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Marija Jović

Edvard Tijan

Saša Aksentijević

Božidar Sotošek

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The Role of Electronic Transportation Management Systems in Seaport Digitalization

MARIJA JOVIĆ, EDVARD TIJAN, SAŠA AKSENTIJEVIĆ & BOŽIDAR SOTOŠEK

Abstract The volume and speed of information exchange among the stakeholders rose with the increase of transport and cargo volume in seaports. Several ways of communication between stakeholders exist, such as electronic exchange systems, shipping web portals and eCommerce. Electronic Transportation Management Systems (e-TMS) tackle the issue of non-uniform format standards and the means of messages exchange which can be solved by the adoption of Mediation Service Software and Electronic Transaction Platforms. With this adoption, the difference between efficient and inefficient traffic management systems becomes clearly visible. Inefficient systems do not possess the possibility to optimize business processes. The development of e-TMS also aims to solve economic and ecological issues. It allows centralized monitoring of business processes, optimization of transport chain management, and gathering data in a way that enables improved decision making.

Keywords: • Electronic Transportation Management Systems • Seaports • Digitalization • Business Processes • Seaport Digitalization •

CORRESPONDENCE ADDRESS: Marija Jović, University of Rijeka, Faculty of Maritime Studies, Rijeka, Croatia, e-mail: jovic@pfri.hr. Edvard Tijan, PhD, University of Rijeka, Faculty of Maritime Studies, Rijeka, Croatia, e-mail: etijan@pfri.hr. Saša Aksentijević, PhD, Aksentijević Forensics and Consulting, Ltd., Viškovo, Croatia, e-mail: sasa.aksentijevic@gmail.com. Božidar Sotošek, Panalpina Croatia d.o.o, Rijeka, Croatia, e-mail: bozidar.sotosek@panalpina.com.

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1 Introduction

Business processes, i.e. physical transactions that are present in seaports differ in developed and underdeveloped seaports. While the electronic data exchange is the basic mode of information exchange in developed ports, the flow of information is slower in less developed ports, mainly because of the presence of paper document exchange. According to Deloitte Port Services, there are four levels of seaport digital integration ("Deloitte Port Services - Smart Ports," 2017): port authority digitalization, port terminal integration, port-city integration and wider supply chain integration. Initially, the ports were focused only on loading and unloading operations and the development of infrastructure. The next phase of integration includes digitalization of the port terminals which includes the unification and standardization of the business processes of the seaport and the surrounding area (other stakeholders), while the final phase refers to broader integration that includes the whole supply chain, leading to full integration.

The need for faster business operations among agents, forwarders and their customers increased with traffic and cargo volume increase. According to European Commission's Proposal for a Regulation of the European Parliament and of the Council on electronic freight transport information (the European Commission, 2018), the information exchange is still largely conducted via paper documents, in a variety of formats; 99% of cross-border transport operations on the territory of the EU still involve paper-based documents at one stage of the operation or another. Costs, time and predictability are decisive factors for companies' competitiveness ("2017 Transportation Management Systems Trends," 2017). One of the problems, or issues that arise from the traditional (paper-based) data exchange in transportation are increased administration costs. Electronic data exchange allows a cut in administrative costs which could create savings of between €20 and 27 billion within the transport sector over the period from 2018 to 2040, according to Commission estimates (the European Commission, 2018). Electronic transportation management systems (e-TMS) can save companies' money by lowering their freight spend (ARC Advisory Group, 2018).

Harmful emissions represent the other problem caused by increased traffic volumes and traffic congestion. Close to 25% of the global CO2 emissions is caused by transport, and between 30 and 40% of this total is produced by cargo transport ("Transport's role in reducing CO2 emissions," 2018). The effective transportation systems should provide an optimal route with recommended optimized non - work stops (Nimchuk and Mckinney, 2018). However, not all participants are taking advantage of the vast benefits a TMS provides (Cerasis, 2016). According to Dreßler, each participant organizes his own transport processes without informing other participants, although the smooth flow depends on communication (Dreßler, Beißert, Beyhoff, and Wirtz, 2016), (Mei and Afli, 2017).

This article focuses on the following research question: What is the role of electronic transportation management systems in seaport digitalization? This question was addressed through a systematic literature review.

The authors will analyse the current state-of-the-art in using electronic transportation management systems, and compare the consequences of using the electronic/digital document exchange, as opposed to paper document exchange. The goal of the research is to prove the importance of electronic transportation management systems in seaport environment. Transparency and easy access to data are the basis for successful seaport business. Therefore, the research problem stems from increased costs and lost time due to the archaic or inadequate execution and monitoring of business processes. This paper presents a review of research papers dealing with this topic, providing a better understanding of eTMS implementation.

2 Methodology

The literature review was conducted in order to research the theoretical foundations of electronic transportation management systems. This article follows a systematic literature review method, which adheres closely to a set of scientific methods that aim to limit systematic error (bias), mainly by attempting to identify, appraise and synthesize all relevant studies (Reis, Amorim, and Melao, 2018). The systematic literature review method is also used as a key mechanism to promote diversity of knowledge in a certain domain (Savaget, Geissdoerfer, Kharrazi, and Evans, 2019).

The authors started with the inclusion criteria by using a combination of keyword "electronic Transportation management system" and alternative keyword "Transportation management system" (title, abstract and keywords). Google Scholar, ResearchGate and SpringerLink's databases were mainly used for this purpose. The search for articles was conducted according on the time limitations (2016-2018) 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.

3 Theoretical framework

Several IT-based solutions exist that enhance communication between agents, shippers, forwarders and other stakeholders:

1. eCommerce: can be categorized according to the type of product, service and platform(Dr Wu, Starr, and Tan, 2017),
2. Shipping web portal or Multi Carrier Web Portal: Shipping portals are web-based communities that allow access to multiple carriers' services through a single site and on a global level,
3. Electronic exchange systems: e.g. Port Community System (PCS).

"Transportation management system adoption rates for smaller shippers has hovered in the 10% range, according to Bart De Muynck, Gartner research director, while about 25% of medium-sized firms and 50% of large organizations used the application to manage their freight activities" ("2017 Transportation Management Systems Trends," 2017). Another research about TMS has been conducted by MarketsandMarkets, a company which, according to their claims, provides quantified B2B research on 30,000 high growth emerging opportunities/threats which will impact 70% to 80% of worldwide companies' revenues ("Market Research Reports, Marketing Research Company, Business Research by MarketsandMarkets," 2018). According to their data, it is anticipated that "the global transportation management system market is expected to grow from USD 78.20 billion in 2017 to USD 202.14 billion by 2022, at a Compound Annual Growth Rate (CAGR) of 20.9%"("Market Research Reports, Marketing Research Company, Business Research by MarketsandMarkets," 2018). Bart De Muynck mentioned two emerging growth markets for TMS; first, the continued international growth in Asia (especially China) and Europe in 2017, and second,

the continued growth of TMS in smaller organizations with less complex transportation management needs (Muynck, 2018).

According to S. Kaewunruen, J. M. Sussman, and A. Matsumoto, there is a variety of transportation systems, including land transportation (road, rail, and maglev), aviation (airplanes, rockets), maritime (ferries, ships, ports), and pipeline (tunnelling, risers, Hyperloop) (Kaewunruen, Sussman, and 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. "These complex sociotechnical systems are interconnected, and undoubtedly, the behind-the-scene catalyst is essential for building new capabilities and innovation as well as improving efficacy and effectiveness of other businesses and industry sectors, such as resource logistics, agriculture, real estate, etc."(Kaewunruen et al., 2016).
Within TMS, one building block that composes it is the vehicular ad hoc networks (VANETs), which provides data exchange between vehicles, roadside units and Traffic Management Centers. Two communication types are enabled in TMS by VANETs. The first one is vehicle-to-vehicle (V2V) communication, used when the vehicles communicate among themselves without the need for any infrastructure. The second one is vehicle-to infrastructure (V2I) communication, used when a vehicle needs to send its information or request some information to/from a central entity and also when a vehicle needs to access certain content in the Internet(De Souza et al., 2017).

Electronic data exchange (EDI) is the electronic, computer-to-computer exchange of business information in a structured format between business trading partners or between various units within an organization (Njoni, Semutwa, Mbaabu, and Osoro, 2016). EDI is being used by many companies to order and pay for goods from suppliers to arrange transportation with carriers to receive orders from customers to invoice customers, and to collect payments from customers (Njoni et al., 2016). In addition to the freight transport problems, problems can arise in the TMS software itself. The problem of the TMS software is "the lack of uniform standards for format and ways of exchanging messages" (Petrović, V.; Badurina, R.; Tijan, 2017). Two solutions used for communication between transport organizers and shipping companies are (Petrović, V.; Badurina, R.; Tijan, 2017):

1. Mediation Service Software (MSS): The mediation services include sending the compulsory data regarding the weight of goods, transport booking, sending shipping instructions, tracking the movement of containers, the exchange of bill of lading data, etc.

2. Electronic Transaction Platform (ETP): Users of electronic transaction platforms are able to communicate with a large number of global shipping companies in a standardized way. It is possible to use a software package (dedicated web portal or an application) or to integrate own applications with the electronic transaction platform.

4 Transportation issues

There are a lot of transport issues such as traffic congestions, redundant administration, loss of time due to unnecessary waiting, etc. "Traffic jams become a common obstacle, so the companies have to move containers as early as possible in the morning and complete all tasks in the afternoon before the rush hours; the overall operational performance of drivers is not efficient since they waste more time on waiting for containers for loading on trucks" (Shi, Arthanari, Liu, and Yang, 2018). Furthermore, traffic jams can also be considered from an ecological point of view. Sustainability is one of the main business considerations, and a lot of effort is being invested in the creation of guidelines and processes that will enable sustainable business.

The difference between an effective and ineffective transportation management system is shown in the Figure 1.

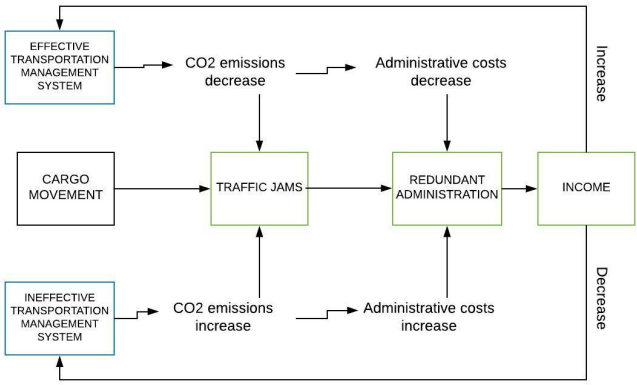

Figure 1: The difference between an effective and ineffective transportation management system. Source: Authors, according to (the European Commission, 2018), ("Transport's role in reducing CO2 emissions," 2018), (Shi et al., 2018)

The total logistics costs in supply networks varies in different countries, from 10% of the GDP in the US to 20% of the GDP in Singapore or the Russian Federation (Lukinskiy and Dobromirov, 2016). A large-scale analysis enables categorizing expenses by their basic components: transportation (40-45%), storage and stock management (30-40%), and administrative and managerial functions (up to 15%) (Lukinskiy and Dobromirov, 2016). According to the European Commission, total costs spent processing freight transport for all transport modes were 7,89 billion euros in 2018; road sector amounted to 5,962 billion euros, rail sector 507 million euros, inland waterways 582 million euros, maritime sector 814 million euros and aviation sector amounted to 25 million euros. Increased administrative costs are the result of increased traffic, but also weak acceptance of platforms that allow electronic data exchange(the European Commission, 2018). The official report of the United Nations Commission on International Trade Law (UNCITRAL) estimates the costs of the shipping documents at $ 420 billion per year at a global level (Mai and Doan, 2018). In particular, in 2014, the Maersk shipping company estimated that "a shipment from East Africa to Europe could involve nearly 30 people and approximately equal number of organizations and generate about 200 communications and transactions"(Mai and Doan, 2018).

The importance of electronic data exchange and the need for elimination of old-fashioned business practices has been shown in the European Commission's Proposal for a Regulation of the European Parliament and of the Council on electronic freight transport information(the European Commission, 2018). Baseline scenario in Table 1, depicting assumed situation, is used as a basis for comparison. Table 1 shows the forecast of administrative costs per sector and the means of document exchange (the European Commission, 2018).

Table 1: Estimated administrative costs in the baseline scenario (millions of euros)

Sector	**2025**			**2030**		
	Digital	Paper	Total	Digital	Paper	Total
Road	140	6474	6614	250	6776	7026
Rail	40	536	576	66	559	625
IWT	7	628	635	18	656	674
Maritime	9	873	882	25	901	926
Aviation	11	20	31	15	21	36
Total	8738			9287		

Source: Proposal for a Regulation of the European Parliament and of the Council on electronic freight transport information, European Commission, 2018., part1/2 https://eur-lex.europa.eu/resource.html?uri=cellar:810e3b10-59bb-11e8-ab41-01aa75ed71a1.0001.02/DOC_1&format=PDF (07.01.2018.)

From the table, it is apparent that the costs of paper exchange would be much higher than the digital/electronic information exchange. The majority of costs would be incurred in the road sector which would maintain its dominant role within the EU in 2025 and 2030. The aviation sector would record the lowest administrative costs.

The importance of electronic exchange of maritime cargo documents, that are increasingly present in international trade, can be seen through the example of the "Bill of Lading" (BL). BL is one of the most important documents in the transportation sector. According to C. Dr Wu, L. Starr, and J. Tan, three main problems associated with the paper BL are (Dr Wu et al., 2017):

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 by 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.

Since ports as traffic nodes cannot act autonomously, it is necessary to develop good ties with the hinterland, and ultimately create a platform that will connect all the supply chain stakeholders. Some seaports operate without integrated e-business platforms covering all business processes, and that is why certain stakeholders are not sufficiently integrated into the transport chain. In such cases, certain segments of the information systems are combined, but parallel records are required to track business processes in the transport chain.

Due to the large differences in information flows within companies, but also between them, data exchange and electronic transaction management can be difficult. The presence of inefficient paper-based exchange was researched in a survey conducted in 400 IT and non-IT managers in the US, Canada, Brazil, the UK, France, Germany, Australia, and Japan employing over 500 people ("Digital transforms the game of business -digital transaction management emerging as key solution," 2015). In this survey the companies had to self-declare the adoption of paperless business processes, depending on "completely analogous (paper-based processes), to fully digital", and to evaluate whether IT managers understand the importance of digitalization of business processes and digital transaction management compared to the results of non-IT managers. Although most of the processes are digitalized, IT managers have declared that 71% of the processes are "fully digital", while non-IT managers have declared that 58% of the processes are "fully digital". The results show that 30% to 42% of their processes are partially digitalized. 80% of the costs and inefficiencies in their transactions are caused by an analogous mode of operation, which imposes a significant burden on companies.

It is important to timely recognize which trends affect the company's development. Core findings of the DVV Media Group GmbH study "Trends and strategies in logistics and supply chain management" are as follows (Kersten, Seiter, Von See, Hackius, and Maurer, 2017):

1. Digitalization of business processes and transparency in the supply chain are the most important trends that companies will need to develop considerably in the future,
2. Compared to 2012, the importance of sustainability has markedly increased, and
3. The overwhelming majority of companies still have a substantial potential for improvement in terms of their individual capacity to adapt to existing trends.

5 Discussion: Positive Effects of Transportation Management Systems Transportation issues

The advantages of electronic or digital data exchange are demonstrated in the aforementioned survey ("Digital transforms the game of business -digital transaction management emerging as key solution," 2015). According to the survey, the positive effects of the advanced transactions management are: improving efficiency (such as eliminating costs associated with paper-based transactions); improved security and compliance with clearer tracking and monitoring of documents and approvals; improved customer experience with faster access to documents and a more streamlined experience; greater agility (such as the ability to make changes faster); accelerated revenue (reducing of transaction cycle time and faster business closing) and improved business insight through reporting and analytics. According to Cerasis , "Rather than having a single person keeping track of multiple products, shipments, and solutions, these transportation management systems organize everything into precise, easy to read lists that can then be used effectively to make the best decision possible" (Cerasis, 2016).

The TMS should be implemented throughout the supply chain as the transportation is a very important segment of each supply chain. According to Dreßler, existing IT-systems do not support a holistic planning of transport considering all participants and their available resources (Dreßler et al., 2016).

According to Mei and Afli, the benefits of using the supply chain management systems are (Mei and Afli, 2017):

1. It provides all the elements involved in the cycle with the right information at the right time,
2. It helps to eliminate unnecessary waste of materials and resources,
3. It contributes to reducing the overhead cost of production since it gives the manufacturer the target amount of goods and services to be produced at a particular time and period, and
4. It helps organizations to meet the needs of their customers in time.

Currently, the attention is being paid not only to economic but also to the ecological issues of seaport business, with the aim to lower the damaging impact on the environment. The most developed seaports draw attention to the priority development tasks which refer to business and the overall development of the seaport system. Unfortunately, in certain less developed seaports, a lack of awareness of the importance of the seaport system development is present. Development of Electronic Transportation Management System could have positive effect on fuel consumption and the reduction of CO2 emissions and other harmful emissions (Shi et al., 2018).

Transportation Management Systems, as stated before, reduce overall costs of transportation. They collect data such as rates and vendor options in a clear, simplified, and prioritized format to aid in the decision-making process. TMS are used by companies to strategize, plan, and execute shipments (Cerasis, 2016). According to OECD research on "Trade facilitation indicators", harmonizing trade documents, streamlining trade procedures, making trade-related information available and using automated processes could reduce total trade costs by 14.5% for low-income countries, 15.5% for lower-middle-income countries and 13.2% for upper-middle-income countries (COMCEC, 2017).

According to the survey-based research of ARC Advisory Group "The Transportation Management Systems Market Research Study", freight savings of approximately 8% could be achieved with the use of an TMS application. Nearly 60% of respondents indicated that less than 10% of the net savings were attributed by the TMS. These freight savings can be attributed to network design, load consolidation, multi-stop route optimization, improved data for

procurement and freight audit (ARC Advisory Group, 2018). According to G. Nimchuk and D. McKinney, "Drivers using this system may be given the ability to manipulate portions of dispatched trip plans through selection of alternative stop locations. The transportation management system may also be configured to calculate and frequently update the ETA for every stop on a planned trip; such updating of the ETA may be performed by the system during the trip planning stage and during actual execution of the trip plan" (Nimchuk and Mckinney, 2018).

6 Conclusion

Business processes related to the transport of goods include numerous stakeholders such as agents, forwarders, carriers etc., (depending on the type of transport). Seaports are important hubs in international trade. The role of seaports was initially focused solely on loading and unloading operations, and not on the development of quality relationships with stakeholders, especially clients. Electronic information exchange and digitalization efforts were usually initiated by the seaport authorities. Over time, electronic exchange was applied by a wide range of stakeholders.

Transparency and easy access to data are of the utmost importance for successful seaport business. The most advanced seaports draw attention to the priority tasks related to business development and the overall seaport system development. Unfortunately, in less developed seaports, there is lack of awareness about the importance of seaport system development. The development of e-TMS enables the stakeholders to centralize the monitoring of business processes. Its implementation provides a number of advantages such as the optimization of the transport chain management, as the key stakeholders such as seaport administrative bodies, freight forwarders and carriers become interconnected. The e-TMS arranges all available information in an accurate and easy-to-read manner, and it helps to make optimal business decisions. Furthermore, not just economic but also ecological issues have been considered, where damaging environmental effects could be reduced by the adoption of e-TMS. It enhances the level of business organization which also reduces harmful emissions that may be caused by, for example, traffic congestion.

Mediation Service Software and Electronic Transaction Platforms represent solutions for communication between transport organizers and shipping companies. The main issue thwarting the adoption of the TMS software is the lack of uniform standards for message formatting and means of their exchange. The consequence of insufficient networking on the intermodal level leads to many problems such as increased costs and time loss caused by non-harmonization of business information systems, with the final consequence being reduced interoperability between the information systems.

The research (through a systematic literature review) proved that the management and decision-making in the modern ports can be made more efficient, effective and sustainable by using e-TMS. It can also be used as a basis for future research and further theoretical development.

The research is based solely on the literature review and as such offers the initial overview of transportation issues and the positive e-TMS impacts, which is also the main limitation.

Future research will be focused on the real challenges that transportation enterprises face regarding the e-TMS implementation. For that purpose, case studies of leading enterprises will be presented in order to identify the factors which affect the successful implementation of e-TMS. Furthermore, based on these results a wider survey will be conducted among a larger set of transportation enterprises.

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