Human behavior in the vicinity of railway facilities and operations

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ABSTRACT

The work presented in this dissertation, was realized with the support of Infraestruturas of Portugal, with the objective of studying the context of railroad crossings, what are the basic foundations of railway operations, relating them to human behavior in the vicinity of the railway, and the implication in the dimensioning of interventions, as well as analyzing how the accessibility promoted and the phenomenon of Trespassing affect the management of railway operations.

In order to achieve this objective, a European-wide questionnaire was carried out, the methodology process for assessing the explanatory variables related to the phenomenon of “Trespassing”, was structured based on two different approaches. The first is related to the potential factors that contribute to the probability of “Trespassing”, the other is inherent to the probability of an accident due to “Trespassing”. In this approach, the research was focused on the indicators that could best be evaluated for their importance and later associated with the events that could occur, in this sense it was decided to use a Likert scale.

The Accessibility and Trespassing Indexes establish the conjugation of the totality of crossings along the length of the railroad, serving as support for the case study, first allowing to gauge the number of accesses per kilometer of rail, and later related to the average distances to be traversed by the populations close to the railway, to cross the railroad, second to obtain knowledge of the statistical significance of spatial correlation in the types of contiguous accesses within the neighbouring municipalities and parishes.

Keywords

Railway infrastructures, Urban Pressure, Trespassing, Human Behaviour

1 INTRODUCTION

In order to better understand the implications of trespassing on the railroad, together with the opportunity to study a real problem, and apply knowledge acquired during the master’s course in Transportation, the Infraestruturas of Portugal proposed the following work. The said company provided data on accidents and numerical crossing locations, which are compared with the results obtained in experimental work.

1.1 PROBLEM

Accidents with people due to the crossing of the railway, has unfortunately been one of the greatest scourges in the history of the railway, with a special focus on developed countries. The occurrence of this phenomenon in Portugal does not escape this rule and the number has been higher than the numbers presented by other countries.

The need to eliminate railway level crossings, considered as conflict points in the railway safety, cannot only be seen as a change between a level crossing by an overpass or underpass in its vicinity, since there is an obligation to optimize resources, involving all stakeholders, highlighting the importance of the causes and motivations of "trespassing" in the public railway domain.

The barrier effect of the railway has implications in terms of social exclusion, by impeding or creating difficulties in pedestrian accessibility, crucial to people activities, especially those with limited mobility, which contrasts with the expected growth and development of municipalities, the mutations of their communities, which are related to aspects of tremendous pressure and new challenges to the railway infrastructure and operations safety management.

1.2 RELATED WORK

In Trespassing analysis, one can find several books and papers which can be useful to understand the problem in hands. Some authors describe the theoretical problem [1, 3, 5, 6, 9, 10, 13] while others explain the theory and the testing in the same work [2, 4, 7, 8, 11, 12, 14, 15, 16, 17]. The researched studies cover the following themes: Statistical Analysis of Accidents - Where, How and When [1, 2, 6, 7, 8]; Correlation of train frequency and accidents [14, 15]; Prevention of Trespassing on the railroad - mitigation measures [11]; Risk analysis risk prioritization [8] ; Characteristics of offenders - risk behaviors [2, 6, 7, 9]; Land uses [16].

1.3 PROPOSAL

Throughout this dissertation, we intend to explain, in the context of railroad crossings, what are the basic foundations of railway operations, relating them to human behavior in the vicinity of the railway, and the implication in the dimensioning of interventions, as well as analyzing how the accessibility promoted, and the intrusion phenomenon affect the management of railway operations.

The study of this issue is pertinent insofar as it reflects current trends whose observation, understanding and intervention can be translated into an important tool to ensure a continuous improvement in the management of infrastructure and the mobility of people in the vicinity of the railroad.

In scientific terms, the dissertation constitutes a contribution to the deepening of knowledge in the area of railway crossings, presenting a strong interdisciplinary character as it establishes a link between interventions and human behavior. On the other hand, with this study, organizations have access to an investigation that, having tried to be impartial and scientifically valid, can be used to clarify any doubts about its consequences.

2 APPROACH

2.1 QUESTIONNAIRE

The aim of the method chosen was to gather the opinion of people with extensive experience in the railway sector, with a relevant knowledge of the Trespassing problem, thus the decisions taken, and the means used, allowed to collect a significant sample in achieving the results presented below. In this perspective, the following steps were defined:

- Questionnaire structure
- Questionnaire disclosure
- Data collection
- Statistical data treatment and limitations that this method presents

The first part of the questionnaire, regarding the probability of occurring “Trespassing”, consists of four main indicators:

- Fencing typology
- Security
- Rail crossing management
- Urban pressure

The second part of the questionnaire, regarding the probability of an accident occurring due to “Trespassing”, consists of six main indicators:

- Number of Tracks
- Train Speed
- Train Frequency
- Time Exposed - Inside of tracks
- Number of people with three types of human behavior
- Kind of person

The questionnaire was sent by e-mail to employees working in areas such as Railway Safety, Railway Network Management, Circulation Management, among others, which they themselves disseminated through their relationship networks, generating a “Snowball” effect”, Between the period of 15th of November 2019 and 10th of January 2020. One hundred and twelve (112) e-mails were received, of which one hundred and six (106) responded to the complete questionnaire, corresponding to 94%, thus constituting a convenience sample enabling the use of the data collected in the preparation of this work.

Notes related to the Excel questionnaire: The e-mails sent where identical with the same content with two (2) documents attached: (i) “Presentation of the Thesis” (.pdf) and (ii) “Trespassing Questionnaire” (Excel). Regarding the questionnaire it was prepared in three (3) excel spreadsheets, namely: Spreadsheets 1 - “example – How to fill”; Spreadsheets 2 - “the probability of occurring “Trespassing”; Spreadsheets 3 - “the probability of an accident occurring due to “Trespassing”.

The questionnaire data confidentiality was assured, being transmitted to all the interviewees that they would receive the final results at the end of the survey and that each individual response where never disclosed.

2.2 THEORETICAL APPROACH – QUESTIONNAIRE

In this approach, the research was focused on the indicators that could best be evaluated for their importance and later associated with the events that could occur, in this sense it was decided to use a Likert scale with five levels, the indicators vary from 1 (Irrelevant); 2 (Not very important); 3 (Important); 4 (Very important) to 5 (Essential) and in the probability events also with the same levels they vary from 1 (Never); 2 (unlikely); 3 (Possible); 4 (Likely) up to 5 (Very Likely) always accompanied by

an illustrative image allowing adding (other types) by the most relevant specialist, the questionnaire allows comments to be made point by point (figure 1), strengthening the previous option.

After filling in [X] in the respective fields, the interviewees are requested to weight the indicators through the decreasing order of the indicators (figure 2), and the values 4 = "The most relevant" are attributed to the case of "Trespassing" ; 3; 2 and 1 = "The least relevant" and in the case of an accident by "Trespassing" the values 6 = "The most relevant"; 5; 4; 3; 2; and 1 = "The least relevant".

The organization of the indicators in two areas reduced the complexity of the problem, highlighting its magnitude for Railway Infrastructures and Operations, this qualitative investigation made it possible to carry out statistical analyses based on the answers obtained through a closed questionnaire. Likert-type data are ordinal, that is, one can only say that one score is higher than the other, and not measure the distance between the points.

2.3 CASE STUDY

The case study focuses on a detailed analysis of the accident rate, the impact of train delays and penalties, and the characteristics of the railway, where accidents occur with a special focus on the most significant railway axes at national level.

The calculation of accessibility indexes and “Trespassing”, reflect the state in which the national territory is located, where the railway crosses the municipalities and parishes of the Minho and Algarve lines in particular, obtaining a sense of the distances to be covered by the populations, in their transition in the authorized places and the realization of illegal crossings (“Trespassing”), allowing to carry out a spatial correlation analysis, using the Geoda software, among them and the extension of the road within the confining geographical areas.

In the other georeferencing software (ArcGIS), the calculated data relating to the Severity, Risk and Danger indices, inherent to the Minho and Algarve lines, were introduced, illustrating the municipalities and parishes, with higher levels of claims by road extension and locations. "Trespassing".

2.4 THEORETICAL APPROACH - CASE STUDY

The accident rates measured using the formulas for calculating the severity (FWI / average number of trespassing locations), risk (Number of harvested / average number of “Trespassing” locations) and danger (FWI / number of harvested), allow know which municipalities or parishes with the greatest number of accidents and resulting human consequences, providing a global and comprehensive view to the infrastructure manager, with a view to implementing a set of procedures at the level of safety, assessing the vulnerability of the railway infrastructure, applying associated predictive models circulation management and set priorities.

The main objective in the use of this diagram, allows to go far beyond a superficial analysis, usually made by the visualization of data aggregated by areas through coloured maps according to the spatial pattern of the phenomenon, called thematic maps.
In this sense, the visualization of a spatial pattern, the realization of this exploratory analysis of geospatial data associated with: (i) the “Trespassing” index (IT) with the accessibility index (IA); (ii) the "Trespassing Index" with the extension of the track (m), thus using the spatial analysis technique based on the Moran Index, which identifies the relationship between a given polygon and its neighbourhood, from a predefined distance, through the covariance existing between them, allowing the examination of the homogeneity / diversity of the data, allowing to identify the spatial correlation structure, that is, the statistical measure, associated with the spatial covariance, that best describes the data, in order to estimate the magnitude of spatial autocorrelation between the Parishes served by the Minho and Algarve lines.

2.4.1 ACCESSIBILITY INDEX

The formulas established for assessing accessibility will be applied in municipalities and parishes close to the extension of the railroad, and later use in geographic information systems, with the average and actual distances associated with these locations authorized to cross the railroad, displayed in tables for analysis in the case study.

The accessibility index (IA) along the railway is based on the Km unit, calculated using the following formula:

IA = NAC / line extension (km) equation (1)

Where, $NAC = NPD^{a} + NPN^{**}$

*Number of uneven passes (NPD) classified in: PI - underpass; PIP - pedestrian underpass; PS - overpass; PSP - pedestrian overpass.

** Number of Level Crossings (NPN)

The average distance (DMAC) between crossings (AC) results from the track length quotient in meters and the number of existing crossings (NAC), the actual access distance (DRAC) calculated by the difference in the kilometre point (PK) of the crossing upstream (PKAC0) and downstream (PKAC1), in the increasing direction of the railway for all accesses (AC), calculated using the following formula:

DMAC = line extension (m) / NAC equation (2)

Where, DRAC= PKAC0 – PKAC1

For calculating the variance (S^2) and standard deviation (Dp), through the difference between the real distance (DRAC) and the average distance (DMAC), the following formulas apply:

$$S^2 = \frac{\sum(DRAC\text{-}DMAC)^2}{n\text{-}1}$$ equation (3)

$$Dp = \sqrt{\frac{\sum(DRAC-DMAC)^2}{n}}$$ equation (4)

2.4.2 TRESPASSING INDEX

The formulas established for assessing Trespassing will be applied in municipalities and parishes close to the extension of the railroad, and later use in geographic information systems, with the average and actual distances associated with these locations authorized to cross the railroad, displayed in tables for analysis in the case study. The trespassing index (IT) along the railway is based on the Km unit, calculated using the following formula:

IT = NTR / line extension (km) equation (5)

Where, NTR = Number of “Trespassing” locations along the railway

The average distance (DMTR) between “Trespassing” locations along the railway (TR) results from the track length quotient in meters and the number of existing crossings (NTR), the actual access distance (DRTR) calculated by the difference in the kilometre point (PK) of the crossing upstream (PKAC0) and downstream (PKAC1), in the increasing direction of the railway for all accesses (TR), calculated using the following formula:

DMTR = line extension (m) / NTR equation (6)

Where, DRTR = PKTR0 – PKTR1

For calculating the variance **(S^2)** and standard deviation (DpTR), through the difference between the real distance (DRTR) and the average distance (DMTR), the following formulas apply:

$$S^2 = \frac{\sum(DRTR\text{-}DMTR)^2}{n\text{-}1}$$ equation (7)

$$DpTR = \sqrt{\frac{\sum(DRTR-DMTR)^2}{n}}$$ equation (8)

2.4.3 BIVARIATE MORAN’S INDEX

The spatial correlation analysis performed using the GEODA software, was used “Bivariate Moran's I” (Bilisa) applying the queen contiguity 1, obtaining the maps of clusters and constant significance applied to the parishes, being the Local Moran Index one indication of data homogeneity and diversity.

The Moran Global Index (I) was subjected to a statistical test whose null hypothesis represents spatial independence, a condition defined by [I = 0]. In this sense, the null hypothesis is rejected if [I] results statistically in a value other than zero, for a pre-established level of significance, where normally, one works with [p-value = 0.05] or [p-value <0, 05], that is, with a 95% confidence margin or greater.

To estimate the significance of the index [I], without assumptions in relation to the distribution, a pseudo-significance test was performed, by generating a certain number of permutations (999), distinct from each other, of the values of attributes associated with the areas, where each permutation produces a new spatial arrangement,

Moran's Cluster diagram also presents it in the form of a two-dimensional thematic map, in which each polygon is associated with its respective quadrant in the Cluster diagram. This thematic map contains four classes (1 - AA, 2 - BB, 4 - AB and BA) called the Global Moran Index Cluster Map (Figure 6 13).

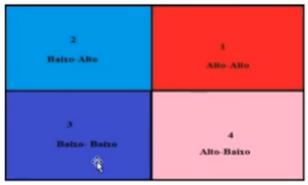


Figure 1 - Colors of values associated with clusters in the quadrants

3 RESULTS ANALYSIS

3.1 QUESTIONNAIRE RESULTS

3.1.1 Probability of occurring "Trespassing" distribution responses

The statistical analysis carried out on the probability of occurring "Trespassing", in the validated Trespassing questionnaires (106), registers in the totality of the inquired opinions that the four indicators are located between N3 - Important (30%), N4 - Very important (42%) and N5 - Essential (22%)

In addition to the presented global level distribution of the indicators, they were also analysed individually (Figure 2), where the most chosen option at the extreme level, N5 (Essential), falls on the indicators Fence Typology and Crossing Management both with 25%, comparatively between the four indicators when we analyse the combined opinions between (N3 + N4 + N5) the central level and the two upper levels of the Likert scale, the Crossings Management indicator obtained 98% of responses, where the security registers a lower value with only 87%.

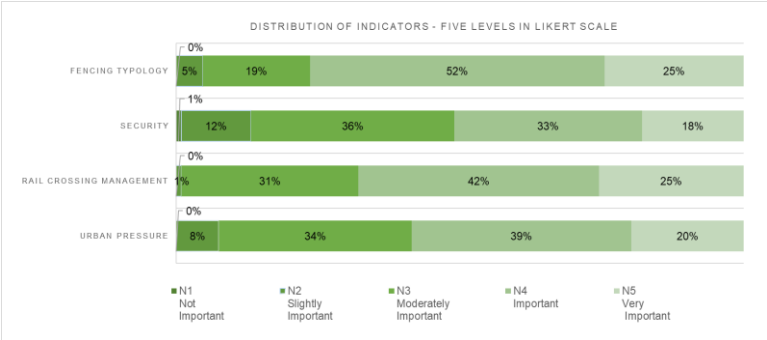


Figure 2 - Frequency of Likert scale levels - Indicators of occurring "Trespassing".

The classification of the four indicators independently referring to the probability of occurring "Trespassing", when ordered in decreasing order, indicates a need for an homogeneous intervention in terms of the type of fence, urban pressure, safety and crossing management (Figure **3**).

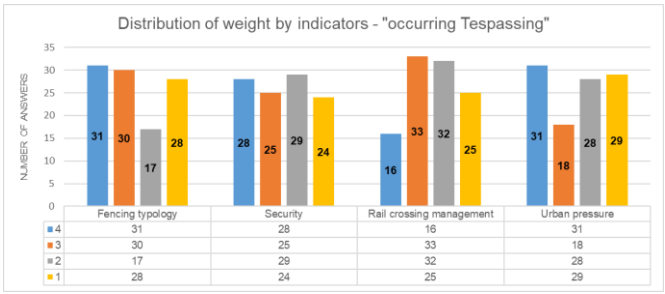


Figure 3 - (No. of responses x Factors) by Indicator of occurring "Trespassing"

3.1.2 Probability of an accident occurring due to “Trespassing” distribution responses

The responses attributed at the five levels of importance, to the six indicators together and both related to the probability of an accident due to “Trespassing”, are considered of enormous relevance by the railway experts. Despite the differences between the different countries, everyone agrees that an accident occurring due to “Trespassing” is a very complex problem to solve and in this sense 62% placed their answers at the two highest levels. In a more detailed analysis of the frequency of responses when the indicators are individualized, the train speed is what stands out the most, followed by the train frequency and exposure time as the most causes of accidents occurring due to “Trespassing”. Although the rest also present high values, their subjectivity is transmitted in the responses with values below level 3 (Figure **4**), reinforcing the idea that the modernization of the railway will have to overcome many challenges by finding technological solutions and in parallel, a thoughtful change in Human behaviour will be necessary to adapt to a changing world.

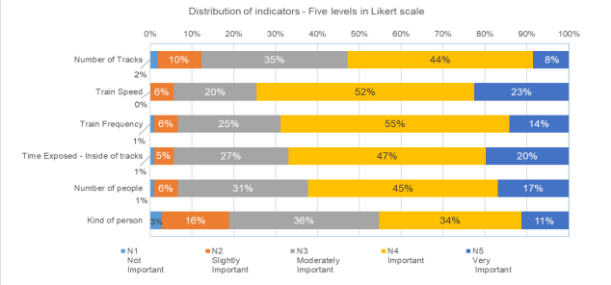
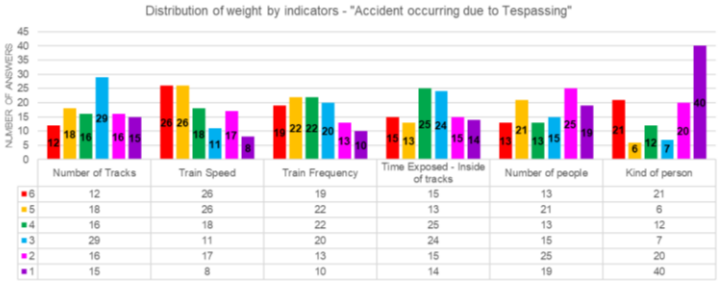


Figure 4 - Indicator x Frequency of responses on the Likert scale

The Trespassing questionnaire had a field where the interviewees had the opportunity to make comments, whereas some of the comments received stated that accidents occurring due to “Trespassing” are rare events in view of the number of trains that run per km of track (CK), also it was stated that the number of individuals that perform “Trespassing” is unknown to infrastructure railway managers over thousands of kilometres of railway.
The interviewees concern in particular with involuntary people, such as children, was remarkable, due to the children unconsciousness in playing games while in the railway, like placing obstacles on the rails, playing with the tightrope on the rail and jumping between sleepers on the lame feet.

3.2 Indicators of an accident occurring due to “Trespassing”

In the attribution of the factors by the indicators in relation to the probability of an accident occurring due to “Trespassing” (Figure 5), train speed is the most relevant, followed by train frequency, the time exposure and the number of lines are two homogeneous groups, however the majority consider little relevant the type of person.



	Number of Tracks	Train Speed	Train Frequency	Time Exposed - Inside of tracks	Number of people	Kind of person
6	12	26	19	15	13	21
5	18	26	22	13	21	6
4	16	18	22	25	13	12
3	29	11	20	24	15	7
2	16	17	13	15	25	20
1	15	8	10	14	19	40

Figure 5 - (No. of responses x Factors) Indicators of an accident occurring due to “Trespassing

3.3 CASE STUDY

3.3.1 Accessibility Index in the Municipalities of Minho Line

The accessibility index in the municipalities of the Minho line, it appears that Gondomar, Valongo and Porto, are those that have the highest accessibility index. However, the greatest distances to be covered by the population are in the municipalities of Vila Nova de Cerveira, Trofa and Maia (Table 1).

Cod_Linha	Concelho	*NAC*	População	Via_ferrea (Km)	IA(km)	DMAC(m)	DpAC
11	PORTO	4	97364	2,668	1,49925	667	327
12	BARCELOS	36	44111	25,527	1,41029	709	623
12	CAMINHA	24	11365	17,867	1,34329	744	692
12	GONDOMAR	6	50713	2,706	2,21701	451	367
12	MAIA	6	33011	4,819	1,24516	803	514
12	PORTO	11	32659	3,531	3,11513	321	389
12	TROFA	11	31536	9,191	1,19684	836	977
12	VALENÇA	14	6420	7,380	1,89694	527	378
12	VALONGO	14	38798	3,300	4,24270	236	429
12	VIANA DO CASTELO	39	54033	27,525	1,41687	706	564
12	VILA NOVA DE CERVEIRA	12	6554	12,300	0,97560	1025	850
12	VILA NOVA DE FAMALICÃO	39	36327	16,763	2,32656	430	331

Table 1 - accessibility index and average distances in the municipalities of the Minho line

In parishes belonging to the municipalities of the Minho line crossed by the railway, about 47% of them have lower accessibility rates and average distances greater than those measured for the entire line.

3.3.2 Accessibility Index in the Municipalities of Algarve Line

The accessibility indices in the municipalities on the Algarve line, it appears that Olhão, Lagos, Silves, Tavira and Vila Real de Santo António, have an accessibility index higher than the global line. However, the greatest distances to be covered by the population are in the municipalities of Lagoa, Castro Marim and Loulé (Table 2)

Cod_Linha	Concelho	*NAC*	Populacao	Via_ferrea(Km)	IA(Km)	DMAC(m)	DpAC
451	LAGOA	8	9004	8,211	0,974	1026	620
451	LAGOS	9	17033	6,288	1,431	699	627
451	PORTIMÃO	13	65797	11,513	1,129	886	792
451	SILVES	21	48589	19,310	1,088	920	611
452	ALBUFEIRA	8	33148	7,806	1,025	976	828
452	CASTRO MARIM	3	8942	5,210	0,576	1737	419
452	FARO	14	52727	11,692	1,197	835	416
452	LOULÉ	20	40441	21,968	0,910	1098	693
452	OLHÃO	27	75878	15,862	1,702	587	561
452	SILVES	3	6491	2,358	1,272	786	469
452	TAVIRA	22	22187	19,426	1,133	883	491
452	VILA REAL DE SANTO ANTÓNIO	15	26366	10,257	1,462	684	412

Table 2 - accessibility index and average distances in the municipalities of the Algarve line

In the parishes belonging to the municipalities of the Algarve line crossed by rail, about 53% of them have lower accessibility rates and average distances greater than those measured for the entire line.

3.3.3 "Trespassing" index in the municipalities of Minho line

The measurement of results at the level of the municipalities, there are worrying indices where the municipalities of Porto, Gondomar, Maia, Trofa Valença, Valongo and Vila Nova de Famalicão present high "Trespassing" indices (Table 3).

Cod_Linha	Concelho	*NTR*	Populacao	Via_Ferrea(km)	IT(Km)	DMTR(m)	DpTR
11	PORTO	6	97364	2,668	2,249	445	224
12	BARCELOS	13	44111	25,527	0,509	1964	1359
12	CAMINHA	5	11365	17,867	0,280	3573	1718
12	GONDOMAR	14	50713	2,706	5,173	193	250
12	MAIA	8	33011	4,819	1,660	602	482
12	PORTO	6	32659	3,531	1,699	589	424
12	TROFA	19	31536	9,191	2,067	484	427
12	VALENÇA	13	6420	7,380	1,761	568	497
12	VALONGO	14	38798	3,300	4,243	236	354
12	VIANA DO CASTELO	32	54033	27,525	1,163	860	1246
12	VILA NOVA DE CERVEIRA	12	6554	12,300	0,976	1025	2185
12	VILA NOVA DE FAMALICÃO	26	36327	16,763	1,551	645	747

Table 3 – "Trespassing índex in municipalities of Minho line

In the parishes of the municipalities of the Minho line, about 50% parishes have a very high number of "Trespassing" locations.

3.3.4 "Trespassing" index in the municipalities of Algarve line

The measurement of results by municipality, there are worrying "Trespassing" rates in Lagoa, Lagos, Portimão, Silves, Faro, Loulé, Olhão and Tavira have very high "Trespassing" rates (Table **4**).

Cod_Linha	Concelho	*NTR*	Populacao	Via_ferrea(Km)	IT(Km)	DMT(m)	DpTR
451	LAGOA	44	9004	8,211	5,359	187	560
451	LAGOS	70	17033	6,288	11,132	90	308
451	PORTIMÃO	92	65797	11,513	7,991	125	499
451	SILVES	55	48589	19,310	2,848	351	1124
452	ALBUFEIRA		33148	7,806			
452	CASTRO MARIM		8942	5,210			
452	FARO	79	52727	11,692	6,757	148	445
452	LOULÉ	79	40441	21,968	3,596	278	2591
452	OLHÃO	89	75878	15,862	5,611	178	588
452	SILVES		6491	2,358			
452	TAVIRA	108	22187	19,426	5,560	180	696
452	VILA REAL DE SANTO ANTÓNIO	3	26366	10,257	0,292	3419	2825

Table 4 – "Trespassing índex in municipalities of Algarve line

In the parishes of the municipalities on the Algarve line, about 67% parishes have a very high number of "Trespassing" locations.

3.3.5 Bivariate Moran´s índex - Significance and Cluster Trespassing

The analysis used in the number of “Trespassing locations correlated with number of accesses (Figure **5**), in the point of view of the infrastructure manager, aims to infer the parishes with clusters that have High-High relations, who identify above-average positive correlations with a P-value <0.005.

The infrastructure manager can adopt intrusion mitigation measures in the most significant parishes, such as localized awareness campaigns warning of the risks of these behaviours or mobility plans articulated with the needs of the populations. On the other hand, it may be interesting for the infrastructure manager to invest in municipalities with High-Low relations, reducing these outliers and avoiding propagation at the level of increasing “Trespassing” indices, in neighbouring parishes with values below the average.

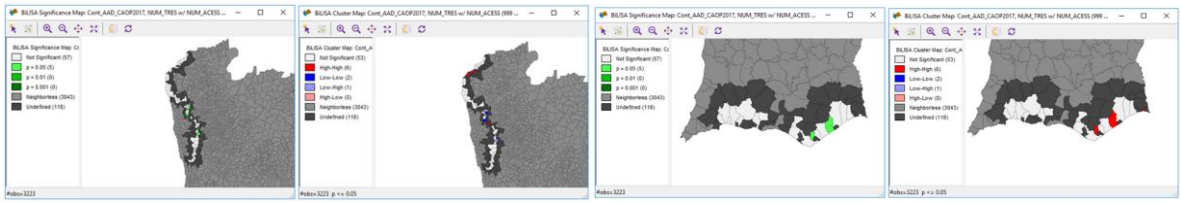


Figure 5 - Bilisa Map of Significance and Cluster Trespassing / Accessibility

The correlation of the number of “Trespassing” with the extension of the railroad (m), the results obtained (Figure 6) serve to support the decision of the infrastructure manager, in the application at the parish level of mitigation actions at the level of fences, surveillance or at the limit application of coercive measures, and investment in new technologies is a solution that can be implemented compared to the construction of new unevenness in the Minho and Algarve line

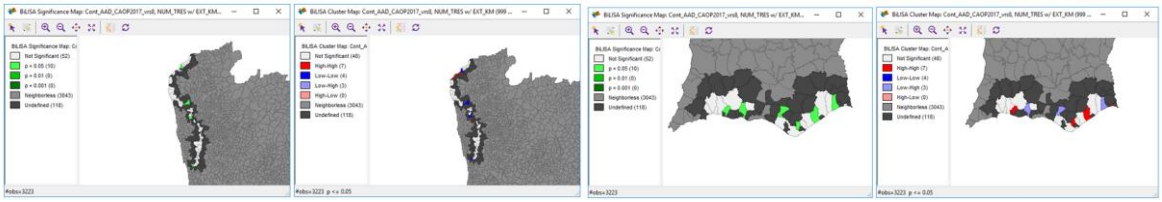


Figure 6 - Bilisa maps of significance and Cluster Trespassing / Line extension

3.4 INDEXES of “Severity - Risk – Danger”

The strategy of mitigation actions at the national level of an impeding, dissuasive or other nature that consolidate the reduction of the “Trespassing” phenomenon, is dependent on the national vision of these events, where the articulation with the local authorities, may result from a hierarchy of the places to intervene, reinforcing the national interest of the railway.

The analysis of the three accident rates (IG - severity index, risk index and hazard index), at the macro level in the different counties crossed by the railway (Figure **7**), were classified in six levels, being the first aggregator of the counties with index at zero, allowing a better visualization in the national territory, as it turns out there is a higher density of municipalities in the Minho line compared to the Algarve line, however the areas of the municipalities in the algarve are higher in relation to the Minho line.

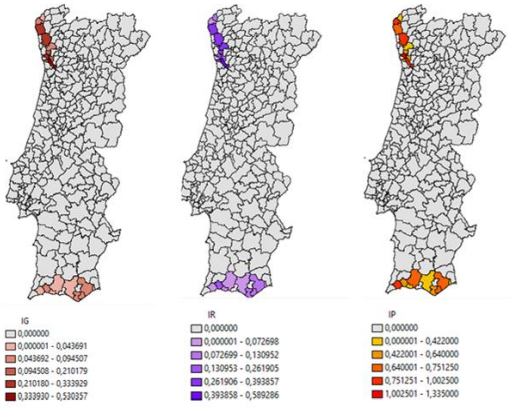


Figure 7 - Thematic map of the municipality's Indexes - of “Severity - Risk – Danger”

As a result of the calculations of the three accident rates in the municipalities, the average number of illegal crossing locations on the Algarve line is much higher than the Minho line, which significantly reduces the values measured in the Severity and Risk indices, which are directly linked to the number of sites. In terms of the danger index, the two lines see similarities in the consequences, as a result of an individual being picked up by a train.

4 CONCLUSION

The investigation carried out in the context of human behavior in the vicinity of installations and the implications for dimensioning, was preceded by a comprehensive literature review on the issue of “Trespassing”, and later supported by a questionnaire carried out by specialists in the railway sector, led to the specification of an exploratory analysis, identifying the explanatory variables associated with delays in rail traffic related to accidents by “Trespassing”.

The opinions collected in the questionnaire reflect a strong need to apply a joint strategy at the level of the rail channel fence typology, investing in safety, reassessing the management of crossings over the railroad, and having a better sense of urban pressure in the municipalities and parishes crossed by the Minho and Algarve line.

The related aspects, with the railway operations collected in the consultation at European scale, allowed to identify the variables related to the accidents and the places of illegal crossing, resulting in enormous concerns in the number of roads crossed with railway exploration, in the speed of the trains, in the times exposure to crossing, circulation and number of people (due to their vulnerability) who practice “Trespassing”.

The knowledge acquired in the case study revealed very important aspects regarding the behavior of pedestrians in the various municipalities and parishes of the Minho and Algarve lines, where the authorized accessibility indexes in the railway infrastructure and the “Trespassing” indexes were identified, which contribute to the negative impacts of traffic management, punctuality, constraints to the normal functioning of command centers and railway operations.

The implications of interventions in accessibility, their costs and use of infrastructure, must be combined through the best practices developed in mitigating the risks of “Trespassing”, in this document it concluded that there are municipalities and parishes that need a different approach, in terms of these actions with their populations.

The urban pressure in the proximity of railway facilities, reinforces the commitment of the railway manager with the municipalities, local communities, national authorities, increasing the safety levels of the railway operation with the objective of reducing the risk of accident with people caught by rolling stock in movement.

The collection and processing of data related to the phenomenon of “Trespassing”, is fundamental for a better observation, interpretation that lead to effective interventions in mitigating “Trespassing” in this sense, it is necessary to establish the procedures related to the information that is intended, to collect , consolidate it, classify correctly, allowing to increase the level of knowledge of this phenomenon, and to strengthen new research approaches.

The recommendation for future research proposals, are directed to the phenomenon of “Trespassing” inside railway stations, cost-benefit analysis in the application of intrusion detection systems, to measure the levels of knowledge and training of employees in the areas of security on “ Trespassing ”.

The good articulation between the agents with an interest in the problem of “Trespassing”, must be done through the sharing of information, joint awareness campaigns, in the rapid identification of these phenomena and in the implementation of risk mitigation actions, more frequent improving their efficiency in resolving these cases.

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