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SCHEDULING OF TASKS IN THE INFORMATION SUBSYSTEM AT AN INLAND TERMINAL

Keywords: inland terminal, intermodal transport, information subsystem.

ABSTRACT

Intermodal transport becomes increasingly popular in cargo transport. This article describes the role of the inland terminal in intermodal transport. Both logistical systems, and inland terminals, together with the movement of loads represent also the flow of information. Though, users and subsystem information, as well as individual elements of the flow of information have been distinguished. The purpose of this article is to characterize an information subsystem in the container terminal, as well as to develop a schedule of tasks in this subsystem.

1. INTRODUCTION

The intermodal transport is the most popular way of moving cargo in the world. Definition of intermodal transport can be found in [8], as the transport of cargo in the integrated loading unit (e.g. container) of the intermodal transport on different means of transport, without the handling of cargo in container. In contrary, the studies [2] and [6] determine it as the transport in which the main part of the transport is performed by rail transport, and the initial or final part of the transport is being carried out by the road transport. Road distance measured in a straight line should not be greater as 100 km for the road-train transport, and 150 km for the road-sea.

In [9], [17], [18], [21], [22], approach to the reliability of logistics systems is presented. Issue of inland terminal was shown in [18], [19] and

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[20] mainly due to the analysis of the process of intermodal transport, together with an indication of the threats that may disturb the correct process of intermodal transport and has shown bottlenecks in inland terminal in Poland. On the other hand, in [10], [11], [14] and [16] the issues of process modeling the movement of the different objects are discussed. Above papers conclude the issues of information flows and cargo flows. None of them have analyzed in detail the information subsystem.

The inland terminals, as already mentioned, link transport and storage functions. In this case, the tariff for the storage of empty or loaded containers is decreasing. Both types of containers are stored within a storage space. The problem is in the intermodal transshipment hubs to adopt an appropriate method of storage of intermodal units as well as the implementation process container depots, so that there is no need of their translocation to another storage location.

Inland terminal [3] is defined as a complex system in which correctly designed elements will permit on its effective activity, through service of the means of transport. Inland terminal should consist of at least three areas:

— **operational area** – place between quay wall and container yard,
— **container yard** – storage area where the storage of loading units also integrated into stacks is possible,
— **terminal area** of landside operation (parking, gate, administration buildings, container maintenance and repair area, empty container storage etc.). [3] Figure 1 shows a scheme of an inland terminal.

Figure 1 illustrates the general scheme of the terminal land. The point infrastructure consists of railway tracks and a storage yard. In addition, places such as entrance gate, exit gate, handling machines (in this case are reachstackers and RTG crane), and administration buildings can be distinguished. The process of handling in the most cases begins from the arrival of the train on the terminal. Subsequently, the train is unloaded by reachstackers or by RTG crane and part of containers are loaded on another mode of transportation. Remaining part of containers can be stored. There exist a need of a separate area for empty containers and the containers for the maintenance and repair on the container yard.

2. INFORMATION SUBSYSTEM AT A CONTAINER TERMINAL

During the research at the container terminal, it was possible to distinguish two subsystems in the operation of a trans-shipment point. The first is an information subsystem with an information flow. The second is a load flow, which is parallel to the information flow and is called

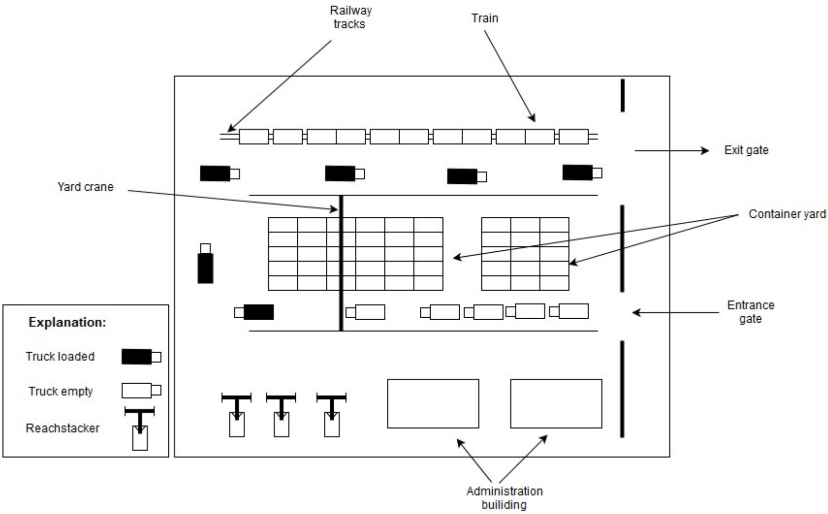

Fig. 1. Scheme of an inland terminal

a mechanical subsystem. For inland terminals, integrated load units are usually transported from carriages to trucks and delivered to the end client or from a truck to a carriage using trans-shipment facilities.

Information system [1] is defined as a set of spatially organized of senders, customers and points of information processing that are derived from business processes using appropriate techniques and tools. Information is transmitted in a particular form as data. The most important feature of an information system are:

— keeping a record the actual states, technical and planning data.
— planning and organizing,
— controlling,
— elaboration of analysis and reports.

The information system [1] should be considered at the same time as a set of components and the relations between them (structure of statics), and the processes in this collections (structure of dynamics).

At the container terminal in the information subsystem, the information can be sent in many ways: oral communication, written, postal correspondence (e-mail), as well as internal communication using special tools, e.g. Intranet. In addition, the information subsystem can be distinguished from the process of forwarded information [4]:

— Generating information: this is the moment in which the employee is preparing some information, for example order of unloading. In this case, the attention should be paid to the information that was generated for the recipient as understandable and accurate, thereby reducing the chance of make a mistake.
— Transmission of information: the process by which the information generated is sent to the recipient. At this stage, the sender shall in particular ensure that information was sent directly to the appropriate recipient.
— Collection and storage of information: this is the stage where the information is collected and archived; the information can be received or generated. This step allows the subsequent processing of information.
— Processing and interpretation of information: the first step is reading the message, then performing of interpretation of the content of this message.
— Using information: after the stage of the interpretation of the message the next step is the command (task) that was included in the sent information. In the case of the generated message (order of unloading), the operator of handling equipment takes the appropriate steps to complete the task.

In case of inland terminals, the most often integrated unit loads are unloaded from train to trucks and delivered to the end customer. The subsystem information can be divided into individual tasks, illustrated in Figure 2.

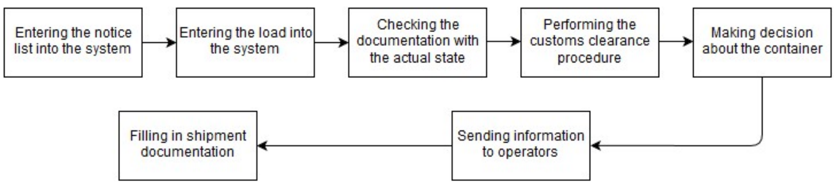

Fig. 2. Flow chart of operations in the information subsystem at an inland terminal [19]

The first information, which is sent to the dispatcher or managers, is a notice list, in which the information about the number of containers which have been sent and arrangement on individual's carriages is stored. At the time of delivery of the train at the container terminal, loads are entered into the computer system. Afterwards, the managers should fill in the shipping documentation. Another important element is the check of the actual state of containers (e.g. if the containers have been damaged). The dispatcher receives the information about the actual number of containers and about the damage of containers. Managers in shipping documentation take the message about the clearance at the seaport (if customs clearance was performed). The containers that have not been clearance, pass customs clearance at an inland terminal. Further element in the information subsystem is the decision of sending the right containers to the customers, and keeping the remaining ones at the terminal. The information which containers are to be set aside for storage yard is sent to the machine operators, stating the detailed place (dispatcher assigned place of container into the system), and which containers are to be loaded for shipping to customers. In case of shipping, managers fill the documents and forward them to the driver. The algorithm of the process is illustrated in Figure 3.

3. MANAGEMENT OF INFORMATION SYSTEM

The inland terminal is a logistics system in which simultaneous flow of cargo and information exists. The container terminal (Figure 1) is not only transshipment point, but also allows the storage of integrated unit loads. In the possibility of a detailed analysis of the information subsystem, the individual processes in the information subsystem (Figure 3) and the estimated duration, to see which processes take too long and the subsequent activities could allow the managers to reduce this time can be distinguished. In the literature, a useful tool for scheduling tasks is a Gantt chart [5], [12] and [13] presented on Figure 4.

Based on Figure 2 times of duration of individual tasks of the information subsystem were founded:

1. Entering the notice list into the system $-t_1 = 10min.$
2. Entering the load into the system $-t_2 = 30min.$
3. Checking the documentation with the actual state $t_3 = 20min.$
4. Performing the customs clearance procedure $t_4 = 10min.$
5. Making decision about the container $t_5 = 5min.$
6. Sending information to operators $t_6 = 2min.$
    a) Assigning storage place $t_7 = 1min.$
    b) Removing the container from the system $t_8 = 1min.$
7. Filling of the shipment documentation $t_9 = 3min.$

Based on the Gantt chart which is presented in Figure 4 the overall time can be calculated: The entire process from delivery of cargo to the terminal, until the shipping of the cargo to customer takes 82 minutes. The analysis of this chart allows further conclusion that the longest task

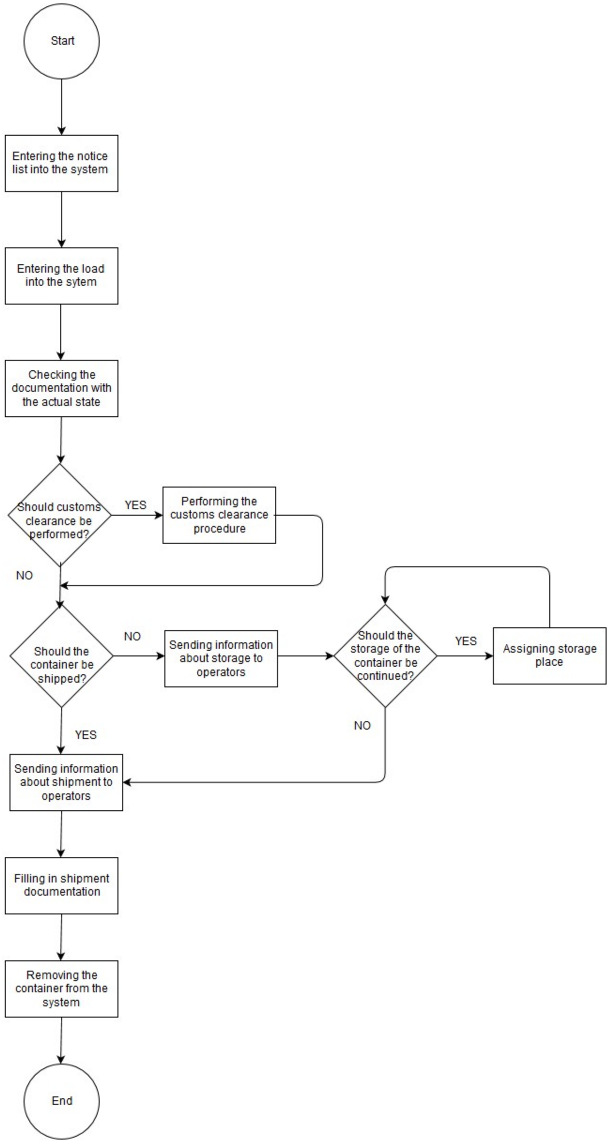

Fig. 3. The information flows in an inland terminal [19]

is entering the load into the system, and the shortest times are assigning storage place and removing the container from the system.

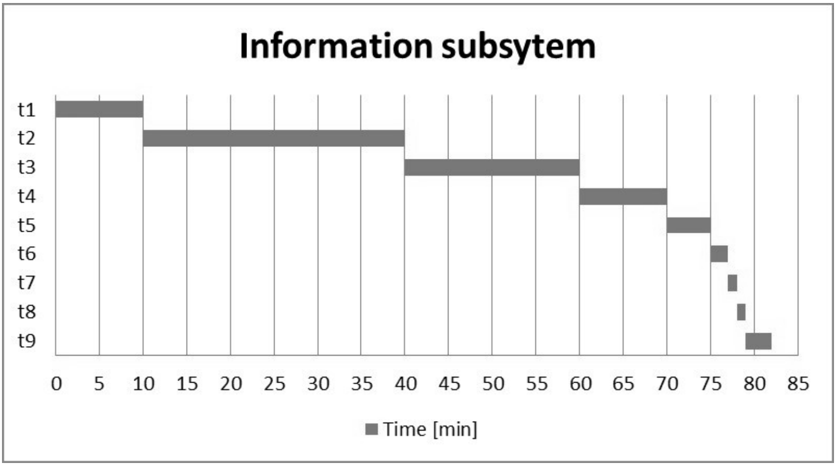

Fig. 4. A Gantt chart for the information subsystem at the inland terminal (based on [5], [12] and [13])

Which activities are the bottleneck in the system can be found by taking into account the information subsystem at the inland terminal. That can be performed in less time. One of the most important statements is that a delay of one task will delay the whole flow of information in this subsystem.

A reliability and uncertainty analysis of the entire process can be performed based on [7] and [15]. For that purpose, a fishbone diagram with uncertainties divided in four groups (art of subsystem, mathematics, quality of the information flow and empiricism) shall be established. With the help of this diagram, further uncertainties of the information subsystem could be defined and precisely analyzed. This shall be done in the future work.

4. SUMMARY

This work allowed understanding the role of the inland terminal in intermodal transport. It is worth remembering that inland terminals, unlike ports, don't give the customers the option of containers storage at a reasonable price. Further, the inland terminal with individual's areas has been presented in this article. One of the most important elements of this work is to characterize the processes occurring at the inland terminal. The same procedure can be found in the logistical systems and inland terminals, together with the movement of loads, which is also a flow of information. Users of subsystem information as well as individual elements of the flow of information have been distinguished. The Gantt chart presented in chapter 2 allowed to put forward the most important conclusion, which is that the delay one task affects to the next delay and next task, and can affect the correct execution of tasks in mechanical subsystem.

LITERATURA

[1] Adamczewski P., Informatyczne wspomaganie łańcucha logistycznego. Zeszyty Naukowe/ Akademia Ekonomiczna w Poznaniu 2000, nr 3, str. 36-56.
[2] Bielli M., Boulmakoul A., Rida, M. Object oriented model for container terminal distributed simulation. European Journal of Operational Research 2006, nr 175(3), str. 1731-1751.
[3] Brinkmann B., Operations systems of container terminals: a compendious overview. Handbook of terminal planning. Springer New York, 2011, str. 25-39.
[4] Coyle JJ, Bardi EJ, Langley Jr CJ. Zarządzanie Logistyczne. Warszawa: Polskie Wydawnictwo Ekonomiczne; 2002.
[5] Durlik I., Inżynieria zarządzania. Agencja Wydawnicza PLACET, Warszawa 1996.
[6] Economic Commission Inter secretariat Working Group on Transport Statistics. Glossary of transport statistics. Fourth edition 2003.
[7] Hinz M., Sochacki S., Rosebrock C. and Bracke S.: Qualitative and quantitative analysis of uncertainties in the risk analysis of field data within the product usage phase. ESREL 2015, Switzerland, Zürich, 7th – 10th September 2015; European Safety and Reliability Association (2015).
[8] Jakubowski L., Technologia prac ładunkowych. Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2008.
[9] Kierzkowski A., Zajac M., Analysis of the reliability discrepancy in container transshipment, 11th International Probabilistic Safety Assessment and Management Conference and the Annual European Safety and Reliability Conference. 2012
[10] Kierzkowski A.: Problems of identification of operation processes for low cost carriers. Journal of Konbin vol. 3, nr 3, s.281-287, 2008.
[11] Kierzkowski A., Kisiel T.: Functional readiness of the security control system at an airport with single-report streams. Theory and engineering of complex systems and dependability : proceedings of the Tenth International Conference on Dependability and Complex Systems DepCoS-RELCOMEX, June 29 - July 3, 2015, Brunów, Poland. Springer, cop. 2015. s. 211-22.
[12] Krawczyk S., Zarządzanie procesami logistycznymi. PWE, Warszawa 2001.

[13] Lis S.: Podstawy projektowania systemu rytmicznej produkcji. PWN, Warszawa 1976.

[14] Restel F.J.: Defining states in reliability and safety modelling. (2015) Theory and engineering of complex systems and dependability: proceedings of the Tenth International Conference on Dependability and Complex Systems DepCoS-RELCOMEX, June 29 - July 3, 2015, Brunów, Poland. Springer, cop. 2015. s. 413-423.

[15] Sochacki, S., Hinz, M. J.-F. Luy und S. Bracke: Beitrag zur Bestimmung von Unsicherheiten und Einflussfaktoren von Daten zur Risikoprognose bei Schadensschwerpunkten in der Produktnutzungsphase. In: Berichte zum Qualitätsmanagement (Hrsg.: S. Bracke, M. Mamrot und P. Winzer), Gesellschaft für Qualitätswissenschaft e.V., Band 13, Seite 259 - 274, Shaker Verlag (2015).

[16] Tubis A., Werbińska-Wojciechowska S., Zagadnienie oceny niezawodności systemu drogowego transportu pasażerskiego. Studium przypadku, Prace Naukowe Politechniki Warszawskiej. Transport (2014).

[17] Zajac M., Kierzkowski A., Uncertainty assessment in semi Markov methods for Weibull functions distributions, Advances in Safety, Reliability and Risk Management: ESREL 2011.

[18] Zając M., Świeboda J., Wąskie gardła w transporcie intermodalnym w oparciu o intermodalny węzeł przeładunkowy Cargosped w Gliwicach. Logistyka 2014, nr 6.

[19] Zając M., Świeboda J., Analysis of the process of unloading containers at the inland container terminal, Safety and Reliability: Methodology and Applications-Proceedings of the European Safety and Reliability Conference, ESREL. 2014.

[20] Zając M., Świeboda J., Klasyfikacja i identyfikacja zakłóceń w funkcjonowaniu systemu transportu intermodalnego na terminalu kontenerowym, Logistyka 2/2016 in progress.

[21] Zajac M.., Valis D., Fundamental risk assessment in example of transhipment system, Reliability & Risk Analysis: Theory & Applications 1.1 (2010): 56-64.

[22] Zajac M., and Zajac P., Zarzadzanie łańcuchem dostaw z wykorzystaniem modelu SCOR., Logistyka. Magazynowanie, Transport, Automatyczna Identyfikacja 3 (2004): 27-29.