

NATURE, TOPICAL ISSUES AND GUIDELINES TOWARDS RESEARCH OF FUNCTIONAL RELIABILITY OF TRANSPORT SYSTEMS

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Abstract: *One of the most important characteristics of transport systems is the reliability of their performance. Significant global efforts are being made in this direction, both by the relevant government structures, and individual transport operators. These efforts are justified because improvements in the sphere of safety and reliability entail considerable benefits to transport users (reducing the waiting time of passengers, improving the quality of service in general, increasing supply chains reliability level, etc.) and for operators offering such a service (higher level of competitiveness, more revenues, etc.). This article examines the nature, existing problems and opportunities for improvement of approaches and methods of analysis, evaluation and management of exploitation reliability (and respectively transport service quality) of transport systems.*

Keywords: FUNCTIONAL RELIABILITY, TRANSPORT, TRANSPORT SERVICE QUALITY

1. Introduction

One of the most important characteristics of transport systems is the reliability of their performance. Significant global efforts are being made in this direction, both by the relevant government structures, and individual transport operators. These efforts are justified because improvements in the sphere of safety and reliability entail considerable benefits to transport users (reducing the waiting time of passengers, improving the quality of service in general, increasing supply chains reliability level, etc.) and for operators offering such a service (higher level of competitiveness, more revenues, etc.). This article examines the nature, existing problems and opportunities for improvement of approaches and methods of analysis, evaluation and management of exploitation reliability (and respectively transport service quality) of transport systems. It must be recognized that the management of functional reliability of transport systems is not unequivocal and cure for the problem solving. This is because transportation systems are complex hierarchical structures distinguished for their the availability of a wide variety of technical devices (rolling stock, means of communication and information management, special equipment, etc.) located and operated a large area. Nay, the normal work (and respectively offered by these systems transport service) could be impaired due to effects of great variety of influencing factors: technical refusals of the means of transport and / or other equipment and devices operating conditions (to which the transport process), characteristics of the organization and management of the transport system itself, etc. There are rare cases where single and seemingly insignificant events exploitation activities give rise to serious operational disturbances of transport systems. The problem of functional reliability of transport systems is not new to exploitation science and practice. Today, however, when the national and global economies are highly dependent on transport, this problem is becoming more and more relevant and significant. Undoubtedly, its solution implies a systematic approach and taking of adequate decisions (including measures to improve) requires adaptation to the problem on known or developing of new methods models for analysis and management of functional reliability. In this article are examined the nature and characteristics of the functional reliability of different types of transport systems, the guidelines and the problems of her the research.

2. Nature of the functional reliability of transport systems

Through physical movement of people and goods transport systems play an important role in the economic development of the country, linking social and economic interaction. Key element of every transport system is the functional reliability. The market of functional reliability is determined by the demand and the level of the proposed reliability, which inevitably change over time. Functional reliability is at once product and factor contributing to the trends in the development of the transport sector. [1]

It should be recognized that today the development of reliable and quality transport services is spent substantial funds globally each year. As a result of the increasing complexity of transport systems and supply chains in combination with rising consumer expectations, functional reliability becomes increasingly necessary and important. On the other hand the vulnerability of the system also increases. Functioning of transport systems can be disrupted by various types of errors, leading with her problems to solve that there are different models.

Some of the primary sources of reliability problems associated with rail schedules are unexpected events such as lack of rolling stock and locomotives, lack of crew or long delays at border stations. For public transport sources of reliability problems can be connected with lack of capacity, lack of drivers, repair of the road network and congestion.

Most of us are faced with unreliable transport services in their everyday life expressed with unexpected delays, leading to a later arrival to school or work or to a missed train or bus. Whether for business or social event or supply of goods reliability is a key quality of movement. The success of rail and road transport is highly dependent on the ability of a transport system to deliver reliable customer service. Transport operators aim to provide higher levels of reliability for consumers, because reliable services are more attractive and can also reduce operational costs.

It must be acknowledged that there have been significant efforts by transport operators and agencies for increasing the quality and reliability of services. Improvements in reliability beneficial both for consumers and for transport operators (fewer variables services reduce the waiting time of passengers and allow efficient use of resources by the operators). This is a situation where everybody wins.

The reliability is a term that may be defined in different ways. This article will examine the reliability in terms of quality of travel, travel time meet the needs of consumers and enabling them to organize their activities.

3. Defining the problems of reliability and guidance to solve them

In order to define the problems associated with the reliability of transport systems must be determined:

- the role and tasks of transport in the lifestyle of the individual and society as a whole;
- the influence of unreliable transport systems on personal and commercial activities.
- measures to be undertaken for the development in the field of transport.

Transport systems are vital arteries of modern economies that facilitate the lifestyle of modern man. A transport enables economic development and enables travelers to travel, socialize and have fun. Transport is vital for our personal and commercial prosperity. Therefore, reliability of transport systems is gaining more importance.

The main function of the transport system is facilitating movement of people and goods between chosen destinations. Insignificant damages can lead to a serious deterioration in state of the entire functionality of the system. Unreliable transport systems have an impact on both personal and on commercial activities. Consumers of transport systems rely on reliable schedules and delays, as well as the early arrivals on the selected route adversely affects the commercial and personal activities. Unreliable transport system increases the time to reach the desired destination. The consequence of delayed transport leads to disappointing trip causing stress.

When talking about the reliability of transport systems, it is important to mention that can be defined in terms of transport operators and from that of consumers (fig.1) using the service.

Transport operators responsible for the designated transport lines are interested in the probability that the means of transport (trains and buses) used for the service will be operated in accordance with a pre-planned schedule (which may be designated as a reliable schedule). For them reliability involves costs as they have to devote part of their resources to deal with the consequences of unreliability. The user on the other hand is interested in the probability that he or cargo will reach its destination at the desired time.

It should be noted that the reliability of a given transport system influences the decision of the trip (time of departure, those decisions are made in order to reach the defined destination at a specific time). This is particularly relevant for business trips when the delay shall be adopted that there is a very high value of the harm. When deciding on departure time traveler strives to minimize the waiting time (futility) in his journey. The traveler should plan extra time for travel since it is forced to leave early to add buffer time and thus devour the unreliability of the transport system in time. This extra time the passenger is considered as costs of the person as taken away his time traveler can use for other potentially more productive activities.

Lack of reliable transport services can have a significant impact on costs and may also affect the transport system. On the other hand, the increase of reliability allows the operator to optimize the use of resources. By reducing the recovery time, operators can increase the availability of drivers and vehicles. Observance of schedules allows the operator to reduce the number of spare vehicles and drivers. The improvement of regularity will reduce the average waiting time of passengers and improve the efficiency of capacity utilization of vehicles. According labor [2] by improving the infrastructure can increase capacity: enhance transport service lines and transfer points, building new highways and roads, improving and constructing new railway lines and terminals. Increase the supply reliability of transport systems leads to reduced likelihood of an unexpected meltdown in service.

Reliability of the various transport systems can be defined in different ways. In the labor [1] reliability defined as the probability of realization of trips within a specified period of time. Travel time depends on many factors. It must be recognized that there are many indicators which are used for expression of efficiency of system reliability. Reliability of public transport is often expressed by the accuracy of the arrival and/or departure of stops and stations. In the railway transport accuracy can be defined as the number of trains run on time.

Unlike rail, the reliability of the road sector is often measured by the average travel time. Average travel time is determined by the expected and unexpected delays (fig.2). Unexpected delays lead to differences in the trip any subsequent trip. Can be identified two forms of unexpected delays. The first concerns the travel time for trips taken at the same time each day (variability) and the second, which concerns the random delays that are the result of accidents or repairs.

Given that the user of the transport system must take into account the expected average travel time and its variability.

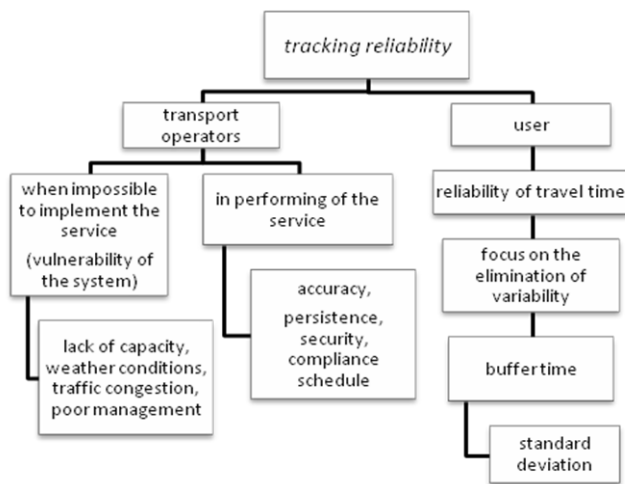


Fig.1 Tracking reliability in terms of transport operators and users.

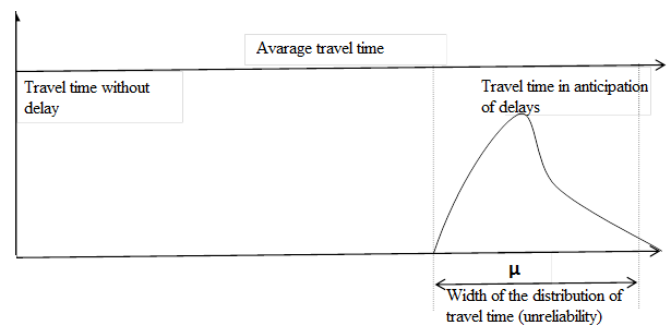


Fig.2 Travel time distribution

To reduce the risk of delay to reach the desired destination, the traveler must provide more than the average travel time. This is shown in Figure 2, where μ represents the average travel time. User expectations in terms of travel time are related to the variable of parameter μ .

Common featured indicator for the reliability of the transport system is that they do not relate to possible options of travel time (day to day), its distribution or particular form of distribution. The distribution of travel time from day to day can be characterized by two features of this trip-width (variance of travel time) and the distortion (the model of distribution of travel time) or more widely or more distorted timing travel to definitely time of day and day to day of the week, less reliable travel time.

By increasing the quality of transport infrastructure that provides the ability to cope with the consequences of extreme weather conditions the probability of reliability (safe travel, meeting the requirements of the traveler, and allows you to organize activities) increases. Bad weather conditions affect the reliability of the transport system. On the one hand deteriorating road conditions leading to a reduction in speed and delays, and the other severe weather conditions increase the likelihood of accidents, leading to disruption of traffic flow and unreliability. The provision of higher capacity may also improve the reliability of the transport system, especially when the unreliability arises from high levels of traffic. The extra capacity can also lead to less vulnerability of the system, if they are provided with alternative connections.

Information plays an important role in the management of reliability. The provision of information to the user who uses a transport system, gives the opportunity to organize your trip (choose another route to arrive on time to the selected destination; delay may be inevitable, if no there is an alternative route). In this case the provision of information can soothe the user and reduce the stress of unforeseen delays. The information can be divided into pre-and during the trip. Probably consequences of delay can be reduced by both forms of information. Information before traveling enables the planning of the trip and thus avoids the possibility of unreliable trip. Information during the trip allows the user of the transport system to change initial planned trip according to current traffic conditions. The provision of information is helpful for both consumers and operators of transport systems. The prediction of travel time allows the operator to plan the response time to incidents and operational problems, while real-time information allows effective monitoring of events development. Reliability of transport systems can be influenced by the quality of information. The more accurate the information provided to the consumer, the more expected travel time approaches the actual travel time and leads to higher reliability of transport systems.

4. Conclusion

We can conclude that in terms of solving the problems of reliability, (fig.3) a transport system can be optimized by:

- Increasing the physical infrastructure capacity or by providing additional capacity or improving existing capacity;
- Better management of existing capacity. This can increase the reliability as well as poor management can increase unreliability;
- Provision of information to consumers, which enable them to reduce the adverse effects of reduced reliability. This can be a cost-effective way to reduce the unreliability and possible impact of unexpected delays in business or personal travel.

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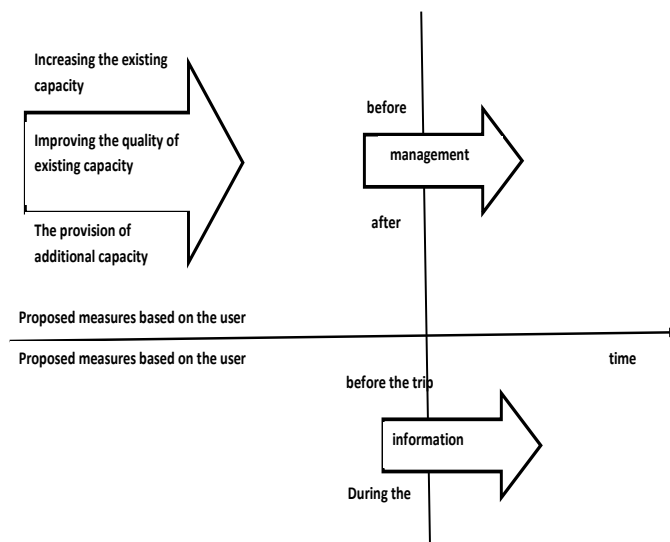


Fig.3 Optimized reliability of transport systems