

Application of RAMS analysis in road transport

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Abstract. Despite the many advantages, each type of transport, there are many people for the health and life of people. This means that some of the challenges that are not productive have higher energy levels. Substitution of the instrument's characteristics. Management of the fleet of tourist company orders enabling the company to improve and client's operational affairs on the elements of reliability, service compliance, readiness and security (RAMS). The RAMS method used in railway transport has found application in monitoring the maintenance of railway vehicles in maintenance management system and the IRIS Standard. In the article, the authors present the method of assessing the technical maintenance of road vehicles based on the elements used in the RAMS analysis.

1 Safety monitoring

Transport from the economic and integration point of view plays a very important role in the economy of every country. Despite many advantages, each type of transport is a source of many threats to people's health and life. This causes new challenges to increase the reliability, availability and maintainability and thus the level of safety. An important element is therefore the selection of an appropriate system of maintenance, guaranteeing the assumed high reliability and readiness at specified operating costs [1].

Maintenance system is designed to help in achieving strategic goals such as:

- high availability and reliability of vehicles,
- minimization of maintenance and use costs,
- high quality of services provided,
- an increase in the level of safety.

Without a suitably chosen maintenance strategy, the company will not achieve such goals that match the scope of services provided by the company [2]. The increase in requirements regarding the level of reliability, availability, safety level and maintenance costs of machinery and equipment implies actions aimed at increasing the efficiency of pre-production processes (such as concept, design, construction), production and operation [3–6]. Many enterprises implement logistics programs that are based on index analyses. In the railway industry, the IRIS (International Railway Industry Standard) standard is becoming increasingly popular, which imposes an obligation to introduce RAMS analysis (Reliability, Availability, Maintainability, Safety) in accordance with the PN-EN 50126: 2002 / AC: 2011E standard. This standard is based on the Quality Management

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System extended by the specificity of the railway. The IRIS standard certificate becomes a requirement for suppliers for the largest rail market corporations.

In the article, the authors try to analyse the possibility of an approach in line with the RAMS analysis in road transport. Reliability, availability, maintainability and safety are the goals set for modern technology. The level of reliability depends on the number and types of damage arising during use and maintenance. One of the factors that have an impact on the occurrence of failures is improper maintenance. An important task in order to increase the reliability of vehicle operation is to reduce the amount of damage resulting from improper maintenance. Reliability of vehicles is reflected in their readiness for use, which is the basic characteristic, captured for strategic purposes of each transport company. Any unplanned out of service hampers the ability to provide transport services and is associated with increased service costs, and may also increase the risk that should be incurred in the course of business. Vehicle fleet management can be improved by monitoring and analysing RAMS-based operating processes.

2 RAMS in rail transport

The relevant standard is EN 50126 Standard "Railway applications – The Specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS)"- this describes four RAMS indicators.

R – Reliability – the probability that an item can perform a required function under given conditions for a given time interval;

A – Availability – the ability of a product to be in a state to perform a required function under given conditions at a given instant of time or over a given time interval subject to the required external recourses being provided;

M – Maintainability – the probability that a given maintenance action, for an item under given conditions of use can be carried out within a stated time interval when the maintenance is performed under defined conditions, using stated procedures and resources;

S – Safety – the degree to which a system is free from unacceptable risk of causing harmful effects.

The PN-EN 50126 standard defines the following parameters [7,8]:

Reliability

- MTBF – Mean time between failures,
- FPMK – Failures per million kilometers,

Availability

- AO – operational availability,
- AP – availability due to planned activities,
- AN– availability due to unplanned activities

Maintainability

- MTTR – Mean time to restore for all actions,
- MTTRNP – Mean time to restore for planned actions,
- MTTRNA – Mean time to restore for unplanned actions,
- MTBM – Mean time between maintenance,

Safety

- MTBHF – Mean time between hazardous failures,
- MTBSF – Mean time between system failures.

Indicators in rail transport for one example are presented in Figure 1 and 2.

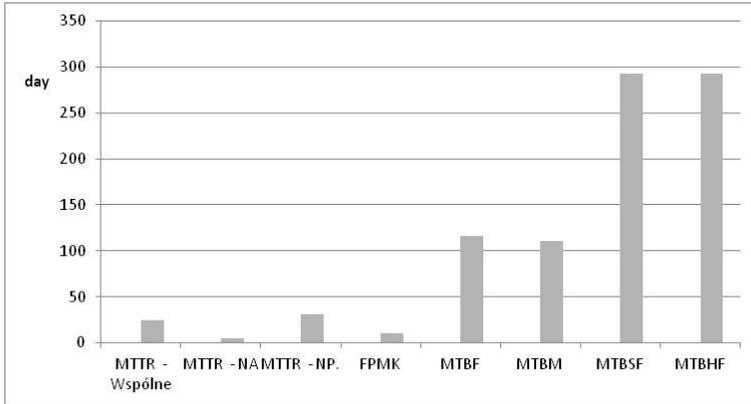


Fig. 1. Graph of RAMS indicators expressed in days [9].

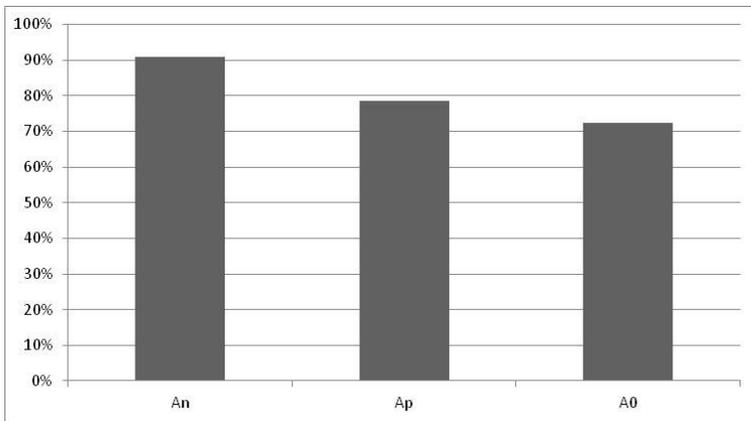


Fig. 2. Graph of RAMS indicators expressed as percentage values [9].

3 RAMS for road public transport

Public transport remains one of the safest ways to travel. Figure 3 shows the number of fatalities in 2016 and 2017 in all road incidents and in incidents involving the bus. The figure shows that the number of fatalities with buses accidents is only 1.45% of all victims in traffic incidents.

Many engineering methods can be used to improve the level of safety, a good example is the technical condition monitoring system. The article describes a 3-month observation of 10 town buses. In the analysed period, they lost 210 failures, and the total distance travelled amounted to 271 000 km.

Indicators used in rail transport have been analysed in terms of their use in road public transport. Due to the characteristics of local transport (i.e. small distances), the Mean Time Between Failures and Mean Time Between Hazardous Failures were changed to Mean Distance Between Failures and Mean Distance Between Hazardous Failures.

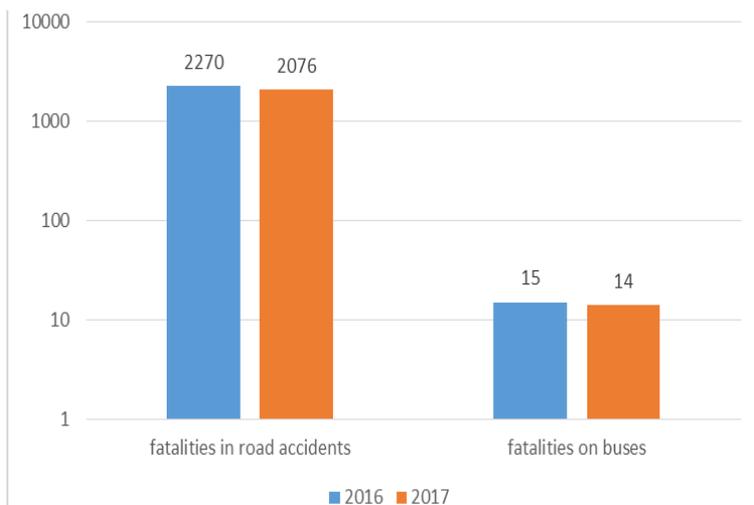


Fig. 3. Number of fatalities in road accidents in 2016-2017 [10].

Critical damages analysed in the article are failures of braking, steering and driving systems. Table 1 shows the results of the indicators for the analysed example.

Table 1. RAMS indicators analysed for road transport [own work].

| No. | Indicator | Result |
|-----|-----------|---------|
| 1 | MDBF | 1920 km |
| 2 | FPMK | 774,9 |
| 3 | AO | 88% |
| 4 | MTRR | 5,52 h |
| 5 | MDBF | 2382 km |

4 Conclusions

The scope of procedures and standards according to which the criterion of rolling stock assessment of particular elements is constantly changing, and in recent time safety of passengers is main reason for these changes. Technological innovation should be based on the needs defined by operators, which result from the analysis of accident rates in enterprises and operational experience. It will pay interest in available technologies that will better suit an open, easily accessible public transport environment. Modern technologies do not exist in isolation from the whole system and can be more useful as multifunctional tools that integrate functionalities from various areas of the transport system. Operators need precisely such tools for the overall management of the transport system, and not just one element of security. Public transport remains one of the safest modes of travel and indeed plays a central role in well-organized communities: changing travel preferences for public transport reduces road accidents [11]. For public transport to be widely elected by citizens, they must have a sense of safety. Ensuring security should therefore be seen as both an investment in achieving the aforementioned objective and as an essential element of passenger service, based evenly on the participation of employees, technologies and procedures, in order to reduce the number of hazards in public transport. The analysed indicators can help to improve vehicle fleet management systems in order

to increase the level of safety. Comparative analysis for various vehicles used will allow to identify the most sensitive and least safe ones. Indicator analysis for various, used vehicles will allow to increase the quality and efficiency of services provided in public road transport companies [12].

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