Simulation Modeling of Railway Technology in Dry Port Concept

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Abstract – **As maritime containerized transport continues to increase, relocation of port facilities inland is one way to achieve efficiency of the transportation chain as a whole. *The* dry port concept is based on creating direct railway linkages between seaport and inland intermodal terminals. This provides increasing productivity, modal shift from road to rail, resulting in reduced congestion at the seaport gates and along the routes. The subject of this paper is comparison between ports with work technology of a conventional container yard and work technology of a port within dry port concept.**

Keywords – **Railway, Container Yard, Dry port concept, Technology, Simulation.**

I. Introduction

Dynamic growth of the world trade, especially its liberalization and globalization, has had great influence on transport sector development. On the other hand, transport enables fast and efficient linkage, thus increasing competitiveness, one of the basic characteristics of the modern trade. Container transport has especially important place in all of this, nowdays representing a leading service for linking transcontinental destinations.

Container transport influences see fleet, ports and terminals, its facilities, and even continental transport system.

Trend in today's development of maritime transport demands intensive research in transshipment sphere. Development of transshipment facilities traditionally steps back from shipbuilding. This causes poor compatibility of maritime service and facilities and terminal capacity. Also, new systems that will enable better compatibility in transport chain.

Relocation of port facilities inland is one way to achieve efficiency of the transportation chain as a whole. Inland intermodal terminals are important nodes in the transport network and have attracted considerable attention. The dry port concept is based on creating direct railway linkages between seaport and inland intermodal terminals.

This paper is primarily focused on comparison of characteristics between conventional port concept applied so far and new concepts, such as dry port. Holding of ships in ports for handling operations and holding containers in container yards have high costs, and it is important to decrease them as much as possible.

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II. Analysis of Container Transport

With the aim of satisfying needs of mega container flows, maritime operators engage ever larger ships to cope with increasing transport demand and for facilitating lower unit costs. Contemporary ships reaching over then 10 000 TEU and ships on order over 15 000 TEU. Increase of ship capacities has enabled a decrease in transport marginal price. Progress in ports and hinterland operations must improve similarly to fully realize the economies of scale. Huge advantage in increase of ship dimensions raised many problems for ports and terminals regarding handling and reduction of time ships spend in port [2]. This caused increase in port costs (Fig. 1.).

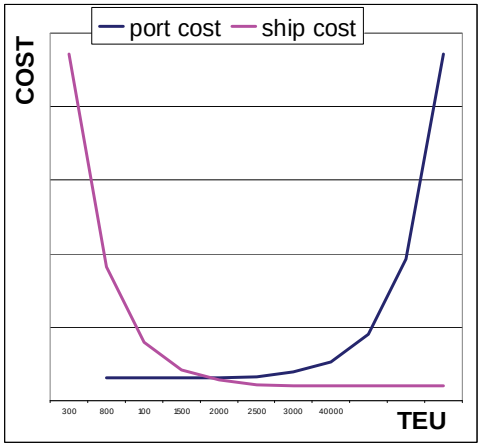

Fig. 1. Transportation costs

III. Ports as Transshipment Points

Nowdays there are many ports with dominant transshipment operations. Their main function is serving container ships of high capacity. Ships of high capacities are much more sensitive to values of transshipment norms. For those reason container ships of capacities higher than 2000 TEU demand very high transshipment norms.

Many subjects look for its place in container terminals. Those are maritime operators on one hand and continental transporters that are directly dependent on its location from technological and financial aspect, on the other hand. Both tend to minimize the time of transport elements flow and increase the flow in main transport directions.

Transshipment ports have two subsystems (Fig. 2.)

1. Anchorage – Vessels – Apron area
2. Apron area – Container yard – Continental transport.

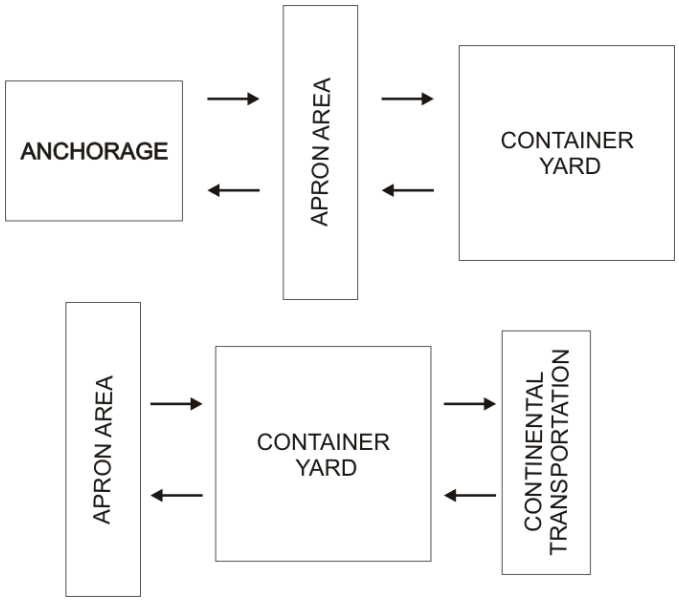

Fig. 2. Port subsystems

Primary function of transshipment ports are enabled by basic manipulation operations [4]. Container mechanisation exploited in operational parts of terminals is used for their realization. Technological process in transshipment ports provides realization of the following operations:

- Manipulation on relation ship-apron area (Gantry cranes)
- Manipulation on relation apron area - ship (Gantry cranes)
- Manipulation on relation apron area - container yard (flexible facilities)
- Manipulation on relation container yard - apron area (flexible facilities)
- Manipulation on relation container yard - continental transport (flexible mechanisation)
- Manipulation on relation continental transport - container yard (flexible mechanisation)

In seaport interface with railway and road transport is preformed directly or indirectly [5].

Direct transshipment demands less investment in facilities and takes up less space. It is possible to perform where railway network with large operational wagon fleet is developed. In terminals, broad-scaled gantry cranes that serve tracks and roads are installed. Container yard is in the function of synchronization of operational mechanisation cycle of continental transporters' arrivals and departures.

Indirect transshipment is more used in exploitation. Container yard has a dominant role mostly serving for realization of technological terminal processes. Ship linkages with continental transport are performed indirectly. Flexible mechanisation serves for both continental transporters and gantry cranes. Indirect transshipment terminals are faced with the problem of inefficient mega carriers serving. This stems from long holds in container yard and space limitation preventing further expansion.

IV. Dry Port Concept

Dry port concept successfully reduces additional infrastructure in ports, as well as operations that are parts of transport chains, not related to container ships operations. This concept keeps indirect transshipment via transit container yard. Transit container yard tends to minimize container hold in ports and functions as arrival and departure spot for block system trains. Block system trains link ports with inland terminals. At inland terminals shippers can leave and collect their goods in intermodal loading units as directly at the seaport [3]. Main activity in dry ports is handling with intermodal loading units. In addition to this activity, an array of other activities necessary to realize ''door to door'' transportation process shall be made in dry ports. These activities include customs clearance, handling of information, short term storage and storage of empty containers, containers maintenance and cleaning. Terminal itself can be connected to one or more ports, one port can be connected to one or more inland terminals and dry port can be part of network for supply chains. According to distance from the coast, dry ports are categories as close, mid-range and distant [3].

All participants in transport chain, maritime operators, ports, railways, road operators, local authority and citizens have advantages of dry port concept application. Advantage for maritime operators is reduction of ship hold in ports. Trough inland terminal construction, port's authority obtains increased participation in transport chain and control on hinterland. Dry port may be considered as ''extended gates'' for sea ports. Increased participation in transport scope represents advantage of dry port concept for railway also. Road transport has positive effect by focusing on and utilizing on shorter hauls. Benefits for local community are traffic intensity and pollution reduction on highway network in hinterland and in city road network in the seaport zones. This concept directly decrease negative impact on environment and increases the quality of life for the citizens.

V. Simulation Model

Simulation models gives opportunity to show certain system behavior in real conditions relatively easily. Simulation models enable comparison of different system solutions. Such analysis is easy to perform changing conditions in which the system functions, system surrounding, service rate, arrival rate, and so on [1]. Modern computers allow few-minute notification of all relevant parameters of functioning even in very complex systems. Complex mathematical equations and various measurements in a system are avoided in application of these models.

This paper provides simulation model of work technology of a port with a conventional container yard and work technology of a port within dry port concept. In formed simulation models gantry cranes, flexible mechanisation, portal cranes and loading bay with inland transport represent servers. Anchorage, container yards, parking lots for lorries and railway sidings can be represented as lines where objects accumulate during the simulation process. Objects are containers, lorries and trains as transport units. There are two

simulation models given, one of a conventional port operations and another within dry port terminal concept. In the first simulation model, it is presumed that containers are further transported by lorries only (Fig. 3.). In the second simulation model, the possibility of block trains usage is considered (Fig. 4.).

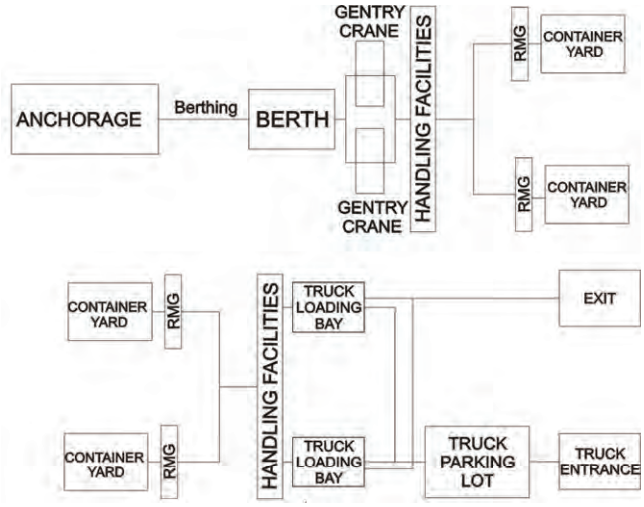

Fig. 3. Block shame of conventional port technology

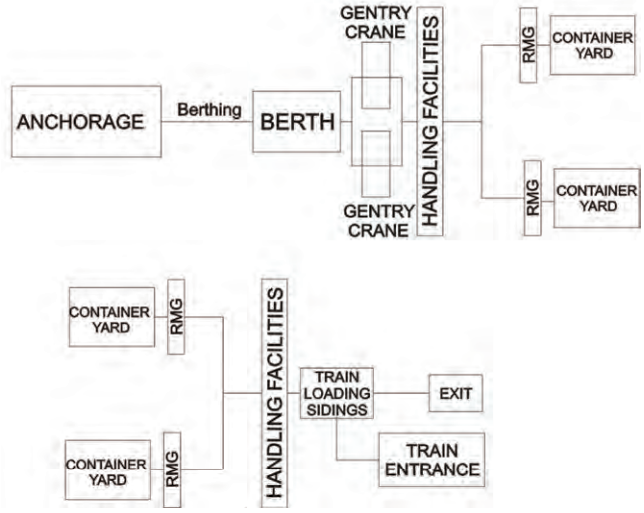

Fig. 4. Block shame of dry port concept technology

Input data that represent intensity of object's flow and intensity of server operations are provided by expert surveys and from available parameter values of port facilities.

VI. Results of Simulation Model

For simulation model creation, Flexsim 5.1.2 simulation software is used.

Quality of work technology in the container terminal can be observed within average container holding time in the terminal. Fig. 5. presents comparison of average container holding time in the container yard in the function of arrival vessels capacity. By application of dry port concept, holding time is decreased comparing to a conventional port. Containers departure by bock trains and transferring additional activities regarding container manipulation to inland terminal, holding time in ports is considerably decreased.

Port capacity is directly dependent upon container holding time. Fig. 6. presents comparison of container yard capacity also in the function of arrival vessels capacity. Dry port concept enables container yard capacity increase without additional investment in facilities and further port expansion.

The simulation model encompassed the research of the port system that can handle ships up to 1500 TEU capacity. Apart from the container yard adaptation, larger ships of Panamax generation would demand adaptation of other terminal parts as well. Analysis and optimization of port facility's capacities do not represent the research subject of this paper, therefore it is not considered in the paper.

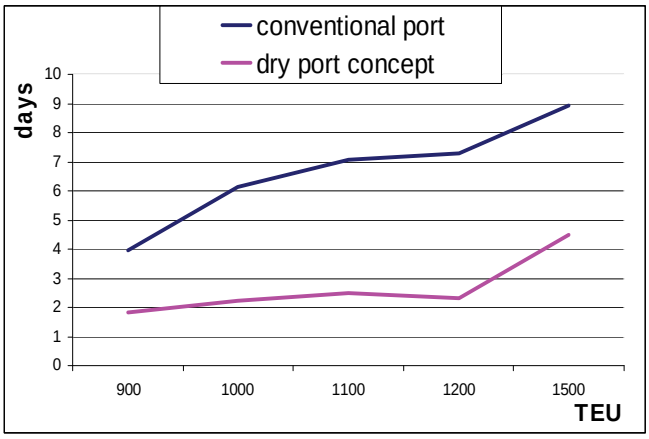

Fig. 5. Container holding time in container yard

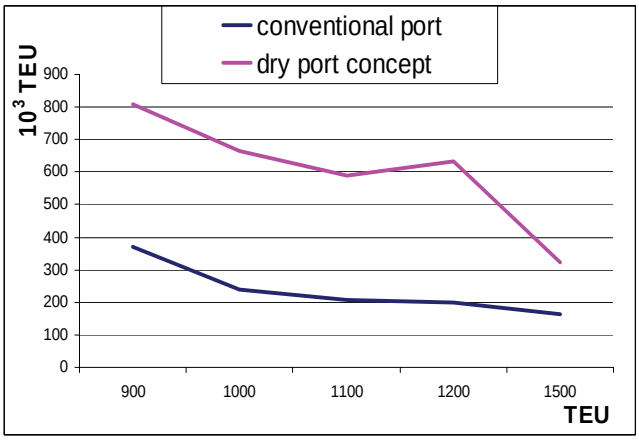

Fig. 6. Container yard capacity

VII. Conclusions

With expected increase in the scope of maritime transport, ports will face the problem of efficient handling with mega carriers. Apart from improving apron area facilities (gantry cranes) it is necessary to develop container yards and technologies of their operations.

Increase in port capacities can be succeeded by further expansion or work technology improvement. Due to land limitations that almost all ports face, great attention is given to new concepts that can solve this problem technologically. Dry port concept, as one of these concepts, enables considerable container holding time decrease in port terminals. Therefore, an opportunity of improved operations inland and port capacity increase is given.

ACKNOWLEDGMENTS

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