

## How Safe is the Rail Platform? A Study of Bangkok Mass Transit System (BTS)

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**Abstract:** Rapid urbanization growth is an international phenomenon, especially in developing countries. Demand for transportation also increase significantly. Mass rapid transit becomes a good alternative to avoid traffic congestion on the road. Elevated rail rapid transit (BTS) in Bangkok was provided to reduce traffic congestion in urban with high efficient and more reliable and existing public transportation. Numbers of BTS passengers have extremely increased from the early operated period and still trend to increase in the future so that platform area is very busy in peak hour. Therefore, it is interesting to analyze the safety perception of passengers on the platform, especially with the on-going process of installation of platform screen door (PSD) on BTS platform.

*Keywords:* Safety, Rail station, Platform screen door, Rail transportation, Skytrain, Bangkok

### 1. INTRODUCTION

Rail rapid transit is an efficient and convenient mode of public transportation especially in urban cities where facing traffic congestion. The major advantage of this mode is high capacity to carry a lot number of passenger to destination in short time with reliable and frequency service. There are many factors that influencing transit ridership for example; frequency, coverage, reliability and ticket fares. However, safety and security factor seems to be less priority influencing ridership in mode choice of rail rapid transit. From the US statistic in the past, rail transportation has low accident rate in transportation if compare with highway transportation which has the highest accident rate (RITA, 2012). Most of rail accident is relate to train accident such as; derailment, train-train collisions, train-car collisions, train-person collisions and damage to properties. Smaller proportions of rail accident occur at train station; nevertheless, station area especially platform has a chance of an accident because it is a connector between the rail track and the station.

Platform is a raised structure within a station providing access to or from the train. Platform-train interface (PTI) accidents are differentiated from other slips, trips and falls around the station. PTI-related accident must result in the passenger completely or partially crossing the boundary between the platform and the rail track, or the platform and the train. There are many factors which affect the occurrence of accident at the PTI; gender, intoxication, period of the day or week, weather. Accident risk relates to PTI accounts for 20% of total rail passenger risk as measured by fatalities and weighted injuries (FWI). In passenger fatality risk, PTI risk accounts for 38% of rail passenger fatality risk. Of this, 9%

occur during boarding or alighting, while other PTI accidents not due to boarding or alighting account for 29%; this is the largest single contributor to rail passenger fatality risk (Rail Safety and Standards Board, 2011). Major PTI accident types not due to boarding and alighting which have high FWI risk are passenger fall from platform and struck by train, passenger struck by train while on platform and passenger fall off from platform onto the rail track (no train present) respectively. These severity accidents are the reason that can explain high fatality risk in PTI accidents not due to boarding or alighting. Another railway serious mortality issue in some countries is suicide. Railway suicide is attempted or completed suicide by throwing oneself onto the electrified track/ or into path of an on-coming train. Most of railway suicide cases occur at platform area more than station area outside platform and level crossing (Radbo and Andersson, 2012). The railway suicide also has impact on the subsequent frequency of suicide as a copycat behavior (Ladwig *et al.*, 2011).

Both intentional and unintentional accidents are distinctive in their strong socio-economical and physiological impacts brought not only to the injury or fatality, but also to the railway company, the driver, the passenger and other witness who seen the accident. Only one accident may affect to wider spread area although a people who are not relate to the accident and cause negative effect to public in many ways. For example, accident news about passenger fell down to rail or suicide by jump to get crashed by train always display in first page of newspaper and broadcast in media. There are many terrible video clip of this kind of accident in internet media. To prevent and reduce PTI accidents, station platform design has a major role to reduce risk of accident. Installation of Platform-Screen Doors (PSDs) is one of an effective way for prevention PTI accident and suicide. PSD is barrier with sliding doors at the edge of platform, these gates slide open or close simultaneously with the train doors. Objective of PSD installation is to limit access from platform to the track, so it will reduced risk of accident while passenger waiting for the train of platform; in addition, PSD also has many benefits beside safety such as saving energy in air conditioning station, prevent litter build up on the track which can be fire risk, improve the sound quality of platform announcement.

It is obvious that platform with PSD has better safety provision than platform without PSD. However, installation of PSD also means expenditure that could not be considered small on the side of rail operator. Therefore, in the economic perspective, the question is whether the installation of PSD provides monetary justification. With high suicide rate of people jumping to the track and high capacity ridership like in Japan, installation of PSD is most likely can be justified or even have to be done. This does not mean that stations in other countries with no suicide case and low incident rate do not have issue in safety. With this in mind, this study tries to investigate the passengers' safety perspectives on the platform of Bangkok Mass Transit System (BTS). Their opinions on the installation of PSD are also examined.

## **2. SAFETY RELATED TO RAIL TRANSPORTATION**

Rail safety is a multidirectional issue and it is important to understand the nature of rail operation to improve the safety factor. Baysari *et al.* (2008) investigated rail accidents and incidents in Australia from forty rail safety investigation reports and concluded that almost half of the incidents were resulted from equipment failures due to inadequate maintenance and monitoring program. Read *et al.* (2012) also examined rail accidents and incidents in Australia occurring between 1999 and 2008 by linking task, training, and social environmental factors to the error types. Their findings confirmed that some error types were more associated with

certain local conditions or organizational factors than other error types.

Some incident related to rail transportation may happen unintentionally, such as accidentally slip and fall on the track, while some others are intentional incidents. Unintentionally accidents indicate that there are safety concerns in the operation of rail as a mode of transportation. Improvements on safety should be addressed to manage and reduce any possible danger that may happen by chance. These improvements may also reduce or discourage any possible intentional incidents.

In some rail stations of Tokyo, Japan, the platforms are increasingly crowded with passengers during commuter rush hours due to many reasons. For the rail operator, it is very important and has a vital value to prevent platform incidents to prove passengers safety and convince passengers while using the rail stations. Sasamoto and Momomoto (1995) investigated the installation of safety barrier with automatic door on the platform of one station in Tokyo. They considered that there are two zones on the rail platform: safety zone and danger zone (Figure 1). Passengers are not supposed to be in or close to the danger zone. Therefore, the fence was constructed as a dividing line between these two zones. In the experiment, it was observed that the barrier and automatic door did not disturb the flow of passengers so they could be used to reduce the number of incidents.

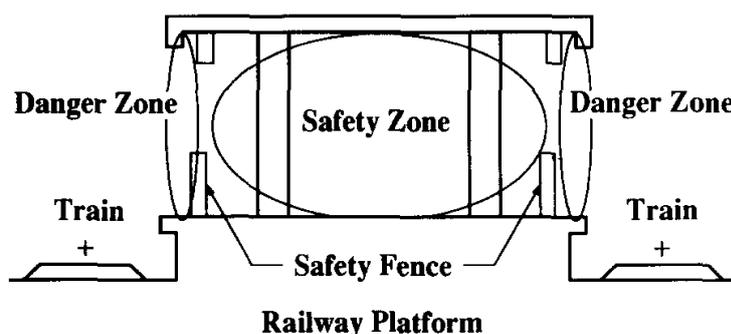


Figure 1. Zoning in railway platform  
(Source: Sasamoto and Momomoto, 1995)

### 3. BANGKOK MASS RAPID TRANSIT (BTS)

The Bangkok Mass Transit System (BTS) is an elevated mass transit railway in Bangkok. Built and operated by the Bangkok Mass Transit System Public Company Limited (BTSC), the project was entirely funded by private enterprise. BTS has been first operated since December 5, 1999 as the first heavy rail mass transit in Thailand with route covering the central business area and inner city zone of Bangkok city. The objective of BTS is to provide public transportation system that reduce traffic congestion in urban area and provide efficient and reliable means of transportation within the central business district (CBD) of Bangkok.

Number of BTS passenger trend to increase every year. Since operated in December 1999 BTS has only 150,000 passengers per day in the first operated year. Until now average number of passengers per month is 16,000,000 which are around 530,000 passengers per day (BTSC, 2012). This high number of ridership is certainly a good revenue generation for BTSC. On the other hand, the increasing number of passengers leads to busy platform situation, especially during peak hour time. Consequently, the chance of PTI accident for passengers while waiting for the train increases as well. During peak hour, in most of major stations, there is not enough space for passenger to walk or queue. Interestingly, since

operated in 1999 there were no severe accident contributes to loss of life has occurred. Only few PTI accidents happened; for instance: passenger was pushed unintentionally and fell from the platform onto track when many passengers standing at platform at peak hour or passenger lose consciousness while waiting for the train and fell onto the track. Fortunately, no fatality PTI accident has occurred. There was a suicide case related to BTS but not by jumping to the rail track. The suicide was committed by jumping from the third floor of a BTS station to the road (Bangkok Post, 2012).

Although accident rate of PTI accident of BTS is pretty low, safety policies at platform are still necessary and important to prevent accident. In 2012, BTSC signs contract for installation of Half-Height Platform Screen Doors (HHPSDs) at BTS stations, a contract worth 620 million baths. In the first phase, HHPSDs will be installed along the platform edges of nine stations: Siam, Asok, On Nut, Sala Daeng, Phaya Thai, Victory Monument, Chit Lom, Phrom Phong, and Chong Nonsi. The automatically operating door system will enhance safety for passengers while waiting for trains at busy platforms. The project is scheduled for completion in December 2013 (BTSC, 2012). Even though PSD was installed, it doesn't mean that this automatic door can prevent PTI accident 100%. Installation of PSD is an effective mean to prevent accident; however, passengers' accident awareness is also crucial for them too. Some passengers may not pay attention on safety on platform area as they believe that accident is less likely to happen. This kind of mindset should be changed with better awareness of safety and avoidance of risky attitudes and behaviors on the platform.

#### **4. RESEARCH METHODOLOGY**

A questionnaire survey was used to achieve the objective of this study. In the developing the questionnaire, review on literatures related to safety on rail platform was conducted. As safety issues on the platform also depend on the design of the station, safety measurements provided by the operator, and behavior and cultural factors of passengers, direct observations on the platform were considered crucial in designing appropriate questions should be addressed to rail users. Passengers' behavior and activities while waiting for the train on the platform that may have risk to PTI accidents were observed, especially during peak hour. Mochit and Victory Monument Stations were the observation areas as both stations are considered main and crowded stations.

In total, 21 questions were finally considered in the questionnaire as indicators to perceived safety on the platform. Most of the questions are concerned about the safety related situations of passengers while on the platform but exclusive of boarding and alighting activities. The indicators can be categorized into five categories: design of station, service provisions of rail operator, passenger's activity, attitude of passenger, and future plan. Questions in the future plan category are questions that related to the installation of PSD. Respondents were requested to give their opinions on the questions by choosing from strongly agree (5) to strongly disagree (1). The questionnaire was translated into Thai language and pilot test was conducted to six lay people on the Thai version questionnaire to reduce ambiguity and confusion on wording, sentence, or format.

Four stations were selected to distribute the questionnaire, i.e. Mochit, Ari, Victory Monument, and Asok Stations. Siam Station, which is the central station, was not included in the survey location as the installation of PSD is in progress for some parts of the platform. To avoid any possible bias in the filling the questionnaire, it was decided to exclude this station. The locations of the stations on the BTS route are displayed in Figure 2. Each station has its own characteristic that hopefully can generate random respondents for the survey. Mochit

Station is the north end station and an interchange station with MRT line. A large park and ride space was provided for this station free of charge. Ari Station located in a business area thus most of passengers are working class people. Victory monument Station is at the center of Bangkok and the main junction of public buses to different directions. Asok Station is a transit station to MRT and located in CDB area. The area is also famous for tourists.

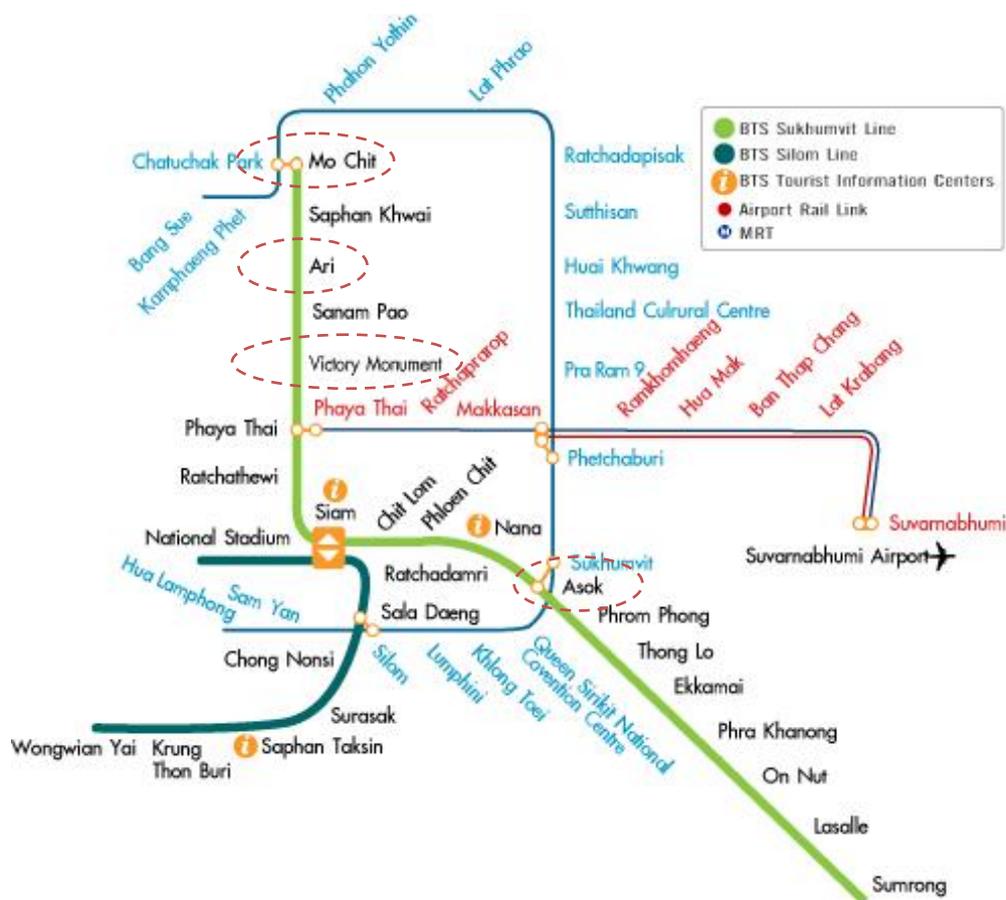


Figure 2. Survey locations on the BTS route

Three survey administrators were dispatched to the locations on weekday from 5-9 November 2012. They personally approached respondents and, if necessary, assisted respondents in filling the questionnaire. The survey was conducted in the stations and on the exit and entry way of the stations. In total, 120 valid questionnaires were collected from the survey. However, the proportion is not equal for each station due to difficulties related to the situation and environment of each station,

## 5. ANALYSIS AND DISCUSSION

Majority respondents of the survey are female. More than half of respondents are in the productive age of 26-60 years old, which is reasonable considering that the current routes are serving mostly business and shopping related locations. Only less than 13% of respondents have education below undergraduate level. More than 80% of respondents have monthly salary or allowance up to 50,000 Baht (US\$ 1700). This seems reasonable as high earning Bangkok citizens prefer to use private cars than public transportation. The use frequency of

BTS among respondents is quite well distributed except for everyday use which has much less share. Personal business dominated the trip purpose using BTS with share close to half and the second majority used BTS for their work commuting. The characteristics of respondents are presented in Figure 3.

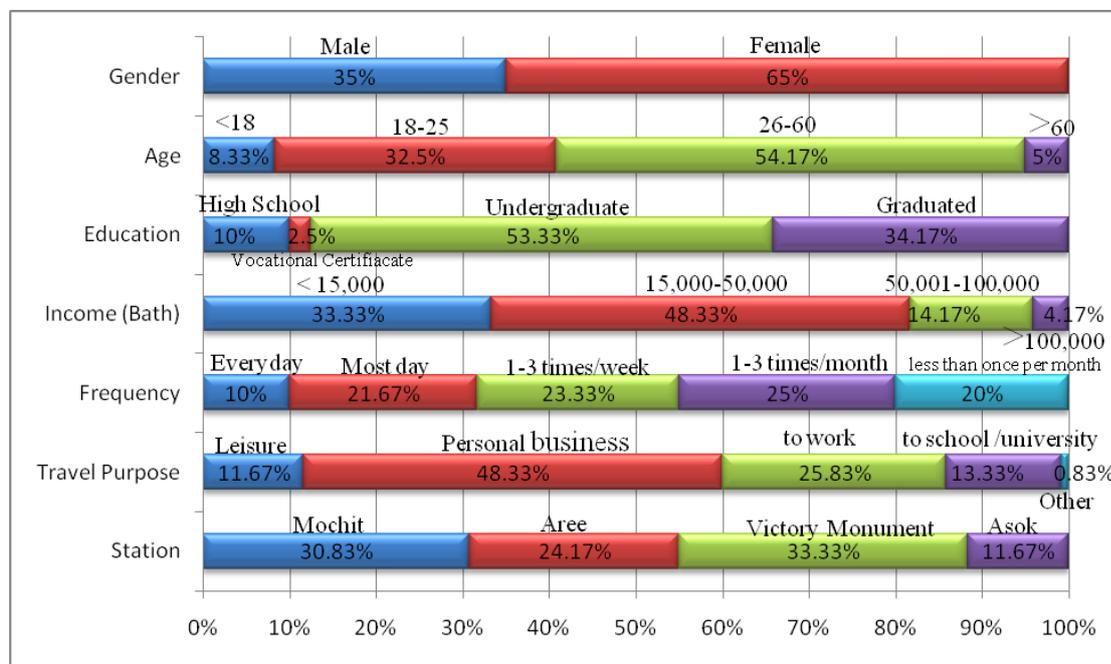


Figure 3. General characteristics of respondents

The mean value and standard deviation of each safety indicator on the platform are presented in Table 1. For almost all indicators, except for future plan category (Nos. 18-21), the higher the mean score implies the more safety concern. There is one indicator in the form of ‘negative’ question, which suggests the conclusion is the opposite way: the lower the score means the more concern in platform safety. This indicator could not follow the question format of other indicators because the current format is a better form to test practicality of the seriousness of safety concern of the respondents. Transform score of this indicator is provided in bracket so the value can be easily compared with others.

The design of station platform in general seems not to be a safety issue but not reach to the level of satisfaction. The available space between the platform edge and the yellow line received only a mediocre response. The difference in elevation between track and platform additionally may make people standing and waiting close to the yellow line feel uneasy. Services related to safety information and precautions were considered important to inform and remind passengers of possible dangers and prevent any possible accident and incident to happen. Adhere to safety should be well informed to passengers so risky activities on the platform can be avoided such as playing around or reading, listening to music and talking to mobile phone while standing close to yellow line.

Other ordinary activities such as bringing many luggages and wearing high heels were considered more on the side of not recommended due to safety reason may be because of no barrier between platform and track. The same tendency was also perceived for indicators of the respondents’ attitude towards safety on platform. Interestingly, although the perception of safety on the platform, in general, is perceived to be below satisfaction level, getting on the train faster overruled all safety concerns.

The activity of bringing many luggages, especially with big and heavy luggage may not

be seen often in the station, although the route is connected to the Airport Link (a railway line to Bangkok international airport, Suvarnabhumi Airport). One of the reasons is the unavailable elevator to be used for ordinary people (elevator is locked and strictly only for disable people) so it is not convenient to carry big and heavy stuff by stair or escalator. However, in the future, when the Airport Link is getting more popular and the elevator is open for public for real. Luggage carrying passengers may cause higher safety concern.

Installation of PSD was perceived positively by respondents even for stations with small numbers of passengers. However, if the installation of PSD means the increment of fare by 5 Baht (20 cents in US\$), this does not receive positive respond from respondents. Assigning more station conductors instead of installing PSD may be an alternative but the idea did not strongly supported.

Table 1. Mean values of safety indicator

No	Safety Indicator	Mean Score	Std. Deviation
Design	1 Station platform design is not safe enough.	2.28	1.001
	2 Space from platform edge to yellow line is not enough.	3.17	1.015
	3 Elevation of track from platform makes you feel unsafe.	3.13	1.112
Service	4 BTSC should provide information about safety tips on platform.	4.08	0.972
	5 BTSC should not let intoxication/drunk passenger to use the service.	4.43	0.941
	6 Warning sound signal when train approach make you more careful.	4.34	0.783
	7 Warning from station conductor makes you more careful.	4.28	0.809
	8 During peak hour, the number of station conductors is not enough.	3.98	0.864
Activity	9 Passenger with many luggage should not standing close to yellow line.	3.82	0.970
	10 Wearing high heels and standing close to yellow line increase accident risk.	3.97	0.970
	11 Teasing and playing around on the platform should be prohibited.	4.55	0.798
	12 Reading, listening to music, talking on mobile phone while standing close to yellow line increase accident risk.	4.13	0.846
Attitude	13 Although you stay behind yellow line, when train approaching, you still feel unsafe.	3.44	1.035
	14 In crowded platform, passenger has more chance to fall into the track.	4.07	1.035
	15 <sup>a</sup> You prefer to wait for the train close to yellow line to get on the train faster.	3.33 (2.67)	1.183
	16 You are more careful on the platform when raining and windy.	4.16	0.917
	17 You are more careful when you are the first passenger waiting for train behind the yellow line.	4.35	0.706
Future plan	18 If BTSC install fence or barrier between track and platform, you feel safer.	4.00	0.970
	19 More station conductors can replace installation of fence or barrier.	3.29	1.177
	20 It is not necessary to install fence or barrier for stations with small numbers of passengers	2.76	1.353
	21 If installation of fence or barrier increases fare by 5 Baht, you are willing to pay.	2.73	1.295

Notes: <sup>a</sup> = 'negative' question

Value in the bracket is transform score for 'negative' question

The questionnaire also inquired respondents' opinion on the installation of PSD. More

than 75% respondents agree with the installation of PSD. Only less than 5% disagreed with majority of them considered that the budget for PSD could be used instead to improve quality of service. The result is illustrated in Figure 4.

In analyzing the data, respondents were grouped by their characteristics. Seven groups were considered to analyze whether there is any significant difference in the perceptions within the group, i.e. station group, gender group (female vs male); age group (up to 25 years vs over 26 years); education group (up to undergraduate degree vs graduate degree); income group (low income vs middle and high income); frequency group (seldom vs often); and trip purpose (commuters vs non-commuters).

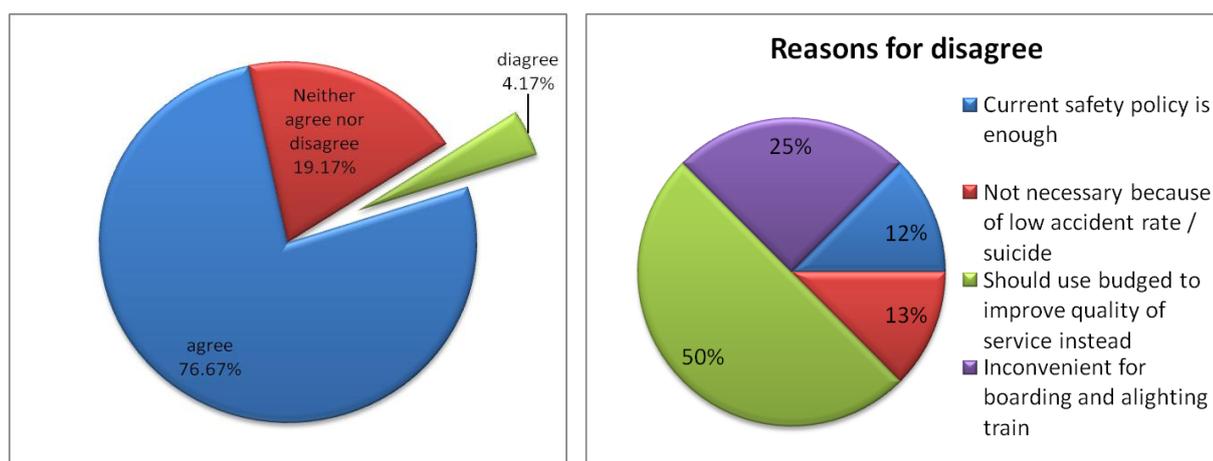


Figure 4. Opinions towards PSD installation

The results of Mann-Whitney tests with significant level of 95% indicates that female and non-commuter are more concern about provision of safety tips and getting on the train first by staying close to the yellow line, probably for the purpose of getting a seat. On the other hand, male is more concern about increasing of fee due to the installation of PSD. Warning signals when train approaching, afraid to fall on the track on the peak hour, and personal activities (reading, listen music and talking on the phone) are also become more consideration for male.

Over 26 years old respondents and seldom BTS use respondents were more concern about provision of safety tips. The earlier group was also more concern about the increase of fee if the PSD is installed. It is also observed that the seldom use respondents were less aware of the PSD on the platform which is reasonable.

Up to undergraduate degree group is more concern about safety when train approach, raining and windy situations, be the first passenger to wait behind the yellow line, and doing personal activities close to the yellow line. Interestingly, low income respondents have more concern about the last three indicators as above than middle and high income respondents. On the other hand, increase BTS fee due to the installation of PSD becomes more consideration for middle and high income respondents than low income respondents with unclear reason.

## 6. CONCLUSION

Train mass rapid transit becomes a necessary need for developing countries to solve traffic congestion. Bangkok is one of the capitals in South East Asian countries that have operated

this kind of mode (BTS and MRT). More research studies still need to be explored related to the operation of this mode in the context of developing countries. One of them is safety on the platform. PTI accident is not an issue for BTS stations and nothing serious has ever happen before. However, the study shows that concerns of safety on platform do exist. Installation of PSD can be one way to reduce these concerns and the idea is strongly supported. Educating and informing passengers about safety awareness and precaution on the platform is also a necessary way to prevent any platform accident and incident.

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