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Achieving Blue Economy goals by implementing digital technologies in the maritime transport sector

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ABSTRACT

This paper analyses how digital technologies implementation in the maritime transport sector companies can help in achieving the Blue Economy goals. Previous research offering a comprehensive overview of digital technologies in the maritime transport sector within the context of the Blue Economy is scarce. To fill this research gap, the economic effects of maritime transport are investigated, and the positive impacts of digital technologies on maritime transport are analyzed, all in the context of the Blue Economy. The authors have concluded that by implementing digital technologies in the maritime transport sector, the Blue Economy goals related to maritime transport (for example transport cost reduction, decreased harmful emissions generated during the voyage and at the berth) can better be achieved, etc.

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1 Introduction

Almost 80 percent of global trade in goods is transported by sea (Ababouch, 2015). Due to the increasing awareness of the importance of the oceans and the seas, the Blue Economy concept has emerged, encouraging more effective management of oceans or "blue" resources (The Commonwealth, 2020). The roots of Blue Economy emergence can be directly and strongly linked to the sustainable development concept. Since the 1960s, the scientific community has paid more attention to sustainable development, especially in environmental, economic, and social dimensions (Kabil, Priatmoko, Magda, & Dávid, 2021).

Blue Economy refers to the use of seas and coasts for economic activities (OpenChannels, 2019). According to (Bušljeta Tonković, 2013), the Blue Economy focuses on sustainability but is not limited to mere conservation. The Blue Economy goals are not only related to the economic development, but also to the sustainable use of the sea and oceans (Patil, Virdin, Diez, Roberts, & Singh, 2016), (Fontes, Sousa, & Conceição, 2019) while improving the quality of life and work and preserving ecosystems (The World Bank, 2017).

In recent years, an increasing number of companies in the maritime transport sector started to implement initiatives to explore new digital technologies and to exploit their potential (Matt, Hess, & Benlian, 2015). Digital technologies are important for business process simplification, cost reduction, and better use of resources and existing infrastructure (European Commission, 2018). In this respect, the increased implementation of digital technologies in the maritime transport sector may play an important role in achieving the Blue Economy goals.

After a preliminary literature review, the authors concluded that a lack of scientific papers researching how digital technologies in the maritime transport sector can assist in achieving the Blue Economy goals is particularly pronounced. To overcome this research gap and to provide a better understanding of how the implementation of digital technologies in the maritime transport sector can help in achieving the Blue Economy goals, authors have conducted a more comprehensive literature review, which is further explained in the Methodology section.

2 Theoretical framework

The Blue Economy lies at the basis of the future of human society because it aims at developing a sustainable and renewable economy, getting benefits from the ocean while reducing pollution and waste (Buono, Li, & Paes, 2021). According to the European Commission, the Blue Economy concept embraces "all economic activities related to oceans, seas, and coasts. It covers a wide range of interlinked established and emerging sectors" (Tianming et al., 2021). Blue Economy requires strong scientific information on the marine environment, detailed knowledge of the activities occurring in the ocean area, and a comprehensive understanding of the impact on the environment (Vega-Muñoz, Salazar-Sepulveda, Espinosa-Cristia, & Sanhueza-Vergara, 2021). The report "Toward a Blue Economy: A Promise for Sustainable Growth in the Caribbean" (Patil et al., 2016) has provided a conceptual framework of the Blue Economy (Figure 1).

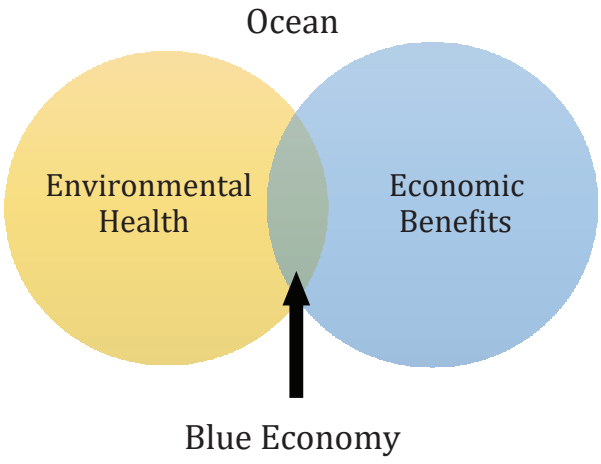

Figure 1 The Blue Economy—A Conceptual Framework (Patil et al., 2016)

They have defined a conceptual framework as follows: a sustainable Blue Economy emerges when economic activity is in balance with the long-term capacity of ocean ecosystems to support this activity and remain resilient and healthy (Patil et al., 2016).

Sustainable Development Goals (SDGs), which are also known as the Global Agenda 2030, are related to Blue Economy goals. The 14th Sustainable Development goal, "Conserve and sustainably use the oceans, seas and marine resources" seeks to promote the sustainable use and development of oceans, seas, marine resources, and ecosystems, which are the foundation of the Blue Economy approach and its economic sectors (Kabil et al., 2021). The Blue Economy can be a driver of European growth, through the development of new competencies and activities that enable sustainable exploitation of ocean resources (Fontes et al., 2019).

The Blue Economy spans through various sectors, one of them being maritime transport, which records continuous growth and includes numerous resources and numerous stakeholders (World Bank Group, 2016), (European Commission, 2019). With sustainable management of existing assets, including shipping and transportation, the Blue Economy concept has the potential to fulfill sustainable development goals (Choudhary et al., 2021).

From the above, the authors conclude that the goals of the Blue Economy are: economic use of the sea and oceans, preserving ecosystems, and improving the quality of life and work. In this respect, the definitions of sustainability, blue growth, and blue economy coincide, and in some studies, they are treated as synonyms such as in the research by (Cisneros-Montemayor et al., 2021), and (Vázquez, García, & Pablo, 2021).

3 Methodology

To enable a deeper analysis of how the implementation of digital technologies in the maritime transport sector can help in achieving Blue Economy goals, the authors have conducted a more comprehensive literature review. The search was performed by using a combination of keywords in the fields *Title*, *Abstract*, and *Keywords*: "Blue Economy", "Blue Economy AND maritime transport", "Blue Economy AND transport", "Blue Economy AND shipping", "Blue Economy AND innovations and maritime transport", "Blue Economy AND digital technologies AND maritime transport", "Blue Economy AND innovations AND shipping", "Blue Economy AND digital technologies AND shipping", "Blue Economy AND innovations AND seaports", "Blue Economy AND digital technologies AND seaports". Due to the pronounced lack of literature on the subject, the authors have used several databases to achieve a broad literature review: Web of Science, Scopus, Google Scholar, ResearchGate, and SpringerLink. Furthermore, the authors utilized the snowball sampling phase to include all relevant studies for this topic (Myllärniemi, 2015) and did not limit their search only to high-ranking journals and conferences. Due to the previously mentioned lack of research, the authors used grey literature related to the Blue Economy and maritime transport, such as reports and materials of private companies, official web pages of seaports, official reports of the European Commission, etc.

To broaden the scope of the literature review, and to further make sure that important references that may not necessarily contain the above-stated keywords are omitted, the authors have also included several scientific papers dealing with the economic aspect of sustainability of the maritime transport sector. In this respect, the authors considered the following fields: the role of digital technologies in decision making, routing optimization, and information exchange.

4 Economic effects of maritime transport

Maritime transport may be defined as the backbone of the increasingly globalized economy (Du, Monios, & Wang, 2019), and the main mode of transport for global trade (Halim, Kirstein, Merk, & Martinez, 2018). As mentioned earlier, the largest share of goods in the world is transported by sea, with 80% of the volume and 70% of the value of total cargo (Khaslavskaya & Roso, 2019). According to the United Nations Conference on Trade and Development, the average annual growth of maritime trade is expected to be 3.5% by 2024 (United Nations Conference on Trade and Development, 2019).

From an economic point of view, the advantages of maritime transport are numerous, such as large individual capacity and the total capacity of the entire transport branch, low transport cost, and the sea as a freeway that does not require large investments in infrastructure (Naletina & Perkov, 2017). According to the EU Blue Economy report from 2020, overall EU maritime transport generated a GVA of €35.6 billion, and profit was mainly generated in freight transport, (€8.5 billion – 46%), followed by passenger transport (€5.8 billion – 31%) and services (€4.4 billion – 23%) in the overall Blue Economy (European Commission, 2020b). Blue Economy indicators are Turnover, Gross value-added, Gross profit, Employment, Net investment intangible goods, Net investment ratio, Average annual salary, etc. (European Commission, 2020b). When transportation systems are inefficient or incomplete in terms of capacity or reliability, they cause increased costs or missed opportunities (Mosaberpanah & Khales, 2012).

Seaports, as key nodes for land-sea interaction, may be defined as "hubs for sustainable Blue Economy", or dynamic nodes for Blue Economy clusters and blue innovation ecosystems (European Commission, 2020a). Seaports strongly affect the development of regional economies (Han, Wang, & Li, 2019). A seaport is often seen as a determinant of economic growth, as it contributes to the development of economic sectors and the generation of economic benefits (Jouili & Allouche, 2016). Costs, time, and predictability are decisive factors for seaport competitiveness ("2017 Transportation Management Systems Trends", 2017). Seaports are essential for the support of economic activities in the surrounding areas (Gherghina, Onofrei, Vintilă, & Armeanu, 2018). According to (Stanković, Marjanović, Papathanasiou, & Drezgić, 2021), the regional economic development of seaport regions is largely determined by the level of seaport development, since seaport activities have multiplier effects on the local, regional and national economy.

5 Positive impact of digital technologies on maritime transport

Digital technological innovations, including the development of smart ships, smart fleets, and smart global logistics are gaining momentum in the maritime transport sector (Gausdal, Czachorowski, & Solesvik, 2018). Global revenues from maritime freight transport are expected to grow to over 205 billion USD by 2023, and the basis for this is the use of digital technologies (*Internationales verkehrswesen*, 2018). Digital technologies may positively influence enterprise competitiveness, social and environmental issues (Madudova, Čorejova, & Valica, 2018), which also applies to the maritime transport sector. According to (Fjørtoft & Berge, 2019), digital technologies may reduce harmful emissions, enable smart, safe, and cost-efficient vessel operations, and simplify information sharing. The Ericsson report shows that digital technologies could help reduce global greenhouse gas (GHG) emissions (Oyedeji, Seffah, & Penzenstadler, 2018). Examples of commonly used digital technologies for sustainable vessel operations include (Fjørtoft & Berge, 2019):

1. Onboard decision support system. During vessel operation, data measured from different sensors and other external sources (e.g., weather information, route planning, other operational constraints) can be used to provide the vessel operator with advice on how to operate the vessel with less use of fuel.
2. Increased connectivity and data security. Due to the improved connectivity onshore and offshore, it is possible to transfer operational data for online support and monitoring for maintenance purposes. Secure data transfer and ownership of operational data will require digital frameworks where ship owners, operators, and equipment providers can share data based on digital and secured contracts.

Modern technologies such as Blockchain, Big data, Internet of Things, and artificial intelligence may help in achieving the Blue Economy goals (Fruth & Teuteberg, 2017). Blockchain can be used for tracking the cargo and providing an end-to-end supply, recording information on the vessel, and implementation of smart contracts and marine insurance policies. As business processes are automatized and digitalized, the costs for clearance and movement of the cargo are reduced (Peronja, Lenac, & Glavinović, 2020), (Vujičić, Hasanspahic, Car, & Čampara, 2020). A blockchain solution "TradeLens", which is developed by Maersk and IBM, is an example of how digital technologies implementation in the maritime transport sector can help in achieving the Blue Economy goals. The solution enables digitalized global maritime trade, and could significantly reduce the cost and complexity of maritime trading (IBM, 2017).

Big data implementation in the maritime transport sector can also assist in achieving the Blue Economy goals. For example, ClassNK-NAPA GREEN software co-developed by ClassNK and NAPA (as shown in Figure 2) offers a real-time big data analysis (Trelleborg Marine Systems, 2018).

ClassNKNAPA GREEN software enables simplified and improved planning, monitoring, and analysis of ship operations, leading to operational savings through increased

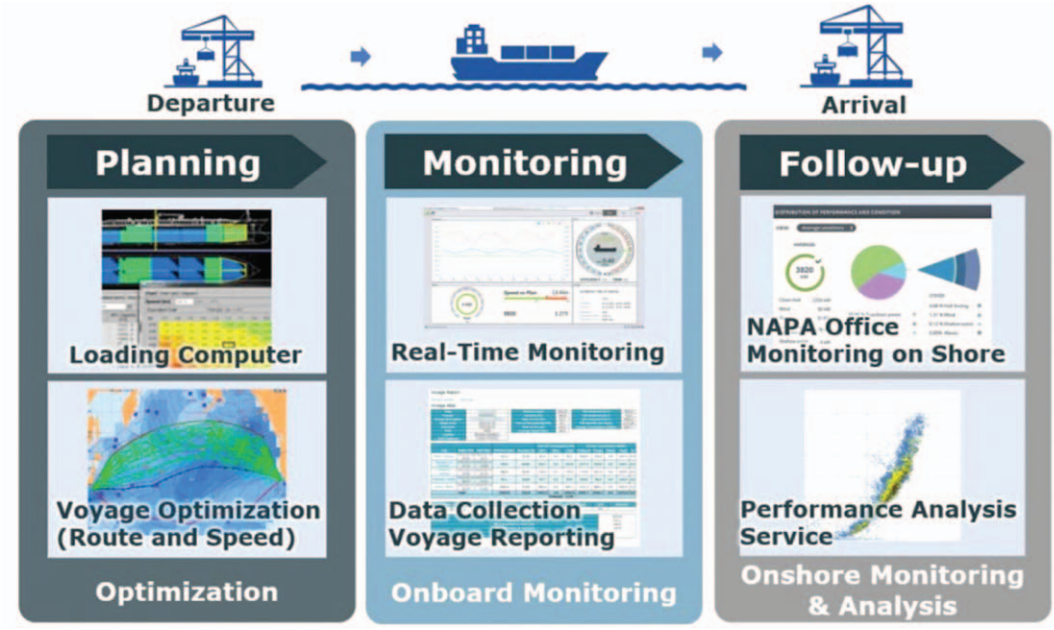

Figure 2 ClassNKNAPA GREEN software (Napa, 2021)

awareness, trim and voyage optimization, and performance analysis (Napa, 2021).

As already mentioned, seaports may be defined as "hubs for sustainable Blue Economy", or dynamic nodes for Blue Economy clusters and blue innovation ecosystems (European Commission, 2020a). According to (Zhang & Ravesteijn, 2019), within the Blue Economy context, sustainable port development is important as ports represent the link between the sea or river with inland cities and territories. Successful sustainable port development may enable the balance of economic growth, ecological needs, and social progress (Zhang & Ravesteijn, 2019). As trade and cargo grow, seaports around the world are looking for ways to manage resources sustainably and cost-effectively, and one of the solutions is the implementation of digital technologies (GreenPort, 2016).

The application of digital technologies is important for the successful operation of seaports, since they reduce costs, facilitate business, increase transparency, and attract new business entities (Mudronja, Jugović, & Škalamera-Alilović, 2020). Port of Rotterdam has recognized the importance of digital technologies that enable the collection and processing of large amounts of information economically, but also preserve the ecosystems. In this respect, Port of Rotterdam is currently developing a series of models for the calculation, analysis, and optimization of greenhouse emissions, which are linked to the software application "Pronto" (Port Technology International, 2019). The application reduces waiting times for ships calling to the port. "The system provides real-time insight into the available berths and handling capacity. For example, if an incoming ship has to wait until a berth becomes available, it can reduce its navigation speed – effectively shortening its waiting time in the port. This cuts the volume of emissions generated during the voyage and at the berth." (Port Technology International, 2019).

6 Discussion and conclusion

The economic benefits of maritime transportation (as a very important segment of the Blue Economy) are various, including large individual capacity and total capacity, reduced transportation costs, etc. (when compared to the other modes of transport). When maritime transportation systems are effective, they provide numerous economic benefits, resulting in positive multiplier effects such as increased employment and profits.

Due to the existence of a large number of stakeholders which operate in the maritime transport sector, as well as the increase in global traffic, a need to implement digital technologies that enable the collection and processing of large amounts of information in an economical way has emerged. For example, one of these technologies is the Blockchain which may assist in reducing administrative costs, and costs related to clearance and movement of cargo.

Seaports are also an important part of the Blue Economy concept. Seaports all over the world are searching for new technologies to help them operate more sustainably and cost-effectively. New digital technologies are important for the efficient operation of seaports as their implementation can reduce costs, simplify business processes and improve transparency. For example, the Port of Rotterdam has recognized the value of digital technologies that allow for the efficient collection and processing of large volumes of data, while also protecting the ecosys-

Table 1 The connection between the Blue Economy, Blue Growth and Sustainability

Authors	Blue Economy, Blue Growth and Sustainability
(Ababouch, 2015)	**Blue Economy** and **Blue Growth** were considered synonymous
(Bušljeta Tonković, 2013)	The definition focused on the ecological aspect, i.e. encouraging renewal, on striving for **ecosystems** to **sustain** their evolutionary path so that everyone benefits from the endless natural flow of creativity, adaptation, and abundance
(Choudhary et al., 2021)	Large connection of terms: Blue Economy and Sustainability: With **sustainable** management of existing assets including shipping, transportation, the ocean or **blue economy** has the potential to fulfill **sustainable** development goals (SDG).
(Cisneros-Montemayor et al., 2021)	The terms Blue Economy, Blue Growth and Sustainability were strongly connected: "Blue Economy intends to be **economically** viable (prosperous) and **environmentally sustainable**, but also culturally appropriate and focused on **social** equity and well-being", "…in research and policy publications that reference related terms such as '**blue growth**' and a '**sustainable ocean economy**'"
(Fontes et al., 2019)	The terms "Blue Economy" and "Sustainability" are largely related: **Blue Economy** enables **sustainable** exploitation of ocean resources through the development of new competencies and activities.

Source: Authors

tems. The software application "Pronto" shows available berths and handling capability in the port of Rotterdam in real-time. In this way, the application reduces waiting times for ships calling to the port.

From all the above, it is possible to conclude that the implementation of digital technologies in the maritime transport sector can assist in achieving the goals of the Blue Economy, i.e. it is possible to gain economic benefits from the oceans, seas, and seaports, while at the same time operating sustainably, and keeping harmful environmental effects under control.

Although the positive impacts of digital technologies on the goals of the Blue Economy in the maritime transport sector have been proved, the question arises, what is the difference between the Blue Economy, Blue Growth, and Sustainability? Table 1 shows the connection between the aforementioned terms.

From the table, it is possible to see that, in this research, it was justified to include papers dealing with sustainability as well, and, the boundary between the terms is almost invisible. Sustainability consists of three aspects: economic, social, and environmental, and it is possible to apply the principles of sustainability in all industries (whether or not related to the exploitation of the ocean). On the other hand, the Blue Economy, which is related to the exploitation of ocean resources, does not exclusively emphasize the "economy" itself, since it does not allow the uncontrolled exploitation of ocean resources. Therefore, the authors, in addition to papers that deal exclusively with the Blue Economy, have also included the papers dealing with the economic aspect of sustainability of the maritime transport sector. Regarding the terms Blue Economy and Blue Growth: The Blue Economy goal is to use ocean resources for economic activities, while Blue Growth refers to the further planned development of such activities.

The literature review process is not without limitations, which opens the doors to further research. The proposed future research questions or venues for future research that should further contribute to academic knowledge and practitioners' understandings may be the following:

- What activities and actions are needed for the successful implementation of digital technologies in the maritime transport sector, to further sustain the Blue Economy goals?
- What is the government's role in influencing and regulating the maritime transport sector, to further sustain the Blue Economy goals?

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References

[1] 2017 Transportation Management Systems Trends. (2017). Retrieved from https://www.vaizva.com/transport-management-systems/2017-transportation-management-systems-trends/.

[2] Ababouch, L. (2015). Fisheries and Aquaculture in the Context of Blue Economy. *Feeding Africa*, *2*(21-23 October), 13. Retrieved from http://www.afdb.org/fileadmin/uploads/afdb/Documents/Events/DakAgri2015/Fisheries_and_Aquaculture_in_the_Context_of_Blue_Economy.pdf

[3] Buono, A., Li, Y., & Paes, R. L. (2021). Editorial for the Special Issue "Remote Sensing of the Oceans: Blue Economy and Marine Pollution." *Remote Sensing*, *13*(8).

[4] Bušljeta Tonković, A. (2013). Gunter Pauli: Plava ekonomija. 10 godina, 100 inovacija, 100 milijuna radnih mjesta – Izvješće podneseno Rimskom klubu. *Sociologija i Prostor*, *51*, 150–154. https://doi.org/10.5673/sip.51.1.8.

[5] Choudhary, P., G, V. S., Khade, M., Savant, S., Musale, A., G, R. K. K., … Dasgupta, S. (2021). Empowering blue economy: From underrated ecosystem to sustainable industry.

[6] Cisneros-Montemayor, A. M., Moreno-Báez, M., Reygondeau, G., Cheung, W. W. L., Crosman, K. M., González-Espinosa, P. C., … Ota, Y. (2021). Enabling conditions for an equitable and sustainable blue economy. *Nature*, *591*, 396–401.

[7] 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

[8] European Commission (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.

[9] European Commission (2019). The EU Blue Economy Report 2019. Retrieved March 22, 2020, from https://op.europa.eu/en/publication-detail/-/publication/676bbd4a-7dd9-11e9-9f05-01aa75ed71a1/language-en/.

[10] European Commission (2020a). Continuously open call for applications for the selection of members of the sub-group on "ports as hubs for a sustainable blue economy."

[11] European Commission (2020b). The EU Blue Economy Report 2020. Retrieved May 10, 2021, from https://blueindicators.ec.europa.eu/sites/default/files/2020_06_BlueEconomy-2020-LD_FINAL-corrected-web-acrobat-pro.pdf

[12] Fjørtoft, K., & Berge, S. P. (2019). ICT for sustainable shipping. In *Sustainable Shipping: A Cross-Disciplinary View* (pp. 137–166).

[13] Fontes, M., Sousa, C., & Conceição, O. (2019). Creating a Blue Economy: Research and innovation partnerships to accelerate the development of ocean-related industries. In *SPBPU IDE '19: Proceedings of the 2019 International SPBPU Scientific Conference on Innovations in Digital Economy* (pp. 1–8).

[14] Gausdal, A. H., Czachorowski, K. V., & Solesvik, M. Z. (2018). Applying Blockchain Technology: Evidence from Norwegian Companies. *MDPI Sustainability*, *10*(6), 1–16.

[15] Gherghina, Ş. C., Onofrei, M., Vintilă, G., & Armeanu, D. Ş. (2018). Empirical evidence from EU-28 countries on resilient transport infrastructure systems and sustainable economic growth. *MDPI Sustainability (Switzerland)*, *10*(8). https://doi.org/10.3390/su10082900.

[16] GreenPort (2016). Smart and sustainable ports. Retrieved May 23, 2019, from https://www.greenport.com/news101/Projects-and-Initiatives/smart-and-sustainable-ports.

[17] Halim, R. A., Kirstein, L., Merk, O., & Martinez, L. M. (2018). Decarbonization Pathways for International Maritime Transport : A Model-Based Policy Impact Assessment. *MDPI Sustainability*, *10*(7). https://doi.org/10.3390/su10072243.

[18] Han, F., Wang, D., & Li, B. (2019). Spillover Effects of Ports and Logistics Developmenton Economic Power: Evidence from the ChineseBTH Regions. *Sustainability*, *11*(16).

[19] IBM (2017). Maersk and IBM Unveil First Industry-Wide Cross-Border Supply Chain Solution on Blockchain. Retrieved May 3, 2019, from https://www-03.ibm.com/press/us/en/pressrelease/51712.wss.

[20] Internationales verkehrswesen (2018). Maritime industry navigates digital transformation to reshape supply chain. Retrieved March 27, 2020, from https://www.internationales-verkehrswesen.de/maritime-industry-report/.

[21] Jouili, T. A., & Allouche, M. A. (2016). Impacts of seaport investment on the economic growth. *Promet – Traffic – Traffico*, *28*(4), 365–370. https://doi.org/10.7307/ptt.v28i4.1933.

[22] Kabil, M., Priatmoko, S., Magda, R., & Dávid, L. D. (2021). Blue Economy and Coastal Tourism: A Comprehensive Visualization Bibliometric Analysis. *Sustainability*, *13*(7).

[23] Khaslavskaya, A., & Roso, V. (2019). Outcome-Driven Supply Chain Perspectives on Dry Ports. *Sustainability*, *11*(5), 1492. https://doi.org/10.3390/su11051492.

[24] Madudova, E., Čorejova, T., & Valica, M. (2018). Economic sustainability in a wider context: Case study of considerable ICT sector sub-divisions. *Sustainability (Switzerland)*, *10*(7), 1–16. https://doi.org/10.14202/vetworld.2017.716-720_old.

[25] Matt, C., Hess, T., & Benlian, A. (2015). Digital Transformation Strategies. *Business and Information Systems Engineering*, *57*(5), 339–343. https://doi.org/10.1007/s12599-015-0401-5.

[26] Mosaberpanah, M. A., & Khales, S. D. (2012). The Role of Transportation in Sustainable Development. https://doi.org/10.1061/9780784412688.053.

[27] Mudronja, G., Jugović, A., & Škalamera-Alilović, D. (2020). Seaports and Economic Growth: Panel Data Analysis of EU Port Regions. *Journal of Marine Science and Engineering*, *8*(12).

[28] Myllärniemi, V. (2015). Quality Attribute Variability in Software Product Lines-Varying Performance and Security Purposefully. Retrieved from https://www.semanticscholar.org/paper/Quality-Attribute-Variability-in-Software-Product-Myllärniemi/11f3186ef836fc380b23b765bb30fd6873f3d556.

[29] Naletina, D., & Perkov, E. (2017). The economic importance of maritime shipping with special reference on Croatia. Retrieved March 20, 2020, from https://www.researchgate.net/publication/324389577_THE_ECONOMIC_IMPORTANCE_OF_MARITIME_SHIPPING_WITH_SPECIAL_REFERENCE_ON_CROATIA.

[30] Napa (2021). Complete package for planning, monitoring and analysis of ship management & operations. Retrieved May 14, 2021, from https://www.napa.fi/software-and-services/ship-operations/classnk-napa-green/.

[31] OpenChannels. (2019). The Blue Economy and Blue Growth | OpenChannels: Sustainable Ocean Management and Conservation. Retrieved June 6, 2019, from https://www.openchannels.org/top-lists/blue-economy-and-blue-growth.

[32] Oyedeji, S., Seffah, A., & Penzenstadler, B. (2018). A catalogue supporting software sustainability design. *Sustainability (Switzerland)*, *10*(7), 1–30. https://doi.org/10.3390/su10072296.

[33] Patil, P. G., Virdin, J., Diez, S. M., Roberts, J., & Singh, A. (2016). Toward A Blue Economy: A Promise for Sustainable Growth in the Caribbean: An Overview. In *The World Bank*. Washington D.C , USA.

[34] Peronja, I., Lenac, K., & Glavinović, R. (2020). Blockchain technology in maritime industry. *Multidisciplinary Scientific Journal of Maritime Research*, *34*(1), 178–184.

[35] Port Technology International (2019). Digitalization to Power Rotterdam Eco-Drive. Retrieved May 23, 2019, from https://www.porttechnology.org/news/digitalization_to_power_rotterdam_eco_drive.

[36] Stanković, J. J., Marjanović, I., Papathanasiou, J., & Drezgić, S. (2021). Social, Economic and Environmental Sustainability of Port Regions: MCDM Approach in Composite Index Creation. *Journal of Marine Science and Engineering*, *9*(1).

[37] The Commonwealth (2020). Blue economy. Retrieved March 19, 2020, from https://thecommonwealth.org/blue-economy

[38] The World Bank (2017). What is the Blue Economy. Retrieved March 20, 2020, from https://www.worldbank.org/en/news/infographic/2017/06/06/blue-economy.

[39] Tianming, G., Bobylev, N., Gadal, S., Lagutina, M., Sergunin, A., & Erokhin, V. (2021). Planning for Sustainability: An Emerging Blue Economy in Russia's Coastal Arctic? *Sustainability*, *13*(9).

[40] Trelleborg Marine Systems (2018). Use of big data in the maritime industry. Retrieved August 6, 2019, from https://www.patersonsimons.com/wp-content/uploads/2018/06/TMS_SmartPort_InsightBee_Report-to-GUIDE_01.02.18.pdf

[41] United Nations Conference on Trade and Development. (2019). Review of Maritime Transport 2019. Retrieved March 20, 2020, from https://unctad.org/en/PublicationsLibrary/rmt2019_en.pdf

[42] Vázquez, R. M. M., García, J. M., & Pablo, J. De. (2021). Challenges of the Blue Economy: Evidence and Research Trends. Retrieved July 16, 2021, from https://enveurope.springeropen.com/articles/10.1186/s12302-021-00502-1.

[43] Vega-Muñoz, A., Salazar-Sepulveda, G., Espinosa-Cristia, J. F., & Sanhueza-Vergara, J. (2021). How to Measure Environmental Performance in Ports. *Sustainability*, *13*(7).

[44] Vujičić, S., Hasanspahic, N., Car, M., & Čampara, L. (2020). Distributed Ledger Technology as a Tool for Environmental Sustainability in the Shipping Industry. *Journal of Marine Science and Engineering*, *8*(5), 366.

[45] World Bank Group (2016). Blue Economy Development Framework; Growing the Blue Economy to Combat Poverty and Accelerate Prosperity. Retrieved March 20, 2020, from http://pubdocs.worldbank.org/en/446441473349079068/AMCOECC-Blue-Economy-Development-Framework.pdf

[46] Zhang, Y., & Ravesteijn, W. (2019). Sustainable Port Development Based on the Blue Economy Framework in China: The Example of Qingdao Port. Retrieved May 4, 2020, from https://www.witpress.com/Secure/elibrary/papers/MT19/MT19012FU1.pdf