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INFRASTRUCTURE AND SAFETY IN THE POLISH RAILWAY TRANSPORT

Abstract

The problem of the transport safety is crucial and is treated as part of the sustainable transport growth policy of the European Union. Safety is one of the key factors which affect the attractiveness of the railway transport, both in regards to the transport of goods and passengers. It is dependent among others on the infrastructure of this transport mode, as the condition of the infrastructure and its parts affects not only the time and comfort of the passengers but also the safety levels of the railway transport. The goal of the article is to analyse how the transport infrastructure affects the safety of the passengers, to characterise the threats and to show the changing trends which lead to the increase of railway transport carriage. Safety threats in the Polish railway transport will be shown in relation to the other European countries as well as the directions of the changes in this matter.

Keywords: rail, transport, safety

Introduction

In the European Union, the European Union Agency for Railways (ERA, 2017) is the organisation which is responsible for the supervision of railway transport (ERA, 2017). Its main duties are to carry out actions to integrate the European railway transport and to start initiatives to increase the safety of the trains and sustain the continuity of service on international routes. Since 2006 the European Union Agency for Railways has been cooperating with the railway sectors of the Member States, the governments and international administrations responsible for the functioning of the railways. The goal of the article is to analyse the threats to safety connected with the railway transport infrastructure and to point out the direction of activities aimed at creating technical norms and safety means which are universal for the European Union and economically acceptable and to create unified norms of the railway signalling, thus improving the safety of this mode of transport.

1. The threats in railway transport resulting from the state of infrastructure

European Union Agency for Railways prepares statements on the safety of railway transport in the European Union. A report called „Railway safety in the European Union" (European Union Agency for Railways, 2017), is generated on the base of data provided, among others, by the national safety authorities (NSA), National Investigation Boards (NIB) and the European Commission. The appropriate national safety authorities, including the Polish Railway Transport Office collect acknowledged safety indicators from the railway carriers as well as the supervisors of the infrastructure. The indicators are analysed comparatively and the results of this analysis are the foundation for the transport policy basis in the EU. One of the goals of the Agency is to promote safety in railway transport, control the risk and build trust for the railway carriers and infrastructure supervisors in the whole European Union. The reports are a detailed analysis of the railway sector safety in EU Member States and they point out the areas which require improvement. The Agency report which was published in 2017 "Safety overview 2017" proves that the airway transport is the safest transport mode in Europe (Figure 1). The risk of fatal accidents is eight times lower in the railway transport than in the road transport (European Union Agency for Railways, 2017). Unfortunately, it has to be stated that the safety levels vary significantly across the EU. The differences are up to ten times in various countries.

The inadequate level of maintenance works and state of infrastructure buildings such as bridges, viaducts, tunnels and conduits as well as the rails affects the safety of the railway transport significantly (Michailiuk, 2014, p. 33). A bad state of railway infrastructure leading to breaks and deformations of the rails, malfunctions of the railway signalling or railway control systems are a significant danger for the carriage of goods and passengers (Figure 2).

In Europe, the condition of facilities supervising the safety of the commotion is still diversified. The system of automatic speed limiting (ATP) is one of those facilities. It calculates the safe speed for a train based on the parameters of the rails and of the vehicles and the changing indicators of the signals. The current real speed of the train is compared with the safe speed and when they get close, the drive is automatically disconnected and the brake systems are applied. When the value of the real speed in relation to the safe speed decreases once again, the ATP system will allow the driver to get back in charge of the train (Barański, Karbowiak, 2012, p. 48). Unfortunately, in Bulgaria, Czech Republic, Ireland, Greece, Lithuania and Poland the system is not yet used.

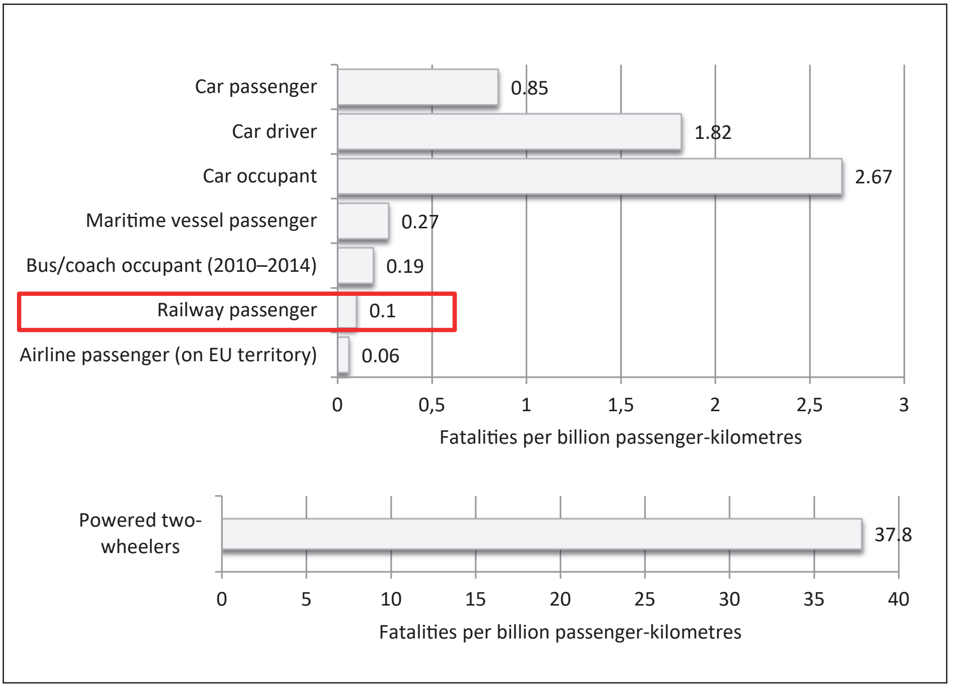

Figure 1. Fatality risk of passengers using different modes of transport (EU-27; 2011–2015)
Source: (own elaboration based on: Safety overview 2017; European Union Agency for Railways, 2017)

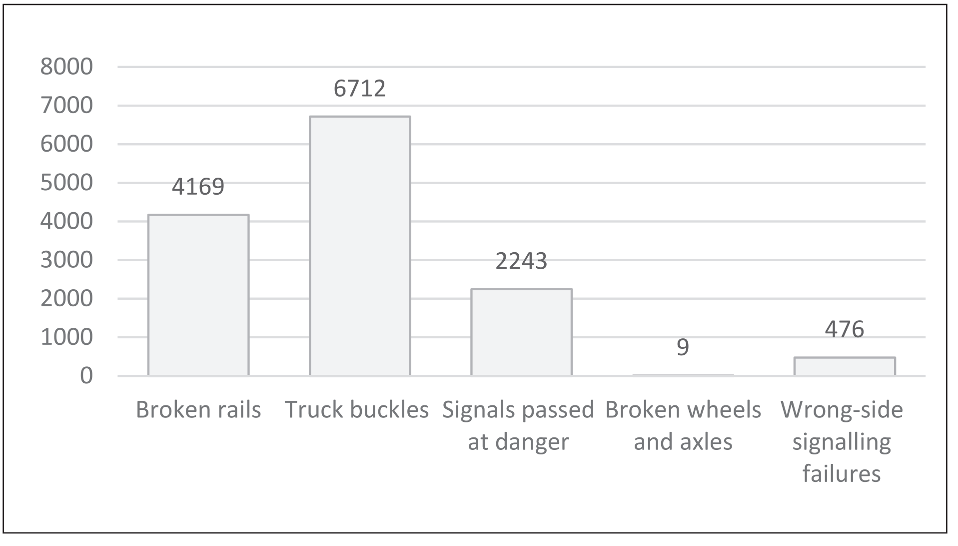

Figure 2. Accidents caused by poor state of rail infrastructure (EU-28, Norway and Switzerland, 2015)
Source: (own elaboration based on: Safety overview 2017; European Union Agency for Railways, 2017)

The delay in the introduction of new technologies used in the control of the motion and diagnostics of railway routes also affects the decrease of safety and reliability. As a result there is a need to increase the funds on the upkeep and diagnostics of the railway routes in the EU Member States so as to converge the differences in the railway infrastructure levels of particular countries

2. The state of the linear railway infrastructure in Poland

According to the Law on railway transport, the railway infrastructure are: "railway lines and other buildings and facilities along with the land, situated within a railway area and used to manage and carry out the transport of passengers and goods, and also upkeep the necessary assets of the infrastructure supervisor" (Dz. U., 2003). PKP PLK is the supervisor of over 90% of rails in Poland. In 2016, PKP PLK used 18 427 km of railway routes. The routes are divided into three categories based on the technical condition of infrastructure:

– in good condition – railway lines operated according to the parameters in which only maintenance work is needed;
– in acceptable condition – railway lines with decreased operation parameters (decreased timetable speed, local speed limits), in order to reinstate the maximal operating parameters, some minor repair work in the form of rail parts replacement is needed apart from the maintenance work;
– in unacceptable condition – railway lines with significantly decreased operating parameters (low timetable speeds, lots of local speed limits, decreased axle loads), which qualify for a complex change of surface (PKP PLK, 2017, pp. 16–17).

Based on Figure 3, only 55% of railway routes in Poland were considered to be in good condition in 2016, whereas 16% were deemed to be unacceptable. In comparison to 2010, this is however a significant increase of the quality – the share of railways in good condition increased by 19 pp. and the share of unacceptable ones decreased by 13 pp. (PKP PLK, 2011, p. 36).

According to the PKP PLK S.A. report, as a result of the improvement of the technical condition of railway routes the maximal timetable (RJP) speed for passengers trains was increased on railways with the length of 2449 km, whereas it was decreased on railways with the length of 840 km (PKP PLK, 2017, p. 16) – Figure 4.

The structure of maximal timetable speeds in the 2016/2017 timetable improved in comparison to the timetable in 2010/2011. However, still only 30% of the routes allow to reach the maximal speed of 80 km/h (Figure 5).

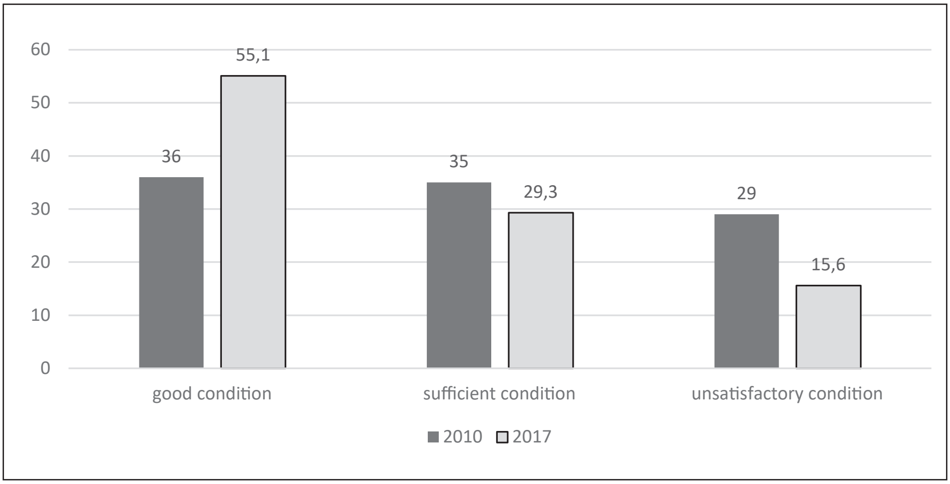

Figure 3. Changes the technical condition of railway infrastructure on the PKP PLK network in 2017 (%)
Source: (own elaboration based on: PKP PLK, 2010, p. 36; PKP PLK, 2017, p. 16)

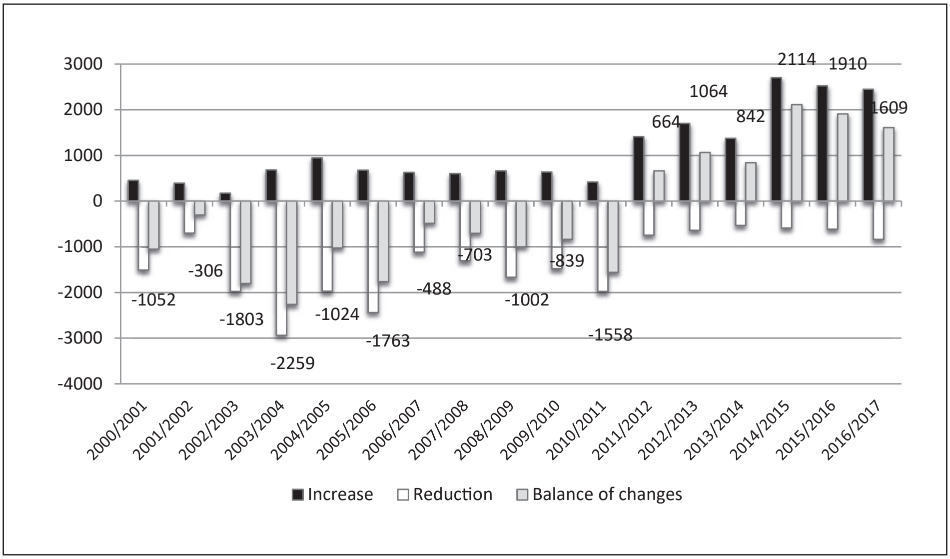

Figure 4. Length of railway lines operated by PKP PLK S.A., on which were introduced changes in maximum timetable speeds
Source: (own elaboration based on: PKP PLK, 2017)

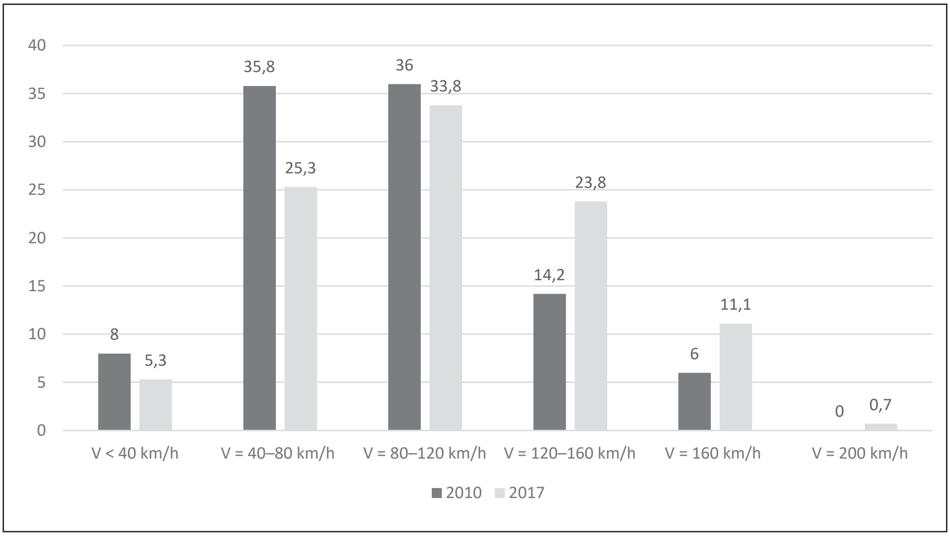

Figure 5. Changes of the structure of maximum speeds in timetable 2016/2017
Source: (own elaboration based on: PKP PLK, 2010, p. 37; PKP PLK, 2017, p. 17)

The safety is also affected by the equipment of the railway infrastructure with the rail traffic control devices (SRK) and their technical state. The SRK devices are divided into stationary (used to control trains within the stations) and linear (used between the stations). In the PKP PLK S.A. network still mostly relay and mechanical devices ar used. The dynamic development of the computer technology allows to use it widely in the automation and SRK systems. The newest SRK systems are computer systems and computer-relay systems (hybrid) and they bring together nuisance, reliability and broad functionality, while also providing a high railway safety level. As of 31.12.2016, computer SRK systems were installed in 147 control districts, thus controlling 2585 switches and 3175 signalling units. The relay control devices cover 1482 km of rails, on which the safe rail traffic is supervised by 27 Local Traffic Control Centres – LCS (PKP PLK, 2017, pp. 18–20). Figure 6 shows the share of various stationary SRK devices. The oldest devices – mechanical are technologically from the 19th century, the slider ones from the beginning of the 20th century, the relay from the half of the 20th century, the computer-relay from the end of the 20th century (3%) and the computer ones from the beginning of the 21st century (unfortunately their share in the used stationary SRK amounts to only 8%). In comparison to 2013, in 2017 the share of computer-relay systems and computer systems in the control of rail traffic increased insignificantly.

The safety of the trains on route is provided by the line blocks, single- and multi-interval, which are installed on 15 861 km of rails. On a vast share of the rails supervised by the PKP PLK S.A. single-interval line blocks are used (on 12 665 km of rails, including 608 km on which blocks developed using the newest computer technique are used). The multi-interval blocks, which improve the throughput of the railway significantly are installed on 3197 km of railway, out of which on 1355 km there are blocks which are equipped with the integrated relay diagnostic systems, which control and register the technical parameters of the system (PKP PLK, 2017, p. 19). In comparison to the year 2013, the share of single- and multi-interval computer blocks increased in the control of trains on route – Figure 7.

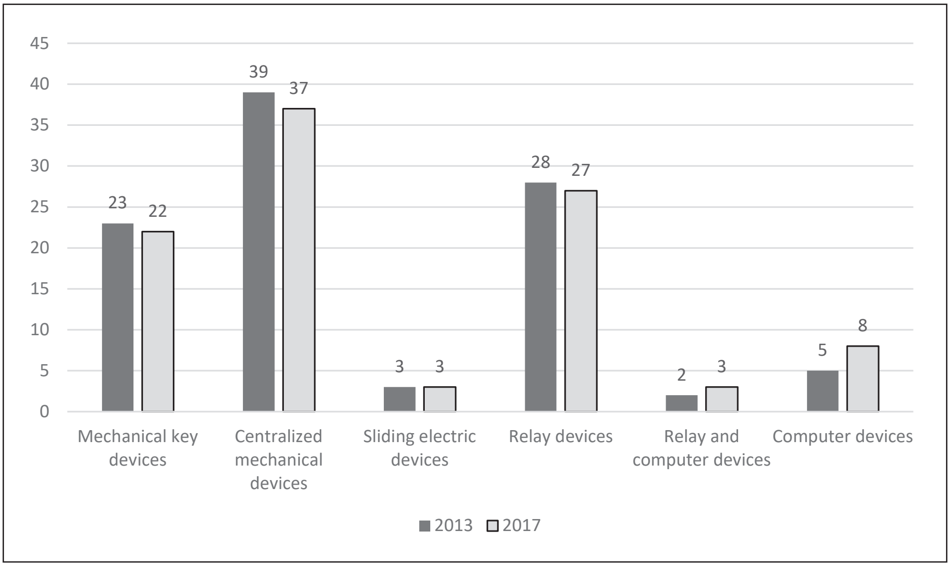

Figure 6. Changes of the structure of traffic control devices at railway stations
Source: (own elaboration based on: PKP PLK, 2013, p. 20; PKP PLK, 2017, p. 19)

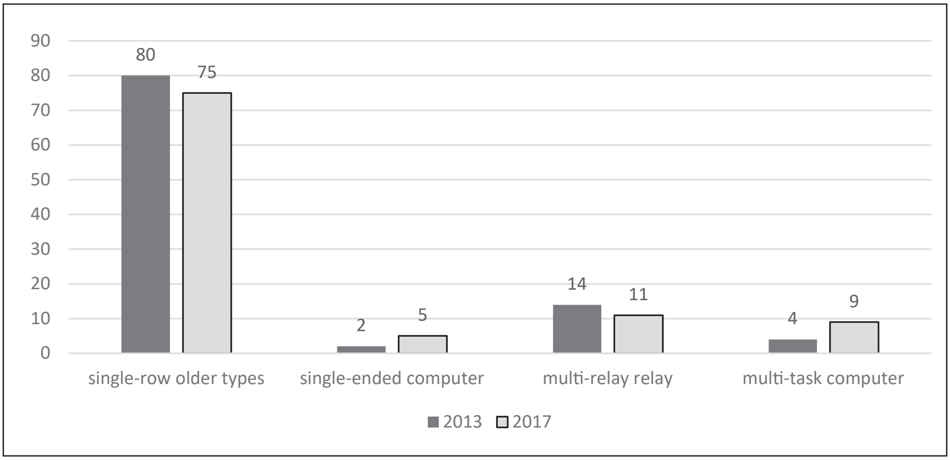

Figure 7. Changes of the structure of traffic control devices on railway lines
Source: (own elaboration based on: PKP PLK, 2013, p. 22; PKP PLK, 2017, p. 20)

The state of the transport infrastructure, as mentioned before, affects the safety of the carriage. An improvement in the condition of railway routes resulted in a decrease in the number of accidents (Figure 8). Figure 9 shows the number of accidents in relation to the operation work in years 2008–2016.

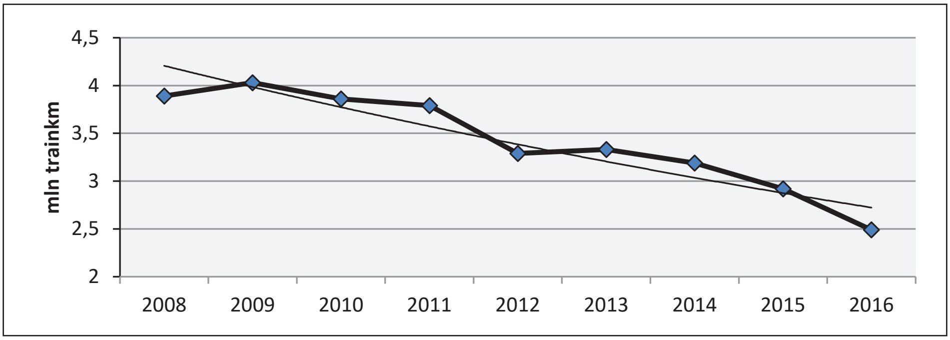

Figure 8. Number of accidents/mln train-km
Source: (UTK, 2016)

Despite the increase in safety, its state in Poland is far from EU standards. In the European Railways ranking Poland is located at the 22nd place (23rd place in 2015) out of 25 analysed countries (it received a grade of 0 for the safety state, whereas Portugal which was behind Poland – 0.2; the highest grades were received by Luxembourg – 3 and United Kingdom – 2.8). A similar state of railway threats as in Poland was observed only in Lithuania, Romania and Slovakia (RPI, 2017).

Accidents to persons were the most numerous ones in the network governed by the PKP PLK S.A. (Figure 9).

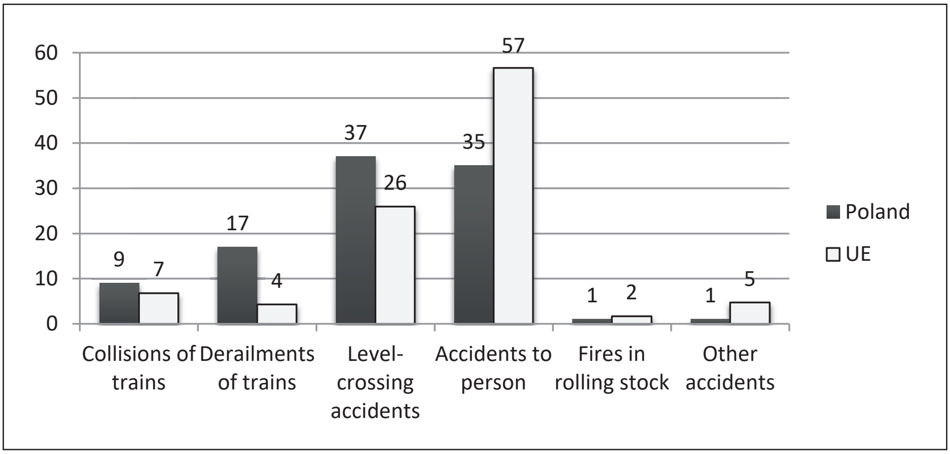

Figure 9. Structure of accidences on PKP PLK railways in 2016 and in EU countries (plus Norway and Switzerland in 2015)
Source: (own elaboration based on: PKP PLK, 2017; European Union Agency for Railways, 2017)

These were the accidents involving people being in the railway terrain or jumping into/out of the trains, accidents at a crossings. Collisions and derailments were 26% of all railway accidents in 2016. Those are the events which usually happen as a result of a failure of the railway system, i.e. the technical devices, procedures, railway operator or infrastructure supervisor (so-called "human factor"). In comparison to the EU accident structure, in Poland the share of accidents connected with the infrastructure state is especially high. Especially the share of accidents on road-rail crossing is high (37%).

3. Threats resulting from the state of infrastructure

Due to the technical specifics of the railway transport vehicles, they are strictly connected with rails and tracks. Whereas a road vehicle might take a detour around the obstacle on a road, a rail vehicle cannot. A bad technical state of the railways, inadequate upkeep of the rails and turnouts leads to a faster usage of the rolling stock, which generates higher upkeep costs both for the cargo and passenger carrier. Apart from that, used rolling stock destroys the tracks (e.g. flat wheel rims deform the rail). The rail upkeep in a proper technical state with the adequate parameters affects not only the comfort of the passengers but also the safety of transport of dangerous materials and high risk cargo (TWR), which if destroyed during the transport could result in adverse effects both for the environment and the people.

A bad state of the rail traffic control devices or their inadequate supervision and maintenance can also lead to an increase in the threats of railway transport carriage (e.g. wrong semaphore signals, improper visualisation of the SRK devices state leading to wrong decisions of the supervisor of the rail traffic).

The Polish Railway Transport Office is the institution which is responsible for the supervision of the railway transport safety. The Director of the Polish Railway Transport Office is a government administration organ and is responsible for the supervision of the whole railway transport, including the safety. A proper supervision on the technical state of operated infrastructure and an effective introduction of prevention measures not only increases the quality of the carriage, but also decreases the threat of negative effects of railway events. When controlling the infrastructure supervisor, the Polish Railway Transport Office analyses, among others:

- the technical state of the railway infrastructure;
- the upkeep of land in the vicinity of rails;
- the technical state of the crossings;
- the process of rail traffic control, including the use of rail traffic control devices;
- the activity of technical emergency services and the documentation – employee qualifications (UTK, 2017, p. 134).

In the report on the safety of railway traffic in 2016, the Polish Railway Transport Office points out the following irregularities as a result of the supervision of the technical state and operations on the railway infrastructure:

1) in relation to the upkeep of rail infrastructure and corresponding land:
   a) bad technical condition of rails and turnouts,
   b) lack of measures to remove the irregularities mentioned in the diagnostic protocols,
   c) no regular control of the rails,
   d) occurrence of "wild crossings",
   e) irregularities relating to signalling and labelling,
   f) no weed and plant removal,
   g) no provision of proper visibility;
2) in relation to the technical state, upkeep processes and classification of crossings between the railway routes and public roads:
   a) bad upkeep of the tracks,
   b) irregularities relating to signalling and labelling,
   c) lack of reaction to diagnostic recommendations,
   d) no provision of proper visibility,
   e) lack of reaction to recommendations of crossing internal control,
   f) irregularities in the upkeep of devices providing the safety of the crossing (UTK, 2017, p. 136).

4. Directions of changes

For a few years, the railway network in Poland has been modernised intensively. The result of the investment effort is not only the increase of the operation parameters of the railways, such as the maximal speed, the axle road, but also the fulfilment of the European directions on the interoperability of the railways. The conditions for the rail traffic operation in regards to the operational speed of the trains are significantly improving. The is the result of the PKP PLK S.A. programme for the modernisation and revitalisation of the railway routes. The extent of the investment projects include: the complex replacement of the tracks, the rail traffic and electroenergetic control devices (track and non-track) and the modernisation of level crossing, including the replacement of the most dangerous level-crossings with multi-level crossings.

The replacement of the old, used and degraded parts of the railway infrastructure and technical facilities with new parts, made with the use of modern technology, leads to a significant increase of the operation parameters of the railway lines (especially the maximal speeds) while at least keeping and mostly improving the traffic safety. Thanks to the modernisation and revitalisation of the railway lines, the risk of adverse events or operation difficulties resulting from the bad condition of the infrastructure is decreased. Likewise, the frequency of the accidents at the crossings is decreased as they are fitted with additional safety measures and devices which warn the traffic user. The level crossings are replaced with viaducts, footbridges and tunnels. As a part of the investments fulfilled by the Centre for Investment Implementation, turnouts, which are the most fragile parts of the railways routes when it comes to derailments, are replaced. In 2016 on the PKP PLK S.A.

549 turnouts were covered by the investment activity (PKP, 2017, p. 39). Furthermore fitting the turnouts at chosen stations with the universal switch locks for the emergency spire closure and mobile frog heads (which allow the train to move through the turnout at a high speed) was one of the goals of the Investment Activity Plan of the Company in 2016. The construction of a railway accessibility control system was started at the stations which don't have this type of facility yet, so as to reduce the threat of the rolling stock collisions. In 2016 within the network administered by the PKP PLK S.A. such systems were fitted at 133 rails of 35 stations. A new investment activity, carried out as a part of the SMS system improvement, was to fir the semaphores at chosen traffic stations with the W 24 indicator – "the indicator of opposite traffic" (allowing the driver to use the rail opposing the regular one), which uses the light emitting diode (LED). Thanks to the use of the LED technology the improvement of the visibility and readability of the aforementioned indicators can be achieved, both thanks to the better visibility of the source of the light as well as the ability to adapt the brightness of the indicator to the environment conditions (time of the day/night, weather conditions). All of the activities increase the safety level of the railway transport (PKP PLK, 2017, pp. 40–41).

It can be expected that the risk of safety threats resulting from bad technical conditions and infrastructure breakdowns will decrease at the parts of the railways which are modernised or revitalised. The frequency of the accidents at the level crossings should also decrease, due to them being fitted with additional safety and warning measures (thus reclassification to a higher category).

Apart from the modernisation and revitalisation of the main railways, the fitting of modern SRK devices, one has to remember about the necessity to upkeep all the operated railways so that there is no decline of the technical parameters allowing a safe railway traffic with acceptable travel times, for which a constant technical supervision is necessary. Furthermore, the control and maintenance of the SRK devices has to be supervised so as to assure an effective and safe operation of devices monitoring the safety of rail traffic.

Conclusions

The technical state of the railway infrastructure, including the SRK devices has a significant impact on the safety of cargo and passenger transport. A technical state and the outdated traffic control devices resulted in various speed limits being introduced to increase the safety. This led to a decline of the attractiveness of this transport mode.

In the recent years the state of the railway infrastructure in Poland has been improving, mainly due to investment programmes of the PKP PLK S.A. which aim to modernise and revitalise the railways, and fit the modern SRK devices based on computer technique, which have higher reliability levels than devices used so far. These activities affect the increase of the cargo and passenger transport safety and allow to achieve higher operation speeds, a proper technical control and the supervision of all currently operated railways and SRK devices. These projects result in a steady increase of the railway transport safety, even though the results are not yet satisfactory when compared to the EU standards.

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