

Research report

Evaluating the effectiveness of barrier installation for preventing railway suicides in Hong Kong

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Abstract

Background: Railway suicide is a serious mortality issue. Most attempters are unmarried psychotic young men under psychiatric care having a high level of lethal intent. Installation of platform screen doors (PSDs) to limit access to the track has been suggested as an effective way for prevention. This study aims to examine the effectiveness of installing PSDs for preventing railway suicides; any sign of substitution of suicide location; and changes in psychiatric profile of suicide deceased after the PSD installation in the subway system of Hong Kong.

Methods: Cases of railway suicide and related information from 1997 to 2007 were provided by the railway operators and the Coroner's Court. The effectiveness of installing PSDs was assessed through a quasi-experimental setting. Poisson regression and chi-squared test were used.

Results: Over the 11-year study period, a total of 76 railway suicide cases (0.71% of all suicides) were reported. A significant reduction of 59.9% ($p=0.0003$) in railway suicides was found after the PSD installation. Analyses confirmed that there was no significant sign of substitution by displacing potential attempters to unsealed platforms ($p=0.9051$). Those having psychosis would be better protected as no suicide cases with such psychiatric background were reported after the installation of PSDs.

Limitations: It has not considered the potential economic benefits of PSD. It is difficult if not possible to examine whether the potential attempters would substitute to an alternative method of suicide.

Conclusions: This study shows that PSDs can effectively prevent suicides with no substitution by “delethalizing” the image and altering people's perception about the desirability of railway suicide. Railway operators should extend the coverage of PSD to all railway stations in Hong Kong without any delay.

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Keywords: Platform screen door; Railway suicide; Restriction to means; Substitution effect; Suicide prevention

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1. Introduction

Railway suicide is a serious mortality issue on public health. It is distinctive in its strong socio-economical

and psychological impacts brought not only to the fatality, but also to the railway company, the driver, passengers and other witnesses of the person-train collision (Schmidtke, 1994; Lindekilde and Wang, 1985; Baumert et al., 2005). Given the huge burden arisen to the whole society, prevention of railway suicide should be an important issue on the public health agenda (Farmer and Rohde, 1980).

Epidemiological studies suggest that the majority of attempters of railway suicide, both fatal and non-fatal, are unmarried young men at the age of around 20 to 30 (Johnston and Waddell, 1984; O'Donnell and Farmer, 1992, 1994; Sonneck et al., 1994; Ladwig and Baumert, 2004; Ratnayake et al., 2007) and many of them are psychotic patients under psychiatric care (Lindekilde and Wang, 1985; Emmerson and Cantor, 1993; Clarke and Poyner, 1994; Ladwig and Baumert, 2004; Ratnayake et al., 2007; Van Houwelingen and Kerkhof, 2008). They appeared to have a high level of lethal intent with expression of their suicidal will prior to the actual attempt (O'Donnell et al., 1996). Several studies have reported that railway stations close to psychiatric facilities and residence of the victim are more likely to have suicide incidents occurred (Johnston & Waddell, 1984; Farmer et al., 1991; O'Donnell and Farmer, 1994; Ratnayake et al., 2007). In the British SOVRN Project, Abbott et al. (2003) speculated that these people tended to die by suicide close to where they live with knowledge of local surroundings.

Though railway suicide is an important public health issue, it has been widely argued that suicide on railway is inevitable and unavoidable based on the rationale of substitution that those who intend to kill themselves could substitute by going to another unsealed railway platform or even displace to use another method for committing suicide (O'Donnell and Farmer, 1992; Mishara, 1999; Beautrais, 2007a,b). In other words, this suggested that the removal of suicide risk at one station could not effectively reduce suicides in the community if the substitution hypothesis holds (O'Donnell and Farmer, 1992; Mishara, 2007a).

However, following the argument that the availability of lethal means is a strong promoter of selecting the means of suicide (Marks and Abernathy, 1974; Farmer, 1979; Farmer and Rohde, 1980; Baumert et al., 2005), restricting passengers' access to the track could be an effective means to prevent railway suicides (Lindekilde and Wang, 1985; O'Donnell and Farmer, 1992; Clarke, 1994; Clarke and Poyner, 1994; Beskow et al., 1994; Baumert et al., 2005; Mishara, 2007a). Indeed, this has been confirmed in many empirical studies while the presence of drainage pits at the

platforms of London Underground system, which provides a space between the train and the ground for the casualty, have been found to be related to a lower mortality compared to stations without drainage pits (Coats and Walter, 1999; Cocks, 1987; O'Donnell and Farmer, 1994). In another case, the underground metro system in Singapore, with platform screen doors (PSDs) installed to separate platforms and trains in railway, has experienced no suicide attempts since its opening in 1987 (O'Donnell and Farmer, 1992; Mishara, 1999). Installation of PSDs has been suggested as one of the most effective ways to prevent railway suicides (Lindekilde and Wang, 1985; O'Donnell and Farmer, 1992; Clarke, 1994; Clarke and Poyner, 2004; Beskow et al., 1994; Coats and Walter, 1999; Baumert et al., 2005; Mishara, 2007a). Unfortunately, due to the technical difficulty and also the huge economic cost that may have incurred for installing PSD in the existing railway environment, many railway networks have dissuaded from adopting this method to other unsealed operating station platforms (Mishara, 1999, 2007a,b; Kerkhof, 2003; Beautrais, 2007a). Thus, there is a paramount need of conducting a rigorous evaluation to provide evidence in relieving doubts on its effectiveness for suicide prevention and public safety.

1.1. The present study

In 2002, the world's first PSD installation programme took place in an operating underground railway network in Hong Kong (MTRC, 2002). The primary purpose of the programme was to conserve energy by keeping the cool air in the underground stations. Meanwhile, this has also introduced a much safer environment that prevents injuries by intentional or accidental fall on railway tracks. To avoid stigmatizations and negative stereotypes from the public, the railway operator, however, has intended not to publicize that objective in the media. From a public health perspective, this PSD installation programme provides a natural laboratory in the community to examine the effectiveness of PSDs in eliminating the risk of suicide and the substitution hypothesis on displacing potential attempters to take their own lives in other stations. Thus, we aim to (1) evaluate the effectiveness of installing PSDs at the underground railway for preventing suicides on railway in Hong Kong; (2) assess any sign of substitution effect to other unsealed railway platforms; and (3) investigate whether there is any change in the psychiatric profile of the suicide deceased on railway after the installation of PSDs.

2. Methods

2.1. Period of time under study

The present analysis covers a period of 11 years from 1997 to 2007. Over the period, the railway track system of Hong Kong was separately managed by 2 operators, the Mass Transit Railway (MTR) Corporation which managed the underground railway network in urban Hong Kong, and the Kowloon-Canton Railway (KCR) Corporation which operated the rail link to connect urban Hong Kong with the New Territories (the sub-urban area) and with the Mainland China across the border (Gaylord and Lester, 1994). As a small and densely populated city in Asia, rail transport in Hong Kong is highly convenient. Having reported from MTR Corporation, it usually takes not more than 30 min to travel from the Central Business District to every station along the railway network (MTRC, 2007). Therefore, the choice of substitution is likely to occur for railway suicide in Hong Kong, if it exists.

In June 2000, the MTR Corporation announced to install 2,960 pairs of PSDs at all the 71 platforms in 30 underground stations on the 3 prominent transit lines (Tsuen Wan Line, the Kwun Tong Line, and the Island Line) (MTRC, 2002). Among these 30 stations, 2 of them are linked with psychiatric institutions through supplementary mode of transport in urban Hong Kong (Hospital Authority, 2007). The on-site installation work began in 2002 and it took 3 years to complete the work in 2005, despite most of the busiest station platforms were sealed with PSDs in the first year of the installation period. Upon the installation work, 8 elevated MTR stations (with 16 platforms) and all the stations of the KCR network remained unsealed and this indirectly creates a quasi-experimental setting for this study to assess the effectiveness of the PSDs for preventing suicides on railway in Hong Kong. The period 1997–2001 is taken as the pre-installation period, while 2003–2007 as the post-installation period.

2.2. Data collection

In view of lacking a central registry system of track-related incident record over the study period, the database was provided by the two railway companies through the Environment, Transport and Works Bureau of the Hong Kong SAR Government. Also, to assure the completeness and quality of data, we reviewed all related materials and document of every reported case at the Coroner's Court of Hong Kong.

As a former UK colony, Hong Kong adopts the British coronial system, under which every unnatural death, prior to giving a verdict of suicide, is investigated by the police, pathological professionals and the coroner by law, making misclassification and incomplete records unlikely. Under the ICD category, all reportable deaths with external cause code as E958.0 (WHO, 1978) (for cases from 1997 to 2000) and X81 (WHO, 1992) (2001 and onwards) that satisfied the definition of “intentional self-harm by jumping or lying in front of a moving object” were classified as railway suicide and included in the database for this study.

Variables collected included gender, age, marital status and, psychiatric diagnosis of the fatality together with date, time and location of the incidence. This information was made available from the death investigation report of each deceased from railway suicide over the whole investigation period.

2.3. Statistical analysis

2.3.1. Effectiveness of PSDs in preventing railway suicides

2.3.1.1. Poisson regression model. To assess the main effect and its statistical significance of PSD installation for preventing railway suicide, we used Poisson regression model (Baumert et al., 2005) by fitting the number of suicidal events over the study period with a dummy variable (D), that takes the value 0 and 1 to indicate the pattern of railway suicide in the pre-installation period (as 0) and in the post-installation period (as 1), respectively. Thus, the estimated slope coefficient (β) from the regression model represents the effect size attributable to the PSD installation. In addition, to adjust for the time trend and gender difference of suicide rate, and the population growth rate for the 11-year period under study, we also included the year of suicide, the gender and age of the suicide deceased and the offset term of mid-year population size of corresponding year into the regression equation as the confounding variables. Mathematically, the regression equation is written as follows:

$$\log(\text{suicides}) = \alpha + \beta(D) + \delta_1(\text{year}) + \delta_2(\text{sex}) + \delta_3(\text{age}) + \log(\text{mid-year population size})$$

In principle, a reduction in the number of suicides can be just attributable to a natural transition in epidemiology, instead of an effective intervention for preventing suicides. Thus, in analyzing the long-term effectiveness of an intervention, any significant transition trend needs

to be taken into consideration. The installation of PSD can be considered effective for prevention of suicide if the number of suicide in the post-installation period was significantly smaller ($\beta < 0$), given that the overall time trend for the period (δ_1) was not decreasing.

For all statistical analyses, a p -value smaller than 5% was considered to be statistically significant. If any estimated parameters of the confounding variable were found not significant, we would take them out and reiterate the Poisson regression to avoid distortion by unrelated variables. All statistical work was performed with the statistical software package SAS for Windows, version 8.02.

2.3.1.2. Average percentage change of the number of suicides (APC). To quantify the effect size of PSD installation for railway suicide prevention, we modified the formula by Baumert et al. (2005) to estimate the average percentage change (APC) of the number of suicides in the pre-installation and post-installation periods as follows:

$$\begin{aligned} & 5 - \text{year average percentage change (APC)} \\ & = [\exp(\beta) - 1] * 100\% \end{aligned}$$

2.3.2. Assessment of displacement effect to other railway stations without PSDs

It is important to find out whether the PSD installation would displace suicidal people to other

railway stations for suicide. To assess the substitution effect, we separately estimated the 5-year APC of railway suicides at MTR and KCR with the described model. Apparently, if the effect of displacement does not exist, the number of railway suicides at KCR, as a control with no PSD, in the post-installation period should not be significantly higher ($\beta > 0$) when compared to the pre-installation period.

2.3.3. Change of psychiatric profile of the railway deceased over the period under study

Given that railway suicide has been found to be related to psychiatric problems, it is worth to explore whether PSD installation is effective in preventing a certain kind of people from committing railway suicide. We conducted a chi-square test to assess the statistical independence between the effect of PSD for mentally ill persons and the same figure for normal persons over the period.

3. Results

3.1. Figures on railway suicides and all suicides

Over the 11-year period from 1997 to 2007, a total of 76 railway suicides occurred in Hong Kong, indicating an average number of 6.9 cases per year, which only accounted for 0.71% of all suicides ($N=10,659$) for the period. Table 1 shows the number and proportion of railway suicides in Hong Kong for the period. Among

Table 1
Number and proportion of railway suicides and all suicides in Hong Kong 1997–2007

Year	Sex				Both sexes	
	Male		Female			
	Railway suicides n , (%)	All suicides	Railway suicides n , (%)	All suicides	Railway suicides n , (%)	All suicides
1997	8 (1.6)	489	2 (0.7)	288	10 (1.3)	777
1998	7 (1.3)	540	4 (1.2)	325	11 (1.3)	865
1999	11 (2)	548	1 (0.3)	320	12 (1.4)	868
2000	5 (0.9)	548	2 (0.6)	356	7 (0.8)	904
2001	9 (1.4)	648	2 (0.5)	382	11 (1.1)	1030
2002	3 (0.4)	742	0 (0)	369	3 (0.3)	1111
2003	3 (0.4)	809	0 (0)	418	3 (0.2)	1227
2004	6 (0.9)	671	1 (0.3)	392	7 (0.7)	1063
2005	4 (0.6)	618	1 (0.3)	386	5 (0.5)	1004
2006	2 (0.4)	576	1 (0.3)	359	3 (0.3)	935
2007 ^a	4 (0.7)	564	0 (0)	311	4 (0.5)	875
1997–2001	40 (1.4)	2773	11 (0.7)	1671	51 (1.1)	4444
2002	3 (0.4)	742	0 (0.0)	369	3 (0.3)	1111
2003–2007	19 (0.6)	3238	3 (0.2)	1866	22 (0.4)	5104
1997–2007	62 (0.9)	6753	14 (0.4)	3906	76 (0.7)	10659

Data source: Coroner's Court & Census and Statistics Department, Hong Kong.

^a Provisional figures.

Table 2

Age, gender and time trend adjusted slope coefficient from Poisson regression and the corresponding 5-year average percentage change of suicides in Hong Kong from 1997–2001 to 2003–2007 by method used

Method	Time trend ^a	β	APC (%)	<i>p</i> -value
Railway	Insig.	−0.91 ^b	−59.9	0.0003
All suicides	↓	0.24	26.9	<.0001

^a For Poisson regression analyses, the time trend of number of suicide for each specified method would be considered as insignificant (Insig.), if the *p*-value of estimated parameter with year of suicide (δ_1) was greater than 0.05.

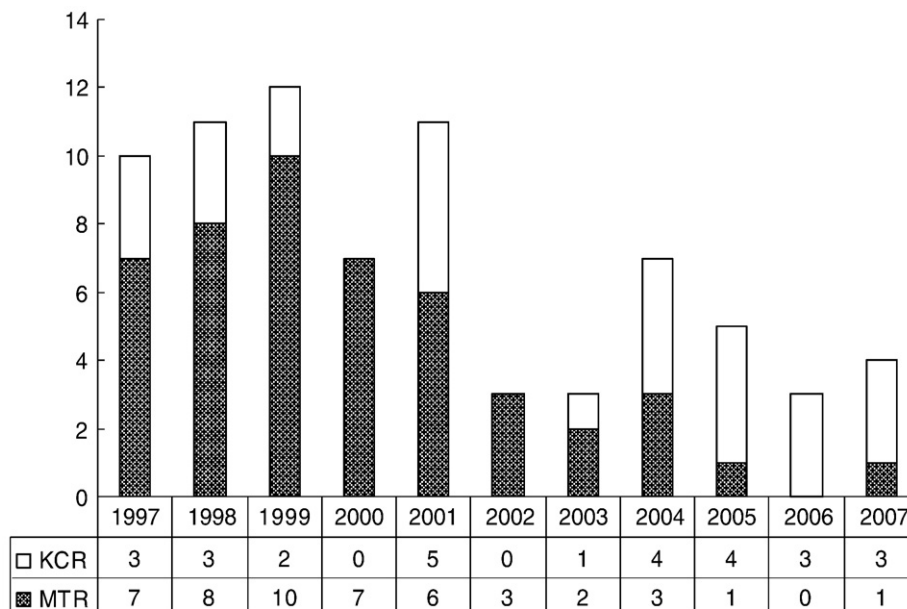
^b Since there was no significant time trend in the number of railway suicides and suicides by other methods over the 10-year observation period, the slope coefficient (β) from Poisson regression was estimated by adjusting the age and gender effect only.

different methods of suicide, jumping on railway tracks was not a popular way in Hong Kong. This method was mainly used by men, as more than 4 times as many men committed suicide on railway track ($N=62$) as women ($N=14$) over the period. Correspondingly, the sex ratio

for all suicides was relatively lower at 1.73 men to 1 woman only.

3.2. Effect of PSD installation on suicide figures

As shown in Tables 1 and 2, there has been an apparent and significant reduction in the number and rate of railway suicides in the general population since the installation of PSD at MTR stations in 2002. Owing to the marked upsurge of charcoal burning suicides since 1998 (Liu et al., 2007), the number of all suicides has recorded a significant increase with an adjusted 5-year APC of +26.9% ($p<0.0001$) over the whole period. In contrast, the corresponding figure for railway suicides over the same period was quite the opposite. A significant decrease in the 5-year average annual number of railway suicides in Hong Kong was observed from 10.2 cases for the pre-installation period to only 4.4 for the post-installation period, which accounted for an age and gender adjusted 5-year APC of −59.9% ($p=0.0003$) by Poisson regression analyses. Also, no significant evidence of any transition trend of railway



	Number of railway suicides (%)	
	Pre-installation period (1997 - 2001)	Post-installation period (2003 - 2007)
KCR	13 (25.5%)	15 (68.2%)
MTR	38 (74.5%)	7 (31.8%)

Fig. 1. Railway suicides by railway system in Hong Kong, 1997–2007.

suicides was found ($p=0.614$), indicating that such a drastic change was very likely to be a result of limiting passengers' access to the railway track by PSD after the post-installation period, rather a natural transition in suicide epidemiology.

3.3. Possibility of displacement to other railway stations

Fig. 1 shows the number of railway suicides found in KCR and MTR networks over the period under study. Passenger volume is a well-known predictor on all track-related incidences (Baumert et al., 2005). Subject to a higher daily passenger volume of the MTR network (with more than 2 million headcounts (MTRC, 1997–2006) as compared to 800,000 in the KCR network (KCRC, 1997–2006) over the whole period under study), it is obvious that the number and proportion of railway suicide incidences occurred at the MTR network ($N=38$, 74.5%) had been higher than that at the KCR ($N=13$, 25.5%) during the pre-installation period (1997–2001). However, the situation reversed after the PSD installation. The number of railway suicides at the MTR network decreased by 81.6% to only 7 cases in the post-installation period whilst that for the KCR network (without PSDs) over the same period remained at a fairly stable level of 15.

Poisson regression analyses (see Table 3) confirmed that the reduction in railway suicides after 2002 was solely contributed by MTR with an adjusted 5-year APC of -82.6% ($p<0.0001$). It is important to note that the change did not appear to displace potential attempters to an unsealed railway platform, as the same figure at KCR was apparently not significant ($p=0.905$).

3.4. Psychiatric profile of the suicide deceased on MTR

Finally, among those who committed suicide in the MTR network, it is worth noting that the overall reduction was not proportionately distributed according to the psychiatric background of the suicide deceased over the period (see Table 4). Prior to the PSD installation, around 66% ($N=25$) of the suicide

Table 4

Railway suicides at MTR network in Hong Kong by whether the deceased had a history of psychiatric problems and their corresponding diagnosis, 1997–2001 and 2003–2007

Had a history of psychiatric problems	Type of diagnosis	Period		Total	5-year period change (%)
		1997–2001	2003–2007		
No		13	3	16	–76.9
Yes	Depression	7	1	8	–85.7
	Psychosis	13	0	13	–100.0
	Others	5	3	8	–40.0
	Overall	25	4	29	–84.0
Total		38	7	45	–81.6

deceased had a documented psychiatric history. More than half of them ($N=13$) were diagnosed with psychosis and the next 28% ($n=7$) were depressive, which is consistent with the existing literature (Lindekilde and Wang, 1985 Emmerson and Cantor, 1993; Van Houwelingen & Kerkhof, 2008). However, in the post-installation period, the number of deceased on MTR network with a psychiatric history reduced by 84% to only 4 while the corresponding figure for those without a psychiatric history was also reduced by 76.9% to 3. A chi-squared test shows that the difference between two groups was not significant ($p=0.66$) owing to a small sample size. Nevertheless, it appears that those having psychosis would be better protected as no suicide cases with such psychiatric background were recorded over the 5-year post-installation period at the MTR network.

4. Discussion

This is a piece of pioneering findings in this area worldwide since MTR in Hong Kong is the first in-the-service railway system to undergo physical modification, which provides good research ground to assess the effectiveness of PSD installation for preventing suicides on railways. This study gives empirical support that PSDs can effectively prevent suicides at railway station platforms with no significant sign of displacement to other platforms. Moreover, it suggests that PSD is an effective means to prevent people with psychiatric problems from committing railway suicides.

4.1. PSD as suicide prevention

Availability and desirability are generally recognized as factors leading to one's choice of means of suicide (Clarke and Lester, 1989). The setting up of PSD has minimized, if not eliminated, passengers' direct contact with a moving train at a platform, thereby reducing

Table 3

Age and gender adjusted slope coefficient from Poisson regression and the corresponding average percentage change of railway suicides in Hong Kong from 1997–2001 to 2003–2007 by railway system

Railway system	β	APC (%)	p-value
MTR	–1.75	–82.6	<.0001
KCR	0.05	4.6	0.9051
Overall	–0.91	–59.9	0.0003

suicide attempters' "success rate" in collision with a moving train. Especially for severely mentally ill patients whose cognitive functions may have been impaired, familiarity with and ease of access to the nearby railway track may be important factors for their choice of committing railway suicide (Van Houweligen and Kerkhof, 2008).

Simply restricting the availability has nothing to do with one's suicidal thought and this may be one of the reasons why some researchers have doubt about the effectiveness of environmental modification. However, PSD installation may have even altered people's perception about the desirability of railway suicide. Traditionally railway suicide has a strongly "lethal" image that does not allow ambivalent behaviour once the act is initiated (Veress and Szabó, 1980; Lindekilde and Wang, 1985; Deisenhammer et al., 1997; Erazo et al., 2004). Attempters may think that they would certainly die instantly and painlessly (Guggenheim and Weisman, 1972; Mishara, 2007a). However, a railway system with PSDs looks much safer and may have dissuaded people from trying this method by "delethalizing" the image of railway suicide. This may be the reason why the finding suggests that there was no displacement to unsealed platforms.

4.2. Epidemiology and intervention

Epidemiological studies so far have provided useful data to identify the "at-risk" groups for suicide prevention. This study demonstrates that interaction exists between intervention on the physical environment and the epidemiological profile for railway suicide. Suicide is a public health problem that requires more effort and participation from stakeholders in the community to formulate effective on community-based strategies. With more knowledge of how environmental factors influence the occurrence of suicides on railway, it is a mutual responsibility for railway operators to extend the coverage of PSD to all railway stations in Hong Kong for the sake of public safety. In addition to prevent suicides, the restriction of access to tracks can also eliminate the chance of injury due to accidental fall and provide a much safer environment to the public.

4.3. Limitations

A limitation of this study is that it has not considered the potential economic benefits arising from the PSD to the railway system. Undoubtedly, the direct installation cost in modifying the physical environment in an operating railway station is substantial with a long payback period.

In Hong Kong, for example, the MTR Corporation totally spent HK\$2 billion (US\$256.4 million) for the PSD installation and estimated to take another 50 years to cover the installation cost from its passengers (MTRC, 2002). This makes promotion work difficult to initiate other railway companies to follow (Kerkhof, 2003) unless there is an evidence to show the work, in addition to energy conservation, can bring them a net economic gain and thus a cost effectiveness analysis on PSD installation is worthwhile. Actually as shown in this study as well as the studies on drainage pits in London (Cocks, 1987; O'Donnell and Farmer, 1994; Coats and Walter, 1999), such modification to the physical environment could also bring about economical benefit in other aspects, especially in avoiding any delay of service when an incidence occurs.

Also, as railway suicides only constituted a small proportion of suicides in Hong Kong, it is difficult if not possible to examine whether the physical barriers at station platforms will displace potential attempters to take an alternative method of self-destruction. Although some studies have pointed out that suicide individuals do not easily displace to an alternative lethal means of suicide (Beautrais, 2007a,b; Hawton, 2007; Mishara, 2007b; Yip and Lee, 2007), method substitution remains one of the major concerns that can never be ignored for suicide prevention purposes. In the review of this article, one of the reviewers suggested that potential attempters of railway suicide may take another way of suicide by jumping from high rise buildings in regions adjacent to stations with sealed platform. However, as there are more than 80% of Hong Kong people living in skyscrapers, jumping from height is the most commonly used method (almost 50%) of suicide in Hong Kong. Therefore, the findings of this study, which accounted for less than 1% of all suicides at about 10 episodes per annum, are practically not adequate to conclude the existence of method substitution and also its influence on suicide prevention.

Nevertheless, it is indubitable that PSD provides a number of important benefits to both passengers and operators and more railway networks are installing this barrier to improve the station environment. In addition to providing a much safer environment, these barriers also improve the scheduling efficiency by reducing boarding time at stations when passengers know where to stand on the platform. (Simmons-Boardman Publishing Corporation, 2004) Recently, a PSD installation work is in progress in the Guangzhou subway system (Wikipedia, 2008) and we expect that such facilities are the way forward for modern metros and will appear in other operating railway networks in Mainland China and other countries in the world.

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Conflict of interest

All authors declare that they have no conflicts of interest.

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