

Integration Sea and River Ports – the Challenge of the Croatian Transport System for the 21st Century

Integracija morskih i riječnih luka – izazov hrvatskog prometnog sustava za 21. stoljeće

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Summary

This paper discusses the indicators of development possibilities for sea ports of national importance which are opened for public traffic: Rijeka, Ploče, Zadar, Split and Dubrovnik, as well as for inland water ports: Vukovar, Osijek, Slavonski Brod and Sisak. Development of traffic and logistic integration processes have been proposed for Croatian sea and river ports, based upon development factors analyses. Croatian sea ports Rijeka, Ploče and inland water cargo ports Osijek, Vukovar, Slavonski Brod and Sisak have been analysed as delivery/forwarding points (nodes), taking into account the directions of goods flows, the participation in the traffic of goods, and all other relevant indicators. The integrated and coordinated approach to the ports and other subjects in the logistic chain redirects the traffic from roads to railways and inland waterways as energy efficient and environmentally – friendly forms of transportation, increases business rationality and optimal organisation users and transportation entities.

KEY WORDS

logistic networks
indicators of development
possibilities
development directions
ports in the Republic of Croatia

Sažetak

U ovom radu su analizirani pokazatelji razvojnih mogućnosti morskih luka koje su otvorene za javni promet kao što su Rijeka, Ploče, Zadar, Split i Dubrovnik, te luke na unutarnjim vodama: Vukovar, Osijek, Slavonski Brod i Sisak. Temeljem analize glavnih čimbenika autori predlažu razvojna usmjerenja procesa prometne i logističke integracije hrvatskih morskih i riječnih luka. Uzimajući u obzir postojeću i planiranu prometnu povezanost, usmjerenost robnih tokova, udio u prometu roba te druge relevantne indikatore, kao otpremna/odredišna mjesta (čvorišta) obuhvaćene su hrvatske teretne morske luke Rijeka i Ploče, a od hrvatskih luka na unutarnjim vodama teretne luke Osijek, Vukovar, Slavonski Brod i Sisak. Integriranim i koordiniranim pristupom luka i ostalih subjekata u logističkom lancu, preusmjerava se promet sa cestovnog na željeznički promet i na promet unutarnjim plovnim putovima kao energetski učinkovitije i za okoliš povoljnije oblike prijevoza, doprinosi se poboljšanju racionalnosti poslovanja i optimalnoj organiziranosti korisnika usluga i prometnih organizacija.

KLJUČNE RIJEČI

logističke mreže
pokazatelji razvojnih mogućnosti
pravci razvoja
luka u Republici Hrvatskoj

1. INTRODUCTION / Uvod

The role of the Croatian sea and river ports is the traffic connection of the Adriatic Sea and the continental part of Croatia, as well as the integration of the country with Europe, which is one of the important prerequisites for the economic, touristic and overall development of the Republic of Croatia. Sea and river ports, which are functionally connected to other elements of the logistic transportation chain, need to provide an optimal continuity and dynamics of the traffic and need to direct the traffic towards more efficient and environmentally-friendly forms of transportation. This functional connectivity will lead

to the improved business performance, optimal organization of users and transportation entities, and coherence between economic development and sustainable environmental policies.

Sea ports are very important in the process of valorisation of development factors because maritime traffic contributes 90% to the trade between European Union and third countries, and 30% to the European Union's inner trade. The possibilities of Croatia can be higher than 7%, which is the contribution of Italian and Croatian ports to the European maritime traffic nowadays [1].

Inland water networks have to be validated as well. They represent important but, at the same time, unexploited part of national resources, which contribute only 3% to Croatian traffic, whereas in the most developed European Union countries the river traffic contributes 25% to the total traffic. It is vital for river traffic that river ports are well connected by road and railroad lines to the main nodes on main traffic corridors. Namely, in order to optimally use its port facilities is very important that the individual subsystems work together and that there are no bottlenecks and capacity constraints on some components which then lead to a reduction in the quality and competitiveness of the port.

The standpoint that "every port has two faces – the first one looking toward the land and the other to the sea" [3] points out the correlation between the port subsystem and other subsystems of the logistic and traffic systems. It also justifies the consideration of integrating sea and river ports into one system, in terms of traffic and logistics, and implementing the system as soon as necessary preconditions are fulfilled. It seems appropriate to mention that such an integrated transport system had already achieved some thirty years ago in the transport of iron ore from the copper rail to Sisak, Osijek and Vukovar, and then down the river to the Austrian-Danube port in Linz [7].

2. THE INDICATORS OF THE DEVELOPMENT POSSIBILITIES OF THE CROATIAN SEA / Pokazatelji mogućnosti razvoja hrvatskoga mora

This section examines the indicators of development possibilities for the sea ports of national importance, which are opened for public: Rijeka, Ploče, Zadar, Split and Dubrovnik, as well as for inland water ports: Vukovar, Osijek, Slavonski Brod and Sisak. The following indicators relevant for cargo ports have been defined:

- Basic factors of port system functioning in Croatia;
- The flow of goods between Croatian sea and river ports;
- Micro-logistic characteristics of Croatian sea and river ports;
- Macro-logistic characteristics of Croatian sea and river ports;
- The advantages of traffic and logistic integration of Croatian cargo sea ports and river ports.

2.1. Basic factors of port system functioning in Croatia / Osnovni čimbenici funkcioniranja lučkog sustava u Hrvatskoj

2.1.1. Traffic connectivity of the Croatian sea ports / Prometna povezanost hrvatskih morskih luka

Most of Croatia's major sea ports – Rijeka, Split, Ploče, and Dubrovnik-Gruž – have unrestricted connection with the open sea, favourable natural sea depth and port infrastructure. These features make them safe ports for the accommodation of larger modern vessels. Turnover of goods in Croatian seaports in the pre-crisis period was moving at above 30 million tonnes of cargo a year that after the outbreak of the global economic crisis has reduced by a third (Figure 1.).

The amount of transported goods has decreased in all types of transportation. The biggest drop more than 40 % was registered in road transport, the most important mode of transport in goods transportation, but also the most important when it comes to connect Croatian sea and river ports.

The port of Rijeka is connected by road network to the direction Rijeka – Zagreb – Čakovec – Budapest, and by rail network to the direction Rijeka – Zagreb – Koprivnica – Dombovar, which connects Rijeka with the Middle European area (Austria, Czech Republic, Slovakia and Hungary), i.e. a strategic transit market for the port of Rijeka. The importance of the port of Rijeka is emphasized by the oil pipeline running toward refineries in Croatia, Hungary, Austria, Serbia, the Czech Republic and Slovakia. The port of Rijeka is the key intermodal node in the land and maritime transport through the Pan-European Vb corridor.

As for the port of Zadar, numerous islands and navigational restrictions of passing between the islands are the limiting factors that make the access of larger ships difficult. The port of Zadar is connected to Croatian hinterland by modern four-lane motorway to the directions Zadar – Bosiljevo – Zagreb and Zadar – Split – Ploče. The port is also connected to other ports by the Adriatic tourist highway running along the coast. The railway passing through the region of Lika connects the port of Zadar to the direction Zadar – Knin – Gospić – Karlovac – Zagreb, while the railways passing along the river Una connects this port to the direction: Zadar – Knin – Bihać – Sisak – Zagreb.

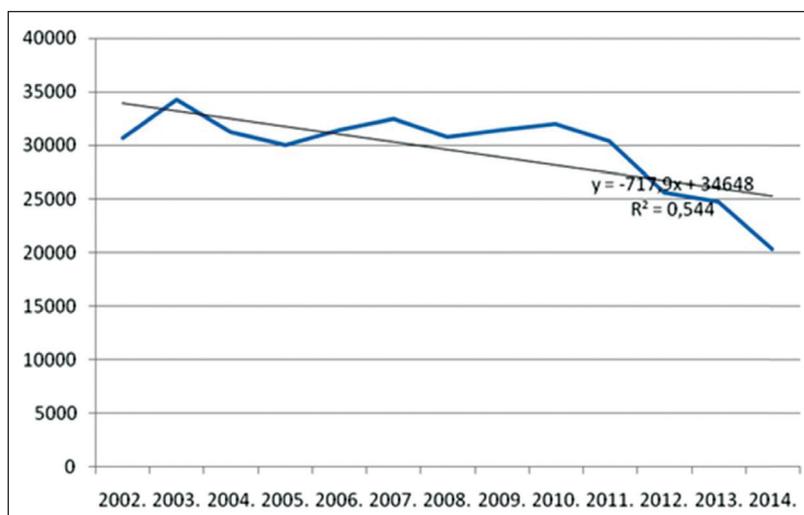


Figure 1 Seawater and coastal transport in the Republic of Croatia (000 t)
Slika 1. Morski i obalni prijevoz u Republici Hrvatsko (000 t)

Source: Authors prepared according to Statistical information, different years

The port of Split is connected to Croatian hinterland by modern four-lane motorway Split – Zagreb and Split - Ploče, and by railway to the direction: Split – Knin – Oštarije – Zagreb. Split and Dalmatian region would benefit from the planned construction of the highway in Bosnia and Herzegovina, passing through Bosanska Gradiška – Banja Luka – Mrkonjić Grad – Šipovo – Glamoč – Livno, and joining the existing Croatian motorway Sinj – Split. That 200 km long highway would connect the river Sava and the river ports of Nova Gradiška and Bosanska Gradiška directly to Split and, at the same time, would shorten the travel to Slavonia, as well as to the Middle and Eastern Europe.

The port of Ploče is connected to the Pan-European Vc corridor Ploče – Mostar – Sarajevo – Osijek – Budapest, and to the direction Hungary – Bosnia and Herzegovina – the port of Ploče in the Republic of Croatia, connecting the Middle European area with the Adriatic Sea [7]. It is also the shortest and the most rational connection between Croatia's north-eastern part (Slavonia) and the south-eastern part (Dalmatia).

The port of Dubrovnik-Gruž is connected to the rest of the country by the Adriatic highway along the coast till Ploče and further by the four-lane motorway Ploče-Zagreb or/and by railway and road to the corridor Vc. It is Croatia's only port which is not directly connected to the inland by railway.

Through investments in port infrastructure, superstructure and traffic technologies, the sea ports of Rijeka, Ploče, Zadar, Split and Dubrovnik-Gruž will become successful and efficient distribution and logistics centres in Croatian port and traffic systems. These investments should be adjusted to passenger traffic for the ports of Zadar, Split and Dubrovnik-Gruž.

2.1.2. Basic characteristics of the Croatian river ports / *Osnovna obilježja hrvatskih rije xćnih luka*

The total length of navigable inland waterways within Croatia's borders is 805.2 km. The total network density is 14 km per 1 000 km², which is relatively dense, compared to the average density of the EU inland waterway network of 9.4 km per 1 000 km². Importantly, the Danube waterway is a part of Pan-European Corridor VII, which links the North Sea (the Port of Rotterdam) and the Black Sea (Port Constance), and is one of the main European cargo transport routes with considerable growth potential.

The main river ports situated along these inland waterways are: Osijek, Sisak, Slavonski Brod and Vukovar. All four of these ports are classified as TEN-T ports. According to AGN (European Agreement on Main Inland Waterways of International Importance) Croatia has two international inland waterway ports (Osijek and Vukovar) and several quays. However, due to diverse navigational conditions, technical and technological obsolescence and under-capacity, market demand for the transport of cargo on the Sava and Danube is uneven.

The Republic of Croatia has established port authorities for the management of ports that are public non-profit institutions 100 % owned by the Republic of Croatia. The activities of the port authorities, among other things, include: 1) organising and supervising docking and the manoeuvring of vessels within the ports; 2) port traffic control; 3) maintaining order and a high degree of safety and environmental protection in the ports; 4) construction and modernisation of port facilities on behalf of the Republic of Croatia.

The port of Vukovar is the most important Croatian river port. The port of Vukovar upon the Danube has been categorised as

navigable and safe all 365 days in a year, and can service class 5 ships. It is located in the intersection of West-South flow of the goods (between Croatia and Bosnia and Herzegovina) and North-East flow of the goods (between Hungary, Serbia and Romania). The port has been reconstructed because of growing traffic volume due to the proximity of the planned canal Danube – Sava. The program of construction of the port of Vukovar includes the construction of buildings, quays, road-railway and communal infrastructure, port cargo handling systems, and the construction and the purchase of terminal facilities. The modernisation of road-rail infrastructure also includes connection to the main traffic corridors Vc and X.

The efficacy of the port of Osijek is diminished because of frequent material deposits and resulting reduction of the depths in the Drava waterway. In spite of this limiting factor, the port of Osijek has good business results. The basis of port development project includes the Drava - Danube waterway, the existence of infrastructure and connection to traffic corridors, as well the tradition of navigation on the Drava.

The main factors that make the port of Slavonski Brod attractive include reliability and safety of navigation on the Sava and its location, at the intersection of the roads and railways connecting the East of Europe with the Mediterranean and the Middle Europe with the South of Europe. The port is situated near the border of Bosnia and Herzegovina in the X traffic corridor and close to the intersection of the X and Vc corridors, and has all necessary prerequisites for intermodal development. The port of Slavonski Brod lacks basic infrastructure. Therefore, the construction of port infrastructure, quays and berths, operational surfaces, port road and railway infrastructure is needed for keeping the status of public open port. The lack of the investments could result in the closure of this port and in complete cessation of navigation on Sava.

In the port of Sisak, low water level and insufficient height of the passages under the bridges on the river Kupa are major constraints for the development of traffic market and modern river traffic technologies. Infrastructure development of the port of Sisak is based upon the construction of the motorway Zagreb – Sisak and the economic zones along the motorway. The construction of a new port is planned south of the settlement Crnac in the area designated for that purpose in spatial planning documentation.

The transport of goods along inland waterways diminished over the years (Table 1.).

Table 1 Transport of goods in inland waterway ports (in 000 tonnes)
Tablica 1. Prijevoz robe na unutarnjim vodenim putovima

| Year | National | International | Total |
|-------|----------|---------------|-------|
| 2004. | 493 | 1039 | 1532 |
| 2005. | 195 | 1251 | 1446 |
| 2006. | 189 | 1320 | 1509 |
| 2007. | 163 | 1305 | 1468 |
| 2008. | 141 | 739 | 880 |
| 2009. | 127 | 406 | 533 |
| 2010. | 145 | 370 | 515 |
| 2011. | 91 | 411 | 502 |
| 2012. | 50 | 596 | 646 |
| 2013. | 42 | 535 | 577 |

Source: Prepared by authors according to the Statistical Yearbook-2015, p.369

Annual turnover is one of the most important technological parameters that assess the market performance of a port or port system. The period from 2000 to 2013 is characterized by two phases. In the first phase the traffic started almost from a dead end and, consequently, in the first five years a rapid growth in traffic can be seen. This was the benefit that occurred due to the situation on the market and revitalization of industry, particularly in northern Bosnia, which is oriented to the Croatian river ports. The second phase in the period after 2007 was characterized by a decline in traffic.

Traffic growth was achieved only in international trade, while domestic traffic, other than transportation of crude oil on the Sava River, was almost non-existent. It is encouraging that despite the crisis the transit traffic remained at about 5 million tons of cargo (cf. figure 2).

Domestic service cannot achieve a significant increase while the Sava and Danube waterways in Croatia are isolated. This fact led the creators of the Croatian Transport Development Strategy to assert that only after the restoration of river infrastructure and the construction of Danube – Sava canal, Sava river traffic reach 3.5 million tons of cargo. True, this forecast was far too optimistic because it assumed that the canal would be finished by 2005, and that the river traffic would grow at an annual growth rate of 4-5%. Unfortunately, these predictions were not even remotely true. A similar prediction of river traffic on the river Sava is a result of Feasibility studies and project documentation for reconstruction and development of transportation and navigation on the waterway of the Sava basin (Figure 3.).

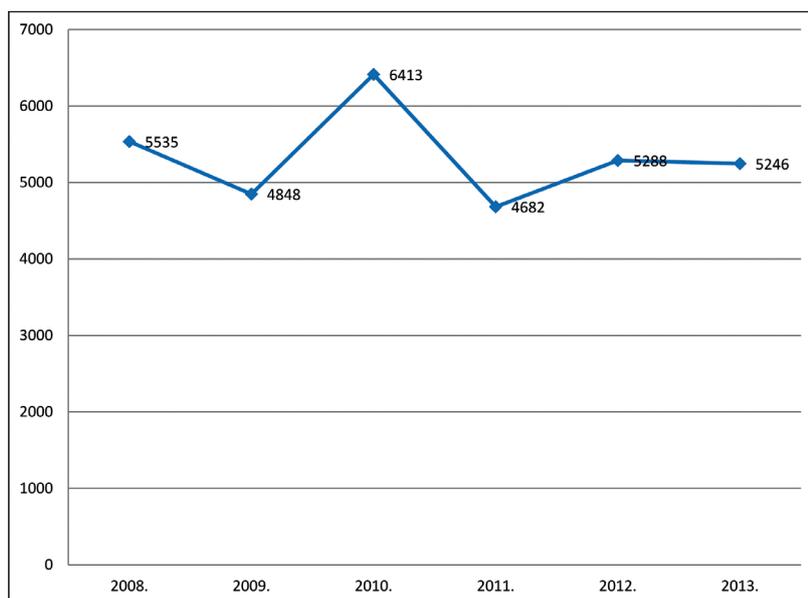


Figure 2. Transit traffic of goods in inland waterway (in 000 tonnes)
Slika 2. Tranzitni promet robe u unutarnjim vodenim putovima (u 000 tona)

Source: Prepared by authors according to the Statistical Yearbook-2015, p. 369

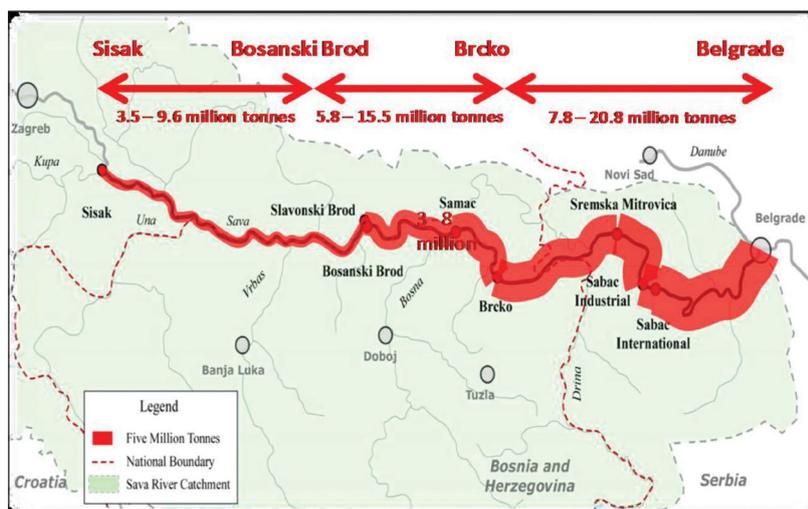


Figure 3 The cumulative traffic on the river Sava (up to the year 2027, the smallest and largest volume of traffic)
Slika 3. Kumulativni promet na rijeci Savi (do 2027. godine, najmanji i najveći obujam prometa)

Source: Feasibility study and project documentation for reconstruction and development of transportation and navigation on the waterway of the Sava basin

Predictions in this study are based on the fact that traffic on the Sava River before 1990 was at the level of 15 million tons of goods per year. The Croatian internal waterway network is a significant, but at the same time almost completely unused part of Croatia's national wealth. Therefore an extremely deliberate and rational approach to future development and water management is required.

2.2. The flow of goods between Croatian sea and river ports / *Protok robe između hrvatskih morskih i riječnih luka*

The results of the study show that the records of the performed traffic and the analyses of the performed traffic are not uniformly recorded and are not published in public (obligations of port authorities, port companies, Statistical Yearbooks).

In the port of Rijeka transit traffic had the most important share in the total traffic, amounting to 75% in 2007. The major transit partners of the port of Rijeka include: Italy 54%, Hungary 21%, Czech Republic 7%, Slovakia 7%, Austria 5%, and others 6% [7]. Recently, new transit markets have emerged in Serbia, Bosnia and Herzegovina and in Montenegro. Traffic in the port of Rijeka in the nine months of 2014 amounted to 1.892.666 tons of cargo, and increased by 12% compared to the same period in the year 2013. The largest growth, according to the structure of the cargo is in a group of bulk cargo (36%) as a result of new business contracted with the Austrian partner.

In the port of Ploče, transit traffic contributes 84% to the total traffic [9]. It is evident that the port of Ploče functions as the port of Bosnia and Herzegovina and partially of Serbia, Montenegro, Hungary, Czech Republic, Slovakia, Romania and Poland. The importance of the port of Ploče and all logistic chain subjects of the corridor Vc should be validated for the Middle European countries by an integrated and coordinated approach. The port of Ploče should play the leading role in the process of integration of Croatia into European traffic and economic system [6].

The traffic trends of Zadar-Gaženica cargo port include the stagnation of the liquid cargo, increase of ore bulk cargo and decrease of containers and general cargo. These trends result from business orientation towards traffic needs of the surrounding area [16].

In 2010, the cargo port of Split-Sjeverna luka handled 300,000 tonnes of cargo. Through investments into port facilities, the plan is to reach 900,000 tonnes of cargo handled yearly (the level reached in 1990) [14]. Sjeverna luka is the bulk cargo port for the surrounding area.

The port of Dubrovnik-Gruž is oriented toward passenger traffic.

There are positive trends in the increased port traffic along the Danube corridor. The port of Vukovar is a transit port for the cargo bound to and from Bosnia and Herzegovina. The importance of Vukovar port will rise through additional investments into multi-purpose terminal, bulk cargo terminal, terminal for pallets, liquid cargo terminal, ship supply terminal, and terminal for grains and oilseeds.

The port of Osijek port has also experienced positive trends

in traffic. The planned port capacity will rise up to 5 million tonnes of goods annually at final stage. The handled cargo will include general cargo, containers, bulk cargo, liquid cargo and RO-RO cargo.

The ports of Slavonski Brod and Sisak heavily depend on crude oil cargo transport between these two ports. However, there are plans to establish the production of biodiesel, metal products, bio-fertilizers, aluminium plates as well as to construct the liquid cargo terminal, shipyard, logistic centre, etc. in the area of the port of Slavonski Brod. Most of the raw materials and final products will be transported by waterways. The port has good prerequisites to become an intermodal node.

The terminal Crnac in Sisak port is situated on the Sava river. It is a port for oils having the capacity of 1.5 million tonnes per year. The road and pipeline connect the port to INA refinery and thermal power plant Sisak, but there is no railway connection [17].

It is estimated that the river transport demand will grow between 2% and 3.4% per year, with higher growth rates expected in Danube countries. Along the Danube corridor, transport demand is expected to rise by average annual rate of 7% [17]. The same can be expected for Croatian ports but the low start position, due to recent renewal of basic port infrastructure in Croatia, should be taken into account.

Currently, the most important international inland waterway ports are the Port of Vukovar, on Corridor VII, and the Port of Slavonski Brod, which is located at the intersection of two Pan-European Corridors (X and Vc) and might in future become linked with the Pan-European Corridor VII and the Port of Vukovar.

2.3. Port-centric logistics systems / *Logistički sustavi luka*

Logistics systems of small countries are based on functionality and ensure the effectiveness of their economic systems. It becomes more and more difficult for small countries to maintain competitive advantages in the long-term perspective by applying the general conceptual methods of logistics. Thus, it becomes necessary to discover new conceptual trends in the science of logistics for the formation and retention of competitive advantages of small countries taking into account the particularities of their logistics systems [8].

According to the research and the Port Reform Toolkit determined by the experts of the World Bank, it is expedient to distinguish five significant factors affecting port activities in the context of global economy: intensification of global competition, new technologies, environmental, security and safety requirements and standards, changing distribution patterns, shifting bargaining power due to realignments / consolidations.

Considering the general classification of logistics systems determined by scientists (Канке, Кошечая, 2010; Meidute, 2012), it is expedient to divide port-centric logistics systems in accordance with the coverage of their activities (on national and international levels) into two groups: micro logistics and macro logistics systems (see Figure 4.).

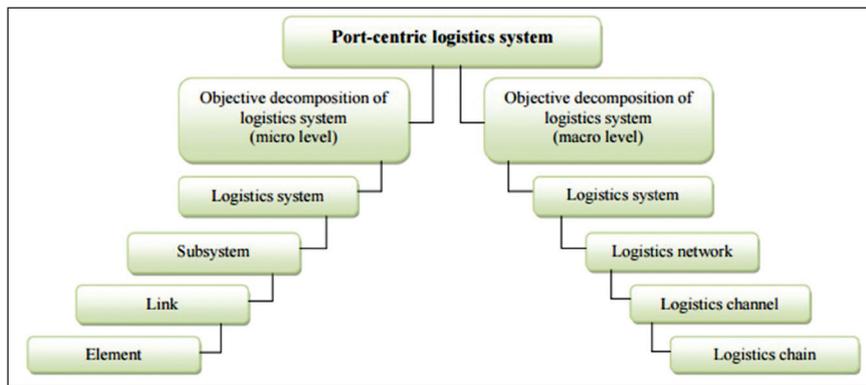


Figure 4 Classification of logistics systems in accordance with the coverage of activities
 Slika 4. Klasifikacija logističkih sustava u skladu s djelatnostima

Source: authors prepared according to [5]

Investment into port and other related transport infrastructure and technological capacity as well as into the land for this infrastructure allows expanding the logistics capacity, increasing its effectiveness and reliability as well as improving the quality of logistics services and enlarging the level of creation of added value.

2.3.1. Micro-logistic factors of the Croatian sea and river port systems / Mikro logistički čimbenici hrvatskih morskih i riječnih lučkih sustava

The sea ports of Rijeka, Ploče, Zadar, Split, and Dubrovnik-Gruž have engaged the well educated managers and other professionals ensuring good efficiency and profitability which will further rise by application of new scientific research results and investments into life-long education of the employees. By outsourcing the logistic services, these ports have minimised the number of dockers engaged in cargo handling, stowing and transfer. The ports have also engaged outsourcing companies in the realization of some development projects but not to the sufficient extent, because cargo transport agents are still primarily engaged in freight-forwarding and do not deal with classic logistic business. The increase in handled cargo quantity will encourage the establishment of specialised logistic companies qualified for logistic outsourcing. The realised or planned large investments into the modernization of port terminals and in raising the port service quality confirm the success of port service financial policy. The correlation between the economic growth and the need for healthy environment has been recognized and Environmental Impact Assessment Study has to be included in all development projects for sea ports, together with an increased application of modern environmentally-friendly transport technologies. The educational structure of managers and other professionals together with their skills should be analysed, keeping in mind that inland water port companies usually employ small number of employees and that they engage specialized professionals for development program realization.

After the large and strong logistic companies have been attracted, the process of outsourcing would bring specialized logistic professionals to carry out specific logistic tasks. The success of financial policies created by port service providers correlates with the diversity of personnel in the ports and external specialized professional support. With the exception

of the port of Sisak, all river ports have harmonized their economic growth with the need for environment preservation.

2.3.2. Macro-logistic characteristics of the Croatian sea and river ports / Mikro logističke značajke hrvatskih morskih i riječnih luka

Port operations are carried out by small scale port operators but the expected traffic increase in sea ports, especially in Rijeka and Ploče, will create the prerequisites for engaging middle and large scale port-logistic operators and will intensify the process of creation of large logistic centres that will allow the operation of new manufacturers, suppliers, exporters, freight-forwarders, carriers, inspectors, and the development of customs office, port docks, road-railway terminals and other facilities.

Port-logistic costs are lower than in the North-European ports. After the arrival of large companies, port-logistic service quality will rise together with the prices. However, once the port-logistic market is stabilised, port-logistic costs will decrease in the next 10 to 15 years. The great majority of the ports have developed modern goal-oriented management concepts with a focus on coordination, planning and information correlation, the analyses and the control of human, material, financial and information resources. The increase of port-logistic intellectual property value will raise the awareness of the need for continuous modernization of controlling in port-logistic sector. Some sea ports use modern information systems that provide coordination of various activities. The full implementation of electronic data sharing among Port Authority, Custom Office, police, port operators, maritime agencies, shipping companies, logistic companies, etc., including the existing vessel identification and tracking system, will boost the competitiveness of the ports.

In river ports, port operations are carried out by small scale port operators specialized for certain types of the goods. As is the case with sea ports, the increase in traffic will create the precondition for middle and large scale port-logistic operators to come. There are no modern goal-oriented management concepts focusing on coordination, planning and information correlation, analyses and the control of human, material, financial and information resources, only occasional controls and surveys have been carried out.

Port-logistic costs are lower than in the developed European inland water ports but similar price trends as for sea ports can be expected.

The previously adopted plans for the implementation of integrated river information systems and port-logistic systems harmonized with international conventions are in the process of implementation.

It is important to underline that the aspect of logistics in the European or Croatian port sector has not been regulated by legislation, although the development of multimodal transport and traffic have imposed the need for adequate regulation of legal relationships among legal entities in these industries. Agreements, guidelines and codes related to multimodality, ecology and safety are occasionally used but the European Union port-logistic legislative is yet to be adopted.

2.4. The advantages of traffic and logistic integration of the Croatian cargo sea ports and river ports / *Prednosti prometne i logističke integracije hrvatskih teretnih morskih i riječnih luka*

The advantages of traffic and logistic integration of Croatian sea ports and river ports include harmonized, market-oriented and eco-friendly transport of the goods, adequately defined by their quantity, type and quality, between sea and river ports, as well as the utilisation of combined and intermodal transport.

The integration implies the benefits of using various types of transport. The advantages of maritime transport include the traffic cost-efficiency and safety, the possibility of long-range transport of large quantities of the goods at the same time, and more favourable dead weight / useful cargo ratio, compared to the transportation by land. The advantages of river transport are: big capacity and price competitiveness of this type of transport for bulk cargo (ore, coal, and construction material) and oils, optimum return on investment ratio [11], and safe, energy efficient, and relatively clean way of transport. The advantages of railway transport include the possibility of transporting large quantities of bulk cargo, good connectivity with ports, safety, energy efficiency, low impact on weather conditions and relatively clean way of transport. The main advantage of road transport is that it represents the most developed and the most important way of land transport. Other advantages include the possibility of door-to-door service and efficiency in assisting the railway transport. The advantage of pipeline transport lies in the fact that this is the cheapest and one of the cleanest ways of transporting energy-generating products.

The integration of sea and river ports and the use of various forms of transportation are realized the following benefits: 1) the convenience of the transport goods over long distances, 2) higher energy efficiency, 3) significantly longer life haul road, 4) better utilization of vehicles, 5) greater safety transport and 6) to better protect the environment.

3. DEVELOPMENT FACTORS AND PROPOSAL OF DEVELOPMENT DIRECTIONS / *Čimbenici razvoja i prijedlog razvojnih smjerova*

The process of functioning of the port and transport infrastructure and superstructure is determined by traffic structure. On the other hand, the logistic structure shapes the processes of planning, management, performance and control of spatial-temporal transfer of the goods with regard to their

quantity, type and quality, as well as the logistic determination of goods.

The sea ports of Rijeka and Ploče, as well as the inland water ports of Osijek, Vukovar, Slavonski Brod and Sisak, have been analysed as delivery/forwarding points (nodes), taking into account the existing and planned traffic connections, the direction of the flow of goods, the share in the traffic of goods, and all other relevant indicators. It is vital for total traffic that sees and river ports are well connected by road and railroad lines to the main nodes on main traffic corridors. Namely, in order to optimally use its port facilities is very important that the individual subsystems work together and that there are no bottlenecks and capacity constraints on some components which then lead to a reduction in the quality and competitiveness of the port.

The sea port of Rijeka participates by 64% in the overall Croatian ports traffic and it is connected to Slovenian, Austrian, Hungarian, Czech, Slovakian, Italian and other Middle-European countries, as well as Serbian, Montenegrin, Bosnian and Herzegovinian markets via the traffic flow direction Rijeka – Zagreb – Budapest. Oil transport starts from the port and terminal in Omišalj on the island of Krk toward Sisak and further, by northern branch of the pipeline, to Hungary, Austria, Czech Republic and Slovakia. The port of Rijeka is the key intermodal connection between land and maritime transport in the Vb Pan-European corridor.

The port of Ploče is Croatia's second largest cargo port by handled cargo traffic. It is connected to the markets in Bosnia and Herzegovina, Serbia, Montenegro, and eastern Hungary by traffic flows along the direction Ploče – Mostar – Sarajevo – Osijek – Budapest. The port is situated in the North-South traffic direction and it is the shortest and the optimum connection between the Baltic and the Adriatic Sea. The better valorisation of that direction will be achieved upon completing the construction of the multi-purpose canal Danube – Sava from Vukovar to Šamac [2] and construction of the port in Bosanski Šamac. The port of Ploče is the key intermodal connection between land and maritime transport in Vc Pan-European corridor.

The ports of Rijeka and Ploče are connected to river ports and other ports (delivery/forwarding points - nodes) by traffic nodes (road-railway terminals, railway terminals) and by multimodal transport network connections (roads, railways, ship lines, waterway canals, and oil and gas pipelines). The strategic location of Croatia, EU membership and being a maritime entry route for cargo from the Far East to the North Adriatic Ports, creates opportunities for development in this sector. The development of the railway network to strengthen the existing high quality motorway network could help Croatia become both an entry and exit point for goods coming in and out of the EU. The government is focusing on improving the rail network to enable the Port of Rijeka and the neighbouring ports in Koper, Venice and Trieste to be more competitive to the established ports in northern Europe, such as Le Havre and Hamburg. There is €3 billion of planned investments in the Rijeka rail route, 85% of which could be drawn from EU funds [11].

The port of Vukovar is situated in the intersection of traffic flows in the direction West-South (between Croatia and Bosnia and Herzegovina) and the direction North – East (connecting

Hungary, Serbia and Romania). It is a key transit port for Bosnian and Herzegovinian cargos. It is also very important due to development projects for economic zones and the area near the orifice of the canal Danube – Sava, as well as to the modernization of road-railway infrastructure entering the port and including the connection to Pan-European traffic corridors Vc and X. The future of Vukovar will become a major river port in Croatia which will be in addition to modern transshipment capacity, develop distribution and trade processing zones, and a logistics centre for Central and Eastern parts of Europe. There its function Vukovar port can be achieved with the port of Rijeka and Ploče, or by rail, which is associated with seaports. The port of Osijek is situated in the international waterway (the rivers of Drava and Danube). The old port is relocated due to integral transshipment demand. It achieves good results regarding the performed traffic.

The port of Slavonski Brod is situated at the intersection of the roads and railways connecting the east of Europe to the Mediterranean and at the intersection of the traffic routes from the Middle Europe to the South of Europe. The port is situated close to the Croatian – Bosnian and Herzegovinian boarder in the X Pan-European traffic corridor, near the junction of X. and Vc Pan-European traffic corridors, which are excellent preconditions for the development of the port as an intermodal node.

After the construction of the motorway Zagreb-Sisak, the port of Sisak and its wider area should become a distribution-logistic centre in order to functionally connect the industrial-economic area of Zagreb with the river of Sava and river traffic.

The ports of Vukovar, Osijek, Slavonski Brod and Sisak are connected to sea ports and other ports (delivery/forwarding points - nodes) by traffic nodes (road-railway terminals, railway terminals) and by multimodal transport network connections (roads, railways, ship lines, waterway canals, and oil and gas pipelines). The main priority needs in the inland waterway sector are: 1) to establish, maintain and improve conditions for safe and reliable inland navigation on the river Sava. In practice this means ensuring international waterway class IV status along a defined section of the river; 2) to better connect the inland waterway network with the main road and rail corridors in order to achieve better integration with the economic hinterland and to create preconditions for the development of inter-modal transport; 3) to upgrade port infrastructure in order to provide greater capacity and better services; 4) to install and operate the River Information System.

The macro-logistic network consists of logistic centres: the mega or large logistic centre in Zagreb (cargo centre Zagreb operates as a “dry port” for the port of Rijeka), macro or medium-size logistic centres in Rijeka, Ploče and Osijek and micro or small logistic centres in Vukovar, Slavonski Brod, and Sisak.

The manufacturers, suppliers, exporters, freight-forwarders, logistic operators, carriers, inspectors, customs offices, sea ports, river ports, road-railway terminals, railway terminals are involved into the macro-logistic network design [14]. Conventional, combined and multimodal forms of transport are performed in the network. Today, we use routes with multiple ports, so reduction of transshipment cost starting to

be crucial factor [4]. Transport technologies as palletisation, containerisation and RO-RO are used. In the future, Huckaback and Bimodal technologies will be introduced. Within the proposed development factors and logistic integration directions of Croatia's sea and river ports, transport networks and logistic networks are in continual interaction and their functions combine.

4. CONCLUSION / *Zaključak*

This study designs and qualitatively evaluates the process of traffic and logistic integration of Croatian sea and river ports by strategically positioned development factors. In the adopted strategies and plans for Croatian river traffic development, the main goals include the establishment of the combined railway-river traffic corridor and the linking the Adriatic to the Croatian hinterland, including the connection of the river ports with the sea ports. The main priority needs in the inland waterway sector are the following: 1) to establish, maintain and improve conditions for safe and reliable inland navigation on the river Sava. In practice this means ensuring international waterway class IV status along a defined section of the river; 2) to better connect the inland waterway network with the main road and rail corridors in order to achieve better integration with the economic hinterland and to create preconditions for the development of inter-modal transport; 3) to upgrade port infrastructure in order to provide greater capacity and better services; 4) to install and operate the River Information System. Only on that way river transport can be the significant factor in logistics chain. This is necessary because costs of inland waterway transport are only 17 percent of the cost of road transport or 50 percent of the railway and river transport is seven times more environmentally friendly than other forms of transportation.

The purpose of development of port-centric logistics systems is to discover the unused opportunities and disproportions of economic growth and its employment for the foundation of the development strategy of the activities of port-centric logistics systems and their interactive transport types and modes. According to the goals of the current traffic policies, a balanced development of various traffic branches is emphasised, because traffic development cannot be separately planned, but only as a part (sub-system) of the unique traffic system. By an integrated and coordinated approach to the ports and other entities within the logistic chain, the traffic is redirected from road traffic to railway traffic and inland waterways which are energy efficient and environmentally-friendly forms of transportation. In addition, such an approach increases business rationality and optimal organisation of users and transportation entities. Investment into port and other related transport infrastructure and suprastructure allows lower logistics costs, shorter transit times of flows in port-centric logistics systems and favourable business conditions. Thus, the investment process in the port and related infrastructure ensures the productivity of port-centric logistics systems and competitiveness of port-centric logistics systems and small countries' economic systems on different levels, and, as a result, economic growth of small countries and their competitive advantages with the feedback to the investment process.

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