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RESEARCH TRENDS OF INLAND TERMINALS: A LITERATURE REVIEW

ABSTRACT

Inland terminals are becoming an increasingly important factor for disburdening port storage capacities and the expansion of the port gravitational areas. The above defines inland terminals as facilities with prolonged activities of seaports, or an integral part of the port. Due to increased interest in the development of inland terminals, the literature in the field of inland terminals since the beginning of its research (1980) to the latest research in 2015 has been analysed and revised. The review will summarize the literature related to development, classification, technological processes and location of inland terminals. In the end, the paper identifies a new proposition for further research based on the current trends and developments in inland terminals as an important factor of intermodal transport.

KEY WORDS

inland terminals; intermodal transport; ports hinterland; inland port; dry port;

1. INTRODUCTION

Significant increase in the world container trade over the past two decades has resulted in an increased capacity of container ships [1] and the capacity together with throughput of ports container terminals. This encourages the development of ports, primarily port equipment, technology, information and communication systems. The requirements for capacity expansion, investments in infrastructure and transport entities, reducing the negative environmental impact, and customer requirements for faster, more efficient and cheaper transportation of goods has become a product for new transport solutions development [3, 4, 5].

Similarly, ports are faced with changes in their operations. Shippers require fast and efficient handling and reduction of container ships detention. This implies expansion of port capacity and implementation of new equipment, and high-quality connections to the hinterland. Additional requirements for fast and high-quality shipping to customers represents a major financial, organizational and operational requirement to which not all the world ports can respond.

Changes in the present transport chain lead to the development of inland terminals. Inland terminals disburden port capacity on the one hand and on the other hand they become a competitive advantage for the less developed ports. This allows them better connections with the hinterland, directly attracting additional cargo. Inland terminals become an additional link in the present transport chain, while the use of intermodal transport technology enables acceleration of transport processes reducing the total transport costs. In the present transport chain, there have been changes in the mode of shipment from the manufacturer to the port and from the port to the end users (*Figure 1*).

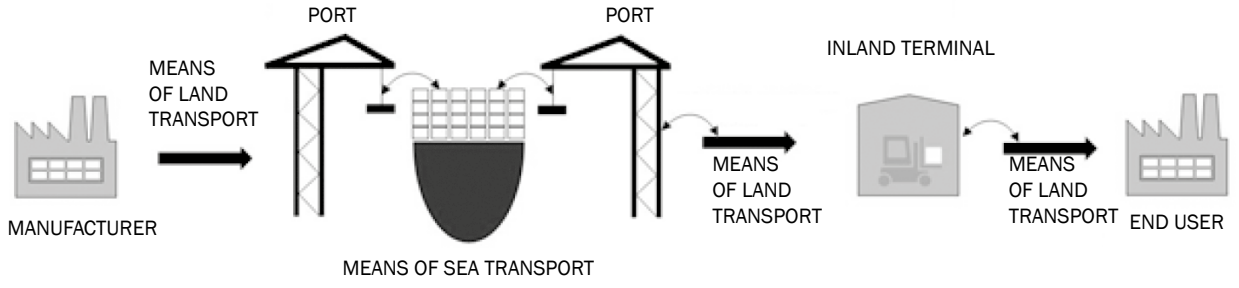

Figure 1 – Transport chain of the present maritime container transport

The aim of this paper is to demonstrate current research trends of inland terminals from the aspect of: development, classification, identification, and optimization of technological processes, determining the locations to optimize certain costs of participants in the transport chain. For this purpose, scientific papers published between 1980 and 2015 have been analysed. Lastly, the paper identifies a new proposition for further research based on the current trends and developments of inland terminals.

2. PUBLISHED RESEARCH ON INLAND TERMINALS SYSTEMS

In this chapter the research published on the following fields: development, classification, technological processes, and location determination of inland terminals (*Figure 2*) have been analysed. Each of these fields has been particularly elaborated, and the analysis of the published papers in a particular field is given below.

2.1 Development of inland terminals

The first studies regarding inland terminals were registered in the early 1980s. Munford [6] in his paper stated the problem of growing congestion at the port gates. For the first time in the literature the term *dry port* was mentioned, which means a terminal which was developed with the aim of relieving the port access roads and a facility which is used to supply the area in which it has been built.

An early definition of a dry port which appeared in a United Nations text in 1982 was [7]: *An inland terminal to which shipping companies issue their own bill of lading for import cargoes assuming full responsibility of cost and conditions and from which shipping companies issue their own bill of lading for export cargoes.*

There is no single definition which describes (classifies) inland facilities, but the literature lists several terms. In the available literature inland facilities, as important hubs in the transport network, are terminologically defined as: *dry port, inland terminal, inland port, inland hub, inland logistics centre* and *freight villages*.

Common to all these terms is that they are related to the inland intermodal terminals, with different functions, which offer a variety of logistic services.

According to the authors, there are three main characteristics that define inland facilities:

– intermodal terminals - railway or inland waterways;
– connection with the port terminal (terminals) by road and railway transport and/or inland waterways across a large capacity corridor;
– groups of connected logistic activities that organize cargo transportation.

Over the years, different methodology to define inland facilities was used. Detailed review of the most important researches related to inland facilities terminology is described in the following paragraphs.

In the 1990s Beresford and Dubey [8] defined dry ports similarly to the term of *inland clearance depot*. In this handbook they defined the ownership shares and services, particularly customs clearance, but without specifying the type of connections with the port(s). Slack [9] defines intermodal transport and its importance in the development of inland transhipment facilities. The same author [10] defines *satellite terminals* as the solution of ports congestion and defines four logistic functions of cargo terminals: cargo transfer between two transport modes; cargo collection for the preparation of transport; warehousing of cargo awaiting collection; delivery and cargo logistic control. He states that services such as container maintenance, customs service and added value services also need to be part of the satellite terminal.

The most important reason for the diversity of terminology is the appearance of inland facilities in different geographical environments and the position on the transport network, in various forms, services and functions and the inclusion of a series of different subjects [18, 19, 21, 30]. The classification of inland facilities depends on parameters which define them. It is, first of all, the transport function parameter (road, road-rail, road-inland waterway, road-rail-inland waterway terminal), parameter of logistic function (e.g. exclusively customs procedures, basic storage operations, storage operations of a wide range of services, production activity, even retail and wholesale activities). They can be classified according to the distance from the port (close, midrange and distant) [25] and according to the ownership structure (property of the port, railway operators, certain regions or public-private ownership).

Currently, the most common terms to describe inland facilities are *inland terminal, dry port* and *inland port*, which are often used to define the inland facilities at which various cargo handling activities and added value services are conducted.

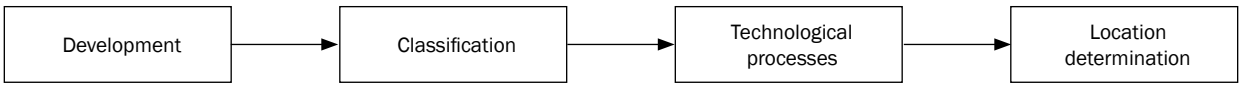

Figure 2 – Structural analysis of literature on inland terminals

The term dry port is the most accepted term to define inland facilities which is often identified with the term of *inland customs warehouse* [2]. Zimmer [26] defined in 1996 intermodal terminals as a facility that provides a range of services needed to market requirements, and this approach can be applied as well for dry ports. According to the European Commission [27] dry port is an inland terminal directly connected with the seaport by railway transport. According to Harrison et al. [28] the dry ports supply the region in which they are located through intermodal terminals, which are integral part of the dry port and represent consolidation point for the goods that require transhipment to different transport modes by offering value-added services.

Roso [25] suggests the term dry port, whose concept is based on: *an inland intermodal terminal directly connected to seaport(s) with high capacity transport mean(s), where customers can leave/pick up their standardised units as if directly to a seaport.*

According to [29] dry port: *provides service of handling and temporary storage of containers, general and/or bulk cargo which enters or leaves the dry port by any transportation mode, such as road, rail, air and inland waterways. Customs and other related services, such as inspections of export and import cargo, whenever possible should be performed in the dry port*.

The term dry port is often used to display that a given inland facility reached a specific level in terms of offered services, such as customs procedures, the presence of 3PL logistics operators and other services [30]. It can be said that the term dry port is sometimes used (misused) when an inland intermodal terminal wants to attract customers, although it offers only container transhipment, temporary container storage with relatively low capacity and only a few basic logistics services such as customs clearance and cleaning and repair of containers.

Rodrigue et al. [18] prefer the term *inland port*. The term inland port represents inland facilities of various types and sizes with a wide range of logistic services, as well as with various forms of ownership located near the production regions. Such terminals found their application in the United States, where they cover a much bigger area than in Europe, with a much greater capacity and container volume, often up to several hundred thousand TEUs per year and also with large storage capacities [30]. In Europe this term refers to inland terminals that are located on inland waterways, particularly in Germany, the Netherlands and Belgium. Therefore, there are obstacles for using the term inland port in Europe since a large number of terminals located inland do not have access to inland waterways, are not in the vicinity of the production areas and do not have container throughput similar to terminals in the USA.

The term *inland terminal*, according to the opinion of the authors, fits best the European definition of inland facilities. It represents intermodal terminal which, besides basic functions of conventional intermodal terminals (container transhipment on different transport modes and temporary container storage), offers a variety of logistics services. The primary function of inland terminal is to unburden the port storage space and to represent a consolidating hub for the container transport which is shipped towards port by railway transport or inland waterways. One of the tasks of inland terminals is to serve its own gravitation area by using different transport modes (rail, road and inland waterways) that allow further distribution of goods arriving from ports. Logistics functions within the inland terminals depend on different participants in ownership structure involved in strategic positioning, development and operation of inland terminal, and what is most important, on its function in the transport network. Such terminals are usually connected to port(s) by railway transport and/or inland waterways and are located near the main transport corridors.

For a terminal located inland, it has to satisfy the following criteria to become an inland terminal [31]:

- direct connection with the port/ports, apart from roads and railway transport and/or inland waterways;
- large capacity transport corridor;
- same facilities and equipment as the gravitating seaport or ports;
- cargo collection and distribution on the local and regional level.

Inland terminals achieve significant role in the transport chain through the importance of connecting ports and their hinterland. A large number of scientific papers on development of inland terminals emerged from the importance to connect ports and their hinterland. Well connected ports and their hinterland, with included inland terminals, allow great advantages for all entities in the transport chain. The display of scientific papers on the importance of connecting ports and their hinterland, and the impact of inland terminals on this process and all participants in the transport chain is given below.

Notteboom [11] and van Klink and van den Berg [12] pointed out the need for ports inclusion in their hinterland development, due to an increase in cargo transportation in containers, along with the development of intermodal transport. They stated the importance of "competition" between ports "fighting" for the position and connectivity with intermodal corridors.

Van Klink and van den Berg [12] and McCalla [13] mentioned the need to extend port business activities and reduce transport costs towards the hinterland by using intermodal transport, as well as the possibility of expanding traditional port hinterland with the use of railway and inland waterways.

Woxenius et al. [14] defined classifications of inland terminals according to their role in the intermodal transport network. They are divided into: terminals with direct connection with the port which have limited capacity and the cargo operations are carried out at locations close to the recipient of the cargo or the port; terminals on major corridors designed for quick reloading of transport units, and the same applying to terminals on fixed routes, but only for small amounts of cargo; hub-and-spoke terminals defined as the central terminals through which all transport flows pass, with large capacity and offering efficient cargo handling. In the same paper *remote terminals* are defined as terminals with low requirements for cargo transhipment and small capacity of storage facilities.

Fremont and Franc [15] compared dry ports and ports, and stated the importance of cooperation between ports and inland facilities on the basis of partnership rather than as competitors. Van Klink and van der Berg [12] defined ports hinterland as an inner region served by the port at a lower cost than other ports in the region. Van der Berg and de Langen [16] dealt with cargo transportation towards ports hinterland, where large volumes of containers that pass through the port make intermodal transport economically and socially most acceptable and most attractive transport means. Port connectivity with its hinterland should be in focus of port strategies for the development of intermodal connections, as well as terminal operators, shipping companies and port authorities.

Podevins [17] stated the importance of connecting ports with their hinterland which becomes a critical factor in ports economic success of the port and competitiveness in the transport chain. He stated that a combination of port container capacity expansion with a flexible and innovative hinterland connections can contribute to transport chain development. He defined the aims of strategic alliances, joint ventures or acquisitions in inland terminals from the port authorities and port operators' point of view: the expansion of port operations to the hinterland; improvement of port logistic services through the development of flexible, reliable and frequent connections with the hinterland by different transport modes; reduction of total costs through simplification of customs procedures which are completed on inland terminals and the expansion of ports transit function through optimum use of space and cargo handling. In this way ports can concentrate on their main activity, containers loading/unloading, which will primarily reduce containers transhipment time, and thus the total cost.

Rodrigue et al. [18], Veenstra et al. [19] and Monios and Wilmsmeier [20] notice the possibility of attracting additional cargo flows from close and remote locations in the ports hinterland through the *inland distribution centres*. Van der Berg and De Langen [21] compared the concepts of inland terminals with the door-to-door and port-to-port systems and defined the advantages from the aspect of shippers, logistics operators and other companies that offer a variety of logistics services. They stated the advantages of inland terminals operational effectiveness, primarily in terms of empty containers repositioning, the impact on the port operations and shippers' activities.

For the development of the proposed system, the cooperation of shipping companies as partners in the design of intermodal services is necessary. Monios [22] noticed the importance of quality management of *intermodal terminals*, and defined management models of intermodal terminals and compared them on the examples of terminals in Europe, North America and Asia. The defined models differ in relationship between the terminal operator and external participants (port and rail operators), as well as the relationship between the terminal operator and the logistics service provider at the terminal. He noticed that for successful management of transport networks in the system of linkage between intermodal terminals and ports, the collaboration of all stakeholders in the process of cargo distribution is necessary.

Wigmans et al. [23] analysed the performance of inland ports in Europe considering the total amount of cargo reloaded at a specific terminal, the presence of the container terminal and the distance over which the terminal makes most of its distribution activities. By using the multivariate regression analysis, the following hypotheses have been confirmed: the performance of individual inland port is affected by the presence of the container terminal that allows the level of cargo handling; the variety of the cargo that arrives at the terminal and the share of distribution on medium distances; and the presence of road links between inland port and the seaport and the final destinations.

Beresford et al. [24] defined the need to improve the transport chain between ports and their hinterland, and this is confirmed by the fact that 60% of the total transport costs are related to the container distribution from seaports and toward ports. This paper defines the methods for allocation of dry ports, and their function and position in the transport network, as well as a future development plan, based on the influence of government and regional policies.

2.2 Classification and function of inland terminals

This chapter will present scientific papers in the field of classification of inland facilities and define their functions in the transport network. The function of inland terminals is defined by its position in relation to the most important economic and financial centres, ownership structure, belonging to a particular transport mode, terminal capacity and the ability to process a wide range of transport units.

Significant research in the field of inland facilities was contributed by Roso [25, 32, 33] Their papers defined the concept of dry ports and set its current definition. In her papers dry ports have been divided into close, midrange and distant from the very port. According to her definition, dry ports concept assumes the way in which seaports and shipping companies control railway operations. She also presented the possibility of reducing environmental pollution by using dry ports, as well as the benefits for all participants in the transportation process due to the use of dry ports.

Noteboom and Rodrigue [34, 35, 36, 37] defined the ownership structure and the basic functions of inland ports and stated that the term of inland facility depends on the ownership structure, geographical location and functions of the inland facilities. They defined the transport function and the division of inland ports into satellite terminals, transmodal centres and transhipment centres, which is similar to the division of dry ports by Roso, according to Monios [30]. They conclude that the role of the transport costs towards ports hinterland in the total cost of maritime container transport amounts from 40% to 80%. This is the reason why many shipping companies consider inland logistics as the most vital area to reduce transport costs. Present terminals are active nodes dimensioned and positioned to expand the port hinterland and to attract goods flows outside the traditional ports hinterland [38].

Inland terminal development and their impact and role in the transport chain have been studied by several authors. Noteboom and Rodrigue [34, 35, 36, 37] compared the European and North American inland ports and their role in the transport chain. The impact of integration of inland terminals from the aspect of individual countries or ports has been researched by many authors. Monios [30] analysed the functions and integration of inland terminals and ports, as well as the impact of inland terminals on the design of transport chains on the examples of Spain. Ng and Gujar [39] investigated the impact of government policies, the efficiency and competitiveness of dry ports in India; and similar survey was conducted on the example of Brazil [40]. On the other hand, Roso et al. [41] defined the organization of dry ports in Sweden. Van der Berg and de Langen [16] defined the development strategy of the Port of Barcelona and the benefits of connecting with potential locations of inland terminals in its hinterland.

Ionnane [46] explored a variety of conditions to achieve personal and social cost efficiency in continental multimodal containers distribution in the case of ports of Naples and Salerno. These conditions were defined as operational measures aimed at increasing the competitiveness and sustainability of port hinterland with the help of mathematical software tool called *Interport model* which includes environmental, economic and social parameters of containers shipment towards port hinterland.

Jaržemskis and Vasiliauskas [42] stated that the problems of port authorities, caused by an increase of container transport, prompt the development of dry ports. Effective dry port must satisfy the objectives of maritime cargo consolidation in transportation flow over short and long distances, and cargo collection and distribution on local, regional and international level. They indicated the functions which individual dry ports must contain, as well as measures that facilitate the implementation of the proposed measures.

Rodrigue [47] pointed out the importance of collocation in the implementation of inland terminals. The collocation allows the expansion of market opportunities through a number of valuable propositions such as: land value, where large-scale collocation projects have a lower cost of land acquisition and enable joint planning of facilities in the terminal, specialization of individual actors involved in the system of collocation and interdependence, where all parties involved in this system have common interests in efficiency implementation of all operations.

Wilmsmeier et al. [2] indicated ports hinterland as an important factor in the choice of port of cargo unloading, and underline inland terminals as active nodes that affect the design of transport chains. They classify inland terminals into those developed from the seaside and those that have been developed on the mainland side. Terminologically, they are defined as *inside-out* and *outside-in terminals*. Inside-out terminals are managed by transport companies (road and rail operators and operators of inland waterways), providers of logistics services or public authorities. Outside-in is a system managed by the port authority, port terminal operators or shipping companies.

Witte et al. [43] analysed the challenges that exist between the location of inland ports and their urban environment at local and regional level. For this purpose, they modified the paper (Wilmsmeier et al. 2011) and the concept of *port city interface* was developed by Wiegmans et al. [44] and Daamen and Vries [45].

2.3 Technological processes in inland terminals

The advantages provided by the application of inland terminals for all participants in the supply chain so far had been researched by several authors. Similarly, the concept and the division of inland terminals according to their distance from the port has been defined. So far, several authors have suggested factors that define inland terminals, but they are still subject of research. One of the most important elements in the maritime container terminals, as well as inland terminals are technological processes. Technological processes represent the activities at the terminal that

are conducted with the aim of better quality of cargo handling, and which require appropriate technological elements and real-time work [47]. These processes at the port terminals are well known and clearly defined, while at the inland terminals they are still insufficiently explored and indistinctly defined. By analysing the database of scientific papers and studies, related to this paper, it was determined that the area of technological processes for optimization at inland terminals occupies only a relatively small number of scientists. Different professional studies were noted that determine the location and function of a single terminal, but do not determine the performance of technological processes. Scientific papers related to the field of technological processes in inland terminals are described in the following paragraphs.

In the paper by Jarušuniene [48] the technological process of road transport vehicles entry in the inland terminal was optimised, i.e. the technological process of transport documents processing at the entry into a terminal. For this purpose, a dynamic model was developed that has accelerated the process of container inspections and dispatch to container storage yard.

Abacoumkin and Gallis [49] examined the possibility of increasing the productivity of terminal equipment on the road-railway inland terminals in Europe on the basis of defined parameters of terminal design and selection of terminal equipment. For this purpose, an expert system has been developed as a part of an integrated modelling tool with the aim of comparative design assessment of conventional and advanced railroad terminals. The proposed expert system is supported by a simulating module and a module for the costs calculation.

Carrese and Tatarelli [50] established a mathematical model based on genetic algorithm which was used for cost optimization of container handling arrived at inland terminal by railway transport. Gronalt et al. [51] developed a simulation tool to optimize some processes at inland terminals.

2.4 Inland terminal location determination

One of the most important trends in the inland terminals are methods to determine the location of inland terminals by satisfying different requirements. The most common requirements that the authors have optimized in their research are: total costs and required investments for inland terminal construction; overall transportation costs (fixed and variable) for different transport systems; overall transport time, and others. The approaches to determine inland terminal location are present in this chapter.

Choosing the location of inland terminals has to be conducted with care, because it can cause irreversible consequences in urban planning and can create bottlenecks that lead to the increase of the price of logistics services [52].

According to Sorensen et al. [53] the best approach to determining the location of inland terminal is the application of network models and the use of multi-criteria analysis. The same authors [53] determined the integration of heuristic procedures to estimate the total costs of inland terminals. They present the problem of hub terminal location determination as NP-hard problem, combining the model designed by Arnold et al. [54] and the use of heuristic problem solving method ABHC (Assigns Base Hill Climber) and GRASP procedure (Greedy Randomized Adaptive Search Procedure).

Arnold et al. [54] proposed a generic mathematical formulation as a solution for the location problem of intermodal transhipment centres. The proposed model minimizes the overall costs, i.e. the sum of unimodal and intermodal transportation costs and fixed costs to determine terminal location.

Racunica and Wynter [55] proposed a heuristic decision-making method developed to estimate the maximal frequency of railway transport availability at any transportation corridor, similar to frequency network model developed by Crainic [56].

Feng and Huang [57] made a multi-criteria mathematical model to optimize the multi-modal intercity logistics flows. This model has been made with the aim of optimizing costs, routing shipments and finding the optimal location of railway terminals.

Lv RS. and Li C. [58] analysed the possible locations of dry ports for the Port of Tianjin Port by using ANP method. The location of dry port has been selected based on a systematic analysis of proposed factors and evaluation model. Wang and Wang [59] used fuzzy clustering analysis to determine and classify alternative locations for dry ports in the economic zone on the Taiwan west side.

Limburg and Jourquin [60] proposed a procedure for determining the location of hub terminal based on the p-median problem. The function of objective of the proposed model includes optimization of road transportation costs by using inland terminals and railways transport.

Kayikci [52] combined Fuzzy AHP methods and Artificial Neural Network (ANN) to determine the acceptable locations of intermodal terminals, while Sirikijpanichkul et al. [61] developed a general agent approach to solve the same problem.

Macharis et al. [62] made a model to determine the location of intermodal terminals based on GIS (LAMBIT model) considering transport time for a variety of transport modes, as well as other costs (fixed and variable costs) of intermodal transportation.

Da Silva et al. [63] have formulated a model for optimizing the location of cargo terminals based on the case of developing countries, precisely Brazil.

Ghodratnama et al. [64] made a mathematical model in which the location of inland node is fixed and its capacity is determined on the basis of production and industrial facilities in its vicinity.

Woo et al. [65] developed a model of inland terminals based on inland terminals as nodes connected to a port, city or the border. This approach enables research in order to use these nodes in the transport chain, which is a different approach compared to previous authors. It also includes differences between the transport operations in these nodes, as well as the associated logistics and storage activities that a single node may have or need not have. This approach allows close cooperation with the infrastructure and investment requirements at the location of nodes, particularly in terms of planning and public involvement.

Rožić et al. [66] presented a model to determine the location of inland terminal using as example the Republic of Croatia. The key objective of the proposed model is to determine the inland terminal location on the railway network which will enable optimization of overall container transport costs. The key condition for this is that all containers are transported by rail from the seaport to the proposed location of the inland terminal.

Ambrosino and Sciomachen [67] proposed a combined linear integrated approach in the problem of solving hub terminal location determination.

3. DISCUSSION

This paper has studied more than 60 references in the field of inland terminals. Although these papers covered a large area of inland terminal research, there are still barriers that prevent the efficient functioning of inland terminals, in the same way as a port container terminal. This is specially noted in the present transport chain, where improved and accelerated cargo distribution toward hinterland and minimization of the overall transportation costs are very important factors. This part of the paper provides an overview of further research, which will enable the establishment of inland terminals as essential hubs in the present transport chain, satisfying the above aims.

It is noticeable that a large number of research included the development of inland terminals and it can be said that this area has been analyzed and defined in a satisfactory way. Although, the exact terminology that can intelligibly describe inland terminals and its environment is still unclear. The same can be said for classification and function of inland terminals.

The need for further research has been observed in the area of determining the location of inland terminals. Especially in terms of determining location that will allow optimization of transportation costs of all transport modes, as well as optimization of cargo distribution to end users.

So far, a lot of research was focused on optimization of container stacking on container ships, in order to optimize the ship stability and reduce the number of container transhipment. The problem of container stacking at port container yard has been well studied, unlike inland terminals. Since this problem affects inland terminals efficiency and productivity, it is necessary to conduct research in this direction. This problem is in literature known as a storage position allocation problem, and consists of container storage location assignment according to the observation problem [68].

Based on the analysis of the literature in this paper, for the development of inland terminals as collection points of sea-borne cargo transportation and location that serves its own gravitational field by various transport modes, it is necessary to optimize the technological processes at inland terminals. The aim of operational organization of every inland terminal is to conduct technological processes in a technical, technological and financial-effective manner.

By improving the process of container receiving and storage, as the most important technological process on inland terminals, it is possible to improve time savings and speed of containers transhipment and thus to provide better service to clients.

It is proposed to focus the future research on optimization of container storage with the objective of reducing unproductive moves This could lead to time savings in container dispatching and increasing of railway transport working capacity, as well as a reduction of overall manipulation costs at inland terminals.

4. CONCLUSION

Modern trends of distribution require from port operators maximally quick and highest-quality transport service and high standard operations, all in compliance with rigorous environmental requirements. The requirements include speeding up of the process of distribution to end-users, and increasing port productivity and efficiency. The possibility of meeting the set conditions is by improving transport services towards the hinterland using rail transport and/or inland waterways, and developing a network of inland terminals. In such a requirement, inland terminals become contact points between the major sea trade routes and the economic activities in the hinterland of the port, which insure infrastructure and superstructure between the port and its hinterland.

Studies regarding inland terminal systems have been conducted already for more than 30 years. Still, there is need for research and improvement of the transport chain in which inland terminals are seen as facilities that enable improvement of cargo flow in ports and its integration in the present logistics chains. To ensure this, it is necessary to fully integrate ports

and inland terminals, which has not been yet fully realized until today. Some of the reasons are the unclearly defined function of inland terminals and ownership structures that describe them. Terminologically, the division of inland terminals was studied and defined by many authors, but the exact terminology that can clearly and intelligibly describe inland terminals in its environment is still unclear.

What needs to be specially noted is the lack of research and analysis of inland terminal technological processes. This is necessary for the development of inland terminals, and optimization of all technological processes. Successful integration of ports and inland terminals requires systematic approach to the basic technological processes. By optimizing the fundamental technological processes at inland terminals, the process of receiving and container positioning, it is possible to provide a high-quality service, as well as savings in time and speed of container transhipment, and finally in financial savings. Regarding further research, it is proposed to determine the possibilities for optimization of technological process of containers positioning, which accounts for the most part in the total handling costs and requires the largest surface areas and capacities.

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ISTRAŽIVAČKI TRENDOVI SUSTAVA POZADINSKIH TERMINALA: PREGLED LITERATURE

SAŽETAK

Pozadinski terminali sve više postaju bitni čimbenici rasterećenja lučkih skladišnih prostora i proširenja lučkog gravitacijskog područja. Navedeno definira pozadinske terminale kao objekte produženih aktivnosti morskih luka, odnosno sastavnim dijelom luke. Zbog sve većih zahtjeva za razvojem sustava pozadinskih terminala, izvršena je analiza i pregled istraživanja u području pozadinskih terminala od početaka istraživanja (1980.) do najnovijih istraživanja u 2015. godini. U radu su prikazana sažeta znanstvena istraživanja pozadinskih terminala s aspekta razvoja, klasifikacije, tehnoloških procesa i lokacije. Kao zaključak, rad identificira potrebu za daljnjim znanstvenim istraživanjima na temelju trendova i razvoja pozadinskih terminala kao važnog faktora intermodalnog transporta.

KLJUČNE RIJEČI

pozadinski terminali; intermodalni transport; lučko zaleđe; pozadinska luka; suha luka;

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