

Possibilities for Implementation of Intelligent Transport Systems into

Croatian Maritime Ports

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Abstract: Rapid economic and social development implies the need for a quick and dynamic development of transport, especially related to implementation of modern transport technologies. Modern transport technologies fulfil the newly created requests as speed, dependability, efficiency, downsizing and security. In addition to having an impact on the commodity price and location of production objects, modern transportation systems also have an impact on investment cost-effectiveness and thereby on the level and the structure of international exchange. The authors will examine the possibilities for implementation of modern transport systems into Croatian maritime ports which is important for Croatia as a profoundly sea-oriented country. Modes of ITS technology application with special emphasis on the learning capacity of the system will also be examined on the example of Croatia. Due to the development of the system in a dynamic environment, flexibility of the system and its environment will be examined in the sense of quick adaptability to new changes.

Key words: intelligent transport systems (ITS); port system; port system management; Croatian maritime ports JEL code: R42

1. Introduction

In the last twenty years, important efforts in scientific research have been made in terms of spreading knowledge of management of complex systems and processes using new information technologies in order to find solutions for traffic issues. Intelligent transport system is a new critical concept which changes the approach and development trend in transport science and technology of transportation of people and goods because it provides solutions for fast-growing problems of traffic congestion and environment pollution as well as for transportation efficiency, security and protection of people and goods in transport.

Basic presuppositions necessary for analysing the system as an intelligent transport system are the following: transport, information exchange and integration of transport subsystems in order to gather, save, process and distribute information on movement of people and cargo.

Based on the available data from business practice and analysing the Croatian chamber of Commerce data base—BizNet, the research presented in this paper aims at determining the application and representation of intelligent transport systems in general and possibilities for using such systems in Croatian ports. The paper

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emphasizes the importance of building national ITS architecture in the sense of information and communication integration of intelligent transport subsystems.

The following issues will be dealt with in the research:

(1) What is the overall extent of ITS usage in Croatian ports, and what is the level of familiarity of Croatian port management staff with possibilities of ITS implementation?

(2) What are the advantages of using ITS in sea ports?

(3) Are there negative sides of using ITS and what are the shortcomings of implementation of such modern systems?

(4) What are the advantages of building the national ITS architecture?

(5) What are the priorities in dealing with the problems of the current status of the national traffic system?

The objective of the paper is to present the status of Croatian port system. In the context of ITS use, special reference is made to the new concept of the container terminal in Rijeka.

2. Development of the Concept of Treffic in the Contex of Rapid World Mobility Development

Bošnjak et al. (2007) point out that traffic is one of the basic problems of the modern world. With the rapid development of needs for mobility in general and transport of goods, physical construction and road reconstruction (build only approach) does not solve traffic problems any more. Božičević et al. (2008) stated that traffic development is caused by the dynamic economic growth. Therefore, there is a need for exploring possibilities of further traffic expansion and development, education, research and application of scientific methodology in grasping the modern concept of traffic.

Zelenika and Nikolić (2003) also state that continuous growth of world economy demands further construction of the transport and traffic system. Modern transport technologies fulfil new traffic requirements like speed, dependability, efficiency, rationalisation and security. In addition to having an impact on commodity price and location of production objects, modern transport technologies also have an impact on investment cost-effectiveness and thereby on the level and the structure of international exchange. In future, the fields of environmental protection and ecology will be of special interest for traffic and transport experts in terms of harmonisation of ecology standards.

Kljajić and Drilo (2008) maintain that in the last twenty years important efforts in scientific research have been made in terms of finding solutions for traffic problems by implementation of new information technologies and new knowledge of management of such complex systems and processes.

3. Intelligent Transport System (ITS)—The New Concept in Modern Consideration of Traffic and the New Approach in Management of Traffic Systems

The new area of classic transport engineering expansion called intelligent transport systems (ITS) provides a new approach and implementation of advanced management and technical and technological solutions that provide improved transport security, efficiency and dependability with reduced impact on environment and society. ITS represent integration of information and communication technologies—ICT with transport infrastructure, vehicles and transport participants (Kljajić & Drilo, 2008).

Hagesava et al. (1999) indicate that the attribute "intelligent" denotes a capacity to operate in changing conditions and enable data processing in real time and they define ITS as "holistic, management and information technology bound expansion of the classic traffic and transport system". The basic concept of intelligent transport systems ITS is and integration of diverse transport subsystems with the aim to gather, save, process and distribute information of people and cargo movements. Basic presuppositions necessary for consideration of the system as an intelligent transport system are the following: transport, information exchange and integration of transport subsystems.

Intelligent transport systems are very complex because they include a large number of subjects and facilities. They are also very expensive, and once developed they remain in use for a long period of time. In the development of ITS, it is necessary to take into consideration all interest groups, wishes, ideas and problems in order to get the system that fulfils the maximum requirements. The cost price of ITS is a result of development projects costs, education and training of future ITS operation staff costs and the cost of integration of a large number of subjects, systems and their subsystems.

Groups Beneficia		Beneficiaries		
1		State offices		
Transport infrastructure providers	2	Regional offices		
	3	County offices		
		City offices		
4	5	Personal vehicle drivers		
Community		Business vehicle drivers		
consumers ,	7	Independent Service Users		
8	8	Passengers with Special Needs		
9	9	Load Transportation Agencies		
	10	Air load		
Load management	11	Rail		
	12	Freight forwarding companies		
	13	Regulatory agencies		
	14	Port authorities		
Dassanger services	15	Transit vehicle services		
		Personal services		
	17	Emergency services		
Public security services		Police, Fire brigade, Towing service		
	19	Ambulance		
	20	Transport vehicle producers		
Service providers	21	Maintenance and building services		
	22	Communication and Information Technology Producers		
		System Integrators and Consultants		
	24	State offices		
Public institutions and interest groups		Regional and local offices		
		Universities		
		Professional Associations/Societies		
	28	Special interest groups (Environment protection, security)		

Table 1	ITS Service Users	(Rožić.	1999.	n. 49)
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Since transport systems operate in a dynamic environment, ITS system has to be build and implemented in a flexible and user-friendly manner, because of the continuous need for improvement based on system expansion, system needs alteration and change of environment. Intelligent motorways, railways, vehicles, trains, aeroplanes, ships, sensors and management systems when integrated, provide easier, safer, and quicker passenger and cargo transport to the destination.

Vuk (2009) instructs us that all entities included in maritime and other transport have to be connected into a common information system. Such a system would be a subsystem of a business, port information and management system, maritime or any other (road, air, rail...) system of transport companies in a micro and macro-region and a part of a state or larger systems. In this way coordination in operation and business is achieved and at the same time own company has been improved. ITS system beneficiaries are listed in Table 1.

The use of ITS system brings about a highly increased competitiveness of a port, dock, maritime shipping company, rail, road or air company in the domestic and especially in the international load transportation market.

4. Features of the Port System

The port system is an open system. It is represented in its relationship to the transport system, economic system, position in the market and the amount of impact the external factors have on its operation (Figure 1).



Figure 1 The Role of a Port in a Logistic Chain (Kolanović & Badurina, 2002, p. 231)

Capital interest groups present with the high level of activity within the port circle have a positive impact on the improvement of the port system. Intelligent transport systems in ports have a task to advance processes and activities in a port with the aim of establishing and maintaining a competitive position of the port by identification and elimination of bottle-necks as obstacles for using advanced technologies and maintaining smooth cargo flow through the port system.

Due to their features and advantages, ITS in ports need to be implemented as parts of national ITS architecture, developed in order to provide a unique framework to help interest groups in strategic planning on the local and global level. Port systems need to provide efficient link for maritime and ground transportation and focus on information and cargo flow. The impact of market globalisation and expansion of requirements results with the need of optimal use of port resources. Therefore it is necessary in planning port operations to calculate with the possibility of growing demand and future needs that the system will face. ITS offers opportunities for optimal use of the existing system using new information technologies.

	Weaknesses				
Strengths Development of integrated subsystems Improvement of internal communication Flexibility of ideas and innovations Functional restructuring Public, private property	 Transport infrastructure Short-term investment Slow change of organisation culture and resistance of beneficiaries Shortage of finances Shortage of flexible technology, efficiency Old information systems Lack of promotion opportunities 				
Opportunities New terminals Increased transit through the port IT development, robot exploitation Training programs, especially about PCs Identification of requests of interest groups Increase of resources	Threats Petrifaction of old systems International and national competitiveness Inflexibility of robots Bulk reduction Creation of port lobbies 				

Table 2	SWOT Analysis o	f a Port System	(Adapted from	ı Edwards &	Kelsey, 2005, p. 56)
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Comprehensive analysis of the port system enables comparison of the internal strengths and weaknesses of the system and external opportunities and threats through SWOT (Table 2).

5. Advantages of Its System Implementation

Efficiency of ITS and advantages of its implementation are linked to modern information technology implementation. Progress in sensor technology and devices for data gathering enables data analysis in real time and providing feedback simultaneously which ensures continuous operation of the system. Financing intelligent transport system development is characterised by high initial investment that decreases in the following years, planning of requests of system beneficiaries and long-term perspective of all interest groups.

Intelligent transport system provides an opportunity for better management of existing resources as well as supra-structure and infrastructure elements. ITS applications aims at reducing congestion, improving safety, mediating the impact of environment on the functioning of the transport system and improving energy performance.

Commercial approach to ITS implementation represents a development of the system of integrated subsystems in the environment by way of using advanced technologies that, from technological and functional point of view, enable efficient and optimal transport management. Terms of ITS development are technologies that include optic cables, CD-ROMs, electro-magnetic environment, positioning systems, laser sensors, digital data base maps and technologies for data presentation on screens like LCDs. Advanced technologies represent the essence of ITS. However, the challenge of using advanced technologies is in their quick becoming dated, rapid change in technology and difficulties in maintaining the desirable standard.

6. Present Condition of the Croatian Port System-Review

Due to favourable geographic position, Croatian sea ports play an important role and have a great potential. A long coastline with many bays and islands (1777.5 km of land coastline represents only 47.6% of the total sea coastline) including 4058 km of island coast and that is the reason for a large number of ports. Out of the total number of Croatian ports, seven of them are International transport ports: Pula, Rijeka, Zadar, Šibenik, Split, Ploče and Dubrovnik.

Different macro-regional position of the three groups of Croatian ports (ports of the North, Middle and South

Adriatic) is reflected in their substantially different transport position and the function they have for the hinterland area that gravitates to them. Total transport capacity of the indicated ports amounts to 23 mil.t. of bulk cargo annually. Together with the capacity of the Oil terminal in Rijeka port of 16 mil.t., it amounts to a total capacity of 39 mil.t. of bulk and liquid cargo annually. The majority of the mentioned transport capacity refers to ports of Rijeka and Ploče. However, the biggest problem is in the facilities of the ports that are technologically dated and their level of exploitation is only 30-50%.

Almost identical indicators refer to the passenger transport. All Croatian passenger ports have 40% less transport compared to their results of twenty years earlier.

Croatian sea ports, especially Rijeka missed the important investment cycle into modern technologies in the 80ies, so the majority of the existent port technologies are dated. In the same period ports in Koper and Trieste in the neighbouring countries, have invested in modernisation and development of new facilities. For example, between years 1980 and 1989, investments into port Koper were three times higher than into the Rijeka port. While in that period ports in Trieste and Koper have build and equipped new container and Ro-Ro terminals and thus adapted their facilities to the new demands of the maritime market, there were no significant investments into port Rijeka until the year 1990 (Dundović & Kolanović, 2002). At the same time, Croatian ports with their ineffective investment, high costs and incompatible prices of port services have been competing among themselves and gradually loosing pace with the international maritime market.

Inadequate and dated railways and roads in Croatia are the reason for redirecting of international transport to close ports in neighbouring countries or even to the distant European ports. Dundović et al. (2005) point that the Croatian rail network with regards to its transport infrastructure partly fits into TEN-corridors and their branches, particularly when it comes to:

- Corridor X: Savski Marof Zagreb Vinkovci Tovarnik
- Corridor VB: Rijeka Zagreb Botovo
- Corridor VC: Ploče Metković Šamac Vrpolje Osijek Beli Manastir



Figure 2 Backbone of the Croatian Transport Network (Steiner, 2008, p. 4)

Dundović et al. (2010) emphasize the following advantages of railway traffic compared to road transport: higher transport capacity, lower energy consumption, less space consumption, higher level of environment protection and security. It needs to be pointed out that due to the decline in economic activities and damage of the railway network caused during the Homeland war, the intensity of the railway transport has not yet reached the pre-war level.

Quality transport infrastructure with the capacity to attract transport flows adopts a regulating function of those very flows. The state with its transport policy measures and adequate infrastructure provision causes high transport corridors to emerge in certain directions. Absence of a coherent economic and transport policy in the past, orientation to continental transport, neglecting of coastal areas, underestimating the role of sea ports and maritime transport and numerous objective and subjective factors are responsible for lagging of the Croatian port system.

Due to increased risk and introduction of additional insurance caused by war activities on the Croatian territory, the transport flows have been redirected to other ports. In 1990 Croatian ports achieved the total transport of 13.342 mil.t. of bulk cargo, with the following distribution: Rijeka 5.8, Ploče 4.58, Šibenik 1.17, Split 1.102, Zadar 0.63, Metković 0.308, Dubrovnik 0.214 and Pula 0.015 mil.t.

Split Port, located in broad area of Kašela bay, is focused on passengers and cargo transport. It is consisted of a City port used for passenger and vehicle transport, Kaštela basin A used for the chemical industry transports, Kaštela basin B used for cement and metal industry transports, Kaštela basin C used for cement and oil-processing industry transports and Vranjica-Solin basin used for numerous smaller industry plants. Compared to other Croatian sea ports, in terms of passenger transport Split port is in the second position, after Rijeka port, and in terms of cargo transport, it is in the third position, after ports of Rijeka and Ploče.

Analysis of the available data shows a positive trend in passenger, vehicles and cargo transport.



Figure 3 Passenger Transport in the Port of Split between 1989 and 2004 (Kasum, 2008, p. 2)

The authors believe that the development of motorways and better connection of the coast area and hinterland will lead to transport growth through the Split port. It is expected that further investment in transport connections will also cut-down the passing time through the port system.

The total transport of the Croatian ports, including liquid cargo, amounted to approximately 30 mil.t. in 1989. Currently, the transport has diminished for 2.5 times compared to pre-war figures. One of the reasons for that is reduction of the orientation area towards Croatian ports caused by the dissent of Yugoslavia and redirection of the



transport of goods from some countries of ex-Yugoslavia to other directions.

Figure 4 Cargo Transport in Split Basin from 1989 to 2004 (Kasum, 2008, p. 4)

Underdeveloped front of seaports-insufficient number of lines that feature modest domestic transport and considerable decline of transit transport have caused falling behind of Croatian ports. Due to a modest trade in goods and the structure of our foreign trade, domestic transport is cannot provide a base for quick and thorough recovery of Croatian seaports. Some improvements can be found in increased international competitiveness of seaports and increased transit transport. During the last ten years the transit transport of neighbouring and Central Europe countries has dropped almost in half. Hungary, Austria, Czech Republic and Slovakia present a good example of that trend. The reason for that trend is in higher competitiveness of the North European seaports and opening of the Raina-Maina-Danube canal and redirection of a part of transit transport towards the North Adriatic ports (attracting the total transport of 65 mil.t. out of which 20 mil.t. of bulk cargo) increased transit transport towards Hungary can be achieved only by improved competitiveness of Croatian ports which includes modern approach to requests of port service customers.

Absence of a coherent maritime and port policy caused an uncontrolled and inadequate development of the Croatian port system. National maritime policies usually stimulate the development of one or two ports bearing in mind the national, international, economic and sea transport industry development. Undefined littoralisation process provides ground for Croatian ports management to have nurtured illusions in the past that each port can take the lead and become a world port. Therefore port capacities have not been adapted to transport needs and often superseded them. At the same time, the ports have been slow in adapting to new transport technologies and maritime market conditions, and their human resources and management could not meet the global challenges and solve technological, organisational, cargo reloading, marketing, information, economic, environment and development strategy issues that a modern port is faced with.

Inadequate policy of financing transport and establishing prices of transport services, especially when it comes to incentives for the development of modern transport technologies caused Croatian ports to fall behind. Compared to the Port of Koper, which back in 1974 realised the importance of coordination and harmonisation of tariffs on single transport lines and introduced a unified body to coordinate tariff policies of ports and railways,

Croatian seaports and other stakeholders still do not have an adequate common policy for setting quality and tariffs on a singular transport line.

Dated port infrastructure and an insufficient level of specialisation of infrastructure and superstructure, inadequate tariff and transit policy, poor business organisation and low work quality, low work effectiveness, administrative staff surplus and inadequate management and marketing expertise are the key factors causing seaports to fall behind and making Croatian seaport system fall short in competitiveness.

The basic legislative presuppositions for the Croatian seaport system development are stated in the 1995 Act on Seaports (*Zakon o morskim lukama*) and the 1994 Maritime Code (*Pomorski zakonik*) that defines seaports as the maritime good. The Act on Seaports classifies seaports and defines the port areas, the port services and their performance. Construction and use of the port superstructure and substructure, port management establishing, structure and operation, code of conduct in seaports and privatisation of existing public port businesses are also defined in the Act on Seaports.

6.1 The New Concept of the Container Terminal in the Port of Rijeka

According to Baričević and Poletan (2005) transport and geographic position of the Port of Rijeka complex is an important factor for its faster integration into the European transport system. The facilities of the existing infrastructure with its transport and technical elements show an inclination towards harmonious operation of the maritime and road and/or rail transport. Dundović and Hlaća (2007) see the Port of Rijeka as a port of national interest open to national and international public transport. The Rijeka port plays an important role in container transport. As presented in the port classification and physical planning of the Primorje County, Rijeka has a distinctive international business importance for Croatia.

The bulk of the Croatian export and import of goods is achieved through the Rijeka port, which is the principal transit port in Croatia for the goods from Hungary, Slovakia, the Czech Republic, Austria, Italy and Serbia. Its geo-transport position and physical features as well as the connection with the hinterland also present the advantages of the Rijeka port.

Also according to Baričević and Poletan (2000), compared data on duration of ground and rail cargo transport on the Rijeka and competitive routes show a pronounced advantage of the Rijeka port as a starting point and in terms of transport duration. Construction of the new railroads from Zagreb to Rijeka, reconstruction and upgrading of the Rijeka-Zagreb motorway to highway channelling the Sava river from Šamac to Sisak, and building the Vukovar-Šamac canal, will make Rijeka an important seaport for the Danube-Adriatic routes. In future, the rise of the container transport is to be expected and the Rijeka port reached its upper limit when it comes to storing and handling capacity of the container terminal. If the Rijeka port wants to keep its competitiveness in the North Adriatic catchment area, adequate upgrading and investments need to follow in order to respond to the increased transport needs.

Geographic position, maritime tradition and the vicinity of the European market with the intensive overseas trade, connection of the maritime and land routes helped the Rijeka port to outgrow its national context. Good transport links and infrastructure especially the road network and shipping lines are necessary for Rijeka to gain primacy transit port position for the neighbouring countries on route to Mediterranean, Middle and Far East and Africa. Maximum transport volume of bulk cargo in transit through the Port of Rijeka was achieved 17 years ago and it amounted to 7.5 mil.t. in a year. A lack of adequate roads linking the main highways with the port located in the city centre present a significant problem for Rijeka. In addition, inadequate railroad capacity also represents a drawback.

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Development Components	Indicative costs (mil. USD)	Bank funding (mil. USD)
A – Port Reconstruction and modernisation	75.10	50.20
B – Development of the Border Area between the Port and the City	43.20	24.60
C – Upgrading of International routes	144.80	78.70
D – Allocation of Funds for Pre-investment	1.50	1.50
Total Funding	264.60	155.00

Table 3 Development Components of the Rijeka Port-funding (Dundović & Hlača, 2007, p. 51)

The aim of the future state initiatives is an attempt to increase competitiveness and assist in maintaining the transport growth and efficiency that will accelerate the process of new construction and modernisation of the seaport system including construction of the new terminals and upgrading the old ones. However, it is important to note that increasing of the competitiveness of the Rijeka port is not possible without modernisation of the road and rail Corridors V and X.

In 2003, The World bank approved a 155 mil USD loan to the Republic of Croatia and signed a partnership with the Rijeka port management, the Rijeka port company and the City of Rijeka in order to implement the planned investment (Gateway Project). The projects are related to modernisation of the existing terminals and upgrading of the new port terminals.

Complexity of the project is reflected in modernisation of the Rijeka port and reconstruction of the gateway route while ensuring an adequate urban development with new city point and public infrastructure created. Financing of consultant services related to management improvements, preparation of BOT-based contracts for the "Zagreb coast" pier extension and construction of the new D-404 road and the supervision of the construction works are secured by the project. Those activities lead to increased efficiency and safety of the port operations using the new Electronic Data Interchange system (EDI) and linking the port authorities and port services. In addition the project provides a fund for financing the program of protection for workers including retirement benefits. The project also foresees adequate system of financial management and training.

Godina Year	Lučki prekrcaj Port Transhipment (TUE)	Kopneni promet Land transport (TUE)	Cestovni promet Road transport (TUE)	Željeznički promet Railway transport (TUE)	Kamioni Lorries %	Vagoni Wagons %
1995	40870	18680	8046	10634	43.07	56.9
1996	29529	12856	6155	6701	47.88	52.2
1997	16474	10530	5604	4926	53.22	46.78
1998	14814	6490	3893	2651	59.48	41.70
1999	6886	8047	4018	4029	49.93	50.06
2001	12711	13928	9090	4838	65.26	34.74
2002	15215	17827	12383	5444	69.46	30.54
2003	28205	31703	23696	8007	74.74	25.26
2004	60864	64058	49324	14734	77	23
2005	76258	78828	62840	15988	79.7	20.3
2006	94390	95989	75794	20195	79	21
2007	145040	141332	107130	34202	75.8	24.2
2008	168761	171700	131033	40667	76.7	23.7
2009	122745	131425	100516	30909	76.4	23.5

Table 4 The Proportion of the Land Transport in Container Reloading in the Rijeka Port (Dundović, 2010, p. 169)

There are certain direct economic benefits expected to be achieved from this project as well as positive effects in terms of transport, social welfare and environmental protection. The direct economic effects include the following:

- Increased port transport and revenue
- Downsizing of operative costs and road transport due to delays

• Improvement of transport service based on trade and economic growth caused by the increased transit transport

- Decrease of the long-term state support to the Rijeka port
- Improved port management
- Increased labour productivity
- Improved working and environmental conditions (reduced traffic congestion, air pollution and the level of noise)
- Improved transport connections between the Rijeka port and the trans-European road network via Corridor Vb.

The rapid growth in traffic through the container terminal of the Rijeka port implies the need for a quick construction of adequate port facilities. The existing terminal has reached its maximum capacity of about 100.000 TEU, and there is a need to build a new one. New storage space will be gained by the extension of the existing storage. A new container terminal with the capacity to accommodate larger ships and enable throughput between 150.000 and 200.000 TEU will be located on the newly constructed banks. A new container crane and warehouse for handling cargo will also be provided.

7. Conclusions

This paper demonstrates a need for implementation of the information subsystem and the network service in the field of modern transport with the aim to achieve a quality logistic support in transport in general and in maritime transport in particular. The necessity for implementation of the Intelligent transport systems (ITS) through integration of information and communication technologies and transport infrastructure, vehicles and transport participants is pointed out in this paper.

The importance of high investments in computer applications and human resources responsible for the use and maintenance of the advanced ITS systems in order to join the logistic chain in an adequate way is emphasised. It is also pointed out that in the development of ITS, it is necessary to considerer all interest groups, wishes, ideas and problems in order to have the system that fulfils the maximum requirements. The dynamic environment of the system determines that the developed system has to be flexible and user-friendly and anticipates future improvements based on the expansion and the needs of the system and its environment.

Furthermore, the paper emphasises that all participants included in maritime and other transport have to be connected into a common information system. Such a system is a subsystem of operation, port information and management system, maritime or any other transport company system in a micro and macro-region and a part of a state or larger systems. Such systems enable coordination in operation and business and at the same time improvement of the own company which brings about a highly increased competitiveness of a port, dock, maritime shipping company, rail, road or air company in the domestic and especially in the international transportation of cargo and passenger market.

The earlier mentioned studies note and prove numerous advantages of the ITS implementation related to the reduction of traffic congestion. Lower capital and operative costs, improved system security and labour

productivity of transport infrastructure. In addition to the mentioned advantages, it is important to note the disadvantages that include high cost of development and implementation of ITS, inclusion of all significant environment components into the system, costs of education and training of ITS operators, ITS development project costs, operation and management costs.

The main question in this paper—what is the status of the transport seaport system in the Republic of Croatia in the context of the opportunity for implementation of the ITS system is as follows: the majority of the Croatian port facilities are technically dated and the level of productivity in them is low. It is necessary to increase investment in modern facilities and technologies, modernisation and into quality transport infrastructure. The need for implementation of a coherent maritime and port policy as well as transport and tariff policy for transport services has also been noted in this research.

Growing awareness, implementation and use of ITS system by the domestic and international port management is noted in this research. The value and importance of the use of ITS in ports in order to achieve better competitiveness of ports, docks, maritime shipping company, rail, road or air company in the domestic and especially in the international cargo transportation market.

The development of the national ITS architecture defines a framework for different approaches with the primary goal of satisfying interest groups. Fulfilling this goal provides benefits for the wide transport region due to planning of the national and international transport and transit transport. The advantages of building the national ITS architecture are the following: national compatibility, reduction of risk for users and implementers of new technologies, opportunity for future development using the open system approach, the effect of synergy in case of request for multiple function and allocation system in order to provide optimal function support, identification of interfaces and necessary data exchange. Through integration of accomplishments in specific transport sectors a comprehensive system is achieved and the constituent elements of the national ITS architecture are transparent. The developed architecture serves as a guide for research projects and designing and financing of transport systems by providing methodology, tools and expertise for future upgrading and development. The long-term benefits of the ITS architecture are as follows: correlation of overall needs and services of transport, improved productivity that can be achieved through elimination of redundant implementation of similar function, reduced costs of expensive changes in the later process of design and implementation, identified interfaces and necessary data exchange, defined starting point for development of functional requirements and system specification, defined list of transport agencies that can take part in the development and implementation of ITS, achieved national compatibility, reduced risk for users and introducers of new technologies and the accomplished effect of synergy in terms of requests for a multiply function and allocation system in order to provide optimal support function.

The priorities for solving the critical problems in status of the national transport system in the Republic of Croatia are the following: the responsibility for strategic planning in the transport sector, legislation issues related to the process of harmonisation of regulations due to economic transition and integration into the European Union, business management issues in public companies, state administration reforms in the transport sector and the policy issues related to investment into infrastructure projects.

Absence of a coherent economic and transport policy in the past, orientation to continental transport, neglecting of coastal areas, underestimating the role of sea ports and maritime transport and numerous objective and subjective factors are responsible for lagging of the Croatian port system. Croatian seaports missed the

important investment cycle into modern technologies in the 80ies, so the majority of the existent port technologies are dated. In the same period the ports in the neighbouring countries, have invested in modernisation and development of new facilities. At the same time, Croatian ports with their ineffective investment, high costs and incompatible prices of port services have been competing among themselves and gradually loosing pace with the international maritime market. Inadequate and dated railways and roads in Croatia are the reason for redirecting of international transport to close ports in neighbouring countries or even to the distant European ports. A general assessment of the current economic and social circumstances in Croatia presented in this paper states more limitations than opportunities. Is it applicable not only to introduction of ITS into Croatian seaports business and management, but also to the general development of all sectors of transport, routes and terminals as a precondition for rapid economic and social recovery in Croatia. In the context of Croatian accession into EU, based on the integrative processes necessary for the quality operation and management of maritime systems and coordination with other systems and environments, poor condition and under-capacity of Croatian ports probably represents a limiting factor for an effective and efficient (not only) maritime transport.

Therefore, a review of the circumstances in Croatian seaports in this paper serves not only a case study on opportunities and limitations of ITS system implementation and other modes of application of modern information technologies into seaport, but also to gain better understanding of such a system and to indentify features and peculiarities of the port management system. There are several highlights to be noted:

• A need for the efficient and fast information "flow" based on an adequate information flow configuration since the quick and efficient information management is a *conditio sine qua non* of the efficient cargo and passenger flow in maritime and other transport sectors

• A necessity for networking of subsystem elements with other subsystems in the environment and with the systems of higher levels

• The role of the efficient functioning of such systems for other systems in the environment including the efficiency of the higher level systems. In the context of this paper it particularly applies to the conclusion that the insufficient use of ITS and other forms of modern technology represents a limiting factor not only for the development of maritime but also other modes of transport. The importance of transport is significant for the development of economy in general, not only of the national economy but also for the development of the mobility and the society in general. The above mentioned context explains the scientific achievement of this paper.

Further research in order to improve the efficiency of the Croatian system need to examine possibilities to enhance competitiveness of the Croatian ports and explore the ways to support the transport growth and its efficiency. In order to expand the research of ITS implementation in maritime and other modes of transport, it is necessary to explore the new possibilities of simulation models in the study of intelligent transport systems. In order to improve the operation of the Croatian ports, ITS implementation as its most important segment needs to be further examined.

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