Economic aspects of automation innovations in electronic transportation management systems

Jović, Marija; Tijan, Edvard; Perić Hadžić, Ana; Karanikić, Petra

Source / Izvornik: **Pomorstvo, 2020, 34, 417 - 427**

Journal article, Published version
Rad u časopisu, Objavljena verzija rada (izdavačev PDF)

https://doi.org/10.31217/p.34.2.22

Multidisciplinary
SCIENTIFIC JOURNAL
OF MARITIME RESEARCH

University of Rijeka
FACULTY OF MARITIME STUDIES

Multidisciplinarni
znanstveni časopis
POMORSTVO

https://doi.org/10.31217/p.34.2.22

Economic aspects of automation innovations in electronic transportation management systems

Marija Jović[1], Edvard Tijan[1], Ana Perić Hadžić[1], Petra Karanikić[2]

[1] University of Rijeka, Faculty of Maritime Studies, Studentska 2, 51000 Rijeka, Croatia, e-mail: jovic@pfri.hr; etijan@pfri.hr; ana@pfri.hr
[2] University of Rijeka, Department of Biotechnology, Radmile Matejčić 2, Rijeka, Croatia, e-mail: pkaranikic@uniri.hr

ABSTRACT

This paper presents an analysis of economic aspects of three selected automation innovations in electronic Transportation Management Systems: Maritime Transport Chain solution and Vessel Estimated Time of Arrival solution (related to the maritime transport) and Delivery Planning solution (related to the transport in general). The theoretical background of transportation, Transportation Management Systems, maritime transportation and seaports is provided, focusing on the economic aspects. A literature review has been conducted, in order to identify the research gap and to focus on the economic aspects of the selected automation innovations. A SWOT Analysis of the Maritime Transport Chain solution, Vessel Estimated Time of Arrival solution and Delivery Planning solution (from an internal and external perspective) is presented, adding to the existing research of the economic aspects of automation innovations in the transport sector.

ARTICLE INFO

Review article
Received 2 November 2020
Accepted 18 December 2020

Key words:
Electronic Transportation Management Systems
Economic aspects
Automation innovations
Maritime transport chain
Delivery Planning
Vessel Estimated Time of Arrival

1 Introduction

Economics and transportation are closely related terms, and when transportation solutions are efficient, they can enable economic benefits such as decreased costs (Jović, Tijan, Žgaljić, & Karanikić, 2020). Transport is constantly undergoing a rise due to the globalization of economy, thus causing the specialization of vehicles and port terminals and the development of various technologies ("Maritime Transport VIII, 8th International Conference on Maritime Transport," 2020). Digitalization in transport and logistics is an important driver for efficiency, simplification, lowering costs, and a better use of resources and existing infrastructures, and provides the potential to spur the automation and change the way cargo and traffic flows can be organised and managed in the future (CLECAT, 2017a). Digitalization pushes the transport sector beyond its traditional boundaries and provides a number of new opportunities to improve the productivity, efficiency and sustainability of logistics (González-Cancelas, Serrano, Soler-Flores, & Camarero-Orive, 2020). Over the last two decades, growing awareness of economic and environmental concerns related to the transport sector has led to the development of competitive and sustainable transport systems. Innovations are identified as one of the main avenues to maintain competitiveness along maritime logistics chains, and are being increasingly recognized as a determinant of success (Acciaro & Sys, 2020).

Numerous benefits are expected from the increased use of connectivity and automation technologies in all modes of transport, at individual and at social level, and they are instrumental for the cross-modal integration of transport (European Commission, 2017). Based on the experience in several scientific and professional projects related to information management in transport, the authors have selected the following automation innovations to be analysed in this paper: Maritime Transport Chain and Vessel Estimated Time of Arrival solution (ETA solution) (related to the maritime transport) and Delivery Planning solution (related to the transport in general).

Electronic Transportation Management Systems (e-TMS) may be defined as platforms that provide numerous benefits such as reduced costs and streamlined operations

(Oracle, 2020). The aforementioned innovations can be applied to e-TMSs which, despite numerous benefits, still have several shortcomings such as such as the lack of a uniform data transferring capability that can prevent simplified data exchange among stakeholders (Jović, Tijan, Aksentijević, & Žgaljić, 2020). Nevertheless, automation innovations possess the potential to improve transport business and may improve e-TMS performance. The goal of the research is to fill the identified research gap by analysing strengths, weaknesses, opportunities and threats of the three selected automation innovations through the SWOT analysis. The SWOT analysis is a technique that involves systematic thinking and comprehensive analysis of factors (both internal and external) (Amin, Yan, & Morris, 2018). In order to achieve this goal, the following research questions were addressed in this study:

1) What are the strengths of the selected automation innovations?
2) What are the weaknesses of the selected automation innovations?
3) What are the opportunities of the selected automation innovations?
4) What are the threats of the selected automation innovations?

After providing the theoretical background of transportation, Transportation Management Systems, maritime transportation and seaports with an emphasis on the economic aspect, authors have identified the strengths, weaknesses, opportunities and threats of the selected automation innovations through the SWOT analysis.

2 Theoretical background

Transport can be considered as the determining factor for economic development and growth (YlberLimani, 2016). Transportation represents the largest share of total logistics costs, and involves numerous stakeholders. Economic parameters that should be evaluated in the transport sector include the market access, connectivity, infrastructure capacity, trade competitiveness and transport costs (Psaraftis, 2019). If the transportation systems are efficient, they provide benefits in terms of reduced costs and competitive advantages (Rodrigue & Notteboom, 2020).

Transportation Management Systems (TMS) may be defined as platforms that provide insight into day-to-day transportation operations, trade compliance information and documentation, and ensure the timely delivery of cargo (Oracle, 2020). Furthermore, Transportation Management Systems enable streamlined shipping processes (FreightQuote by C. H. Robinson, 2019), improved management and optimization of the transportation operations (Oracle, 2020) as well as the improved planning and decision making (considering certain parameters) (AQT Solutions, 2019). Providing the value-added information services and analytics is increasingly important to maintain a competitive edge and to fulfill the regulatory requirements (Heilig & Voß, 2017).

Despite the numerous benefits that the Transportation Management Systems bring, certain disadvantages related to TMS exist. First of all, not all software systems are designed with the same features or service models, so it is possible to end up with a system that is not tailored to the needs of the company, and adapting to the specific requirements can be expensive (Oberg, 2020). Furthermore, Transportation Management Systems may lack a uniform data transferring capability and storage format in order to achieve data sharing and integration functionalities (Xu, Zhen, Li, & Yue, 2017).

Maritime transport is the backbone of the increasingly globalized economy and the international trade system (Du, Monios, & Wang, 2019). The maritime transport plays a substantial role in the supply chains worldwide since it ships a share of 80 per cent of the volume and 70 per cent of the value of goods traded globally (Bălan, 2020). Maritime shipping is a key sector in the economy, accounting for 90% of global economic trade (Longarela-Ares, Calvo-Silvosa, & Pérez-López, 2020). Given the large capacity of ships, deep-sea transport involves important economies of scale, making it a rather economic mode of transport (Reis & Macário, 2019). Over the last few decades, globalization and the container revolution, as well as the relationship of policy-oriented factors such as the elimination of trade barriers and the liberalization and deregulation of markets have transformed the port and shipping industry, consequently, driving radical changes in economic growth (Gonzalez-Aregall, Bergqvist, & Monios, 2019).

A seaport is the main node of maritime transport (Kotowska, Mańkowska and Pluciński, 2018), the nerve of foreign trade of a country ("Relevance Of Major And Minor Ports In International Trade – iPleaders," 2016), involves a large number of stakeholders (Heilig, Schwarze, & Voss, 2017) and plays an important role in guaranteeing efficient and safe cargo flows in global logistics networks (Heilig et al., 2017). Seaborne trade volumes are growing and the resulting traffic load on the road infrastructure in port areas calls for new solutions to improve handling and coordination of vehicles and shipments (Hofmann & Branding, 2019). Seaports have to continuously improve their operations, both commercial and administrative, in order not only to optimize their business but also to achieve sustainable growth in cargo volumes (Tijan, 2012). Furthermore, involved stakeholders have multiple shared and conflicting aims, which evolve over time and must be considered when negotiating and planning current and future priorities (Thorisson, Alsultan, Hendrickson, Polmateer, & Lambert, 2018).

Seaports are the key for the support of economic activities in the surrounding areas (Gherghina, Onofrei, Vintilă, & Armeanu, 2018), and may be defined as one of the main factors of economic growth (Irannezhad, Hickman, & Prato, 2017). As trade and cargo volumes continue to grow internationally, seaports around the globe are looking to new technologies to help manage resources in a more cost-effective manner (GreenPort, 2016). A seaport's sustainable operation is related to the cooperation with logistics actors outside the port perimeter and an integrated approach to port infrastructure and resource planning (Psaraftis, 2019). Government, customers, and other involved stakeholders are the main actors that encourage companies to incorporate sustainability factors into their supply chain management schemes (Denktas-Sakar & Karatas-Cetin, 2012). Vessel Estimated Time of Arrival, one of the selected automation innovations, is a software-based innovation aimed at predicting the arrival and departure time of a ship with high precision, increasing the efficiency of port operations. The solution is based on the integration of data sources and Machine Learning algorithms. Another selected automation innovation, Maritime Transport Chain has been developed to meet the need for increased efficiency of the transport operations. Since numerous stakeholders in maritime transport and seaports exist, this innovation may improve the communication and information exchange.

In terms of automation, since the introduction of automated stacking cranes at the European Container Terminal in Rotterdam in 1990, automation in seaports has progressed steadily and developed into almost all terminal functions (Notteboom, 2017). The extent of automation ranges from remote controlled operations under safe and efficient conditions to fully autonomous terminal operations (Notteboom, 2017). Seaports have adopted automation more slowly compared to other sectors, although the pace is now starting to accelerate (Chu, Gailus, Liu, & Ni, 2018).

A lack of research and scientific papers offering a comprehensive overview of the economic aspects of selected automation innovations in the transport sector is particularly pronounced. To overcome this research gap and to provide a better understanding of the existing and possible impacts of selected automation innovations, the authors have conducted the SWOT analysis of the selected automation innovations.

3 Methodology

Based on the preliminary literature review and the authors' experience in several scientific and commercial projects related to digitalization in transport (most notable being DigLogs – Digitalising Logistics processes ("Digitalising Logistics processes (DigLogs)," 2019), Electronic Transportation Management System ("Electronic Transportation Management System – e-TMS," 2019), and Information management in seaport clusters ("Information management in seaport clusters," 2017)), the authors have decided to analyze the following automation innovations in transport: Maritime Transport Chain solution, Vessel Estimated Time of Arrival solution and Delivery Planning solution. The aforementioned innovations have been singled out according to the votes of DigLogs project partners.

The authors have decided to further analyze the innovations and started with the inclusion criteria by using a combination of search words (considering the title, abstract and keywords):

- Maritime Transport Chain,
- Maritime Transport Chain AND economic aspects,
- Maritime Transport Chain AND economic influence,
- Vessel Estimated Time of Arrival,
- Vessel Estimated Time of Arrival AND economic aspects,
- Vessel Estimated Time of Arrival AND economic influence,
- Delivery Planning,
- Delivery Planning AND economic aspects,
- Delivery Planning AND economic influence.
- Transportation Management System,
- economic aspects AND automation innovations,
- economic influence AND automation innovations,
- economic aspect AND automation innovations AND transport,
- economic influence AND automation innovations AND transport,
- automation innovations AND maritime transport.

The search for articles was conducted according to the set time limitations (2014-2020) and mostly included journal articles and conference papers. Web of Science, Scopus, Google Scholar and SpringerLink's databases were used for this purpose. To ensure that the possible useful findings from various fields were not excluded, the authors did not limit the queries to a specific field or index.

Figure 1 shows the research areas within the Web of Science database where the search words: Maritime Transport Chain, Vessel Estimated Time of Arrival and Delivery Planning were detected, considering all fields. The following Web of Science Categories were selected: Transportation and Transportation Science Technology.

The total number of hits for the selected search words was 477. The largest number of papers belong to the Transportation area, followed by the Engineering area, and the Business economics area. This presents a research gap – the economic aspects of selected innovations are not properly addressed in the current literature, and justifies the need to conduct a deeper research into the economic aspects of automation innovations in electronic Transportation Management Systems.

After analyzing the papers regarding the automation innovations in the databases, the impacts of the selected automation innovations have also been analyzed through the several cases. For that purpose, the authors have also analyzed web pages, press articles and other relevant sources related to automation innovations in the transport sector.

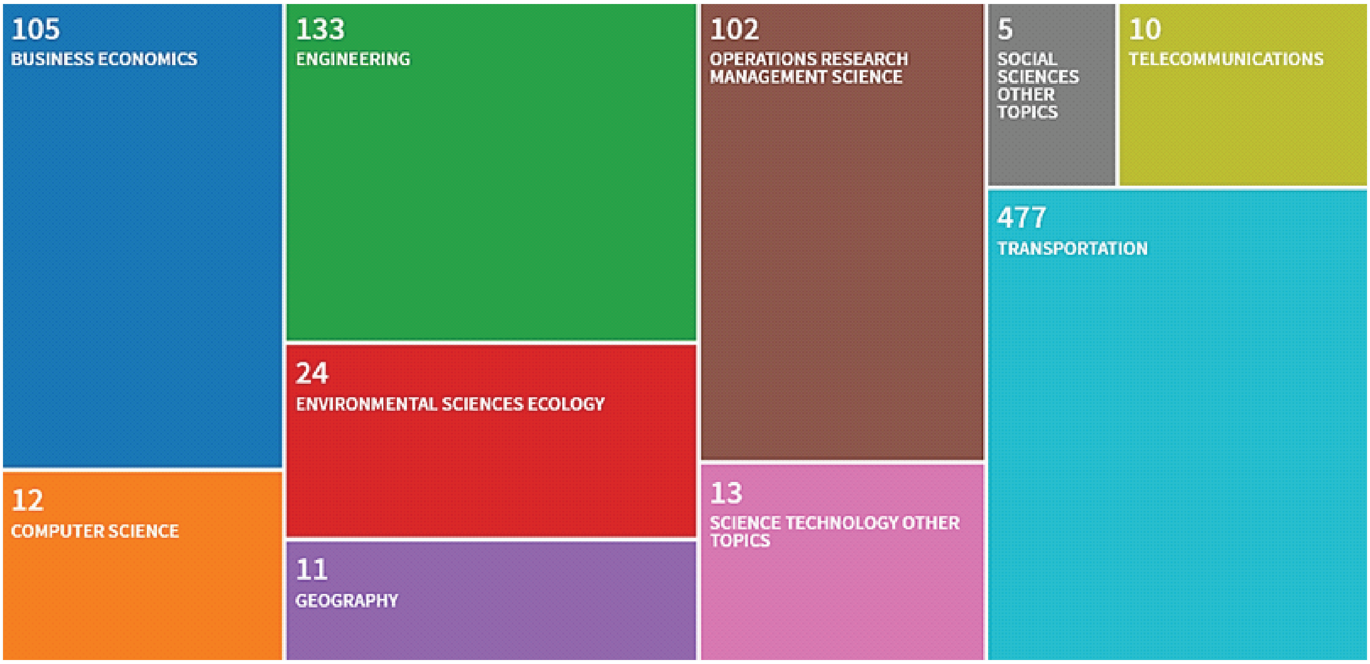

Figure 1 Research areas where the search words: Maritime Transport Chain, Vessel Estimated Time of Arrival and Delivery Planning were detected

4 Swot analysis of automation innovations

Transport companies recognize that developments in technology and innovation (including automation) will be key to building a safe, successful and sustainable industry in the future (Material Handling and Logistics, 2018). Automation has been applied in various ways in the transportation industries (Britannica, 2020). In this respect, the authors have focused on the innovations that may be utilized for handling different processes in maritime transport and transport in general, which will be explained below. In order to develop the successful strategies regarding the implementation of automation innovations, all aspects of the selected innovations (strengths, weaknesses, opportunities and threats) must be considered through the SWOT analysis (Nezhad et al., 2020). The selected automation innovations are: Maritime Transport Chain solution, Vessel Estimated Time of Arrival solution and Delivery Planning solution.

4.1 Maritime Transport Chain solution

The Maritime Transport Chain solution, which stems from the need for increased efficiency of transport processes, can be observed as a fully interconnected system in which all parts (links in the chain) must be closely interconnected. In other words, if one part of the system does not work properly, it can negatively affect the entire system. Maritime Transport Chain solution may be defined as a digital network through which carriers, ports and freight forwarders are interconnected in the movement of goods (Tradelens, 2020). Major challenges are related to the harmonization of the different parts of the network, which can have a high degree of inhomogeneity regarding the processes and tools. Being a wide-scale innovation, implementation benefits can easily spread to many actors in the transport chain. For example, the Maritime Connectivity Platform is one of the Maritime Transport Chain solutions (Figure 2). The Platform connects all maritime stakeholders with maritime information services of all kinds and enables the interoperability and transition between the existing and future communication and information systems (EffiecienSea, 2020).

Another example of the Maritime Transport Chain solution is the Awake Platform (Awake.AI, 2020). The platform brings all maritime logistics actors together to plan operations and achieve sustainability goals by reducing emissions and enabling optimization of different processes within the maritime sector. The platform is an open and collaborative platform, a single place for information trusted by all maritime logistic actors (Awake.AI, 2020).

Despite the evident benefits, it was necessary to analyze the potential negative perspectives of this innovation. In this respect, the authors have conducted a SWOT analysis of the Maritime Transport Chain solution:

Strengths: Timely information (such as estimated time of arrival messages) may reduce overall costs since it positively affects the utilization of existing transport capacity while terminals may decrease their reshuffling times per container (Elbert & Walter, 2014). Enhanced predictability of operations related to a port call as well as reduced turnaround and waiting times for carriers (vessels, trains, etc.) affect cost reduction as well (UNCTAD, 2018). "On average, players in the maritime transport chain who exchange high-quality information assess their company performance significantly better and at the same time claim to have increased their customer satisfaction to a higher degree than companies without such an exchange of information" (Elbert & Walter, 2012). One of the strengths of the Maritime Transport Chain solutions is the possibility of integration with the disruptive technologies, such as the blockchain, Internet of Things, etc. (DigLogs project, 2020). Blockchain, as a distributed electronic ledger system (present in the transport chain), enables decentralization, real-time peer-to-peer operation, transparency etc. (Fry & Serbera, 2020), (Javed et al., 2020), which further reduces overall costs in the long run. Internet of Things (IoT) is increasingly present in the transportation chain, either as smart sensors, controllers, embedded devices in cargo manipulation machines and even ship themselves (Muñuzuri, Onieva, Cortés, & Guadix, 2020).

Weaknesses: One of the weaknesses of Maritime Transport Chain solutions is the complexity: for example, the necessary modifications (regarding the implementation of innovations and new technologies) depend on numerous factors, such as the maturity of the existing technical solutions, which can ultimately result in high investment costs. Furthermore, due to a large number of involved stakeholders in the maritime transport chain, it is necessary to implement a set quality standard and to measure the dimensions of quality in all aspects of maritime policy, taking into account all the factors that define maritime transport services (Šamija, Kolanović, & Dundović, 2015). The existence of conflicts between interests of different parties in the whole process slow down the effective collaboration among all stakeholders (Liu & Wang, 2019), which slows down the execution of the business process and consequently increases costs due to unnecessary delays. Due to the specifics of maritime transport, the weaknesses that are present in any planning and implementation of technological solutions are very similar: the lack of interoperability and/or standardization: not all stakeholders implement the same technology solutions and platforms or use the same networks (CLECAT, 2017b), (European Commission, 2018), which also increases the overall costs.

Opportunities: Fuel is the single largest running expense for any ship owner, and a Maritime Transport Chain solution may enable ship captains to optimize their voyages to save time, fuel and money (SeaFocus, 2016). The vessel master will receive the information regarding the port availability and can thus optimize the vessel route and speed ("Taking maritime transport into the digital age," 2020), which will consequently reduce fuel costs. Low fuel costs can offset low transportation tariffs in the market. Seaports can obtain up-to-date data on all ships and can plan their resources accordingly (Sea Traffic Management, 2013), thus reducing unnecessary resource costs. One of the opportunities that the Maritime Transport Chain solutions can provide is the increased efficiency and streamlined administrative procedures: by sharing information, all parties using the Maritime Transport Chain solution can improve their operations and reduce costs. Furthermore, cargo can move more speedily through the maritime logistics chain ("Taking maritime transport into the digital age," 2020). Digitalization will spur automation, lead to the further technological development (such as the smart ships) and positively impact safety and environmental performance. Digitalization has also enabled more far-reaching concepts, such as the Big data, Internet of Things, blockchain and cloud computing, which can pro-

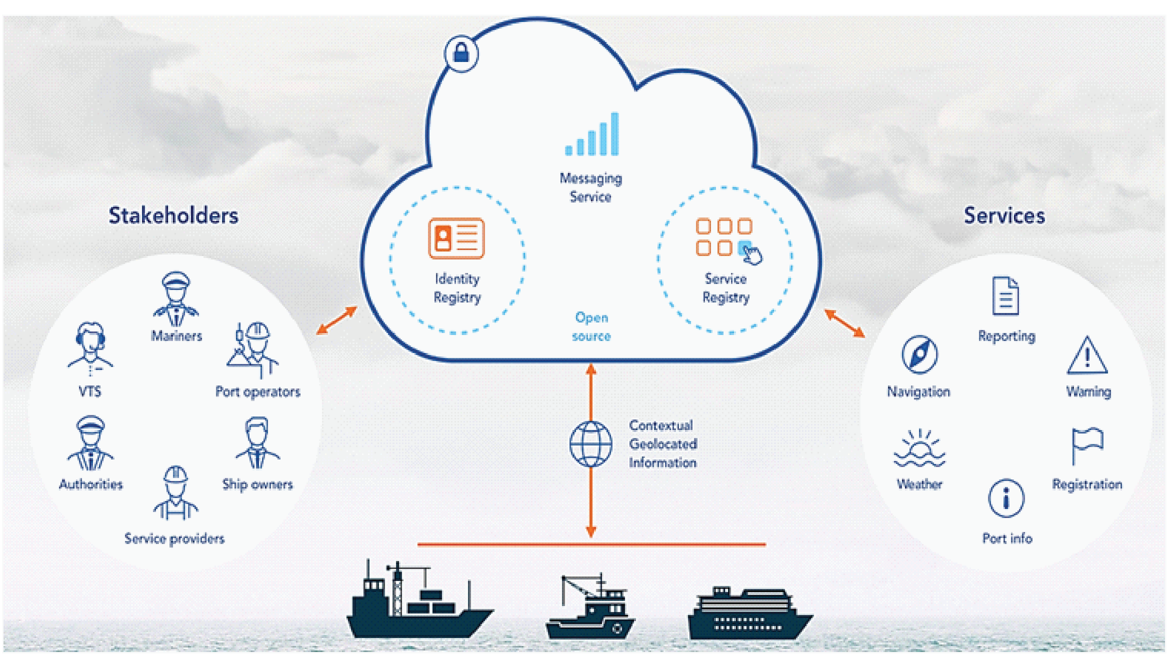

Figure 2 Maritime Connectivity Platform (EffiecienSea, 2020)

vide the shipping industry with new ways to collect, process and exchange valuable data in real time (European Council for Maritime Applied R&D, 2017), which will provide the opportunity for further cost reduction in the long run. Furthermore, the evolution of IoT and the use of Big Data creates the prospect of logistics and transport becoming data-centric industries, where information takes precedence in logistics services' value propositions over the actual ability to move cargo (Notteboom, 2017). Future prospect anticipated through the more efficient use of collected data is a higher level of cooperation between the actors in a transport operation or supply-chain, which provides real-time information, enabling cost savings (Giusti, Manerba, Bruno, & Tadei, 2019).

Threats: One of the threats for the successful implementation of the Maritime Transport Chain solutions is the lack of stakeholder cooperation: information sharing between stakeholder in the maritime transport chain is reported to be very conservative and limited to data exchange on cargo and related documentation required by country-specific legislation (Pahl & Voß, 2017). Another important threat for the successful implementation of the Maritime Transport Chain solutions, which is common for any digital transformation or a digitalization process, is the employee's resistance (Kozak-Holland & Procter, 2019), and there will also be a need to retrain employees in order to successfully utilize the innovative technologies or services. This will require additional investments, but in the long run, the costs will be reduced. Other identified threats are the lack of organizational agility (Kwon & Park, 2017), (work reorganization is necessary in order to better adapt to new requirements), absence of adequate infrastructure and poor access to funding (Verina & Titko, 2019).

4.2 Vessel Estimated Time of Arrival solution

Estimated time of arrival (ETA) is a transport term that determines the remaining time at which aircraft, cars, vessels, or emergency services will reach their destination (Shiphub, 2020). The Vessel Estimated Time of Arrival solution may be defined as a monitoring tool which can provide the carriers a better indication of whether their vessel arrival will be achieved on-time. This can serve as an indication of whether the vessel needs to speed up to meet the deadline, or if there is room for slowing down, thus saving on fuel (Parolas, 2016). A seaport with the implemented ETA solution is able to predict the arrival time of a vessel to a specific berth location with high precision, thus increasing the port efficiency. Several Vessel Estimated Time of Arrival solutions already exist such as ETA Monitoring Service (EMS), which can provide a valuable tracking service – an indispensable tool for keeping track of a vessel's location and monitoring its ETA (Hermess, 2020). The vessel's ETA is continuously updated throughout the voyage as new weather or position data is received (Hermess, 2020). Port of Rotterdam uses a Shiptracker, an online tool which provides real-time estimated time of arrival. Shiptracker is based on Automatic Identification System (AIS), big data and machine learning algorithms (Port of Rotterdam, 2020). (Alessandrini, Mazzarella, & Vespe, 2018) have included both AIS and Long-Range Identification and Tracking historical maritime traffic data collected over a desired area of interest. The solution is based on an optimized data-driven path-finding algorithm. The Vessel Estimated Time of Arrival solution provides numerous benefits and possibilities; however, the negative aspects of this innovation exist as well. The following is the SWOT analysis of the ETA solution:

Strengths: ETA solution increases port operational efficiency and safety (Alessandrini et al., 2018). The ETA solution optimizes arrival and departure processes, helps stakeholders to avoid delays and to provide customers with better estimations of delivery time ("Improving accuracy on Calculated ETA," 2019). Strong connections with customers and reliable data may enable the profitability of the company. The ETA solution enables planning of operations at all levels and departments, both for the seaport and the shipping companies. It enables the stakeholders in the transport chain to intervene in case of disruptions, to and reduce idle times idling, which lead to unnecessary costs. This results in more efficiency for everyone: for example, ramp operators know when to expect the incoming transports and are able to ensure an efficient and balanced use of their resources, haulers reduce long and unproductive waiting times at ramps, and shippers avoid contractual penalties, while maintaining a high service quality (PTV group, 2020). The ETA solution is a long-term cost-effective supply chain optimization solution that can be implemented in weeks (Savi, 2016). The following are the various strengths of the ETA solution related to each stakeholder; Shipping companies: shorter port call turnaround times, better predictability, lower bunker and charter costs (Port of Rotterdam, 2019). Terminals: better terminal capacity utilization by improving the turnaround times and by reducing waiting times (Port of Rotterdam, 2019). Agencies: more time for services to clients thanks to the clear and streamlined communication and fewer telephone calls to ask for updates (Port of Rotterdam, 2019). Port Authorities: increased predictability and cargo volume, (Port of Rotterdam, 2019), which ultimately leads to higher earnings.

Weaknesses: The potential weaknesses of the ETA solution are the possible high investment costs and vulnerability (the solution can be hacked). Furthermore, although the real-time monitoring is already possible, further improvements are needed in the area of monitoring of the entire journey of goods, and in the area of forecasting further movement, especially in case of large disturbances (RailNetEurope, 2019). Besides, the quality of the forecast data depends on the quality of the input data (RailNetEurope, 2019), and the vessel ETA is often unreliable because it is manually input (Alessandrini et al., 2018). Sufficient accuracy is not guaranteed as the speed of the ship is affected by a number of environmental factors (Shin et al., 2020). Although ship operators must notify the Estimated Time of Arrival at predetermined time intervals, they often have to update the latest ETA due to unforeseen circumstances. This causes a number of inconveniences that often affect the efficiency of terminal operation, especially in a daily planning scenario (Pani, Vanelslander, Fancello, & Cannas, 2015), which implies the cost increase.

Opportunities: One of the opportunities that the ETA solution can provide is the better accuracy of data which cannot only help stakeholders to improve forecasting and reduce unnecessary costs, but can help the customers and business in general. Furthermore, this innovation can enable more informed decisions, smarter preparation and improved operations ("Improving accuracy on Calculated ETA," 2019). Another opportunity that the ETA solution can provide is the improved customer service by providing a precise and reliable time of arrival estimation. Furthermore, a realistic ETA given sufficiently ahead of time may allow to re-plan downstream operations or to launch substitute deliveries ("Estimated time of arrival Challenges within a complex logistics chain," 2017). Through the combination of Big Data, supply chain analytics, and other advanced technologies, it is possible to obtain complete transparency within the supply chain due to the real-time, dynamic operational intelligence that provides the accurate shipment ETAs – enabling stakeholders to plan for and to respond to supply chain challenges and disruptions (Savi, 2016). Further investigation of the patterns in the data related to sudden stops of the vessels might enable better prediction, while applying machine learning algorithms to the location and ice condition data could enable beneficial predictive analytics for winter navigation for both fully-manned and unmanned vessels (Jussila, Lehtonen, Laitinen, Makkonen, & Frank, 2015). Enhanced ETA information can improve capacity management, reduce risk buffers and increase resource utilization (Balster, Hansen, Friedrich, & Ludwig, 2020), and all this may further reduce the costs.

Threats: The misleading estimates can increase waiting times and decrease employee utilization, which also implies cost increase. The majority of challenges of the ETA solution can be observed in the technological aspects. A standard international voyage can take more than 30 days, and the data collected during this journey may be overwritten and not extracted and saved on an external device. On short voyages, the data may also be deleted after the voyage or during the upcoming voyage, thus becoming inaccessible for a long term analysis (Koga, 2015). Furthermore, the traditional toolsets are no longer sufficient, as well as the offered bandwidth for the high seas communication (Mirović, Miličević, & Obradović, 2018). Besides, unauthorized individuals can willfully insert, delete or update information in order to reach economic advantages or to disguise illegal activities (Windward, 2014).

4.3 Delivery planning solution

Delivery Planning is an innovative IT solution which enables better planning of cargo deliveries based on the real-time information and predicted traffic conditions. This tool is a specialized Decision Support System that calculates and suggests routes by processing normalized real-time data coming from external sources and systems used by the port community. It can be based on Big Data and Port Community Systems (which may be defined as platforms which enable intelligent and secure exchange of information between stakeholders and optimize the business processes through a single submission of data) ("Port Community Systems," 2019). For example, Navigate, the new journey planner for container transport developed by the Port of Rotterdam Authority, allows any entrepreneur to quickly determine and plan an optimized transport route online (Port of Rotterdam, 2017). This journey planner offers different options based on the selected point of departure and desired destination. Each itinerary specifies the various sea shipping, rail and/or inland shipping connections through which the container can reach its destination (Port of Rotterdam, 2017).

Similar to the other innovations explained above, the Delivery Planning Solution has to be analyzed both from the positive and the negative perspectives. In this respect, the SWOT analysis of Delivery Planning solution is conducted:

Strengths: The strength is visible through the reduced number of necessary vehicles, reduction of overall total time for delivery and fuel consumption (Galić, Carić, & Fosin, 2013), which consequently reduces costs. One of the strengths of the Delivery Planning solution is the ability to easily connect to the existing Port and Maritime information systems (with a suitable interface). Harmonious systems should be implemented in order to achieve greater visibility and a lower occurrence of errors of the overall supply chain. This will eventually result in lower total costs for the organization, even beyond the transportation costs (Cerasis, 2018). Another strength of the Delivery Planning solution is the automatic suggestion or selection of travel routes before the trip and even during the trip, considering the various factors such as the traffic, etc. (Fixlastmile, 2019). Furthermore, the solution enables the improved coordination among stakeholders: its value includes such benefits as reduced paperwork, improved accuracy, timely information receipt, and reduced inventories (Masudin & Kamara, 2017). By saving the time needed to complete business processes, all stakeholders operating in the maritime transport sector could achieve significant financial savings.

Weaknesses: The data quality depends on the frequency of data collection and the quality of sources. It may include data such as the traffic conditions, weather data, cargo data, etc. Lower data quality may increase costs and delivery time. Furthermore, most of the monitoring technologies of the goods transportation still have some defects and shortcomings, such as the monitoring information is confined to the positioning and geographical information of the goods or vehicles without the physical status sensing during the transport procedure (Xu et al., 2017). Furthermore, many types of the Transportation Management Systems (delivery planning) are independent from each other, so that they lack a uniform data transferring and storage format to achieve the data sharing and integration (Xu et al., 2017). This may increase costs, reducing the competitiveness of seaports and shipping companies. One of the weaknesses of the Delivery Planning solution is the insufficient quality of data sources: good quality data sources are needed in order to obtain the useful data for more efficient planning processes. This includes creating an interface for acquisition of the data from the existing sources. Other potential weaknesses of Delivery Planning solutions may be: high implementation and maintenance costs and vulnerability (inherent characteristics of the information system used for Delivery Planning solution can be exploited to compromise the system and gain unauthorized access).

Opportunities: One of the opportunities that the Delivery Planning solution may provide is the use of smartphone logistics apps: not only can the smartphone logistics manager track the location of mobile goods with ease, but it can receive real-time alerts that inform stakeholders of unexpected events (Sigfox, 2020). If, for example, a truck carrying important cargo gets stuck in traffic, or travels away from a pre-determined route, the smart logistics app will issue an alert that informs the manager about the delay and provides a new estimated arrival time. Likewise, if a container traveling by ship or rail is delayed, the manager will be informed about the event in real time, instead of having to wait until it arrives late at its next destination (Sigfox, 2020). Furthermore, the solution can speed up the planning and integration with the existing systems, reduce the driving times and missed deliveries with the selection of the most efficient routes (OptimoRoute, 2020). The solution may also minimize the costs through reducing the distance driven, decreasing fuel consumption and reducing vehicle servicing and maintenance (Descartes, 2020).

Threats: One of the threats for the successful implementation of the Delivery Planning solution is the limited infrastructure: when the cargo travels through areas with limited infrastructure, tracking becomes difficult (Sigfox, 2020). Another threat is the occurrence of unexpected events during the delivery process, such as the violation of handling requirements, which may cause damage to the cargo (for example, food ripening) (Tsang, Wu, Lam, Choy, & Ho, 2020), thus increasing costs. Furthermore, situations that cannot be predicted in advance may occur, such as traffic congestions. If the solution does not work properly, logistics managers will not be able to find out about delayed or misrouted cargo until this cargo arrives hours late – or not at all – at the destination. In this respect, the results will be the reduced productivity, delayed production and damaged client relationships (Sigfox, 2020).

5 Conclusion

Maritime transport and seaports are an important part of the economy, and definitely affect the development of economic activities. Due to the globalization and the increase of cargo volumes, there is a growing need for new technologies to improve transport efficiency and to keep the operating costs as low as possible. Electronic Transportation Management Systems represent one of these technologies and enable simplified and improved shipping processes, providing numerous economic benefits. Since e-TMS's have certain shortcomings such as the lack of a uniform data transferring capability, automation innovations can positively affect their performance. However, despite numerous benefits and possibilities that the automation innovations provide, it was also necessary to analyze their negative aspects, i.e. the weaknesses and threats.

The authors have singled out and analyzed the following automation innovations in the transport sector, according to the set time limitations (2014-2020): Maritime Transport Chain solution, Vessel Estimated Time of Arrival solution and Delivery Planning solution. In relation to the total number of hits for the selected search words (Maritime Transport Chain solution, Vessel Estimated Time of Arrival solution and Delivery Planning solution) in the Web of Science database, the economic aspects were ranked third. In this respect, the authors concluded that the economic aspects of selected automation innovations have not been properly addressed, presenting a research gap and justifying the need to research the three selected automation innovations from the economic point of view. The authors have filled the identified research gap (a lack of research and scientific papers offering a comprehensive overview of the economic aspects of selected automation innovations in the transport sector) by analyzing strengths, weaknesses, opportunities and threats of the three selected automation innovations.

Maritime Transport Chain solutions, as one of the selected automation innovations, provide numerous benefits and opportunities such as reduced costs, high quality and timely information, etc. Furthermore, the automation can spur the development of smart ships and positively affect the environmental performance. On the other hand, the weaknesses such as existence of independent technology solutions and the complexity may increase costs and reduce the competitiveness of seaports and shipping companies. Another automation innovation, Vessel Estimated Time of Arrival solutions enable the improved planning of business processes, as well as the reduction of delays and costs in the long run. However, the identified weaknesses are the high investment costs and vulnerability. Besides, if the accuracy of the data used as a basis for estimates is not accurate, misleading estimates can increase waiting times and reduce employee utilization, leading to increased costs. Delivery Planning solutions decrease transport time and the emission of polluters, etc. On the other hand, when the cargo deliveries pass through areas with limited infrastructure, tracking becomes almost impossible.

This research has proven that the weaknesses of automation innovations exist, and the negative aspects are present. However, automation innovations in e-TMS will be upgraded over time, minimizing the weaknesses and threats and enabling numerous benefits such as cost reduction, improved use of resources and improved planning (which can also further reduce the costs). This research was only based on the literature review, and considers only three selected automation innovations which were the main research limitations. It offers only the initial overview of the importance of automation innovations in e-TMS from the economic aspect. Future research will include other automation innovations in order to obtain a broader insight of their economic impacts on e-TMS.

Acknowledgment

This work was supported by University of Rijeka under the Faculty of Maritime Studies projects, by Electronic Transportation Management System e-TMS project (New products and services as a result of research, development and innovation-IRI, Operational Programme Competitiveness and Cohesion, 2018–2020), and by "DigLogs–Digitalising Logistics Processes" (Interreg V-A Italy–Croatia 2014-2020) project.

References

[1] Acciaro, M., & Sys, C. (2020). Innovation in the maritime sector: aligning strategy with outcomes. Retrieved July 21, 2020, from https://www.tandfonline.com/doi/full/10.1080/03088839.2020.1737335?scroll=top&needAccess=true.

[2] Alessandrini, A., Mazzarella, F., & Vespe, M. (2018). Estimated Time of Arrival Using Historical Vessel Tracking Data. https://doi.org/10.1109/TITS.2017.2789279.

[3] Amin, S. H., Yan, N., & Morris, D. (2018). Analysis of Transportation Modes by Evaluating SWOT Factors and Pairwise Comparisons: A Case Study. Retrieved February 26, 2020, from https://www.researchgate.net/publication/326016808_Analysis_of_Transportation_Modes_by_Evaluating_SWOT_Factors_and_Pairwise_Comparisons_A_Case_Study.

[4] AQT Solutions. (2019). What is a TMS? Retrieved May 13, 2019, from http://www.aqtsolutions.com/what-is-a-transportation-management-system/.

[5] Awake.AI. (2020). Awake.AI launches Smart Port as a Service – the most comprehensive collaboration platform for maritime logistics. Retrieved October 29, 2020, from https://www.oneseaecosystem.net/awake-ai-launches-smart-port-as-a-service-the-most-comprehensive-collaboration-platform-for-maritime-logistics/.

[6] Bălan, C. (2020). The disruptive impact of future advanced ICTson maritime transport: a systematic review. Supply Chain Management: An International Journa, 25(2), 157-175.

[7] Britannica. (2020). Transportation. Retrieved October 30, 2020, from https://www.britannica.com/technology/automation/Transportation.

[8] Cerasis. (2018). The Transportation Supply Chain: Transportation's Role in Supply Chain Management to Lower Total Costs. Retrieved May 15, 2019, from https://cerasis.com/transportation-supply-chain/.

[9] Choumert, D. (2017). Estimated time of arrival Challenges within a complex logistics chain. Retrieved February 1, 2020, from http://marketplaceseminar.org/IMG/pdf/s4-1_p-denis_choumert.pdf.

[10] Chu, F., Gailus, S., Liu, L., & Ni, L. (2018). The future of automated ports. Retrieved October 1, 2020, from https://www.mckinsey.com/industries/travel-logistics-and-transport-infrastructure/our-insights/the-future-of-automated-ports#.

[11] CLECAT. (2017). Digitalization in transport and logistics. Retrieved October 26, 2020, from https://www.clecat.org/media/Position paper CLECAT Digital Transport and Logistics_1.pdf.

[12] Denktas-Sakar, G., & Karatas-Cetin, C. (2012). Port sustainability and stakeholder management in supply chains: A framework on resource dependence theory. Asian Journal of Shipping and Logistics, 28(3), 301–319. https://doi.org/10.1016/j.ajsl.2013.01.002.

[13] Descartes. (2020). Route planning optimisation and dynamic scheduling software. Retrieved October 2, 2020, from https://routinguk.descartes.com/our-solutions/route-planning-and-scheduling.

[14] Digital Transport & Logistics Forum. (2018). Towards paperless transport within the EU and across its borders. Retrieved from http://ec.europa.eu/transparency/regexpert/index.cfm?do=groupDetail.groupMeetingDoc&docid=15358.

[15] Du, K., Monios, J., & Wang, Y. (2019). Green Port Strategies in China. In Green Ports, Inland and Seaside Sustainable Transportation Strategies (pp. 211-229). Elsevier. Retrieved from https://www.researchgate.net/publication/330047958_Green_Port_Strategies_in_China.

[16] EffiecienSea. (2020). Maritime Connectivity Platform. Retrieved October 29, 2020, from https://efficiensea2.org/solution/maritime-connectivity-platform/.

[17] European Commission. (2017). Connected and Automated Transport: Studies and reports. Retrieved October 26, 2020, from https://ec.europa.eu/newsroom/horizon2020/document.cfm?doc_id=46276.

[18] European Council for maritime Applied R&D. (2017). Maritime Technology Challenges 2030: New Technologies and Opportunities. Retrieved from https://www.ecmar.eu/media/1813/ecmar-brochure-maritme-technology-challenges-2030.pdf.

[19] Fixlastmile. (2019). Real Time Delivery Tracking Management Software. Retrieved January 31, 2019, from https://www.fixlastmile.com/features/.

[20] Freightquote. (2019). What is a Transportation Management System (TMS)? Retrieved May 13, 2019, from https://www.freightquote.com/define/what-is-transportation-management-system-tms.

[21] Fry, J., & Serbera, J.-P. (2020). Quantifying the sustainability of Bitcoin and Blockchain. Retrieved July 7, 2020, from http://shura.shu.ac.uk/25742/1/JEIM.pdf.

[22] Gausdal, A. H., Czachorowski, K. V., & Solesvik, M. Z. (2018). Applying Blockchain Technology : Evidence from Norwegian Companies. MDPI Sustainability, 10(6), 1985. https://doi.org/10.3390/su10061985.

[23] Gherghina, Ş. C., Onofrei, M., Vintilă, G., & Armeanu, D. Ş. (2018). Empirical evidence from EU-28 countries on resil-

ient transport infrastructure systems and sustainable economic growth. Sustainability (Switzerland), 10(8). https://doi.org/10.3390/su10082900.

[24] Giusti, R., Manerba, D., Bruno, G., & Tadei, R. (2019). Synchromodal logistics: An overview of critical success factors, enabling technologies, and open research issues. Transportation Research Part E: Logistics and Transportation Review, 129, 92-110.

[25] Gonzalez-Aregall, M., Bergqvist, R., & Monios, J. (2019). Port-Driven Measures for Incentivizing Sustainable Hinterland Transport. In Green Ports, Inland and Seaside Sustainable Transportation Strategies (pp. 193-210). Elsevier.

[26] González-Cancelas, N., Serrano, B. M., Soler-Flores, F., & Camarero-Orive, A. (2020). Using the SWOT Methodology to Know the Scope of the Digitalization of the Spanish Ports. Logistics (MDPI), 4(3).

[27] GreenPort | Smart and sustainable ports. (2019). Retrieved May 23, 2019, from https://www.greenport.com/news101/Projects-and-Initiatives/smart-and-sustainable-ports.

[28] Heilig, L., Schwarze, S., & Voss, S. (2017). An Analysis of Digital Transformation in the History and Future of Modern Ports, 1341–1350. https://doi.org/10.24251/HICSS.2017.160.

[29] Heilig, L., & Voß, S. (2017). Information systems in seaports: a categorization and overview. Information Technology and Management, 18(3), 179-201. https://doi.org/10.1007/s10799-016-0269-1.

[30] Hermess. (2020). Estimated ship arrival time service. Retrieved October 29, 2020, from http://www.hermess.nl/eta-monitoring-service/.

[31] Hofmann, W., & Branding, F. (2019). Implementation of an IoT- and Cloud-based Digital Twin for Real-Time Decision Support in Port Operations. IFAC-PapersOnLine, 52(13), 2104-2109.

[32] IPleaders. (2016). Relevance Of Major And Minor Ports In International Trade. Retrieved March 7, 2019, from https://blog.ipleaders.in/relevance-major-minor-ports-international-trade-2/.

[33] Irannezhad, E., Hickman, M., & Prato, C. G. (2017). Modeling the Efficiency of a Port Community System as an Agent-based Process. Procedia Computer Science, 109, 917-922. https://doi.org/10.1016/j.procs.2017.05.422.

[34] Jardas, M., Dundović, Č., Gulić, M., & Ivanić, K. (2018). The Role of Internet of Things on the Development of Ports as a Holder in the Supply Chain, 54, 61-73.

[35] Javed, M. U., Javaid, N., Aldegheishem, A., Alrajeh, N., Tahir, M., & Ramzan, M. (2020). Scheduling Charging of Electric Vehicles in a Secured Manner by Emphasizing Cost Minimization Using Blockchain Technology and IPFS. Sustainability, 12(12), 5151.

[36] Jović, M., Tijan, E., Aksentijević, S., & Žgaljić, D. (2020). Disruptive innovations in electronic transportation management systems. Retrieved October 26, 2020, from https://www.researchgate.net/publication/342599677_Disruptive_innovations_in_electronic_transportation_management_systems.

[37] Jović, M., Tijan, E., Žgaljić, D., & Karanikić, P. (2020). SWOT analysis of selected digital technologies in transport economics. Retrieved October 26, 2020, from https://www.researchgate.net/publication/344440791_SWOT_analysis_of_selected_digital_technologies_in_transport_economics.

[38] Koga, S. (2015). Major challenges and solutions for utilizing big data in the maritime industry. Retrieved August 6, 2019, from http://commons.wmu.se/all_dissertationshttp://commons.wmu.se/all_dissertations/490.

[39] Kotowska, I., Mańkowska, M., & Pluciński, M. (2018). Inland shipping to serve the hinterland: The challenge for seaport authorities. Sustainability (Switzerland), 10(10). https://doi.org/10.3390/su10103468.

[40] Kozak-Holland, M., & Procter, C. (2019). The Challenge of Digital Transformation. Retrieved December 12, 2019, from https://link.springer.com/chapter/10.1007/978-3-030-33035-4_1#citeas.

[41] Kwon, E. H., & Park, M. J. (2017). Critical factors on firm's digital transformation capacity: Empirical evidence from Korea. International Journal of Applied Engineering Research, 12(22), 12585-12596.

[42] Longarela-Ares, Á., Calvo-Silvosa, A., & Pérez-López, J.-B. (2020). The Influence of Economic Barriers and Drivers on Energy Efficiency Investments in Maritime Shipping, from the Perspective of the Principal-Agent Problem. Sustainability, 12(19).

[43] MarineTraffic. (2019). Improving accuracy on Calculated ETA. Retrieved January 2, 2020, from https://www.marinetraffic.com/blog/improving-accuracy-on-calculated-eta/.

[44] Masudin, I., & Kamara, M. S. (2017). Electronic Data Interchange and Demand Forecasting Implications on Supply Chain Management Collaboration: A Customer Service Perspective. Jurnal Teknik Industri, 18(2), 138. https://doi.org/10.22219/jtiumm.vol18.no2.138-148.

[45] Material Handling and Logistics. (2018). Automation to Define Future of Transport But There are Obstacles. Retrieved October 30, 2020, from https://www.mhlnews.com/transportation-distribution/article/22055320/automation-to-define-future-of-transport-but-there-are-obstacles.

[46] Mei, J., & Afli, E. M. K. (2017). Supply Chain Management : the Effectiveness of, 5(2), 1-9.

[47] Mirović, M., Miličević, M., & Obradović, I. (2018). Big data in the maritime industry. Nase More, 65(1), 56–62. https://doi.org/10.17818/NM/2018/1.8.

[48] MONALISA project. (2020). Taking maritime transport into the digital age. Retrieved February 2, 2020, from http://www.sjofartsverket.se/pages/36039/MONALISA 2_0 web.pdf.

[49] Mosconi, E., Packmohr, S., & Santa-Eulalia, L. A. De. (2019). Making Digital Transformation Real, (January).

[50] Muñuzuri, J., Onieva, L., Cortés, P., & Guadix, J. (2020). Using IoT data and applications to improve port-based intermodal supply chains. Retrieved October 1, 2020, from https://reader.elsevier.com/reader/sd/pii/S0360835219300488?token=A8C12352B6340A7FA489D109DE798CB9E85E3BFADD3B7B490714E0ECEACA90FF129F4054128ADB9EA-2F276A749E8BA1B.

[51] Nezhad, M. M., Shaik, R. U., Heydari, A., Razmjoo, A., Arslan, N., & Garcia, D. A. (2020). A SWOT Analysis for Offshore Wind Energy Assessment Using Remote-Sensing Potential. Applied Sciences, 10(18).

[52] Oberg, E. (2020). 4 Advantages and Disadvantages of Transportation Management Systems.

[53] OptimoRoute. (2020). Efficient Retail & Distribution Route Planning for Small and Large Fleets. Retrieved October 2, 2020, from https://optimoroute.com/business-type/retail-distribution/.

[54] Oracle. (2020). What Is a Transportation Management System? Retrieved October 1, 2020, from https://www.oracle.

com/applications/supply-chain-management/what-is-transportation-management-system.html.

[55] Osés, F. X. M. de, & Sanabra, M. C. i. (2020). Maritime Transport VIII. Retrieved October 1, 2020, from https://www.researchgate.net/publication/344284994_MARITIME_TRANSPORT_VIII.

[56] Parolas, I. (2016). ETA prediction for containerships at the Port of Rotterdam using Machine Learning Techniques. Retrieved May 10, 2020, from https://repository.tudelft.nl/islandora/object/uuid:9e95d11f-35ba-4a12-8b34-d137c0a4261d/datastream/OBJ/download.

[57] Port of Rotterdam. (2017). How to plan the best route for your container. Retrieved October 30, 2020, from https://www.portofrotterdam.com/en/news-and-press-releases/how-to-plan-the-best-route-for-your-container.

[58] Port of Rotterdam. (2019). Pronto. Retrieved January 31, 2019, from https://www.portofrotterdam.com/en/tools-services/pronto.

[59] Position Paper Digitalization in transport and logistics. (2017). Retrieved from https://www.unece.org/fileadmin/DAM/trans/conventn/cmr_e.pdf.

[60] PTV Group. (2020). Boost the transparency of your supply chain with ETA from PTV Drive&Arrive. Retrieved October 30, 2020, from https://www.ptvgroup.com/en/solutions/products/ptv-driveandarrive/.

[61] RailNetEurope. (2019). Estimated Time of Arrival (ETA PROGRAMME). Retrieved January 31, 2019, from http://rne.eu/tm-tpm/estimated-time-of-arrival/.

[62] Reis, V., & Macário, R. (2019). Understanding the freight transport sector. In Intermodal Freight Transportation (pp. 13-41). Elsevier.

[63] Savi. (2016). Estimated Time of Arrival-as-a-ServiceTM (ETAaaS). Retrieved January 2, 2020, from http://www.savi.com/wp-content/uploads/Savi_ETAaaS_Datasheet.pdf.

[64] Sea Traffic Management. (2013). MONALISA 2.0 – Enhanced Maturity in Information and Communication Technology. Retrieved October 28, 2020, from https://www.seatraffic-management.info/news/monalisa-2-0-enhanced-maturity-in-information-and-communication-technology-ict/.

[65] Shiphub. (2020). ETD and ETA – What is it? Retrieved October 27, 2020, from https://www.shiphub.co/etd-and-eta-what-is-it/.

[66] Sigfox. (2020). The New IOT-Powered Supply Chain: How Smart Logistics Tracking is Creating a Leaner, More Agile Global Economy. Retrieved February 2, 2020, from https://www.sigfox.com/en/new-iot-powered-supply-chain-how-smart-logistics-tracking-creating-leaner-more-agile-global-economy.

[67] Springer International Publishing. (2019). Sustainable Shipping. (H. N. Psaraftis, Ed.), Sustainable Shipping: A Cross-Disciplinary View. Springer Nature Switzerland AG. https://doi.org/10.1007/978-3-030-04330-8_6.

[68] Theo Notteboom. (2017). The Future of Port Logistics: Meeting the Challenges of Supply Chain Integration. Retrieved August 6, 2019, from www.ing.be.

[69] Thorisson, H., Alsultan, M., Hendrickson, D., Polmateer, T. L., & Lambert, J. H. (2018). Addressing schedule disruptions in business processes of advanced logistics systems. Retrieved October 1, 2020, from https://onlinelibrary.wiley.com/doi/full/10.1002/sys.21471.

[70] Tijan, E. (2012). ICT Enablement of Administrative Processes in Croatian Seaports. In Bled eConference eDependability: Reliable and Trustworthy eStructures, eProcesses, eOperations and eServices for the Future. Retrieved from https://www.researchgate.net/publication/287063148_ICT_enablement_of_administrative_processes_in_Croatian_seaports.

[71] Tradelens. (2020). Trade made easy. Retrieved October 27, 2020, from https://www.tradelens.com/.

[72] University of Rijeka, Faculty of Maritime Studies. (2017). Information management in seaport clusters. Retrieved May 20, 2020, from https://www.pfri.uniri.hr/web/en/projekti/aktivni/2017_-_Tijan_-_eng.pdf.

[73] University of Rijeka, Faculty of Maritime Studies. (2019a). Digitalising Logistics processes (DigLogs). Retrieved May 20, 2020, from https://www.pfri.uniri.hr/web/en/projekti/aktivni/04-2019/DigLogs-eng.pdf.

[74] University of Rijeka, Faculty of Maritime Studies. (2019b). Electronic Transportation Management System – e-TMS. Retrieved May 20, 2020, from https://www.pfri.uniri.hr/web/en/projekti/aktivni/01-2019/eTMS-EN.pdf.

[75] Verina, N., & Titko, J. (2019). Digital Transformation: Conceptual Framework. Retrieved February 28, 2020, from https://www.researchgate.net/publication/333066242_Digital_transformation_conceptual_framework.

[76] Windward. (2014). AIS Data on the High Seas: An Analysis of the Magnitude and Implications of Growing Data Manipulation at Sea. Retrieved August 6, 2019, from http://www.arbitrage-maritime.org/fr/Gazette/G36complement/Windward.pdf.

[77] Xu, K., Zhen, H., Li, Y., & Yue, L. (2017). Comprehensive Monitoring System for Multiple Vehicles and Its Modelling Study. Transportation Research Procedia, 25, 1824–1833. https://doi.org/10.1016/j.trpro.2017.05.160.

[78] YlberLimani. (2016). Applied Relationship between Transport and Economy. IFAC-PapersOnLine, 49(29), 123-128.

[79] Zaman, I., Pazouki, K., Norman, R., Younessi, S., & Coleman, S. (2017). Challenges and opportunities of big data analytics for upcoming regulations and future transformation of the shipping industry. Procedia Engineering, 194, 537-544. https://doi.org/10.1016/j.proeng.2017.08.182.