INFRASTRUCTURE DEVELOPMENT OF INTERNATIONAL IMPORTANCE FOR THE MODERN TRANSPORT SYSTEM

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Abstract

High - quality transport infrastructure is one of the key elements of the modern economy. At present, in the context of growing transportations volume, the development of transport infrastructure is of particular importance for all countries. The role of dry ports in constructing cross-border logistics networks attracts more attention to the countries governments. This article discusses the concept of "dry port" as an element of transport and logistics infrastructure for the modern transport system, and the prospects for the development of such facilities in international significance. The paper focused on the modern transportation network, which connects the inland cross-border logistics network through dry ports through concept of smart logistics at the macro level on the scale of continental cooperation in Eurasia. The main goal of this article is to develop a methodology for the formation of integrated infrastructure management of international importance in the concept of "Dry port" and "Smart logistics", taking into account the peculiarities of the use of transport and cross-border infrastructure of countries for the formation of new transport solutions in the East-West-East corridors.

Keywords: transport infrastructure, transport corridor, cross-border infrastructure, "Dry port", Smart logistics

1. Introduction

The possibility of the transport potential realization and the required infrastructure creation are the key advantages of the transcontinental cooperation in Eurasia. Such a work will lead to the list of positive moments among which are the countries' transit potential realization, the localization of the industry along the TransEurasian transport corridors, the export development and the strengthening of the continental countries and regions connectivity. The key players in this process are China, Russia, Kazakhstan, Belarus, European Union (EU) countries. The urgency of this issue is rapidly growing in context of unification of the Eurasian economy union (EAEU) and Chinese initiative "One belt one road" (OBOR). For China, it is strategically important to overcome the imbalance in the economic

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development of the country's internal regions and to set measures that are being implemented to develop a new transport infrastructure, which will contribute to the growth of transport to the West. For the EAEU countries, pairing with the Chinese initiative of the OBOR is also relevant. Due to the growing cargo flow, the importance of large transport hubs is increasing [1, 7, 12, 18, 17, 20].

A significant part of the research devoted to the interaction of different modes of transport in transport hubs considers the problems associated with the optimization of location and minimizing the time spent in the hubs without taking into account the mutual influence on the final result of transportation in new transportation conditions [9, 13, 14, 19]. Organization of cargo transportation in the scale of modern transport systems raises numerous issues related to the effective exploitation of infrastructure of international importance.

Authors propose an approach to the organization of the transport hubs infrastructure, based on the use of "dry port" concept as well as a successful combination with the technology of "smart logistics" provides an integrated approach to solving the problems of cargo traffic on the scale of continental cooperation in Eurasia.

In European countries, the practice of creating "dry ports" is quite developed, which allows to provide intermodal service that meets modern standards for quality and speed of cargo handling. Intermodal services are implemented by companies taking into account infrastructure capabilities and standards for quality and speed of cargo handling.

Therefore, in this study, the authors consider the interaction of different modes of transport in terms of their effective interaction in «dry ports». Further, the authors focus on the concept of dry ports as a technology that makes it possible to effectively use the infrastructure of various types of transport (road, rail, sea). The authors clarify the definitions of dry ports and their functions as objects of the infrastructure of international intermodal services. Also methodical bases of transport systems management at effective use of participant's infrastructure have been suggested by authors.

Also authors propose the effective combination of road and rail transport in the smart logistics concept. The smart logistics concept means the development of the suburb transport-logistics terminals with the functions of acceptance, handling, custom clearance, deconsolidation of cargo with the further shipment of the small consignments to the specialized city rail terminals by regularly scheduled short container trains and small-tonnage autos.

2. Ways of integration

A number of EU countries associated with Asia by rail, though not massively, but have already started to enjoy the benefits of Trans-Eurasian transport corridors. European transport companies, logisticians and consumers of transport services are cautious about the new possibilities of transcontinental transit, and in some cases do not have sufficient information (including the conditions of transportation, cost, timing of delivery of goods, etc.).

Russia's role as an integrator of the Eurasian transport market is growing, a significant part of which is container transportation projects. Significant results were achieved this year by JSC "United transport and logistics company-Eurasian railway Alliance" (UTLC ERA, a joint venture of JSC "Russian Railways", SA "Belarusian railway" and JSC "Kazakhstan Temir Zholy"). In order to optimize the transportation process and reduce its cost, the company is implementing a new technology for sending long container trains, called UTLC XL train (eXtraLongtrain). It is used on the China-Europe-China transit route in order to increase the efficiency of the use of the Alliance Railways' capacities. The standard length of container trains running on the main transit routes is 57 conventional wagons (forty-one 40-foot containers). The long-haul container train consists of 80 conventional wagons consisting of forty-four 80-foot platforms with a full load (eighty-eight 40-foot containers). The average speed of the container train on the Dostyk-Brest section was 1100 km/day. To increase the competitiveness of the transit service, the company intends to continue the use of this technology on all the transit routes.

JSC "Russian Railways logistics" (the Russian Railways daughter company) expanded its railway service of the non-raw export launching the possibility of cargo dispatch of the good, requiring special temperature conditions in refrigerator containers. At present time there are weekly import and export general cargo consignments China- Russia-China that take 12-14 days. The service is realized in cooperation with the Russian export center supported by the Russian Railways, and in partnership with the Freight Village RU terminal.

The operator of Far East Land Bridge (an Austrian subsidiary of JSC "Russian Railways logistics", FELB) organized the first regular container service from Chengdu (China) to Melzo (Eastern suburb of Milan). As for the reverse loading, it will be provided with the European fruits and sweets. The train will cover about 10 thousand km in 18 days. Transshipment from one track width to another (from 1435 to 1520 mm and vice versa) is carried out at the border crossings Alashankou – Dostyk and Brest – Małaszewicze.

FESCO transportation group (FESCO) in partnership with the Chinese Zhengzhou International Hub (ZIH) has launched a regular container train from Hamburg (Germany) to Zhengzhou (Henan, China) through the border crossing Grodekovo / Suifenhe. The transit train from Europe to China through the far East of Russia is the longest of the regular international routes on the Russian Railways network – its total length is 10 294 km. Total transit time is 18 days. The new service cargo flow basis are the goods exported by ZIH from Germany.

There is also a successful European experience. For example, regular scheduled Express Rail Cargo from Łódź (Poland) to Chengdu (China) and from Chengdu (China) to Łódź (Poland), which was launched in 2013 by the company Hatrans logistics. They provide flexible rail freight services in partnership with a leading Rail service provider on the route China – Central and Eastern Europe as well as to the EU countries. Transit countries are Kazakhstan, Russia and Belarus. Each train consists of 41 wagons, 40' of loaded containers. Railway transport from the time of loading to the rail terminal in Lodz takes 12 days.

The report [16] "Transport corridors of the Silk road: the potential for the growth of cargo flows through the EAEU" founded that while maintaining the current tariff and subsidizing

rail transport by China in 2020, the container turnover on the China — EAEU — EU axis can reach 250 thousand 40-foot containers.

However, the growth in long-term traffic is limited by a number of internal and external factors. It is the question how to realize the potential of Trans-Eurasian transit. One of the key areas of work is the elimination of non-tariff and technical barriers. Infrastructure (transport and logistics infrastructure), border-customs and administrative-legal restrictions are obvious among the considered limitations.

3. Dry ports – an important component of an effective international transport system

The new realities of modern life make us take a new glance at the transport and logistics environment of the infrastructure and a more rational approach to the justification of approaches to the planning of transport activities. At the same time, one of the top issues is whether the transport infrastructure in general and seaports in particular will be able to cope with the increasing volume of freight traffic and the growing demand on effective transport solutions. In modern conditions, long-term strategic development and planning on the basis of common priorities is necessary, especially the increasing of seaports' productivity, the use of new technologies, the increase of the innovation level. However, the main deterrent to the development of ports is land infrastructure. In this regard, the well-established work of ports and railways, as well as infrastructure capabilities, are fundamental factors of the integration of these modes of transport [5].

Most of the port stations - the places of different types of transport connection, do not have the possibility of territorial development corresponding to the processing capacity of the port berths. There is a lack of capacity of the stations themselves, that reduces their maneuverability, leads to untimely service of cargo areas of ports, increases the duration of customs clearance procedures, hinders the productivity and turnover of the port terminals. To eliminate the existing problems, it is advisable to introduce the concept of "dry ports", providing an integrated approach to solve the problems of cargo flows organization.

The technology of increasing the cargo turnover of seaports using the terminals providing similar services for the processing of goods outside the seaport except for the loading and unloading of ships on the principle of "dry port" was developed by the world community and fixed at the Conference on trade and development of multimodal transport and container transport in 1982 as the following definition: "internal ground terminal, where the shipping companies issue their own import bills of lading for imported goods, taking full responsibility for the price and condition and from which shipping companies issue their own bills of lading for export shipments" [4, 9, 19]. This definition characterizes the role of "dry ports" from the perspective of the interaction of sea carriers and cargo owners.

From the point view of intermodal transport, another definition is more important [15]: "Dry port is an inland land terminal directly connected to the sea port (s) by means of high-capacity vehicles, where customers can deliver/receive their standardized cargo spaces directly at the port». In other words, the "Dry port" is an internal land terminal, which has

a direct connection with the seaport through a specially established transport infrastructure. Communication can be arranged by road, rail or river transport.

Despite the variety of definitions, today the term "dry port" is not fixed [10]. Some believe that the "dry port" is a large terminal, primarily having the status of a temporary storage warehouse, with a staff of brokers, freight forwarders, people who will provide services. The others believe that the "dry port" is a transport and logistics center, including port terminals at the checkpoint, created for sorting, temporary storage and customs clearance of goods that are delivered under the simplified transit procedure [1, 4, 9, 12, 13].

Intergovernmental agreement on dry ports [16] defines a "Dry port" as a place within the territory of the country with a logistics centre connected to one or more modes of transport intended for processing, temporary storage and statutory inspection of goods transported in international trade and committing applicable customs control functions and formalities.

The term "dry port" due to the definitions by many professionals also means that the port itself is not directly connected with the sea (ocean) but it is a kind of branch of another port in its traditional purpose. "Dry port" performs the function of a transshipment knot, being a kind of buffer zone, expanding the possibilities and simplifying the implementation of sea freight for traders, geographically located at a considerable distance from the ports. This makes it possible to significantly unload the terminals of sea ports, which has a beneficial effect on the functioning of the entire transport and logistics infrastructure throughout the country. Another important function of the dry port is to act as a customs terminal [10].

The emphasis should be on the fact that the use of "dry ports" as a technology, which helps to improve the performance of ports, is advisable from the point of view of the unusual ports transfer functions associated with inspections only if the transshipment of goods is administered and organized in convenient way [4, 15].

To optimize the entire logistics system, it is necessary to have a network of "dry ports", which will handle the needs of all incoming export-import cargo of the cities, located nearby, and then the formation of short smart trains to deliver goods to final consumers to the specific area of the city. Undoubtedly, the development of the network of "dry ports" will allow the participants of the transport and logistics market to expand the list of services and ensure higher profitability of their business [6].

In accordance with the Intergovernmental agreement on "Dry ports", a list of existing infrastructure facilities operating on the principles of "dry ports" has already been defined in accordance with certain principles: the dry ports are normally located in the vicinity of: inland capitals, provincial/state capitals; and/or existing and/or potential production and consumption centres with access to highways and/or railways including the Asian Highway and/or Trans-Asian Railway, as appropriate [8]. These centres can be the ground of such network.

A lot of things depend on the choice of location to create such an object. "Dry port" should not be "detached" from the seaport on the one hand, and the commodity warehouses on

the other. It should be located at the intersection of the main logistics routes. At the same time, "dry ports" should be in transport links with other "dry ports", border points/ground customs control posts/integrated checkpoints, seaports, inland waterway terminals and/or airports. It is also important that the "dry port" has to be versatile, that can provide a full range of services for the processing of various types of goods. Thus, "dry ports" should be integrated into the logistics chains of the unified transport system.

4. Methodical bases of transport system management at effective use of participants infrastructure

transport system management at effective use of infrastructure requires the integration of all the transport process participants. Fulfilling the purposes of coordination and cooperation of the logistics chain participants is it worth highlighting three stages of its formation: strategic planning, tactic planning and operation management [2, 3].

Strategic planning is interrelated and balanced complex of all the interested transportation participants plans, that coincide with the compromise decision while eliminating the contradictions of transportation participants needs and the possibilities of the supplying units (traffic and processing capacities and so on). The process of such a plans agreement achievement is quite contradictory due to the presence of a plenty of interested market participants and limitation of the technical condition of the infrastructure transport system. To create the strategic plan it is required to take into account a plenty of cargo forwarders plans V (volumes of each type of cargo forward in tons and transport vehicles of each type and kind, points of load and destination):

$$V \in \{T_i;\ Q_i;\ N_{tr}{}^{rt};\ C_d;\ C_a;\ P_d;\ P_a\}, \tag{1}$$

so that

T_i – the date of cargo shipment;

Q_i – the volume of cargo "i" shipment;

N_{tr} – a number of transport vehicles required for the transportation, pieces;

r – a kind of transport vehicle (platform, track et al.);

t – a type of transport vehicle (container, trailer, semi-trailer et al.);

C_d – shipper;

C_a – consignee;

P_d – cargo shipment point (railway of non-public use, cargo front, platform, railway and the country of shipment);

P_a – cargo destination point (station, railway and country).

Transport system database includes the following units' information

$$LSC \in \{W, \sum_{i=1}^{n}\sum_{j=1}^{m} TO_{ij}, t_{lsc_{ij}}, P_{lsc_{ij}}, TE_{lsc_{ij}}, C_{lsc_{ij}}\}, \tag{2}$$

so that

W – potential volume of cargo handling in unit "j";

TO – content of technological operations of processing and movement of the cargo in front of the unit;

t_{lsc} – scheduled time for the operations fulfillment in front of the unit to process and move the cargo flow;

P_{lsc} – traffic capacity of the unit for this kind of cargo;

TE_{lsc} – technical equipment of the unit for cargo flow processing and movement;

C_{lsc} – the price of the cargo processing and movement in front of the unit;

n – a number of cargo kinds;

m – a quantity number of the units.

After the reception and processing of the information a lot of variants and basic units ("dry ports") are being formed. In the process of volumes negotiation there can appear the situation according to which the demand for the certain transport decision is overcoming the proposal. In this case the special proposals for the clients are being worked out. Such proposals are usually: the alternative route choice, the other infrastructure objects ("dry ports", seaports, terminals), the kind of transport change, the other terms and type of delivery and so on. Algorithm of the transport system strategic planning is iterative, when the shippers' plans are being corrected in accordance with data of the traffic capacities of the transport system units with the help of the multistage computing procedures (fig. 1).

The transport system (or a number of competitive chains) is formed in consideration with the fulfillment of the requirements, announced by the customers (cargo holders, consumers of the transport services), formed on the result of preliminary negotiations of the strategic plan. These requirements are criterions thresholds:

$$Z = \{T^{max}, C^{max}, K^{min}\}, \tag{3}$$

so that

T^{max} – term of delivery according to the application;

C^{max} – the maximum allowable price of the transshipment;

K^{min} – the acceptable level of the services quality.

In general, the transport system model is:

$$F_{lsc} = \{C, T, K\}, \tag{4}$$

so that

F_{lsc} – transport system model based on the requirements of the transport services consumers;

C – total expenditures on cargo promotion in front of the transport system;

T – the duration of the cargo presence in the transport system;

K – the quality of the services in the transport system.

The transport system choice model is worked out in order to choose the most combination of criterions, characterizing the requirements of the transport services consumers. This model makes it possible to enter the additional parameters.

To get the only decision out of plenty possible decisions there is an approach, based on the idea of identifying the compromise point in the space of optimal criterions. Meanwhile A is supposed to be a compromise point as the maximum of the square sum of deviations from the criterium values

$$A = \left\{ \max \left[\sum_{v=1}^{k} \left(\frac{K_v(A_i) - K_v}{K_v} \right)^2 \right] \right\}, \tag{5}$$

so that

A_i – a number of permissible values of the criterions of optimality;

k – a number of the criterions of optimality;

K_v – the threshold level of the criteria values;

$K_v(A_i)$ – acceptable values of optimality criteria .

The aggregative algorithm of the chain variant choice based on the requirements of the transport services consumers (fig. 2).

The effect of the certain transport system functioning taking into consideration the variants of "dry ports" as the chain formation units is identified by the maximum possible amount of effects: reduction of the total costs while delivering cargo; reduction of the terms of the cargo presence in the chain; the usage of the transport system unit infrastructure; the reduction of the time wastes while being in the transport system unit; the clients' logistics service level [11].

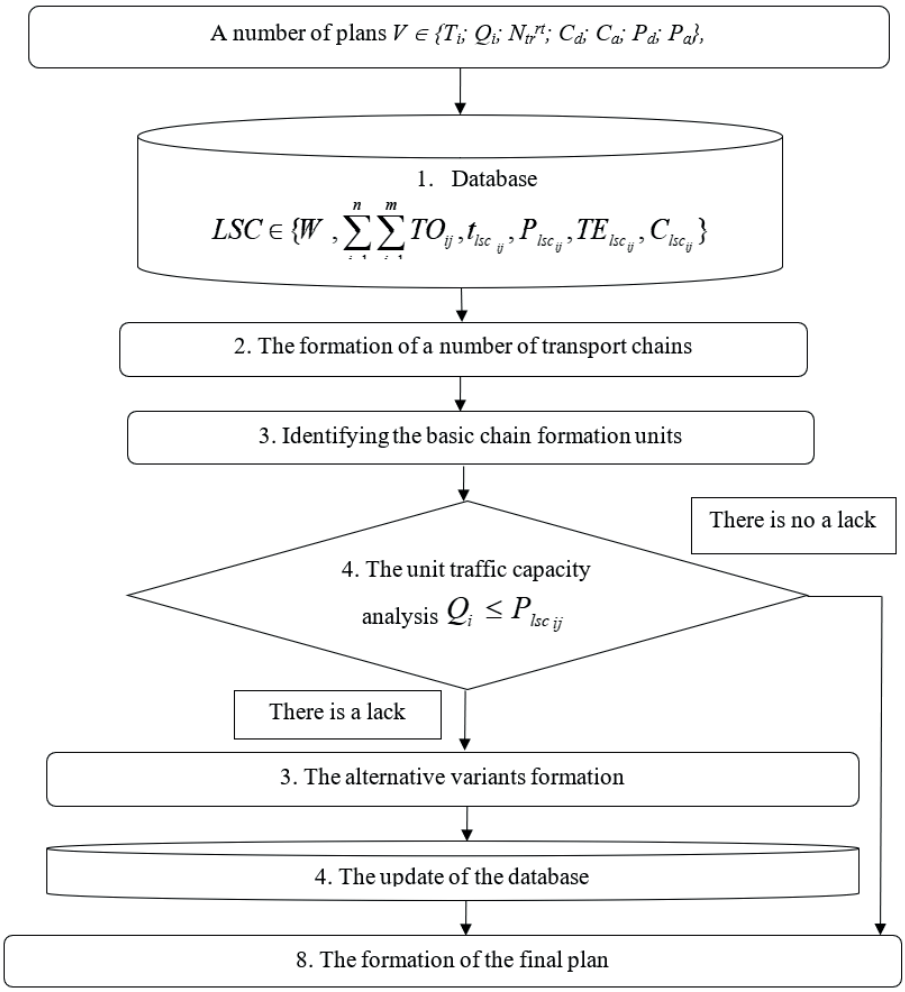

Figure 1 – The aggregative plan of the strategic planning of the transport system

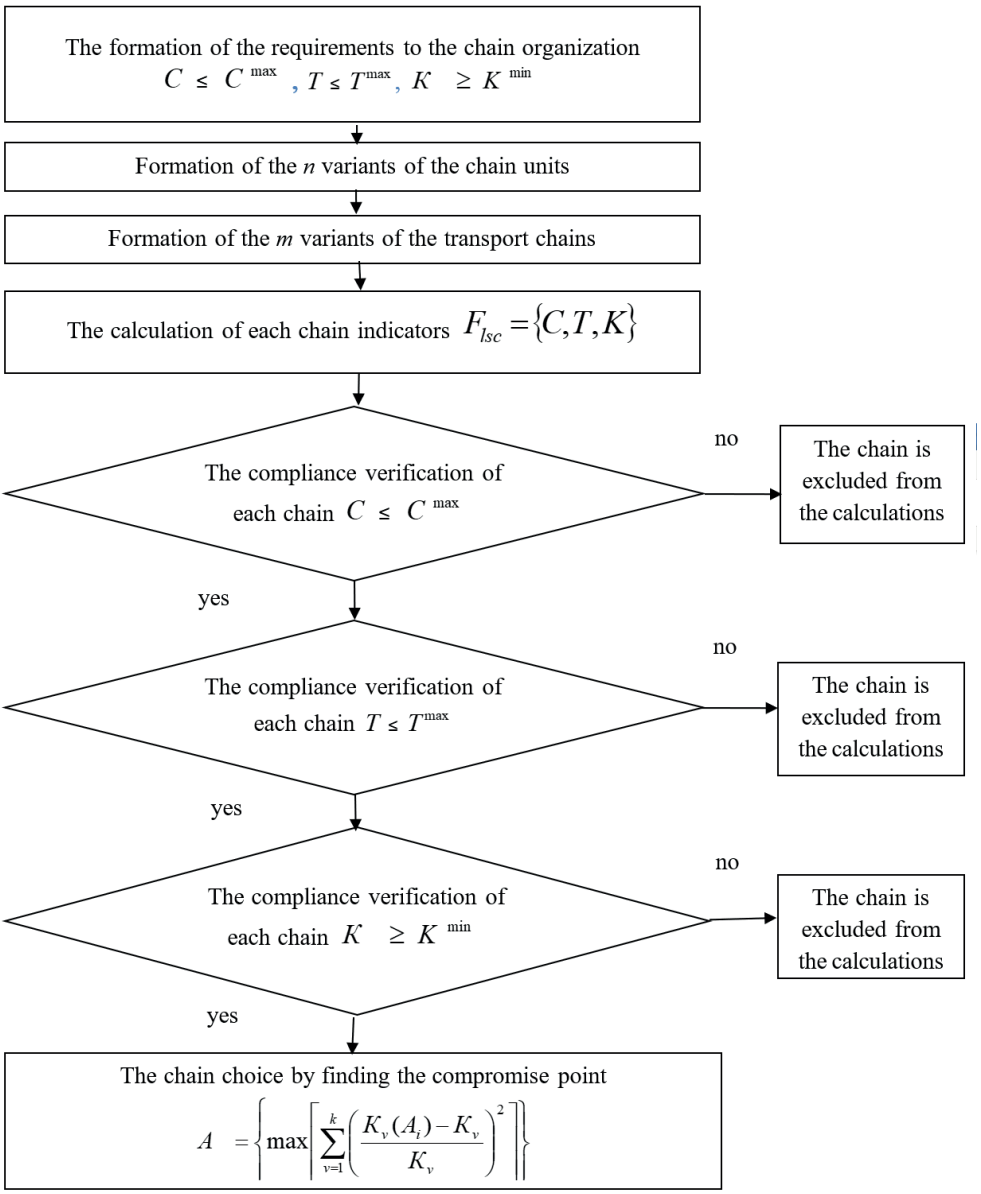

Figure 2 – The aggregative algorithm of transport system variant based on the consumers requirements

5. Cross-border infrastructure in central and eastern europe

As is known, some European industrialized countries do not have direct access to the seas (Slovakia, Czech Republic, Serbia, Austria, Hungary, Switzerland). As a result, these countries do not have the ability to handle goods arriving by sea in ports on their territory. At the same time, the demand for both incoming and outgoing container traffic is growing every year, correlating with the growth of foreign trade operations with China, the United States, South-East Asia, the Middle East and Africa. The creation and development of the "dry ports" of international importance already existing on the territory of these European countries will allow to deliver goods by rail from sea ports immediately upon the arrival of sea container ships to the ports of the Mediterranean, Aegean, Ionian, Black and Baltic seas and to process, complete customs clearance, sorting of goods directly in the countries consuming these goods without opening seals on containers before arriving at the final destinations, with due observance of customs and legal regimes. Goods will be shipped immediately to the destination without accumulation in the seaports of coastal countries for processing and customs clearance.

This "dry port" is very convenient for all the participants of the transport industry. Firstly, it allows to unload the sea terminal, secondly, storage of containers (as well as other goods) in the "dry port" is much cheaper, thirdly, significant savings on customs payments (paid directly before the export of goods from the "dry port", where the goods can be stored for a long time), fourth, it improves the logistics of goods (the possibility of formation of consignments) and has many other advantages.

It is also worth noting one serious barrier in the synchronized development of the transport infrastructure of the countries. Due to the peculiarities predetermined by the historical development of transport systems of the European countries, there is currently a problem of different gauge in international rail transport from East to West and in the opposite direction. When crossing the Belarusian-Polish, Ukrainian-Slovak, Ukrainian-Romanian, Finnish-Swedish borders trains need to change platforms with bogies.

The authors suggest to create large terminals and logistics centers of different gauge widths at the docking points will allow to take advantage of this situation, namely to consolidate the cargo coming from different departure stations, based on the delivery address. For example, the Belarusian border station Brest receives trains from Guangzhou, Shanghai, Chanda, each of which has 20 containers to Berlin, Vienna and Bratislava. At the border terminal it is possible to form new trains according to the destination station. In this case, it will not be necessary in the provinces of China to form trains exclusively to a specific European country. Container trains can be formed of any goods bound for Europe. Such framework will consist of a network of terminals (transport and logistics centers) along the boundary of the 1520 mm and 1435 mm gauge separation zones and shall be located on the transport corridors leading to the Nordic countries and the Central and southern European countries.

From this point of view, we should pay attention to the terminal "Dobra", owned by the company "Cargo Slovakia" (ZSSK Cargo), leased by PJSC "TransContainer" (a subsidiary of Russian Railways). The terminal lease is part of the project to develop container cargo transportation along the international transport corridor No. 5 (Italy – Slovenia – Hungary

– Slovakia – Ukraine) with the perspective of delivery of containers from the ports of the Asia-Pacific region by sea to the ports of Koper and Trieste, and from there – regular block trains to the terminal "Dobra" with further transshipment of containers from the platforms of the European gauge of 1435 mm to the platforms of the gauge of 1520 mm and shipment to Russia. Terminal "Dobra" meets all the requirements of the proposed concept and can be an effective alternative to overloaded Brest.

For the sustainable and efficient development of the European transport and logistics infrastructure, such terminals («dry ports», freight villages) are required to be established at the Finnish-Swedish border, the Ukrainian-Romanian border, the Lithuanian-Polish and the Russian-Polish border. Thus, the created cargo frame will ensure the passage of cargo from East to West in any of the directions with transshipment from one track to another through modern, digitized terminals with further dispatch of targeted consignments to the destination.

In addition, the border terminal and logistics centers will be the main elements of the implementation of the concept of "Smart logistics", that is already taking root in many major cities around the world.

6. Smart logistics at the macro level

The concept of "Smart logistics" is the development of the terminal in the form of a hub ("dry" port) with the functions of receiving, processing, customs clearance, deconsolidation of large consignments, followed by sending goods to specialized urban railway terminals of small targeted consignments of short container trains running on a regular basis. This system excludes transit of large-capacity trucks and it allows to significantly reduce the load on the street and road network of the city. In other words, the freight needs of cities are met through the efficient use of the suburban terminal without the need to allocate space and resources to already limited areas within the urban area.

A striking example of the implementation of such technology is the transport and logistics center "Vorsino" of already mentioned company Freight Village RU, which is a unique example of the complex format of the cargo village, which is a "dry port" of Federal importance, the distinctive features of which is a favorable location at the intersection of major transport routes, including international transport corridors. The terminal is located in the Kaluga region of the Central Federal district of Russia in sufficient proximity to Moscow and its infrastructure. There is direct access to the Federal road network, the railway and even the airport. On October 18, 2018, a pilot flight of a shortened container train from the Vorsino terminal to the Kuntsevo-II distribution center in Moscow took place, which was a transitional moment from the theoretical to the practical stage of the project implementation.

Although "Smart logistics" is an innovative technology at the beginning of implementation in the logistics systems of large urban agglomerations, its traditional understanding has already been formed, according to which the development of regional transport and logistics centers (hubs) for the reception, processing, customs clearance and crushing of large consignments. Small targeted shipments of goods for urban consumption arrive at retail

city terminals ("smart terminals") by shortened trains ("smart trains") running on a regular basis. Cargo delivery from "smart" terminal to door urban customers performed light-duty "truck taxi".

As a result, the system of road network of cities excludes auto transit of loaded and empty containers, following the suburban warehouses, where today there is a processing of incoming cargo. Thus, it is supposed to deliver goods by smart trains from suburban hub terminals to urban "smart terminals" at distances up to 100 km.

Developing this idea, it is possible to consider large transport terminals – hubs, specifically located due to natural causes of infrastructure constraints that make it impossible to continue the movement of the train towards the final destination without special technological procedures, as satellites not only of cities for their supply of goods, but also of entire countries and even regions. In particular, terminal "Dobra" can become a container satellite of the whole region of Eastern and Southern Europe, including Slovakia, Hungary, Austria, part of Poland, Romania. Of course, in this case, the technology of changing wheel sets on trains to change the track gradually may not be in demand for freight trains, because after processing at the border terminal and sorting the cargo, the containers will be directly transshipped between trains, sent on other platforms as part of other shorter container trains. But the importance of targeted delivery and the requirements for the development of modern logistics should be taken into account in the formation of the main directions of development of cross-border freight railway movement. At the same time, of course, these border terminals, "dry ports" should become hubs for the development of "Smart logistics", and in the traditional sense to meet the needs of nearby cities. In conclusion, it should be once again emphasized that the transport and logistics infrastructure of the "dry ports" format can optimize logistics.

7. Conclusion

Summarizing the research of the concept of infrastructure development of international importance, the authors have revealed that with the growing demand for incoming and outcoming cargo transportation, the creation and development of dry ports of international importance will allow goods to enter by rail from sea ports and carry out the processing, customs clearance, sorting of goods already directly in the countries – consumers of these goods with due observance of customs and legal regimes. The authors have focused on the concept of dry ports as a technology that makes it possible to effectively use the infrastructure of various types of transport. The authors have clarified the definitions of dry ports and their functions as objects of the infrastructure of international intermodal services. The authors have suggested bases of transport systems management at effective use of participant's infrastructure. The main attention was paid to the methodology of the transport system formation through "dry ports", based on the idea of determining a compromise point in the space of optimality criteria in order to choose the best combination of criteria characterized by the requirements of transport services consumers. Also in the article the creation of cross-border framework through the concept of "smart logistics" at the macro level was suggested by authors. Continental cooperation in Eurasia demands new transport products that are constantly being developed. This research perspective

is necessary, as it provides recommendations for improvements in the operation and efficiency of cross-border infrastructure of international importance.

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