BUSINESS EXCELLENCE IN THE FIELD OF TRAFFIC AND TRANSPORT TECHNOLOGY

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UDK/UDC: 658.562:656
JEL classification / JEL klasifikacija: L_{91}
Review / Pregledni rad
Received / Primljeno: March 17, 2009 / 17. ožujka 2009.
Accepted for publishing / Prihvaćeno za tisak: June 15, 2009 / 15. lipnja 2009.

Summary

The paper deals with the research of traffic and transport phenomena in the field of traffic technology and with the recognition of requirements and evaluation of establishing a quality system. The scientific and technological research in the field of traffic and transport technology with a scientific and applicative contribution have to include an integrated systemic approach and formalized description of the studied system obtained by using systemic methodologies. Identification of stakeholders is of special importance. Quality indicators defined and differentiated at the level of single stakeholder groups determine the quality of the traffic system and the generated services on the transport market. The scientific contribution of the paper reflects clear and unambiguous connection of stakeholders and definition of business excellence as their development strategy integrating three aspects: technical aspects and efficiency, time harmony and reliability as well as transport safety and security. The paper provides an original definition of activities needed to achieve business excellence in the area of traffic technology. The model represents the basis for further scientific and technological research of interoperative technological activities in the development of science and traffic as a whole.

Key words: *traffic technology, business excellence, transport system quality, transport market, interest groups*

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1. INTRODUCTION

The field of traffic technology represents a very wide and complex area of human activities. The development of transport has to be comprehensive, respecting the estimate of economic and social effects on traffic, as well as the factors that influence the standard of living. Employment should also be taken into consideration. Business excellence in the area of traffic technology is necessary because of the openness of the systems which is reflected in the relations of the system and its surrounding with the stochastic characteristic of the system which results from the changes on the market, economic power of the subjects, political situation and other non-controllable factors. The dynamic character of the traffic system, marked by activities as continuous changes of the system values in time, initiates the need for defining the quality of the traffic service and the need for defining the business excellence as a development strategy of the stakeholders in the field of transport technology.

2. SYSTEMIC RESEARCH IN THE FIELD OF TRAFFIC TECHNOLOGY

Scientific research in the field of traffic technology marks the need for a systemic approach based on a defined traffic phenomenon. Identification of the traffic representative represents the initial phase in the research, in which it is necessary to determine the structure of the studied traffic system with its characteristic laws. The laws present in the traffic system generate the behaviour of the system, especially the behaviour and action of its stakeholders. Since the research of the problems in the field of transport technology is marked by the consideration of different aspects of the system (technical, technological, organizational, economic, environmental, and legal), a comprehensive approach to the research is necessary, as well as holistic thinking and study of the synergic influence of the development and establishment of coherent traffic sub-systems based on defined traffic models.

2.1. Definition and classification of traffic models

When it comes to technology as part of science in which alternative ambient is built, traffic models are observed according to the general classification as given in foreign and national references.

According to M.P. Wahl, "The purpose of the model is rational understanding of the reality. The models are mental aids in order to make the complex relations of facts clear. The model is like a simplified picture of the reality for the purpose of scientific research, although all the relevant influencing factors are included in their actual value orders and relations of dependence, more suitable than the respective actual situations."

C.W. Churchman's definition says "Model is a presentation of the system that is being researched, a presentation given in order to be used in forecasting the effect which is the result of the efficiency of this system due to possible changes in itself."

H.J. Weiss and M.E. Gershon define the model as a presentation of entities or systems that are studied, and they see the reason of its usage in complexity which is lower than in real systems, making it simpler for manipulation and testing.

The models can be classified according to various criteria:

1st criterion: function (what is the purpose of the model):

- descriptive,
- predictive, and
- normative

2nd criterion: structure (what is the model like):

- iconic,
- analogue, and
- symbolic

3rd criterion: time reference

- static, and
- dynamic

4th criterion: certainty reference

- deterministic,
- probabilistic, and
- games.

5th criterion: generalization

- general, and
- specialized

6th criterion: level of abstraction:

- conceptual,
- logical, and
- physical.

The development of the model by generalization and abstraction is conditioned by recognizing all the important values that affect the system behaviour and neglecting everything that needs to be neglected since *one could not handle it*. The establishment of a model that presents a generalized system requires generalization and formalization. As a rule, in modelling the traffic system and its sub-systems, only static models of general type i.e. descriptive statistics are used.

To predict the effect of the traffic system the following are most often used:

- queuing theory,
- queuing systems (mass serving systems),
- theory of graphs and network planning,
- operations research.

2. 2. Study of effect of the traffic system by classic approach and descriptive statistics

The classic approach to the study of the effect of the traffic system by classic is directed towards the isolation of the sub-system and its technical, technological, and economic phenomena from the action of the environment and their division into smaller parts – until it enables the study of elementary laws to which these parts are subjected. Based on the studied and defined elementary laws and explanations, the laws of the phenomena as a whole are determined.

Today, the dominant way of monitoring and evaluating the success of functioning (operation) of the traffic system and its subsystems is based on the implementation of statistical methods at the level of descriptive statistics.

The statistics of traffic services include data on:

- annual volume of cargo according to basic cargo types,
- number of users,
- number of employees,
- main cargo transport flows,
- division of transport into import and export according to cargo type,
- main import and export routes and areas.

The main drawback in monitoring the success of functioning, i.e. system operation, based on the statistical data analysed by statistical methods, lies in the usage of data on the number of users which is not a sufficient indicator since out of all the subjects only the data on the user are monitored. Neither monitoring of all subjects and their results provide sufficient data since subjects' interests are neglected, and they directly influence the functions of the traffic system, technological activities and quality management system initiating the system improvement. Monitoring the success in traffic technology development according to the number of employees also fails to be useful because automation and improvement of the technological processes result in a reduction in the number of employees.

3. SYSTEMICALLY FORMALIZED DESCRIPTION OF THE STRUCTURE OF TECHNOLOGICAL SYSTEM AND TECHNOLOGICAL PROCESSES OF THE TRAFFIC SYSTEM

The systems capture the interest of scientists since the age of Aristotle, whose formulation "The whole is more than the sum of its parts" represents the first scientific definition of a systemic problem.

According to IEEE Dictionary, "A system is an organized group of people, machines and methods required to achieve a certain objective".

B. Klaić's definition says "A system is a set of parts connected by a general function".

According to A. Rapaport, "A system is a conceptual analogue of certain general properties of the observed essentials."

G.J. Klir used a special class of definition–theory templates to define a system. The Klir-Orchard paradigm, resulting from the General System Theory (GST) is necessary to understand and implement the systemic thinking.

According to the general system theory, "A system is a sequence of certain components in such interrelation that they form a whole".

According to general system theory the basic properties of a system are:

- set of values and their level of analysis, system activity,
- time invariant relations between values – system behaviour,
- entirety of analysis and connections (UC – structure), and
- state and transitions between conditions (ST – structure).

By applying the GST assumptions, which show that certain concepts, principles and methods do not depend on the specific characteristics of the phenomena but can rather be applied in different areas of science and technology, and from the aspect of generalized modelling, the interdependence of the phenomena is studied and complexity becomes the subject of research.

Defining the system in the field of transport technology by respecting Klir's methodology is focused on the following definitions.

Definition 1: ***Set of values (external and internal) and analysis levels***

a) Set S is a given set of values assigned to the given level of analysis.

b) System S has three members (X, t, L) where:

$X = \{x_1, x_2, \ldots, x_n\}$ set of external values

t = time

$L = \{ L_1, L_2, \ldots, L_n, T \}$ level of analysis.

Definition 2: ***Activity***

a) Set S is a set of changes over time of the observed values.

b) System S has one member (M) where:

$M = \{(x_1 (t), x_2 (t), \ldots, x_1 n(t)) \mid t \in T, x_i(t) \in X_i V\ i= 1,2,\ldots, n\}$.

Definition 3: ***Real UC structure***

a) Set S is a given set of elements, their constant behaviour and set of links between elements and the environment.

b) Set S has two members (B, C) where:

$B = \{ b_1, b_2, \ldots, b_r \}$ - set of behaviour

$C = \{ c_{ij} \mid c_{ij} = A_i \cap A_j, i \neq j \}$ – set of characteristics.

Definition 4: ***Real ST structure***

a) Set S is a set of conditions and a set of all transitions between conditions.

b) Set S has two members (S,R(S,S)) where:

S - set of conditions

R (S,S) – set of all relations over set S which is used to define the transitions between conditions (S x S) or

c) Set S has three members (S,R(S,S), P (R)) where:

P (R) – measure of probability defined on R so that:

if (s_i, s_j) E R, then $P(s_j \mid s_i)$ conditional probability of transition from state s_i into state s_j.

4. CONCEPT OF QUALITY IN TRAFFIC TECHNOLOGY

General definition of quality according to the quality encyclopaedia[4] is: Quality is a measure or indicator of volume i.e. amount of utility value of a product or service to satisfy the precisely defined needs at a certain place and at a certain moment, i.e. at the moment when this product and this service in the social process of exchange are confirmed as goods.

According to HRN EN ISO 8402 standard the definition of quality says:[5]

Quality is a total of properties of a certain entity which make it capable of satisfying the expressed or assumed requirements.

After revision in 2000 the official definition of quality was given in standard ISO 9000 and it says: Quality is a degree to which a set of inherent characteristics fulfils requirements.

The concept of quality in the technology of transport and traffic is generated by providing services in traffic according to the laws that are valid on the transport market.

Service is any action or act that one party can offer another, and that is completely intangible and does not result in any kind of ownership of something. Its generation can but needn't be related to a physical product.[6]

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[4] N. Injac: Mala enciklopedija kvalitete, 1st part, Oskar, Zagreb, 1998, p. 64.

[5] Ibidem, p. 65.

[6] P. Kotler: Upravljanje marketingom, Northwestern University, Mate, 2001, p. 467.

Services are present in every aspect of our lives. Their complexity and diversity have dramatically risen over the last century. Contrary to the common opinion, it is the services, and not the tangible products, that gave incentive to the modern economic growth.[7]

Services occupy almost two thirds of the overall world output. Trading with services grows faster than any other area and cover one fifth of the world trade.[8]

According to Juran[9], service represents work performed for somebody else. According to the same author, the definition of serving activities usually excludes industry, agriculture, mining and civil engineering, and often contains: public transport, telephone communications, energy supply services, medical services, sales of all types of goods, all types of financial service, media, public information, personal services (washing, cleaning, hair-cut, etc.), professional services, state services, etc.

The past scientific and applicative research and studies in the field of traffic technology mentioned various indicators of performance and quality indicators, but the problem is how to assess them in relation to their significance for the future quality assessment system or quality marking. The main important studies for the analysis of relevant indicators include:

- OECD: Benchmarking Intermodal Freight Transport, Paris, 2002
- IQ Consortium: Intermodal Quality Deliverable 1: Model for evaluation of terminal performance, Report Number 1.2.4, Brussels, 1998
- ECMT: Transport Benchmarking – Methodologies, Applications & Dana Needs/ Paris, 2002
- TfK Transport Research Institute/ (1999): /Benchmarking container terminals, Gothenburg, 1999
- A. Ballis: Introducing level of Service Standards for Intermodal Freight Terminals/TRB 2003 Annual Assembly, Washington D.C., 2003.
- ISIC project- Integrated Services in the Intermodal Chain, DG TREN, 2005.

The concept of quality in the field of transport technology is closely connected to the concept of performance indicators that have to be clearly defined and transparent. Quality indicators describe the level of service of the traffic system (i.e. the nodes, intermodal terminals, ports, logistics-distribution centres), whereas performance indicators directly describe the productivity of the technological processes. By increasing productivity the traffic intermodal node may process several transport units with less resources and thus increase its profitability. Productivity is influenced by the factors that otherwise affect profitability. This means that when the transport intermodal node attempts to improve profitability by changing these factors, this could at the same time also affect productivity. In the worst

[7] J. E. G Bateson, K. D. Hoffman: Managing Services Marketing, Forth Worth, The Dryden Press, 1999, p. 6.

[8] B. Stauss, P. Mang, Cross-cultural Services Research: Past, Present and Future, Journal of Services Marketing, 13(1999), No. 4/5, p. 332.

[9] J.M. Juran, F. M. Gryna: Planiranje i analiza kvalitete, 3rd Ed., Zagreb, MATE, 1999.

case, the attempt to improve productivity by changing one of the factors, for instance, by offering the customers a more attractive service, could have negative effect on profitability and eventually lead to lower profitability. Quality indicators and performance indicators have to be able to describe and measure the activities and the processes of nodes and have to be applicable for the comparison of different transport intermodal nodes.

Whereas quality indicators are of greater importance for the customers, the operators of transport intermodal nodes are more interested in performance indicators. Node users (e.g. of terminals, ports) want to know which services are offered at a respective node, and what is the level of their service, whereas node operators need to be interested in the evaluation of the quality of their success compared to their competitors. For the transport strategists the quality and performance indicators are important, since in the conditions when high-quality and successful traffic services are available, the modal shift can be supported. Political authorities might also find interest in the data on sustainability to support the operators of transport intermodal nodes (employment rate, energy consumption, emissions, etc.) and this also includes quality indicators.

Quality indicators are structured in connection to different aspects of quality:

- reliability / punctuality,
- flexibility / frequency of service,
- availability,
- capacity / services with added value / other quality indicators,
- level of transport safety,
- level of environmental protection,
- availability of professional human resources.

5. BUSINESS EXCELLENCE – DEVELOPMENT STRATEGY OF TRAFFIC SYSTEM STAKEHOLDERS

Over the last decades, stronger competition, information technology promotion intended for traffic production as well as the development of transport industry as a whole, have had a significant influence on the stakeholders of the traffic system world-wide. Therefore, new production possibilities and new methods of combined and intermodal transport have been introduced, management strategies, production processes and products – service characteristics have been redefined. The issue of "quality" has become evident in the transport industry, whereas the influences of quality on the customers' perception and customer behaviour have become the main factors that affect the final customers' decision regarding the selection of the transport mode and traffic concept. The quality can be considered the main factor of long-term competitive success and of customer's satisfaction. Total quality management (TQM) is a product of complex combination of strategic business components and management practice.

In the field of traffic technology, quality has been lately considered with increasing attention, qualitative and/or quantitative results related to development and management approaches to the stakeholders of the traffic system have been defined, and business excellence has been accepted as a possibility of redefining the development strategy of the stakeholders.

The traffic system is a complex system with a large number of subjects. The term "subject" has been substituted by the term "stakeholders". Stakeholder is an individual or a group with the same interests and priorities in the transport system which are used to determine the purpose and basic objectives of their functioning. Not only is the successful functioning of the traffic system and its subsystems determined by the availability of the infrastructure and differences in technological activities, but the stakeholders and their interaction according to the general requirements need to be defined in detail.

Within the traffic system three groups of stakeholders are defined:

1. internal stakeholders that are part of individually complex organizations (operators, etc.);
2. external stakeholders (carriers, cargo owners, and all others who directly or indirectly participate in the transport process);
3. government bodies who include government administration bodies for transport at the national, regional and local level.

The identification of stakeholders' requirements depends on finding the answers to the following questions:

1. Who are the stakeholders?
2. What are the current stakeholders' requirements, clearly and unambiguously defined; can one predict the requirements that will occur in the near future of the system functioning?
3. Are there interactions among single stakeholders?
4. Are the stakeholders' requirements in compliance with safety and security requirements?

Achieving business excellence should be used by the stakeholders as a development strategy which includes three aspects:

1. technical aspects and efficiency,
2. time harmony and reliability, and
3. safety.

Total quality management of the transport service is defined by means of the following criteria:

1. frequency, minimal size of delivery, collection and delivery according to "door-to-door" principle, safety and reliability,
2. possibility of using transport means whose technical characteristics correspond to the physical requirements of freight and traffic flow parameters;
3. availability of correct and reliable information on the freight status during transport and usage of the freight tracking system;
4. presence of the market approach to determining (negotiating) of the price-quality relation of the service;
5. possibility of resolving border-crossing procedures.

6. TRAFFIC SUBSYSTEM MANAGEMENT ACTIVITIES IN ORDER TO ACHIEVE EXCELLENCE

To define activities that need to be undertaken in order to achieve business excellence the double approach has been accepted: a) analysis of EQA criteria context, and b) literature on traffic subsystem management (e.g. port). The research results are presented in Table 1. The first column of the table shows EQA criteria, and the second one presents the elements for the realization of excellence in transport industry (e.g. port). More precisely, the qualitative analysis of EQA criteria leads to a set of activities, policies and strategies that have to be taken into consideration as basic culture and practice of quality management in performing the business excellence model in traffic nodes with total quality.

Literature on management is oriented mainly to functions, logistic chains and resource management, rather than technological processes and stakeholder-customer relation. Only a few authors mention the issue of total quality management in the transport industry.

The development of human resources is among the most important priorities of advanced traffic subsystems. There are approaches that believe that human resources and knowledge management, rather than technology and capital, are the key elements of successful development. Education regarding health protection and safety at work, as well as ergonomic improvement of freight equipment meet the labour requirements.

Due to the functionality of traffic intermodal nodes, the focus of studying business excellence in the area of traffic technology lies in the research of the start-end points of transport: ports and intermodal terminals. The main "position" of the port towards the supply chain offers to big ports the possibility to develop logistics with added value, whereas horizontal and vertical integration and networked port operation can reorganize seaports into important hubs within the logistics system. The existing common initiatives between the private sector and the port authorities regarding the development of information systems are oriented to serving the common interests and providing the necessary information. Therefore, the process criteria refer to the development of the management culture based on the processes.

Table 1: Activities in order to achieve business excellence in transport industry based on the analysis of EQA criteria

EQA criterion	ACTIVITIES OF TRAFFIC SUBSYSTEM MANAGEMENT IN ORDER TO ACHIEVE BUSINESS EXCELLENCE: DIMENSIONS OF THE TRAFFIC SUBSYSTEM WITH TOTAL QUALITY
1. Management **ENABLER**	Long-term dedication to TQM and distribution of resources for quality organization. Management culture at the level of the traffic subsystem (everyone involved in management, teamwork, process control, education, etc.) Engagement of employees in realizing specific goals, authorizations and motivation of employees. Focusing on the change in management techniques and improvements. Determining the vision and mission for a company and implanting excellence values.
2. Policy and strategy **ENABLER**	Definition of stakeholders and their expectations from (means providers, regulatory bodies, community, competition, users, employees, suppliers, shareholders, partners, communities – alliances of transport operators, networks, development of horizontal and vertical partnership). Information management *(information on the structure of a subsystem of stakeholders for the needs of strategic thinking).* Development of a strategic business plan *(using techniques such as balanced scorecard) based on the vision and mission (division, analysis and updating of plans).* Development of employees' dedication to the mission and objectives of subsystems. Development of management and support process *(quality and safety management, human resources management, communication with stakeholders, information system, financial processes).*
3. People **ENABLER**	Explicit definition of subsystem personnel *(employees who have full employment, who work part-time, auxiliary workers, workers with limited work contract, volunteers).* Development of human resources management plan. Development of assessment process *(prizes and awards for employees).* Development of employees – education – authorization of employees *(development of teams dedicated to excellence).* Feedback on the employees' satisfaction – management process.
4. Partnerships and resources **ENABLER**	Defining double strategy and culture for resource management: **a)** within the organization, and **b)** outside the organization *(partnerships and suppliers for public sector, competitive businesses within the transport industry).* Defining partnerships between *(organization, enterprises, etc.)* all those who are related to the technological subsystem activities, that create additional value for the users (in some examples, *competitors can be partners*). Definition and management of "internal" resources through 4-fold analysis: **a)** finances, **b)** buildings, technology and equipment, **c)** technology, **d)** information and knowledge. Partnership of the private sector and management in developing the information systems. Interactive information exchange between subsystems and its users through formal processes.
5. Processes **ENABLER**	The development of management culture based on the processes rather than functions. Development of the process model: *determining and construction of key and auxiliary processes as part of the strategic plan, in order to satisfy the needs of stakeholders.* Connecting the processes with specific measuring factors *(inclusion of horizontal and vertical integration of ports as element in transport chain).*
6. Users results **RESULTS**	Users are all those who receive products and/or services. Every traffic subsystem functions as a user-oriented organization measuring the satisfaction of the external users. Key business indicators are the users' satisfaction, users' fidelity and their values. Segmentation of users leads to specific measures, i.e. special terminals intended for and available to the most important users.

7. Results of people (employees) **RESULTS**	Employees should be considered important stakeholders. The employees' perception is measured by their satisfaction and motivation. Development of internal specific measures for employees' performance. Special strategy is developed to inform all the employees about the results of the port and employees.
8. Social results **RESULTS**	Defining the position of the traffic subsystem using the elements of cooperative civil strategy and influence in relation to the "Society" in the sense of individuals or groups affected by technological activities, apart from personnel, external customers and suppliers. Cooperative civil action in the traffic subsystem refers to at least five policies: **a)** individual safety, **b)** long service life of the port, **c)** resources preservation, **d)** harmony with the local community, and **e)** contribution to the public interest. To a certain extent this 5-fold strategy of cooperative action can be measured. Defining a communication strategy of the traffic subsystem in connection with social results.
9. Key effects – results **RESULTS**	Defining key results of business regarding strategy of the traffic subsystem, quality, plans and customers' experiences. Presentation of key business results according to key results (both financial and non-financial) and according to measures and indicators of key results (tonne, time of service, time necessary to handle freight, environmental standards, revenues from using berth per tonne of cargo). Business results have to be clearly related to the ownership status. Building up of control and/or management culture based on the measurement results.

Traffic intermodal nodes need to achieve closer relations with the local authorities by initiating partnerships oriented to the objectives that are of common interest within the context of integrating the interests of the local authority into the development strategies. Efficient action of the environmental management system (EMS) and continuous monitoring of the internal conditions and the conditions on the market require *inputs* through a formal procedure. Raising the environmental awareness allows stronger cooperation with the local authorities regarding the implementation of EMS. Furthermore, the initiatives of *"corporate management"* have very high priority oriented to building up trust and credibility of intellectual capital, development of social responsibility towards the local authorities, regulatory bodies, etc.

Traffic intermodal nodes need to be oriented to achieving business results through improvement of financial indicators that refer to the infrastructure and equipment, productivity and investments. The increase in productivity is achieved mainly by connecting logistics of transport with the modernization of the transport chain and dynamic optimization of activities in the traffic flow.

7. CONCLUSION

This paper has presented the nature of scientific and technological research in the field of traffic and transport technology and the needs for integrated systemic approach and formalized description of the studied system in order to achieve business excellence. Since the studies in the field of traffic and transport technology are marked by consideration of different system aspects (technical, technological, organizational, economic, environmental, and legal), a comprehensive approach to the study as well as holistic thinking has been necessary, especially the application of GST assumptions, which show that certain concepts, principles and methods do not depend on the specific characteristics of the phenomenon, but can rather be applied in different areas of science and technology. The concept of quality in the study of traffic subsystems has been specially defined and combined with the quality indicators structured with regard to different aspects of quality. The results shown in the paper represent a basis for further study of interactions of stakeholders of the technological activities of traffic flows based on the defined methodology of identifying the stakeholders and their requirements. The traffic subsystem of traffic management activities given in the paper, with special emphasis on the development and human resources management should be implemented by transportation planners and transportation managers.

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POSLOVNA IZVRSNOST U PODRUČJU TEHNOLOGIJE PROMETA

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Sažetak

Rad se bavi istraživanjem prometnog fenomena u području tehnologije prometa te prepoznavanjem potreba i valorizacijom uspostave sustava kvalitete. Znanstvena i tehnološka istraživanja u području tehnologije prometa, sa znanstvenim i aplikativnim doprinosom, moraju uključivati integrirani sustavni pristup i formaliziran opis istraživanog sustava dobiven korištenjem sustavnih metodologija. Posebno važno je identificiranje interesnih skupina koje prema pokazateljima kvalitete definiranim i diferenciranim na razini pojedine interesne skupine determiniraju kvalitetu prometnog sustava i generiranih usluga na transportnom tržištu. Znanstveni doprinos rada odražava jasno i jednoznačno povezivanje interesnih skupina i definiranje poslovne izvrsnosti kao njihove razvojne strategije koja integrira tri aspekta: tehnički aspekti i učinkovitost, vremenski sklad i pouzdanost te transport safety and security. U radu su originalno definirane radnje u cilju postizanja poslovne izvrsnosti u području tehnologije prometa. Model predstavlja podlogu daljnjih znanstvenih i tehnoloških istraživanja interoperabilnih tehnoloških aktivnosti u razvoju znanosti i prometa u cjelini.

Ključne riječi: *tehnologija prometa, poslovna izvrsnost, kvaliteta prometnog sustava, transportno tržište, interesne skupine.*

JEL klasifikacija: ***L_{91}***

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