The Analysis of the Collisions of Rail Vehicles with Animals with Regard to the Railway Traffic Safety

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Although animal-train collisions are common they are poorly recognised. They pose a threat to the passengers' safety and also cause countable loss for railway operators in the form of rolling stock repairs and delays. The problem is much more significant in passenger transport due to the higher speed compared with cargo trains. The scale of damages caused by collisions also depends on the size of the animal and the type of locomotive. The analysis of collision sites and careful collection of data by all the railway operators would have a significant influence on railway transport safety and costs.
Keywords: animal-train collisions, safety, railway transport.

1. INTRODUCTION

Safety is one of the basic human needs. Without the feeling of safety one cannot develop. Safety has two main components: an inviolable guarantee of one's survival and the freedom of their development. A sense of safety is determined both by the objective and quantifiable factors and subjective factors difficult to quantify and not always rational. The role of the latter is not smaller than of the first one because it is the subjective feeling of safety that leads to taking action on a personal level. Objective safety assessment (measured e.g. by statistical data) is used to make decisions at a higher level. In the safety assessment, or rather its opposite – that is the risk, insurance companies specialise [1,7].

Each mode of transport, including rail, while fulfilling its mission to carry passengers from point A to point B is supposed to be, above all, safe. Ensuring safety refers not only to the participants of traffic, but also to all the components at the contact with railway lines and other elements of environment. Regulations concerning the safety of rail traffic mainly cover the safety issues related to transport of passengers. The safety of animals is considered to be secondary [2].

2. THE SITUATION ACCORDING TO THE RAILWAY OPERATORS

At the beginning of 2012 a research begun related to railway vehicle collisions with animals. The research was carried out at the source, i.e. among rail operators, both passenger and cargo ones. Taking into account the fact that the operators and infrastructure managers are obliged to develop and implement the Safety Management System (SMS) under which all accidents and other dangerous incidents are reported, investigated and analysed, it would seem that the amount of information gathered would be enormous.

However, it appeared that only one cargo operator out of 12 keeps such records. Nevertheless, other operators were able to provide certain information on animal-train collisions. Half of them did not record any collisions and the others claimed that only a few collisions occur annually. Only three operators informed that the rolling stock required a repair as a result of a collision. None of them recorded any stoppages or train delays as a result of collisions, but there happen situations where drivers slow down after an animal is noticed on the track or stop the train for a while in order to avoid collision.

It is easier to obtain information from passenger transport companies. Four out of six

operators whom we managed to contact keep the records of collisions while the other two informed us about number of collisions which ranges from 1-2 yearly to a few a week. This is related to the nature and territorial coverage of a given operator. Three operators noted train stoppages due to collisions and also three had to repair the rolling stock. In one case the cost of a single repair was PLN 50,000.

The information gathered shows that collisions occur more often to the operators whose trains move with greater speed, hence more often to the passenger operators than to cargo ones. Moreover, the damage to the rolling stock occurs more often to passenger operators which is strictly connected with the speed and the construction of the rolling stock. High speed of the passenger train results in limited capability of response from the driver in the situation when an animal appears on the railway track compared with statistically slower cargo train moving at the average speed of about 40 km/h. What is more, the operators who transport passengers use mainly (EZT) electric traction combined units or (SZT) diesel traction unit as well as rail buses which are more susceptible to damage during collisions than the solid cargo locomotives and the costs of their repair is then higher.

3. SELECTED OPERATOR'S DATA

Thanks to the courtesy of the largest passenger operator Przewozy Regionalne Sp. z o.o. (Regional Transport Service) detailed data were received concerning the collisions with animals in 2012. Each of the 268 incidents was registered and the following data were noted: date, hour and place of collision, type of damage (or lack thereof), delay, and usually species of animal involved. This information makes it possible to carry out analyses on the animal species which are mostly involved in collisions, periods of higher risk of such accidents, as well as places where most animals get killed.

Figure 1 shows the percentage of animals of different species in all accidents. Animal species involved in collisions were mostly large forest animals (roe deer – 106 cases, wild boar 58, red deer 38 and moose 12), but there was also reported a relatively large number of collisions with dogs (15), and single cases of collisions with farm animals (3 with horses and one with a cow, one with a donkey and one with flock of sheep) and birds (4 records). Often more than one animal was involved in a collision (when a train ran into a herd of animals) – it happened in 32 cases out of which 20 concerned wild boar. This is particularly important for safety matters, because collisions with wild boar often result in damage to the trains [4,5]. Interestingly, more than half of the collisions with wild boar herds occurred in just a month and a half (the second half of October and November). In the case of roe deer, only four cases out of more than 100 reported that there was more than one animal. Deer herds were involved in accidents in 4 cases, and a pair of moose in one case.

The next two figures (2 and 3) show the number of collisions broken down by months and hours of the day. One can clearly see an increase in incidents in late fall and early winter – more than a half of all accidents happened in the quarter from October to December. It probably has to do with the period of oestrus among forest animals, when the reproductive instinct takes precedence over self-preservation instinct. In the daily dynamics the risk of animal-train collisions increases in the morning (4-8 am, 35% of all collisions) and evening (4-11 pm, almost 50% of collisions), when the animals are most active, especially moving from rest areas to foraging grounds and back [2,6]. One has to remember that in these times (5-8 am and 4-7 pm) are also passenger traffic rush hours. These two independent factors overlap adding to the final result.

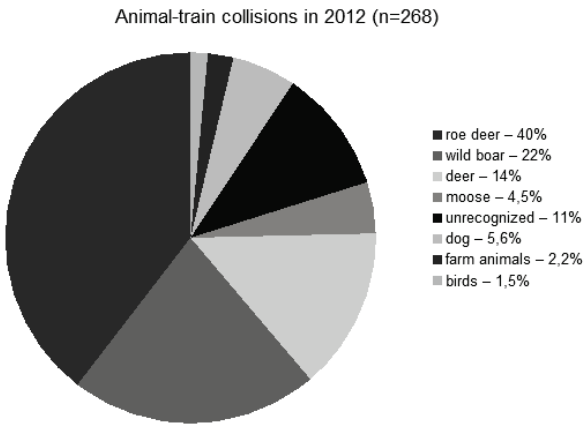

Fig. 1. Percentage of different species of animals in collision with trains in 2012

The places of collision were also analysed on the base of data received (figure 4). The railway lines (marked in black) where passengers were transported by the Regional Transport Service Company the incidents were marked in the form of red circles. It is worth emphasising the fact that the Mazovian Province was hardly taken into account in this analysis, since the Regional Transport Service Company do not conduct business activity

there. The trains which were involved in these incidents in this Province belonged to the company servicing inter-provincial sections (InterRegio).

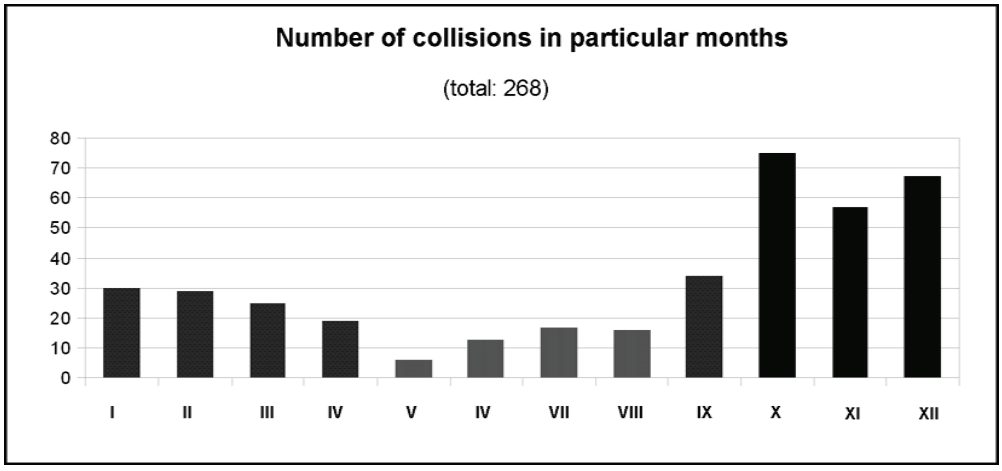

Fig. 2. The number of collisions with animals broken down by individual months of 2012

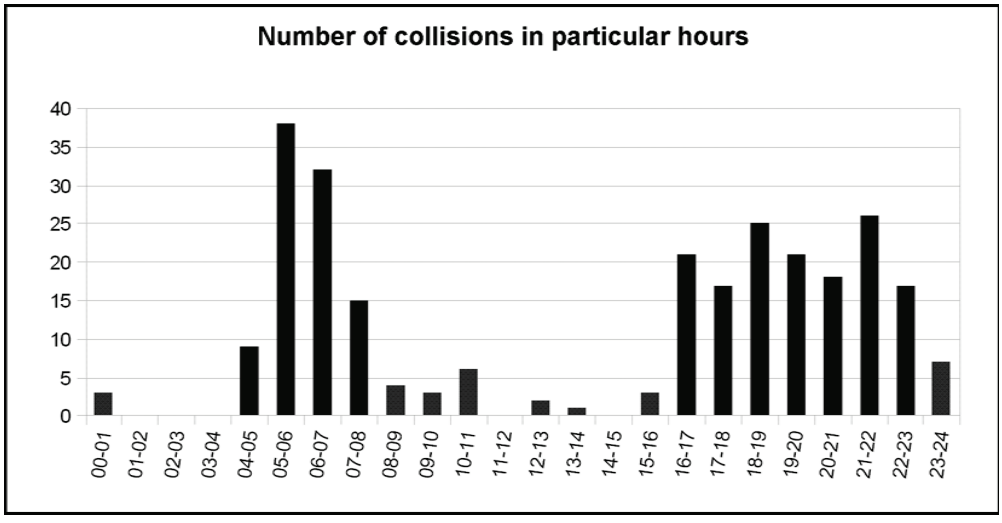

Fig. 3. The number of collisions with animals broken down by hour of the day (data from 2012)

We can see three larger clusters of incidents when looking at the map of Poland with marked places of collisions with animals: Northwest area – from the border Lower Silesia through Lubuskie, Pomerania to Masuria: the area of Lower and Upper Silesia; South-East area – from Rzeszów to Lublin.

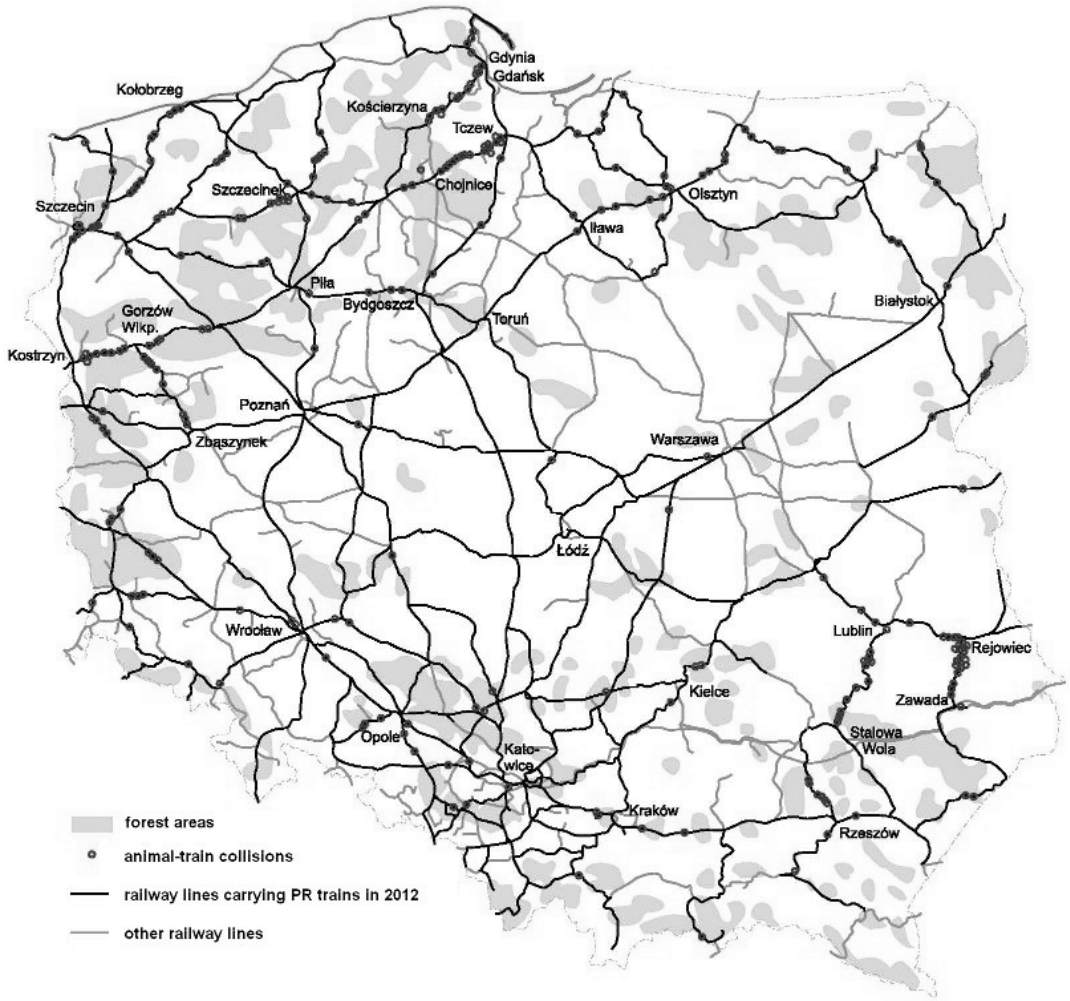

Fig. 4. Location of the places of animal-train collisions on the map of railway lines detailing the forest areas in 2012.

The collisions in the Northwest area can be correlated with statistically the biggest afforestation (dominated by forest areas and wetland) and the smallest population density of the area but with relatively dense railway network at the same time. Collisions occurring in Silesia are most likely the result of the biggest traffic density on an extensive rail network and occur in the protective forest belts around the industrial areas of Upper Silesia and Opole Province. Most of the reported collisions in this region took place outside the larger forest areas, in field-forest mosaic areas – in such areas animals can find safe hiding places close to attractive feeding grounds, which are often fields.

4. EFFECTS OF THE COLLISIONS

It would seem that a small roe deer does not pose a threat to the locomotive, however, this is not true. Impact force depends on the speed of a train – the higher it is the more likely is the damage and the more severe it will be. Most of the accidents are avoidable at the speed of 30-40km/h – the animals have then enough time to notice the train and react, i.e. to leave the track [8] and drivers can take time to notice the threat and slow down or even to bring the train to a halt. However, at the speed of 100 km/h the stopping braking of the train exceeds 800m. Then, the driver does not have enough time to effectively respond to the forthcoming threat, i.e. the collision with an animal crossing the track whereas applying emergency braking creates a specific threat to the train passengers or cargo [4,5]. Train speeds will be increased to 160km/h once the planned modernisation and construction of new railway lines have been completed which in turn will further increase the risk. Figure 5 shows effects of a collision with a large animal.

Light rail vehicles and modern locomotives are more vulnerable to damage due to their lightweight

design. These vehicles may, as a result of a collision with an animal, be subject to very serious damage, the repair or overhaul of which can exceed the cost of purchasing a new unit. This is because in currently manufactured locomotives the end walls are commonly built with composite materials behind which some units and components necessary for locomotive operation are often placed which makes the locomotive very sensitive to mechanical shocks. Apart from the locomotive repair costs there are also financial losses related to stoppage of locomotive running. Besides stopping railway traffic resulting from an accident shall mean some complications in meeting the timetable, and the resulting thereof financial loss for the operator and line managers.

In extreme cases, even derailment of the train may occur when it runs over the heard of animals. Sometimes there are favourable conditions for such accidents – first of all winter movement of large mammals along the tracks cleared of snow. When the train is approaching, the animals will rather run on the tracks than to the side and into a thick snow layer which ends up in animal being run over by the train. This route is mostly used by species especially undesirable on the tracks from the point of view of traffic safety: moose and wild boar [2,3,8].

Fig. 5. The bottom of a driver's cabin floor after a collision with a big animal; a damaged Hasting's joint (photo: K. Wiśniewska)

Generally, the damage to the rolling stock was found in just over half of the registered incidents. Most of the damage occurred as a result of running over the red deer (77% collisions ended up with damage) and moose (75%) followed by wild boar (60%) and roe deer (47%). In the case of large farm animals, running over a cow or herd of sheep resulted in locomotive damage, and no damage was found when running over horses in two cases (no data were given for the third collision with a horse and donkey). As expected, running over a group of animals in most cases ends up having to make a repair unlike a collision with a single animal – the damage was found in 75% of collisions with a herd of big animals, and only in 47% of collisions with a single big animal.

In the case of collisions with dogs the damage occurred in 60% (9 of 15) described cases, and four recorded collisions with birds ended with damage. This does not mean, however, that these animals constitute such a high threat, but incidents involving small animals are rarely recorded. It is difficult to estimate what is the magnitude of death cases of small animals from collisions with trains as part of such incidents may not even be noticed by drivers.

What kind of damage occurs most often? The damage to the air ducts occurred in nearly half of all cases, and in more than one quarter there was damage to the plough. In addition, the following was recorded among others: plough crack, buffer beam damage, cooling and heat pipes damage, traction engine damage. The smash of a quickly moving train with 40-50 kg roe deer may result in damage to the brake cock and consequently forced end of journey. Collisions with birds usually ended in breaking the headlight and in case the damage to a mirror and side window. In nearly 60% of the cases a delay of the train occurred as a result of collision – figure 6 shows the time of delay of the train after it had hit an animal. In situations where there was a delay, in 37% of the cases the train began to move within 5 minutes, in 32% in 6-15 minutes, and the delays above one hour accounted for 10% of cases, including five lasting 2-3 hours. The maximum delay time recorded was 178 minutes. After running over a moose the locomotive was damaged and it was necessary to use another locomotive.

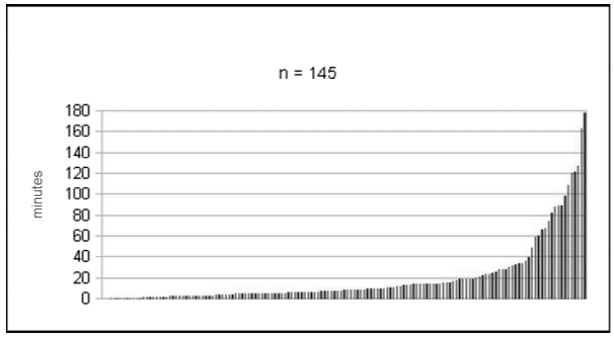

Fig. 6. The time of delay of a train (one bar represents one event in which there was a delay of a train).

In 32 cases secondary delays were recorded (they occur when more trains are delayed due to one event). Figure 7 shows the total time of delay, and figure 8 the number of delayed trains. It was necessary to cancel the trains in three cases (two times one and once two). The total delay in two cases came to approximately six hours. The train ran over two horses in the first case and one of which got killed instantly and the second one had to be put down by a veterinary surgeon called in to the accident site. The railway tracks were reopened after the dead bodies of horses had been removed, the total number of five trains were delayed. The second case of such a long delay as the aforementioned one was an accident where a moose was involved, two trains were delayed.

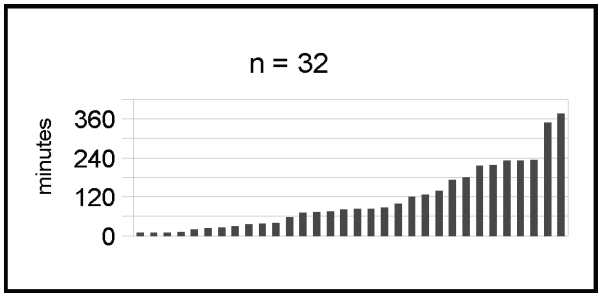

Fig. 7. Total time of delay (one bar represents one event in which there was a secondary delay).

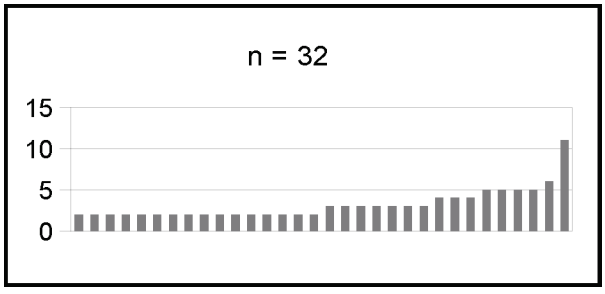

Fig. 8. Number of delayed trains (one bar represents one event in which there was a delay of more than one train)

The data received from one railway operator covering one year do not naturally present the whole spectrum of possible consequences of collisions. The likelihood of a railway disaster occurrence resulting from running over animals is very slim, and such accidents happen very rarely throughout the country. However, one should not forget about such a threat.

In 2001 in Poland, in the vicinity of Rzepin a trail derailed after it had collided with a herd of wild boars migrating on the tracks, luckily there were no fatalities. In 2008 in Germany, InterCityExpress train ran into a flock of sheep being on the track. It happened at the inlet to the 10-km tunnel. Several cars derailed and continued their journey for 3km chafing against the tunnel walls – only this prevented possible fatalities. In February 2012 at the Krasnoyarsk Railway owned by the Russian Railways, a freight train collided with a herd of big animals which resulted in its derailment and a number of tanks carrying hazardous substances caught fire. The aforementioned examples show how dangerous the accidents caused by the collision with animals can be [5].

5. SUMMARY AND CONCLUSIONS

Collisions with animals are a widespread phenomenon with tangible consequences for railway operators which reflect the costs of rolling stock repairs and sometimes train delays. It is hard to estimate the magnitude of the phenomenon because some operators fail to keep appropriate documentation. However, if we are to seriously approach the care of the highest level of railway traffic safety, then the presented phenomenon should be treated in the same way as any other kind of hazard where proper preventive measures should be applied.

The information received from the rail operators shows that the issue is far more serious in the case of passenger transport which is due to greater speed of trains and the design of locomotives. The size of the damage also depends on the species of animals involved in an accident, tendency of animals to migrate in herds is also of significant importance. Roe deer get run over by trains more than any other animals, luckily due to their small size such collision hardly ever results in train damage. The most dangerous for the safety of railway traffic are red deer, moose, and wild boar herds. Occasionally, collisions with large farm animals, dogs and birds occur as well – even the latter ones may cause minor damage to a locomotive.

Collision prevention should be of interest for not only the animal lovers but also the managers and users of railway lines – all the more so because the collisions with animals may lead to much more serious consequences than just locomotive damage or delay of a few trains.

When analysing a map of Poland and the accident sites a conclusion can be drawn that if the collisions were meticulously recorded by all operators (and this process is neither costly nor tedious) then after one year we would have the possibility to carry out an analysis of a much more

detailed material which would make it possible to precisely and surely indicate the sites on the rail network which should be subject of special attention and where you should apply suitable equipment or systems for the protection of animals (e.g. animal overpassages or acoustic animal protection devices UOZ-1). They would be most efficiently used there reducing the rich of damage to the rolling stock and protecting, at the same time, the highest possible number of animals from death after being run over by train.

At the end we would like to sincerely thank Przewozy Regionalne Sp. z o.o. (Regional Transport Service Company) and other railway operators for providing the material for analysis.

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