DISRUPTIVE INNOVATIONS IN ELECTRONIC TRANSPORTATION MANAGEMENT SYSTEMS

MARIJA JOVIĆ[1], EDVARD TIJAN[1], SAŠA AKSENTIJEVIĆ[2] & DRAŽEN ŽGALJIĆ[1]

[1] University of Rijeka, Faculty of Maritime Studies, Rijeka, Croatia, e-mail: jovic@pfri.hr, etijan@pfri.hr, zgaljic@pfri.hr
[2] Aksentijević Forensics and Consulting, Ltd., Viškovo, Croatia, e-mail: sasa.aksentijevic@gmail.com

Abstract This paper provides an overview of selected disruptive innovations (Blockchain, Internet of Things and Big Data) in electronic transportation management systems in general, and their possible impact in maritime transport. The theoretical background is provided, including transportation, electronic transportation management systems and selected disruptive technologies. The impact, major challenges and success factors in implementing disruptive innovations in maritime transport are pointed out and elaborated. Finally, authors provide the discussion and the future perspective of selected disruptive innovations, with an emphasis on maritime transport.

Keywords: disruptive innovations, maritime transport, blockchain, internet of things, big data.

Univerzitetna založba Univerze v Mariboru

DOI https://doi.org/10.18690/978-961-286-362-3.1
ISBN 978-961-286-362-3

1 Introduction

The effective transportation management systems should provide an optimal route with recommended optimized non - work stops (Nimchuk & Mckinney, 2018). However, not all participants are taking advantage of the vast benefits a transportation management system provides (Cerasis, 2016). According to (Dreßler, Beißert, Beyhoff, & Wirtz, 2016), each participant organizes his own transport processes without informing other participants, even though the smooth transportation flow largely depends on communication. Numerous transport issues exist such as traffic congestions, redundant administration and loss of time due to unnecessary waiting (Marija Jović, Tijan, Aksentijević, & Sotošek, 2019). According to (Tijan, Agatić, Jović, & Aksentijević, 2019), various stakeholders are still faced with a tedious task of producing and distributing paper documents to numerous administrative authorities.

Disruptive innovations may play an important role in electronic transportation management systems (e-TMS) and in improving transport business. According to (F. Ullah, Sepasgozar, & Wang, 2018) "Disruptive innovations are initially characterized by significant limitations compared with existing technologies but have the potential for dramatic improvements in efficiency, cost reduction or other highly significant benefits".

This article focuses on the following research question: What is the role of disruptive innovations in electronic transportation management systems? Based on the literature review and the experience in planning, execution and follow up of several projects related to digitalization in transport, the authors of this paper have singled out the following disruptive innovations: Blockchain, Internet of Things (IoT) and Big Data.

Blockchain technology is a potential solution to numerous problems such as: insufficient availability of cargo monitoring and lack of transparency (resulting from poor data handling (Marija Jović, Filipović, Tijan, & Jardas, 2019). Furthermore, advanced "digital" seaports such as port of Rotterdam are the proof of the profitability of IoT applications and the successful monitoring of digitalized business processes (M Jović, Tijan, Aksentijević, & Čišić, 2019). Another disruptive technology Big Data is also increasingly present in the transport, in terms of:

operations (enabling ship owners to determine the optimum speed, thus affecting fuel consumption), voyage operations, tracking or monitoring (Marx, Gebhard, Jović, & Tijan, 2019).

A lack of research and scientific papers dealing with disruptive innovations in maritime transport is pronounced. To overcome this research gap, the authors conducted the review of available literature and sources.

The goal of the research is to point out the importance of selected disruptive innovations in electronic transportation management systems (with an emphasis on maritime transport). Transparency and easy access to data are the basis for successful transport business. Therefore, the research problem stems from increased costs and lost time due to the archaic procedures and inadequate execution and monitoring of business processes in transport.

This paper presents a review of research papers and other sources (such as official webpages of seaports, seaport stakeholders and maritime transport enterprises), providing a better understanding of disruptive innovations in electronic transportation management systems.

2 Background

Transportation is a multimodal, multi-problem and multi-spectral system, as it involves different categories and activities, such as policy-making, planning, designing, infrastructure construction and development (Almasi, Sadollah, Kang, & Karim, 2016). Transportation involves interconnected stakeholders who have to exchange documents in order to execute and complete transport services (Tijan, Jović, Jardas, & Gulić, 2019).

A Transportation Management System (TMS) is a platform that is designed to streamline the shipping process (Freightquote by C.H. Robinson, 2019). Transportation Management Systems assist in managing certain aspects of the transportation process (AQT Solutions, 2019):

1. Planning and decision making – TMS will define the most efficient transport schemes according to given parameters.
2. Transportation Execution – TMS will allow for the execution of the transportation plan such as carrier rate acceptance, carrier dispatching, electronic data interchange (EDI.
3. Transport follow-up – TMS will allow following any physical or administrative operation regarding transportation: custom clearance, invoicing and booking documents, sending of transport alerts (delay, accident, non-forecast stops…).

Transportation Management Systems still have some shortcomings such as (Xu, Zhen, Li, & Yue, 2017), (Sigfox, 2020):

1. 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.
2. Numerous Transportation Management Systems lack a uniform data transferring capability and storage format to achieve data sharing and integration functionalities.
3. Using of "obsolete" RFID technologies in Transportation Management System: although RFID tags help track goods as they arrive at each destination, they give no information about what happens in between.

As the goal of the research is to point out the importance of selected disruptive innovations in electronic transportation management systems (focused on maritime transport), it is necessary to define the term "disruptive innovative technologies". Despite different perspectives among entrepreneurs, academics and policy makers, innovations are defined broadly as the development and use of new ideas and behaviors in organizations and narrowly as implemented technologically new products and processes or significant technological improvements in products and processes (Majamäki & Akpinar, 2014a). Disruptive technologies, a term coined by Professor Clayton Christensen and colleagues, are defined as a set of technologies that displaces the existing methods or technologies and shakes up the industry to open new avenues for innovation and business development (F. Ullah et al., 2018), (Hongdao, Bibi, Khan, Ardito, & Khaskheli, 2019).

Maritime transport is the main mode of transport in global trade and one of the cornerstones of globalization (Halim, Kirstein, Merk, & Martinez, 2018). (Sanchez-Gonzalez, Díaz-Gutiérrez, Leo, & Núñez-Rivas, 2019) categorized the use of the latest digital technologies in maritime transport in the eight domains: autonomous vehicles and robotics; artificial intelligence (AI); Big Data; virtual reality, augmented and mixed reality; internet of things; the cloud and edge computing; digital security; and 3D printing and additive engineering. According to their research, the most widely studied domains are robotics, artificial intelligence and Big Data, especially unmanned vehicles in robotics and the use of artificial intelligence as a means of supporting vessels aids for navigation.

The concept of Big Data comes with a set of related components that enable organizations to put the data to practical use and solve several business problems. These include the IT infrastructure needed to support Big Data; the analytics applied to the data; technologies needed for Big Data projects; related skill sets; and the actual use cases that make sense for Big Data (Kobielus, 2018).

The Blockchain technology is based on a method where previously unknown parties can jointly generate and maintain practically any database on a fully distributed basis where transaction correctness and completeness are validated using consensus of independent verifiers (Tijan, Aksentijević, Ivanić, & Jardas, 2019). In the shipping industry, Blockchain was initially used to enable confidential financial transactions between the stakeholders, without relying on "third parties".

Internet of Things (IoT) is also considered as one of the disruptive technologies and has attracted lots of research attention in the recent past (I. Ullah, Ahmad, Mehmood, & Kim, 2019), (I. Ullah, Ahmad, & Kim, 2018), (Sánchez, Álvarez, Antolinos, Fernández, & Iborra, 2018). Furthermore, the continued development of the IoT, which will ultimately connect people, processes and data into wide-scale networks, could affect how transportation services are provided (Texas A&M Transportation Institute, 2016).

3 Research methodology

Based on the literature review and authors' experience in several commercial and scientific projects related to digitalization in transport, authors have singled out and analyzed the following selected disruptive technologies in transport: Blockchain, Big Data and Internet of Things. The aforementioned projects are DigLogs - Digitalising Logistics processes (University of Rijeka, Faculty of Maritime Studies, 2019a), Electronic Transportation Management System - e-TMS (University of Rijeka, Faculty of Maritime Studies, 2019b), and Information management in seaport clusters (University of Rijeka Faculty of Maritime Studies, 2017), etc.

Blockchain technology is a potential solution to numerous problems in maritime transport such as: insufficient availability of cargo monitoring (maritime transport involves many stakeholders) and lack of transparency (resulting from poor data handling), relying on paperwork in 21st century (Marija Jović, Filipović, et al., 2019). Furthermore, Big Data and its analyses provide deep understanding of causalities and correlations in maritime transport, improving decision making (Marx et al., 2019). Internet of things, as another innovation, facilitates planning and management of business processes by implementation of modern information technologies (M Jović et al., 2019).

The authors started with the inclusion criteria by using a combination of keywords connected with logical operators - "disruptive innovations and transportation management system" and alternative keywords transportation management system" and "disruptive innovations and maritime transport" (title, abstract and keywords). Web of Science, Google Scholar, ResearchGate and SpringerLink's databases were used for this purpose. The search for articles was conducted according to the set time limitations (2014-2020) and mostly included journal articles and conference papers. To ensure that possible useful findings from various fields were not excluded, the authors did not limit the queries to a specific field or index.

A total of 66 sources have been identified, including 18 sources related to the challenges and success factors in pursuing disruptive innovations and 19 sources related to the impact of disruptive technologies on electronic transportation management systems.

The importance of the disruptive innovations is demonstrated in the paper through the analysis of several cases as well, such as: Port of Rotterdam, the partnership between Maersk and IBM; the partnership between port of Veracruz, Mexico and blockchain logistics company dexFreight etc.

4 Results

In this chapter, authors have analyzed the challenges and success factors in pursuing disruptive innovations, as well as the impact of disruptive technologies on electronic transportation management systems.

4.1 Challenges and success factors in pursuing disruptive innovations

Variety of transportation systems exist, including land transportation (road, rail, and maglev), aviation (airplanes, rockets), maritime (ferries, ships, ports), and pipeline (tunneling, risers, Hyperloop) (Kaewunruen, Sussman, & Matsumoto, 2016). Because of the different priorities of key stakeholders (carriers, shipping companies, agencies) involved in transport management, different technologies are needed for a specific business area. Furthermore, with the emergence of disruptive digital technologies, companies are facing unprecedented challenges and opportunities (May & Kiritsis, 2019).

Disruptive innovations, including Blockchain, Big Data and Internet of Things, in maritime transport faces certain challenges or risks which should be minimized in order to fully exploit their advantages. Table 1 enumerates the challenges in pursuing disruptive innovations, grouped by disruptive technologies in general and by selected disruptive technologies: Internet of Things, Blockchain and Big Data.

Table 1: Challenges in pursuing disruptive innovations

	Challenges	**Author(s)**
Disruptive technologies in general	Integrating and exploiting new digital technologies (at the level of the company)	(Hess, Benlian, Matt, & Wiesböck, 2016)
	Anticipating the business logic within formerly unknown markets	(Amshoff, Dülme, Echterfeld, & Gausemeier, 2015)
	Identifying disruptive innovations that have market potential, obtaining adequate funding at initial stages of the business, marketing of the disruptive innovation, the length and riskiness of the process	(Majamäki & Akpinar, 2014b)
	The firms' inability to adopt to new innovations	(Gemici & Alpkan, 2015)
Blockchain as a disruptive technology	Blockchain technology immaturity, no single underlying standard, concepts are difficult to be mastered and there is a need for programming intervention even in the simplest forms of implementation	(Tijan, Aksentijević, Ivanić, & Jardas, 2019)
	The lack of regulation (some facets of smart contract technology might be adopted by the logistics market, just to be overregulated, or even to be considered illegal)	(Gatteschi, Lamberti, Demartini, Pranteda, & Santamaría, 2018)
	Distributed trust and therefore security and privacy are the core of the Blockchain technologies, and have the potential to either make Blockchain technologies a success or cause them to fail	(Karame & Capkun, 2018)
Internet of Things as a disruptive technology	Security challenges; possible attacks on devices (IoT), confidentiality of information would be compromised in ports, i.e. business processes or designs that are key for the competitiveness of the port itself	("IT: The Biggest Threats to Digital Security for Business

		According to the Experts | Kiandra IT," 2018)
	Governments and companies cannot agree upon a definition what is an authorized data access.	(M Jović et al., 2019)
	Connecting things to the Internet is based on an IP network, and if its security is not closely monitored, the entire IoT network can be compromised.	(Gamundani, 2015)
Big Data as a disruptive technology	Big Data challenges may include capturing data, data storage, data analysis, search, sharing, transfer, visualization, querying, updating and information privacy.	(Kotlarsky, Oshri, & Willcocks, 2018)
	Competitive conditions are not perfectly established or organized; what is allowed and not allowed has to be determined and respected by all involved players	(Trelleborg Marine Systems, 2018), (Koga, 2015)
	The more affordable, sophisticated or high-performance tools are necessary	(Rødseth, Perera, & Mo, 2016), (Windward, 2014), (Koga, 2015)
	Lack of qualified labor force	(Mammadova & Jabrayilova, 2017), (Koga, 2015)

Main cause of the firms' inability to become adapted to new innovations (Gemici & Alpkan, 2015) is the fact that when disruptive technologies emerge, many leading firms that have been successful in excelling at sustaining innovation, found themselves on the threshold of a new and harsh competition they are not familiar with. In order to overcome these challenges, important success factors that need to be taken into consideration are: clear vision and goals; identifying disruptive innovations that have market potential; obtaining adequate funding at initial stages of the business (Majamäki & Akpinar, 2014b).

According to (Karame & Capkun, 2018), distributed trust and therefore security and privacy are at the core of the Blockchain technologies, and have the potential to either make them a success or cause them to fail. In this respect, personal data, and sensitive data in general, should not be trusted in the hands of third-parties, where they are susceptible to attacks and misuse (Zyskind, Nathan, & Sandy' Pentland, 2015). Instead, users should own and control their data without compromising security or limiting companies' and authorities' ability to provide personalized services. One of the solutions is a platform which will combine a Blockchain, re-purposed as an access-control moderator, with an off-Blockchain storage solution (Laurent, Kaaniche, Le, & Vander Plaetse, 2018).

As previously mentioned, connecting things to the Internet is based on an IP network and if its security is not closely monitored, the entire IoT network can be compromised (Gamundani, 2015). Therefore, the security needs to be controlled from the very start, in the stage of making a "device connection", but it is also essential to include the "monitoring" phase coming after the implementation because of new and emerging forms of threats (M Jović et al., 2019).

4.2 The impact of disruptive technologies on electronic transportation management systems

Broadly speaking, disruption provides a solid ground for digital transformation and is becoming a prime objective for industries across the world, since it leads to the implementation of novel business and delivery models by allowing various forms of co-operation between companies, employees, and customers (Hongdao et al., 2019).

Significant advances in transportation technology are often triggered by sudden disruptive changes in technological capabilities. Table 2 shows the possible impacts of disruptive technologies in general as well as the impact of Internet of Things, Blockchain and Big Data (as disruptive technologies) on electronic transportation management systems. Later, the analysis of their impact is made, using a set of real cases.

Table 2: The impact of disruptive technologies

	The impact	**Author(s)**
Disruptive technologies in general	Disruptive technologies lead to a severe shift in value-creation networks giving rise to new market segments.	(Amshoff et al., 2015)
	The rapid development and adoption of the Internet and digital technologies increasingly changed business processes, leading to a disruptive digital transformation of the global industrial value chain	(Savastano, Amendola, Bellini, & D'Ascenzo, 2019)
	Disruptive technologies are initially characterized by significant limitations compared with existing technologies, but have the potential for dramatic improvements in efficiency, cost reduction or other highly significant benefits.	(Brackin, Jackson, Leyshon, & Morley, 2019)
Internet of Things as a disruptive technology	Automatic traffic routing based on the real-time information of conditions of traffic (rail, road, air, water) congestion and yard occupancy	(Aksentijević Forensics and Consulting Ltd., 2019)
	IoT could affect how transportation services are provided	(Texas A&M Transportation Institute, 2016)
	Ability to automatically react to the anomalies in order to prevent traffic congestion and waiting times	(Aksentijević Forensics and Consulting Ltd., 2019)
	Better planning of deliveries based on the real-time and predicted traffic conditions	(Aksentijević Forensics and Consulting Ltd., 2019)
	Connectivity to upcoming new communication standard like v2v (vehicle to vehicle) and v2i (vehicle to infrastructure) for peer-to-peer (p2p) real-time information gathering	(Aksentijević Forensics and Consulting Ltd., 2019)
	Integration of autonomous driving (robotic) solutions in the restricted environment (port community) for traffic optimization	(Aksentijević Forensics and Consulting Ltd., 2019)

Internet od Things and Decision Support Systems	Port operators and administration can better mitigate the environmental impact of logistic operations and take appropriate measures to correct or even prevent unwanted situations	(World Port Sustainability Program, 2019)
	The possibility to predict unwanted environmental conditions based on the machine learning of data from the past, meteorological forecasts and port traffic estimates for the future	(World Port Sustainability Program, 2019)
	Acquired data may be also reused as a trigger to handle other operations and activities in the port communities, which will streamline the operations and at the same time diminish the peek burden and impact on environment and local community	(World Port Sustainability Program, 2019)
	Allow transactions between companies to simplify, facilitate interfirm collaboration, increase trust among partners, and decrease costs of transactions in many industries	(Gausdal, Czachorowski, & Solesvik, 2018)
Internet of Things and Blockchain	The integration allows stakeholders to securely communicate, collaborate, and transact without human intervention and brings productivity and efficiency in the business.	(Hossain, 2018)
	More transparent, efficient, and secure monitoring of variables such as air and water pollution	(Bublitz et al., 2019)
Big Data	Can be used for improved predictions of arrival times and calculations of the needed speed	(Marx et al., 2019)
	Can bring advantages to the maritime transport sector regarding efficient routing, operation optimization and safety improvements	(Marx et al., 2019)
Big Data and Internet of Things	Optimization of movement of cargo manipulation machinery based on real-time, IoT and Big Data based information	(Aksentijević Forensics and Consulting Ltd., 2019)

IoT applications in shipping vary from route optimization to maintenance and smart cargo storage (Aksentijević Forensics and Consulting Ltd., 2019). One of the best real-life cases of usage of IoT technology is Port of Rotterdam, where there is in place a system for collecting data regarding ships in dock, cranes in the yard and individual containers. The port's operators now have greater transparency, better

prediction of estimated time of arrival and completion of operations than any other shipping hub in the world, helping them to move 25-50% more containers per hour than any other of its competitors in region (Riviera Maritime Media, 2018).

In the previous research regarding the electronic transportation management systems (Marija Jović, Tijan, et al., 2019), authors demonstrated the importance of electronic exchange of maritime cargo documents through the case of "Bill of Lading" (BL). BL is one of the most important documents in the transportation sector. According to (Dr Wu, Starr, & Tan, 2017), three main problems associated with the paper-based BL are:

1. Delays: Ships frequently arrive at the discharge ports before the paper BL as the paper BL has to be transported from party to party usually using the courier service. The non-availability of the paper BL at the discharge port means that the cargo cannot be delivered.

2. Costs: The cost of issuing and managing paper BLs, Letters of Indemnity (LOI), and other paper documents are estimated to constitute upwards of 15% of the physical transportation costs. When electronic BLs are used, the requirement for LOIs is reduced by some 90% (Dr Wu et al., 2017). This means a huge reduction in costs for the participants involved.

3. Security risks: Paper BLs are easily misplaced, stolen or lost. Again, when a paper-form BL is missing, the carrier often agrees to deliver the cargo against a LOI or a bank guarantee. The carrier, however, remains responsible for mis-delivery claims under forged BLs and stolen BLs.

The following case proves the importance of disruptive innovations in electronic transportation management systems, considering BL: in August 2018, the first ever container processed with the revolutionary new Blockchain-based CargoX Smart Bill of Lading™ was released in the port of Koper, Slovenia. The Bill of Lading for this shipment has been issued electronically and transferred with the help of an ultra-secure and reliable public Blockchain network in just minutes instead of days or weeks, and the chances of loss, theft or damage to the Bill of Lading have been dramatically reduced to near-zero (Marine Insight, 2019).

In another research "Economic and ecological aspects of electronic Transportation Management Systems in seaports" (Tijan, Jović, & Karanikić, 2019), authors have focused on Port Community System. Blockchain technology applied to port management will make it possible to store and share information on ship loads, improve financial operations and contracts, among many other possibilities (PierNext, 2018). The possible positive impact of Blockchain in Port Community System is visible in the Blockchain Port Community System. The port of Veracruz, Mexico, has contracted blockchain logistics company dexFreight to develop a proof-of-concept project for a blockchain port community system (Business Blokchain HQ, 2018). The goal is to develop a blockchain-driven port community system (PCS) for improving the efficiency of freight and logistics at the port as well as optimizing and streamlining the carrier onboarding processes. Another example is blockchain-powered Cargo Community System. The data in Cargo Community System is gathered from various sources, including shippers, customs authorities, freight handlers, port agents and road haulage companies (SAFETY4SEA, 2019). The goal is to streamline and speed up cargo data exchange between all private and public stakeholders (PortSEurope, 2019).

5 Discussion and future perspective of selected disruptive innovations in electronic transportation management systems

As mentioned above, a transportation management system is a platform that streamlines the shipping process, including planning and decision making (AQT Solutions, 2019). Blockchain, a new decentralized database technology, could help to increase collaboration, the sharing of trusted information and efficiency, reduce costs and risk, and forge new business models in the transport sphere over the coming years, thus enabling simplified planning and improved decision making (Mukherjee, Carter, & Koh, 2018). For example, Maersk and IBM joined together in order to develop a Blockchain solution aimed at digitalizing global trade, and they called it "Tradelens". Furthermore, inspired by this initiative, other established industry actors have also begun to form their own partnerships or to join industry wide consortiums hoping to reach the promised benefits of Blockchain technology. According to IBM, the joint Blockchain initiative had the potential to "vastly reduce the cost and complexity of trading" ("Maersk and IBM Unveil First Industry-Wide Cross-Border Supply Chain Solution on Blockchain," 2017).

Various experts consider that successful Blockchain implementation is possible only if all stakeholders are involved in the process, such terminal operators, manufacturers, banks, insurers, brokers and port authorities. As long as Blockchain technology exists only in a limited area within the smaller pilot projects, benefits of Blockchain technology (e.g. reducing time of document processing) will not be fully exploited (Marija Jović, Filipović, et al., 2019).

Furthermore, one of the transportation management system's shortcomings is the following: 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). However, in the last few years several projects that involve Big Data have been initiated, for example in Oslo Fjord, where the data was collected from different sensors of the ships and transmitted to the captain and the staff in real-time after proper optimization (Nita & Mihailescu, 2017). The results were promising: the routes have been optimized as a consequence of recalculation enabled by real-time tracking data provided by the ships' sensors, the temperature of refrigerated containers was provided, and the equipment was monitored, all in real time (Nita & Mihailescu, 2017).

According to (Zghurovsky & Zaychenko, 2019), "Data extracted from IoT devices provides a mapping of device interconnectivity. IoT is also increasingly adopted as a means of gathering sensory data, and this sensory data has also been used in transportation contexts".

The evolution of IoT and the use of Big Data creates the prospect of logistics becoming a data-centric industry, where information takes precedence in logistics services' value propositions over the actual ability to move cargo (Theo Notteboom, 2017).

6 Conclusion

Transportation consists of different categories and activities (such as: policymaking, planning, designing, execution) and involves interconnected stakeholders who have to exchange various documents (such as the Bill of Lading). Maritime transport is the main mode of transport in a global trade. Due to the existence of numerous

stakeholders and large volumes of data, it is necessary to simplify and accelerate data exchange.

Transportation management system is an electronic platform which streamlines the shipping processes. It allows monitoring of physical or administrative operations regarding transportation, planning and decision-making. Several shortcomings of e-TMS exist, such as the lack of a uniform data transferring capability that can prevent simplified data exchange among stakeholders. Furthermore, RFID technology in TMS does not provide the information about the cargo through the entire transport process.

Companies in the maritime transport sector are facing notable challenges resulting from the emergence of disruptive technologies, for example, Blockchain technology immaturity, lack of regulation, and security and privacy issues. Nevertheless, disruptive innovations definitely possess the potential to improve transport business. Blockchain, Internet of Things and Big Data technologies are singled out due to their promising characteristics and the potential for simplifying procedures, enhancing cargo monitoring and better decision making.

Through the literature review and provided cases, authors have pointed out the importance of selected disruptive innovations in electronic transportation management systems. Blockchain-driven port community system aims to improve the efficiency of freight and logistics at the port and to optimize and streamline the carrier onboarding processes. Internet of Things technology enables improved transparency, and better prediction of estimated time of arrival. The conjunction of Big Data and IoT can be exploited to enable real-time tracking of ships and equipment. On the other hand, if the perimeter of disruptive technologies' implementation is limited to the smaller pilot projects, the benefits of the technologies will not be fully reaped.

This research is based on the literature review and considers three selected disruptive innovations (which is also the main limitation of the research), and as such offers the initial overview of the importance of disruptive innovations in e-TMS. Future research will include other disruptive innovations in order to obtain a broader insight of disruptive technology impacts on e-TMS.

Acknowledgements

This work was supported 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 University of Rijeka under the Faculty of Maritime Studies projects.

References

Aksentijević Forensics and Consulting Ltd. (2019). Cross-border action plan for enhancing maritime and multimodal freight transport, D.3.3.1, best practice analysis, Promoting Maritime and Multimodal Freight in the Adriatic Sea (PROMARES), Interreg Italy-Croatia project. Croatia.

Almasi, M. H., Sadollah, A., Kang, S., & Karim, M. R. (2016). Optimization of an improved intermodal transit model equipped with feeder bus and railway systems using metaheuristics approaches. Sustainability (Switzerland), 8, 6, 537. https://doi.org/10.3390/su8060537

Amshoff, B., Dülme, C., Echterfeld, J., & Gausemeier, J. (2015). Business Model Patterns for Disruptive Technologies. International Journal of Innovation Management, 19, 03, 1–22. https://doi.org/10.1142/S1363919615400022

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

Brackin, R. C., Jackson, M. J., Leyshon, A., & Morley, J. G. (2019). Taming disruption? Pervasive data analytics, uncertainty and policy intervention in disruptive technology and its geographic spread. MDPI ISPRS International Journal of Geo-Information, 8, 1, 34. https://doi.org/10.3390/ijgi8010034

Bublitz, F. M., Oetomo, A., Sahu, K. S., Kuang, A., Fadrique, L. X., Velmovitsky, P. E., … Morita, P. P. (2019). Disruptive Technologies for Environment and Health Research: An Overview of Artificial Intelligence, Blockchain, and Internet of Things [Accepted]. MDPI International Journal of Environmental Research and Public Health, 16, 20, 3847. https://doi.org/10.3390/ijerph16203847

Business Blokchain HQ. (2018). Blockchain Port Community System to Enhance Efficiency at Mexican Port. Retrieved January 1, 2020, from https://businessblockchainhq.com/business-blockchain-news/blockchain-port-community-system-enhance-efficiency/

Cerasis, A. P. O. F. (2016). The Uses and Substantial Benefits of Transportation Management Systems. Retrieved May 4, 2019, from https://cerasis.com/wp-content/uploads/2016/04/TMS-e-Book.pdf

Dr Wu, C., Starr, L., & Tan, J. (2017). Electronic Bills of Lading Sharing expertise. UK P&I Club: Legal Briefing, (May). Retrieved from https://www.ukpandi.com/fileadmin/uploads/uk-pi/Documents/2017/Legal_Briefing_e_bill_of_Lading_WEB.pdf

Dreßler, D., Beißert, U., Beyhoff, T., & Wirtz, T. (2016). A Concept for an Integrated Transport Management System in Distributed Production Networks (pp. 565–575). Springer, Cham. https://doi.org/10.1007/978-3-319-23512-7_55

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

Gamundani, A. M. (2015). An impact review on internet of things attacks. Proceedings of 2015 International Conference on Emerging Trends in Networks and Computer Communications, ETNCC 2015, (May), 114–118. https://doi.org/10.1109/ETNCC.2015.7184819

Gatteschi, V., Lamberti, F., Demartini, C., Pranteda, C., & Santamaría, V. (2018). Blockchain and Smart Contracts for Insurance: Is the Technology Mature Enough ?, 8–13. https://doi.org/10.3390/fi10020020

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

Gemici, E., & Alpkan, L. (2015). An Application of Disruptive Innovation Theory to Create a Competitive Strategy in Turkish Air Transportation Industry. Procedia - Social and Behavioral Sciences, 207, 797–806. https://doi.org/10.1016/J.SBSPRO.2015.10.169

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

Hess, T., Benlian, A., Matt, C., & Wiesböck, F. (2016). Options for Formulating a Digital Transformation Strategy. Options for Formulating a Digital Transformation Strategy CIOs, 2016(June), 17–33. https://doi.org/10.1108/10878571211209314

Hongdao, Q., Bibi, S., Khan, A., Ardito, L., & Khaskheli, M. B. (2019). Legal technologies in action: The future of the legal market in light of disruptive innovations. Sustainability (Switzerland), 11, 4, 1–19. https://doi.org/10.3390/su11041015

Hossain, S. A. (2018). Blockchain computing: Prospects and challenges for digital transformation. 2017 6th International Conference on Reliability, Infocom Technologies and Optimization: Trends and Future Directions, ICRITO 2017, 2018-Janua, 61–65. https://doi.org/10.1109/ICRITO.2017.8342399

IT: The Biggest Threats to Digital Security for Business According to the Experts | Kiandra IT. (2018). Retrieved January 14, 2019, from https://kiandra.com.au/blog/it-the-biggest-threats-to-digital-security-for-bus/

Jović, M, Tijan, E., Aksentijević, S., & Čišić, D. (2019). An Overview Of Security Challenges Of Seaport IoT Systems. Retrieved from https://bib.irb.hr/prikazi-rad?rad=986080

Jović, Marija, Filipović, M., Tijan, E., & Jardas, M. (2019). A Review of Blockchain Technology Implementation in Shipping Industry. Scientific Journal of Maritime Research, 33, 2, 140–148.

Jović, Marija, Tijan, E., Aksentijević, S., & Sotošek, B. (2019). The role of Electronic Transportation Management Systems in Seaport Digitalization. 32nd Bled EConference Proceedings. Retrieved from https://www.bib.irb.hr/992899

Kaewunruen, S., Sussman, J. M., & Matsumoto, A. (2016). Grand Challenges in Transportation and Transit Systems. Frontiers in Built Environment, 2(February), 1–5. https://doi.org/10.3389/fbuil.2016.00004

Karame, G., & Capkun, S. (2018). Blockchain Security and Privacy. IEEE Security & Privacy, 16, 4, 11–12. https://doi.org/10.1109/MSP.2018.3111241

Kobielus, J. (2018). What is big data analytics? Everything you need to know. Retrieved August 19, 2019, from https://www.infoworld.com/article/3220044/what-is-big-data-analytics-everything-you-need-to-know.html

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

Kotlarsky, J., Oshri, I., & Willcocks, L. (2018). Digital Services and Platforms: 12th Global Sourcing Workshop 2018. La Thuile, Italy.

Laurent, M., Kaaniche, N., Le, C., & Vander Plaetse, M. (2018). A Blockchain based Access Control Scheme. In 15th International Conference on Security and Cryptography (SECRYPT 2018) (pp. 168–176). Porto, Portugal. https://doi.org/10.5220/0006855601680176

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

Majamäki, L., & Akpinar, M. (2014a). Challenges and success factors in pursuing disruptive innovations: A Finnish high-tech start-up case study. Finnish Business Review, (September), 1–11. Retrieved from http://urn.fi/urn:nbn:fi:jamk-issn-2341-9938-1

Majamäki, L., & Akpinar, M. (2014b). Challenges and success factors in pursuing disruptive innovations: A Finnish high-tech start-up case study. Retrieved from https://verkkolehdet.jamk.fi/finnish-business-review/2014/09/08/2014-1/

Mammadova, M., & Jabrayilova, Z. (2017). Opportunities and Challenges of Big Data Utilization in the Resolution of Human Resource Management. Problems of Information Technology, 07, 1, 33–40. https://doi.org/10.25045/jpit.v07.i1.05

Marine Insight. (2019). 7 Major Blockchain Technology Developments In Maritime Industry In 2018. Retrieved July 5, 2019, from https://www.marineinsight.com/know-more/7-major-blockchain-technology-developments-in-maritime-industry-in-2018/

Marx, R., Gebhard, B., Jović, M., & Tijan, E. (2019). Big Data Management in Maritime Transport. Journal of Maritime and Transportation Sciences, 57, 1, 123–141.

May, G., & Kiritsis, D. (2019). Special issue on smart sustainable manufacturing systems. MDPI Applied Sciences (Switzerland), 9(11), 3–5. https://doi.org/10.3390/app9112264

Mukherjee, S., Carter, C., & Koh, S. C. L. (2018). Blockchain Disruption in Transport. Retrieved October 18, 2019, from https://www.researchgate.net/publication/333809102_Blockchain_Disruption_in_Transport

Nimchuk, G. W., & Mckinney, D. J. (2018). System for Planning Trips With Estimated Time of Arrival (ETA) and Projected Time of Availability (PTA) Calculated For Each Stop, 1. Retrieved from http://www.freepatentsonline.com/y2018/0080776.html

Nita, S. L., & Mihailescu, M. I. (2017). Importance of Big Data in Maritime Transport. Scientific Bulletin of Naval Academy, 20, 1, 2–6. https://doi.org/10.21279/1454-864x-17-i1-079

PierNext. (2018). The Second Revolution of Port Community Systems. Retrieved January 1, 2020, from https://piernext.portdebarcelona.cat/en/governance/the-second-revolution-of-port-community-systems/

PortSEurope. (2019). Ci5: the first Cargo Community System in the world to integrate Blockchain technology. Retrieved January 1, 2020, from https://www.portseurope.com/ci5-the-first-cargo-community-system-in-the-world-to-integrate-blockchain-technology/

Riviera Maritime Media. (2018). The maritime IoT landscape in the next decade. Retrieved October 16, 2019, from https://www.rivieramm.com/opinion/the-maritime-iot-landscape-in-the-next-decade-23759

Rødseth, Ø. J., Perera, L. P., & Mo, B. (2016). Big Data in Shipping - Challenges and Opportunities. In Proceedings of the 15th International Conference on Computer Applications and Information Technology in the Maritime Industries (COMPIT 2016) (pp. 361–373). Lecce, Italy.

SAFETY4SEA. (2019). Partners launch blockchain-powered cargo community system. Retrieved January 1, 2020, from https://safety4sea.com/partners-launch-blockchain-powered-cargo-community-system/

Sanchez-Gonzalez, P. L., Díaz-Gutiérrez, D., Leo, T. J., & Núñez-Rivas, L. R. (2019). Toward Digitalization of Maritime Transport? MDPI-Sensors (Basel, Switzerland), 19, 4. https://doi.org/10.3390/s19040926

Sánchez, P., Álvarez, B., Antolinos, E., Fernández, D., & Iborra, A. (2018). A teleo-reactive node for implementing internet of things systems. MDPI Sensors (Switzerland), 18, 4. https://doi.org/10.3390/s18041059

Savastano, M., Amendola, C., Bellini, F., & D'Ascenzo, F. (2019). Contextual impacts on industrial processes brought by the digital transformation of manufacturing: A systematic review. Sustainability (Switzerland), 11, 3. https://doi.org/10.3390/su11030891

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

Texas A&M Transportation Institute. (2016). Disruptive Technologies and Transportation (Final Report). Retrieved September 9, 2019, from https://static.tti.tamu.edu/tti.tamu.edu/documents/PRC-15-45-F.pdf

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

Tijan, E., Agatić, A., Jović, M., & Aksentijević, S. (2019). Maritime National Single Window — A Prerequisite for Sustainable Seaport Business. MDPI Sustainability, 11, 17, 1–21.

Tijan, E., Aksentijević, S., Ivanić, K., & Jardas, M. (2019). Blockchain technology implementation in logistics. MDPI-Sustainability (Switzerland), 11, 4. https://doi.org/10.3390/su11041185

Tijan, E., Jović, M., Jardas, M., & Gulić, M. (2019). The Single Window concept in international trade, transport and seaports. Pomorstvo : Scientific Journal of Maritime Research, 33, 2, 130-139. Retrieved from https://www.bib.irb.hr/993505

Tijan, E., Jović, M., & Karanikić, P. (2019). Economic and ecological aspects of electronic Transportation Management Systems in seaports. Retrieved December 31, 2019, from https://www.bib.irb.hr/1003853

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

Ullah, F., Sepasgozar, S. M. E., & Wang, C. (2018). A systematic review of smart real estate technology: Drivers of, and barriers to, the use of digital disruptive technologies and online platforms. Sustainability (Switzerland), 10(9). https://doi.org/10.3390/su10093142

Ullah, I., Ahmad, R., & Kim, D. H. (2018). A prediction mechanism of energy consumption in residential buildings using hidden markov model. MDPI Energies, 11, 2, 1–20. https://doi.org/10.3390/en11020358

Ullah, I., Ahmad, S., Mehmood, F., & Kim, D. (2019). Cloud Based IoT Network Virtualization for Supporting Dynamic Connectivity among Connected Devices. MDPI Electronics, 8, 7, 742. https://doi.org/10.3390/electronics8070742

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

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

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

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

World Port Sustainability Program. (2019). Port of Bari – Artificial intelligence for environmental monitoring and prediction. Retrieved October 16, 2019, from https://sustainableworldports.org/project/port-of-bari-artificial-intelligence-for-environmental-monitoring-and-prediction/

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

Zghurovsky, M., & Zaychenko, Y. P. (2019). Big Data: Conceptual Analysis and Applications. Retrieved from https://www.springer.com/gp/book/9783030142971

Zyskind, G., Nathan, O., & Sandy' Pentland, A. (2015). Decentralizing Privacy: Using Blockchain to Protect Personal Data. Retrieved from https://www.enigma.co/ZNP15.pdf