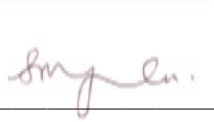
RSR Railway Safety Regulator

Improving Personal Safety on Commuter Trains at Stations in the Republic of South Africa

Part 1: Study of Platform Train Interface

OFFICIAL SIGN-OFF

There is a rise in the number of platform train interface incidents in South Africa, many of them resulting in fatalities on the railways. This research was conducted in collaboration with the University of Pretoria and is is aimed at determining ways in which the risk of PTI incidents can be reduced and what control measures can be put in place to increase rail safety. The body of work will also investigate what factors contribute to PTI and suggest solutions that may be more effective in tackling this issue.



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Abbreviations and Acronyms

BOC	Bombela Operating Company
CSIR	Council for Scientific and Industrial Research
DoT	Department of Transport
MSA	Moving South Africa
NIP	National Infrastructure Plan
NRSR Act	National Railway Safety Regulator Act 16 of 2002
NTLA	National Land Transport Act
PFMA	Public Finance Management Act
PTI	Platform-train interface
PRASA	Passenger Rail Agency of South Africa
RSR	Railway Safety Regulator
SABS	South African Bureau of Standards
SADC	Southern African Development Countries
SANS	South African National Standard
SDI	Spatial Development Initiative
SDO	Sustainable Development Outcomes
SMS	Safety Management System
TFR	Transnet Freight Rail

DEFINITIONS

Unless the context indicates otherwise:

"accident" means an accident arising out of and during an employee's employment and resulting in a personal injury, illness or the death of the employee;

"Danger" means anything which may cause injury or damage to persons or property;

"Employee" means, subject to the provisions of subsection (2), any person who is employed by or works for an employer and who receives or is entitled to receive any remuneration or who works under the direction or supervision of an employer or any other person;

"Employer" means subject to the provisions of subsection (2), any person who employs or provides work for any person and remunerates that person or expressly or tacitly undertakes to remunerate him, but excludes a labour broker as defined in section 1(1) of the Labour Relations Act, 1956 (Act No. 28 of 1956);

"Hazard" means a source of or exposure to danger;

"**Human Factors**" means factors which include the perceptual, physical and mental capabilities of people and the interaction of individuals with their job and working environments, the influence of equipment and system design on human performance, and the organisational characteristics that influence safety-related behaviour at work;

"Incident" means an incident as contemplated in section 24(1).

"**Industry**" means the railway industry and includes operators, suppliers, carriers, contractors and consulting engineers;

"Inspection authority" means any person who with the aid of specialized knowledge or equipment or after such investigations, tests, sampling or analyses as he may consider necessary, and whether for reward or otherwise, renders a service by making special findings, purporting to be objective findings, as to:

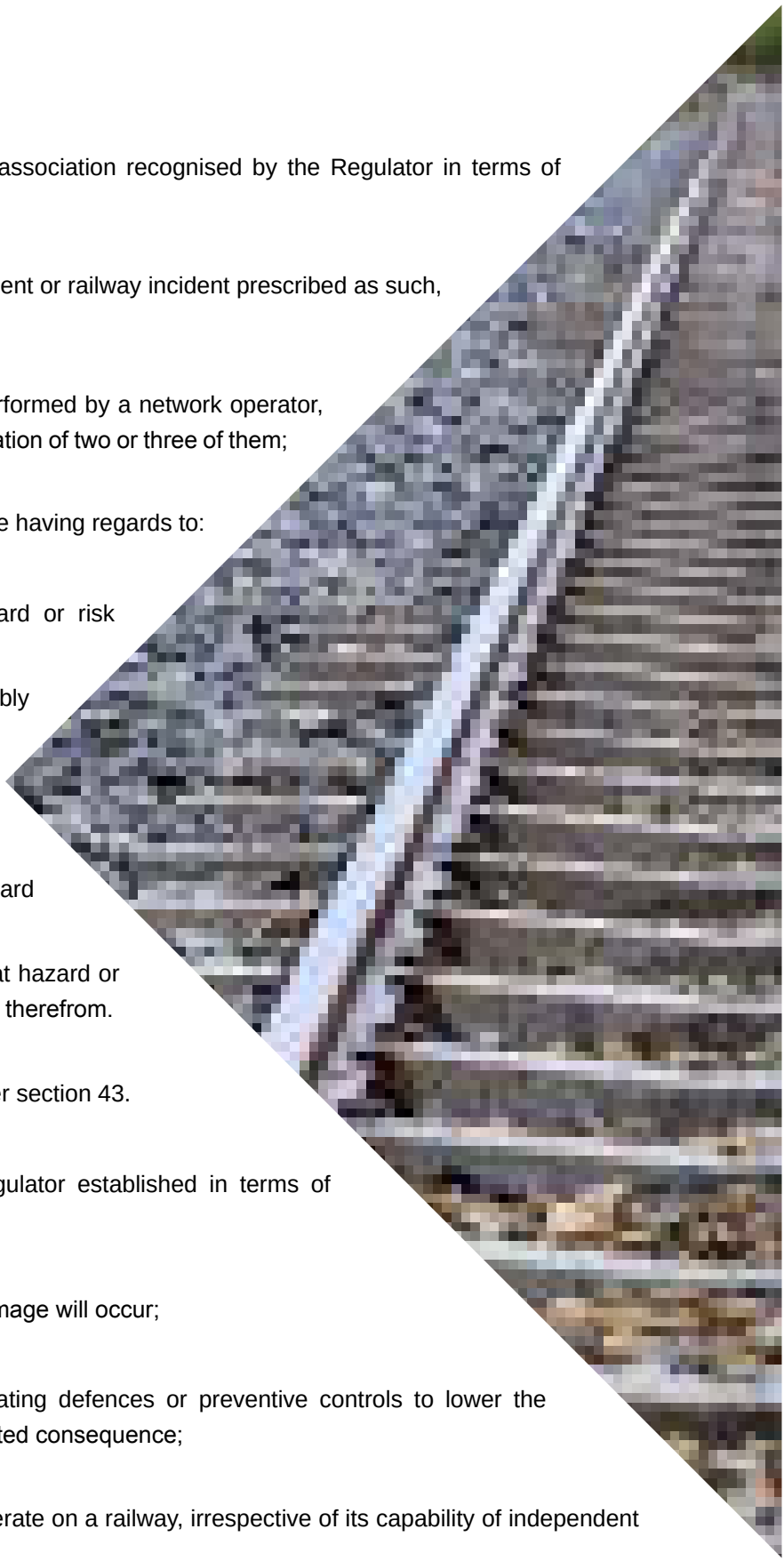
- the health of any person;
- the safety or risk to health of any work, article, substance, plant or machinery, or of any condition prevalent on or in any premises; or

"Inspector" means a person designated under section 28.

"**Network**" means a system of railway infrastructure elements comprising track, civil infrastructure, train control and signalling systems and where applicable electric traction infrastructure which constitutes running lines, and any part of the following on which those elements are situated:

- railway yards;
- marshalling yards;
- sidings and private sidings;
- freight terminals;
- depots;
- stations; or
- any other matter that may be prescribed;
- *[Definition of "network" substituted by s. 1 (c)of Act No. 69 of 2008.]*

"**Railway**" means a guided system designed for the movement of rolling stock that has the capability of transporting passengers, freight or both on a track and includes the land, network, rolling stock, plant, machinery, goods and other immovable or movable property of every description or kind used or set aside for use in connection with or for the purpose of a railway operation;



"**Railway industry association**" means an association recognised by the Regulator in terms of section 7 (2) (b);

"**Railway occurrence**" means a railway accident or railway incident prescribed as such, which could include criminal activity;

"**Railway operation**" means the activities performed by a network operator, train operator or station operator, or a combination of two or three of them;

"Reasonably practicable" means practicable having regards to:

- the severity and scope of the hazard or risk concerned;
- the state of knowledge reasonably available concerning that hazard or risk and of any means of removing or mitigating that hazard or risk;
- the availability and suitability of means to remove or mitigate that hazard or risk and
- the cost of removing or mitigating that hazard or risk in relation to the benefits deriving therefrom.

"Regulation" means a regulation made under section 43.

"**Regulator**" means the Railway Safety Regulator established in terms of section 4;

"**Risk**" means the probability that injury or damage will occur;

"Risk mitigation" The process of incorporating defences or preventive controls to lower the severity and/or likelihood of a hazard's projected consequence;

"**Rolling stock**" means a vehicle that can operate on a railway, irrespective of its capability of independent motion;

"**Safe**" means free from any hazard;

"**Safe railway operation**" means a railway operation in which the risks associated with the railway operation which may impact on the safety of persons and property transported by railway and the safety of other persons, other property and the environment, are as low as is reasonably practicable in the given set of circumstances, and does not include security;

"**Safety**" means the lack of railway occurrences, fatalities, injuries or damage within railway operations;

"**Safety Management System**" (SMS) means a formal framework for integrating safety into day-to-day railway operations and includes safety goals and performance targets, risk assessment, responsibilities and authorities, rules and procedures, monitoring and evaluation processes and any other matter prescribed;

"**Safety management system report**" means a written submission, made by an applicant, in support of a safety permit application that describes the applicant's safety management system and may include any other matters prescribed;

"**Safety permit**" means a permit issued by the Rail Safety Regulator.

"**Security**" means freedom from intentional harm or damage to persons or property;

Standard" means any provision occurring:

- in a specification, compulsory specification, code of practice or standard method as defined in section 1 of the Standards Act, 1993 (Act No. 29 of 1993); or
- in any specification, code or any other directive having standardization as its aim and issued by an institution or organization inside or outside the Republic which, whether generally or with respect to any particular article or matter and whether internationally or in any particular country or territory, seeks to promote standardization.

"**Station**" means a facility for passengers to enter or leave a train, including a railway passenger terminal and a passenger halt and may include facilities for passenger modal transfer and commercial activities forming part of the station and may also include any other place that may be prescribed, but excludes that part of the network running through the station;

[Definition of "station" substituted by s. 1 (e) of Act No. 69 of 2008.]

"**Station operator**" means a person in control of a station, and the management of a station;

"**Train operator**" means a person or persons who have the ultimate accountability for—

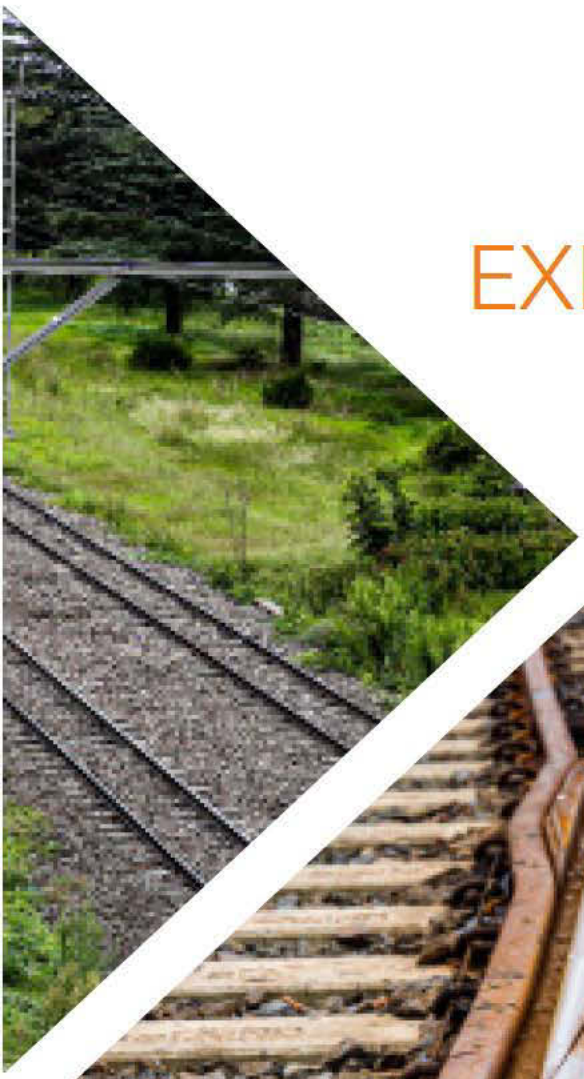
(a) the safe movement of rolling stock on a network;

(b) safety and integrity of rolling stock; and

(c) safety of freight or persons being conveyed;

[Definition of "train operator" substituted by s. 1 (f) of Act No. 69 of 2008.]

EXECUTIVE SUMMARY



1. EXECUTIVE SUMMARY

Occurrences at the platform-train interface (PTI) which involves passengers and commuters form a significant part of all the passenger and commuter occurrences on the railways of South Africa. Most of these occurrences are concentrated in the large metropolitan areas of Gauteng, Cape Town and Durban where large commuter train services are operated by Metrorail, the commuter rail services division of the Passenger Rail Authority of South Africa.

PTI accidents are categorised in two distinct ways: accidents occurring while boarding or alighting trains and/or accidents occurring at the platform edge not during boarding or alighting. Key to railway safety management is the risk management approach. Such an approach aims to ensure that railway operators identify their technical as well as operational hazards and manage the resultant risks to people, property and the environment to a level that is as low as is reasonably practicable. The aim of the study was thus to understand the factors that contribute to platform-train interface occurrences and suggest solutions that may be more effective to reduce the risks.

From an analysis of PTI occurrences, RSR and PRASA investigation reports and literature review, the main hazards identified at the platform train interfaces are the platform/train gap, overcrowding, unsafe passenger behaviour, poor lighting at station platforms and in the trains, failure to conduct proactive inspections and risk assessments, trains running late, failure to deploy an adequate number of train marshals and/or security personnel and cancelled trains.

The study recommends that the following needs to be implemented to reduce the risk at the platform train interface: reduce the large vertical and horizontal vertical gap, install visible signage at the platforms, conduct maintenance as planned, assign more marshals/security personnel at the stations, install safety barriers or fences at stations and educate the public on platform train interface risks.

2. OVERVIEW

The Railway Safety Regulator (RSR) obtains its legal mandate from the National Railway Safety Regulator Act No. 16 of 2002 as amended ("the Act"). The main objectives of the RSR are to oversee safety of railway operations, promote improved safety performance in the railway industry, develop any regulations and standards required in accordance with the Act, monitor and ensure compliance with the Act, and give effect to the objectives of the Act. In overseeing railway safety, the protection of people (public and employees), property and the environment is paramount.

One of the ways in which the RSR monitors the safety performance of railway operations is through the analysis of the occurrence data reported by operators. The RSR produces an Annual State of Safety (SoS) report that outlines the safety performance of railway operators from recorded and analysed safety data.

Previous SoS reports, such as the SoS Report 2018/19 (2019), have noted a subset of incidents that involve the harm of commuters on trains and at stations. These incidents are either categorised as security-related incidents or PTI occurrences. Security-related incidents, as reported in the SoS Report 2018/19, increased by 20 per cent overall between 2017/18 and 2018/19 with the overall harm to persons increasing by 15 per cent since 2017/18. Contrastingly, PTI occurrences contributed to 16 per cent of the overall recorded operational occurrences in 2018/19.

In this regard, one of the Key Performance Indicators (KPIs) under Outcome 1 in the 2020/21 RSR Annual Performance Plan (APP) was to conduct a research study on personal safety on trains and stations. To meet the KPI under Outcome 1 of the APP target, this study primarily focuses on personal safety at stations by centring on PTI occurrences.

3. PURPOSE OF THE RESEARCH STUDY

The study will identify strategic interventions that would enhance the safety of commuters at stations. The three pillars, namely engineering, enforcement, and education will form the basis of the solutions that will be proposed.

The research will identify international best risk control practices to address any gaps identified and will answer the questions related to the adequacy of the following:

- Passenger management procedures, technologies and systems at stations;
- Passenger and community awareness engagements;
- Station infrastructure maintenance and design; and
- Train Working Rules impacting on commuter safety.

The study will identify strategic interventions that would enhance the safety of commuters at stations. The research is in line with the RSR's strive to achieve zero occurrences. The three pillars of engineering, education and enforcement will form the basis for the solutions that will be proposed.

4. INTRODUCTION

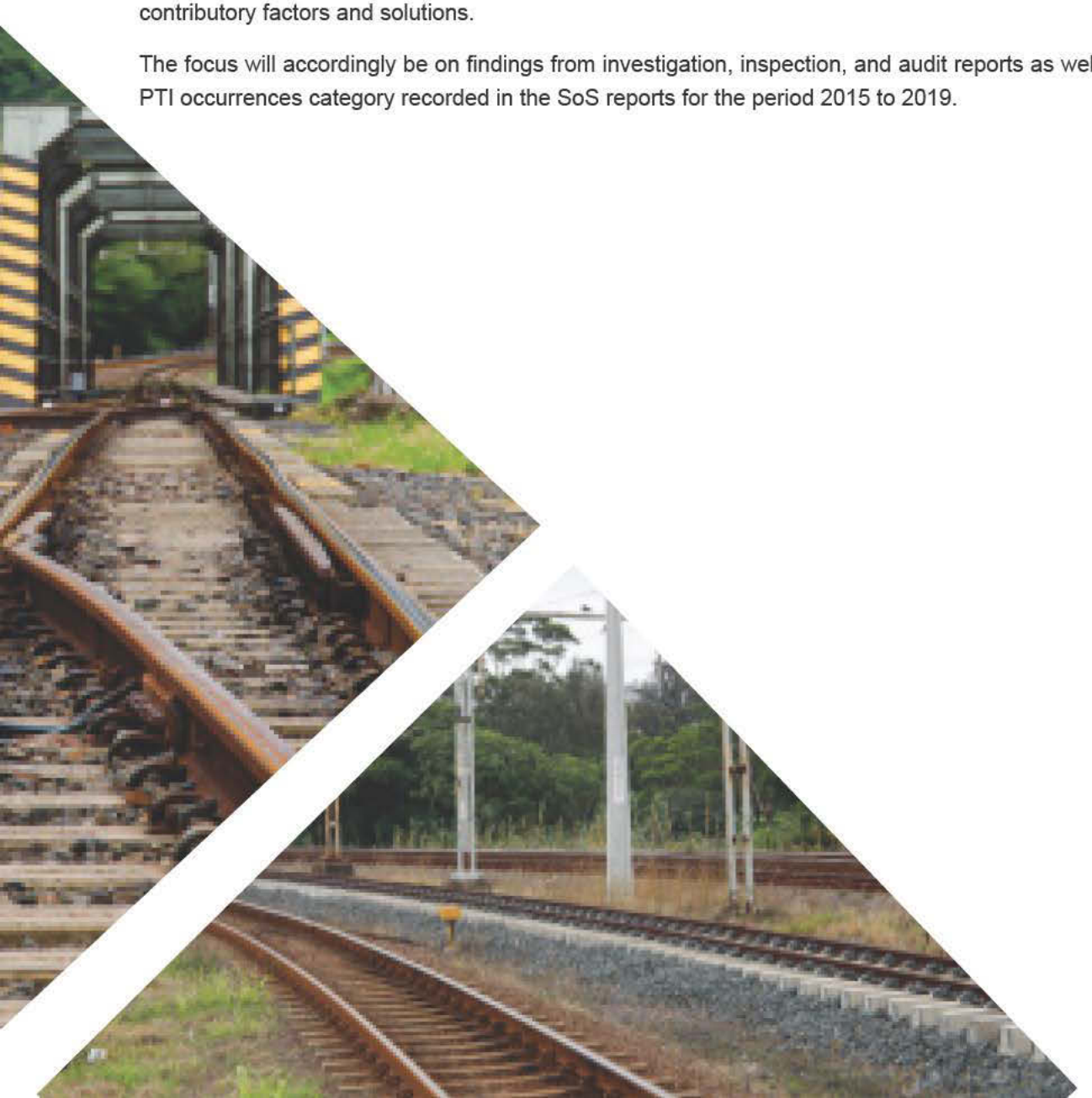
PTI incidents in the South African railway industry are a regular occurrence. The SOS report of the 2018/19 financial period describes PTI occurrences as a "weekday, peak hour phenomenon" pointing possibly to a link between the occurrence of PTI incidents and an overcrowding challenge at stations. The speculation of a link between PTI occurrences and overcrowding may be justified considering the findings of the SOS Report 2018/19 on the areas where the highest recorded cases of PTI occurrences are undeniably the Gauteng, KwaZulu-Natal and Western Cape provinces – the provinces which are also large metropolitan areas – represent 99 per cent of the PTI occurrences recorded during the 2018/19 financial period.

The SOS Report 2018/19 stated that 97 per cent of PTI occurrences resulted in injuries. According to this same report, PTIs have resulted in nine fatalities per year from 2011 to 2019 and have increased by 30 per cent since 2010/11 (based on total numbers).

Although the frequency of the incidence of PTI occurrences is well recorded, little attention has been paid to unpacking the contributory factors associated with these occurrences and making recommendations to reduce the identified risks. This present project will thus concern itself with understanding factors that contribute to PTI occurrences and suggesting solutions that may be more effective to reduce the risks.

This research study will accomplish this by utilising a multidisciplinary and holistic approach to collating contributory factors and solutions.

The focus will accordingly be on findings from investigation, inspection, and audit reports as well as on the PTI occurrences category recorded in the SoS reports for the period 2015 to 2019.



5. LITERATURE REVIEW

Seriani, Fujiyama, and De Ana Rodriguez (2016) purported that the PTI was possibly among one of the most unsafe spaces for passengers boarding and alighting trains at stations. This was because the PTI is a complex space presenting diverse risks and hazards for passengers. Indeed, accidents can occur during entraining and detraining or merely at the platform edge even when there is no entraining and detraining. The PTI in its base form refers to the interaction between the surface height of the station platform and the floor height of the train with the floor height of the train ideally meeting the platform surface with no vertical and horizontal gaps. This is, however, not always possible because gap-clearances between the train and platform are a necessity. To minimise the risk of trains striking the platform, vertical and horizontal gaps are permitted (Holloway, Thoreau, Road, and Boampong; 2015). These gaps also permit for different forms of rolling stock to pass through the stations. Factors such as the movement of the track, the platform construction, and the types of trains passing through the station influence the gap sizes (Devadoss, Ahmad, and Raman; 2012).

Essentially these gaps ensure that trains can operate safely at authorized speeds (Holloway, Thoreau, Road, and Boampong; 2015).

Figure 1 below shows the types of gaps referred to in this study. Gap sizes that are too narrow are not ideal as they could result in trains striking the platform. A balance in the size of the gaps is essential as gaps that are too wide lead to passengers experiencing difficulties in boarding or alighting the train at the platform

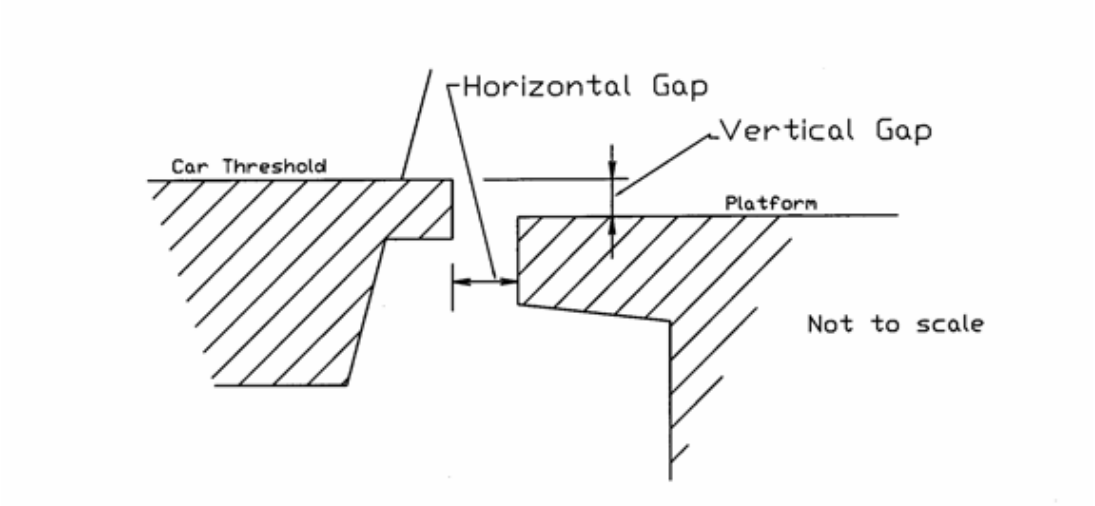


Figure 1. Horizontal and vertical gap between the train and High- Level Platform

The horizontal gap between the platform and train on a straight (tangent) track should, however, remain constant. The gaps are usually slightly increased on vertical and horizontal curves. Changes in the size of the vertical and horizontal gap is at times a result of the shifting of platforms and tracks due to resurfacing, maintenance, weather, etc. In addition, the vertical and horizontal gaps between a platform and train tend to vary in response to the coach floor height. Furthermore, the gaps can vary with track and load conditions.

Many rail stations, including the Main Line Passenger Service (MLPS) stations of PRASA Rail, have the common platform type known as a Low-Level Platform (LLP). This platform type is low by design and requires a specific rolling stock that is accessible by use of steps to the rail coach. This type of platform is nevertheless not the focus of this study.

5.1 PTI occurrence categorisations in South Africa

PTI occurrences are defined as follows:

- Occurrences where a passenger fell on the platform while entraining/detraining a stationary or a moving train;
- Occurrences where a passenger fell between the train and the platform while entraining/detraining a stationary or a moving train;
- Occurrences where an employee fell on the platform while entraining/detraining a stationary or a moving train;
- Occurrences where an employee fell between the train and the platform while entraining/detraining a stationary or a moving train;
- Occurrences where a contractor or contractors employee fell between the train and the platform; and
- Occurrences where a contractor or a contractor's employee fell on the platform while entraining/ detraining a stationary or a moving train.

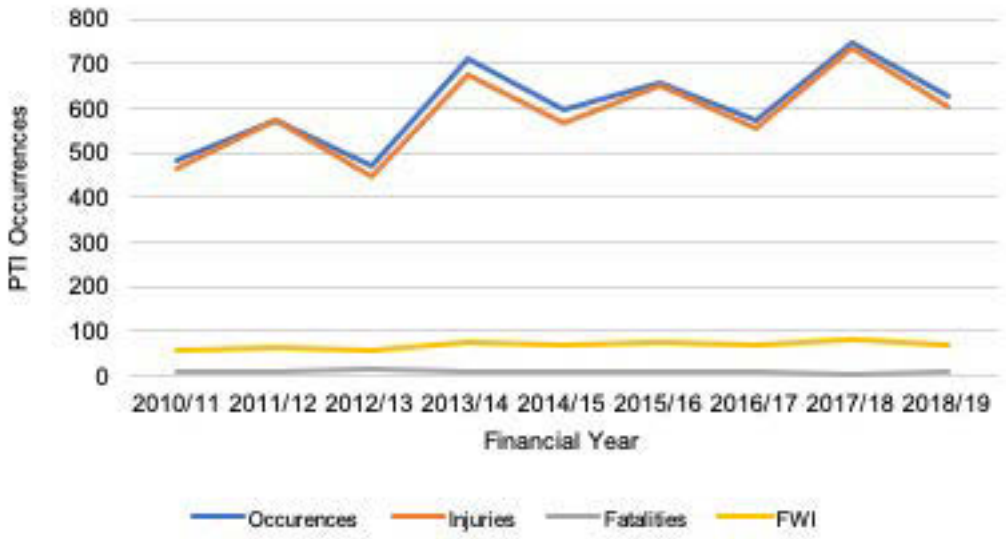


Figure 2. Graph showing the number of PTI occurrences and related fatalities and injuries

Figure 2 was adapted from the SoS Report 2018/19 and shows that PTI occurrences and injuries have been on the increase since the 2010/11 financial year. The number of deaths resulting from PTI occurrences have remained relatively stable (accounting for an average of nine fatalities per year) since 2010/11. This suggests that the challenge of PTI occurrences has not been managed effectively over the years.

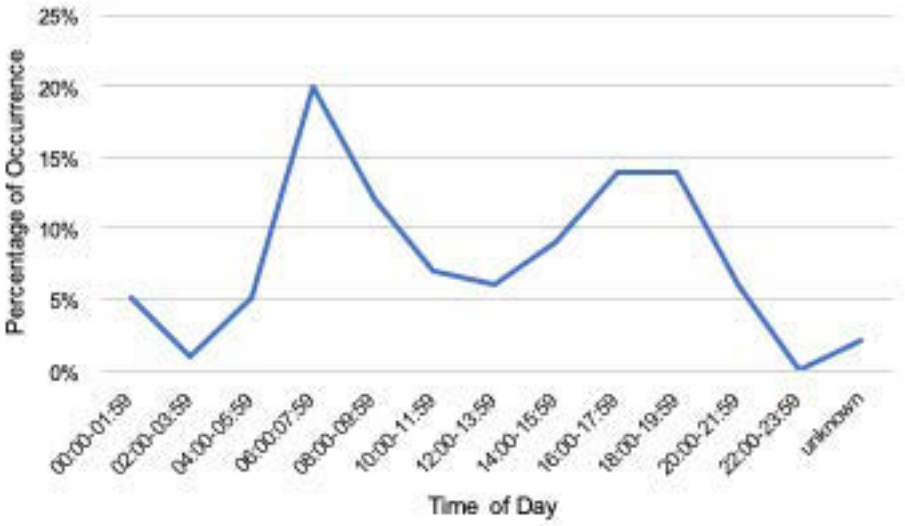


Figure 3. Graph showing time of the day analysis of PTI occurrences in 2018/19

From *Figure 3*, it is evident that PTI incidents tend to occur during the morning and afternoon at peak times. Most incidents occur during the morning peak hours between 06h00 and 08h00 and the afternoon peak hours between 16h00 and 20h00. The occurrences of PTI incidents during peak periods indicates that the number of the PTI occurrences may be directly proportional to station/ platform overcrowding.

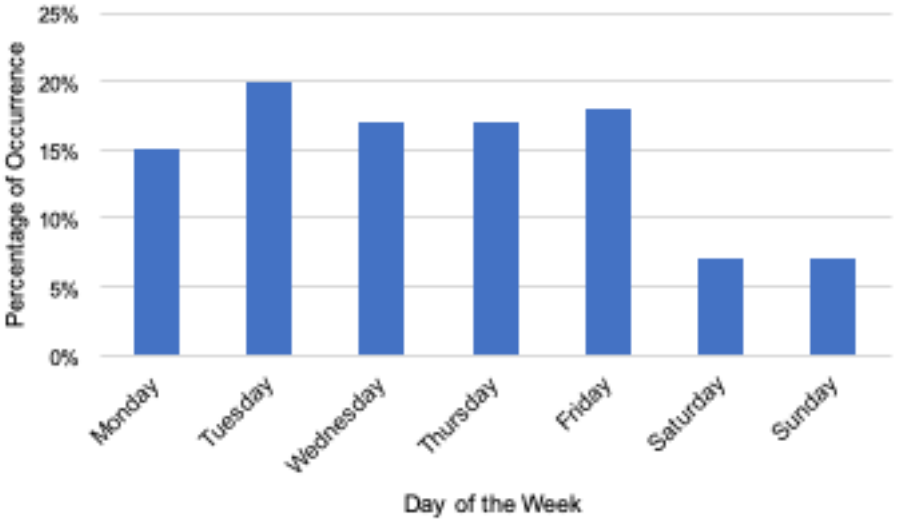


Figure 4. Graph showing the day of the week PTI occurrences analysis in 2018/19

Based on *Figure 4*, PTI occurrences are highest on Tuesdays and Fridays and lowest on Saturdays and Sundays. This suggests that overcrowding may be a main contributor towards the PTI occurrences.

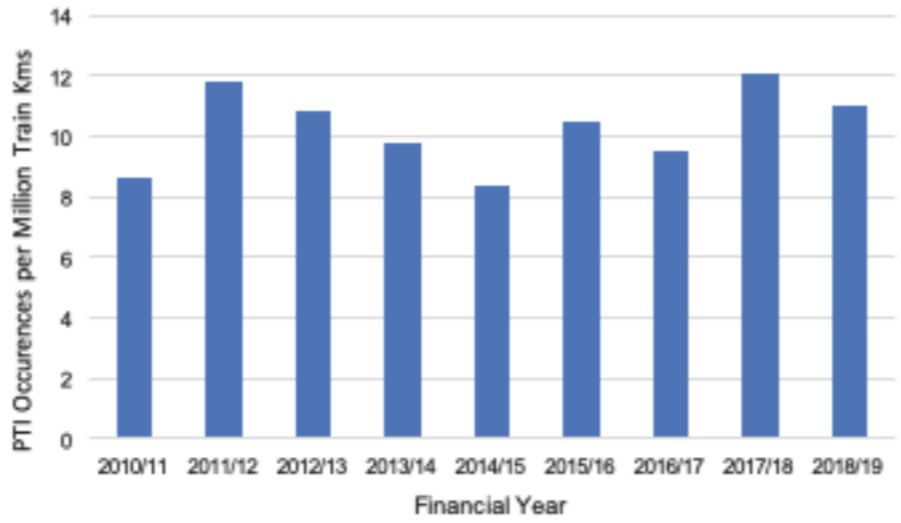


Figure 5. Graph showing all the PTI occurrences per million train km

Based on *Figure 5,* despite a 9 per cent reduction in 2018/19 PTI occurrences compared to 2017/18, PTI occurrences have increased by 28 per cent since 2010/11. This increase is amplified by a reduction in PRASA train km.

5.2 Risk Management at the PTI

Key to railway safety management is the risk management approach. Such an approach aims to ensure that railway operators identify their technical as well as operational hazards and manage the resultant risks to people, property and the environment to a level that is as low as is reasonably practicable (ALARP). This approach recognises that, while there is an ideal level of safety, the costs of achieving this ideal might outweigh the benefits and limit the viability of railway operations. It is, however, implicit that railway operators shall protect their commercial and social responsibilities by running safe railways.

Risk Management Process

Railway operators worldwide have adopted a system safety and risk-based approach to manage safety risks. The system safety approach is a holistic process for hazard analysis because it considers the overall passenger railroad system.

A passenger railroad system is made up of the following elements:

- People;
- Procedures;
- Equipment and facilities; and
- Operating environment.

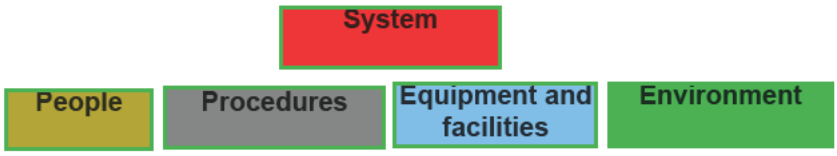


Figure 6. Figure depicting the Risk Management Process components

These elements interact and integrate with each other for the system to function. Changes to one element or part of an element may have an adverse effect on the other element of the system and thus, affect the safety of the system.

The risk-based approach requires operators to conduct risk assessments by firstly identifying all hazards present at the station platforms, analysing and quantifying the risk and making decisions on what measures and controls to take to eliminate or reduce the risks to an acceptable level. Operators and regulatory bodies have developed various risk models, but the underlying principles are the same and depicted in Figure 7: The risk management process.

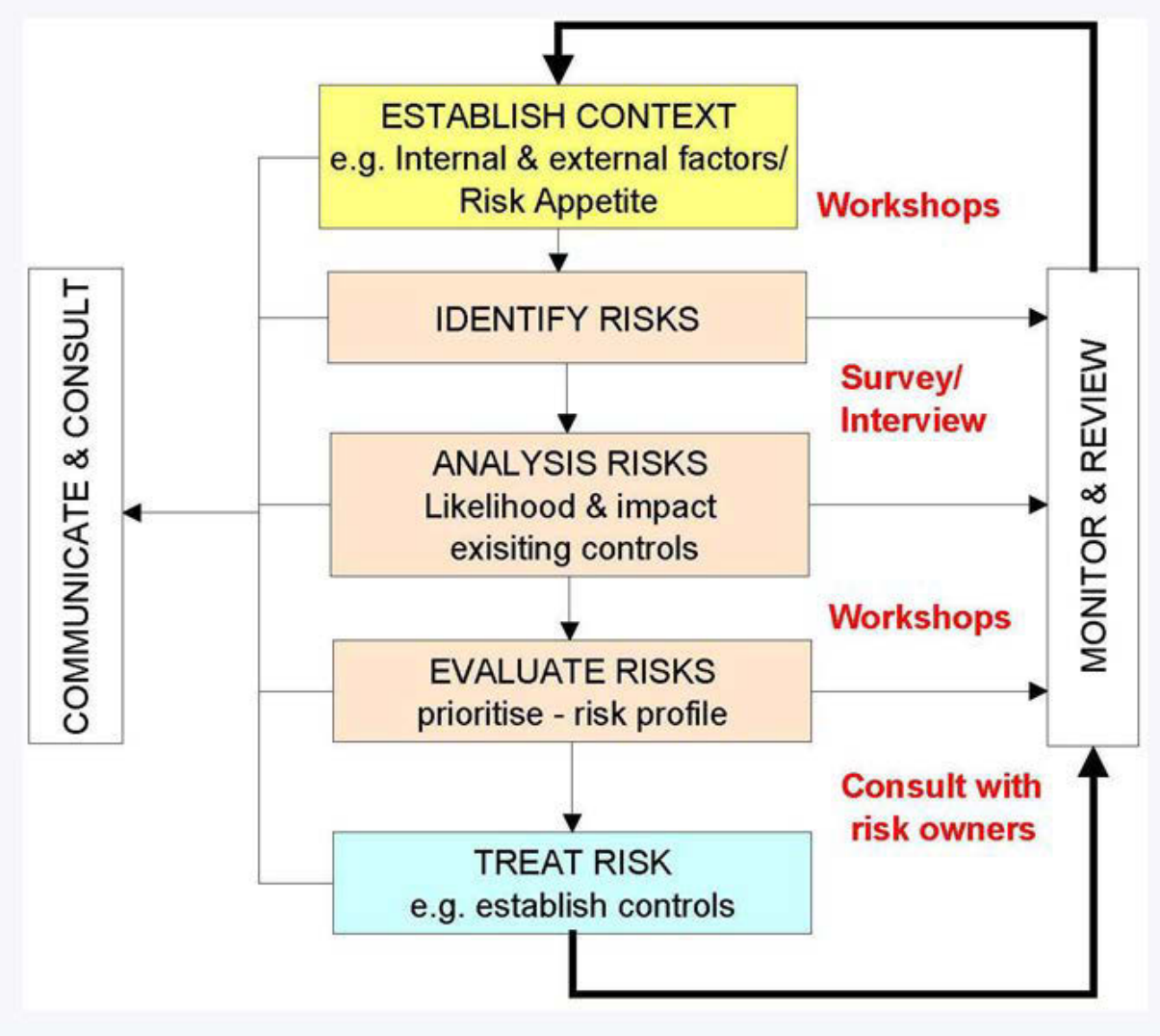


Figure 7. Risk Management Process

This research did not go into details of the risk management process but made use of guidelines for conducting a gap safety hazard analysis that can minimize risk to passengers. The hazard analysis guidelines are based on the United States Department of Defence 1993 document "System Safety Program Requirements," Mil-Std-882C and the hazard identification and resolution process described in APTA publication "Manual for the Development of System Safety Program Plans for Commuter Railroads."[3] The APTA document and Mil-Std-882 are excellent methods for conducting hazard analyses in a disciplined, structured manner. A disciplined and structured approach is valuable because it allows hazards to be systematically identified, documented, analysed, and addressed. The methodology ensures that all hazards and mitigation strategies are adequately covered. The process provides a permanent record of the hazard analysis and serves as a reference document to review and analyse future accidents or changes in system operations.

5.3 PTI occurrence contributory factors

Mills and Leach (2016) carried out a research project in which they identified and prioritised passenger behaviours that contribute to the occurrence of PTI hazardous events. The behaviours identified included rushing, standing to close to the platform edge when a train is departing/arriving or not at the platform, lack of awareness, (related at times to not seeing or realising the size of the step/gap and/or leaning on the train), crowding on the platform (especially when there were unplanned service disruptions), intoxication, sensory impairment (for example visual impairments), technology use (like mobile phones and tablets leading to distractions) as well as accidental slips, trips and falls (sometimes from a passenger making a physical mistake or misjudging the step).

Mills and Leach (2016) also identified several operational, rolling stock and infrastructure factors that contribute to PTI events. The infrastructure factors included the platform (notably when it was slippery, uneven, or had obstructions), as well as the height and width of the gap between platform and train. The operational contributory factors included maintenance on platform, dwell time, and service issues (such as inaccurate announcements, delays, changes, frequency, cancellations, staff errors, etc.). Rolling stock factors comprised of onboard space, train fittings, footsteps/plates and hustle alarm exits.

To improve safety on the platforms the following were prioritised:

- Raising awareness of PTI risks and facilitating behavioural change, through education, communication and staff interactions;
- Supporting and empowering vulnerable passengers or those requiring assistance;
- Providing staff with the skills, time, and equipment to better engage with passengers;
- Support reductions in PTI;
- Enhancing management of intoxicated passengers;
- Improving platform management and
- Improving the provision, location, and content of information for Customer Service.

6. METHODOLOGY

While the South African railway industry includes railway operators within the dangerous goods, raw material, passenger and freight business, the focus of this study is on the railway operators that are in the passenger business as these businesses will readily have passengers affected by PTI related risks. The Passenger Rail Agency of South Africa (PRASA) and Bombela Operating Company (BOC), trading as Gautrain, mainly transport passengers. PRASA, as reported by the SoS reports throughout the years, has been the operator to which most of the PTI occurrences were attributed. Consequently, this study focuses exclusively on PTI management within PRASA's network.

This study utilised a qualitative research method to collect meaningful and in-depth insights into the causes and potential solutions of PTI occurrences. The first method employed was to conduct a review of available literature on PTI management and standards in South Africa and other countries. Information from International Railway Safety conference papers and other international and local strategic documents were reviewed. The annual State of Safety Report 2019/20, compiled by the RSR was used to obtain the most recent statistics.

Secondly, an international benchmarking study focused on railway safety and the strategies that align best practice internationally was conducted. The objective was to evaluate strategies employed by organisations to minimise noted high PTI risks.

Thirdly, an analysis of 20 investigation reports was conducted noting any station design, security, PTI measurements, signage, and commuter behaviour failures. The intention of the investigation report analysis was to evaluate the specific factors that tended to contribute to PTI occurrences as well as identify the departments and fields the risk factors emanated from. The investigation reports were also used to weigh the effectiveness of existing control methods.

Lastly, an analysis of PTI occurrences as well as RSR and PRASA investigation reports was conducted. To effectively manage PTI risks, the first step is to identify the hazards at the station platforms. A hazard identification process through a risk assessment was carried out from this analysis to produce a risk identification and mitigation worksheet.

7. RESULTS & DISCUSSION

7.1 Investigation reports analysis

An analysis of 20 investigation reports was conducted. This analysis noted any station design, security, PTI measurements, signage, and commuter behaviour failures as investigated. The following table includes the summary findings and observations noted from the reports reviewed. The table containing the full analysis data is attached in the appendices (Appendix 1).

Table 1. PTI Investigation report findings & observations summary

Challenges	Observations & Findings
Passenger Behaviour	Passengers observed: • Using the bridge to access the station. • Walking past the exit gate after detraining and exiting the station illegally. • Jumping on the railway lines to move between platforms. • Accessing the station from the railway line at platform ends instead of using the normal access way. • Not using the access gate. • Embarking or disembarking trains that are in motion. • Having difficulties in entraining and detraining due to the height of the train.
Technology	• Trains get overcrowded. • Train delays and/or cancellations. • Shortage of trainsets. • Announcements at some stations are made through the public announcement (PA) system that is not audible or clear enough for at certain stations.
Training and Awareness	• Stations without information boards or other types of awareness material on the platform or coaches. • No procedure in place to guide the Customer Service agents on how, what, and when to announce to commuters when trains are coming into the stations, this is only communicated at the meetings. • The security personnel deployed at the stations do not have the skills and training to control the crowds.
Design and Maintenance	• No scheduled maintenance that takes place. • The vertical and horizontal platform clearance out of specification in accordance with track manual Annexure 1, Sheet 3 of 5 at most stations. • No PTI clearance measurements. • Many of the stations did not have access for people who are differently abled. • The digital information boards to alert commuters about the train service often not operational.
Safety and Risk Management	• Risk assessments frequently not conducted. • Conducted risk assessments are either generic with no consideration for PTI-related risks or include action plans where identified risks are not mitigated. • The platforms at a significant number of stations were vertically and horizontally misaligned. • The fencing at certain stations is frequently vandalised. • There is a shortage of security personnel at most of the stations, hence the stations cannot be properly secured and reluctance to stop commuters from entering and exiting the station through the platform ends.

The above table indicates that challenges were noted across a range of safety critical areas, pointing to a possible underlying systemic insufficiency fuelling PTI occurrences.

Passengers were observed illegally entering the platform; some entrained and/or detrained moving trains, while others moved from platform to platform by jumping on the railway line. Some passengers did not use the access gates and entered the platform at the platform ends from dilapidated fences. Passengers were reported to rush to the train during peak hours when it arrived. The absence of assistance devices for differently abled persons at most stations meant that persons with different abilities had to rely on others to get into the station as well as on the train and off the train. Some passengers were observed having difficulties entraining and detraining due to the height of the train. This difficulty is often inflated during peak hours when the train is full, increasing the risk of injuries.

It was reported that the Customer Services Department conducted safety awareness campaigns aimed at informing passengers of the dangers of trains and illegal crossing of railway lines.. The campaigns are conveyed through communication modes that convey messages directly to the commuters such as electronic notice boards and verbal announcements. These campaigns were, however, not conducted at all or most of the PRASA stations. Often the department did not evaluate the effectiveness of the campaigns and the absence of conducting the campaigns consistently across all stations. These campaigns may be more effective if PRASA evaluated if they were accomplishing their intended purpose and adjusting them accordingly. It may also assist if the safety campaigns were extended to the schools and communities in the surrounding townships.

It was reported that risk assessments were frequently not done at stations. At stations where risk assessments were conducted, they tended to be very generic, failing to address the risk of people falling on the platforms or the risk of having a misalignment of the vertical and horizontal clearance. Where the risk assessment included relevant hazards, action plans that emanated from the assessment were not rectified. For instance, an action plan for putting more security guards on site to address assault was never actioned or monitored. Action plans regarding preventing people from walking on the track and illegally entering the stations had not been implemented. One risk assessment had classified overcrowding as part of the risk but there was no mitigation plan to address the risk. In most stations at PRASA, the number of security personnel deployed did not match the requirement indicated in the security risk assessment. The shortage of security personnel at almost all stations contributed to the unsafe behaviour of passengers as there were not enough security personnel to enforce PRASA's access to the station rules or monitor behaviour at platforms and in the stations. This challenge of having an adequate number of security personnel is two-fold as the security personnel that are deployed are often outnumbered and under trained to manage crowds or de-escalate and respond appropriately in volatile situations.

Many of the stations did not have awareness material on their platforms and coaches, material warning passengers of gaps between the train and platform or to be careful when embarking or disembarking the train. While it was seemingly a practice at PRASA to make announcements at the stations, this was not consistently done as some stations did not have PA systems while others had no functional PA systems. Announcements were not conducted as frequently as is required at other stations due to the absence of a permanent announcer stationed at the station. When announcements were done, they were at times inaudible and hard to hear. Additionally, station announcers did not give passengers the same information when announcing. It was observed that the announcers were not given a written script that is repeated by all announcers. There was also no training implemented for the Customer Services personnel on how and when to conduct announcements at the stations. The personnel reported using their own discretion and having access only to a generic announcement checklist with no indication given of which announcements to prioritise.

All the stations investigated did not have an adequate number of security personnel or station marshals. It was communicated that the number of security personnel deployed at the stations was not based on the station size and service requirement. It was reported that it was a practice that only two guards were deployed per station; these security guards in the bigger stations often found it difficult to cover the entire station effectively. This has consequences for station safety as it was relayed that most incidents happen without the security witnessing it due to the small number of security personnel available. Another consequence of this was that the security personnel were always reactive, hardly able to prevent an injury or a death from occurring. A more concerning consequence of having an inadequate number of security personnel deployed at the stations is that it intensifies the likelihood of commuters disregarding safety procedures at the stations. This increases the likelihood of passenger behaviour at the stations not being managed. The unavailability of security personnel at the stations tacitly permits passengers to continue engaging in behaviours such as ignoring the hooter, jumping on the railway lines to move between platforms, attacking train drivers/ metro guards, vandalising station equipment, and entraining a moving train. The unsafe and inappropriate behaviour of passengers similarly increases their risk of suffering an injury while embarking or disembarking the trains.

Overcrowding on trains and at stations is a major issue that is influenced by several factors. It appears to be the area were all the minor failures from the different departments merge to create a hazardous situation. Often overcrowding is worse when there are service disruptions such as train delays and/or cancellations. These disruptions are often exasperated by a shortage of trainsets. Trainsets are frequently reported to be in short supply after other trainsets became defective. The challenge of overcrowding is further exacerbated when the communication informing passengers of delays, breakdowns, repairs and expected wait times is unavailable. It was noted that most stations did not have a train schedule and those that did had an outdated schedule. This increases the likelihood that passengers will rush to board a train, entraining while it is moving, jumping from one platform to the next via the railway line, etc. all to ensure that they get on the train at the station in case it is the last available train. Sometimes, passengers get on the train after having waited at the station for prolong periods of time. Other stations' ticket offices are not manned, therefore, access control is not always managed even at the stations where people do not access the station illegally. At other stations, the access control challenge is due to a inherent open system that is not enclosed or fenced. Such a system makes it easier to illegally enter the station.

7.2 Benchmarking summary

The summary of the benchmarking process that was conducted is included in Table 2 below.

Table 2. Benchmarking summary outline

Organisation	Strategy to Manage PTI Occurrences
Office of Rail and Road (ORR)	• Proactive inspections on risk management of PTI and other related activities such as emergency planning, crowd management at stations, driver competence training and conductor competence. • Ensure operators and train/locomotive designers and manufacturers are aware of infrastructure challenges to integrate solutions in all the trains/locomotives designs.
Railway Safety and Standards Board (RSSB)	• Creation and utilisation of the PTI Risk Assessment Tool for use as a primary approach to assess PTI risk at station platforms. • Prioritisation of redesign as a solution where PTI misalignment resulting in large gaps was recorded. • Accounting for passenger characteristics in managing PTI accidents.
Bangkok Mass Transit	• Mandated platform redesign to reduce the train and platform gap. • Fitting of Platform Screen Doors (PSDs). • Installing safety barriers with automatic doors on platforms including safety zones and fenced danger zones. • Passenger awareness through safety campaigns. • Assigning more station conductors (station marshals).
University of Addis Ababa	• Platforms redesign • Consideration for PTI risk during the design of trains. • Visible signage at the platforms. • Barrier installation • Assigning more station conductors/marshals especially during peak periods. • Installation of safety barriers or fences at stations. • Education of the public on PTI risks.

The table above shows that the organisations summarised used an array of different methods to reduce PTI occurrences and minimise the risk of injury for passengers on the platform. The many strategies employed made use of technological, communicative, training focused, risk management and resource enhancement methods to tackle PTI challenges. The strategies employed included conducting scheduled inspections to proactively ensure efficiency of processes, systems, and assets. Not using reactive risk mitigation methods. Other methods involved remaining aware of challenges to aid in the formulation of solutions and noting existing challenges and factoring that information in when designing new locomotives, trains, and stations.

The strategy that seems to be key is carrying out risk assessments with the risks identified being mitigated and solutions implemented. Another solution includes employing redesign as a mandatory and primary solution for platform misalignment and not making do with the challenge. Conducting awareness campaigns to inform the passengers was a commonly seen strategy as well as installing safety barriers to reduce the risk of injury from slipping, tripping, and falling at the PTI. Increasing the number of station marshals to reinforce the expected behaviour was also a commonly used strategy. Another organisation chose to factor in passenger characteristics when deciding on appropriate mitigation factors and strategies that aided in the design and implementation of effective PTI management measures.

From table 2, it is evident that the main strategies make use of the following:

1. Platform redesign to minimise PTI risks;
2. Increasing the presence of station marshals;
3. Installation of safety barriers that physically reduce the risk of falling or tripping at the gap;
4. Passenger awareness interventions; and
5. Proactive risk assessments and inspections.

It appears that organisations who have experienced PTI occurrences have adopted a system and risk-based approach to the management of safety risks and management of PTI risks.

7.3 Hazard identification

A risk assessment was conducted to identify the main hazards, causes and effects at the PTI from analysing PTI occurrences, RSR and PRASA investigation reports and literature review. The outcome of the risk assessment process is the risk log documented in a risk assessment worksheet shown in Appendix 2: Platform/train Interface Passenger Safety Risk Assessment Worksheet.

A further analysis was conducted to formulate a summary table including existing PTI controls implemented at PRASA stations and recommended controls to minimise the risks. The results of this exercise are collated in table 3 below.

Table 3. PRASA existing controls and recommended controls to mitigate PTI risks

Mitigating strategy	Hazard	Existing controls	Recommended controls
Hardware and Technology	Platform Train Gap	• Station modernisation program	• Redesigning of the platforms to reduce the gap between the train and the platform; and • Installation of safety barriers or fences with gates; and • Installation of platform gap fillers.
	Overcrowding	• PA systems	• Installation of safety barriers or fences; and • Platform supervision – CCTV.
	Poor lighting	• Maintenance plans	• Reinforcing the inspection and maintenance regime; and • Gap safety lighting.
	Passenger behaviour	• Station marshals	• Installation of safety barriers or fences with gates; and • Passenger announcements and community awareness sessions.
Policies and Procedures	Platform Train Gap		• Developing and implementing gap safety programmes; • Developing a manual to improve rail safety at PTI; and • Developing safe train dispatch procedures.
	Overcrowding		• Developing crowd control procedures
	Poor lighting	Maintenance plans	• Reviewing maintenance policies and procedures. • Reinforcing inspection and maintenance regimes.
	Passenger behaviour		• Developing and implementing policies for handling rowdy and disruptive passengers e.g intoxicated passengers..
Employee training	Gap		• Developing specific training for gap safety management for targeted employees, train crews, platform marshals and station staff.
	Overcrowding		• Developing specific training for crowd management for targeted employees, train crews, platform marshals, station staff and security personnel.
	Passenger Behaviour		• Developing specific training for handling passengers and make employees aware of policies and procedures to deal with rowdy and intoxicated passengers.
Passenger Awareness	Gap Overcrowding Passenger Behaviour	Awareness campaigns	• Developing railway safety educational modules to be taught at schools and universities; and • Reviewing and developing comprehensive passenger awareness programmes.

From an analysis of PTI occurrences, RSR and PRASA investigation reports and literature review, the main hazards identified at the platform train interfaces are:

- The platform/train gap;
- Overcrowding;
- Passenger behaviour;
- Poor lighting at station platforms and in the trains;
- Trains running late;
- Cancelled trains;
- Inadequate security and platform marshal deployment at stations;
- Insufficient asset maintenance; and
- Ineffective passenger communication.

The platform/train gap is of major concern in the PRASA network as most of the platforms do not conform to the platform standard. There are stations with a vertical gap that is as large as 500mm. These excessive gaps coupled with overcrowding during the morning and evening peak periods create a recipe for disaster at the PTI. The horizontal and vertical gaps between the platform and train floor are depicted in Figure 1. The SANS 3000-2-7 the Stations Standard stipulates that the horizontal gap should not exceed 275mm and the vertical gap shall not exceed 250mm.

8. CONCLUSIONS

This study set out to identify contributing factors to PTI occurrences. It identified that PTI incidents tended to occur due to failures in technological, risk management, safety management, training and awareness, design as well as maintenance strategies. Failures in these different areas, emanating from different departments within PRASA, point to a possible catastrophic failure of the safety management system related to PTIs.

When comparing the implemented control methods to manage PTI risks by PRASA to those employed by other organisations, it was evident that PRASA had significant gaps. Some of the control methods that were in place were not implemented across all the stations and having an inadequate number of resources was often a contributing factor. The organisations surveyed utilised five primary methods to manage PTI risks and of the five, PRASA had partially implemented two. However, from the data collected and analysed, it would be worthwhile for more resources to be dedicated to considering the feasibility of implementing some of the recommendations presented in this study.

RECOMMENDATIONS

Railway organisations throughout the world have developed and implemented numerous solutions to mitigate the PTI risks. The recommended solutions described below have been selected as they are more likely to be applicable to the South Africa railway environment taking into consideration cost and ease of implementation.

9.1 Hardware and Technology

Hardware and technology solutions can offer effective hazard mitigation and should be considered carefully. Engineered systems are advantageous because many are not prone to human error caused by not following procedures or not acting. There are many different types of hardware and technology used in the passenger railroad industry used to reduce the platform/train gap or to assist passengers to safely board or alight from trains. It is vital for station operators to thoroughly evaluate any proposed technology or hardware solutions because they may create other safety hazards. The operators must therefore carry out risk assessment of any proposed technology solutions to identify any additional risks arising from the proposed solutions.

The decision on the type of mitigation measures to employ at a particular station should be informed by the outcome of the station specific risk assessment. The following are some of the solutions employed world-wide directly extracted from the literature reviewed, which can be deployed in the South Africa railway environment, to mitigate the PTI risks:

9.1.1 Platform barriers and fences

Platform barriers or fences with gates offer a quick and cost effect solution to stop passengers from being trapped between the train and platform at overcrowded stations (especially during peak periods) and to stop passengers from falling onto to the track before the train arrives. Platform barriers can be installed at stations where overcrowding has been identified as one of the risk factors. Figure 8 shows platform barrier on the Hamburg-Berlin line in Germany.

Figure 8. Platform Barrier with gates

9.1.2 Moveable platforms

This is a more costly solution but can be deployed where the gap is excessive like on curved platforms where correction of gap by modifying the platform may not be feasible due a range of factors. Figure 9 shows a moveable platform at South Ferry New York Subway.

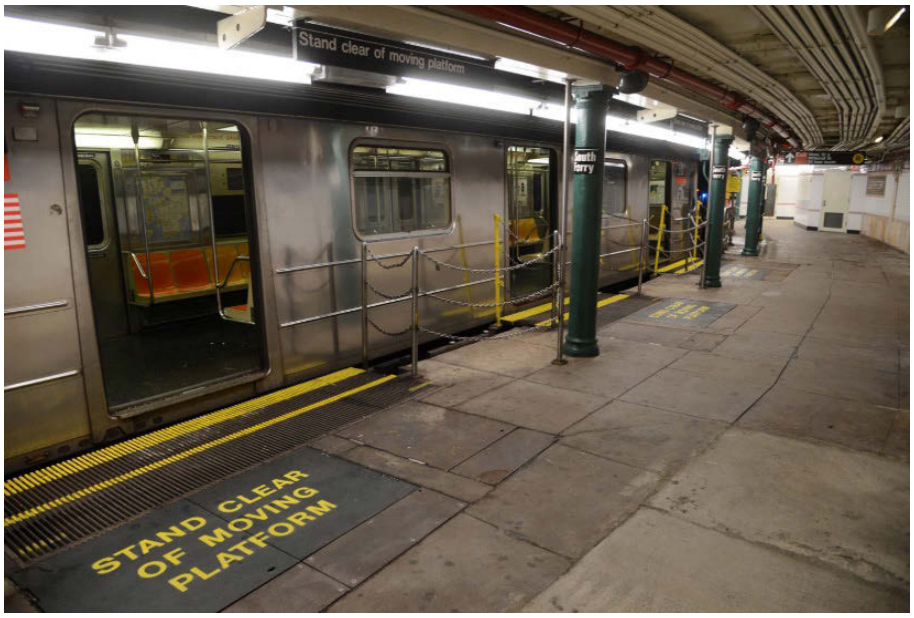


Figure 9. Moveable platform at South Ferry Station New York subway

9.1.3 CCTV for platform supervision

Modern trains have in-cab CCTV that relays pictures from multiple cameras that are set up so they can see the platform-train gap along the whole length of the platform even if crowded. Operators of older trains achieve the same ends using multiple CCTV monitors on the platform, opposite the driving position. Resolution is pretty good and virtually all incidents are spotted before a train moves.

9.1.4 9.1.4 Platform gap fillers and watch the gap stencils

Platform gap fillers shown in Figure 10 are mounted in strips along the edge of platforms to reduce the gap between the platform and the entrance of a passenger train ensuring that when a train has stopped at a platform, passengers are able to enter and exit safely.

Platform gap fillers are strategically located along the platforms where the train car doors open and can significantly reduce the likelihood of a passenger slipping through the gap between the platform and the train. This solution, custom made by Delkor Rail Australia, is suitable for the PRASA rail system as it was developed to overcome the large differences between gap sizes at various platforms in different locations, a scenario which exist in the PRASA environment [4].

Figure 10. Platform Gap Fillers

Figure 11. Wash the gap stencils

9.2 Policies and Procedures

Policies and procedures are an integral component of safe operation.

Operators need to have developed and implemented policies or procedures that serve as hazard mitigation strategies to improve safety of passengers at the PTI. The passenger railroad should use the hazard analysis to identify the specific types of policies and procedures that are needed. The hazard analysis may show that the railroad already has all the necessary policies and procedures in place. However, sometimes the analysis will indicate the need for new or modified policies and procedures to support the gap safety programme.

The following are some of the procedures and programmes which are being implemented by passenger operators in Europe, USA, UK, and which this research recommends being adopted by PRASA:

- Development and implementation of gap safety programme;
- Manual to improve rail safety at PTI (2017) [5] and
- Safe train dispatch procedures [6].

9.3 Employee training

Training is essential for establishing and maintaining employee involvement in mitigation strategies designed to minimise the risk posed by the gap.

Policies or procedures developed as PTI risk mitigation strategies should be addressed in training programmes, as necessary. The training should be focused on the groups that are responsible for carrying out the policies and procedures such as:

- Train crews;
- Maintenance staff;
- Station personnel;
- Station supervision;
- Station security; and
- Railway police.

Training should also be developed for those who deal directly with PTI issues.

The type of training that is provided will vary depending on the requirements for hazard mitigation. Train drivers and conductors may need training in such areas as:

- Look back procedures;
- Monitoring door openings and closings;
- Assisting special needs passengers on and off the train and
- Platform monitoring.

Track, rolling stock, and platform maintenance workers may require training in:

- Critical maintenance procedures that affect the platform/train gap;
- Approved inspection procedures for monitoring the platform/train gap and
- Quality control during and after maintenance procedures that affect the gap.

9.4 Passenger Outreach

A comprehensive passenger outreach program can serve as an effective method to enlist the help and cooperation of the passengers in gap safety. The program should utilize a variety of media to effectively present the information. The media may include:

- On-board announcements;
- Signage;
- Posters;
- Brochures;
- Seat Drops;
- Videos; and
- Onboard announcements can be used to address gap safety. Amtrak and some other railroads operating in the northeast include "watch the gap" in the conductors' station announcement.

Signage instructing passengers to "watch the gap" in the vestibule or on the station platform may also be appropriate. However, it is important not to provide so much signage in the vestibule area as to become ineffective or to detract from other important signage in the area.

Posters with gap safety themes can be mounted on advertising racks throughout the train. Gap safety (or general safety) brochures can be in racks next to train timetables or incorporated in public timetables distributed to passengers. Additional information can be included on tickets or monthly passes. On some railroads, seat drops may be appropriate. Seat drops are brochures, letters, or pamphlets left on every passenger seat at the beginning of service. Each passenger would have to pick up the material before sitting. Videos are another important tool – especially on commuter railroads that have advertising or information monitors on their trains or platforms.

Passenger outreach announcements and materials should be clear and concise but detailed enough to define the gap and the related safety issues. The message should be targeted at all passengers – both regular customers and one-time users – so that everyone will fully understand the gap issue and act accordingly.

9.5 Passenger behaviour

Passenger behavior is often random and hard to control. Train crews are hard pressed to reliably predict what a passenger may do next. However, there are steps that can be taken to influence or respond to undesired passenger behavior – especially behavior that may lead to unsafe acts during boarding and alighting from trains.

The key to responding to unsafe passenger behavior is to have policies and procedures in place to address the issues as they occur. The responsibility for developing the policies and procedures belongs to the passenger operators but the responsibility for addressing the behavior rests primarily with the on-board crew. Passenger operators should establish passenger behavior policies and insist that their crews enforce those policies. The railway operators should determine if there are adequate existing policies in place to address the types of behavior that lead to gap safety issues.

Passenger behavior issues are delicate issues, but they must be addressed in a consistent and responsible manner. The railway operator must provide their onboard crews with the tools that they need to control the situation. This includes the policy, appropriate training, and support when the policy is applied. If a passenger railroad uses new or existing policies as a hazard mitigation strategy, then the policies must be enforced. The passenger railroad should use efficiency testing or observations to ensure that crews consistently follow the policies.

Other types of passenger behavior can be broken down in a similar way. Using a hazard management team to explore passenger behavior issues by asking questions and reviewing policies can lead to identifying appropriate mitigation strategies to address the behavior.

PTI risk accounts for the largest proportion of passenger fatality risk, and the second largest proportion of passenger FWI risk. Although most of the PTI FWI risk occurs while boarding or alighting, most of the PTI fatality risk occurs while not boarding or alighting the train.

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APPENDICES

Appendix 1: Findings and observations from PTI investigation reports.

Station	Station design	Signage	Commuter Behaviour	Security Visibility	PTI Measurements	Challenges
Angus station on the Vereeniging railway line	Overcrowding		• Illegal platform entrance • Train surfing • Some passengers walked past the exit gate after detraining and exited the station illegally just after the platform	More security requested Inadequate security	None submitted *	• Lack of funding to cater for the defects that are reported • Hard to monitor whether the safety campaigns are successful • Generic risk assessment not actioned
Barracks Station	• Uneven platform • Overcrowding • No ticket office and the station are not manned	Faded yellow markings on the platform that indicate the safety clearance for the trains	Injured whilst trying to board the train in motion	Inadequate security	None submitted *	• Access control challenge is due to an inherited opened system that is not enclosed or fenced. • Generic and not specific risks related to Barracks station, for example it talks about parking area and ticket office, but there is no parking area and ticket office at Barracks station. • Planned maintenance is not conducted due to the unavailability of maintenance equipment • Perway clearance

Cape Town Station	• Overcrowding especially if there are delays and cancellations • No provisions for people with disabilities.		Jump off from the train that is in motion and when commuters get pushed and fall on the platforms	Inadequate security	Vertical clearance from platform 1-23 is reasonably off None submitted *	• Train delays and cancellation contribute to most of the incidents at the platforms • Platform clearance for Perway does not corresponds to the standard of platform clearance in the track manual • Generic RA • Train cancellations
CT- Claremont	• Overcrowding • No provisions for people with disabilities • Platform vertical and horizontal misalignment	• No warning boards that specifically address or warn commuters of platform	• Train surfing • Commuters fall while trying to board a moving train	Inadequate security or platform marshals	None submitted *	• Poor PA system • Electronic information boards are not working at some of the stations along the section Digital boards at the some of the stations are not operational.
Capital Park to Koedoespoort	• Overcrowding • Vertical and horizontal gaps	• No digital information boards • No PA system • Info boards not present at all stations	• Illegal platform entrance • Squatters living at stations • Jumping on the railway lines to move between platforms, ignoring the hooter, vandalise station equipment, attacking train drivers/ metro guards and entraining a moving train	Inadequate security or platform marshals	None submitted *	• Vertical and horizontal gaps No one manning ticket office (no access control to the stations) • Shortage of trainsets due to a shortage of critical components. • No risk assessment

Doornfontein Station	• Overcrowding • Vertical and horizontal gaps	• PA not operational digital destination boards not functional	• Commuters are accessing the station at platform ends instead of using the normal access way • Few using access gate embarking or disembarking trains that are in motion	Inadequate security or platform marshals	None submitted *	Commuters were not alerted about the dangers of vertical and horizontal gaps between the trains and platforms
Dunswart – Delmore	• Overcrowding • Large vertical and horizontal gaps • No accommodation for disabled people	• PA not operational digital destination boards not installed	• Commuters were pushed while disembarking trains and fall on the platform at the stations	Inadequate security or platform marshals	None submitted *	Elevator has never worked since it was built
Dunswart– Daveyton	• Overcrowding • Large vertical and horizontal gaps • No accommodation for disabled people • No access control	• PA not operational • Digital destination boards not functional	• Commuters are accessing the station at platform ends instead of using the normal access way	Inadequate security or platform marshals	None submitted *	Elevator has never worked since it was built

Durban – Clairwood Corridor	• Overcrowding • Vertical and horizontal gaps • No accommodation for disabled people	• Digital information boards not functional • Faded yellow clearance markings	• Illegal platform entrance • Passengers are boarding moving trains.	Inadequate security or platform marshals	None submitted *	• Shortage of trainsets • No risk assessment
Eatonside-Vereeniging Corridor	• Overcrowding • Large vertical and horizontal gaps		• Illegal platform entrance • Passengers are boarding moving trains.	Inadequate security or platform marshals	None submitted *	• Shortage of trainsets • No risk assessment
Sarepta–Langa	• Overcrowding • Large vertical and horizontal gaps • No accommodation for disabled people	• PA not operational • Digital destination boards not functional		Inadequate security or platform marshals	None submitted *	Station not fenced
Mzimhlophe - Naledi Corridor	• Overcrowding • Large vertical and horizontal gaps • No accommodation for disabled people • No access control • Insufficient or no lighting at several stations	• PA not operational • Digital destination boards not functional	Commuters are accessing the station at platform ends instead of using the normal access way	Inadequate security or platform marshals	None submitted *	• Station not fenced adequately • Shortage of trainsets

Koedoespoort-Pienaarspoort Corridor	• Overcrowding • Large vertical and horizontal gaps • No accommodation for disabled people		• Passengers are boarding moving trains.	Inadequate security or platform marshals	None submitted *	• Station not fenced adequately • Shortage of trainsets
Isando Station	• Overcrowding • Vertical and horizontal gaps • No accommodation for disabled people		• Illegal platform entrance • Passengers are boarding moving trains.	Inadequate security or platform marshals	None submitted *	• Shortage of trainsets • Station not fenced adequately
Koeberg – Athlone	• Overcrowding • Large vertical and horizontal gaps • No accommodation for disabled people • No access control	• PA not operational • Digital destination boards not functional	Illegal platform entrance	Inadequate security or platform marshals	None submitted *	
Wadeville – Kwesine	• Overcrowding • Large vertical and horizontal gaps	• No safety notices • No train schedules displayed	• Illegal platform entrance • Passengers are boarding moving trains.	Inadequate security or platform marshals	None submitted *	Machinery shortage for maintenance

South Coast Stations	• Overcrowding • Large vertical and horizontal gaps • No accommodation for disabled people	• PA not operational • Digital destination boards not functional	Commuters are accessing the station at platform ends	Inadequate security or platform marshals	None submitted *	• Shortage of equipment/machines (tamper and screening machines)
New Canada Station	• Overcrowding • Large vertical and horizontal gaps • No accommodation for disabled people • No access control		• Illegal platform entrance .	Inadequate security or platform marshals	None submitted *	
Refinery – Jupiter	• Overcrowding • Large vertical and horizontal gaps • No marking on platform edge					• Poor station maintenance
Zwelethu-Umlazi Corridor	• Overcrowding • Large vertical and horizontal gaps • No accommodation for disabled people • No access control	Digital destination boards not functional	• Commuters are accessing the station at platform ends • Walking on the railway line	Inadequate security or platform marshals	None submitted *	• Shortage of trainsets • Station not fenced adequately

Appendix 2:

PLATFORM-TRAIN INTERFACE PASSENGER SAFETY RISK ASSESSMENT WORKSHEET			
HAZARD IDENTIFICATION			MITIGATION APPROACH
Hazard	**Cause**	**Effects**	**Mitigation Strategy**
Excessive Train or platform gap	• Misalignment between train/ platform designs • No/Poor maintenance of track and RS	• People fall into tracks • Caught between train and platform	• Platform Screen doors Correct gaps to set standards. • Passenger announcement policy includes watch the gap • Announcement at all stations
Crowding at platforms	• Peak periods: • Trains running late • Few trains • No crowd management plans/strategies (lack of management leadership)	• Increased PTI incidents • Slips • Falls • Fainting • Pick pocketing • Theft of passenger valuables e.g. cellphones, bank cards	• Initiate crowd control procedures during special events Policy requiring a station platform monitors especially during peak periods • Passenger train dispatch and platform safety measures
Train doors not closing (Old trains)	• Poor maintenance • Lack of spares • Absolute rolling stock • Lack of management control • Vandalism	• Passengers alighting or boarding before train stops resulting in falls Passengers boarding departing moving trains resulting in falls	• Daily car inspection requires that all mechanical and electrical door interlock devices be in working order • New policy established to take trains with malfunctioning interlocks out of service
Poor lighting at platforms	• Poor maintenance • No maintenance plans • Lack of management control		• Light survey every 24 months • Installation of additional light sources • Frequent maintenance of lighting sources
Slippery platform (rain season)	• Poor drainage • Poor maintenance	Boarding or alighting train passenger could slip and fall into the gap.	• Establish new maintenance policy to include platform drainage inspection • Passenger announcement policy includes warning about slippery conditions during rain or snow events • Passenger announcement policy includes watch the gap announcement at all stations • Follow existing maintenance and inspection plan to verify proper track alignment to platform • Change specification for platform painting to include abrasives to improve footing

Potholes on platforms	No maintenance		• Regular station maintenance • Compliance with applicable maintenance standards
Passenger caught in closing door (new trains)	Train crew not attentive while closing the door.	Passenger caught in door or falls in gap as train moves.	• Operating instructions include door closure and look back procedures • Training of crews on departure procedures • Efficiency testing and observations policy includes requirements from observing crews during look back procedures • Daily car inspection requires that all mechanical and electrical door interlock devices be in working order • New policy established to take trains with malfunctioning interlocks out of service