# Incidents with passengers in Portugal at the platform-train interface 

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#### Abstract

The platform-train interface is a critical area in the rail transportation. In Portugal, the absence of a standardization of the platforms and the difference between the types of rolling stock has called attention from CP - Comboios de Portugal to this area, due to the increasing number of accidents happening there.

This thesis intends to show all the features of this kind of accidents that happened between 2012 and 2018 during boarding and alighting in the trains of CP - Comboios de Portugal. It resulted in an huge analysis on the critical points, identified after the treat of the data. Lastly, recommendations to what can be done in order to create a more safety platform-train interface area to the passengers are provided.




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## 1. Introduction

Fall is defined as to suddenly go down onto the ground or towards the ground without intending to or by accident. [1]

The WHO (World Health Organization) points that the risk factors regarding to the falls are multifactorial, that is, it can be biological, as age or diseases, behavioural, socialeconomic (for instance, social isolation), weak net of social support and environmental, as the lack of mobility support structures in the daily space. [2]

The risk of fall increases on the people over 65 years old (definition of WHO for a person been considered elderly) comparing to other age groups [3, page 1]. The falls are the most frequent domestic accident and the main cause of accidental deaths for this part of the population [4]. About $28 \%$ to $35 \%$ of the elderly people have this type of accident every year [5, page 9].

The health problems related to the aged citizens are several and complexes. However, the ones caused by falls are heavier and heavier, both for the family and for the society. Between 2000 and 2013, in Portugal, for each 100 hospitalizations of people over 65 years old, 3 were caused by fall. In average, theses hospitalizations lasted for 13 days. Besides that, $6 \%$ of the hospitalizations provoked by fall had the death outcome in the hospital [4].

The elderly population has been increasing in Portugal. According to Instituto Nacional de Estatística (INE = National Statistics Institute), in 1993 the estimated relation between elderlies and teenagers under 15 years old was 81 for each 100.10 years late, this relation changed to 108 elderlies for each 100 teenagers. In 2013, 139 people over 65 years for each 100 people under 15 years [4]. This results in more and more falls and in a directly proportion the need to adequate the daily environment and the health facilities for the necessities for the elderly people.

Moreover, the falls are also a big problem for the young people. Each year, about 1500 people in this age range die due to a fall in Europe. Even though this is not the main cause of death for this group, accidents like that are often causing disability, with risk of longterm sequel. In 2004, the WHO estimated that for each dead child due to fall, 4 are permanently disabled, 37 hospitalized and 690 miss a school or work day. Specifically speaking in Portugal, the falls are the biggest cause of going to urgency and hospitalization, representing $4 \%$ of the accidental deaths among children and teenagers. [6].

One of the critical places for falls is the means of transport. Stairs, steps, sliding floors and open places, which suffer with the weather situations, are traps for this kind of accidents. Especially on the railroad, the platform-train interface is an area that deserves a special attention. Accidents on the railroad are always very dangerous, and, in some situations, they generate serious injuries and even the death. Besides the invaluable price of the loss of a relative, these accidents can be very expensive for the state and the society. Just for comparison, a road accident with a severe injury has a total cost of about 126,000 Euro for the society [7].

Comboios de Portugal (CP) has been registering an increasing of the number of passengers every year [8] and hence an increasing number of the falls during the boarding and alighting of trains [15], exposing the safety fails on the facilities and in the rolling stock.

Because of this, emerged a necessity to make a detailed analysis about this kind of accidents.

## 2. Methodology

In 2012, a new Sistema Integrado de Gestão de Ocorrências (SIGO) was implemented. SIGO is an application that permits the register, description and query of an event that implies disruptions of the normal operation of traffic or rail service. Its purpose is the treatment of the registered information, its evaluation and monitoring allowing the adoption of adequate preventive and corrective measures, with the objective of guaranteeing and reinforcing the quality and safety of the service provided [16]. The system collects the events witnessed by the train officer, train driver, other railroad workers and even the passengers, through communication to the company.

The event report consists in a form with the following fields:

- Description: it is indicated, among others, the day and time of the event, cause, train number and an extended description of the episode;
- Location: it is informed the line or depot and the kilometric point where the event happened;
- Composition: it is registered the information about the rolling stock;
- Consequences: it is pointed any result of the event: train delayed or suppressed, human or material damages, extra trains operated, etc.

From this data arises an Excel sheet with the intention of dividing all the information in cells about the incidents with passengers during boarding or alighting, to use later to measure the variables involved.

The fields are:

- SIGO: identification number of the event in the system;
- Year: year when the event happened;
- Month: month when the event happened;
- Day: weekday when the event happened;
- Line: line where the incident happened;
- Train: number of the train involved in the episode;
- Rolling Stock: type of rolling stock involved in the event;
- Coach: number of the coach involved in the accident;
- Door: number of the door where the fall happened;
- Station: station where the event happened;
- Platform/Line: platform or line of the station where the event occurred;
- Boarding/Alighting: passenger boarding or alighting;
- Passenger gender: woman or man;
- Age: age of the involved passenger;
- Age group: age cluster of involved passengers;
- Stop outside the normal place: train stopped where expected or not;
- Train in movement: train moving or not in the moment of the fall;
- Alighting out of the station: alighting outside a station or not;
- Hour: time when the event happened;
- Day period: period of the day when the event happened;
- Severity: injury severity level suffered by the victim;
- Foreign: nationality of the victim from another country or not;
- Others: other information/details about the accident, if needed.

With this data, it was possible to analyze all events of fall during train's boarding and alighting from 2012 to 2018.

## 3. Statistics

Accidents with passengers has been a big issue for the whole European Union. However, the security for the passengers on the rail transport has improving throughout the years. Below, it is possible to see the total number of accidents with passengers in EU28 that resulted in fatalities or serious injuries:


Graph 1 - Passengers fatalities and serious injuries in EU28 between 2006 and 2016 [9]
Comparing to the others countries of SERA (Single European Railway Area), it is possible to see that in absolute numbers Portugal is not one of the critical places for accidents with passengers. The Graph 2 shows the general overview of the accidents with passengers with fatalities and serious injuries in SERA from 2012 to 2016.


Source: ERAIL

Graph 2 - Passengers fatalities and serious injuries by country between 2012 and 2016 [9]
Despite not being one of the countries that most register passenger fatalities and serious injuries, throughout the 7 years between 2012 and 2018, 777 passengers falls were registered during boarding or alighting in CP's trains.

### 3.1. Falls throughout the years

The falls distribution by year during this period is below.


Graph 3 - Falls by years

The graph shows that the absolute number of falls has been increasing over the years as well the number of falls/million passengers. However, in the last years, the relative number of falls/million passengers remained almost constant. A higher number of passengers will result in a higher number of accidents during the boarding/alighting movement, so it is very important to take in consideration the not increasing relative number of falls to conclude that some arrangements taken during these years had a positive impact.

### 3.2. Falls throughout the months

The monthly falls distribution during this 7 years period is in Graph 4.


Graph 4 - Falls by months
It is interesting to note that during the months with more rain (November to April), the number of falls are normally smaller, both as absolute and relative numbers. All months during this period have a value lower than the average of 0.967 Falls/Million Passengers. This show us that the weather conditions is not so critical for the numbers of falls.

### 3.3. Falls throughout the days

The daily distribution during this period is in Graph 5.


Graph 5 - Falls by days of the week
About 70\% of the CP's traffic is of urban trains, what justifies the higher number of falls during the working days, but also impresses the number of falls on Sunday, considering that the number of passengers is lower.

It is possible to highlight two points:

1. During the weekends, many passengers are not using the train as main transport. Also, the weekend's passengers are, usually, sporadic passengers, so they are less familiar with the rolling stock;
2. People on leisure trips are more likely to report an incident than the ones who are time-pressed by work duties [10].

### 3.4. Falls by passengers movement

One important point is the movement of the passenger during the fall.
The split is in Graph 6.


Graph 6 - Distribution of the falls per boarding / alighting

### 3.5. Victims' features

From the description of the accidents, it was possible to make an analysis on the kind of passenger who is more propitious to have a fall.

Referring to the passenger gender, the results are in Graph 7.


$$
\text { Graph } 7 \text { - Passenger's gender }
$$

We cannot neglect the differences between the clothes used by man and woman (mainly regarding to the shoes), but it is known that female passengers are more likely to report an accident than the male passengers [10].

Moreover, in about $18 \%$ of the events the age of the passenger is available. The considered age groups (years) are:

- 0 to 10 ;
- 11 to 20;
- 21 to 40 ;
- 41 to 65 ;
- Over 65.

Referring to the passenger age groups, divided by gender, the results are in Graph 8 (female victims) and Graph 9 (male victims).


Graph 8 - Age groups of the female victims


Graph 9 - Age groups of the male victims
With this data, it is possible to understand that the female passengers over 65 years old are the critical group regarding to falls.

Moreover, it was possible to know that in 30 accidents the passenger involved was from another country, distributed as in Graph 10.


Norte is the most important line in Portugal, connecting the two biggest cities and being a part of the urban line of Lisbon.

Sintra and Cintura are lines inside the metropolitan area of the capital.

Algarve is the line in the south, a region that attracts many tourists and has many foreign people living there.

In 28 of these 30 occurrences with foreign passengers, the information about the nationality of the passenger is available (Graph 11).


### 3.6. Falls by line

Graph 12 presents the falls distributed by the line where they happened.


Graph 12 - Falls regarding to the lines where they happened

Cascais is the only line exclusively for urban traffic, even though Sintra has more than $90 \%$ of the traffic being urban.

Norte, Minho, Cintura and Douro are lines with mixed traffic.

### 3.7. Falls by rolling stock

The outcome of the analysis on the typologies of rolling stock involved in incidents is in Graph 13.


Graph 13 - Falls regarding to the rolling stock series involved
The series of rolling stocks presented in the graph represent $94 \%$ of the falls.
The coaches and 4000 are rolling stocks that operate the long-distance services; meanwhile $3150+3250,2300+2400$ and 3400 are in operation for the urban traffic in Lisbon and Porto. The others operate mainly regional trains.

### 3.8. Falls by stations

The distribution in function of the stations highlights the stations where most falls happened during these 7 years (Graph 14).


Graph 14 - Falls regarding the stations where they happened
The stations presented on the graph represent about $40 \%$ of the total falls.
The first two stations (Porto - Campanhã and Lisboa - Oriente) are among the most important stations in Portugal and receive urban, regional and long-distance traffic.

Cais do Sodré and Porto - São Bento are stations exclusive for the urban traffic.

## 4. Analysis of rolling stock and infrastructure features

The most critical rolling stocks are the long-distance trains. Talking to the trains' guards, they consider the biggest problem the boarding/alighting with big luggage.

In the case of the rolling stock 4000, the last step (a folding step) is always under the platforms of the stations where these trains stop (all platforms are higher than 70 cm ).

Below, Figures 1 and 2 showing this situation.


Figure 1-4000 in Porto - Campanhã


Figure 2-4000 in Lisboa - Oriente

Because of this, many people bypass the last step (Figure 3).


Figure 3 - Passenger boarding in a 4000 in Lisboa - Oriente
In average, a human step is about 40 cm [11]. Due to this discontinuity on the stairs, the people decide to make a longer step. This long step plus busy hands can result in a fall.

A wider gap between the train and the platform is considered a less safe scenario than a taller step [12]. In this situation, the train floor is virtually in the same height of the platform, but far from the edge, which is considered a jeopardy condition.

Another risk situation like that happens with the series 592 in some stations. The last step is very low in platforms higher than 50 cm . Figures 4 and 5 show how the stairs of a 592 stand in comparison to the platform of the Viana do Castelo station, which has platforms with 70 cm .


Figure 4-592 in Viana do Castelo station


Figure 5-592 in Viana do Castelo station
The COMMISSION REGULATION (EU) No 1299/2014 of 18 November 2014, that regulates the specifications for TSI (Technical Specifications for Interoperability), says that a nominal platform height for railroads with the large gauge is 915 mm . In the previous situation, it is possible to see that the infrastructure adapted itself faster than the rolling stock, creating a undesirable scenario.

The 4000 and the 592 have large entrances and good handrails on both sides. However, the coaches, due to the type of door used (folding doors), have its entrances occupied by a part of the door (Figure 6).


Figure 6 - Entrance of a coach
In addition, this door does not have any device to lock it in the open position. It can move with very weak pull. Therefore, the handrail applied on the door does not provide an adequate support for the user.

Moreover, these doors have an opening knob, which can hold a bag, and thus provoke the loss of the passenger's balance (Figure 7).


Figure 7 - Coach's door. Highlight to the opening knob and handrail
Another point verified was the stairs of the rolling stocks. A good relation between the height $(\mathrm{H})$ and the depth $(\mathrm{D})$ is $2 \mathrm{H}+\mathrm{D}=64$ [13], furthermore, in Portugal there is one law that regulates the stairs standardization for buildings (Decreto-Lei no 163/2006), saying that the height should be at maximum 18 cm and the depth not smaller than 28 cm .

Considering these measures defined by the law as measures for a comfortable and accessible stairs for every citizen, it was possible to verify that some rolling stocks do not provide an adequate access.

On the rolling stock 592, the stairs inside have very short tread (depth) (Figure 8).


Figure 8 - Depth of a step of the stairs of a 592 comparing to a 27 cm foot
In the case of the rolling stock $2300+2400$, there is no stairs inside, but, as the floor is always higher than the platform, there is an external step for the access. Specifically, this step has a higher height and lower depth than the measures used as references (Figure 9).


Figure 9 - Dimensions of an external step of a 2300+2400
On the rolling stock 2240, which has a big concentration of falls during the boarding movement, the stairs present a good tread, but, unfortunately, the height of the step is very high (Figure 10).


Figure 10 - Dimensions of a step of a 2240
However, most of the treads are in yellow by a special anti-slip paint. This helps a lot in terms of calling attention of the users, plus avoids problems with wet weathers and allows a good perception from the passengers in order to know exactly the position of the step.

It was possible to see in a rolling stock of the series $3150+3250$ stopped in Cais do Sodré station that sometimes there is no contrast between the platform's edge, the step on the rolling stock and the floor of the line (Figure 11).


Figure 11 - Entrance of a 3150+3250 in Cais do Sodré station

The yellow color on the steps improves the visibility for the passengers for the gap between train and platform, thereby avoiding a footstep on this crack.

The long distance's trains have reserved seating: the passenger has to sit on a specific seat in a specific car.

In the case of the 4000, the numbers of the cars are always the same, because it is an indivisible train. However, the identification of the cars is not so clear in some trains. It was possible to see the absence of a good identification in some situations(Figures 12 and 13).


Figure 12-4000 without car identification


Figure 13 - Entrance of a 4000 without car identification
However, since the end of 2016 [14], CP has started a renovation due to the half-life intervention on the 4000 , with a new painting scheme. This new painting scheme has big and clears car's numbers (Figure 14).


Figure 14-4000 with the new painting scheme. Highlight to the good car identification
With good car identification, the passengers can identify their cars easily, avoiding the need of run to board in the train.

On the other hand, the coaches are single units and usable in different trains, quantities and positions. Consequently, their commercial numbers are individual per each train, with a small side identification plate, near to the entrance (Figure 15).


Figure 15 - Coach with a poor identification of the commercial number
Therefore, it is very hard to see the number of the car. In some situations, the absence of the identification is complete (Figure 16).


Figure 16-Coach without an identification of the commercial number
This can result in many useless movements by the passengers to find their car.

Another thing that provokes useless movements by the passengers is the absence of information about the position of the train or the car in the platform. In figures 17,18 and 19 there are examples about a situation of a regional train using a 2240 (about 70 m of length) on the station Lisboa - Oriente, where all the platforms are longer than 200 m .


Figure 17 - Passengers distributed along the platform 5, waiting for the regional train


Figure 18 - Some passengers moving to get in the regional train after its arrival


Figure 19 - Passengers running in order to get in the regional train
The same problem happens during the boarding at a 4000 .


Figure 20 - Passengers moving after the arrival of a 4000
These two points (identification of the car and information about the position of the train stop in relation to the platform) cause a boarding in a hurry, which is an undesirable situation.

Specifically speaking about the Sete Rios station, the 3rd station in terms of falls, the biggest problem was with the boarding movement on coaches, responsible for about $66 \%$ of the incidents registered in this station. Graph 15 shows it.


Graph 15 - Falls in Sete Rios per rolling stock series
All trains with coaches that stop in Sete Rios have Lisboa - Oriente as its first or final stop and all are going or coming from the south of Lisbon. Checking the trains involved in the incidents, the following outcome is in Graph 16.


Graph 16 - Falls in Sete Rios during the boarding movement in the coaches per trains
Among the trains presented in the graph above, just the train 674 has Lisbon as its final destination, that is, all other trains are southbound. This situation (boarding in trains with coaches going to the south) is related to more than $60 \%$ of the falls registered in this station.

Sete Rios has the peculiarity of being a station inserted in a curve and has a large passengers' traffic, due to the correspondence with a metro station and a bus station.

The trains southbound always stop at the platform number 4. In this case, the platform is on the left of the train and the train is making a curve to the left, as it is possible to see in Figure 21.


Figure 21 - Train with coaches during the boarding/alighting service at platform 4 of Sete Rios
Due to the curve to the left, the platform on the left and the position of the doors of the coaches, placed on the extremities of the cars, the distance between platform and stairs increases (Figure 22).


Figure 22 - Passenger boarding in a train with coaches at platform 4 of Sete Rios

In addition, the super-elevation of the track, because of the curve, reduces the height of the first step in relation to the platform. Thus, the passengers always bypass the first step (Figure 23).

This results in a necessity of a huge step by the users in order to board on the train.


Figure 23 - Passenger boarding in a train with coaches at platform 4 of Sete Rios
CP also has written warnings inside its trains, informing about the risks involving the railroad services, as well as sound notices and messages.

However, sometimes the position of some warnings is not adequate.


Figure 24 - Position of a warning in a rolling stock of the series 3150+3250

The warning positioned in a high point is not good; as the passenger should look down to see the floor and where is the step (Figure 24).

In the series 592, the warnings are very well located. They were placed near to the opening knob and almost in the same level of the view of the passengers (Figure 25).


Figure 25 - Position of a warning in a rolling stock of the series 592
In addition, the rolling stock 592 has a light that turns on when the door-closing order is done by the driver and also a very good warning sound (Figure 26).


Figure 26 - Visual warning through the light in a 592 train

Even though the written warnings are always presenting the messages in at least one foreign language, the sound messages are just in Portuguese, messages like mind the gap, attention to the stairs, among others. As it was possible to see, CP has many passengers from other countries and, for most of them, a message just in Portuguese will not make them aware of the risks.

## 5. Potential Solutions

Improve the access to the rolling stock is the most important point in order to avoid accidents during the boarding or alighting. Large single piece doors are essential to provide safety for the passengers. It allows placing the handrails in a good and safe position, besides create more space for the boarding or alighting with big luggage. CP has a good example on the rolling stock series 2240. It has a large door and good handrails (Figure 27).


Figure 27 - Entrance of a 2240
The SNCF (Société Nationale des Chemins de fer Français) has the same type of coaches as CP, but they did modifications in order to replace the folding door (Figure 28) by a single piece door (Figure 29).


Figure 28 - SNCF coach with a folding door


Figure 29-SNCF coaches with folding door (left) and single piece door (right)
This modification is possible without a considerable intervention.
Provide good stairs in all the rolling stock is also fundamental to grant an easy and comfortable access for all passengers. Anti-slip paint added with good dimensions for the steps will provide more safety for the users during the boarding or alighting. However,
it's very important to draw attention of the people to the steps. CP has broadly applied the yellow color on the steps in a way to make the step more flashy, but there also other ways to do it, as, for instance, LED strips on the step's edge (Figure 30).


Figure 30 - LED strips in order to indicate the limit of each step
Instead of just a LED strip and/or a strong color, another possibility to draw the attention to the steps is a light focus on the step. Ideally, theses focus must be installed directly on the stairs, for the purpose of avoiding obstacles between the light and the steps, what would impede the device to fulfill its function properly. Moreover, a light focus installed on the stairs with the light directed to the platform would contribute also to the view of the step and the positioning of the stairs in relation to the platform. Due to the range of heights presented in the stations of Portugal, it is very important to make the users aware of this differences. This could allow, for instance, the passengers to realize that the last step of the series 4000 is below the floor of the station.

Furthermore, it is crucial to draw the attention to the gap between the train and the platform. The light focus on the stairs and the yellow color on the steps could help in this point as well, but it is necessary to have something also on the platform. In Sete Rios station it was possible to verify the presence of a black and yellow diagonal stripes on the edge of the platform (Figure 31).


Figure 31 - Black and yellow strip on the edge of the platform in Sete Rios
However, the maintenance of this kind of stripes shall be very frequent. The stripes must be visible so the passengers are able to see the limits of the platform.

The Metro Lisboa applied another solution to draw attention for the platform-train gap. In Baixa-Chiado station was installed a blue light under the edge of the platform (Figure 32).


Figure 32 - Metro Lisboa Baixa-Chiado station
Undoubtedly, this kind of solution would work only in closed stations or during the night.
Written messages are also great to aware the passengers. CP has messages inside the trains, but there is no written messages on the stations. In some metro systems and trains stations
around the world, there are messages on the strip on the edge of the platform. In the Museum Station in Sydney, Australia, there are a few messages applied on the floor, near to the gap (Figures 33 and 34).


Figure 33 - Message "MIND THE GAP" written on the platform of the Museum station, in Sydney, Australia


Figure 34 - Messages written along the platform of the Museum station, in Sydney, Australia
The same solution is also used elsewhere (Figures 35 and 36).


Figure 35 - Messages written on the platform in Malaysia


Figure 36 - Message "MIND THE GAP" written on the platform in London Underground
These messages must be written in a way to draw attention and also allows the passengers to read it and get the information that has been transmitted. Therefore, it should be a short message, written in big letters and with colors that contrast with the floor. In addition, it is desirable that the message was written in other languages, or at least an international language, like English. It should also be applied inside the trains, with another detail: positioning in a place that can be seen easily by every user.

Another problem was about the lack of information about where the train will stop in relation to the platform. In some stations in Portugal it was possible to see the presence of
plates on the platform with the number of the platform and also a letter indicating the zone. Figure 37 shows one example of this plate in the Lisboa - Oriente station.


Figure 37 - Plate indicating the platform and the zone of the platform in Lisboa - Oriente
In Lisboa - Oriente, this plates are 50 m away from each other and from A to E. Another station with the presence of this kind of plates is Lisboa - Santa Apolónia (Figure 38).


Figure 38 - Plate indicating the platform and the zone of the platform in Lisboa - Santa Apolónia
Although these plates are already installed, they are not being used. It would be great if this information was used to avoid the necessity by the passengers to run to get in the train. In the trains without reserved seat, it could be used to communicate the users where
the train will stop. In the long-distance trains, in which the seats are reserved, this information could be used also indicating where each carriage will stop. This info could be added in the train tickets too. In the Figure 14, for example, it would be possible to add on the ticket or inform in a screen on the platform that the cars 4 and 5 will stop in the zone $C$ of the platform number 4.

One good solution was found in Tiburtina station, in Rome, and many other stations in Italy, where there are screens informing the passenger where each coach will stop (Figure 39).


Figure 39 - Screen informing which coach will stop in this point of the platform in Tiburtina station, in Rome, Italy

Screens also allow the information to be transmitted if the length of the trains are different, just turning off screens if necessary.

In Augsburg Hauptbahnhof station and in many other stations in Germany, it is used as well the plates with letters on the platforms, with the addition of an information about the position of each coach on the screen where is showed the next train coming (Figure 40).


Figure 40 - Information about the position of each coach in relation to the platform in Augsburg Hauptbahnhof, in Augsburg, Germany

Making an individual analysis about the issues identified in Sete Rios station, the best solution in terms of commercial service and safety of the passengers is to change the platform where the trains with coaches southbound stop, from line 4 to line 3 .

For theses trains, the platform of line 3 is on the right and generates a big reduction in the distance between the train and the platform (Figure 41).


Figure 41 - Entrance of a coach stopped in the line 3 of Sete Rios station
However, the line 3 is the line used by the trains in the opposite direction. The trains southbound would need to change the line in the entrance and in the exit of the station. There are switches that would allow this movement without a necessity of a long run (Figure 42).


Figure 42 - Switches in the entrance (above) and in the exit (below) of Sete Rios station for the southbound trains

Nevertheless, this solution would have to be approved by IP, the railway traffic controller in Portugal, because it would have an impact in the train's operation, mainly for the urban trains, that in some periods of the day can have a very tight headway.

## 6. Conclusion

Improve the security in the platform-train interface and thus reduce the number of incidents with passengers there is essential to make the railroad transport a better transport mode for everyone.

After all analysis, though a lot has been done in order to create a more safety environment in the platform-train interface area, there is still some changes to do.

Obviously, when the human behaviour is involved it is hard to be sure that there will be no longer incidents. However, it can be reduced as much as possible by creating a new behaviour by the passengers and giving them conditions to avoid undesired situations during the boarding and alighting on the trains. In some situations the conditions for the passengers were not the most adequate. Therefore, there are tools and changes to provide a better environment in the platform-train interface for the users.

As it was showed in this thesis, there are a lot of solutions all around the world, revealing that this problem is present in many countries and rail systems. It was possible to realize that wider doors, better accesses, good handrails and information are indispensable to provide more safety and comfort to the passengers. Even when it is hard to achieve all these features, at least there are better options among the non desirable ones. For instance, it is better to have a higher step than a wider gap between train and platform.

Taking all good points, the achievement of creating a very safety platform-train interface area is possible and thus reduce this social problem that has been reaching people everywhere.

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