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# DISRUPTIVE INNOVATIONS IN ELECTRONIC TRANSPORTATION MANAGEMENT SYSTEMS

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**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.

## 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 & Akpınar, 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, Antolíns, 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**

	<b>Challenges</b>	<b>Author(s)</b>
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 & Akpınar, 2014b)
	The firms' inability to adopt to new innovations	(Gemici & Alpkın, 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 & Akpınar, 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, repurposed 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**

	<b>The impact</b>	<b>Author(s)</b>
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 of 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 peak 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 Blockchain 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.

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