ONTIME CT - A PROTOTYPE OF INTEGRATED WEB-BASED AND MOBILE INTERACTIVE INFORMATION SYSTEM FOR ONLINE REAL-TIME SCHEDULING OF CONTAINER DELIVERY AND RECEIPT ACTIVITIES IN CONTAINER TERMINALS

AHMED AZAB AND AMR B. ELTAWIL

Department of Industrial Engineering and Systems Management (IEM), Egypt-Japan University of Science and Technology
P.O. Box 179, New Borg El-Arab City, Postal Code 21934, Alexandria, Egypt

ABSTRACT: Miscommunication and information flow problems are considered the main reasons for cargo delays, improper decision making, and bad schedules resulting in truck congestion within the container terminal. Both, the container terminal and the trucking companies are seeking to deliver container handling services to customers in a professional way. Moreover, they mainly target to achieve the maximum utilization for their resources and facilities. In this paper we propose a novel mobile information system to be implemented in the container handling sector in Egypt. Using the design thinking approach, we tackle the problem of miscommunication and poor coordination between the container terminal and the trucking companies. We propose an integrated online "web-based" and "mobile" interactive information system to link the container terminal planners with the trucking companies' dispatchers and the drivers. This system is expected to provide a robust solution to schedule the delivery/pick-up appointments, track the container status and optimize the utilization of the different resources. The prototype is developed using the "Axure" platform.

Keywords: container terminal, delivery/pick-up scheduling, mobile application, web-based IS, hinterland operations.

INTRODUCTION

Seaports are the linkage nodes between countries in the global supply chains for the containerized cargo transportation. Most of cargos are received/delivered from/to the seaports are containerized. The immense growth of the containerized cargos' transportation increased the managerial efforts for the seaports and related logistics. Most of seaports around the world adopted development strategies to coop with this rational growth in containerized trade. In addition, advanced technologies and systems are used in the facilities

and operations to support the managerial decision, plans and schedules. Maritime container terminals tend to be part of a larger seaport, and it represent the transaction point between the shippers and distributers. Furthermore, existing infrastructure and equipment can be used more efficiently, e.g., by means of powerful information technology and logistics control software systems including optimization methods (Günther and Kim 2006). The transaction management received considerable interests on both the academic side and business side in the recent years.

Due to the need of developing a real-time control for various operations within the seaports, information technologies exhibited an imperative use in supply chain management. The complexity of supply chain management has also forced companies to go for online communication systems (A. Gunasekaran, E.W.T. Ngai, 2004). In the containerized-cargo transportation industry, the main stakeholders are container terminals, trucking companies, and customers (figure 1). The communication among those main stakeholders becomes more complex as the trend of containerized-cargos trade increases.

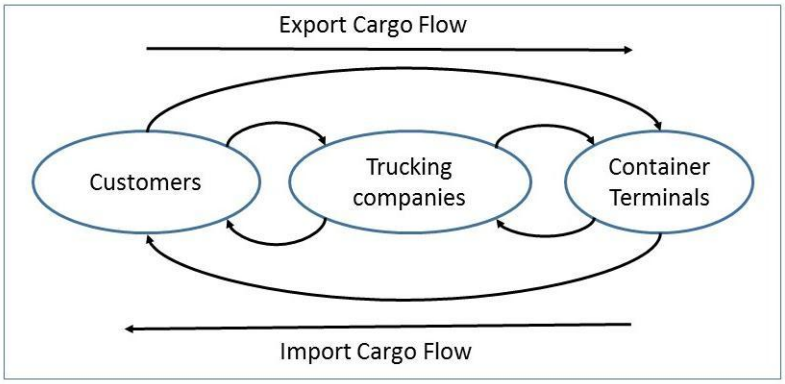


Figure 1. The main stakeholders in the container transportation supply chain and cargo flow

Studying the communications interaction among the stakeholders of the containerized-cargos transportation sector needs more efforts. Modern information systems and communication technology enable the application of optimization methods in different areas of real terminals (Stahlbock and Voß, 2008). Many problems due to poor communications and information flow are found. As a result, there are many negative consequences due to these problems

like cargo delays, high transportation costs, high storage costs, and less customer satisfaction. In this paper, these problem will be addressed and analyzed. A Design thinking approach is used as a novel strategy to study such problems. To the best of our knowledge, there are no previous contributions of how design thinking approaches can be used and implemented to study the problem of miscommunication and information flow in maritime logistics.

The remaining of this paper is organized as follows. The second section is the literature review. The problem is described in the third section. Section four illustrates the design thinking approach that is followed in this paper. The prototype is explained in section five. Finally, the conclusions and future work are driven is last section of this paper.

LITERATURE REVIEW

Scarce literature is found for studying the logistics and information systems' problems using the design thinking approaches. To the best of our knowledge, there is any contribution of using the design thinking approaches to tackle the maritime logistics' problems. Generally, some researchers addressed the implementation of information technology in maritime logistic management. S. Makris et al. 2008 discussed how modern information technology, particularly the ISO 10303- STEP and eXtensible Markup Language - XML, can be utilized jointly to support the communication of different partners in worldwide maritime services. Almotairi et al. 2009

presented a comprehensive theoretical analysis and conceptual foundation of the port logistics platform as it relates to supply chain management discipline using a system theory approach. They identified three systems namely: port logistics system, multimodal transport system and information and communication System as a constituent of the port logistics platform. Asbjørnslett et al. 2012 used an analytical decision-making approach to illustrate how information and communication technology can be used to enhance the supply chain management operations in maritime logistics. Recently, Ralf Elbert et al. 2016 introduced an explicitly model of key business processes in maritime transport chains, and they provided analysis of how information is exchanged in in maritime transport chains. Their main contribution was to provide deeper insights into business processes and corresponding information flows for the maritime transport chain which has been largely neglected in past literature.

PROBLEM DESCRIPTION

Receiving or delivering a container form/to the seaport is a process with multiple activities. Seaport received an announcement for the vessel(s) arrival. Customer have previous knowledge about the vessel(s) arrival time. Customer contact trucking company to provide the service of delivering their containers from and to container terminals. Some containers are needed to be picked up from the arriving vessels and others are needed to be load to the arriving vessels before the departure. Trucking companies, in turn, shall organize the picking up and dropping off operations with the container terminal operators. In some container terminals, there is an obligatory appointment system, which forces the trucking company to commit predetermined appointments. In other terminals, the appointments are not mandatory, but in both cases the trucker are supposed to follow the instruction of pick up or dropping off operations. The containers are going to be scanned and documents should be checked. The driver ID and truck license are sometimes required by the terminal operators. The previous processes are performed at gates. The terminal gates are the facilities where the containers are given the permission to access or leave the terminal.

From the academic experience, the container terminals face congestion problems and resources idling problems due to the unscheduled or poor scheduled arrivals of the trucks. Similarly, the trucking companies are vulnerable to long service time and more waiting at gates. Some causes of these problems are found to be communication and information flow problems. In this paper, we followed a new direction of solving these problems. Most of researchers tried to solve these problems form a technical point of view. They used the optimization techniques and operation research methodologies. In this paper, it is hypothesized that one should dig deeply for the root causes of these problems and provide the robust analysis and solutions. An innovative thinking methodology is adopted to develop a reliable information system prototype to tackle the problem of miscommunication. Moreover, the sharing economy concept is introduced through the prototype to solve the trucking companies resources utilization problems form the view of informatics.

DESIGN THINKING APPROACH

Design thinking is considered a strategy for innovative problem solving. It contains approaches that enable in deriving the right hypothesis and generating ideas and solutions. These approaches based on series of brain storming activities as powerful techniques for generating ideas and initiating solutions. Moreover, it is used by designers to solve complex problems, and create preferable solutions for customers. Figure 2. Shows the design thinking process that is described by Lindberg et al. 2011. The approach that is used in this paper begins by defining the problem. After the problem definition, a process of deifying the actual users and real stakeholders in the problem are identified. The ideation process is the most productive phase in this design thinking approach. An extensive brainstorming process is followed to generate ideas and initiate solutions. Converting these ideas and solutions to a product or a tool is achieved by building a series of prototypes. The final step is to test the prototype and this phase is not included in this paper.

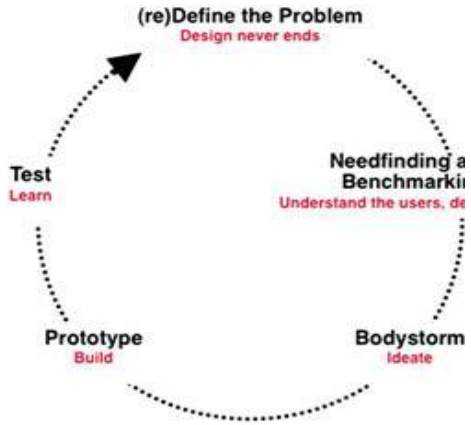


Figure 2. Design thinking process (Lindberg et al. 2011)

In the previous section the first step of the used approach is described by describing the problem of miscommunication and information flow that leaded to delays and wasting the resources. Moreover, the users or stockholders in this problem are specified: the container terminals and trucking companies. The next step is "Bodystorm" or "Brainstorm" which

includes ideation and analysis of the problem

Brain storming Process

In this phase of the design process, the factors that influence in the problem are derived during series brainstorming activities. The target was to understand the nature of interaction between the container terminals and trucking companies. In addition, initial imagination of the solution is introduced during the brainstorming. The type of information that are supposed to be shared between the both stakeholders are gathered. In container terminals, the gate operators should know many information about the cargo type, number of containers to be handled, the preferable arrival time for the truckers to the gates and the type of operation which may be dropping off and/or picking up containers. All of these information and more should be announced previously by the trucking company before going to the terminal. The gate operator in turn will be able to make a specific appointment based on the available information. Some of information are not available to both stakeholders. The appointment should consider not only the trucking company needs, but also the capacity of the terminal to serve all truck, the working hours, the resources level in the yard area, etc. the truck drivers are supposed to be informed with the position of the container and the expected departure time with certain satisfaction about the service. Avoiding the congestion is one of the main goals of the terminal operator.

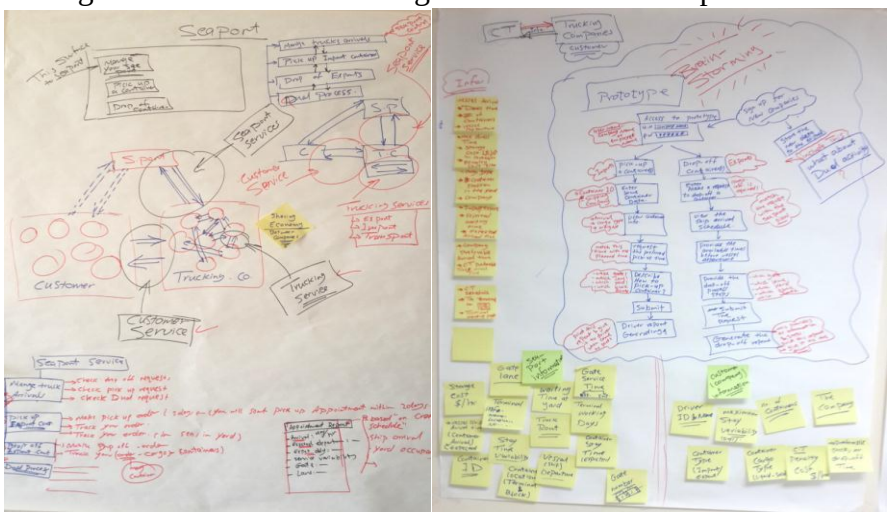


Figure 3. Brain storming process.

Analysis using the "Insight matrix"

After the brainstorming process, the need for analysis the causes that affect the delay problem and late deliveries for cargos in container terminal are examined. In this step, the goal was to reach to the root causes of the problem and studying to what extend each cause influences the poor scheduling and long waiting of trucks at container terminal gates? . A list of ideas are collected for the brainstorming process. Many causes like yard crane schedule, number of gates, number of arriving trucks, information flow between both side, etc. The insight matrix is used to analyze all possible causes (figure 4.). The insight matrix is used to analyze and visualize the correlation between the various factors that are needed to be studied. From analysis, the information flow between seaports and trucking companies exhibited high correlation. In this paper, information system is proposed for tackling the information problems that leads to delays, congestions, and utilization and scheduling problems.

	tuck emissions	truck speed	truck waiting in yard	storage space	yad crane schedule	stacking	yard congestion	walk-ins	conflict btw tucks	crane waiting	no-shows	storage cost	info. Flow btw CT & Truck	info. Flow Between Truck	late tucks	late deliveries	truck waiting out	customer complaints	gate capacity	queue out the gates
tuck emissions	3	2	3	1	1	0	0	2	3	0	0	0	0	0	0	0	3	1	2	3
truck speed	2	3	2	2	2	1	2	2	1	2	0	1	1	1	2	2	1	0	1	0
truck waiting in yard	3	2	3	3	3	3	3	3	2	0	2	1	1	2	2	3	3	1	1	0
storage space	1	2	3	3	3	3	3	3	2	2	3	3	2	2	3	2	2	2	1	1
yad crane schedule	1	2	3	3	3	3	3	3	3	3	3	2	2	1	2	2	2	2	2	2
stacking	0	1	3	3	3	3	3	3	3	1	3	3	3	3	2	2	2	2	2	3
yard congestion	0	2	3	3	3	3	3	3	3	3	2	1	3	3	1	2	1	1	2	1
walk-ins	2	2	3	3	3	3	3	3	2	3	2	1	3	3	2	2	3	3	2	2
conflict btw tucks	3	1	2	2	3	3	3	2	3	3	0	1	1	2	2	2	2	2	2	3
crane waiting	0	2	0	2	3	1	3	3	3	3	3	1	2	2	3	3	1	1	2	2
no-shows	0	0	2	3	3	3	2	2	0	3	3	3	3	3	2	2	3	1	1	1
storage cost	0	1	1	3	2	3	1	1	1	1	3	3	2	3	2	1	1	3	1	1
info. Flow btw CT & Truck Co.	0	1	1	2	2	3	3	3	1	2	3	2	3	3	3	3	2	3	3	3
info. Flow Between Trucking Co.	0	1	2	2	1	3	3	3	2	2	3	3	3	3	3	3	3	3	3	3
late tucks	0	2	2	3	2	2	1	2	2	3	2	2	3	3	3	3	3	2	2	3
late deliveries	0	2	3	2	2	2	2	2	2	3	2	1	3	3	3	3	3	3	2	2
truck waiting out	3	1	3	2	2	2	1	3	2	1	3	1	2	3	3	3	3	3	3	3
customer complaints	1	0	1	2	2	2	1	3	2	1	1	3	3	3	2	3	3	3	3	3
gate capacity	2	1	1	1	2	2	2	2	2	2	1	1	3	3	2	2	3	3	3	3
queue out the gates	3	0	0	1	2	3	1	2	3	2	1	1	3	3	3	2	3	3	3	3

Figure 4. Analyzing the problem using the insight matrix

PROTOTYPE

The final stage, in this paper, for the design thinking process is developing the prototype. The prototype is developed based on three consecutive phases. The conceptual prototype, the procedural prototype, and finally the appearance prototype. Figure 5 illustrates the prototype phases in design thinking approach.

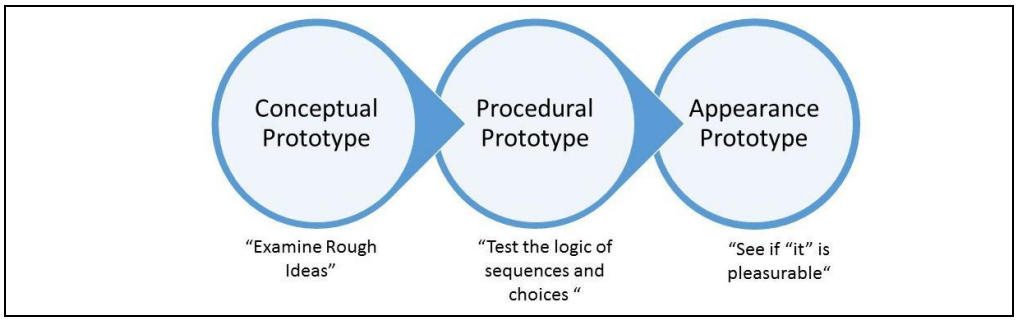


Figure 5. Consecutive phases of prototypes during design stage.

Conceptual Prototype

The conceptual prototype is the first phase of the design development. As the target is to reduce the delays and waiting at container terminal, the name of the application is selected to be "OnTime CT". For the seaport, less congestions at the gates is the main goal from scheduling the trucks arrivals. On the other hand, trucking companies aims to increase the service quality for customers besides reducing the cost of the transportation. One of the main reasons of reducing the transportation cost is increasing the resources utilization. To achieve all of these goals, a website integrated with a mobile application is proposed. Both seaports and trucking companies are supposed to use the website and interact through it. Drivers are proposed to receive and deal with online information using the mobile application. Table. 1. Shows the conceptual prototype.

Table. 1 The conceptual prototype

Application Name : OnTime CT
What is it? It is an integrated website and mobile application to gather and share information between customers and trucking companies.
How does it work? • A data base of trucking companies will be built. • Trucking companies can aces the system to make appointments and use the sharing resources service. • Terminal operators can access to the system to receive the arrival requests and make the appointments. • Driver are connected to the system through the mobile application.
Who are the users? Container terminal operators & trucking company's operators, and
What are the targeted benefits? • Reducing the cargo delays. • Reducing the terminal congestions. • Increasing the recourse utilization for the trucking companies. • Providing information for all stakeholders.

Procedural prototype

After developing the conceptual prototype, the need for a procedure to organize the information flow inside the system is introduced in the second phase of the prototype. Procedural prototype is developed to represent information architecture of the system (Figure 6.). Gate operators in container terminal are able to receive picking up/ delivery requests form the trucking companies. They can provide a schedule for trucks arrival based on the information that they get for the arrival requests. Trucking companies operators receive the final appointment and process them to the drivers thought the "OnTime CT Drivers" service. In addition, trucking companies can share trucks or drivers that are not used, and they can search for resources on the website for the shared resources of other companies.

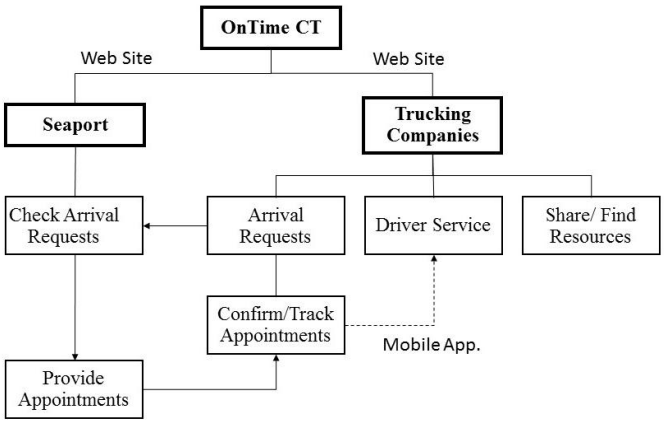
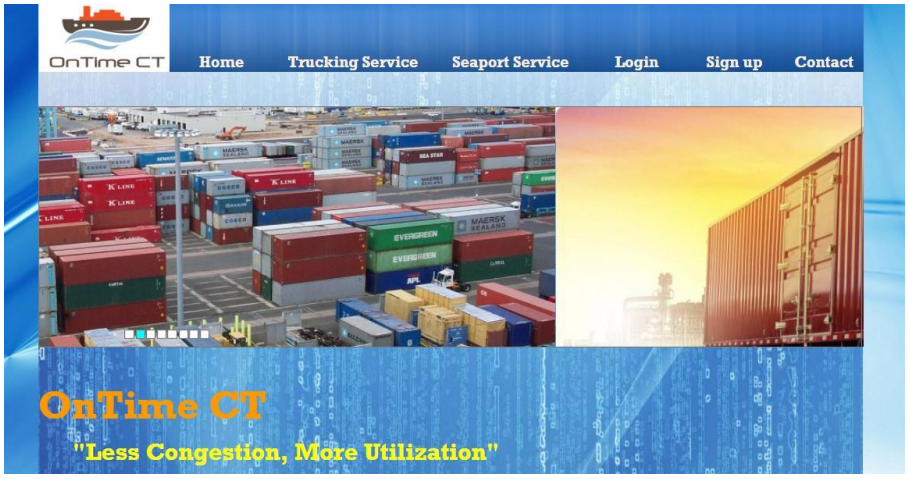


Figure 6. Information Architecture (procedural prototype)

Appearance prototype

The appearance prototype is the final phase of the design. Figure 7 illustrates the proposed information system prototype. The website main menus are the "Trucking service" and "Seaport Service". Users can access the system easily using an account. The home page that is shown in the figure contains the main menus that user can use. Easy reachable options are provided in the appearance prototype. The mobile application is provided to support the appointment system and schedules that provided through the website. Users can use this prototype and visualize the interaction among them. All levels of the procedural prototype are introduced into this final prototype with pleasurable way for users. This prototype is built using the "Axure" platform which enable the designer to build his/her prototype without coding. The final stage of the design process is to test the prototype. We intend to extend the work in the future to the "test stage" and provide the results from the real field.



a. OnTime CT : Web-based Prototype.(http://iri3cl.axshare.com/#c=2)

b. OnTime CT - Driver Service : Mobile application-based Prototype (http://qbul1a.axshare.com/#c=2)

Figure 7. Appearance prototype

CONCLUSIONS AND FUTURE WORK

Maritime logistics are considered one of the main sectors that are very important not only on the organizational level, but also on the national level. As the complexity of the problems increases, the need to use innovative solution approaches became imperative. In this paper, we introduced a novel strategy in solving the waiting problems and congestion in container terminal using the design thinking concepts and approaches. An integrated information system is developed to enhance a reliable communication between the main stakeholders': Seaports and trucking companies. This system is expected to activate the interaction between the stakeholders. Information is shared easily and processed to develop the appointment schedules for trucks' arrivals. In addition, resources and facilities utilization are predicted to increase. One the most important hidden stakeholder is the trucker. Drivers contribute in this chain and can provide valuable data for the whole system using simple tool like the mobile application. Our future work will focus on the implementation of this system and studying deeply the types of information that needed to operate this system efficiently.

REFERENCES

1. Günther H-O, Kim K-H (2006) Container terminals and terminal operations. OR Spectrum 28:437–445
2. Information systems in supply chain integration and management A. Gunasekaran a, E.W.T. Ngai (2004) European Journal of Operational Research
3. Operations research at container terminals: a literature update (2008) Robert Stahlbock · Stefan Voß
4. On the information modeling for the electronic operation of supply chains: A maritime case study S. Makris, V. Xanthakis, D. Mourtzis, G. Chryssolouris (2008)
5. 5- Port logistics platform integration in supply chain management Badi Almotairi* and
6. Kenth Lumsden (2009) Int. J. Shipping and Transport Logistics
7. Information Technology in maritime logistics management: a case-based approach from
8. CoA to SLABE Asbjørnslett, H Lindstad… - Maritime logistics. …, 2012
9. The role of inter-organizational information systems in maritime transport

chains Ralf
10. Elbert & Holger Pontow & Alexander Benlian (2016)
11. Design Thinking: A Fruitful Concept for IT Development? Tilmann Lindberg , Christoph
12. Meinel, Ralf Wagner (2011)