FEASIBILITY STUDIES OF SOLUTIONS TO ADDRESS INFORMAL PEDESTRIAN CROSSING OF THE RAILWAY LINES IN THE CITY OF CAPE TOWN

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ABSTRACT

In the City of Cape Town, pedestrians follow desire lines and cross railway lines to access public transport, public facilities and employment areas. The informal crossing of railway lines is unsafe and has resulted in many fatalities and severe injuries with disruptions to the commuter rail service. Locations in which informal crossings and/or injuries and fatalities are concentrated are called "Hotspots" and 17 such locations have been identified and prioritized for intervention. GIBB (Pty) Ltd was appointed in 2016 to undertake detailed site investigations, identify proposed interventions and prepare conceptual designs where pedestrian bridges or underpasses are proposed as interventions for Hotspots. A Cost Benefit Analysis (CBA) based methodology was developed in the absence of local and international warrants to aid in deciding when new pedestrian bridges or underpasses can be regarded as an appropriate intervention. The methodology developed provides a tool which can be used by decision makers who need to address either informal crossing of railway lines or major roads. The project as a whole also provides many valuable lessons to be considered, notably the need for the collection of data that is of a high quality.

1 INTRODUCTION

1.1 Background

In the City of Cape Town, pedestrians choose to cross rail lines to access public transport, public facilities (e.g. schools, clinics, municipal offices, etc.) and employment areas (e.g. industrial areas). The informal crossing of railway lines is unsafe and has resulted in fatalities and severe injuries with disruptions to the commuter rail service. Furthermore, such incidents have a traumatic impact on train-drivers who cannot prevent such incidents from occurring (Bokaba, 2005; Rail Safety Regulator, 2018) and likely have a similar impact on the families of casualties (e.g. the loss of a bread winner).

A comprehensive study to investigate informal pedestrian movement along and across rail lines in the City of Cape Town's area – the "*NMT Rail Hotspot Identification Study, 2014"* – was undertaken between April 2013 and May 2014. The study focused on the identification of locations where informal crossings and/or injuries and fatalities are concentrated, called Hotspots, and proposed interventions to address these locations. During the assessment of the rail corridors, 17 Hotspots were identified and prioritised using multiple criteria

analysis including volume of pedestrian movement along and across railway lines, number of pedestrian casualties and frequency of train movements.

GIBB (Pty) Ltd was then appointed in 2016 for the contract for the *"Provision of Professional Services to Develop the Feasibility Studies and Conceptual Designs for City Wide Hotspot locations Along and Across Railway Lines"*. The purpose of the project was to undertake detailed site investigations, identify proposed interventions and prepare conceptual designs where pedestrian bridges or underpasses were recommended.

1.2 Purpose of the paper

The paper aims to share the methodology developed and applied in the feasibility studies, and lessons learnt with other transport authorities who are likely dealing with such issues so that they may consider adopting a similar approach. While the paper focuses on addressing the informal crossing of railway lines, the methodology is also applicable to informal crossing of major roads.

1.3 Scope of the paper

The paper will explain why the "*NMT Rail Hotspot Identification Study, 2014"* was commissioned, what the project entailed and what its conclusions were. It will then describe the process followed in the "*Provision of Professional Services to Develop the Feasibility Studies and Conceptual Designs for City Wide Hotspot locations Along and Across Railway Lines"* project and, specifically explain the use of drones to survey Hotspots and the development of a Cost-Benefit Analysis (CBA) based methodology to aid in determining whether or not an pedestrian bridge or underpass should be constructed.

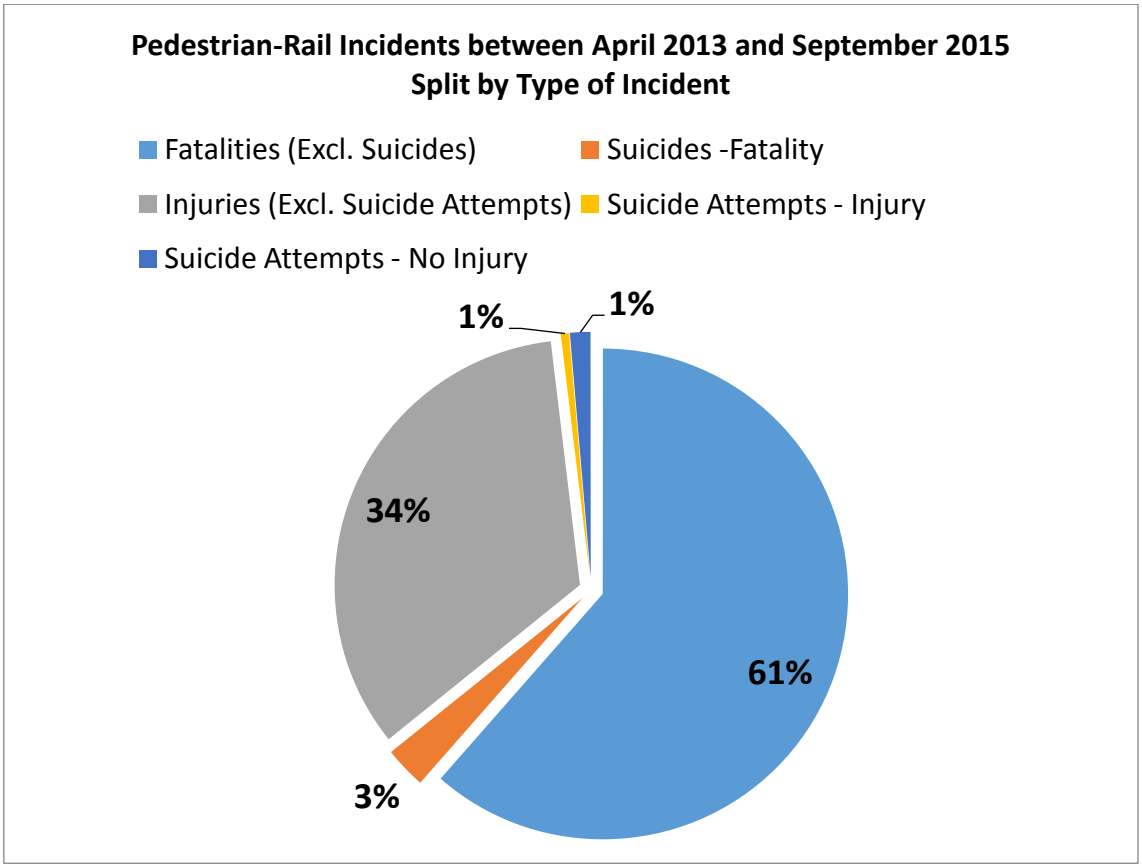
The paper will not include the details of the calculations or share the outcomes of the investigations for specific Hotspots.

2 NMT RAIL HOTSPOT IDENTIFICATION STUDY, 2014

2.1 Background

The City of Cape Town routinely conducts non-motorised transport (or "NMT") surveys and awareness programmes and whilst doing so, pedestrians were regularly observed in the rail reserve crossing and walking along rail lines. This behaviour generally forms part of pedestrian's desire lines and is often part of their journey to places of importance (e.g. public transport, amenities, employment centres and so forth), however the crossing of railway lines is unsafe and illegal, and has resulted in fatalities and severe injuries. When pedestrians are struck by trains it results in disruptions to the commuter rail service for recovery purposes, financial costs or a possible large-scale human impact (Rail Safety Regulator, 2017).

An analysis of primary data of incidents along railway lines within the Cape Town area received from the Rail Safety Regulator (RSR) for the period of April 2013 to September 2015 was undertaken. Of the 498 incidents recorded for this period, 366 involved pedestrians. A breakdown of the pedestrian related incidents is shown Figure 1 below.



Source: Based on primary crash data received from the Rail Safety Regulator

Figure 1: Type of pedestrian-rail incident between April 2013 and September 2015

Approximately two-thirds of all pedestrian-rail incidents during this period resulted in fatalities and the balance in injuries. Five percent were suicides or attempted suicides. The majority of pedestrian fatalities and injuries are, therefore, pedestrians being struck by trains whilst crossing or walking along railway lines or at stations. It can be conjectured that the majority of these incidents are commuters or persons accessing services.

It should be noted that a current shortcoming of the primary data is that, where incidents do not occur at stations, they are recorded according to the two stations adjacent to where the incident occurred. This is not precise enough given that stations can be spaced very far apart. Where incidents occur near to stations, the data does not indicate on which side of the station the incident occurred.

To address the problem of pedestrians being struck by trains, a request was submitted by representatives of the Passenger Rail Agency of South Africa (PRASA) through the former Rail Steering Committee to investigate the movement of pedestrians across railway lines in the City of Cape Town.

The terms of reference for the project were to investigate and map the NMT movements along and across railway lines in the City's area, identify the NMT rail Hotspot locations and provide recommendations to address the locations where regular pedestrian movement occurs. Investigation of the rail network and operations included the following aspects:

- Identification of all formal vehicle and pedestrian level crossings and availability of street-to-street access at stations.
- Review of incident data (data provided by Metrorail).

- Review of aerial photography to identify desire lines.
- Review of the rail corridor operations (number of trains scheduled to determine frequency).
- Stakeholder interviews with the Metrorail Area and Station Managers.
- Review of existing legislation, warrants and safety operations.
- Assessment and identification of institutional responsibilities.

2.2 Level crossing assessments

Vehicle level crossings were included in the investigation as large numbers of pedestrians cross rail lines via vehicle level crossings e.g. pedestrian movement along Military Road in the Steenberg area. Twenty four pedestrian and vehicle level crossings were visually audited and assessed in terms of NMT infrastructure, pedestrian protection and accessibility, access control systems, fencing and signage (13 vehicle level crossings and 11 pedestrian level crossings).

2.3 "On-track" video observations

High quality video recording devices were mounted on the front and back of moving trains in order to capture actual NMT movement along and across the rail lines for all the rail corridors. The video recording devices used have a wide angle view lens which made it possible to also capture the rail reserve fencing. Due to poor light conditions in the winter months, the video recordings were undertaken during the PM peak period between 16:00 and 18:00. The video footage was used to capture the following information onto the GIS:

- NMT movement along railway line.
- NMT movement across railway line.
- Infrastructure (pedestrian bridges/subways, road bridges and level crossings).
- Locations/ sections where rail reserve fencing is missing.

2.4 "Hotspot" identification, surveys and ranking

The rail network and operations investigation (which included the accident data) and on-track video observations were used to identify the 17 Hotspot locations. A Hotspot is defined as a location where large numbers of pedestrians regularly informally cross railway lines with a history of fatalities or significant probability of incidents due to the high number or frequency of crossings. It must be noted that apart from the 17 Hotspots, there are also other informal crossing locations. The Nomzamo crossing in the Strand area was a known Hotspot that has been investigated and was, therefore, excluded from the Hotspot identification process.

Additional field surveys were undertaken at the 16 Hotspot locations during the AM peak period (05:30 – 08:30) and Midday period (12:00 – 15:00). For these surveys, NMT movement was counted along the rail lines, across the rail lines and also pedestrians that access and get off the platform onto the tracks instead of using the station access.

The survey data was used as input into the multi-criteria analysis (MCA) and the 17 Hotspots were ranked, which was in essence a prioritisation for intervention. Interventions were then proposed and included fencing, NMT pathways, pedestrian bridges/ underpasses, signage indicating that informal crossing of rail lines are illegal and awareness campaigns.

2.5 Findings from the Hotspot Identification Study, 2014

The Hotspot Identification Study produced the following conclusions:

- Informal pedestrian crossing of the railway lines is a common occurrence in the Metro South East (Langa to Kapteinsklip Stations and Langa to Chris Hani Stations) due to the lack of formal crossing opportunities in the form of pedestrian bridges/ underpasses and vehicle bridges.
- Pedestrians undertake informal pedestrian crossings to save time (they follow the most direct route) and money (rather walk than pay for public transport). However, the purpose for crossing could also be as simple as *"… to collect firewood for heating and cooking on the other side of the railway line."* (Statement made during an engagement with the Rail Commuter Forum).
- Incidents (fatalities from a pedestrian/ train related incident) between stations are ascribed to the nearest station as incidents are not captured according to the geographic location.

Of the 17 Hotspot locations identified during the investigation, feasibility studies have been completed by service providers for the Nomzamo crossing in the Strand area and the area south of Nyanga Station. Feasibility studies to determine the required interventions were required for the 15 remaining Hotspot locations.

3 FEASIBILITY STUDIES FOR THE 15 NMT RAIL HOTSPOTS

The City of Cape Town appointed GIBB (Pty) Ltd as a technical service provider to develop the feasibility studies and conceptual designs for city-wide Hotspot locations. The feasibility studies would include surveys, data collection, site analysis, identification of appropriate interventions, determine pedestrian bridge or underpass locations (should it be the recommended intervention) and prepare concept designs.

3.1 Lessons learnt from site visit

The data collection phase began with site visits by the project team to various railway and road Hotspot locations on Monday, 8 February 2016. The Hotspot locations were selected to demonstrate the typical problems associated with Hotspots and the potential solutions. The site visits provided an understanding of the context of informal pedestrian crossings and specific aspects such as fencing, bridges, landscaping, vandalism of fences and bridges and use of the rail reserve as a corridor for NMT movement.

Some of the key lessons learnt were:

- Fencing should be implemented with pedestrian bridges, as many pedestrians will still cross at-grade.
- The fencing provided must be robust and capable of withstanding vandalism. The use of steel or concrete palisade fencing and vibracrete walls were found to be ineffective (particularly the former). High concrete panel walls (approximately 3m tall) have proven to be very effective thus far (installed south of Nyanga Station).
- The placement, horizontal alignment, responsiveness to the surroundings and provision of approaching footways are critical for ensuring the success of the pedestrian bridge.

- Transport engineers that conduct Transport Impact Assessments for new developments that will be situated near railway lines and the authorities that approve these developments must consider the need for pedestrian bridges or underpasses.

3.2 Project Management Team (PMT)

The PMT comprised officials from relevant City Departments and representatives from PRASA/ Metrorail. The main objectives of the PMT were to introduce the project to key stakeholders, finalise the project methodology and establish the core technical team.

3.3 Data collection for all Hotspots

An extensive data collection exercise was undertaken (both desktop and primary sources) as input into the site analysis and the following information was collected:

- Services information: electrical (City and ESKOM), potable water, stormwater, sewer, telecommunication.
- Railway track speed limits acquired from Metrorail (Raymond Maseko).
- Future rail corridor widening scheme acquired from Metrorail (Piet Cilliers, Raymond Maseko and Duma Goso).
- Lidar data for all Hotspots covering areas ranging from 0.35km^2 to 3.84km^2 sourced from the City.
- Proposed developments from the City's Spatial Planning and Urban Design Department (SPUD) as well as PRASA CRES (Moseli Ntsiki).
- Google Earth kml files of land owned by the City of Cape Town, Biodiversity Network with protected areas, initiation sites, open watercourses, wetlands and urban conservation areas.
- Land ownership.
- Drone survey of pedestrian movement during the AM peak period for 12 Hotspots.
- Manual counts of pedestrian movement during the AM peak period for 3 Hotspots.
- Interviews of pedestrians crossing informally by way of a questionnaire.

3.4 Application of drone technology and manual counts

- The necessary permission was obtained from Metrorail prior to the commencement of the surveys and where needed, arrangements for security were made.
- Reconnaissance site visits were conducted during peak period prior to surveys being conducted, to ensure that pedestrian activity at the Hotspot did not diminish and determine which method of survey would be appropriate.
- Twelve of the 15 Hotspots were considered too complex for manual counts and were selected for aerial drone footage. Footage of the 12 selected Hotspots has been recorded and detailed analyses completed.
- The drone footage was recorded during the morning peak period (05:30 to 08:30) at a height of approximately 50m. The summer months were selected for the recordings to ensure adequate visibility of pedestrians and to avoid inclement weather which is less likely during summer.
- The footage from the drones were analysed in detail to identify pedestrian desire lines and then count the number of pedestrian travelling along these desire lines.

- The analysis of the pedestrian movements were categorised as:
  a. Street-to-street movement; that is, pedestrians crossing the railway line to get from one street to another,
  b. Direct 'illegal' platform access. This entails pedestrians climbing on or off the ends of station platforms, to either evade fares or for convenience, and
  c. Longitudinal movements along the railway lines. This involved pedestrians using the rail tracks, rail maintenance road or rail reserve as a pathway.

- The footage was extremely valuable in identifying how many pedestrians cross at the different crossing locations (desire lines across the railway lines) and the purpose for being within the rail reserve (as categorised above).

3.5 Mapping of the survey information and utility services

GIS maps were developed of the pedestrian movement (captured from the drone footage and manual surveys). The maps reflect the pedestrian volumes per pedestrian desire line, categorised by movement type (as explained in the previous section). A map that was prepared for one of the investigated Hotspots located east of Langa Station is included overleaf as Figure 2 as an example.

Utility services and other relevant information were mapped separately (e.g. flooding, road based public transport, fencing, general observations made during site visits) for each of the Hotspot locations, as inputs for ultimately developing an appropriate intervention for a particularly Hotspot.

3.6 Cost-Benefit Analysis based methodology

During the course of completing the project, it was established that a structured methodology for determining under which circumstances a pedestrian bridge or underpass should be provided across railway lines was lacking – both locally and abroad. It was, therefore, necessary to develop a methodology for this project specifically.

A methodology based on the principles of a Cost-Benefit Analysis (CBA) was developed to appraise a proposed pedestrian bridge or underpass. The pedestrian bridge or underpass is targeted at serving the street-to-street movement category of movements identified at Hotspots. The other movement categories i.e. accessing stations illegally or walking within the rail reserve without crossing, are not best addressed by pedestrian bridges or underpasses.

A fundamental input from Metrorail was that they plan to close off the rail reserve at Hotspots by constructing high concrete walls (as mentioned earlier, such walls have been effective at Nyanga Station). The wall is, therefore, a separate project to the construction of a pedestrian bridge or underpass and, thus, in terms of a CBA based methodology:

- Economic benefits would only comprise the value of time saved by pedestrians making use of a pedestrian bridge or underpass as opposed to walking to the next available crossing opportunity. The savings that would arise from zero disruptions to train services, prevention of cable theft or lives saved were not considered, as these would occur as a result of the wall i.e. regardless of whether or not a pedestrian bridge or underpass is implemented. Economic costs comprise the construction cost of the pedestrian bridge or underpass as well as approaching pathways, lighting and the accommodation or relocation of utility services. The cost of constructing the wall,

however, is excluded as the wall will be constructed whether or not a pedestrian bridge or underpass is constructed.

- The Benefit-to-Cost Ratio (BCR) is, therefore, the value of time saved by pedestrians relative to the cost of constructing and maintaining the pedestrian bridge or underpass and associated infrastructure.

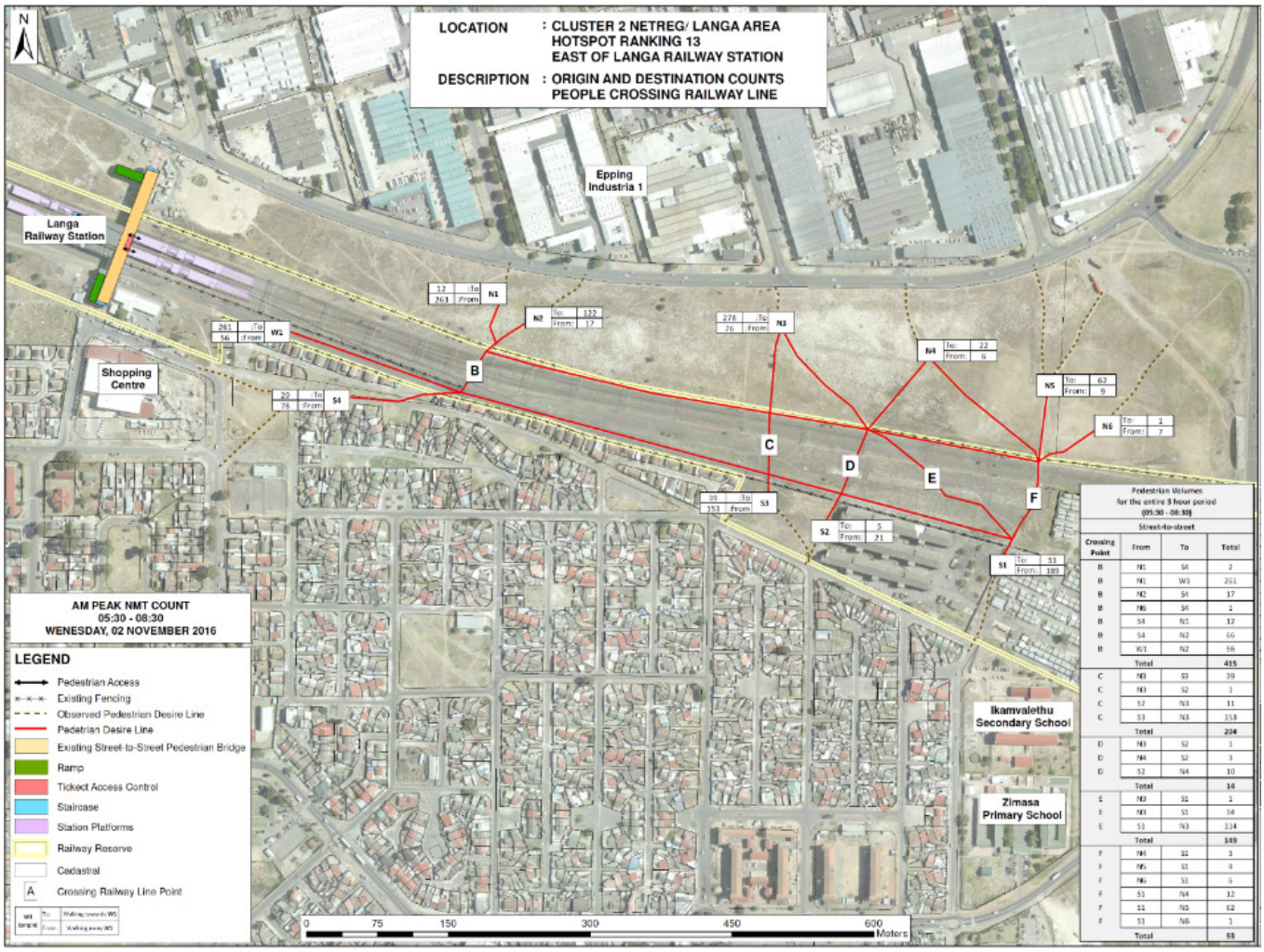


Figure 2: Example of pedestrian movement map – East of Langa Station

A MS Excel spreadsheet model was developed to facilitate and standardise the above calculation. Some of the steps and inputs required for its use are:

- Selecting the position, horizontal alignment of the structure and stairs and ramps, and the horizontal alignment of the pathways, and then measuring the lengths of these components.
- Estimating the detour routes that pedestrians would walk to the next nearest crossing opportunity following the construction of a wall only; and then the routes walked by pedestrians following the construction of both a pedestrian bridge or underpass and wall. The distances of the detour routes for the two scenarios are then measured.
- Estimating the volume of pedestrians per desire line for both of the above scenarios.
- Determining the population growth rate for the area to escalate the pedestrian volumes per annum. Statistics South Africa's census data was used in this regard.
- Estimating NMT trips generated by planned developments or public transport facilities near the Hotspot.

The above are inserted into the MS Excel spreadsheet which then computes a BCR that helps to inform the decision on whether a pedestrian bridge or underpass should be constructed.

3.7 Interpretation of results of CBA based methodology

A BCR that is greater than 1 implies that the cost of the infrastructure project is justified. However, the methodology and associated MS Excel spreadsheet is not perfect, as it relies on assumptions e.g. the demand to cross at the Hotspots would remain, the detour routes that pedestrians would use following the implementation of a wall etc. For this reason, engineering judgement must be applied when using this methodology.

Other inputs that should be considered are:

- Stakeholder comments e.g. the public, regional transport engineers, planners and urban designers and so forth
- Consideration of other interventions (discussed hereafter)

3.8 Other intervention options

Other appropriate interventions could be implemented whether or not a favourable BCR is determined for a proposed pedestrian bridge or underpass at a Hotspot. For example, a road-over-rail bridge present within a reasonable walking distance of a Hotspot could be upgraded to include better NMT facilities as opposed to constructing a new pedestrian bridge or underpass.

4 CONCLUSIONS

The number of fatalities and injuries that occurred along and across railway lines between April 2013 and September 2015 are unacceptably high. Based on observations of Hotspots since 2015, it appears that informal crossings of railway lines have become more prevalent and therefore, the rate of fatalities and injuries could have increased since 2015.

The fatalities and injuries that occur along railway lines result in disruptions to rail services, traumatise train drivers, have financial-costs and may take away or maim the bread-winners of families (often the poor, who walk to save on fares).

Interventions are urgently required, but these interventions must be appropriate, well-planned, effective (e.g. complementary use of high concrete walls – not palisade fencing) and, given the City's limited resources, only provided where really required (where the cost is proportionate to the benefit).

This project has demonstrated the value of high quality data such as that provided by the use of drone footage i.e. accurate data on the number, directions and purpose for walking within the rail reserve. High quality location data (i.e. geo-tags) on where pedestrian fatalities and injuries occur along railway lines can assist further in developing interventions.

This problem should also be dealt with proactively (not only after Hotspots have been created). When new developments that are expected to generate or attract significant amounts of pedestrian traffic are being planned or approved by authorities, pedestrian bridges or underpasses must be considered.

Lastly, it should be noted that this problem is not unique to railway lines, as many pedestrian fatalities and injuries occur on highways and freeways. Consideration should be taken of the lessons learnt and the use of the methodology developed for this project.

5 REFERENCES

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