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INNOVATION MODELING TRAFFIC AND TRANSPORT

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Abstract: Traffic and transportation are very important for the industry. New way of organizing and optimizing transport can help the development of a country's industry, as well as the preservation of the environment. Railway traffic can be an innovation solution for environmental protection. All types of goods can be transported by rail, with good traffic organization. Modelling of railway infrastructure and timetables is of crucial importance for the renewal of railway infrastructure and for monitoring user requests. Also, passenger railway traffic with timetable which monitor request passenger is very good solution preservation of the environment. Rail traffic with good organization can provide global transport security and a cleaner planet.

Keywords: modeling, railway, traffic, innovation transport, timetable.

1. INTRODUCTION

The traffic system consists of technological subsystems of different types of traffic. Each individual type of traffic represents a complex technological system, which differs from the others in terms of basic technical, technological and economic properties. Freight transport the supports the economy is characterized by:

- spatial action of the transport process,
- a unique process of production of transport services,
- the integrity of the transport process and means of transport,
- the presence of transport users in the process (production time can't be separated from consumption time).

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2. CHARACTERICTICS OF TRANSPORT

2.1. Advantages and disadvantages of model of transport

The features of railway traffic that make this mode more suitable than others are reflected in the following:

- railway traffic is practically independent of climatic conditions, as it is able to transport goods with a high degree of accuracy and regularity throughout the year, night and day, regardless of climatic conditions,
- the railway has a large quantitative transport capacity, because it can transport large quantities of goods, over long distances and overcome large transport irregularities,
- low resistances between rails and points and the transport of heavy trains enable the railway to achieve high productivity of the work of assets and labor with lower transport costs per unit of transport service compared to road traffic,
- the possibility that railway exploitation can be carried out through the application of increasing automation and cybernetics represents a real progressive improvement of railway traffic safety,
- benefits of realizing the development of various forms of combined transport,
- the railway itself can carry out the transport process in the case of transport over industrial tracks, and in other cases it is required to cooperate with other modes of transport, primarily with road transport.

The railway is a complete unit, but at the same time it is "difficult to move" because the railway network is large and territorially distributed. Because of this, it is immobile, inelastic and rigid to a certain degree, so it is often forced to give way to other modes of transport.

The road traffic has advantages, due to transport process can be unfold directly between production and consumption centers. These possibilities make it flexible and adaptable to a wide range of activities, thus creating a number of socio-economic advantages in the organization and implementation of transport services:

- high maneuverability when transporting goods,
- the possibility of "door-to-door" transportation and, in this sense, direct contact with users,
- relative ease of use and great possibilities in providing additional services to clients,
- the variety of forms of transportation that are performed, due to the variety of types of means of transport used, their specialization and carrying capacity,
- relatively small sums of investment required to meet the given volume of goods transportation than with railways,
- in comparison to other types of traffic, it has a small volume of exploitation costs related to initial and final operations,
- faster delivery of goods compared to rail and water transport, which enables the reduction of the needs of the recipient of the goods in working capital and warehouse space,
- a better possibility of ensuring the accommodation of goods during their transport than with other modes of transport.

In addition to advantages, road traffic has a number of disadvantages:

- high consumption of fuel per transport unit (very important in conditions of energy crisis),
- in relation to maritime, river and railway traffic, a high coefficient of the ratio of the vehicle fleet's own weight to the amount of transported goods (tare-net ratio),

- low efficiency of driving power utilization,
- high cost of transport compared to rail, river, pipeline and sea transport, especially on longer distances.

Seen from a general – social aspect, the most suitable sphere of road traffic use is:

- transportation of goods over short distances and delivery (pick-up - pick-up) from the manufacturer to the railway or pier (port),
- long-distance transportation of perishable and expensive goods,
- carrying out transportation by serving intermediate processes in industry.

The most significant technological and economic advantages of river transport are:

- very high, practically unlimited permeability of waterways,
- lower resistances to the movement of ships compared to the resistances to the movement of assets on land roads, which ensures more efficient use and less fuel consumption per transport unit,
- compared to land transport, it has a significantly higher carrying capacity of the vehicle fleet, which results in a smaller number of service personnel per transport unit and the possibility of a wider use of high-production transshipment machinery during loading and unloading,
- compared to rail and road traffic, it has a significantly lower coefficient of ratio between the ship's own weight and its carrying capacity,
- lower consumption of metal per one ton of the ship's carrying capacity.

The main disadvantages of river traffic that limit its application are:

- dependence on the geographical connection of the river network;
- increased transport distances, compared to other modes of transport, due to the unfavorable geographical layout of the river network;
- diversity of exploitation conditions on individual sections and changes in these conditions during navigation;
- lower speed compared to other types of traffic, especially in various climatic conditions;
- the existence of various seasonal downtimes in exploitation (frost, drought, etc.);
- the variability of the water level, which on the Sava river, for example: changes drastically, in just a few days the water level can rise or fall by several meters.

Compared to other modes, maritime transport has the following advantages:

- unlimited throughput capacity, which is practically reduced to the processing capacity of seaports,
- low fuel consumption and low energy costs,
- resistance to movement is significantly lower than in land traffic, which requires a significantly lower traction force per transport unit,
- for long-distance transports, transport costs are lower than for other types of transport,
- the use of ships with a large carrying capacity ensures high work productivity compared to other modes of transport,
- labor productivity in maritime transport is 5 - 6 times higher than in rail and river transport, and transport costs are on average 2 - 3 times lower than in these types of transport,
- on average, one ton of useful load capacity is: in the case of railway traffic from 0.7 to 0.8 t tare, in the case of road traffic 1.2 t, and in maritime traffic about 0.4 t tare (where the hull, power unit, equipment, ship supplies and fuel).

Disadvantages of maritime transport are:

- dependence on natural-geographical and navigational conditions (wind, waves, tides, low tides, mud and other climatic factors),
- the need to build complex and expensive port facilities (ports and terminals).

The previously listed advantages and disadvantages of each type of transport can lead to the conclusion that each type of transport can be suitable depending on the type of goods, delivery terms, transport price, elasticity and the like. Also, important factors that influence the choice of a certain type of transport are: transport capacity, safety as well as reliability and accuracy. It is very important to state that earlier research has shown that water transport has the lowest fixed and variable costs of transport, while rail and air transport have the same share of variable and fixed costs in transport. Road transport has the lowest fixed costs, and the highest variable costs that participate in the formation of the value of the transport price.

3. RAILWAY TRAFFIC

Railway traffic is a large complex dynamic system that has it's own structure - elements of the system and connections between elements - it has its own subsystems, hierarchy and environment (Pejić, 2022). The traffic system is a set of roadways, rolling stock and telecommunications devices, commercial, administrative, educational, scientific and other bodies and organizations and their workers, which ensures that the traffic performs its tasks as a purposeful, functionally unified unit.

Traffic tasks are not the same in all areas, countries or regions at the same time. Differences in transportation needs arise due to differences in the structure and number of the population, population density, and people's habits and needs for consumption of goods. Then, there are also regional differences in the economy, in the quantity and type of goods that are produced. Due to all these differences in the environment of the traffic system, the function of the traffic system is different in different areas.

The function of the traffic system also depends on its structure. As with all other large dynamic systems, the structure of the traffic system consists of its elements, as well as the way in which these elements are interconnected in the process of realizing their functions. Since the traffic system is a complex system, there are first connections between elements in lower-order subsystems, and then connections between higher-order subsystems, which is required by the hierarchy of large complex systems (Milanović, 2012).

Also, rail traffic can provide complete and continuous support to both industry and passengers. The needs and requirements of transport users have the characteristic of changing over time and space. Consequently, when the demand changes in the transport market, it occurs changes in the flow of passengers and goods, and carriers must adjust their offer would be competitive. Transport planners, constantly monitor changes on the transport market, and to offer the service in accordance with their own capacities of transportation that is in line with newly emerging needs for transportation.

Changes in the offer and demands for transportation services require planners to constantly reassess the relationship between the volume of traffic and the capacity of the roads on which it takes place. For support planners in the field of adapting the transport offer to the market by monitoring the relationship of traffic and traffic infrastructure and the adoption of various strategic, tactical and various methodologies, methods and sophisticated tools have been developed for operational decisions computer application base (Milanović & Gopčević, 2017).

Based on the transport service market research indicators, it can be determined whether and which elements of the transport service quality require special attention when planning for the next period.

Users can be good consultants when planning the transport offer. Previous research has shown that one satisfied user of the transportation service shares his experience with at least three other people who may become new users, while on the other hand, one unfavorable experience is transmitted to at least ten people, which can lead to a decrease in demand.

The subject and goal of this paper is to show the importance of planning cooperation, as well as how good planning can achieve environmental preservation.

3.1. Transport technologies in rail traffic

Technologies for transporting goods in railway traffic, where only he participates in the entire transport route, can be divided into:

- classical goods transport systems (transportation of individual wagon shipments or groups of wagons),
- transportation of goods by scheduled trains.

The classic system of transporting goods almost doesn't exist, because most of the world's railways do not see the justification of the costs incurred during such shipments. The costs incurred during such shipments can be divided into:

- costs for delivery and removal of cars from loading and unloading tracks,
- collection and transportation costs (collection trains) to marshalling stations,
- costs of processing and formation of trains in shunting stations,
- long and uncompetitive transport time for most types of goods and users.

Shunting stations can function and be profitable and competitive on the transport services market only if:

- well-utilized trains can be formed from incoming flows (according to the number of cars, mass or length),
- arriving trains can form relatively constant flows on the main routes – routes,
- the transport distances are such that the loss of time in the shunting stations can be mitigated at least to some extent compared to the competition's transport time.

Delivery and shipment of goods by route trains is the most efficient way of transporting goods by rail, both for users and for the railway. Routing is increasingly present on today's market, but users of goods transportation by route trains can be divided into several groups:

- a group of users who have constant and large flows of goods, "shipper's route trains",
- users who are not always able to ship sufficient quantities of goods that are necessary for the formation of an ad hoc route train, that is, as needed,
- users of route trains that travel between production and consumer centers, "logistic route trains".

Both loading and unloading have limitations in terms of infrastructure owned by the loading/unloading place. Also, weather conditions can affect exploitation. It is important to draw the conclusion that every company should take care of the infrastructure they need in order for loading/unloading to be done as efficiently as possible, that is, how they improve all other business segments in accordance with them, and the transport sector needs to improve.

4. SAFETY AS A QUALITY FACTOR THAT AFFECTS THE QUALITY OF THE TRANSPORT SERVICE

The railway system is a standardized based on strict rules and a special way of organizing work. As a very complex system, it has numerous rules, procedures, standards and specifications in order to function successfully. In addition to regulating safety, they are also necessary to ensure reliable, orderly and economical operation of the system, the preservation

of human health and the human environment, as well as the mutual compatibility of various parts of the railway system. In addition, technical standards on railways have a great influence on the transport market and its development, as well as the social conditions of employees. The railway traffic safety system consists of institutions competent to define, enact, implement and supervise the implementation of norms in that area (Milanović & Pejić, 2021).

These institutions include classic state bodies such as competent ministries or directorates, independent state bodies, sectoral associations and associations, railway companies, i.e. infrastructure managers and operators, the railway industry as well as international institutions. International institutions can have an interstate character or a professional or business character as international associations. Technical standards affect many areas in the railway sector. They cover issues ranging from the greatest public interest to the business interests of companies to individual social interests. That is why both the authority and the interest in determining technical standards on railways move from the state to local bodies to companies and trade unions. Also, considering the international character of railway traffic, international institutions also participate in it.

Legal norms in the field of security can be classified into two groups:

- laws and by-laws (regulations) that represent a legal obligation and are passed by state bodies,
- standards, specifications and manufacturer's instructions which are voluntary and which are adopted by the sector (companies and associations).

Standards are usually adopted at the level of associations and organizations for standardization, while specifications and instructions are usually adopted by companies. Both essentially represent voluntarily introduced norms by the sector. However, if a legal regulation refers to certain standards or specifications, they also become mandatory for implementation. Technical norms can be introduced through an international agreement or by direct recognition of an international regulation by a country or company. In that case, international agreements and regulations are mandatory and take precedence over national legislation.

Laws and other technical regulations in the field of railway traffic safety, in addition to defining rules, procedures, standards, must also determine the manner of application of the regulations.

Technical regulation is a very complex and multidisciplinary issue with a major impact on the position of the entire railway sector. It is clear that inadequate regulations can threaten safety, as well as cause great economic, social and social damage. Due to its size and complexity, the railway system is divided into subsystems. According to the European concept of interoperability and safety, the railway can be divided into the following subsystems: infrastructure, control, management and signaling on the infrastructure, energy, railway vehicles, traffic regulation and management, maintenance, telematics applications for services in the transport of goods and passengers (Pejić, 2024).

All technical means in the mentioned subsystems can be classified into two basic groups, namely: immovable (stable) and movable (mobile).

The group of immovable assets includes railways and stations with all their facilities, electric traction facilities, stable signaling equipment, depots and workshops. In a word, immovable assets make up the railway network. The group of movable assets includes vehicles, i.e. towing and towed vehicles.

The functional subsystems of the railway system are:

- Traffic regulation and management subsystem,
- Subsystem maintenance,
- Subsystem of the telematics application for the transport of passengers and goods.

5. TIMETABLE IN RAILWAY TRAFFIC

Planning the timetable and building the railway network or improving the existing ones through software has not yet gained importance in the Balkans and if software packages are available.

If it were insisted on a global level that traffic modeling and simulations are done through software before being implemented in a real system, railway traffic would be better organized and would have many more users.

For example, it would exclude Open Track software. For modeling and simulation in this softwer, should have use methodology phases as follows:

- Phase 1. Definition of the problem,
- Phase 2. Designing the study,
- Phase 3. Designing the conceptual model,
- Phase 4. Formulating inputs, assumptions, and process definition,
- Phase 5. Data collecting, separating, selecting and preparing,
- Phase 6. Choosing the simulation tool, simulation language or simulation software,
- Phase 7. Building and verifying the simulation model,
- Phase 8. Calibrating and validating the simulation model,
- Phase 9. Simulation experiments planning (scenarios planning),
- Phase 10. Exploiting the simulation model (experiment with the model), performing the simulation by defined scenarios,
- Phase 11. Analyzing the simulation results,
- Phase 12. Presenting the simulation results, and
- Phase 13. Defining the model life cycle (Huerlimann & Nash 2017).

Based on the methodology and if we know well all the disadvantages and advantages of the railway system, we can conclude that we could always and at any time get a well-planned timetable and well-suited to users. There are also other software that can give equally good results (Kuzmanović et al., 2019).

6. IMPACTS OF TRAFFIC ON THE ENVIRONMENT

Traffic is the biggest polluter of the environment, if it uses different fuels for its drive, which leave harmful substances when burned. To reduce environmental pollution, the solution can be found in rail traffic, because of that more and more trains use electricity for their propulsion. Also, on more and more parts of the railway line, are provided power supply for electricity.

Water and soil pollution also results from traffic, due to the release of chemical substances and the release of toxic gases. Noise is a growing problem, it is becoming stronger and more unbearable, causing many negative consequences, hormonal and organic disorders in people.

Traffic is the biggest cause of noise, which increases depending on the type and number of means of transport, structure of means of transport, speed, road surface, location of roads and railways, etc. Road traffic, from the aspect of its development, number and basic characteristics, creates significantly more noise than railway traffic. Research has shown that for the same volume of traffic, the noise level in road traffic is about twice as high compared to the noise level in railway traffic. Also, from the aspect of safety, rail traffic is more favorable (Milanović, 2010).

In addition to safety and the impact on the environment, rail traffic, if well good planned, can be more favorable for the population in cities. If the network of railway stations is well developed, as well as if the timetable is adapted to the user's requirements.

7. CONCLUSION

Innovations and additional research of user requirements could contribute to the satisfaction of users of the transport service. Investing in the development of institutes that deal with research, planning and designing is of key importance for the development of all types of traffic.

The development of railway traffic would be also affect the reduction of environmental pollution.

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