ADDRESSING TRESPASSES AND RAIL SUICIDES IN PORTUGAL: AN INTEGRATED APPROACH

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Summary

Trespasses and level crossing accidents have been the most significant causes of fatalities in railway accidents in Portugal, accounting for more than 97% in 2016-2021. Given the seriousness of this problem, and since accident prevention is a core function of the railway system, IMT, the Portuguese national rail safety authority, has developed a methodology to address pedestrian-train occurrences. This approach analyses the current situation in terms of prevalent accidents and distribution of hotspots and critical zones within the network, and provides a set of mitigation measures to be applied on site, whose effectiveness will be assessed and monitored in the next stages of this project.

1. BACKGROUND

Instituto da Mobilidade e dos Transportes (IMT), among several other roles, is the Portuguese National Railway Safety Authority. Its duties include supervising the activity of the infrastructure manager and the railway undertakings on the Portuguese rail network, aiming to improve the safety level of the daily operation, according to the European framework established for rail safety. Monitoring the occurrences that relate to the registered accidents and incidents is a very important part of this role.

In this context, accidents and incidents involving pedestrians and rolling stock in motion have been a major concern for IMT. In fact, considering the data from the Common Safety Indicators, Portugal is the third-worst case in the European Union (EU) in number of fatalities per million km, in 2018-2020 (Figure 1), rating highly above the EU 27 member-states average value.

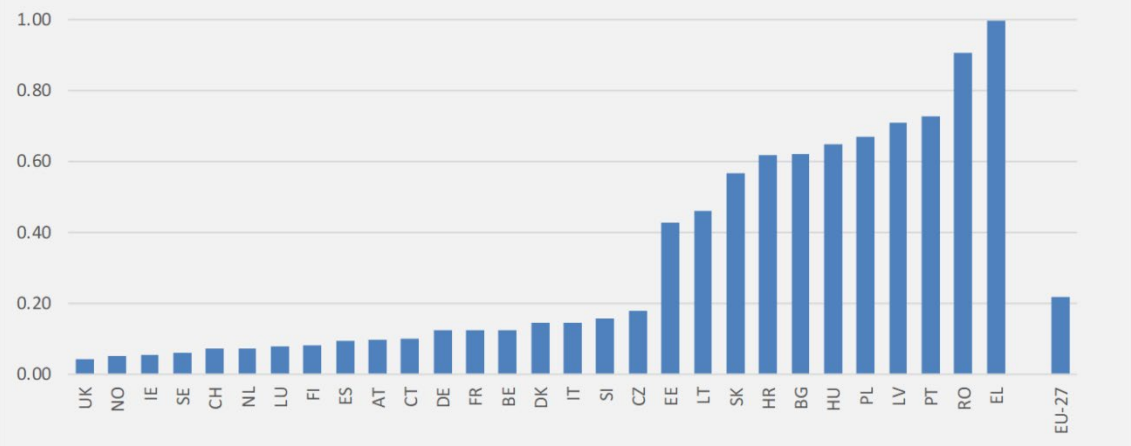

Figure 1 - Fatalities with accidents and incidents involving pedestrians and rolling stock in motion per million km in the EU, 2018-2020 [1]

Most of these accidents occur at the interfaces of the railway system with other modes of transport. In 2016-2020, 97% of fatalities occurred at these interfaces, with 67% corresponding to accidents to persons caused by rolling stock in motion and 30% to occurrences in level crossings (including accidents involving pedestrians) (Figure 2).

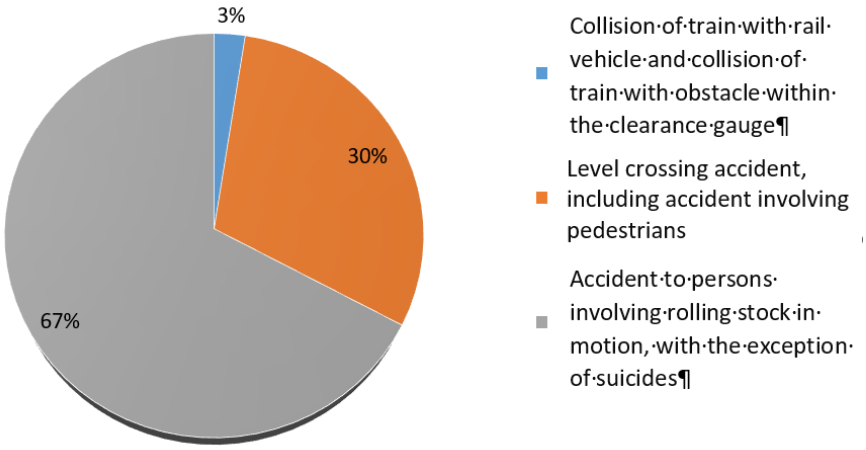

Figure 2 – Distribution of fatalities per accidents category in Portugal 2016-2020 [IMT data]

These numbers represent accidents and, thus, do not include suicides on the railway. But suicides are also a major problem faced by the railway system, since their numbers are higher than those of accidents with pedestrians (see Section 4).

With this in mind, the main purpose of this work was to develop a methodological approach to address pedestrian-train incidents in the Portuguese railway network. During the first stage, the current situation was analysed, the prevalent type of occurrences established and the hotspots and critical zones within the network identified. At the following stages, mitigation measures will be selected for each identified situation, and implemented. The effectiveness of these measures will then be assessed and if needed previous steps revisited.

2. METHODOLOGICAL APPROACH

Over the last decades, incidents with pedestrians in rail context has been the subject of several studies. Generally, these studies combine a systematic analysis of these occurrences, in all their typologies, with the implementation and subsequent evaluation of mitigating solutions. The purpose of such approach is to achieve an integrated analysis of this problematic, in all dimensions involved – from a strictly technical perspective to its sociologic and culture dimensions.

The methodology followed by this kind of approaches often involves the definition of a plan comprehending successive phases, encompassing a cycle of several stages and ensuing actions, from the identification of the problem to the evaluation of the implemented mitigation measures.

The study developed for the RESTRAIL[1] project (*REduction of Suicides and Trespasses on RAILway property*) is a significant example of this type of approach. This collaborative initiative was the outcome of an interdisciplinary consortium of 17 actors from 12 countries, including research centres, universities, rail infrastructure managers, railway undertakings, among others [2]. The main objective of the project was to contribute to the reduction of fatalities related to trespasses and suicides in the rail context, as well as to decrease the disruptions caused by occurrences of this type. Therefore, the rail sector was delivered a cost-benefit analysis methodology for mitigation and prevention measures [2;3]. Its outcome included a set of 25 measures, 11 application cases (involving the implementation of several of these measures) and an online toolbox, aiming to assist decision-making [3].

RESTRAIL's methodology comprehends a cycle of 6 stages: 1) Describing and understanding the problem, by identifying the problem and all involved actors and resources; 2) Analysing the target-situation, by defining and locating the problem and the involved behaviour, identifying the already implemented measures and establishing the goals for new measures; 3) Selecting the mitigation measures, based on the identified target-problem; 4) Setting the implementation plan, in which the specific measures are selected and the costs presented; 5) Implementing the plan; and 6) Evaluating the results of the mitigation measures, especially their short-term and long-term effectiveness [4].

The methodology adopted by this study was based on the RESTAIL approach but adapted to the Portuguese context, to meet the available tools and resources and, thus, enable its full practical application. A cycle was defined comprising the following 3 stages:

1) Identifying and characterizing the problem:

   It was carried out through the analysis of all occurrences in the previous years, considering their typology, location, key actors, operational situation and infrastructure characteristics. These occurrences were disaggregated and classified, according to their type and location. Critical zones and hotspots were then identified based on accident incidence.

2) Exploring mitigation measures with the rail sector:

   Considering the prevalent type of occurrences in each critical zone or hotspot and the target-situation, a set of mitigation measures is defined to be implemented.

[1] www.restrail.eu

3) Assessing and monitoring mitigation measures effectiveness:

   After implementing the selected measures, their effects are evaluated and monitored for a period. This assessment may lead to the repetition of the process from one of the previous stages, according to the new identified situation.

The first stage is completed. The next chapters will present the work developed in this stage. The following stages will be addressed, as a prospective, on Section 5.

3. SIGNIFICANT ACCIDENTS WITH PEDESTRIANS IN RAIL CONTEXT

As part of the first stage of the methodology, and to better understand the problematic of train-pedestrian significant accidents, a detailed analysis of the 2016-2021 registered occurrences was carried out. A total number of 154 occurrences was considered in this analysis. Despite being train-pedestrian events, suicides in rail context were addressed on a separate analysis (see Section 4), which followed a similar outline.

This process involved the disaggregation and classification of these occurrences according to criteria related to type of occurrence, location, actors, operational situation and infrastructure characteristics. This process was based not only on the information provided by the infrastructure manager and the railway undertakings to IMT (which is a statutory requirement), but also on data collected through platforms such as Google Earth. The result of this process is a tree diagram (Figure 3).

The occurrences were disaggregated according to location, expressed in 3 main categories: station, open track, and level crossing. Most occurrences (circa 40%) happened in open track, although the number of cases related to stations is similar (also around 40%, but slightly lower in absolute number). The number of level crossing occurrences (around 20%) is much lower. From this initial level, the tree diagram was then extended in three main “branches”, each corresponding to one of those categories.

In the next level, different criteria were used for each of these “branches”:

- Stations: location and operational situation involved.
- Open track: type of trespassing and maintenance status of fencing (if one is present).
- Level crossing: type of level crossing.

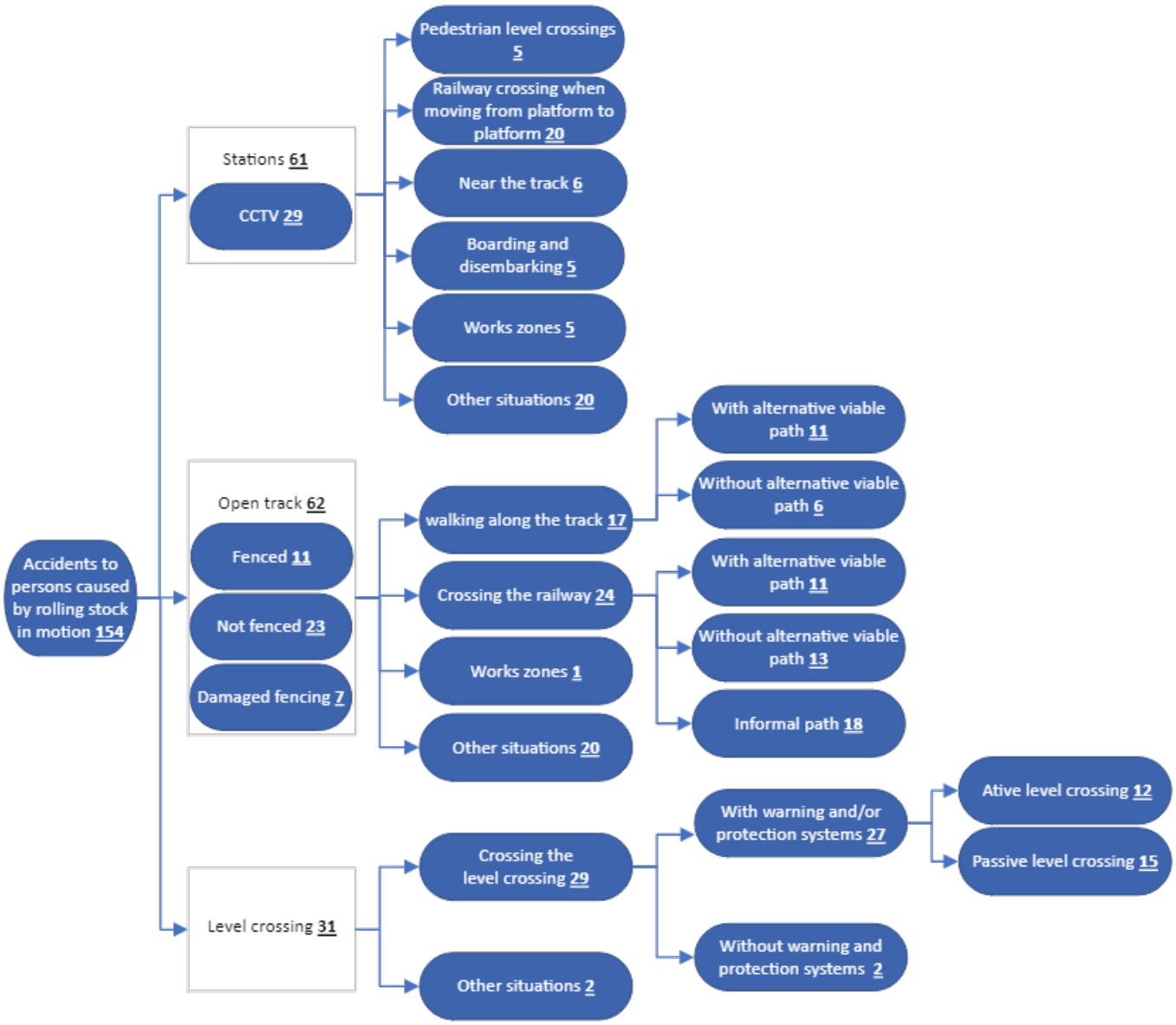

Figure 3 - Tree diagram with accidents to persons caused by rolling stock in motion in Portugal (2016 – 2021)

In the case of occurrences at stations, most cases (nearly 33%) involved pedestrians crossing the railway when moving from platform to platform. In all these cases, the railway was a double or multiple-track line. Other relevant situations (even though with a much lower incidence) concerned pedestrians near the track, pedestrians in level crossings (formal level crossings at stations), situations related to boarding and disembarking, and cases in work zones (each one with nearly 10% of total cases).

Nearly half of these stations had a CCTV system. This parameter was considered to understand its impact on pedestrian behaviour – visible CCTV equipment might have a deterrent effect on risk behaviour. However, since CCTV systems were identified in just nearly half of the cases, its effect is not particularly evident.

On open track, most cases (circa 37%) occurred in locations where the track was not fenced. Nevertheless, a significant number of occurrences happened in fenced track (around 29%). In nearly 40% of these cases, fencing was damaged.

On the other hand, most occurrences on open track (circa 39%) involved persons crossing the railway. It is worth noting that there was an informal path nearby the railway in around 75% of these locations, even when a formal alternative (a protected pedestrian path) was available. The second-most common situations on open track involved pedestrians walking along the track (around 27%). Similarly, in most of these locations (nearly 65% of them) there was an alternative viable path nearby the railway, which could have been used instead of the track. It is considered an alternative viable path if its length is up to 500m.

This is a remarkable finding, which has been monitored by the national safety authority. In fact, these cases frequently indicate that, given the disruptive effect of the railway on the territory, there is a lack of accessible, comfortable, convenient, and safe alternatives for pedestrians to avoid using the track itself. Moreover, it can also be an indicator of low effectiveness of the already implemented deterrent measures (very often, fencing).

Finally, on level crossings, most cases occurred on facilities with warning and/or protection systems (around 87%). Most of these occurrences (more than 55%) involved passive level crossings, closely followed by active level crossings (circa 44%). This was an expected outcome since these are common in urban areas with more pedestrian traffic.

This analysis was followed by the identification of critical zones and hotspots along the Portuguese railway network. As expected, most occurrences take place on densely populated areas, with especial regard to the metropolitan areas of Lisbon and Porto (Figure 4). For each one of these zones, the prevalent type of occurrence was identified.

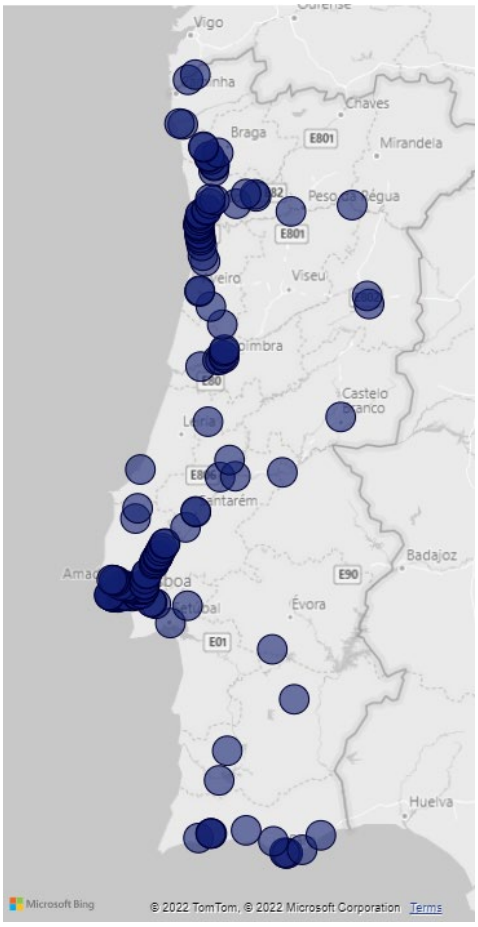

Figure 4 – Geographic distribution of accidents to persons caused by rolling stock in motion in Portugal (2016 – 2021)

4. THE RAIL SUICIDES PROBLEMATIC

A similar outline was followed for occurrences involving rail suicides (235 cases in 2016-2021). These occurrences were disaggregated and classified according to location, considering 3 main categories: station, open track, and level crossing. Most suicides took place on open track (around 52%), followed by suicides at stations (circa 36%). Only around 12% of rail suicides occurred on level crossings (Figure 5).

Within each of these categories, classification was carried out considering the following criteria:

- Stations: location and situation involved.
- Open track: location, visibility conditions and maintenance status of fencing, in case there is fencing in place.
- Level crossing: existence of street lighting.

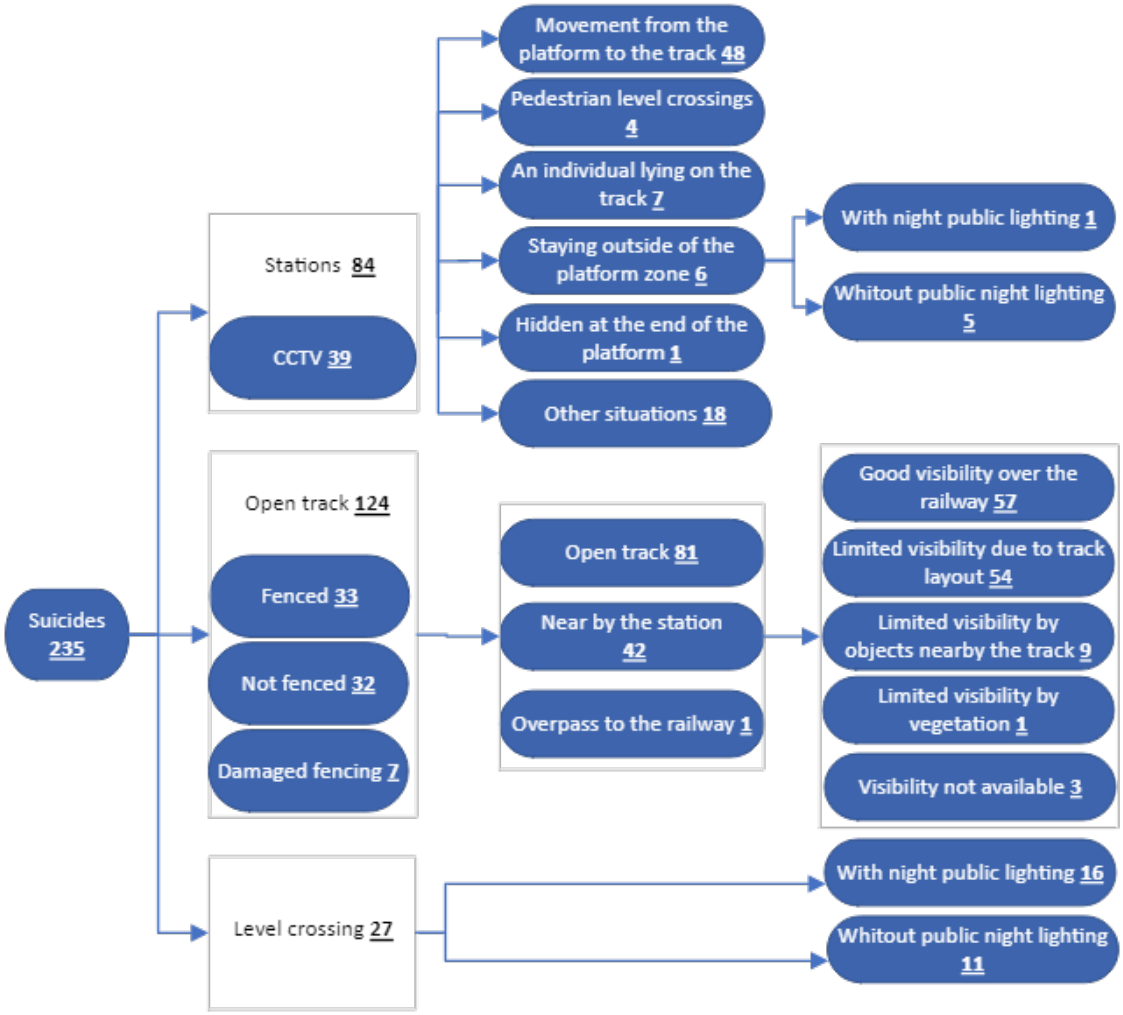

Figure 5 - Tree diagram on suicides in Portugal (2016 – 2021)

Most suicides at stations (around 56%), involved a movement from the platform to the track. Other significant situations had an individual lying on the track and staying outside of the platform zone, in places with limited night-time lighting conditions (both around 8%). In more than 45% of these cases, stations had a CCTV system.

On open track, most cases (circa 65%) occurred at locations far from stations, while around 34% happened nearby these interfaces. To set these influence areas around stations, a maximum distance of 500 metres was considered. Moreover, most of open track suicides (around 52%) occurred in places with limited visibility, whether due to track layout (nearly all situations), objects nearby the track or vegetation.

Most suicides on open track (around 33%) occurred on fenced sections of the railway, while around 26% of cases happened in places without fencing. It is worth mentioning that fencing was damaged in approximately 18% of the cases that took place on fenced sections of the railway.

On level crossings, most suicides (around 59%) happened in locations with street lighting, which indicates that this feature is not particularly relevant for these events.

An additional classification was carried out for rail suicides, regarding the season (Figure 6), weekday (Figure 7) and period of the day when the occurrence happened (Figure 8). This analysis provided interesting and unexpected results. In fact, most rail suicides occurred in March/April, which correspond to Spring. The second-most prevalent months were July/August (Summer) and September/October (Autumn). Only then these categories are followed by Christmas season (second half of December and the first half of January), which is commonly associated with a higher prevalence of suicides, in general. This unanticipated outcome is going to be further explored. In fact, it expresses the underlying complexity involved in this phenomenon and why its mitigation requires a multidisciplinary approach. Besides, the national railway authority has already started working with the support of health authorities and organisations to address this problem.

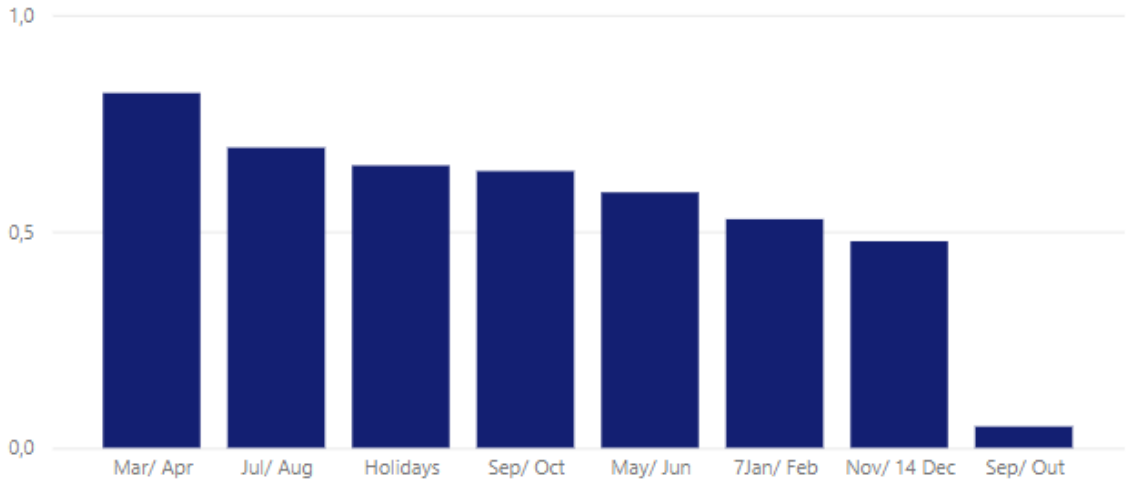

Figure 6 - Weighted annual distribution of suicide occurrences in Portugal (2016 – 2021)

Figure 7 - Weighted weekly distribution of suicide occurrences in Portugal (2016 – 2021)

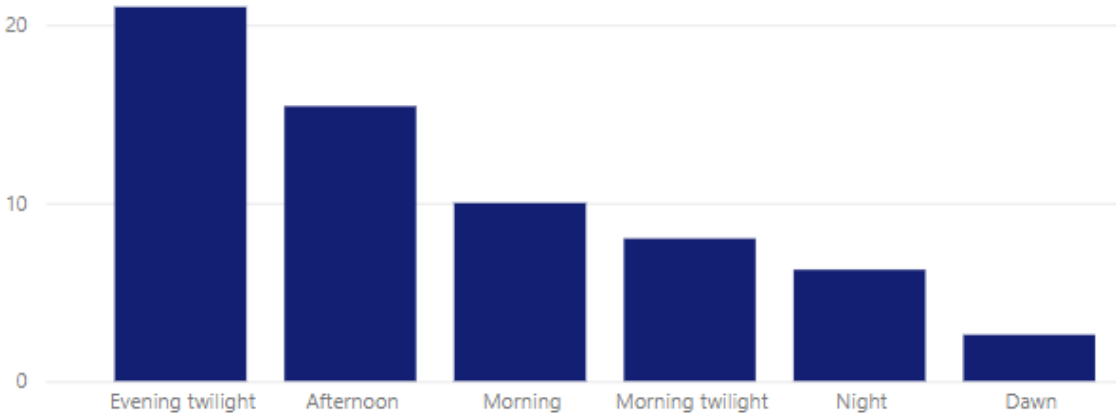

Figure 8 - Weighted daily distribution of suicide occurrences in Portugal (2016 – 2021)

Furthermore, it was possible to conclude that most suicides happened on working days, while most of these occurrences happened during the evening twilight or in the afternoon. Peak hour periods did not seem particularly relevant (Figure 9).

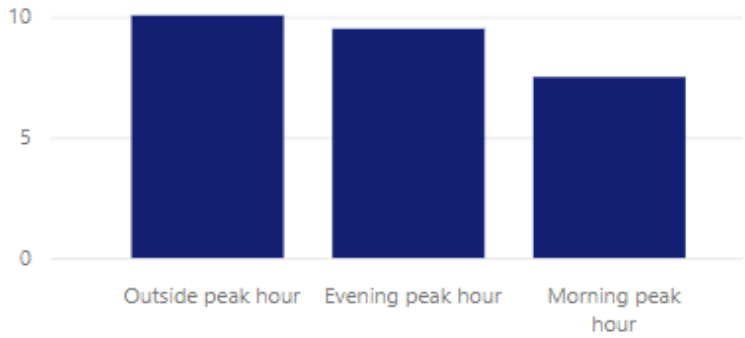

Figure 9 - Weighted peak hour distribution of suicide occurrences in Portugal (2016 – 2021)

This analysis was also followed by the identification of critical zones and hotspots along the Portuguese railway network. Most suicides are also associated with the most densely populated regions of the country, with especial regard to the metropolitan areas of Lisbon and Porto, as well as Minho and the Algarve. For each one of these zones, the prevalent type of rail suicide was identified. (Figure 10)

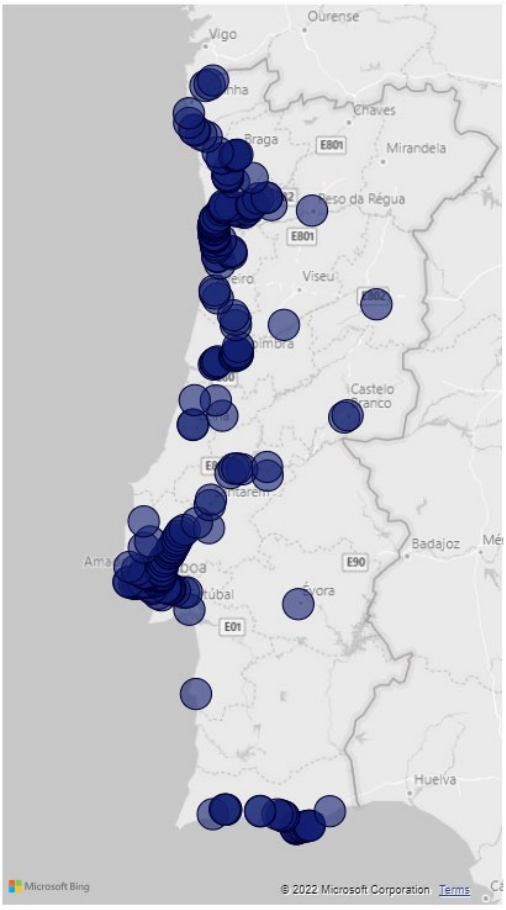

Figure 10 – Geographic distribution of suicides in Portugal (2016 – 2021)

5. WHAT'S NEXT: MITIGATION MEASURES

For each type of prevailing occurrence, mitigation measures will be defined and implemented in the RFN, both for the general case network and for each critical area. The international experience already provides several examples of measures with proven effectiveness, some of which have already been fully or partially implemented in the RFN and many others that could be considered. It is therefore important, at this stage, to list the most relevant measures to be considered in the next stage of the application of this methodology.

Fencing off the railway channel is one of the most widely used measures to prevent trespassing. On open track, several types of fencing have been implemented, from the most common: enclosing the limits of the railway channel to isolate it from the surrounding areas, to the specific placement of fencing at critical points or near objects

adjacent to the railway [5,6,7]. The fence installed at these locations may be complemented by devices that can soil the intruder's clothing as they trespass [4].

At stations, fencing is one of the most frequently measures used. The fence can create separation between lines, to prevent crossings of the track [6], or it can be applied at the centre of the platforms [4,6]. Applying a fence at the ends of the platforms prevents pedestrian access to the restricted areas of the dependencies and to the railway channel [6]. Finally, there is also the use of sliding doors and anti-intrusion grilles [4,5,6,7].

Another type of common enforcement measures is the installation of lighting systems. Lighting critical areas may contribute to increase safety in these areas, by highlighting the dangers to which a potential intruder is subject to, or to indicate that the illuminated area is under surveillance [6,7]. On the other hand, lighting can also be an important instrument for deterring trespassing, through, for example, the adoption of repellent lighting systems or connected to motion sensors (in some cases, with tracking lights) [4].

Signage is one of the most used instruments to prevent trespassing. The range of signage to be applied is prescribed in specific national regulations, varying from network to network. Prohibition and danger signs are normally used, marking the limits of the permitted pedestrian circulation area, often associated with information or warning signs [5,6,7].

Other physical or technological measures include the use of CCTV cameras, which can be associated with intelligent systems, with an audible warning [4,6,7]. Likewise, an audible warning may also be associated with an intruder detection system [5,7]. Finally, physical changes may be introduced in the areas adjacent to the railway channel, to make it more difficult for pedestrians to trespass or to increase visibility (by removing vegetation, for example) [6,7].

Another type of mitigation measures that are very relevant are educational and public awareness actions, with special emphasis on the public of school age [6]. Media or advertising campaigns for information and public awareness can be developed, making use of public space or the various media [4,6,7]. On the other hand, the media should be mindful of the way news involving occurrences on the railway network are presented [5] as it may influence behaviour in the general public. These campaigns may also target the general public or a specific community [7].

Training staff from the railway sector is also an important measure to mitigate the occurrence of accidents to persons caused by rolling stock in motion in the railway network [4,6,7]. Finally, and with a proven deterrent effect, there are surveillance, patrolling and policing actions by the security forces [4,5,6,7]. The presence of agents of these forces or of the railway companies on the platforms of the stations is an important instrument to influence the behaviour in passers-by.

6. CONCLUSION

The methodology applied in this work aims at analysing the current situation in the Portuguese Railway Network with accidents and incidents involving pedestrians and rolling stock in motion. This analysis focused on the prevalent accidents and distribution of hotspots and critical zones within the network and intends to provide a set of mitigation measures to be applied on site, which effectiveness will be assessed and monitored in the next stages of this project.

The first phase of this method completed. Comprehensive and detailed analyses were carried out for both trespasses and suicides, involving a total number of 154 trespasses and 235 rail suicides in 2016-2021. These occurrences were thoroughly segregated and classified according to their location, typology, operational situation, person(s) involved and infrastructure characteristics. This classification was carried out in successive levels, from general location to more specific and detailed aspects, and the outcome is a tree diagram. In the case of suicides, these occurrences were further categorized by season, weekday, and period of the day. The location of the hotspots and critical zones was then identified and prioritised for future intervention.

The main findings of this first stage are the following:

• On open track most trespasses occurred in areas where appropriate accessibility is not provided by the local network. In most cases an informal path can be found nearby the railway.

• A significant number of suicides occurred far from stations and other interfaces. On the other hand, most trespasses at stations involved pedestrians crossing the railway between platforms, while most suicides were the result of movements from the platform to the track.

• Unexpected results were obtained when suicides were classified according to season, with Spring months as the most relevant period of the year, which demonstrates the underlying complexity of this phenomenon and why its mitigation requires a multidisciplinary approach, which is ongoing with the support of health authorities and organisations.

• Level crossings were the least relevant location both for trespasses and suicides.

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