A SYSTEMATIC LITERATURE REVIEW LOOKING AT DIGITIZING CONTAINER HARBORS

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Abstract

This article presents a systematic literature on the use of information technology within the field of maritime shipping. First, the review scope, the search terms, the data sources, the search process, the inclusion and exclusion criteria, and the data extraction and analysis procedures are presented. The findings show that RFID is still reported to be in its infancy. Truck appointment system might only work in certain situations as truck drivers might not have a choice of when to pick up its container. There is no centralization of the operation. Creating a digital dashboard to display potential wait-time based on past days truck companies can better plan their day if they have the chance to do so. The benefits of such system are to offer real-time information to its users. Digitalization also allows for predictive analytics to take place this takes the process to another level.

Keywords*: Digital dashboards, Mobile Application, Truck Appointment System, Smart Port, Harbor.*

INTRODUCTION

Ports located within cities are commonly experiencing traffic congestion on the roads that are leading to the port area. These ports were commonly built at a time when the amount of cargo being shipped was low, containers were not yet invented, and there were no cars and trucks on the road. Time and money are wasted when trucks are queueing, and the resulting emissions are detrimental to the environment. Today, worldwide, shipping accounts for more than 90% of the transport of goods in the world, and in 2008 around 8 million tons of goods were transported by various types of ships (Fruth and Teuteberg, 2017). The digital transformation of ports appears to be a slow process, even though the use of IT may be a necessity to address current and future challenges (Heilig and Voß, 2016).

BACKGROUND

The use of information technology (ICT) within shipping gives more rapid access to information for shippers and carriers, improved communications with customers and business partners, helps the reduction of costs, gives higher productivity, and a better quality of service. The use of information technology consists of three main phases; communication, cooperation and co-evolution. The communication phase encompasses the technology used for communication with vessels, which originally was the telegraph and telex. Since the 1960s, computers can be interconnected to a network, and this allowed information to be processed and managed much faster and more cost-effectively than was previously possible. The cooperation phase consists of the use of electronic systems for the processing of orders, sales, negotiations and contracts, etc. The introduction of EDI-systems is part of this phase. The co-evolution phase is described as a phase where cooperation between customers and companies (including competing companies) leads to a community which is sharing business, knowledge and infrastructure (Nikitakos & Lambrou, 2007).

The first and second generations of digital transformations were mostly focused on establishing the foundation for improved information flows in terminals and port communities, and to enable and improve terminal automation, trading, and interaction between different actors. The development of EDI, and the first EDI-based port community systems (PCS) in 1983, enabled electronic document exchange between actors which were involved in port operations. In the late 1980s the first terminal operating systems were introduced to the market. Technologies such as GPS and RFID were introduced in the mid-1990s and are used to improve the efficiency and safety of port operations. At the end of that decade systems using optical character recognition (OCR) were introduced to aid in inspection procedures. Another technology which was introduced during this decade is the automatic identification system (AIS). The first decade of the 2000s brought truck appointment systems (TAS) which are designed to reduce truck queueing at terminal gates (Heilig, Lalla-Ruiz, and Voß, 2017).

Vessel Traffic Services (VTS) are systems which provides various types of information to ships, in order to provide efficient, environmentally friendly, and safe navigation within an area. It is also used by coastal authorities to keep track of the ships in their areas. Originally, ships would announce their arrival at a port using flag signals. In the 19th century, radio technology was used for communication. Later, VTS became a radar-based system, used to track and to assist in safe port entry when there was poor visibility. The first formal VTS systems combined the tracking ability of radars with the facility to send messages concerning navigation by radio to ships (Organization Maritime International, 2018).

AIS is a digital information system which broadcasts a ship's position, speed, draft, the ship's call sign, the MMSI (Maritime Mobile Service Identifier), among various other information. This information can be received by other ships and by shore-based base stations (Tandberg, 2011; YaoYu and ChangChun, 2011). The International Maritime Organization mandates the use of AIS technology on vessels of 300 gross tonnage and over which are doing international voyages or calling ports in the EU, cargo ships of 500 gross tonnage and over, and on passenger ships (International Maritime Organization, 2018). AIS may be used for collision avoidance, track ships and their cargo, and for traffic management (Tetreault, 2005).

RFID may be used for several purposes in the port environment. It may be used at the gate, in order to collect information about the vehicles (trucks) and their drivers by using an RFID-tag that has been fixed to the front window of the vehicle. RFID tags also has applications in the port area. RFID may be used to record when a container has been locked and unlocked, in order to detect whether any tampering has taken place. This use of the technology is known as E-Seals. RFID-technology may also be used for container tracking, when at least two container terminals have implemented the technology. However, the use of RFID within container transportation is currently still in an early stage (Shi, Tao, and Voß, 2011).

Container terminals offers transfer facilities to move containers between vessels and trucks and vice versa. Mandatory Truck Appointment Systems, where the drayage firms book appointments at specific time slots, enables the terminal to provide fast service of inland transport nodes. This can be a strong competitive advantage. The trucks enter the container terminal at the designated time slots to deliver or to pick up containers (Zehender and Feillet, 2014). However, events such as bad weather, delayed cargo, traffic jams or technical problems at the container terminal means that it at times may not be possible for a truck to utilize the assigned timeslot (Li, Chen, Govindan, and Jin, 2018).

Digital transformation has potential to change the shipping industry. Currently, big data, modelling and simulation are some of the important topics within the field (Fruth and Teuteberg, 2017).

RESEARCH METHODOLOGY

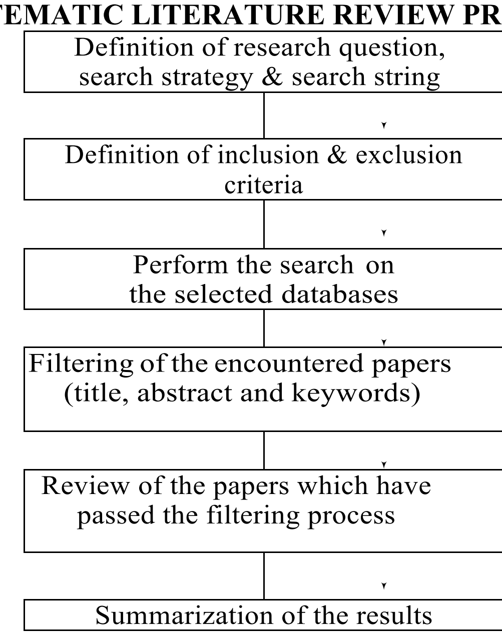
Systematic literature reviews are performed to discover what has previously been written on a topic, to answer practical questions about what existing research has covered about a subject, or to provide a theoretical background for subsequent research. A systematic literature review may also be used as a starting point for research for others who have interest in a topic (Okoli and Schabram, 2010). In order to gain a relevant insight into the topic of information sharing and road-based container transport in combination with maritime shipping (also known as drayage), it was determined that it would be helpful to perform a systematic literature review. This review was conducted according to the guidelines described by Kitchenham (Kitchenham, 2004).

Search Terms

The following search string was used when searches were performed in the databases:

"smart port" OR "gate appointment system" OR "truck appointment system" OR customer AND (hinterland OR drayage) OR information AND (drayage OR hinterland)

FIGURE 1
SYSTEMATIC LITERATURE REVIEW PROCESS



The terms "*smart port*", "*gate appointment system*", "*truck appointment system*" were selected as these terms are highly relevant to this topic. Relevant synonyms were considered for inclusion to the search string. It was deemed necessary to add the terms "*customer*", "*shipping*", and "*hinterland*" in order to ensure that it would be possible to find sufficient amount of relevant studies.

Inclusion and Exclusion Criteria

A study selection is done in order to be able to find papers which have relevance to the research questions. A key criterion was that the study must have a focus on the customers' use of information technology within the field of maritime shipping.

The articles collected are limited to 5 years (2014-2018). The following inclusion criteria were formulated:

- The paper must contain at least one of the following words in the title, abstract, and/or keywords: a) gate appointment system, b) truck appointment system, and c) smart port.

- In the abstract, keywords and/or the title, the word "customer" must exist in combination with one of the following terms: a) drayage, b) hinterland, c) maritime shipping.

- In the abstract, keywords and/or the title, the word "information" must exist in combi- nation with one of the following terms: a) drayage, and b) hinterland.

- The paper must either: a) have relevance to the topic of road-based transport of containers within the field of maritime shipping, and b) be a review related to the topic of information sharing within the field of maritime shipping.

- The paper must be an academic work, which has been published in a journal or in a publication of proceedings. The full text of the paper is available. The exclusion criteria are as follows: a) the full text is not available through the libraries which Østfold University College has access to, b) the study has not been published in the English language, c) the title and/or the abstract does not match the inclusion criteria, d) the article has no relevance to the research questions.

Data Sources and Search Process

The search strategy used for finding the relevant literature is described. The following databases were used to find relevant literature:

- IEEE Explore (https://ieeexplore.ieee.org/)
- Science Direct (https://www.sciencedirect.com/)
- Springer Link (https://link.springer.com/)

These databases were chosen as they are among the most relevant sources of articles within the broad field of computing. A search was also conducted on ACM Digital Library (https://dl.acm.org), however the search string had to be rewritten to fit the requirements of the search interface of this database For all of the results, the titles and keywords were reviewed for relevancy. Articles which were deemed irrelevant were discarded. The remaining articles were saved in a reference management system for further review. The titles, abstracts and keywords of the saved articles were read, and checked against the inclusion and exclusion criteria. The full text of the articles which passed the inclusion criteria were read. In some cases, the title, abstract and the keywords of an article passed the inclusion criteria, but upon reading the full text, it was apparent that the article did not pass the criteria. When this was the case, the article was rejected.

SYSTEMATIC LITERATURE REVIEW RESULTS

All of the encountered papers were checked against the inclusion and exclusion criteria. Table 1 displays the number of articles which were returned by the given database after specifying that only freely available studies should be listed by the library database. This was necessary when searches were performed on Springer Link. When searching on Science Direct, it was specified that the search string should be used with only the title, the abstract, and the keywords.

TABLE 1
THE RESULTS OF THE FILTERING PROCESS

Database	Total number of results	Number of papers selected based on title, abstract and/or keywords	Number of papers selected based on the full text (content)
IEEE	43	12	7
Science Direct	147	13	13
Springer Link	442	10	5
Total	632	35	25

When the search string was entered into Springer Link, a total of 3463 results were returned by this database. In order to find relevant studies, the search was limited to a number of disciplines. Table 2 lists the disciplines selected and the number of papers encountered within these disciplines. Several other disciplines were also investigated but were found to have no relevant articles.

TABLE 2
THE RESULTS OF THE FILTERING PROCESS

Discipline	Total number of results	Number of papers selected based on title, abstract and/or keywords	Number of papers selected based on the full text (content)
Logistics	38	1	0
Business and Management	110	3	3
Economics/ Management science	58	0	0
Social sciences – geography, general	107	0	0
Computer Science	41	0	0
Engineering	88	6	2

The main findings are that the encountered studies which relates to research question 1 can be classified into two categories, "*reviews*" and "*models and algorithms*". The studies which can be categorized into the former category consists of literature reviews and studies on various topics related to information technology, ports (including smart ports) and drayage. Studies which belongs to the category "*models and algorithms*" contains scheduling algorithms, disruption management, routing of drayage trucks, combining of orders to reduce the number of trips with empty containers, and collaboration- and optimization models for use with truck appointment systems. The studies in this category also contains results of experiments/simulations which have been performed to test the proposed models.

TABLE 3
ARTICLES RELEVANT TO RQ´S

RQ	Relevant Articles	Articles
RQ1	Daham, Yang, and Warnes, 2017; Douaioui, Fri, Mabrouki, and Demma, 2018; Escudero, Munuzuri, Guadix, and Arango, 2013; Gracia, Gonzalez-Ramırez, and Mar-Ortiz, 2017; Heilig and Voß, 2016; Huiyun, Xin, Lixuan, Xiangjun, Zhihong, and et al., 2018; Ku and Arthanari, 2016; Li et al. 2018; Nabais, Negenborn, Benitez, and Booto, 2013; Namboothiri and Erera, 2004; Namboothiri and Erera, 2008; Phan and Kim, 2016; Ramirez-Nafarrate, Gonzalez-Ramirez, Smith, Guerra-Olivares, and Voß, 2017; Shiri and Huynh, 2016; Shuo, Jian, and Ruoxi, 2016; Schulte, Gonzalez, and Voß, 2017; Torkjazi, Huynh, and Shiri, 2018; Wickert, Sonntag, and Meimbresse, 2012; You and Ritchie, 2017; Zehendner and Feillet, 2014; Zhang, Lee, and Li, 2016; Zouhaier and Said, 2016	22
RQ2	Gracia et al., 2017; Ku and Arthanari, 2016; Namboothiri and Erera, 2004; Zhang et el., 2016	4

Note. Gracia et al. were applicable to both categories.

The following research questions have been formulated for this systematic literature review:

- What have the published studies reported on the topic of the use of information technology with a focus on the customers, within the field of maritime shipping?

- What are the reported advantages and disadvantages of the use of these systems?

In this context, the customers are typically freight companies and truck drivers and the goal is to use this information to further develop a digital dashboard.

Research Question 1

It was found that the studies which answered RQ 1 could be grouped into two distinct categories in order to increase the readability of this literature review, "*reviews*" and "*algorithms and models*". The subsections can be seen below.

Reviews

The following segment discusses reviews related to information sharing within the field of maritime shipping.

Wickert et al. (2012) performed a study on several topics related to ICT and container terminal management. The study starts with a review on the research and development of ICT management in container terminals. One finding in this review is that with transshipment terminals in the hinterland, the efficiency is strongly influenced by the physical and the information related infrastructure. To develop and to implement a container terminal system is a process that is costly. Seaport terminals can handle the costs of using large software systems, due to the large amounts of cargo that is being moved, and the associated revenue and profit. For hinterland terminals, this is generally not the case, as they do not have this possibility due to financial reasons. Processes are often performed on paper or with the aid of spreadsheet software. This also means that exchanging data with other tools is difficult or not possible. In order to perform optimization and to achieve faster processing of containers, it will be necessary to develop ICT tools which are suitable from a financial and operational viewpoint. The development of operation concepts that are seen as innovative is also a necessity. The paper mentions that some pilot projects were being conducted on this topic. The study mentions that interacting pilots will be the best way to perform development, as the actors in the pilot can determine whether a solution meets their needs. A number of case studies, which describes several pilot projects and their results is described at the end of the paper. Among the results, it was found that predictive process optimization can be achieved when there is a high level of automated data input, instead of when much data has to be entered into systems manually.

Shuo et al. (2016) investigated the implementation of smart port technology in Huizhuo, China. The implementation was performed in order to increase the competitiveness, efficiency and quality of the port. The study notes that smart port technology enables the centralization and exchange of information. The system will use GIS, display tide and water depth, the berth vessel type and the state of the vessels, pier allocation of equipment, anchorage state, and to display the ship's current situation within the terminal operation.

Heilig and Voß (2016) performed a comprehensive review of information systems and related information technologies in seaports. The paper gives an introduction to various technologies and how these are used in drayage and ports (container terminals). Some of the technologies are EDI, GPS, OCR, RTLS, RFID, and WSN (wireless sensor networks). The paper notes that within the field of shipping, the use of RFID and mobile devices is still in its infancy. The papers also present a survey of information systems in seaports. Among the systems mentioned are port community systems (PCS), vessel traffic services (VTS), terminal operating systems, gate appointment systems, automated gate systems, automated yard systems, systems used for traffic control information, intelligent transport systems, and hinterland intermodal information systems for ports. Both the core technologies and the information systems are described in detail, with numerous references.

Douaioui et al., (2018) performed a study on the topics of smart logistics and smart ports. The authors determined the major challenges which have led to research on the topic of smart ports. The main pillars of smart ports and their success criteria has been determined by the authors. According to the study, there is no single definition of the term smart logistics. However, the term focuses on the development of technology in four main components, which includes information and communication technologies, and efficient scheduling. Another finding is that smart ports are based on the interconnection of the stakeholders of the port logistics chain, and on port automation.

Huiyun et al. (2018) has performed a literature review on truck appointment systems. The paper states in the introduction that truck congestion and environmental damage are global problems, and that truck appointment systems have become an important way to limit traffic. The paper gives a summary of collaborative optimization, modelling methodologies, queueing structures, research points, in relation to truck appointment systems. The paper proposes three possible directions for future research.

Algorithms and Models

The following segment presents algorithms and theoretical models related to drayage, scheduling, and truck appointment systems.

Namboothiri and Erera (2004) developed an optimization model for drayage operations which incorporates a time-dependent congestion delay at the port. The study notes that congestion can lead to inefficient drayage operations, and that drayage firms wants to complete the container move requests within the time windows, achieving a minimum total transportation cost. The proposed model contains a set partitioning integer programming formulation, a smart enumeration technique, and a solution heuristic based on column generation heuristics. The authors note that the model determines pickup and delivery sequences with a minimum of travel time. The computational results show that the heuristics are able to solve problems within a reasonable amount of time, and that the results are mostly almost optimal.

Namboothiri and Erera (2008) proposes a scheduling framework based on optimization, for determining high-quality schedules and truck routes for a drayage firm. The approach is based on a heuristic known as integer programming. This approach models a port access control system. A set of hypothetical problem instances were generated, which are similar to real-world drayage operations. The results of the performed computational experiments shows that the terminal operators must provide sufficient access capacity to the drayage firms, and that drayage firms have to make good appointment selections with the ports in order to maintain high levels of customer service. It was also found that the duration of the appointment window has an influence on the drayage firms' ability to provide a high level of customer service.

Nabais et al., (2013) proposes the use of a multi-agent system to guarantee cooperation among terminals in a seaport. The study considers the performance of a seaport its' the terminals within, by how content its clients are. A model is proposed, which considers the cargo type, the destination of the cargo, and when it is due. A control agent is assigned to each terminal, which solves an optimization problem. The control agent attempts to ensure that cargo arrives on time at the agreed locations. A simulation was performed using the proposed framework.

Escudero et al., (2013) proposes the utilization of real-time information about vehicles' positions, collected using systems such as Galileo, GLONASS or GPS. The paper describes the Drayage Problem with Time Windows (DDPTW), which seeks to find the best distribution of tasks to vehicles. This is done using an optimization algorithm which is based on heuristics and metaheuristics. Simulations shows that the proposed method reduces the number of unmet time windows.

Zehendner and Feillet (2014) proposes a mixed integer linear programming model, which aims to find the number of appointments to accept in a truck appointment system. The model considers the total amount of work to be done, and the available capacity for the handling of containers. The study has a focus on container terminals where straddle carriers are used to serve road-based modes of transport, such as trucks, trains, and modes of transport on water, such as barges and vessels. The proposed model determines the number of truck appointments to offer, as well as the number of straddle carriers to allocate to the various modes of transport. The model aims to reduce the total amount of experienced delays. Experiments were conducted using a model for optimization, and simulation model based on discrete events. This model was to evaluate the solution. The experiments were done using real-life events at the Grand Port Maritime de Marseille. The result shows that a well-considered truck appointment system can reduce the interruptions of barges, vessels, trains and trucks.

Phan and Kim (2016) proposes the use of a truck appointment system where trucking companies and terminals collaborate on determining truck operation schedules and appointments for the arrivals of trucks. The paper proposes a mathematical formulation for the appointment process. The mathematical model is elaborated using a numerical example. The truck operations are managed using penalties for appointment changes and failure to show up on the appointed time. Trucking companies submit their appointments to the terminal. The terminal operator informs the trucking companies with the expected time for each time interval and yard block. Trucking companies uses this information to reschedule their truck operations, and to change their appointment applications. The applications are then resubmitted to the terminal. It is a requirement that all appointment applications are confirmed by the trucking companies. Due to this, the submission process is repeated until the process is completed. The terminal operator may charge a penalty when trucks have been scheduled for arrival within peak hours. This is done in order to motivate the truck operators to schedule operations to off-peak hours.

Shiri and Huynh (2016) propose a mathematical model for the drayage scheduling problem with time window constraints (DSPTW). The model addresses the problem when there is a time window when it is possible to pick up or drop off a container at a customer, and at the same time also a time window set by the truck appointment system at the terminal. The aim is to determine the most optimal sequence for drayage for each truck in a sub-fleet. The proposed mathematical model is an extension of the multiple travelling salesman problem with time windows (m-TSPTW), with some differences. The model was tested with on a hypothetical network, by performing a series of experiments which had real-life characteristics. The results show that the model finds the optimal solutions within a reasonable time. Among the conclusions are that drayage firms benefits from truck appointment systems which minimizes gate queuing time, and that truck depots should be located close to both the terminal and the empty container depot.

Ku and Arthanari (2016) proposed a stochastic dynamic programming model, which is used to compute the expected minimum number of rearrangements of the containers within a single stack of containers. The containers have been given time windows for departure, which are decided by the truck appointment system.

Zhang et al. (2016) performed a study on information sharing in conjunction with the inland transportation of containers. The study is a theoretical study on the value of having specific information regarding containers, and how this information can be used to plan of the inland transport volumes of the different modes of transport (such as road, rail, or barge). The study found that performing partial information sharing gives most of the same benefits as the full sharing of information.

Zouhaier and Said (2016) presents an optimization model for truck scheduling, which takes into account the uncertainty of arrival time. The model attempts to reduce the truck deviation time, that is when the appointment time desired by the truck driver is not given by a truck appointment system. This may happen due to resource constraints at the terminal. Results given by the model are also presented.

Ramirez-Nafarrate et al., (2017) performed a study on potential configurations of a truck appointment system, and evaluated the impacts of this on yard operations, in relation to the export of goods. A discrete-event simulation model was used for the evaluation. The problem which has been analyzed is based on operations at the port of Arica in Chile. Due to increasing volumes of cargo, the port is experiencing problems with congestion. At the time the study was performed, there was no schedule for truck arrivals (i.e. no truck appointment system), and no information about any arrivals was available for the terminal. The model used contains a discrete-even simulation model of the gate, which is based on data from four days of operations at the terminal. The input data for scenarios when a truck appointment system was used, was based on data from the port of Sydney, Australia. The study found that the use of a truck appointment system can reduce waiting time and queue length at the gate, as well as the number of container re-handles at the yard. The paper notes that there are some challenges to handle when a truck appointment system is implemented, and that the design and implementation of such as system is not trivial.

Schulte et al. (2017) suggests the use of a truck appointment system to enable collaboration between truckers, in order to reduce the number of trips where the trucks are empty. This will help reduce the total amount of emissions generated by the trucks. The proposed solution considers CO_2 emissions, the reduction of emissions, and the cost objectives for a collaborating group of truckers. The study presents an optimization model based on the multiple travelling salesman problem, and numerical experiments performed using the proposed model. The results show that the proposed approach reduces both emissions and costs.

Daham et al. (2017) formulates a mixed integer linear programming model which handles the combination of orders in delivery to save transportation cost when there are orders with single and multiple destinations. The results show that the model achieves a reduction of cost of 23% compared to when individual deliveries are done. The model also decreases the number of empty trips.

Gracia et al. (2017) studied the impact of the use of lane segmentation policies and booking levels with a truck appointment system. The study was done using the characteristics of the container terminal in San Antonio, Chile. A simulation model was designed, with a terminating, non-state model, with no warmup bias. The model was run for a week. Three performance indicators were used in the model cycle. These measured the level of congestion along the entrance to the terminal per day, on the on peak and off-peak schedule. The results of the simulation show that the implementation of a truck appointment system will give benefits when it comes to the mitigation of congestion at the control gates of the port terminal. The port benefits by having advance knowledge of the aggregate amount of trucks per time zone (segment), in order to better be able to schedule the port's use of resources. The use of truck appointment systems may cause a reduction of emissions.

You and Ritchie (2017) proposed an analytical framework to process GPS data. The framework consists of eight steps to identify cycles and three criteria for the elimination of noise. The study found that drayage trucks which were a part of the Clean Trucks Program (CTP) in California, had some distinctive behaviors. Data was gathered from GPS units installed on these trucks. Using this data, it was found that trucks which the clean trucks at the San Francisco Pedro Bay had distinct trip characteristics and repetitive trip patterns.

Li et al., (2018) performed a study on disruption management using truck appointment systems. The study notes that services can experience deterioration due to events such as traffic jams, delayed cargo, bad weather, breakdown of the crane, etc. The study notes that when deterioration occurs, the truck appointment system does not work as intended. The study presents a set of key indicators to measure the performance of the management of disruptions, four strategies to handle disruptions, and the results of a simulation done using 125 numerical experiments. The results showed that the P&MM strategy revealed the best performance on the key performance indicators (KPI) when it comes to disruption recovery.

A paper by Torkjazi et al. (2018) extends the work and the model proposed by Shiri and Huynh (2016) by adding a new mathematical formulation, and by considering more than one drayage firm when appointment reservations are made. The model addresses the situation when a truck appointment system needs to consider the operation time of drayage firms and the queueing time at the gates of the container terminal. The methodology consists of four main steps where after the fourth step, adjusted appointment times are sent to the drayage firms. The allotted times may be adjusted by the firms. Numerical experiments were also performed. These were randomly generated but based on real life characteristics. The results show that the proposed truck appointment system gives a cost reduction of the drayage operation.

Summary

A majority of the studies presented algorithms and models related to drayage, scheduling, and truck appointment systems. In summary, researchers are pointing out that offering a digital system will help reduce traffic in and out of the port. The ports become more efficient with digitalization; one can more easily share information with its partners. Such as displaying the current situation in terms of ships arriving and the on and off-loading process. RFID is still reported to be in its infancy. Containers can be outfitted so clients can see where the container is in the process but this also requires the originator to share this information with the arrival port and trucking company so the entire trip can be tracked. In many harbors there might also be some pen and paper reporting which can add extra work. At the moment exchanging data is difficult as everyone operates with their own systems. Besides, a smart port system will help to centralize the operation. However, a truck appointment system might only work in certain situations as truck drivers might not have a choice of when to pick up but a system will certainly help the driver to see how long of a wait there is as each load takes approximately 15 minutes. Last, digitalization also allows for predictive analytics to take place this takes the process to another level.

Research Question 2

The following segment presents what the encountered studies have reported on the advantages and disadvantages of the use of information technology within the field of maritime shipping.

Namboothiri and Erera (2004) noted that environmental concerns rather than possible efficiency gains were the main motivation for the implementation of port access control systems (truck appointment systems) in the US. In addition, the study notes that in California, drayage firms may book appointments up to two weeks in advance of the day they are going to the port. It is possible for the drayage firm to decide later on which move request they want to serve in each appointment.

Ku and Arthanari (2016) reports that when a truck appointment system is utilized, the optimistic scenario is that all trucks arrive at the terminal at the designated time slots. However, this appears to be difficult to implement. The paper cites several studies which describe a number of reasons for why this is the case. Among the reasons given are congestion, inability to control border crossing time, and delays at the customer end, at marine terminals, or at other locations.

Zhang et al. (2016) notes that it is common that there is an absence of advance information. This may be caused by unconnected information systems - if there is such a system at all. For example, the bill of lading may be written by hand.

Gracia et al. (2017) report that one disadvantage of using truck appointment systems is that the system reduces the flexibility for the truck carriers. Some carriers may be unable to make a booking, due to the terminal’s need to balance the workload. In addition, some cargo may have to be delivered at a specific day or time.

Summary

As one notices there are both positive and negative opinions in regard to harbors offering a tuck appointment system such as better oversight for all parties, less wait time, less traffic congestions, less pollution, centralized operation etc.

Creating a digital dashboard to display potential wait-time based on past days truck companies can better plan their day if they have the chance to do so. Some truck companies have no choice of when they can pick up a container as their client might dictate when the container needs to be delivered.

To our knowledge, no study has been conducted on the use digital dashboards to share information with customers of harbors at the time of collecting this literature. A continuation of this systematic literature review should be conducted by looking at various digital options, create a prototype, and gather feedback from users employed in this industry. The benefits of such a system is to offer real-time information to its users being truck driver, harbor employees, schedulers etc. to ensure the harbor remains competitive in the future.

SUMMARY

This study presents the systematic literature review. A total of 632 papers were returned when the search string was entered into the databases. Of these, 35 papers were selected based on the titles, abstracts and/or the keywords. 25 of these articles were found to be relevant, when the full text was read. This systematic literature review can help anyone trying to digitize a harbor. To summarize our findings

- RFID is still reported to be in its infancy.
- Truck appointment system might only work in certain situations as truck drivers might not have a choice of when to pick up its container.
- There is no centralization of the operation. Exchanging data is difficult as everyone operates with their own systems. There is so many parties involved. Some ports still use pen and paper for some of its work.
- Creating a digital dashboard to display potential wait-time based on past days truck companies can better plan their day if they have the chance to do so. The benefits of such system are to offer real-time information to its users.
- Digitalization also allows for predictive analytics to take place this takes the process to another level.

To better prepare for the future and ensuring there is less of a footprint, it is important for the harbors to offer technologies to ease the delivery process. When a container ship arrives, it can carry 200 containers, and each truck can only carry one or two containers depending upon size. This gives a clear picture of the traffic situation. The big challenge is that every party operates with its own system and nothing is centralized. Some still operate with pen and paper. In conclusion, reading the literature we cannot find any articles addressing digital dashboards or creation of such. This is something that is really needed in this industry.

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