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Integrative Dry Port Concept: A Chance for the Balkans*

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Abstract: Dry ports can be in the hinterland of sea ports as well as river ports. In addition, they can provide the services of classic logistics centers. Combining these three roles leads to a kind of integration not only of functions, but also of transport modes, parts and participants of the intermodal network, also to synergistic effects of the joint action of the parties involved. Therefore, this extension of the dry port concept can be called an integrative dry port. This very concept can be one of the chances for overcoming some of the environmental, economic, and social challenges of the logistics and economy of the Balkan Peninsula, bearing in mind its specific position in the context of geography and the global logistics network. The main contribution of this paper is the description of the new concept of the integrative dry port and the consideration of its applicability in the Balkans.

Keywords: Integrative dry port, Sea ports, River ports, Synergy, Intermodal network, Balkan Peninsula.

1. Introduction

Dry ports (DPs) are intermodal terminals in the hinterland of sea or river ports, to which they are connected by road or rail transport links. Part of the volume of operations is relocated from the port to DPs, which reduces the load on the port and the negative effects it brings (congestion, negative effects on the environment, etc.). In the context of the increasing volume of flows and numerous sustainability challenges, this concept plays an increasingly important role.

Areas connected to both the sea and inland waterways, i.e. rivers, enable the simultaneous introduction of DPs for both sea and river ports. In addition, in the gravitational zone of these terminals can be found a large number of companies that need the services of classic logistics centers.



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Such conditions favor the implementation of a new concept - integrative dry port (IDP) [1, 2]. Combining the functions of DP of seaport, DP of river port and classic logistics center, this concept brings a general integration of modes of transport, participants, parts of the intermodal network, functions, etc. By putting their own most valuable strengths and potentials at the service of common interests and thus compensating for the shortcomings of other parties, all participants in the development of IDP realize the benefits of synergistic action.

The importance of DP is evidenced by a large number of studies on this topic. Although the concept of DP was first mentioned several decades ago, it experienced a significant affirmation at the beginning of the XXI century [3-5]. Recently, there are particularly current papers that consider DP in the context of sustainability [6-8]. Also, the focus is on the problems of choosing the location of the dry port [9]. From the aspect of the geographical area to which they refer, as expected, the largest number of research and case studies deal with the trends and state of the DPs network [10-13] or by choosing their location [14-16] precisely in the territories of their greatest concentration or potential for opening (China, Western Europe). In recent years, there have been studies dealing with areas that are less developed in terms of the DPs network, such as Central and Southeastern Europe [17-24]. Most of the research deals with DP of seaports, except a couple of papers that deal with DP of river container terminals [23, 24]. Although proposed in research [1, 2], the concept of integrative dry port has not been discussed and described in detail until now.

In this paper, on the basis of a review of the relevant literature, the concept and types of DPs are analyzed, and by synthesizing the acquired knowledge the new concept of IDP, and the convenience of its application in the Balkans are described. The main contribution of the paper is the theoretical foundation of the concept of integrative DP based on the synergy of various participants and the consideration of its applicability in the Balkans, based on insight into the situation, existing research, reports on trends in the economy and logistics of the region

The paper is organized as follows. After the introduction, the second section describes the research methodology. The third section describes the development and role of different types of DPs. In the fourth section, the new integrative dry port concept is defined and described, while the fifth section discusses its applicability to the Balkan Peninsula. At the end, concluding remarks and directions for future research are given.

2. Methodology

In order to understand the concept, characteristics, role and typology of dry ports, an insight was made into the existing relevant literature. The source search was performed using Google Scholar, by systematically entering combinations of two or more terms from one or more groups shown in Table 1. The first group consists of the term "dry port", outdated, related terms or synonyms (e.g. inland port), terms wider coverage (e.g. intermodal terminal), terms referring to ports in the hinterland of which dry ports can be located (e.g. sea port), etc. The second group contains terms that more precisely define research dealing with the conceptualization, structuring and typology of dry ports. The third group represents geographical determinants that are related to the area of interest of this paper. Finally, the fourth group indicates the type of problem, objective or research methodology in papers. This group of keywords was singled out as special after reviewing several researches about dry ports in the observed geographical area and determining the dominant direction of their interest (defining the location of the dry port) and then completed by adding similar terms.

I group	II group	III group	IV group
dry port, intermodal termi-	concept, devel-	Balkan Peninsula, Bal-	location,
nal, land freight terminal,	opment, role,	kans, Western Balkan,	locating,
land port, inland port, in-	function, ser-	Adriatic Sea, Black sea,	allocation,
land terminal, inland clear-	vice, type, kind	Aegean Sea, Mediterra-	selection,
ance depot, inland contain-		nean, Danube region,	choice,
er depot,		names of the countries of	evaluation
sea port, river port, inland		the Western Balkan re-	
waterway container termi-		gion, (Serbia, Montenegro	
nal		etc.)	

 Table 1 – Groups of search keywords.

Some of the entries were: "inland container depot", "dry port role", "dry port Serbia", "location dry port inland waterway container terminals Western Balkan" etc. Papers whose title contains the mentioned combinations, as well as other papers that deal with this topic to some extent, were analyzed. Apart from this way, the authors found the sources by searching the cited sources. After that, through a preliminary analysis, a selection of relevant and useful sources for the given topic was made. Then a detailed analysis of the selected sources was performed and useful information was synthesized to describe the new concept of an integrative dry port and its applicability for the area of the Balkan Peninsula.

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3. Development and role of dry ports

The development of different transport modes, the desire to use their functional-technological, economic and ecological advantages, led to their combination, with the use of containers, swap bodies, and other units, that is, to the development and mass application of intermodal transport. Effective intermodal transport requires the development of a network of terminals [25], which enables consolidation and deconsolidation of intermodal flows and accompanying services (warehousing, VAL services, etc.). Among them, DPs play one of the most significant roles. Typologies and classifications of dry ports are defined in the literature according to different criteria: transport modes, role in the network, functions and services, location and economic environment, number and proximity of ports, ownership (Table 2). One of the most important classification criteria in the context of intermodal network integration is the type of port (sea or river) in the hinterland of which the dry port is located.

Criterion	Dry port types	Research
Transport modes	Road-railway, Road-river etc.	[26]
Role in net- work	Satellite terminal, Load center, Transmodal center	[27]
Type of port	Dry ports for sea or river ports	[1, 2]
Functions and services	Dry ports with functions of classic intermodal ter- minals or classic logistics centers	[1, 2]
Location and economic en- vironment	Seaports-based, city-based and border dry ports	[10]
Number of ports	Dry ports for one port or more ports	[2]
Proximity to the port(s)	Dry ports at short, medium and long distances	[28]
Ownership Dry ports owned by railway operators, peripheral public administrations or public-private companies		[28]

 Table 2 – Classification of dry ports.

3.1. Dry ports of seaports

As one of the mass and cheaper modes of transport, maritime transport has a large share (80% of the total volume, 70% of the total value of goods flows) [29] in intermodal transport chains. Analogous to the heavy load of maritime transport routes, there is a growing pressure on seaports, which leads to congestion, especially in their immediate surroundings, lack

of space for port activities, negative impact on the environment, etc. [30]. Therefore, ports need additional capacities. However, the specific characteristics of ports, caused by their geographical position and historical development, do not allow expansion.

To overcome these challenges, the dry port concept was developed. This concept was mentioned as early as the 80s of the 20th century, and since then various terms and definitions have been associated with it [20]. DP is an auxiliary system of the port(s) in whose hinterland it is located to bring about its/their load relief, performing most of the port functions. It can be connected by different modes of transport, both with the port(s) in whose hinterland it is located [31], and with other hubs of the intermodal network [20]. There is usually a road or rail (shuttle) connection between the DP and the home port [17]. The distances of DPs from home ports can be different, and can reach as much as 1400 km [32]. They exist on all continents, except for Antarctica, but most of them are in Europe, China and India [33]. In Europe, they are particularly developed in Italy, Germany and Spain [34]. DP is a favorable solution for the mentioned problems, in all aspects of sustainability (ecological, economic, social) [20].

3.2. Dry ports of river ports

Although it is predominantly related to sea ports, the DP concept can also be applied in the case of river ports [21, 23, 24], which enables its expansion deeper into the interior of the continental area. The development of DPs for existing river intermodal terminals expands their gravity zone, and the establishment of regular shuttle connections between the DP and the river terminal enables efficient integration of the river mode of transport into the existing intermodal transport system [23].

Moreover, the concept of DPs of river ports can be implemented in the city logistics of cities on the river, in a two-echelon system of goods delivery. If the river terminal in the city is used as an urban consolidation center, micro-consolidation centers in urban areas play the role of DPs for the river port (terminal) [24]. Such DPs are called city-DPs.

4. Integrative concept of dry port and synergy of participants

Considering the geographical position, some locations on the continental area represent potential locations of DPs, for sea and river ports simultaneously. In addition, in order for the potential of such locations to be used to the maximum, it should, apart from the functions "taken over" from the port, offer and functions of classic logistics centers, intended for the needs of logistics, trade, industry and other companies from the gravity zone. In this way, different modes of transport, parts of the intermodal network,

participants, functions, etc., are connected and integrated. Therefore, this concept can be called an integrative dry port (IDP) (Figure 1) [1].



Fig. 1 – *IDP concept* [1].

Many different entities are interested in the development of IDP. Owners and operators of sea and river ports can have various benefits from the introduction of IDP (higher participation of intermodal transport, reduction of logistics costs, attraction of flows, etc.) [22]. Cities where ports are located and their population also receive certain benefits by introducing IDP (reduction in the volume of freight traffic and its negative impact on the environment, improvement of attractiveness and living conditions, etc.). Governments at different levels (local, regional, national) and international organizations have numerous interests in participating in the development of IDP (attracting flows and economic activities, economic development, increasing the number of employees, etc.) and participate in it in various ways. Financial institutions, domestic and international (banks, funds, etc.), are potential financiers of IDPs. Logistics, trade, industrial and other companies from the gravity zone are potential users of the terminal. The development of IDP enabled them to serve the flows, use different services. etc.

The cooperation of the mentioned participants achieves synergistic effects, i.e. better results than in the case of individual actions (Figure 2). Synergy of participants from different sectors, regions and countries can be created in the field of IDP planning, financing, management and development. In order to achieve this, the qualities and potentials of each participant should be maximally affirmed and used. Cooperation between companies and governments, the public sector and the creation of public-private partnerships (PPPs) are particularly important, due to the efficient sharing of costs, risks, etc. PPPs in this area are complex, requiring high financing costs and clearly defining projects, but experience shows that they can be

successful if they are defined adequately, especially if the public sector takes on greater risk [35].



Fig. 2 – The role of synergy in the success of the implementation of the IDP concept (supplemented on [1]).

5. The Balkans as a potential area of IDP development

The region of the Balkan Peninsula represents a gateway for a significant part of the goods flows entering Europe [20]. The continental areas of the Balkans are located between the Danube, Black Sea and Mediterranean regions, between which there are significant interactions [2]. In this region there is a large number of seaports (Thessalonica, Piraeus, Durrës, Bar, Ploče, Rijeka, Split, Trieste, Kopar) with significant capacities, results and ambitions, a large number of economic entities that express the need for logistic services that would be provided to IDPs, as well as the Danube River and the ports located on it, which represent an important and large, but still underutilized potential of container transport [36, 37].

In recent decades, the volume of flows across the observed region has increased, and there is a tendency for further growth. In 2017, the Mediterranean area handled 98.9 million TEU, compared to 83.7 million in 2008, an increase of about 18% [38]. A significant part of these flows, including their increase during and after the mentioned period, are connected to ports on the Balkan Peninsula. For example, in the period from 2008 to 2022, the total container throughput of the port of Piraeus increased about 4 times, reaching about 5 million TEU, so it went from 17th to 5th place in the European Union [39]. Despite the consequences of economic (2008), COVID and the crisis in Ukraine, the port of Constanta achieved a record turnover of 75.6 million tons of goods in 2022, which is about 12% more than in 2021, and 24% more than in 2008 [40]. Also, the river ports of the region, even the Danube ports in Ukraine are performing or planning to increase the volume of flows (2-7 million tons in 2024 compared to the previous year) [41].

The presence and development plans of the Trans-European transport network (TEN-T), i.e. its corridors, both those that touch this area (Baltic-Adriatic and Mediterranean corridors), and those that pass through it (Orient / East - Med and Rhine-Danube corridors). The TEN-T network in the Western Balkans includes: 5,287 km of roads, 3,857 km of railways, 1,345 km of the basic network of inland waterways, 3 seaports, 4 ports on inland waterways and 10 airports [42]. 915.66 km of TEN-T roads are currently under various forms of upgrading with a total value of about 8 billion euros, and the development of railway and inland waterways infrastructure is also planned [42].

The current reconstruction of the railways in Vojvodina (Serbia) will include about 400 km of railways, and it is performed in cooperation with companies from China, which indicates that the economies of distant countries with intensive global flows have an interest in the development of this region and its linear and nodal logistics infrastructure.

The development potential of intermodal transport in some countries of the Danube region is not given enough attention even in strategic and planning documents [36, 37], which represents one of the first steps in the development of river container transport. Numerous studies have been conducted on the convenience of applying the DP concept, different in terms of territorial coverage: Serbia [43], the Western Balkans [18], the Adriatic region [17], the Danube region [23], central and southeastern Europe [22]; types of DP: for maritime (e.g. [20]) and river ports [24]; type of problem: number [23], location [17], allocation [18] etc. In many of them, locations in Serbia and surrounding countries have proven to be suitable for locating DPs, both for sea and river ports, and thus IDPs. More precisely, taking into account the geographical position, it can be concluded that the region that includes Serbia, Bosnia and Herzegovina, North Macedonia, the continental parts of Croatia, Bulgaria and Romania is particularly favorable for locating IDPs, while the parts of the Balkan Peninsula, which are closer to the sea, are more suitable for locating classic DPs (Figure 3). One of the examples of locations favorable for locating IDPs is the area of the city of Kragujevac. For the role of a seaport terminal, this city is recommended for its traffic-geographical position in the center of the Balkan Peninsula and Serbia, i.e. near equidistance from the ports on the surrounding seas. On the other side, due to its proximity to the Danube, especially the ports in Belgrade, Smederevo and Pancevo, this city is also a favorable location for dry port of river terminals, which was also confirmed by research [23]. Finally, a large number of companies in the area of this city or in its surroundings have or are planning economic and logistics activities, which indicates that the role of a classic logistics center would be very justified.



Fig. 3 – Potential areas of IDP and DP development in the Balkans and the surrounding area (based on [1]).

Despite this, the Balkan Peninsula, as well as the wider area of Central and Southeastern Europe, does not have a sufficiently developed network of DPs. By the recommendations for the development of intermodal transport [25], it is necessary to work on the development of DPs and IDPs in the countries belonging to these regions through the following steps:

- Establish associations and organizations as platforms for the cooperation of participants, exchange of experiences, promotion and realization of the goals of the development of the (I)DP concept;
- Establish internal and international cooperation in the field of (I)DP development between academic institutions, economic entities and governments;
- Consider the development (network) of (I)DPs as a sustainable solution for existing economic, environmental and social challenges;
- Consider international experiences, standards and goals and take them into account when planning (I)DPs;
- Define a favorable strategic-planning and institutional framework for the development (network) of (I)DPs and consider institutional measures to encourage the development of (I)DPs;
- Conduct a preliminary study and a feasibility study;
- Consider the potential locations of (I)DPs by conducting new and insight into existing research;
- Consider financing modalities, especially PPP as the most desirable form of investment-management structure for (I)DPs.
- Start construction (network) of (I)DPs.

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6. Conclusion

The IDP implies an expansion of the DP concept, which includes the roles of DPs of seaports, DPs of river ports and classic logistics centers. The synergy of participants in the development of IDPs, including the private and public sectors, represents a chance for greater application of alternative modes of transport, integration of the intermodal network and optimization of flows on it. On the other side, this would result in benefits for all participants and contribute to the development of the gravity area. Therefore, the development of a network of IDPs and DPs is particularly important for areas such as the Balkan Peninsula, which faces growing sustainability challenges. One of the directions of future research can be precisely the determination of the most favorable location or locations of IDP(s) in this area. In addition, potential problems, challenges and shortcomings in the implementation of this concept should be considered. Finally, a more detailed analysis of the goals, interests and role of participants in the development of IDPs is needed.

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