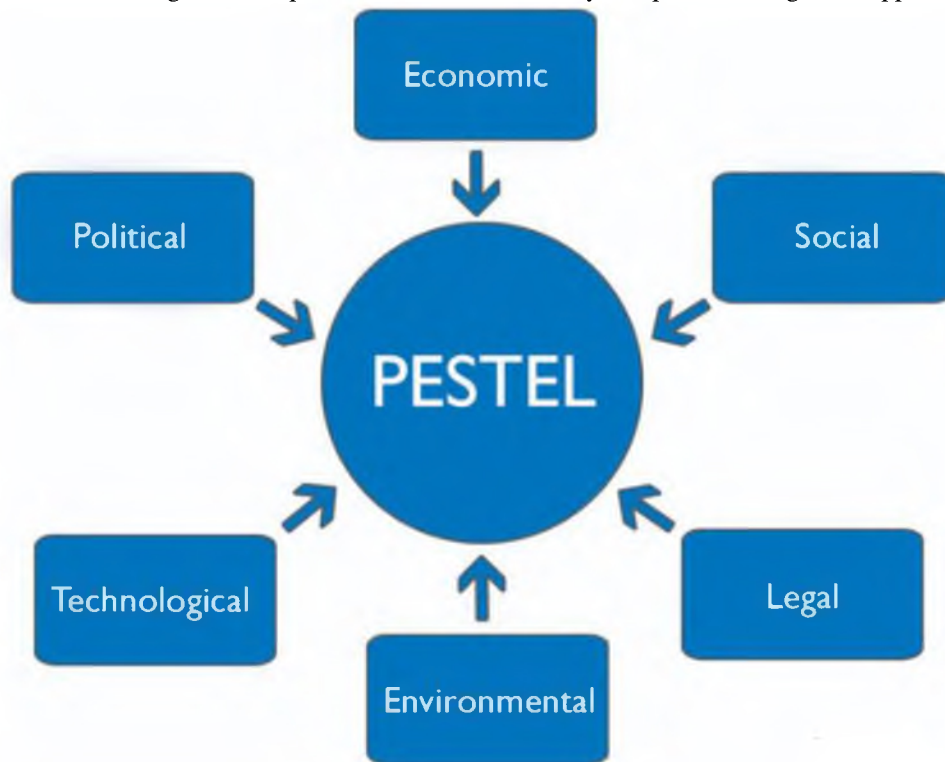


Figure 6 – PESTEL Analysis (source: <https://www.professionalacademy.com/blogs/marketing-theories-pestel-analysis/>)

3.2. Strategic Analysis with the SWOT Analysis method

The SWOT (strengths, weaknesses, opportunities, and threats) analysis is a framework (tool) used

to evaluate a company's or area/field competitive position and to develop strategic planning. SWOT analysis assesses internal and external factors, as well as current and future potential. Specifically, in globally:

Table 1 – SWOT Analysis of Logistic 4.0 in Shipping

Swot Analysis	
Strengths	Weaknesses
<ul style="list-style-type: none"> • Contribution to the growth of the world economy • Increase in maritime business profits • Decrease in general expenditures • Greater traceability • Greater effectiveness and transaction speed • Decrease in administrative and operational dangers • Creation of added value in the offered services • Creation of competitive advantage • Improvement in the management of supply chain processes 	<ul style="list-style-type: none"> • Ship-owners aren't fully informed on cyberspace threats • Administration staff and crew aren't fully trained • Ignorance of impending financial loss in case of cyberspace attacks • Shipping still uses dated informatics models • Matters of system integrity and durability are posed • Weakness in supporting such systems from a large part of the global fleet ships
Opportunities	Threats
<ul style="list-style-type: none"> • Total interconnection of mobile offshore units, ports and ships • Production efficiency • Collection, storing and transmission of huge chunks of data • New ways to communicate –remote (damage tracing, import of data etc.) 	<ul style="list-style-type: none"> • Cyberspace attacks along with financial loss • Incapacity in navigation due to cyberspace attacks (breakdown of electronic systems) • Cargo loss • Damage in energy industry followed by possible hazard to marine and human life • Dependence of the entire chain on one software • Danger of ship collision due to operational inadequacy of the navigation system

4 Discussion and Conclusions

The current configuration of the business environment is characterized by innovation and high competitiveness because all trade activities are extended in e-business. Our era is still characterized as the era of information since the new means of communication are transmitting in real time. Businesses are exploiting this emergence by giving special importance to the timely transmission of information. For them, a basic concern in this new environment is the need to adapt in the constantly changing needs of their clients and to be thought of as successful. In order for this to be achieved in our era, every business could and should rely on new technological solutions.

In our 4th Industrial Revolution we can observe a considerable pace of change in the technology and it also signals the ushering of an era that combines advanced production techniques with smart technologies.

The essay at hand is presenting how smart technologies can impact and reinforce the efficiency of businesses that are active in the sector of logistics and logistics businesses that are active in shipping.

These technologies, as mentioned above, can also be characterized as “state of the art” and are comprised of autonomous “smart” robots, data analytics, artificial intelligence, augmented reality and of interconnected devices that are based on the Internet of the Things (IoT).

Therefore today, a business that is active in the world of logistics is called upon to cross into a transitional stage during which it will achieve a competitive advantage over others. The basic question that arises is, what the benefit is for a business to use the tools of the 4th Industrial Revolution. The basic advantage for a business is the in real time realization of the existence of a fact, the consequent drawing in of all available information on it, the finding of a solution and, finally, the decision making and its implementation.

In conclusion, the business is characterized by its ability to perceive and react both immediately and effectively in various incidents within and outside of it. The faster a business adapts to these changes the more its competitive position in the market will become. The business's benefits will be doubled. For example, the general expenditures will be reduced, its earnings will increase, the clients' satisfaction etc.

In the last chapter of this essay we have an analysis of the macro environment with the use of methods like PESTEL and SWOT Analysis. For starters, using the PESTEL Analysis we wanted to investigate the external environment of marine logistics with the aim of pinpointing the challenges or the opportunities that a shipping business can encounter if it undergoes digital transformation changes according to Industry 4.0.

From a political standpoint, there is a lack of investments from state entities and governments because the transition to digital systems or the purchase of new technological achievements brings high costs. For this reason, businesses should search for or already have resources. From a financial standpoint an investment venture of a shipping business's digital transformation would provide it with more financial power, added value in its service, income growth and a reduction in operation costs.

Furthermore, by analyzing the social environment of the maritime logistics some domineering social beliefs have been discovered. More specifically, machines will replace the human work force in the future. Nevertheless, after our analysis what comes to light is that digital transformation offers new job positions that bear no social discrimination based on gender. It only demands of its candidates to bring the proper technical know-how and the skills.

Technology, as seen in this essay, is thought to create a system of interconnection and remote control of the entirety of a shipping business's material assets, offering a total update with automated processes and the cloud. Another challenge is that of managing the huge chunks of data in the logistics sector because the ever expanding size of data creates an increasing need for their protection. The fear of private sensitive

information that involves maritime logistics businesses leaking, is noteworthy and even though the various protection entities have tried to counter it with guiding principles and regulations, it doesn't seem to bear any fruits if they themselves don't take protective measures.

It is worth noting that these companies have a responsibility when it comes to the protection of the environment. The digital transformation offers eco-friendly solutions because fleets can be equipped with smart and eco-friendly systems or systems that help in the recording of daily emissions, thus helping in controlling the damage done to the marine environment.

To summarize, with the help of the SWOT analysis we discerned many opportunities and possibilities that the new technological advances offer in maritime logistics and at the same time quite a few weaknesses and threats that businesses with dealings of this sort need to look after. Many weaknesses and threats were also found when using the PESTEL method. For this reason, businesses are called upon to study these weaknesses and turn them in to opportunities.

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МЕТОДИКА ОПРЕДЕЛЕНИЯ ЭКОНОМИЧЕСКОЙ ЭФФЕКТИВНОСТИ ВЫБОРА ВНУТРЕННЕЙ ТРАНСПОРТНО-ТЕХНОЛОГИЧЕСКОЙ СХЕМЫ ОРГАНИЗАЦИИ РАБОТЫ МОРСКОГО КОНТЕЙНЕРНОГО ТЕРМИНАЛА

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Статья посвящена методике определения экономической эффективности выбора внутренней транспортно-технологической схемы. В ходе работы были выделены особенности и механизмы организации работы морского контейнерного терминала. Выявлены методы и подходы, а также применены положения логистики, системного подхода, теории принятия решений, теории бухгалтерского учета и др.

Ключевые слова: экономическая эффективность, транспортно-технологическая схема, подходы, модели.

METHODOLOGY FOR DETERMINING THE ECONOMIC EFFICIENCY OF SELECTING THE INTERNAL TRANSPORTATION AND TECHNOLOGICAL SCHEME OF ORGANIZING THE OPERATION OF THE MARINE CONTAINER TERMINAL

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The article is devoted to the methodology for determining the economic efficiency of choosing an internal transport and technological scheme. In the course of the work, the features and mechanisms of organizing the work of the sea container terminal were identified. Methods and approaches are identified, and the provisions of logistics, systems approach, decision-making theory, accounting theory, etc. are applied.

Key words: economic efficiency, transport and technological scheme, approaches, models.

1. Введение

Транспортно-технологическая схема (далее ТТС) – структура (система), состоящая из ее элементов и частей, которые находятся во взаимодействии внутри этой структуры и во взаимодействии

с внешней средой. Как ведет и существует объект определяется направленностью всех взаимодействий (сознательной, бессознательной, predetermined, случайной).