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Improving of Platform Train Interface (PTI) Safety Based on Platform Screen Door (PSD) Technology at (KTM Serdang and LRT Terminal Bersepadu Selatan)

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Abstract: The goal of this research is to give background information on platform-train-interface (PTI) safety as well as examples of best practices. First of all, the Platform Train Interface (PTI) are the boundary between the platform and the train (or track if no train is present). Common accidents happen such as slips, trips and falls while getting on and off, people can be trapped in the train doors and dragged along, fall onto the track and be struck by the train. Passengers may be injured if they fall through a gap between the train and the platform. In order to increasing and maximizing the safety passenger at platform, Platform screen door technology have been applying at the platform. Platform screen doors (PSD) are the sliding barrier doors installed at the edges of station platforms in many modern metro stations and occasionally on heavy rail systems. This system serves many functions among which are the suicide prevention, optimization of station energy consumption and safety, particularly by shielding passengers from gaining access to the rail tracks. In order to get the data related to main train platform hazard and how PSD system can help in term of passenger's safety, survey questionnaire and HIRARC analysis has been use in this project at 2 non-PSD system train station. In this study, we able to achieve 155 respondents which consists of students, station staff and general user for the questionnaire and for HIRARC analysis we able to list down 3 main activities that can contribute to accident happen at train platform. The result shows that Platform Screen Door Technology have a big potential to become the new standard door system at all train platform in term of safety toward passengers and accidents prevention. With 91% of the respondents consisting of the educated class agree PSD system are efficient and suitable to be apply in all train in Malaysia.

Keywords: Platform Screen Door (PSD) System, Rail Accident Investigation Branch (RAIB), HIRARC Analysis and Survey Questionnaire

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1. Introduction

Platform Screen Doors (PSD) refer to door systems that are usually installed at platform edges of modern metro stations. They serve purposes such as safety precautions, thereby shielding passengers from gaining access to the railway lines. This, of course, prevents the danger of accidents that may occur because of human intrusion into the railway tracks. PSD are there to serve other purposes, which include, for example, suicide prevention, reduction of energy consumption for the environmental control system, platform noise mitigation and air quality improvement among a lot of others. It is part of the PSD effects as categorized by earlier studies to be among the factors affecting dwell time of trains at stations. This, according to Anderson and Harris, creates a considerable economic disbenefit to the railway system. This is because, the PSD can induce delay to the train doors opening and closing time (static dwell time) thereby extending the time. for both alighting and boarding. By extension, any delay produced to the passenger flow creates more congestion at platforms which may lead to additional capacity demand for passenger facilities of the terminals such as stairs and escalators; and as well, additional demand for station services such as shops, travel information services, ticketing etc. [10]. The present study captures the state-of-the-art understanding of the factors associated with PSD presence, identified and categorized all those factors into positive and negative effects, presented optional functions that could come with PSD, it's causal structure, associated costs and recommendations for further research

1.1 Background study

To begin with, the PTI (platform train interface) is the line that separates the platform from the train (or track if no train is present). Many sources of railway inquiry from diverse projects throughout the world have recorded and analysed incidents at the Platform-Train Interface (PTI). Human behaviour and platform design are blamed for the start of these tragedies. The space between the train and the platform is one of the most important components of platform design. When combined with other human behavioural stress factors, the presence of a big gap gives a potential for PTI accidents to occur. To investigate the impact of the gap size on passenger behaviour, an observation survey was conducted. The findings of the observations indicated that the magnitude of the gap had no effect on passenger behaviour. The three primary stress factors that might result in PTI events at stations were a lack of information distribution through proper communication, overcrowding, and train design. PTI events at railway stations are thought to be caused by these stress factors paired with a large gap size. Suicide prevention has also become a major societal concern on a global scale, with several research and programmes aimed at preventing suicide, particularly in the railway industry. The goal of this study is to provide background information and examples of best practises relating to platform-train-interface (PTI) safety with platform screen doors technologies in order to improve station safety, reliability, and punctuality, as well as increase station attractiveness and convenience.

1.2 Problem statement

Even though public rail travel is one of the safest modes of transportation, accidents can sometimes happen, resulting in injury or even death. The risk is greatest on the platform, where passengers are near to the guideway and must take a step from the platform to the vehicle. Heavy rail running on considerably elevated rails poses the greatest risk. People falling from the platform onto the lower track area and suicide are two of the most typical platform incidents. Suicide on the tracks is a heartbreaking issue that railway operators all around the world are dealing with, with certain busy train stations even becoming known as "suicide hotspots.". Over half of all rail-related fatalities are suicides, according to a study published in the BMC Public Health journal on the socio-environmental causes of railway suicide. Furthermore, the World Health Organization (WHO) says that suicide rates have climbed by 60.00 % globally in the previous 45 years, with one death every 20 seconds expected by 2020. Also good are large, open platforms with little impediments. The most dangerous platforms are those used

by heavy train, although low light-rail platforms increase the risk of passengers wandering onto the guideway. Due to damaged, uneven, and slippery platform surfaces, incidents such as tripping and slipping might occur. In terms of the platform train interface's danger. Door control systems, for example, do not always detect thin things trapped behind closed and locked doors. Trains can move off pulling whatever is stuck along the platform if a trapped object is not identified, posing a high danger of death or serious harm. Next, the repetitious nature of the driving duty on metros, suburban trains, and trams, particularly on automated trains, might cause drivers to lose focus. This might lead them to overlook crucial visual signals throughout the dispatch process, resulting in individuals being pulled behind the truck as it drives away. Passengers with impaired eyesight or movement may be at increased danger on station platforms and when entering or disembarking from trains. There were no tactile surface markers on the platform that may have alerted the visitor to their proximity to the edge.

1.3 Research objective

The objectives of this study are:

1. To identify an accident and safety awareness base on Rail Accident Investigation Branch (RAIB) record related to Platform train interface.
2. To develop a HIRARC analysis at LRT Terminal Bersepadu Selatan & KTM Serdang.
3. To determine and analyse the data collected to improve platform train interface safety with platform screen door technology base on questionnaire at KTM Serdang and LRT Terminal Bersepadu Selatan.

1.4 Scope of the study

The scope of this project has been set to achieve all the objectives. The incident regarding platform train interface for this study we refer to Malaysia rail incident investigation and also referring to Rail Accident Investigation Branch (RAIB) which there independently investigates accidents from various existing project to improve railway safety, and inform the industry and the public. This study will have a comparison between PSD Full Height and PSD Half Height in term of design, functionality and particularity passenger's safety. HIRARC will be carried out and assessed at 2 station which is LRT Terminal Bersepadu Selatan and KTM Serdang. This study also will determine and analyses the collection data from questionnaire and observation about improving platform train interface with platform screen door technology in this new era of railway station. This survey will focus target toward students, station staff and among general public who use train transportation.

2. Materials and Methodology

This project research will be conducted as a quantitative study by using an adapted questionnaire which will be answered by student, workers and among general public use train transportation at train station. Moreover, HIRARC analysis will be conducted based on observation on the passenger's changeover, train operation and platform safety features.

This research will be carrying out a Questionnaire and HIRARC analysis at 2 non-PSD system train station which is KTM Serdang and LRT Terminal bersepadu selatan.

2.1 Procedure of survey questionnaire

Data collection procedures will be starting by the formulation of questionnaire which will begin based on literature review and adapted questionnaire used in most of previous studies. A part of quality control of research, data pilot requires to be completed before conducting real data collection. As questionnaire been tested and validated, questionnaire distribution can be proceeded among targeted research population at the location. The distribution survey questionnaire has been done using QR code scan which directly to the google form question. By obtaining the research data, the next process

is data analysis by using pie chart from Google Form questionnaire. At the end of the data collection procedures is mainly the report writing to describe and discuss the data obtained.

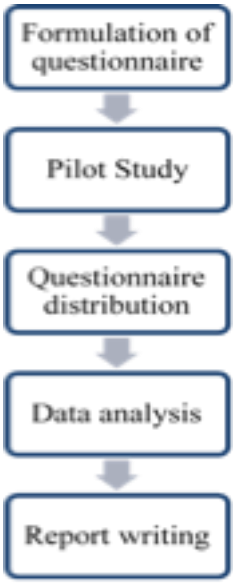

Figure 1: Data Collection Procedures

Figure 2: QR Code scan questionnaire for respondents

2.1.1 Instrumentation

The questionnaire consists of five (5) sections which are as follow; Section 1: Participants Demographic information, Section 2: Train Transportation, Section 3: Train Platform Hazards, section 4: Human Factor Error, Section 5: Platform Screen Door (PSD). In section 1 which is the participant demographic information, the info that require to obtain from respondent gender, age, email address, and educational level. Next, section 2 will be focused on respondent using train transportation info such as frequency of use and destination, train available in respondent area, ease of using train transit and any info regarding accidents or near misses' experience at train platform.

As for section 3, consists of several statements that related to platform hazard and some example of accidents happen at the train platform. For section 4, some goes to section 3 which is platform hazard but more focus on human error factor. Lastly for section 5 will be a simple explanation about the PSD system and several statements regarding benefits of PSD system toward passenger's safety at train platform. Respondents require to tick answer that best describes their response to each of the following statements.

2.2 Procedure of HIRARC analysis

The method of the HIRARC being carried out is a Quantitative Method. The Risk Assessment

result, Quantitative Risk Matrix Table and Risk Level Action Table, Severity Table and Probability Table are being shown and described.

Risk Assessment being conducted is determine by the Risk Rating which being calculated by using a formula in Figure below.

Risk Rating Calculation Formula

Risk (R) = Probability (P) X Severity (S)

- The first step is to determine the Likelihood or Probability as in Table 1.

Table 1: Likelihood Determination

Likelihood	Description	Rating
Most Likely	The most likely result of a hazard / event being realized	5
Possible	Has a good chance of occurring and is not usual	4
Conceivable	Might be occur at some time in future	3
Remote	Has not been known to occur after many years	2
Inconceivable	Is practically impossible and has never occur	1

There are five levels of Likelihood to be determined. Determination of Likelihood is start from the Most Likely, Possible, Conceivable, Remote and Inconceivable. The rating given for MostLikely is 5 until the lowest rating for Inconceivable which is 1.

- The second step is to determine the Severity of hazard as in Table 2

Table 2: Severity Determination

Severity	Description	Rating
Catastrophic	Numerous fatalities, irrecoverable property damage, and productivity	5
Fatal	Approximately one single fatality major property damage if hazard is realized.	4
Serious	Non-fatal injury, permanent disability	3
Minor	Disabling but not permanent injury	2
Negligible	Minor abrasions, bruises, cuts, first aid type injury	1

There are five level of Severity to be determined. Determination of Severity is start from Catastrophic, Fatal, Serious, Minor and Negligible. The rating is from 1 to 5 and Catastrophic is the highest rating and Negligible is the lowest rating.

- The third step is to determine the Risk Rating as in the Quantitative Matrix Table as in Table 3

Table 3: Quantitative Risk Matrix Table

	Severity (S)				
Likelihood (L)	Negligible (1)	Minor (2)	Serious (3)	Fatal (4)	Catastrophic (5)
Most Likely (5)	**5**	**10**	**15**	**20**	**25**
Possible (4)	**4**	**8**	**12**	**16**	**20**
Conceivable (3)	**3**	**6**	**9**	**12**	**15**
Remote (2)	**2**	**4**	**6**	**8**	**10**
Unconceivable (1)	**1**	**2**	**3**	**4**	**5**

- The fourth step is to record the Risk Rating and the Risk Level Action is described as inTable 4.

Table 4: Risk Level Action

Risk	Action
15 – 25 High	A High risk required action to control the hazard as detailed in thehierarchy of control. Action taken must be documented on the risk assessment form including date for completion.
5 – 12 Medium	A Medium risk required a planned approach to controlling the hazardand applies temporary measures as required. Action taken must be documented on the risk Assessment from including date for completion.
1 – 4 Low	A risk identified as Low may be considered as acceptable and furtherreduction may not be necessary. However, if the risk can be resolvedquickly and efficiently, control measures should be implemented and recorded.

3. Results and Discussion

Table 5: HIRARC analysis

NO	TASK	POTENTIAL HAZARD	RISK RATING (RR) CALCULATION (P X S)		RR	RECOMMENDED CONTROL MEASURES
			Probability	Severity		
1	- Waiting train in the peak hours.	- Crowding on the platform - Passengers jump/fall to the trackside or suicide - Being too close to the platform's edge.	3	3	9	- A barrier between platform and train door should be apply (PSD system) - Passenger information display can give info regarding safety awareness at train platform. - Provide an alarm device to alert passengers with arrival train at the platform.
2	Passengers flow during changeover	- disorderly passenger behaviour - passenger late boarding and disembarking can lead to trapped in closing doors and dragged along the platform - slips during the changeover	4	4	16	- Improve the ability of door control systems, such as sensitive edges and anti-drag systems, to identify the presence of a trapped object. (PSD system) - provide emergency exit door were people are able to escape from track side by simple pressure on a panic bar. (PSD system). -
3	Electric Train Operation	- a lack of concentration on the part of drivers - During the dispatch process, station staff may overlook vital visual clues. - people being dragged when the vehicle moves off	2	4	8	- Verifying sure the train is clear of everyone and anything before it departs. - Implement procedures to mitigate the danger of relying too much on the door control system to identify trapped objects. - Provide CCTV at every corner of the platform

3.1 Survey questionnaire

The Survey Questionnaire has been done at 2 non-PSD system train station KTM Serdang and LRT Terminal Bersepadu Selatan. Based on the result from pie chart, it shows that more than 80.00 % of the respondents agree with the several statements regarding to platform train hazard and human factor error in their train station area where it is main contributes to accidents or near misses. This factors should be taken seriously due to 23.60 % of the respondent's rate that somewhat challenging when using train

transit and 57.60 % of the respondents use train transit almost every day to go to workplace and entertainment. 36.80 % of the respondents have ever experience any accidents or near misses at train platform. In the presence of this Platform Screen Door technology, 95.00 % of the respondents rate safe and very safe toward level of safeness of having a PSD system compare to non PSD system at train platform. This data is parallel to the statement where PSD are efficient and suitable to be apply in all train in Malaysia with 91.60 % of the respondents agree.

3.1.1 Pie cart result

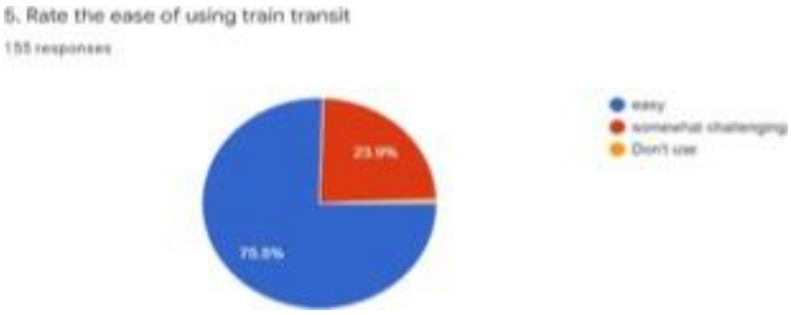

Figure 3: pie chart shows 118 respondents rate easy when using train transit while 37 respondents find it somewhat challenging

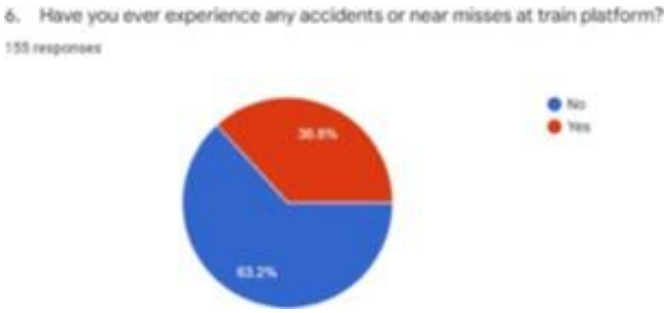

Figure 4: pie chart 98 respondents have no experience any accidents or near misses at train platform while 57 respondents have experience it

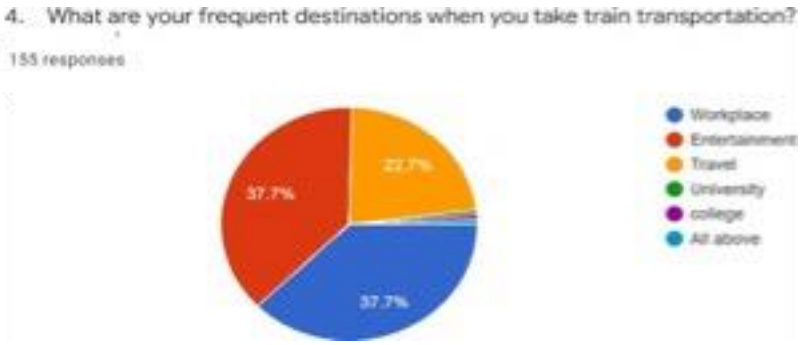

Figure 5: pie chart shows workplace and entertainment both have 58 respondents while 36 respondents use train for travel. 3 respondents use for others (college, university and all above)

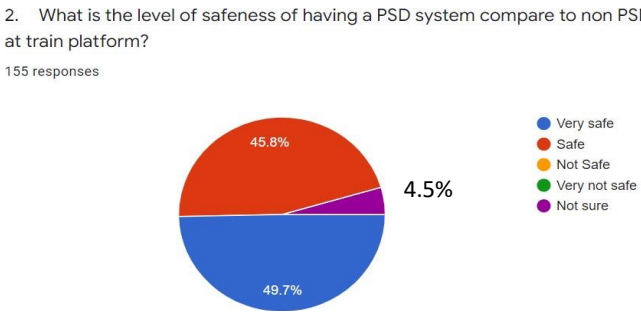

Figure 6: pie chart shows 77 respondents choose very safe and 71 respondents choose safe with the statements. Only 7 respondents were not sure

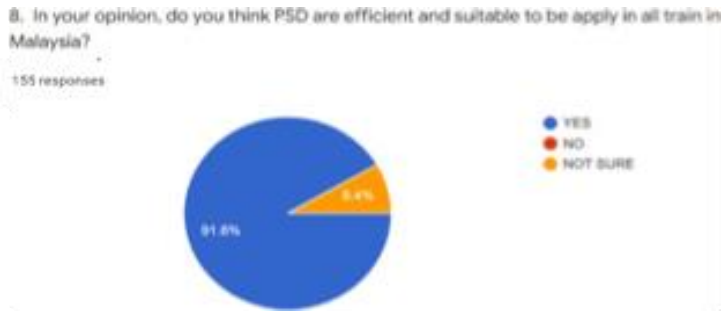

Figure 7: pie chart shows 142 respondents choose PSD are efficient and suitable to be apply while another 13 respondents were not sure

4. Conclusion and recommendation

The three objectives of this project are being achieved by applying Platform Screen Door (PSD) system at Platform Train Interface toward improving passenger's safety and health. Next, by referring to the Rail Accident Investigation Branch (RAIB) towards identify an accident and safety awareness at train platform have been done. The result shows the six key themes are issues of great importance to the RAIB which is interaction of passengers with trains, gaps between platforms and trains, managing risk to disabled passengers, door control systems, final safety checks and loss of attentiveness. With the guidelines from RAIB, early safety measures can be taken to avoid any accidents and near misses happen at train platform. Moreover, HIRARC analysis have been done based on the observation from passenger's changeover, behavior and platform design, it shows that waiting train in peak hours and electric train operation activity has risk rating at 9 (Medium) and 8 (Medium). A Medium risk required a planned approach to controlling the hazard and applies temporary measures as required. Action taken must be documented on the risk Assessment from including date for completion. While passengers flow during changeover achieve value of risk rating at 16 (High). A High risk required action to control the hazard as detailed in the hierarchy of control. Action taken must be documented on the risk assessment form including date for completion. Lastly, the survey questionnaire has 155 respondents have answered the questionnaires successfully. The result shows that Platform Screen Door Technology have a big potential to became the new standard door system at all train platform in term of safety toward passengers and accidents prevention. With 91.00 % of the respondents consisting of the educated class agree PSD system are efficient and suitable to be apply in all train in Malaysia

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