

An Approach for Actions to Prevent Suicides on Commuter and Metro Rail Systems in the United States



MTI Report 12-33



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REPORT 12-33

**AN APPROACH FOR ACTIONS TO PREVENT
SUICIDES ON COMMUTER AND METRO RAIL SYSTEMS
IN THE UNITED STATES**

Jan L. Botha, PhD
Marissa K. Neighbour, BS
Satnam Kaur

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College of Business
San José State University
San José, CA 95192-0219

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16. Abstract The primary goals of this report are to discuss measures to prevent suicides on commuter and metro rail systems, and to outline an approach for suicide prevention on rail systems. Based on existing literature and analysis of data obtained from the Metrolink system in Southern California, it was found that most suicides occur near station platforms and near access points to the track. Suicides occurred most frequently when relatively more trains were in operation and in areas of high population density. There do not appear to be suicide "hot spots" (e.g., linked to mental hospitals in the proximity, etc.), based on data analyzed for U.S. systems. The suicide prevention measures range from relatively inexpensive signs posting call-for-help suicide hotline information to costly platform barriers that physically prevent people from jumping onto tracks in front of trains. Other prevention measures fall within this range, such as hotlines available at high frequency suicide locations, or surveillance systems that can report possible suicide attempts and provide the opportunity for intervention tactics. Because of the relatively low number of suicides on rail systems, as compared to the overall number of suicides in general, a cost-effective strategy for preventing suicides on rail systems should be approached in a very focused manner. The prevention measures executed by the rail authorities should be focused on the suicides occurring on the rail systems themselves, while the broader problem of suicides should be left to community-based prevention efforts. Moreover, prevention measures, such as surveillance and response, could "piggyback" on surveillance and response systems used for other purposes on the rail systems to make such projects economically feasible.			
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To order this publication, please contact:

Mineta Transportation Institute
College of Business
San José State University
San José, CA 95192-0219

Tel: (408) 924-7560
Fax: (408) 924-7565
Email: mineta-institute@sjsu.edu

transweb.sjsu.edu

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EXECUTIVE SUMMARY

The primary goals of this report are to discuss measures to prevent suicides on commuter and metro rail systems, and to outline an approach to prevent suicides on rail systems.

It was found that the number of suicides committed on rail systems in the U.S. is relatively low compared to the total number of suicides committed in the U.S. in general. There were only 180 suicides from 2003 to 2008 on 48 commuter, heavy and light rail systems—about 30 suicides per year. By comparison, in 2010 alone, there were 38,364 suicides in the U.S. as a whole. It could reasonably be concluded that overall suicide prevention should be the responsibility of the community at large. The rail authorities should be focusing their limited resources on preventing and possibly mitigating suicides on the rail property itself and on individuals attempting to access the rail property to commit suicide. The community abutting a rail system could be affected by the suicides on the rail system and may look to the rail authority to become involved in community-based suicide prevention measures. However, from a cost-effective point of view, the rail authority should only become involved with community-based program when there is a direct connection to preventing suicides on the rail system itself, such as through providing phones linked to a community-based suicide prevention center. Rail authorities may be tempted to become involved in a broad community-based program, to improve public relations, but they will probably be better served by focusing on their own effort to prevent suicides on the rail property. Questions regarding the motivation to commit suicide should be left to the broader community.

It is recommended that an approach based on the principles of benefit-cost analysis should be followed to identify and prioritize candidate suicide countermeasures on rail systems. The approach basically consists of identifying the locations and times in which candidate projects with high benefit-cost ratios would more likely be present. Candidate projects that could decrease the number of suicides would then be identified. As a next step, the benefit-cost ratios of the projects should be calculated. The “benefits” would consist of the decrease in costs associated with suicides, while the “costs” would be the expenses associated with implementing the countermeasure. Projects with a benefit-cost ratio greater or equal to one would be considered feasible from an economic point of view. Then the projects would be prioritized based on the benefit-cost ratios.

The locations of candidate projects could be identified as places with relatively high frequencies of suicides, which most likely would yield the highest probabilities for suicide reductions. These locations were found to be associated with areas of high population density, station platforms, and areas close to entry points to the rail property, such as a road crossing. It should be noted that in other areas of the world, such locations have been associated with “suicide hot spots,” such as proximity to mental hospitals. There is yet no evidence that such locations have played a measurable role in the U.S., but this may be due to the very low incidence of suicides on U.S. rail properties.

The benefits consist of reducing the costs to society resulting from the suicides. The Center for Disease Control and Prevention estimated that the average cost of a suicide amounted to about \$1 million based on 2005 data. It is recommended that research be carried out to determine the cost of a rail suicide in the U.S. because it is potentially higher than the cost

of the average suicide. Cost elements not normally present in the costs of the average suicide may be represented in the costs of a rail suicide. Such costs may include travel delays on the rail system and the effects on the surrounding road and public transportation systems, as well as the costs of restoring the rail system to full operational status. The costs associated with the impacts on engineers and train crews are also part of the latter cost. The cost effects of personnel turnovers should also be included.

When using the cost of the suicide in the analysis, the “point-of-view” issue must be clarified. The usual approach to determining the costs for tax-funded public projects is to count all costs regardless of to whom they accrue. That would mean that societal impacts, such as the cost of counseling people who are affected by the suicides but who may not be members of the rail system staff, should be included in the costs. Including this higher cost would allow justification for higher spending. Conversely, a privately-owned rail system would possibly include only its own costs associated with the suicides, which would lead to a relatively lower expenditure on countermeasures. Most publicly-owned rail systems utilize tax funds, and the higher cost estimates for suicides would be justified. It is essential to recognize that an accurate estimate of the cost of a suicide is critical in determining the benefit-cost ratio, feasibility, and priority of a countermeasure.

Maintaining records associated with suicides and countermeasures would aid in the correct estimation for similar future projects even if these estimates would change by location. It is recommended that an organization such as the Federal Transit Administration (FTA) assume responsibility for conducting the appropriate analyses and maintaining a depository for relevant cost data from other rail authorities because it may not be cost-effective for each rail authority to maintain this level of expertise. In addition, the FTA could undertake the lead role for disseminating relevant information and data. It should be noted that neither the availability of funding nor the legal feasibility for having the FTA undertake these tasks has been researched as part of this project, nor has it been discussed with the FTA. The FTA could initiate further research on this topic or take action as desired. The Federal Railroad Administration (FRA) could also become involved because some rail lines are shared with freight rail systems and long-distance passenger trains.

A relatively inexpensive suicide prevention measure could consist of placing signs with phone numbers to call for help at station platforms and access points to the track. A benefit-cost analysis likely would not be necessary because the cost is relatively low, and the cost of carrying out a benefit-cost analysis may not be warranted. However, benefit-cost analyses for higher-cost projects become very important in view of the anticipated difficulty of implementing such projects. The major reason for this difficulty is that relatively few suicides occur on rail systems, and consequently there is relatively little opportunity to decrease the cost of suicides. It may be necessary to “piggyback” on projects that have objectives other than reducing suicides in order to justify implementing the countermeasures. A case in point is implementing barriers on platforms, where preventing suicides is a by-product or a concomitant benefit to the primary project goal of preventing people from being jostled and inadvertently pushed onto the tracks. Another example is installing barriers to act as “seals” to make air conditioning feasible.

A number of other prevention measures can be utilized that fall between posting signs and total access restriction to tracks. These measures are composed of surveillance and response. They can be implemented in numerous ways, with varying degrees of effectiveness and cost. Surveillance can be accomplished directly by rail personnel or by equipment such as closed-circuit television. Personnel can handle identification, either on location or remotely. Then a response and intervention may be carried out by personnel already on the rail property, or perhaps by loudspeaker. Another option is to target all trespassers in certain locations.

Previous research showed that suicides are committed either close to a station platform or close to rail crossings. By targeting these locations, a large portion of suicides may be prevented. “Piggybacking” onto other functions already being carried out by rail personnel could significantly reduce the cost of suicide prevention and lead to a benefit-cost ratio greater than one. Station agents, maintenance and operations staff, and security officers could be trained to execute these tasks, while personnel who deal with vandals may already be well-suited. If there were a community center staffed with personnel answering suicide hotlines, they possibly could be contracted to monitor remote cameras on rail property to identify people who show signs of wishing to commit suicide, and then to initiate a response.

The number of commuter rail systems in the U.S. is relatively small, and they have a comparatively low incidence of suicide. Because of this, a strategy for preventing suicides may be carried out in what may be described as a focused manner, coordinated by one or a limited number of agencies. In contrast, road fatalities number in the tens of thousands per year, with many road authorities implementing crash mitigation. This situation does not lend itself to coordination by one or only a few organizations because of the vast number of roadways and jurisdictions. In the case of commuter rail systems, suicide prevention could possibly be approached within the following framework (note that the literature review indicates that some of these actions already take place, although not all of them within the U.S.):

1. “Saturate” all rail commuter systems with relatively inexpensive signs that could help to prevent suicides at platforms and other entry points to tracks. This tactic should commence in densely populated areas and could be carried out in a relatively short time at relatively low cost. Track the major costs of implementation and suicide frequencies annually.
2. Hotlines could be implemented in a similar way, but they would be more expensive than signs. Pilot projects could be identified to document the incidence of calls, procedures, costs, etc., to determine the efficacy of this tactic. Linking to existing hotlines should be considered.
3. The next step would consist of implementing the systems focused on surveillance, identification, and response. A first step may be to implement a pilot project with a rail system that has a relatively high incidence of suicides. The implementation methods and procedures, the associated costs, and the suicide frequencies within the affected section of track should be documented. Such a documented pilot project

could commence with platforms and rail crossings in densely populated areas. Because it will take a long time and several projects to determine the effectiveness in terms of suicide prevention (because suicides are such rare events), the initial focus should be on gaining experience and accumulating cost data. Based on this experience with costs, the coverage of commuter rail systems with these types of suicide prevention projects could then be systematically expanded. By more accurately estimating the monetary and societal cost of rail suicides and the benefits of reducing them, a better sense could be made of whether the prevention measures are cost-beneficial. Monitoring the frequency, locations, and times of all suicides annually for all commuter rail systems, such as done in this and previous research, should not be difficult or very costly.

4. A similar approach to placing barriers on platforms could be carried out, but based on the literature review, this measure probably would be better suited to metro systems with limited access. It likely would be too costly for the average commuter rail system.

I. INTRODUCTION

The primary goals of this report are to outline an approach to identifying, selecting and implementing suicide countermeasures for commuter rail systems in the United States. Implementing countermeasures for rail system suicides is complicated. Each of these events has a significant effect on the rail system because it is a very public death. Railway suicides may account for only a small percentage of all suicides, but the numbers of deaths and the effects from these events are still significant.^{1,2} These events affect not only the families and friends of the victims, but they can also affect the railway personnel, eyewitnesses, and the community.³⁻¹² In an article published by Krysinska and De Leo in the *Australian and New Zealand Journal of Psychiatry* (2008), they mentioned that the costs of railway suicide are substantial due to the loss of human lives, driver and bystander trauma, and the delays of railway service.¹³ Mishara (2007) expands this list by discussing a railway suicide's high cost on society; not only is there an economic burden for the rail service, but all the passengers are forced into a highly inconvenient situation.¹⁴ The cost would also include the trauma, time, and monetary costs forced upon families and friends to take care of the unfortunate turn of events.

Unfortunately, few railway suicide prevention programs have been implemented, and therefore there is not much evidence for their effectiveness.¹⁵⁻¹⁷ Also, for some programs that have been implemented, systematic evaluations have not yet been completed.¹⁸ In other cases, programs have been implemented, but they include a number of different mitigation practices, such as call-in hotlines for people contemplating suicide, trained personnel to address suicide attempts, etc., so it is difficult to determine the effectiveness of a specific program component.¹⁹ Another problematic factor is that most or all of the tests for the effectiveness of a preventive method are based on small samples of data.²⁰ Having a few more or fewer suicides in a study period, due potentially to outside variables, could completely change the analysis or make it impossible for proper analysis. Additionally, each country and network collects and reports suicide data differently, thus creating more potential inaccuracies in data analysis.²¹

Ideally, suicides should be prevented and, should they occur, the effects of the suicide impacts should be minimized as much as possible. It should be noted that this study focused on suicide prevention and not on suicide impacts.

In the following section of the report, an approach to identifying, selecting, and implementing prevention and mitigation measures will be discussed, followed by a discussion of the locations where and times when prevention measures should be implemented. Next, the efficiency and effectiveness of various countermeasures will be considered. Suggestions will be given for possible countermeasure implementation strategies. Finally, a summary will be presented of major findings and recommendations.

II. AN APPROACH TO IDENTIFYING, SELECTING, AND IMPLEMENTING SUICIDE COUNTERMEASURES IN COMMUTER RAIL SYSTEMS

The objective of this section is to propose an approach to identifying, selecting, and implementing suicide countermeasures on commuter and metro rail systems.

To place the approach in context, this report will discuss the magnitude of the suicide problem on the rail systems as well as the general types of countermeasures. Next, the framework for evaluating and prioritizing the countermeasures is outlined, followed by a discussion of whether prevention should be focused on the broad community or restricted to the rail property. The cost of suicides will be given consideration as well as some specific aspects of classes of countermeasures.

MAGNITUDE OF THE PROBLEM AND FOCUS OF PREVENTION EFFORTS

According to the FTA “2009 Rail Statistics Report” published by the Federal Transit Administration (FTA),²² 382 public fatalities occurred from 2003-2008, of which 180 were suicides. Therefore, there were about 64 public fatalities and 30 suicides on average per year. The number of rail organizations featured in the study is not mentioned in the report, but the report refers to the State Safety Oversight (SSO) Program. In another report published in January 2012 by the Office of the Inspector General,²³ it is stated that “28 SSOAs oversee 35 light rail and 13 heavy rail systems operated by 48 transit agencies.” Updated data obtained from Mr. Timothy Braxton of the FTA indicated that 272 fatalities were reported for 46 rail systems from 2007-2011. This amounts to an average of 45 fatalities per year, which is fewer than for the previous period.

By comparison, according to the Centers for Disease Control and Prevention, 38,384 suicides occurred in 2010 in the U.S.²⁴ Most of these suicides were carried out by firearms, suffocation, and poisoning. In general, railway suicides account for a small percentage of suicides. However, for those who do choose this form of suicide, it may be due to the lack of resources for a less public means of death.²⁵ Other contributing factors, given by Andriessen and Krysinska, include levels of accessibility, density of railway networks, social acceptability of using railways for suicidal purposes, and psychopathological backgrounds of victims.²⁶ Law, et al., mention similar reasons for choosing a certain method of suicide over another.²⁷

Accessibility and availability can have major effects on an area’s relative frequency for specific means of suicide. For example, in Hong Kong, over 80% of the people live in skyscrapers, and therefore almost 50% of the suicides are due to skyscraper jumping.²⁸ As another example, in the United States, where guns are integrated so heavily into the system, firearms are by far the leading cause of suicide. Studies have shown that gun suicides in the U.S. are over 50% of the overall suicides (Swissinfo.ch, 2010), whereas the rates in other countries are nowhere near that figure.²⁹ Switzerland is under scrutiny for having the highest rate in Europe at about 24-28%.³⁰ However, other European countries have a much lower percentage of suicide by guns: England and Wales stand at 2.8%, and

Scotland at only 1.8%.³¹ Even other English-speaking countries such as Canada have an extensively lower rate at about 19% (in 2000).³² Because most of the literature review for this report was based on studies from other countries, this factor definitely should be analyzed critically when considering mitigation measures in the United States. Therefore, in the United States, it may be difficult economically to justify implementing suicide relief campaigns specifically designed for mitigation at railways in other countries.

Krysinska and De Leo (2008, *Australian and New Zealand Journal of Psychiatry*) reviewed many studies and reported that railway suicides accounted for between 1% and 12% of all suicides internationally.³³ In an observational study conducted in Germany from 1991-2000, it was found that 7.0% of all suicides were completed by means of railway (Baumert, Erazo, and Ladwig).³⁴ This result was also provided in the 2011 study by Lukaschek, Baumert, and Ladwig (*BMC Public Health*),³⁵ and Mishara (2007, *Crisis*).³⁶ The Netherlands was one of the only countries found to have a higher percentage³⁷⁻³⁹ between 10-14%.^{40,41} Kerkhof has been suggested that the higher proportion of railway suicides is due to the Netherlands' high population density, and because almost everyone lives within 20 kilometers (about 12.5 miles) of open track (Mishara, 2007).⁴² Holdaway et al. reported that the railway suicide percentages in 2004 were 5.3% in Belgium, 5.0% in Sweden, and as mentioned, 7% in Germany.⁴³ Mishara found other evidence including about 5% railway suicides in England and Wales (Clarke, 1994; Symonds, 1985), 9.4% in Turkey from 2000-2002 (Ozdogan et al., 2006), and 3% in Canada (Transport Canada, 1996). Mishara also found rates from other studies including 12.4% for the Netherlands, 6.2% for Sweden, 6.2% for Japan, 5.7% for Austria, 3.1% for Denmark, and 2.7% for Hungary.⁴⁴

Victims generally choose a method of suicide based on its perceived success rate, familiarity, and accessibility (Holdaway et al., 2012).⁴⁵ Clarke and Poyner agree that alternative methods may not be chosen due to less attractive qualities.⁴⁶ However, potentially due to a lack of other resources (such as a gun or poison), suicide by railway may be a victim's best option.⁴⁷ It has been proven that those who choose to commit suicide on railways believe it to be a fast, easy, and foolproof method. This, however, is not necessarily the case. For instance, Krysinska and De Leo stated that 90% of railway survival victims from the London Underground had believed they were going to die from their attempt.⁴⁸ Mishara (2007, *Crisis*) believes that psychiatric patients and others must be educated about the "false beliefs that rail suicides provide a certain, painless, and immediate death."⁴⁹

Research showed that a wide range of completed-attempt percentages were present for different countries and railway systems. Mishara speculated that these differences are most likely due to "operational characteristics of the railway and metro systems, such as the speed at which trains travel and enter stations, their ability to stop to avoid a collision, and suicide prevention measures" such as suicide pits.⁵⁰ In an article from the *European Journal of Public Health*, Baumert, Erazo, and Ladwig discussed a German railway study that reviewed data between 1991-2000.⁵¹ During this period, 9,510 suicide attempts were made with 8,653 being fatal. This accounts for a 91.0% fatality rate.⁵² Lukaschek, Baumert, and Ladwig (2011, *BMC Public Health*) also stated that the fatality rate for railway suicides is over 90%.⁵³ In a study completed by Radbo and Andersson in Sweden, 41 of the 47 victims (87%) had fatal train collisions.⁵⁴ Mishara quoted similar results for the Netherlands—90% death rate.⁵⁵ In a review by Holdaway et al. from the Rail Safety and Standards Board (RSSB), it was

reported that the suicide success rate for “mainline train systems” was around 80-90%, with variations between systems.⁵⁶ From a study completed by the RSSB for Great Britain between 2001/02 to 2009/10, it showed that 79% of the attempts were fatal.⁵⁷ Holdaway et al. also mentioned that the fatality rate in metro systems tends to be lower.⁵⁸

Although the above-mentioned studies reported a high rate of success for railway suicide, there also have been reports on the lower side. Krysinska and De Leo (2008, *Australian and New Zealand Journal of Psychiatry*) found from many studies that the fatality rate ranged from 43% to 94%.⁵⁹ Holdaway et al. examined some research with low death rates. In a study completed on the German FRG system for 391 victims who attempted suicide at a station, 94% of males and 92% of females came out injury-free.⁶⁰ The same study also suggested that serious injuries happened more often on open-track attempts (22% of males and 41% of females).⁶¹ Mishara reviewed a large amount of evidence of low fatality rates. There was a 32% fatality rate for attempters on the Boston, Massachusetts subway trains between 1966-1972 due to the trains entering the station relatively slowly (Guggenheim and Weisman, 1972).⁶² Mishara had reported in his 1999 study that the fatality rate in the Montreal metro was 28%.⁶³ It was stated that 64% of victims were successful in the Munich, Germany subway system from 1980-1999 (Ladwig and Baumert, 2004).⁶⁴ Between 1981-1986, the death rate in London was 43% (Cocks, 1987), 42% in Hong Kong, and 48% in Toronto (Gaylord and Lester, 1994).⁶⁵ Mishara also mentioned from a 1992 study by O'Donnell and Farmer that in a comparison of 23 urban transportation systems, the fatality rate was between 20% and 80%.⁶⁶

Given that rail suicides constitute a relatively small portion of overall suicides in the U.S., it seems logical for rail authorities to focus their suicide prevention efforts on the attempts committed on rail property. While some suicidal individuals exhibit signs of wanting to commit suicide, others do not. This is an important consideration for the development of a strategy for implementing countermeasures. Selecting an appropriate countermeasure depends on where those wanting to commit suicide wish to carry out their act, whether it will be at station platforms, away from platforms, etc. These issues will be addressed in more detail later in the report.

A community abutting a rail system could be affected by suicides committed on the rail system. The residents may look to the rail authority to become involved in community-based suicide prevention measures. From a cost-effective point of view, U.S. rail authorities should become involved in such efforts only if they are directly tied to the efforts to prevent people from using the rail system to commit suicide. The cause of suicides is a problem that should be addressed by the broader community. While it may be tempting for a rail authority to become involved in a community-wide suicide prevention effort for the sake of improving public relations, the required funds likely would be better utilized for a more focused suicide prevention effort on the rail system itself. In all likelihood, the magnitude of effort that a rail authority could afford to contribute to a community-based suicide prevention project would be very small when compared to what would be required to prevent the comparatively large number of suicides committed by other means. By participating in such an effort, a rail authority may run the risk of creating an expectation that its effort would be successful, whereas the size of the effort would most likely lead to disappointing results. This in turn could lead to bad publicity. The public relations effort could probably

be more suitably centered on making information available on the specific suicide efforts of the rail authority to prevent people from using the rail system as a means of suicide.

TYPES OF COUNTERMEASURES

The intent of this section is to present a general discussion of the types of countermeasures that would be appropriate under different circumstances. The specific types of prevention and mitigation measures will be discussed more fully in later sections.

Community-Based Programs

For people who show no indications for committing suicide, prevention measures of a general community-based nature could be implemented. These would include any program targeting the general population, such as community mental health programs or posted signs with phone numbers to call for counseling. Also included would be other forms of help if people wanted to talk with someone about contemplating suicide. These types of measures are outside the scope of this project, which is concerned with suicides directly connected to commuter rail systems.

Signs

Posting signs (with telephone numbers to call for help) on platforms and other places, where access could be gained to the track, could aid in suicide prevention for those potential victims who exhibit suicidal tendencies, as well as for those who do not.

Access Control

A more direct intervention would consist of preventing or controlling access to rail tracks. This measure would help all individuals who may accidentally fall or intentionally jump in front of a moving train. This could include overall access control at road crossings (grade-separated crossings as well as preventing other access from the road to the tracks, possibly with a fence on the road) and fencing off the remainder of the track. Barriers that prevent access to the tracks at station platforms fall into this category of countermeasures.

Surveillance and Emergency Personnel

Adding surveillance and response efforts to part or all of the rail property in order to detect trespassers, including people who want to commit suicide, could be implemented if controlling access is not an option. There are several possible implementation options. The surveillance could be done by personnel at selected locations such as the rail stations, or remotely with electronic equipment. The surveillance personnel could be trained to identify people with suicidal tendencies and then carry out a response. This may involve physically dispatching personnel to the location for intervention or responding remotely over a loudspeaker. Having trained people conduct the surveillance could lead to a more targeted and effective response.

Pits

Pits or an excavated area under the rail tracks could be provided as a refuge while a train is passing. It may be surmised that this measure would be primarily effective for people who fall onto the tracks accidentally, but it possibly could be of help to people who decide at the last moment not to go through with a suicide attempt.

Train Operation

The impact of a suicide attempt could be mitigated by running trains at lower speeds through stations and other locations where there is history of a high incidence of suicides.

EVALUATING AND PRIORITIZING THE COUNTERMEASURES

Suicides on commuter rail systems have social and economic impacts. Whereas it would be difficult to quantify the social impact of a suicide, the economic impacts can and have been quantified. The cost of suicides and the implication thereof will be discussed in the next section of this report. From an economic perspective, any measure directed at decreasing suicides that would cost less than the economic value of the reduction in suicides could be considered economically feasible.

An approach based on the principles of benefit-cost analysis could be followed to identify and prioritize candidate suicide countermeasures on rail systems. The benefits are the monetary costs of the reduction in suicides resulting from a countermeasure, and the costs are those of the countermeasure. The first step in this approach consists of identifying the locations and times where candidate projects with high benefit-cost ratios would likely be present. The most obvious locations would be those with high incidences of suicides because they would offer the most potential benefits, i.e., reduction in the cost of suicides. Candidate projects, which could decrease the number of suicides, would then be identified based on the benefit-cost ratio. Projects with a benefit-cost ratio greater or equal to one would be considered feasible from an economic point of view. The projects would then be prioritized based on the benefit-cost ratios.

It should be kept in mind that the use of benefit-cost analysis in project identification and prioritization does not necessarily mean that it is always strictly implemented or the only consideration in project selection. It should be recognized, however, that whatever other factors are taken into account, the benefits are at least equal to the cost and that the project priority is justified. Using benefit-cost analysis to the extent possible would promote effective and efficient decision-making that would optimize use of scarce resources and put the suicide prevention effort on a systematic basis. The methods used for calculating benefit-cost ratios and prioritizing projects based on benefit-cost ratios are well documented in texts on economic analysis. However, executing a benefit-cost analysis and the accompanying data processing is not trivial. It is notable that this type of analysis has been the cornerstone of project selection for road safety management, as documented in the Highway Safety Manual.⁶⁷

Some measures, such as posting signs to deter people from committing suicide, have relatively low costs and, conceivably, would be affordable for most commuter and rapid rail systems. Consequently, the actual benefit-cost ratio would not be much of an issue; the focus would be on the effectiveness of a sign and some concomitant effects, including liability if the signs were not properly maintained.

At the other end of the spectrum are other measures, such as controlling access through barriers and fencing, which could result in significant costs; the calculation of the benefit-cost ratio would become a determining factor. As noted before, the number of suicides on rail systems is relatively low; therefore, the decrease in the cost of the suicides may not offset the cost of the countermeasure – i.e., the benefit-cost ratio may be less than one.

Cost of Suicides and the Implication for Countermeasures

Calculating the cost of a suicide is a daunting task. A review of available information on this topic revealed an array of cost breakdowns. No data were found for the cost breakdown of suicides on railways, but some estimates have been made for suicides in general. The Centers for Disease Control and Prevention estimated that the average cost for a suicide at \$1,061,170 based on 2005 data.⁶⁸

It is recommended that research be carried out to determine the cost of a rail suicide in the U.S. because it is potentially higher than the cost of the average suicide. Cost elements that are not normally present in the cost of the average suicide may be represented in the cost of a rail suicide. Such costs may include the cost of travel delays on the rail system, the effects on the surrounding and associated road and public transportation systems, and the cost of restoring the rail system to full operational status. The “point-of-view” issue must be clarified when using the cost of the suicide in the analysis. The usual approach to determining the costs for public projects funded by taxes is to count all costs regardless of to whom they accrue. That would mean that societal impacts, such as the cost of counseling people who are affected by the suicides and who may not be members of the rail system staff, should be included in the costs. Including this higher cost would allow justification of higher spending. Conversely, a privately-owned rail system would possibly include only its own costs associated with the suicides, which would lead to a relatively lower expenditure on countermeasures. Most publicly-owned rail systems utilize tax funds, and the higher cost estimates for suicides would be justified. It is essential to recognize that an accurate estimate of the cost of a suicide is critical in determining the benefit-cost ratio and the feasibility and priority of a countermeasure.

If the estimated \$1 million cost of a suicide were accepted and all suicides occurring on the systems in the reporting in the 2009 Rail Safety Statistics Report⁶⁹ (approximately 30 per year) were eliminated, then the benefits would amount to \$30 million per year. In order to obtain a benefit-cost ratio of at least one, the equivalent uniform annual value of the initial cost plus the increased maintenance and operation costs could not exceed \$30 million. For illustrative purposes, if the increased maintenance and operation costs were ignored and only the initial cost were considered (using a real discount rate of 5% and a project life of 20 years), the present worth equivalent to the \$30 million per year would be about \$274 million. (Note that these numbers are approximate and do not take inflation

into account.) The cost of grade separation, fences, tunnels, and barriers to upgrade all the systems to resemble something like the Bay Area Rapid Transit System (BART) in the San Francisco Bay Area would probably run into billions of dollars, thereby rendering such a solution for eliminating suicides economically infeasible. It was stated previously that the economic cost of a suicide could exceed \$1 million, which would allow more investment in countermeasures. However, preventing someone from committing suicide on rail property may not prevent the person from using another means to commit suicide, which would negate the real savings of preventing the suicide. There still would be the benefit of sparing trauma to the rail personnel and preventing traffic delays and similar costs.

III. SUICIDE LOCATIONS AND TIMES

The locations where there may be high incidence of suicides can be divided into two categories. The first category may be linked to sources of people who may be inclined to commit suicide, such as a mental hospital. Locating such “hotspots” would enable the focusing of prevention measures by either treating people at the source or taking preventive measures on that specific part of the rail property. The second category contains those areas on the rail property where most suicides occur regardless of the source, as well as the peak periods when most suicides occur. Knowing the periods of highest incidence for both of these location types would allow more targeted suicide prevention efforts.

These two major location types will be discussed in the following section, followed by an analysis of data obtained for the Metrolink, a commuter rail system in Southern California.

INFORMATION FROM PAST STUDIES

The definition of a location with a high incidence of suicides or a “hotspot” is not precise and is generally determined by whoever analyzed the data and wrote the report. Cox et al. (2013) defined a suicide hotspot as a “specific, accessible and usually public site which is frequently used as a location for suicide and gains a reputation as such.”⁷⁰ Andreissen and Krysinska’s (2012) five-year study, on the other hand, defined a hotspot as any location where at least two suicides were committed within a two-kilometer section.⁷¹ Andreissen and Krysinska created a list of the major characteristics of hotspots that included ease in accessibility to the railway, presence of level crossings within walking distance, and the close proximity to a mental health institution.⁷² They also mentioned that evidence was found from the Netherlands, United Kingdom, and Australia that hotspots were located near mental facilities.⁷³

Based on research, it appears that the peak times for committing suicide on railways is 1.5 to 3 hours after sunset for males, and 7 to 8 hours before sunset for females (Mishara, 2007) (Holdaway et al., 2012).^{74,75} Holdaway et al. also concluded from research of international studies that the railway suicide rate peaks in the late morning and again in the evening.⁷⁶ From a Swedish study in which most of the railway suicides were shown to occur during the daytime, Mishara explained that this was probably due to the train traffic density being higher during the day.⁷⁷ However, Mishara found that in Germany, more suicide fatalities occurred during the night.⁷⁸ Mishara reported from the Erazo, Baumert, and Ladwig (2005) study of Germany that the highest fatality rates occur by attempts from men on open tracks during the night on rail lines where the trains are traveling fast.⁷⁹ Botha et al.⁸⁰ analyzed the suicide patterns occurring on the Caltrain commuter rail system in California and found that the time of suicides correlated fairly well with the peak periods of train operations.

When someone chooses to commit suicide by railway, it can be completed at a station, on open track, or at a rail crossing. While jumping in front of a train at a station would be considered a highly public event (due to a crowded station), attempting suicide on open track or at a rail crossing is usually more private. Studies have shown a wide range of results for the location of railway suicides.

In a study done by Radbo et al. in Sweden from 2000-2002, it was found that 55% of victims had died away from the stations, while 30% of them had done so at the stations (Krisinska and De Leo, 2008) (Mishara, 2007).^{81,82} Lukaschek, Baumert, and Ladwig (2011) reported similar results for a German study—about two-thirds of the victims had committed suicide on the open tracks, and the other one-third were committed in stations.⁸³ A more detailed study by the RSSB (Holdaway et al., 2012) from 2001/02 to 2009/10 showed that about 50% of victims committed suicide on open track, about one-third at stations, and about 10% at level crossings.⁸⁴ Holdaway et al. subsequently found that, based on data of 84 suicides committed on the East Coast Main Line in Great Britain between 1994/5 and 1998/9, 26.2% of the deaths occurred at the platform or on another part of the station, and 33.3% took place on open track.⁸⁵

Mishara reported from a Netherlands study that 45% of railway suicides occurred at or near railway crossings.⁸⁶ Similarly, Mishara stated that in Turkey, most of the suicides occur at level crossings.⁸⁷ Radbo and Andersson (2012) commented from their study of the Stockholm area in Sweden that there appeared to be a relationship between population density and suicide incidents, but that the incidents often occurred at the outskirts of urban areas, which offered more seclusion.⁸⁸

It was also noted by Lukaschek, Baumert, and Ladwig (2011) that 70% of those who committed suicide at the stations chose specific locations such as the head or end of the station platform.⁸⁹ These data complement the Clarke and Poyner data, which say that about two-thirds of the station suicides occur in the first one-third of the station entrance.⁹⁰

In their study of the Caltrain system, Botha et al.⁹¹ found that 20% of suicides occurred at stations, and two-thirds within one-half mile of station platforms. Two-thirds also occurred within 0.3 of a mile of the road crossings.

Clarke and Poyner (1994, *Social Science and Medicine*) said that on the London Underground, about 85-90% of suicidal incidents take place on the platforms, and 10% occur in the tunnels.⁹² Krysinska and De Leo discussed a study completed in the UK by Symonds; 64% of victims had died publicly, with most jumping from a crowded platform, and about 33% had died privately on open tracks.⁹³ The higher proportion of suicides occurring on stations on the London Underground may be explained by the fact that access elsewhere on the system is limited.

It has been found that the number of railway suicides generally correlates with population density. Mishara found evidence from Clarke's 1994 study that the number of railway suicides in England increased proportionately to the expansion of their railway system.⁹⁴ Most likely, this would be due to most victims committing railway suicide near their residences.⁹⁵ Holdaway et al. also mentioned that suicides are most likely to occur near the home of the victim.⁹⁶ Radbo and Andersson indicated that prevention programs should be executed at the locations where most suicides occur.⁹⁷ From a study taken of five districts in Belgium between 2003-2007, it was found that the regional distribution of railway suicides mirrored both the regional division of all suicides and the population size (Andreissen and Krysinska, 2012).⁹⁸ Botha et al.⁹⁹ also found correspondence between areas with higher population and suicides.

FINDINGS FROM THE METROLINK STUDY

The primary intent of this data analysis was to determine suicide patterns along the Metrolink Rail System in Southern California to supplement the information from past studies. Conclusions summarized in the charts and tables were extracted from raw data provided by Metrolink. The data consisted of 49 data points from 2005-2011 and included details such as date, day, time, line, cab/location, and county. Raw data for 2012 were not provided, although Metrolink's analysis exhibits 21 suicides for 2012, which is significantly higher than the previous years. Also, slight discrepancies can be found in Metrolink's analysis versus the analysis done for this report.

The data do not indicate a clear trend on a year-to-year basis (Figure 1). It is difficult to determine long-term trends based on such a short period combined with the relatively small number of events.

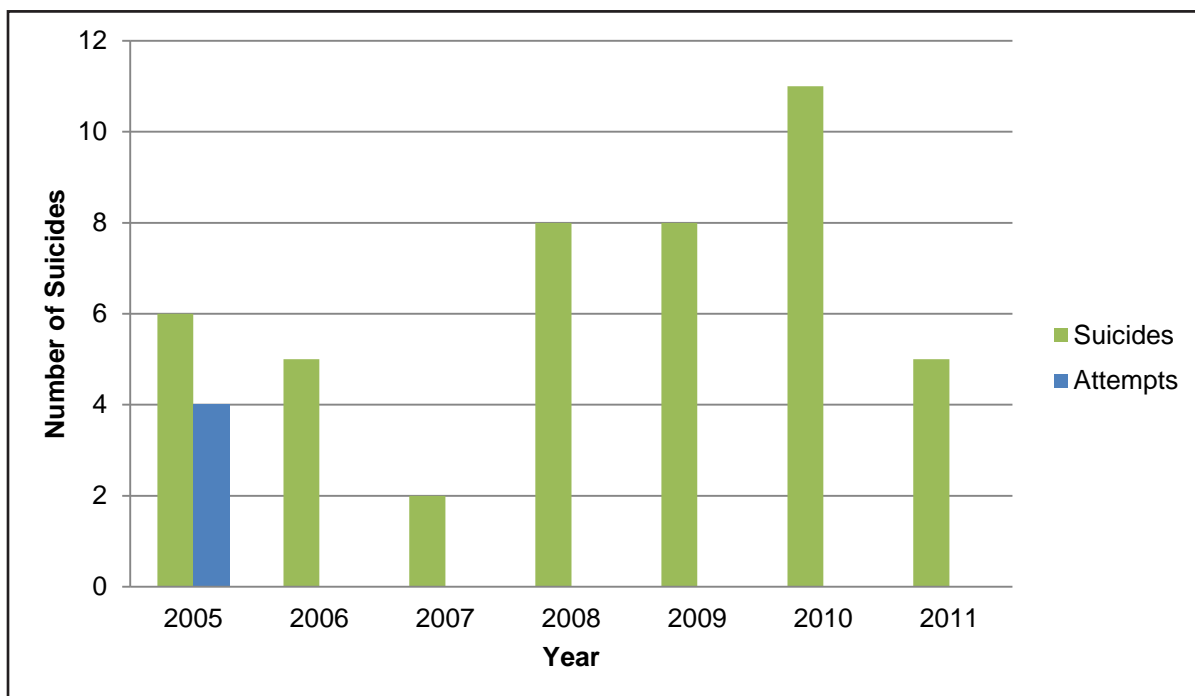


Figure 1. Number of Suicides and Attempts per Year

A majority of suicides occurred during the workweek (Figure 2), with relatively higher numbers on Wednesdays and Fridays. Ridership on the rail system decreases on Saturdays and Sundays, resulting in fewer running trains compared with the workweek schedule. In fact, only four out of eight rail lines offer service on Saturdays and Sundays.¹⁰⁰ This decreases the number of opportunities for incidents and suicides involving trains.

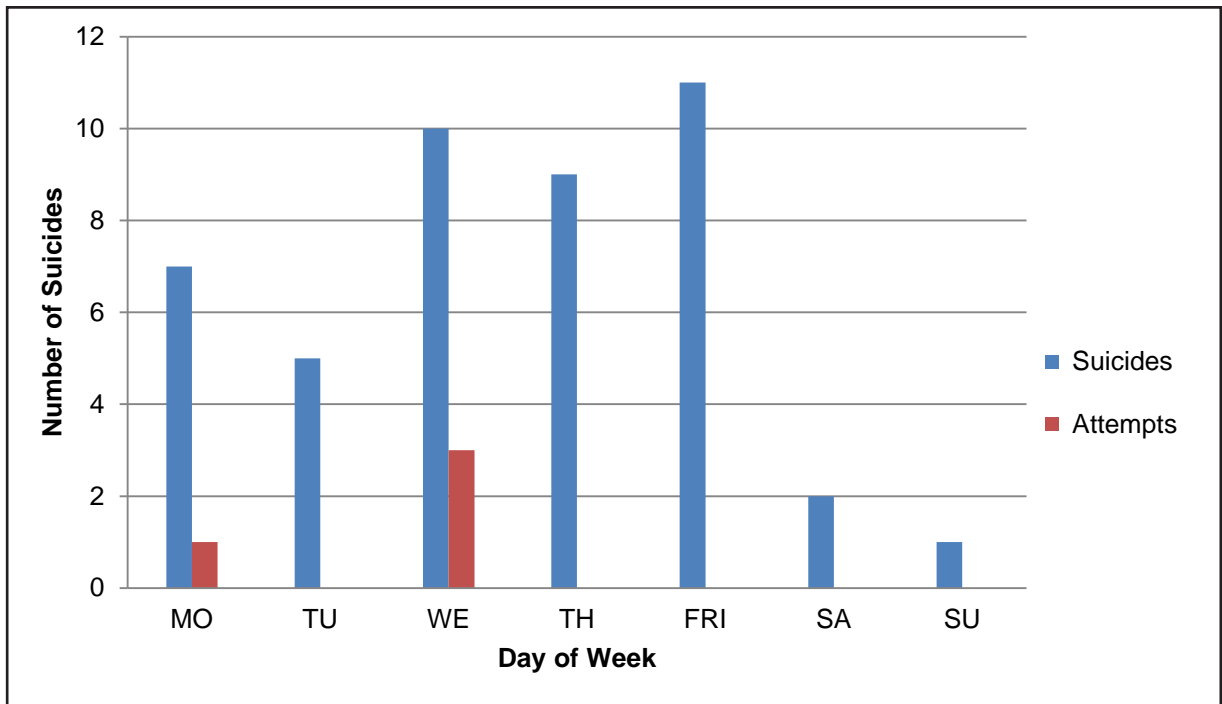


Figure 2. Number of Suicides by Day of the Week

The data indicated that the peak periods of suicides correlate with the peak periods of train operations and commuting hours. Most incidents occurred between 2 p.m. and 5 p.m., with 4 p.m. as the hour with the highest number of incidents (Figure 3). Frequency of running trains and usage of trains is highest during these hours.

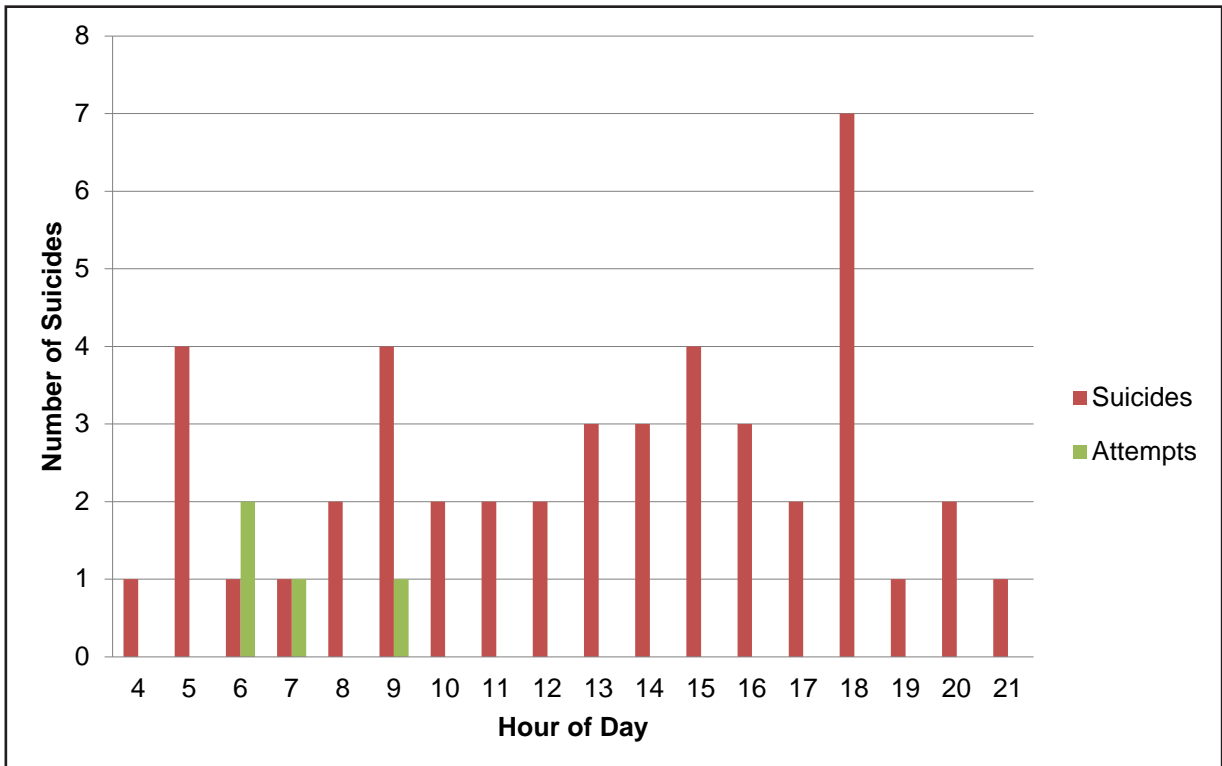


Figure 3. Number of Suicides by Hour of the Day

A comparison between the numbers of suicides at crossings versus the numbers at other locations indicated that about 37% of suicides were committed at crossings. This indicates that prevention measures at crossings could target a significant portion of individuals contemplating suicide (Table 1).

Table 1. Suicides at Crossings versus Other Rail Sections

Other Sections	63.3%
Crossings	36.7%

Figure 4 illustrates the frequency of suicides in specific counties that are serviced by the Metrolink system. The populations of the same five major counties are shown in Figure 5, based on data from the Census Bureau.¹⁰¹ These data indicate a correlation between the population and the frequency of suicides in specific areas. It would indicate that an area with a high population has an increased likelihood of suicides.

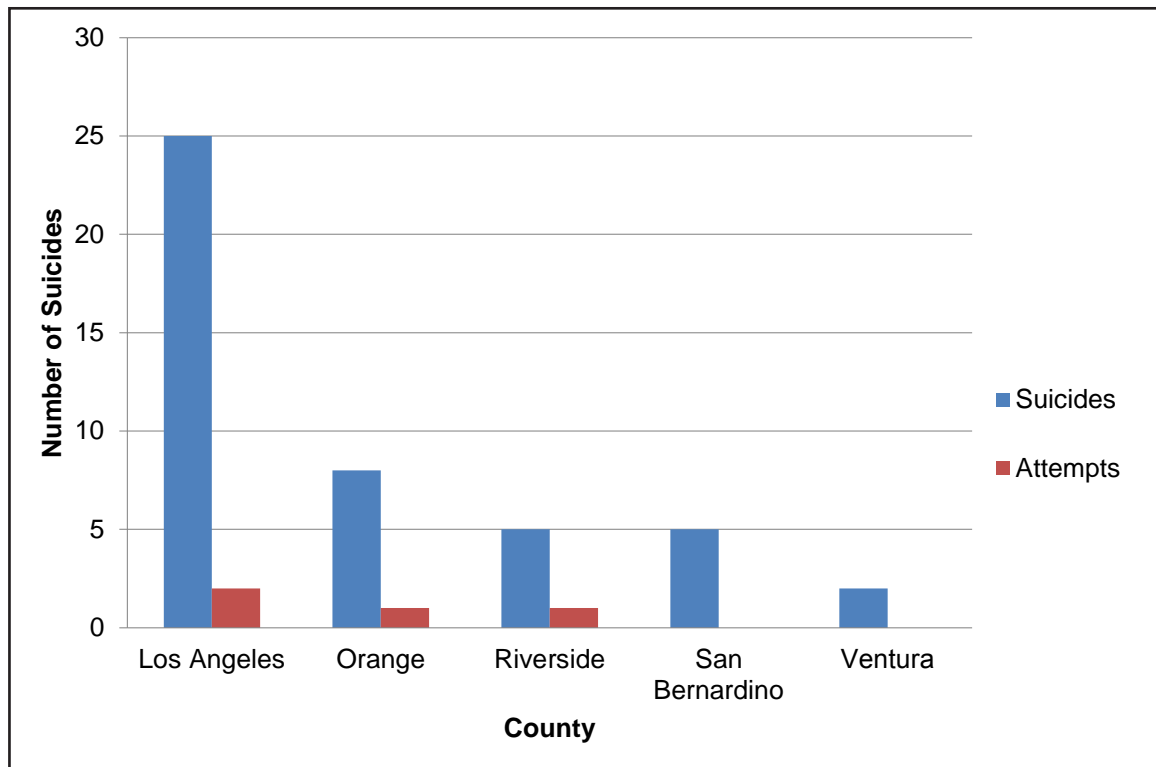


Figure 4. Number of Suicides per Southern California County

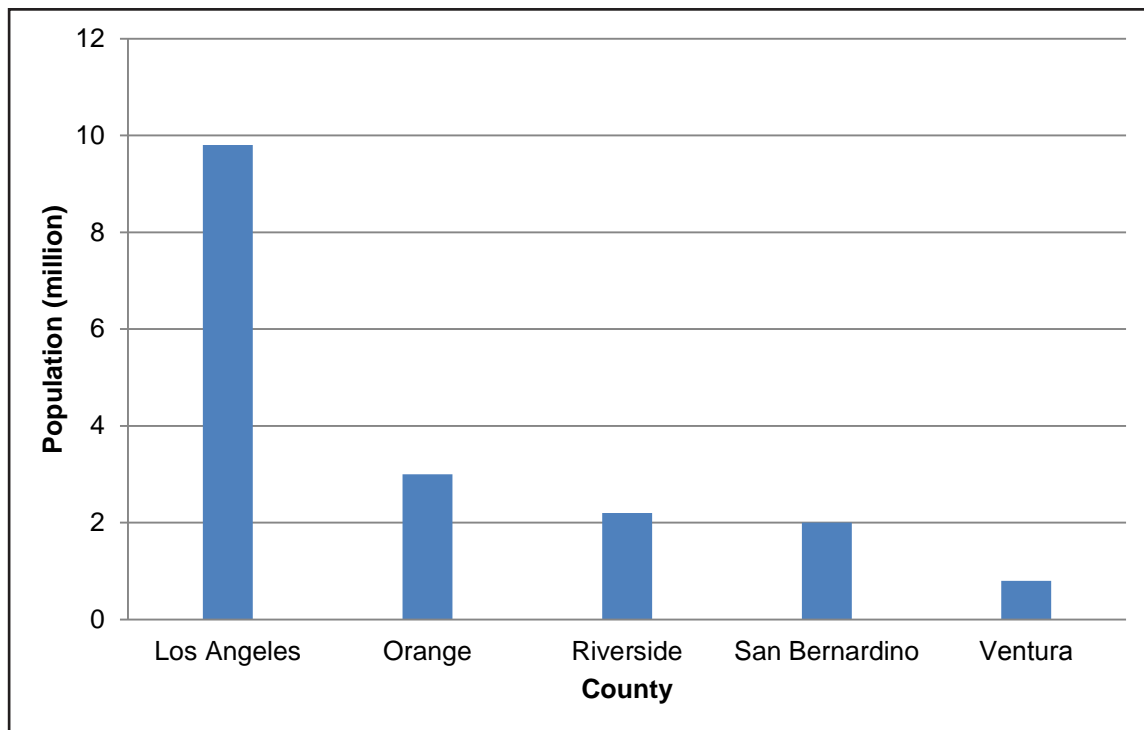


Figure 5. Population of Southern California Counties (2010)

PERSPECTIVE ON FINDINGS

From the discussion just presented, it can be concluded that a variety of times and locations have been identified as likely venues for suicides on rail systems. There is significant variation in the times, but one common fact is that suicides can occur only when the system is in operation. In addition, some evidence shows that more suicides occur during peak periods of operation.

A few studies have linked locations to sources of suicides, such as mental hospitals, although such a link was not established for the U.S. It was found in a number of studies that suicides occur at locations where people have access to the tracks, such as at platforms and road crossings. It is important to note that the suicides do not necessarily occur at the points of access, but they do occur within a relatively short distance from these points. It was also found that more suicides occur in areas with high population. These findings are very important for devising strategies and tactics to prevent suicides because the prevention efforts can be focused on these areas.

IV. EXPERIENCE WITH AND RELEVANT ASPECTS OF COUNTERMEASURES

The following sections will examine the experience with and relevant aspects of suicide prevention practices, with a focus on rail suicides. The discussion will include community-based programs as well as use of signs, access control, and surveillance and response systems.

COMMUNITY-BASED PROGRAMS

As commented by Mishara, most suicide prevention measures have focused on the surface issue—preventing people from being hit by trains—instead of the underlying one.¹⁰² Training personnel, general practitioners, and other medical staff to detect and alleviate depression and suicidal ideation in potential suicide victims can be quite beneficial in reducing railway suicides and suicides as a whole. The WHO discusses evidence of success. In Gotland, Sweden between 1983 and 1984, two-day programs given to all its general practitioners led to a drop in the suicide rate, a decrease of inpatient care for depression, and a decrease in the number of sick-leaves taken for depression.¹⁰³ After the program was suspended, however, these rates rose back to pre-program levels.¹⁰⁴ Another example was from a study in Hungary in which a five-year depression management program was implemented for general practitioners and their nurses.¹⁰⁵ With the addition of a “Depression Treatment Clinic and psychiatrist telephone consultant service,” it was found that a huge decrease occurred in depression, suicide rates, and suicidal ideation in comparison with the control groups.¹⁰⁶

A huge percentage of railway suicide victims have been shown to have psychological disorders,¹⁰⁷⁻¹¹¹ with depression and schizophrenia (psychosis) as the two major forms.¹¹²⁻¹¹⁵ Krysinska and De Leo (2008, *Australian and New Zealand Journal of Psychiatry*) wrote about a study completed on the railway systems in the United Kingdom, which found that about 60% of victims were diagnosed with psychiatric disorders.¹¹⁶ Other results reported by Krysinska and De Leo on the percentages of victims with psychiatric issues included 83% in Queensland, 53% in the Netherlands, and up to 81% based on a few other studies.¹¹⁷ Holdaway et al. (2012) found data in a 1996 study of the U.K. showing that 75% of suicide attempters were receiving mental health care.¹¹⁸ In a study completed by Mishara at the Montreal metro between 1986-1996, it was found that 73% of the 129 victims had received inpatient psychiatric treatment.¹¹⁹ In Hong Kong, analysis showed that 66% of suicide victims had psychiatric histories (Law et al., 2009).¹²⁰

Mishara found disappointing evidence in his 1999 study in which the majority of metro suicide victims had not been taken seriously by their psychiatric personnel after threatening to kill themselves the previous day.¹²¹ Therefore, it is important for the staff of psychiatric institutions to be well-educated and trained properly for evaluating and treating suicidal patients.¹²²

Due to the high percentage of suicidal individuals with mental instabilities, psychiatric patients should be a targeted group for intervention and research. Holdaway et al. suggests that working with psychiatric services could be beneficial for personnel training purposes; the psychiatric workers could help identify other insightful ways for targeting suicidal individuals.¹²³ Mishara agrees that developing a partnership with psychiatric

emergency services and institutes may be helpful for railway personnel.¹²⁴ Although results were not given in the study, Andreissen and Krysiniska discussed a comprehensive suicide prevention program, implemented by Infrabel, which included working with local psychiatric services.¹²⁵

As stated previously, the number of suicides on rail systems is comparatively small, and rail authorities should focus their limited resources on prevention measures near or on rail property. As will be discussed in a later section, there could be cooperation between rail authorities and community-based programs to decrease suicides on rail systems.

SIGNS AND HOTLINES

Signs with suicide hotline numbers can be placed in rail stations/platforms and other locations where a high incidence of suicides may be expected. The hotline is basically connected to live individuals in a suicide prevention call center. In addition, actual telephones with direct access to a suicide prevention call center could be installed at rail stations, platforms and other locations where comparatively high frequencies of suicides may be expected.

The suicide hotline telephones can also be placed at locations where suicides are more likely to occur. The hotline is basically an emergency service with live individuals available to help the caller. In addition to signs, telephones may be provided with direct access to the emergency service.

These forms of suicide mitigation take on a more passive role and encourage the potential victim to seek help. Because only a small percentage of railway suicide victims rush onto the tracks immediately,¹²⁶ there is an opportunity for help signs and telephone hotlines to deter people from committing suicide. Holdaway et al. mentioned that since many suicide victims have an impulsive and temporary intent to kill themselves, messages of dissuasion could prove effective.¹²⁷

Some journal articles discuss the use of posters and hotlines at railways, but they state that little evidence on their effectiveness has been recorded.¹²⁸⁻¹³⁰ Although this may be true for railways, these forms of mitigation have shown promise for success in other applications. In a journal article published in *BMC Public Health* in 2013, Cox et al. evaluated many different studies that had evidence of suicide prevention.¹³¹ Three of these studies had examined the effectiveness of help signs and hotline telephones at specific locations (“hotspots”). All three studies reported decreases in the suicide rates in their specified locations.

One of the studies was reported by Lester (2005), who evaluated the addition of “crisis emergency telephones” (and of police presence) on the Sunshine Bridge in St. Petersburg, Florida, USA.¹³² Lester compared his findings for a three-year pre- and post-intervention period. The results showed that 25 suicides were reported for the pre-installation period (8.3 per year from 1996-1998), while 19 suicides were accounted for in the post-installation period (6.3 per year from 2000-2002).¹³³ Due to the small evaluation period and only a small difference in the number of suicides before and after the sign installation, it is difficult to conclude whether or not these results are indeed cause and effect.

Another study, examined by Wong et al. (2009), discussed a community-based program that was initiated in Cheung Chau, Hong Kong for the purpose of reducing the number of suicides that occurred through charcoal burning in rented “holiday flats.”¹³⁴ A major part of the initiative was the addition of a 24-hour telephone hotline service and the hotline numbers written in every holiday flat.¹³⁵ Wong et al. recorded a 4.25-year pre-intervention period from 1998-2002 and a 3.5-year post-intervention period from 2002-2006.¹³⁶ On the island of Cheung Chau, the results showed that 37 suicides were completed in the pre-installation period (8.7 per year), while only 6 suicides were completed in the post-installation period (2.0 per year).¹³⁷ For comparison purposes, Wong et al. also examined the number of suicides completed on two other islands with “similar demographic profiles” and found no comparative change during the study period.¹³⁸

The third study was completed by King and Frost (2005). They evaluated the effectiveness of placing signs with the Samaritan’s information in car parks in the New Forest, Hampshire, England.¹³⁹ (Samaritan’s is the largest suicide prevention network, located in about 40 countries, whose mission is to reduce the occurrences and effects of suicide.) This seemed necessary due to the great number of people committing suicide by car exhaust.¹⁴⁰ King and Frost compared suicides from the 10-year pre-installation period (1988-1998) and the three-year post-installation period (1998-2001). With signs placed in 26 car parks displaying the Samaritan’s national telephone number, the car park suicides decreased from 10.0 per year to 3.3 per year in the pre- to post-installation periods, respectively.¹⁴¹ Krysinska and De Leo, and Holdaway et al. discussed similar findings.^{142,143} King and Frost also recorded the suicide count in comparable forest districts without help signs and found no changes in the number of suicides during the study period.¹⁴⁴ Additionally, they found that the total amount of suicides for the district also decreased, meaning that suicide substitution most likely did not occur.¹⁴⁵ Holdaway et al. found evidence from an unpublished source that a continued three-year evaluation showed that suicides in the New Forest district remained low, with most occurrences happening in the car parks without signs.¹⁴⁶

Evidence has also been found that suicidal individuals use the services of suicide hotlines with beneficial outcomes. Holdaway et al. mentioned a study by Gould et al. (2007) who had reviewed the thoughts and actions of suicidal patients during the course of telephone sessions.¹⁴⁷ Gould et al. discovered a large decrease in suicide attempts throughout the course and a continued decrease in “hopelessness and psychological pain” in the weeks to come.¹⁴⁸

ACCESS CONTROL

Platform screen doors (PSDs) are one type of barrier commonly being implemented or retrofitted into train stations in many European and Asian countries.¹⁴⁹ They are also becoming popular in many airport shuttle systems in the United States. These sliding-door systems create a barrier wall between the platform and the railway tracks; the doors open only when an incoming train has come to a complete stop. Different forms of platform screen doors exist, including those that extend to the ceiling for an air-tight effect; those that extend almost to the ceiling, still allowing natural ventilation; and half-height screen doors. These latter doors are much less expensive but also less effective in preventing people from intentionally jumping in front of a train.¹⁵⁰

Reducing access to the railway tracks has proven to be an effective way to reduce railway suicide rates.¹⁵¹⁻¹⁵⁹ Coats et al.,¹⁶⁰ Cox et al.,¹⁶¹ and Law et al. believe that the complete separation of trains and passengers is the ultimate method for suicide prevention,¹⁶⁰⁻¹⁶² and platform screen doors fall under this category. In Hong Kong in 2002, platform screen doors were installed on all 71 underground platforms of the Hong Kong Mass Transit Railway, creating an air-tight barrier between the railway tracks and the platforms.¹⁶³⁻¹⁶⁵ The primary purpose of this railway addition was to save energy by keeping the underground stations cool, but it also created a safer environment. The suicide rate at the Hong Kong Mass Transit Railway dropped by 81.6%.¹⁶⁶⁻¹⁶⁸ A similar system was put into place on the Singapore Mass Transit System to save on air conditioning costs; no accounts of suicide had been recorded from when the sliding-door system was implemented in 1987 through the early 1990s.^{169,170} It can be seen that in both cases, the drop in suicide rates was a beneficial side effect of the primary goal of air control.

Although the barrier system has proven to be highly effective in preventing suicides on railways, it is also expensive.¹⁷¹⁻¹⁷⁶ A few articles have discussed these expenditures for the New York MTA. Alex Goldmark wrote an article in *Transportation Nation* (2011), in which he reported criticisms to potential sliding-door barriers being built on the NY MTA. Goldmark wrote that State Senator Diane Savino (New York, 23rd District) was completely against the idea of barriers because the expense to build and maintain the infrastructure would be so costly compared with the number of people it would help.¹⁷⁷ Savino also believes that with the economic situation at that time, no budget was available for such an expense.¹⁷⁸ Christopher Zara wrote an article in the *International Business Times* (2012), wherein he noted that in 2012, 146 people were hit by New York City trains, amounting to an accident about every 2.5 days, and posed the question as to why platform screen doors could not be installed to prevent these incidents.¹⁷⁹ He reported that the Metropolitan Transit Authority could not afford these installations and also reported that there may not be support in New York City for rate hikes to pay for the costs of these improvements.¹⁸⁰

Some estimates have been made for the cost of platform sliding-door systems.

Not only are they expensive, but they also are not a viable option for established railway systems. Coats and Walter, Holdaway et al., Mishara, and Clarke and Poyner agree that retrofitting existing railway systems is generally not practical or affordable.¹⁸¹⁻¹⁸⁴ Mishara mentioned that the Montreal metro system task force had estimated that the cost of implementing a sliding-door system into the existing stations “could surpass the system’s annual operating budget.”¹⁸⁵

Another disadvantage to implementing platform screen doors at the railway stations is that they would protect only the passengers at the stations. Research has shown (and discussed in another section of this paper) that about one-third of railway suicides occur at the stations. Therefore, these expensive systems would be “saving” only one-third of the potential suicides if there were other places to access the tracks.

A benefit-cost analysis was completed by Law et al. (*Journal of Affective Disorders*, 2009) regarding the Hong Kong Mass Transit Railway system’s platform screen doors.¹⁸⁶ It was stated that the MTR Corporation spent \$256.4 million for installation of the PSD system.

It was also estimated that it would take 50 years to recover the cost through passenger boarding ticket sales.¹⁸⁷ Due to these facts, gaining support for implementing more of these systems is a challenge; evidence must prove that PSDs are cost-effective.

Law et al. used the “WHO-CHOICE” method and a modified method to analyze the cost-effectiveness of the platform screen door system. The WHO-CHOICE method took into account only the “avertable disability-adjusted life-years (DALYs),” whereas the modified method accounted for the avertable DALYs due to railway injuries, the avertable waiting time of passengers due to dysfunctional flow of the railway system, and the “corresponding financial savings from the loss of fare revenue.” Law et al. used the cost-effectiveness classifications recommended by Murray et al., which was based upon the WHO’s Commission on Macroeconomics and Health. It was stated that a project is highly cost-effective if the cost of a “healthy life-year” saved is less than the state’s GDP per person. The project is considered cost-effective and not cost-effective if the saved-life cost is between 1 and 3 times the GDP per person, and if the cost is more than three times GDP per person, respectively.¹⁸⁸

By using the results from the pre- and post-installation periods (1997-2001 and 2003-2007, respectively), it was calculated that 881 healthy life-years and 201 passenger years were averted after the installation of the platform screen doors. With an estimated life expectancy of the PSDs at 25 years and a savings of about 3100 DALYs, it was found that the incremental cost-effectiveness ratio (ICER) per life-year was \$77,900. This method resulted in 3.13 times the GDP per capita. Therefore, the traditional method of accounting for DALYs alone was not economically cost-effective. For the modified method, in addition to the DALY’S, it was estimated that 460 avertable passenger life-years were saved and \$7.9 million was saved from loss of fare revenue. These amounted to an ICER of \$65,000 per life-year, or 2.62 times the GDP per person. Therefore, it can be seen that the modified version is cost-effective from a larger societal perspective. As mentioned by Law et al., comparing the results of these two methods exhibits how changing the analyzed criteria can have a significant impact on the resulting outcome. Therefore, Law et al. believe that analyzing the DALYs alone is not a sufficient method for calculating the effectiveness of the platform screen doors. It also should be noted that other factors contribute to the decision process of a cost-effective system, but when information is omitted, unreliable estimates are inevitable.¹⁸⁹

For this specific case, a significant component was not accounted for in the analysis: electricity savings. It was mentioned earlier that the main purpose for installing the platform screen doors at the Hong Kong Mass Transit Railway stations was to insulate the areas for better air conditioning control. With that said, it seems obvious that the energy savings should be a large contributor to the cost benefits of the system. Therefore, all the savings from energy-efficiency for the post-installation period would increase the cost-effectiveness of the platform screen doors.

SURVEILLANCE AND RESPONSE

Training personnel to detect and handle suicidal behavior is a method to help prevent railway suicides. These personnel, who also may be referred to as gatekeepers, may

consist of anyone who works for or with the railway system. The chosen workers could be trained to recognize and potentially prevent suicidal intentions as they go about their everyday responsibilities. Two different forms of trained personnel will be discussed, including those who have been trained to alleviate a situation in progress and those who have been trained to help prevent a situation from ever arising.

Training personnel to be aware and respond properly to suicidal behavior can be a powerful method to prevent suicides on railways. In an article published in *BMC Public Health* (2011), Lukaschek et al. says that “gatekeeper training” may be one of the most effective methods for preventing railway suicide.¹⁹⁰ In the study, a questionnaire was given to 202 German Federal Police officers in June 2010; based on their responses, Lukaschek et al. concluded that “identifiable behavioral patterns” can be detected in people attempting to commit suicide.¹⁹¹ Officers observed the victims performing similar actions, such as leaving behind personal belongings, avoiding eye contact, making erratic gestures, mimicking, moving around, having erratic communication patterns, having general confusion, being influenced by alcohol, etc.¹⁹² The two most identified behaviors—leaving behind personal belongings and avoiding eye contact—were seen in about 50% of the victims.¹⁹³ Holdaway et al. verify this finding from evidence found from Gaylord and Lester (1994); it stated that suicide victims from the Hong Kong subway had left personal belongings or sentimental items, and had covered their faces before attempting suicide.¹⁹⁴

A study completed by Radbo and Andersson in the *International Journal of Environmental Research and Public Health* (2012),¹⁹⁵ found a complementary piece of evidence. Between 2005-2008, it was determined that a majority of the suicide victims from the Stockholm areas in Sweden (where the research took place) had been waiting nearby or on the railway tracks for a while before the train arrived,^{196,197} In the 2007 *Crisis*, Mishara also reported from a Sweden study that 75% of victims had waited or loitered near the train tracks before attempting suicide,¹⁹⁸ and that only about 14% of victims attempted suicide immediately.^{199,200} Mishara found a coinciding result from an English study by Abbott et al. (2003) that victims had a tendency to wait before a suicide attempt.²⁰¹ Holdaway et al. concluded from Symonds’ (1994) journal article that people who committed suicide on railway platforms waited for a while amongst the crowd and also acted strangely.²⁰² With all this evidence, it is evident that not only can suicidal behavior be detected, but there is also time to intervene. By having the knowledge of behavioral patterns and a period of time prior to the suicide attempt, it seems that prevention intervention is possible.

Experience and proper education are highly important for suicide prevention through gatekeeper intervention. From the Lukaschek et al. study, a German police officer had experience with 17 suicides, on average.²⁰³ Although many of these suicides were not personally seen but were informed by eyewitnesses, 35% of the officers still reported to have prevented at least one suicide.²⁰⁴ It was found that being successful in suicide prevention came from the years of experience as an officer and the number of suicides each had experienced.²⁰⁵

Properly educating gatekeepers would be a necessity. Lukaschek et al. believe that using some of the knowledge gained by suicide-experienced police officers would be a good start.²⁰⁶ Also, evidence has shown that at some stations located near psychiatric facilities

in Hong Kong, staff have become adept at identifying suicidal individuals and sometimes preventing them from jumping (Clarke and Poyner, 1994)²⁰⁷ The training program would teach gatekeepers to detect and recognize people at high risk for suicide, evaluate their risk level, and properly manage the situation.²⁰⁸ Proper management and approach would be the most important and sensitive step; if done incorrectly, it could lead to dire situations. For example, Holdaway et al. wrote of a study completed by Rosen (1976) in which two individuals had jumped from a bridge due to the type of approach taken by the bridge employees.²⁰⁹ The jumpers stated that they may not have jumped if the workers had approached them in a calmer and gentler manner.²¹⁰

The World Health Organization declared that gatekeeper training programs have been successful by increasing the use of mental health services and reducing the risk of suicide in depressed and suicidal individuals.²¹¹ The WHO suggests implementing a program that trains staff to identify potential suicide victims, improve staff attitudes, increase staff medical and psychological knowledge, reduce staff anxiety toward suicides, increase staff confidence in preventing suicides, and increase the number of staff members with the abilities to monitor and manage a suicidal situation.²¹²

Unfortunately, there have been mixed messages on how well a training program would work. In a literature review written by Holdaway et al. for the Rail Safety and Standards Board (RSSB), it reports that the “opportunity for intervention may be limited.”²¹³ One of these reasons is due to the small window of opportunity for intervention. Research has found that many victims impulsively decide to commit suicide with very little time between the initial thoughts and completion.²¹⁴ Holdaway wrote about a study completed by Deisenhammer in which 82 patients had been interviewed a couple days after attempting suicide; it was reported that almost half the victims attempted suicide in 10 minutes or less from their first current thought.²¹⁵ Holdaway et al. also mentioned from Deisenhammer et al. that 76.8% of the suicide victims from a study had reportedly had some form of “interpersonal contact” prior to the attempt, but that professional helpers or key personnel seemed to be limited in their possibility for intervention.²¹⁶ The victims’ inclination toward pre-suicidal contact generally came in the form of a loved one.²¹⁷

Some evidence contradicts the notion that victims portray acts of odd behavior. Holdaway et al. found from a study by O’Donnell et al. (1996) that only one person had displayed weird enough behavior that could have been detected by gatekeepers (or a monitored CCTV surveillance system).²¹⁸ Farmer et al. (1992) had comparative evidence from research of the London Underground—that the suicide victims had not necessarily done anything unusual enough for trained staff to be suspicious.²¹⁹ Holdaway et al. also brought up the argument that railway staff and key personnel may not have time to pay attention to people and identify potential suicide victims, while victims may not be in a state of mind to accept help.²²⁰

Surveillance systems at railways can be used as an aid for suicide prevention. Mishara (2007) discussed how surveillance systems are becoming more widespread and are being installed in many metro and railway stations worldwide;²²¹ this demonstrates that now is the perfect time to incorporate suicide prevention into the surveillance systems. This form of mitigation can be implemented not only to combat suicides, but it can also be used for

other important purposes. Many examples for the use of surveillance at railways were given by the Federal Transit Administration (FTA) including: monitoring the safety and security of passengers, employees, equipment, and materials on and off the vehicles; providing incident responses; protecting the railway system against “fare evasion and fraudulent claims;” alerting operators and personnel of possible delays or closures, and of intentional acts of crime or violence; etc.²²² Mishara made a similar argument about the multifaceted uses of surveillance systems—preventing suicides while also providing a safer environment by identifying crimes and accidents.²²³ The FTA also mentioned that surveillance systems are very versatile and could be beneficial in all modes of public transportation including urban and rural bus, rail, and ferry systems.²²⁴

Surveillance systems are not versatile only in functionality, but also in implementation. Setting up some form of surveillance could work in anyone’s budget—the complexity of the system is up to the buyer. With the large variation of existing surveillance technologies, the appropriate system can be developed and implemented to fit individual locations’ needs. Some of the existing technologies include video surveillance such as closed-circuit television (CCTV) cameras, radar technology, alarms, global positioning systems (GPS), motion detectors, etc. These technologies can be placed in or around the stations, in or on the vehicles, on the tracks, at level crossings, or anywhere else that seems appropriate.

The following uses for surveillance identify some of the ideas and technologies given by research findings. Clarke and Poyner (1994) mentioned how some trains from the Jubilee and Central lines in England were considered for the use of CCTV monitors. Placed inside the trains, they would allow the drivers to watch for potential situations developing at stations and to stop the trains, if necessary.^{225,226} Holdaway et al. and Clarke and Poyner also believe that stations should be equipped with emergency stop buttons to allow station workers to halt trains in cases of emergency.^{227,228} Clarke and Poyner discussed how this technology has already been established on the Victoria line in England.²²⁹ Another idea from Clarke and Poyner to deter suicides at railways was to strategically use CCTV cameras to increase victims’ sense of being watched. Even potential suicide victims aren’t generally motivated to kill themselves when being directly watched.²³⁰ Because victims committing suicide in stations most commonly jump in front of an oncoming train at the entrance of the station,^{231,232} placing obvious cameras blatantly at stations’ headwalls may discourage them from doing so.²³³ Mishara agrees that placing more “obvious” surveillance cameras may reduce suicide attempts.²³⁴

Honeywell has developed many technologies to improve the safety of railways.²³⁵ One of these systems, known as Platform Track Intrusion Detection System (PTIDS), uses radar technology for platform safety.²³⁶ This system can detect if an object is blocking the railway tracks, sitting between trains, or appearing at tunnel entrances.²³⁷ The system is virtually maintenance-free and weatherproof; with its low “false-alarm” rate, the safety system automatically stops the train if an object of reasonable size is detected on the tracks.²³⁸ Honeywell has also created another safety system that detects objects located at level crossings when the gates are down for train-passing.²³⁹ If there is an obstruction, the system sends a signal to the level crossing control system, which prevents the train from passing.²⁴⁰

As previously mentioned, suicides are sometimes reported inaccurately and/or incompletely.²⁴¹ Using surveillance systems would help minimize this claim.^{242,243} The monitors would allow detectives to decide whether a death was accidental or suicidal and would potentially help with identity recognition. Not only would this improve accuracy, but the systems would also help dictate the effectiveness of different suicide prevention measures. The World Health Organization mentioned that without having a viable surveillance system, the evaluation of suicide prevention programs is difficult or impossible.²⁴⁴ Also, if surveillance systems were implemented in many railway systems around the world, data collecting would become more regulated, and comparing suicide data from different countries would be more accurate.²⁴⁵

Surveillance systems would also work hand-in-hand with trained personnel. As discussed in a previous section, many suicide victims show signs of identifiable behavior patterns.²⁴⁶ Therefore, if the individuals monitoring the surveillance systems were trained to identify these suspicious acts, help could be sent to alleviate the situation. From an article in the *International Journal of Environmental Research and Public Health* (2012), Radbo and Andersson also suggest that in situations when railway platforms are very crowded and personnel monitoring would be difficult, a surveillance or sensor system at areas of great risk (such as where the train enters the terminal) would improve the safety at the station and potentially allow time for personnel to save potential victims from self-harm.²⁴⁷

The Federal Transit Administration and Mishara (2007) believe that, in order for surveillance systems to be more effective, trained personnel^{248,249} and video monitor observers²⁵⁰ would be required.^{251,252} If there weren't enough workers to monitor the video screens and dispatch help or notify drivers in times of need, the surveillance system would be deemed less useful.²⁵³

Although little evidence is available on the effectiveness of surveillance systems on mitigating suicides at railways, they have proven to be effective in other ways. They have created safer environments for transit systems, and they have helped to save money from litigations.²⁵⁴ For example, the South Eastern Pennsylvania Transportation Authority (SEPTA) had outfitted four of its 1388 buses with a surveillance and monitoring system, which resulted in a "32% reduction in claims and a \$15 million decrease in annual payouts."²⁵⁵ Similar results were produced when the Dallas Area Rapid Transit (DART) installed cameras in 68 of its 687 buses. Claims were reduced by 35%.²⁵⁶ In another case, eight or more CCTV cameras, performing constant surveillance, were placed in all Washington Metropolitan Area Transit Authority (WMATA) stations. The result was a decrease in crime rates.²⁵⁷ Other benefits listed by the FTA included "reductions in fare evasion and assaults on transit-agency property," and that transit users reported feeling safer with the addition of CCTV cameras.²⁵⁸

Given the benefits that surveillance systems have to offer (in general and for suicide prevention), the costs and other issues warrant discussion. The FTA reported that the integration of a security system with other technologies can be expensive.²⁵⁹ Mishara claimed that the installation and expense of surveillance systems are usually cost-efficient, but the personnel necessary to monitor the systems can be extremely costly.²⁶⁰ The FTA agreed that the need for personnel training and monitoring may increase due to the

addition of a surveillance system.²⁶¹ Cameras integrated into larger security systems were more cost-efficient than stand-alone cameras.²⁶² The FTA also stated that supplementary storage equipment would be necessary to archive data.²⁶³

One issue that has been considered is the effectiveness of certain surveillance systems for suicide prevention. Mishara discussed how, even with the best surveillance system, it may still be difficult to identify a potential victim and intervene in time.²⁶⁴ Mishara (2007) also had evidence of effectiveness from his own study at the Montreal metro system in Canada.²⁶⁵ He said that about 30 suicide interventions occurred every week, but most were initiated by suspicious metro personnel or passengers calling the control dispatchers.²⁶⁶ Some calls even came from suicide prevention centers informing the metro station of a potential attempter, but in the Montreal metro station during Mishara's time of review, interventions due to surveillance camera information were very rare.²⁶⁷

DRAINAGE PITS

Drainage pits, also known as "suicide pits," are another form of barriers that indirectly prevent suicides on train tracks. As described by Coats and Walter (1999) in the *Biomedical Journal (BMJ)*, drainage pits create about a one-meter gap between the ground and the railway tracks, enabling victims to fall below the wheelbase and prevent being struck.²⁶⁸ Although these pits that span the entire station platform were originally intended for platform drainage purposes,²⁶⁹ they have successfully reduced the mortality rate for accidental and suicidal victims.²⁷⁰⁻²⁷⁵ Based on Coats and Walter's study of the London Underground, about half the train stations have drainage pits.^{276,277} In their observational study from January 1996 to March 1997, they compared the mortality rates of the railway stations with and without drainage pits; the results showed that stations with drainage pits reduced the mortality rate by about half—from 76% to 44%.²⁷⁸ A similar result reported by Krysinska and De Leo (2008), from O'Donnell and Farmer's (1992) study of the London Underground from 1973-1990, found that the mortality rate for train platforms with and without drainage pits was 45% and 66%, respectively.²⁷⁹ It can be seen that the reduced mortality rate due to drainage pits was "purely fortuitous as pits were introduced for engineering reasons."²⁸⁰

The cost of implementing drainage pits in existing platforms would be very expensive. Clarke and Poyner estimated in 1994 that the cost per platform would be about £200,000 (about \$310,000 based on the average 1994 currency rate exchanges).²⁸¹ They also mentioned, however, that the pit costs would be much lower when built into new stations.²⁸²

V. POSSIBLE STRATEGIES FOR COUNTERMEASURE IMPLEMENTATION

Based on the preceding discussions, this section will summarize tactics for rail countermeasures and provide suggestions on actions that would make the implementation more effective and efficient. In addition, improvements to the institutional framework and related issues will be discussed, which could also lead to more successful and efficient implementation of countermeasures.

COUNTERMEASURE TACTICS

As stated previously, the locations where candidate projects could be identified would be places with relatively high frequencies of suicides because these locations would most likely yield the highest probabilities for reducing suicides. These locations were found to be associated with areas of high population density, station platforms, and areas close to entry points to the rail property, such as a road crossing. It should be noted that in other areas of the world, such locations have been associated with “suicide hot spots,” such as the proximity to mental hospitals. No evidence yet indicates that these types of locations have been identified in the U.S. This may be due to the very low incidence of suicides on rail properties in the U.S.

Posting signs in strategic places with phone numbers to call for those who are contemplating suicide would be relatively inexpensive. The signs could be concentrated in areas where they are more likely to be seen. The most desirable locations for signs should be station platforms, entrances to the right-of-way such as road crossings, and places where high concentrations of trespassers are prevalent. Moreover, the specific designs of the signs could be based on experience with existing rail and road signs to ensure that they are readable and notable with the correct degree of primacy (prominence compared to other signs). Signs are currently designed for this purpose, such as the signs posted by Caltrain.²⁸³ Care should be taken that the signs conform to all existing sign regulations on railroad property.

Phones with a direct connection to people whom a person contemplating suicide could talk to could also be installed, although this may cost more and would require some careful benefit-cost analysis. Regarding the staffing of the phone line, the best option for a rail authority would probably be to establish a partnership with a community-based center that deals with these types of issues. Given the low frequency of suicides on rail systems, the benefits would probably not outweigh the costs of establishing such a center for the exclusive benefit of the rail authority.

In the case of providing barriers on station platforms, where the prevention of suicides is a by-product or a concomitant benefit to the primary project goal of preventing people from being jostled and inadvertently pushed onto the tracks or of improving air quality with air conditioning, the prevention of suicides could be included in the overall benefit-cost analysis of the barriers.

A number of other prevention measures can be utilized that fall between posting signs and total access restriction to tracks. These measures are related to surveillance and response. This measure can be implemented in numerous ways, with varying degrees of effectiveness and cost. Surveillance can be performed directly by rail personnel or by equipment such as closed-circuit television. Identification can be performed directly by personnel, either on location or remotely. Personnel already on the property can carry out direct response and intervention, or perhaps by loudspeaker. Another option is to target all trespassers in certain locations. Previous research discussed in Section 3 showed that suicides are committed either close to a station platform or close to rail crossings; by targeting these locations, a large portion of suicides may be prevented. "Piggybacking" onto other functions that rail personnel already carry out has the potential to significantly reduce the cost of suicide prevention and lead to a benefit-cost ratio greater than one. Station agents, maintenance and operations staff, and security officers could be trained to execute these tasks, while personnel who deal with vandals may already be well-suited. If there were a community center staffed with personnel answering suicide hotlines, they could possibly be contracted to monitor remote cameras on rail property to identify people who show signs of wishing to commit suicide. The staff then could initiate a response.

From 2009-2011, a total of 2480 incidents on the Metrolink rail system of Southern California required a response. These incidents are classified into several categories, which include trespassers, gate malfunctions, passenger illness, etc. Trespassers accounted for a total of 830 incidents. It is apparent that the total number of incidents encountered by the organization during this period is much larger than the 49 suicides that occurred during the much longer period from 2005-2011. These data provide some context for the argument made above. It shows that incidents must be addressed continually. Rail authority personnel could possibly carry out monitoring of and response to people who show signs of contemplating suicide, especially if the cost of the required training would be relatively low.

A POSSIBLE STRATEGY FOR IMPLEMENTATION

The number of commuter rail systems in the U.S. is relatively small, and they have comparatively low incidence of suicide. Because of this, a strategy for preventing suicides may be carried out in what may be described as a focused manner, coordinated by one or a limited number of agencies. In contrast, road fatalities number in the tens of thousands per year with many road authorities implementing crash mitigation. This situation does not lend itself to coordination by one or only a few organizations because of the vast number of roadways and jurisdiction. In the case of commuter rail systems, suicide prevention could possibly be approached within the following framework. (Note that the literature review indicates that some of these actions already take place, although not all of them within the U.S.):

1. "Saturate" all rail commuter systems with relatively inexpensive signs with the purpose of preventing suicides at platforms and other entry points to tracks. This tactic should commence in densely populated areas and could be carried out in a relatively short time at relatively low cost. Track the major costs of implementation and suicide frequencies annually.

2. Hotlines could be implemented in a similar way, but they would be more expensive than signs. Pilot projects could be identified to document the incidence of calls, procedures, costs, etc., to determine the efficacy of this tactic. Linking to existing hotlines should be considered.
3. The next step would consist of implementing the surveillance, identification, and response systems. A first step may be to implement a pilot project with a rail system that has a relatively high incidence of suicides. The implementation methods and procedures, the associated costs, and the suicide frequencies within the affected sections of track should be documented. Such a documented pilot project could commence with platforms and rail crossings in densely populated areas. Because it will take a long time and several projects to determine the effectiveness in terms of suicide prevention (because suicides are such rare events), the initial focus should be on gaining experience and accumulating cost data. Based on this experience with costs, the coverage of commuter rail systems with these types of suicide prevention projects could then be systematically expanded. By more accurately estimating the monetary societal cost of rail suicides and the benefits of reducing them, a better sense could be made of whether the prevention measures are cost-beneficial. Monitoring the frequency, locations, and times of all suicides on a yearly basis for all commuter rail systems, such as done in this and previous research, should not be difficult or very costly.
4. A similar approach to implementing barriers on platforms could be carried out, but based on the literature review, this measure probably would be better suited to metro systems with limited access. It likely would be too costly for the average commuter rail system.

There are some additional considerations for the implementation of the proposed strategy.

Cost estimations associated with countermeasures would change by location, but it would be helpful to maintain records of costs to establish a database that could aid in the correct cost estimation of similar future projects. Because it may not be cost-effective for each rail authority to maintain the expertise to conduct the appropriate analyses and maintain a depository for relevant cost data from other rail authorities, it is recommended that an agency such as the Federal Transit Administration (FTA) assume responsibility for this task, as well as disseminating relevant information and data. It would also be desirable that funding be directed toward promoting suicide prevention projects. It should be noted that neither the availability of funding nor the legal feasibility for having these tasks undertaken by the FTA has been researched as part of this project nor discussed with the FTA. The FTA could initiate further research of this topic or take action as desired. The Federal Railroad Administration (FRA) could also become involved because some rail lines are shared with freight rail systems and long-distance passenger trains.

Regarding the benefits of reducing suicides, it was noted previously that the specific cost of a rail system suicide may be higher than the cost of an average suicide; therefore, it would be beneficial to research the cost of a rail suicide. Regarding costs, it is important to estimate the marginal costs of “piggybacking” onto existing operations of commuter rail systems.

VI. MAJOR CONCLUSIONS AND RECOMMENDATIONS

It was found that the number of suicides committed on rail systems in the U.S. is relatively low compared with the total number of suicides committed in the U.S. Only 180 suicides occurred from 2003-2008 on 48 commuter, heavy, and light rail systems—about 30 suicides per year. By comparison, in 2010 alone, 38,364 suicides occurred in the U.S. as a whole. It could be reasonably concluded that overall suicide prevention should be the responsibility of the community at large; the rail authorities should be focusing their limited resources on the prevention and possible mitigation of suicides on the rail property itself and on individuals attempting to access the rail property to commit suicide. The community abutting a rail system could be affected by the suicides on the rail system and may look to the rail authority to become involved in community-based suicide prevention measures. However, from a cost-effective point of view, the rail authority should only become involved with community-based program when there is a direct connection to preventing suicides on the rail system itself, such as through providing phones linked to a community-based suicide prevention center. Rail authorities may be tempted to become involved in a broad community-based program, to improve public relations, but they will probably be better served by focusing on their own effort to prevent suicides on the rail property.

While it may be tempting for a rail authority to become involved in community-wide suicide prevention efforts for the sake of improving public relations, the funds required for this probably would be used more effectively in a focused manner on the rail system itself. The magnitude of the effort that a rail authority could afford for a community-based suicide prevention project most likely would be very small compared with the amount required to prevent the comparatively large number of suicides committed by other means. By participating in such an effort, a rail authority may run the risk of creating an expectation that its effort would be successful, whereas the size of the effort would most likely lead to disappointing results. This in turn could lead to bad publicity. The public relations effort probably could be more suitably centered on making information available on the rail authority's specific suicide prevention efforts.

It is recommended that an approach based on the principles of benefit-cost analysis be followed to identify and prioritize candidate suicide countermeasures on rail systems. The approach consists of identifying the locations and times in which candidate projects with high benefit-cost ratios would more likely be present. Candidate projects, which could decrease the number of suicides, would then be identified. As a next step, the benefit-cost ratios of the projects should be calculated. The "benefits" would be the decrease in the costs of the suicides, and the "cost" would be the expense associated with implementing the countermeasure. Projects with a benefit-cost ratio greater or equal to one would be considered feasible from an economic point of view. The projects then would be prioritized based on the benefit-cost ratios.

The locations where candidate projects could be identified would be places with relatively high frequencies of suicides because these locations most likely would yield the highest probabilities for suicide reductions. These locations were found to be associated with areas of high population density, station platforms, and areas close to entry points to the rail property such as a road crossing. It should be noted that in other areas of the world, such

locations have been associated with “suicide hot spots,” such as the proximity to mental hospitals. There is yet no evidence that these types of locations have been identified in the U.S., but this may be due to the very low incidence of suicides on rail properties in the U.S.

When calculating benefit-cost ratios, the benefits are the monetary costs of suicide reductions resulting from a countermeasure. One amount mentioned in this regard is approximately \$1 million.²⁸⁴ It is recommended that research be carried out to determine the cost of a rail suicide in the U.S. because it is potentially higher than the cost of the average suicide. Cost elements that are not normally present in the costs of the average suicide may be represented in the costs of a rail suicide. These may include the cost of travel delays on the rail system and the effects on the surrounding and associated road and public transportation systems, and the cost of restoring the rail system to full operational status. The costs associated with the impacts on engineers and train crews are also part of the latter cost. The cost effects of personnel turnovers should also be included. The “point-of-view” issue will have to be clarified when using the cost of the suicide in the analysis. The usual approach for determining the costs for tax-funded public projects is to count all costs regardless of to whom they accrue. This means that societal impacts, such as the cost of counseling people who are affected by the suicides and who may not be members of the rail system staff, should be included in the costs. Including this higher cost would allow justification of higher spending. Conversely, a privately-owned rail system would possibly include only its own costs associated with the suicides, which would lead to relatively lower expenditure on countermeasures. Most publicly-owned rail systems utilize tax funds; therefore, the higher cost estimates for suicides would be justified. It is essential to recognize that an accurate cost estimate of a suicide is critical to determine the benefit-cost ratio and the feasibility and priority of a countermeasure.

Maintaining records associated with suicides and countermeasures would aid in the correct estimation for similar future projects even if these estimates would change by location. It is recommended that an organization such as the Federal Transit Administration (FTA) assume responsibility for conducting the appropriate analyses and maintaining a depository for relevant cost data from other rail authorities because it may not be cost-effective for each rail authority to maintain this level of expertise. In addition, the FTA could undertake the lead role for disseminating relevant information and data. It should be noted that neither the availability of funding nor the legal feasibility for having the FTA undertake these tasks has been researched as part of this project or discussed with the FTA. The FTA could initiate further research on this topic or take action as desired.

It should be noted that the use of benefit-cost analysis in project identification and prioritization does not necessarily mean that it is always strictly implemented or that it is the only consideration in project selection. Notwithstanding these considerations, it is important to note that this type of analysis has been the cornerstone of project selection for road safety management, as documented in the Highway Safety Manual.²⁸⁵ Including all other factors taken into account, it should be recognized that when a project is implemented, it means the benefits are at least equal to the cost and that the project priority is justified. Using benefit-cost analysis to the extent possible would promote effective and efficient decision-making that would make optimal use of scarce resources and would put the suicide prevention effort on a systematic basis.

In projects such as placement of signs, there probably would not be a need for benefit-cost analysis because the cost is relatively low, and the cost of carrying out a benefit-cost analysis may not be warranted. However, benefit-cost analyses for higher-cost projects become very important in view of the anticipated difficulty of implementing such projects. The major reason for this difficulty is that relatively few suicides occur on rail systems, and consequently there is relatively little opportunity to decrease the cost of suicides. Based on the discussion in the report, it may be necessary to “piggyback” on projects that have objectives other than reducing suicides in order to justify implementing the countermeasures. A case in point is the implementation of barriers on platforms, where preventing suicides is a by-product or a concomitant benefit to the primary project goal of preventing people from being jostled and inadvertently pushed onto the tracks. Another example is installing barriers to act as “seals” that help improve air quality with air conditioning.

A number of other prevention measures can be utilized that fall between posting signs and total access restriction to tracks. These measures are composed of surveillance and response. This measure can be implemented in numerous ways, with varying degrees of effectiveness and cost. Surveillance can be accomplished directly by rail personnel, or by equipment such as closed-circuit television. Personnel can handle identification, either on location or remotely. A response and intervention may then be carried out by personnel already on the rail property, or perhaps by loudspeaker. Another option is to target all trespassers in certain locations. Previous research showed that suicides are committed either close to a station platform or close to rail crossings. By targeting these locations, a large portion of suicides may be prevented. “Piggybacking” onto other functions already being carried out by rail personnel has the potential of significantly reducing the cost of suicide prevention and leading to a benefit-cost ratio greater than one. Station agents, maintenance and operations staff, and security officers could be trained to execute these tasks, while personnel who address vandalism may already be well-suited. If there were a community center staffed with personnel answering suicide hotlines, they possibly could be contracted to monitor remote cameras on rail property to identify people who show signs of wishing to commit suicide. Then they could initiate a response.

A possible strategy for implementing the recommended systematic approach could consist of systematically providing coverage of rail systems with prevention measures in all critical locations. It could start with placing signs with information about suicide prevention hotlines, etc. at platforms and entrances to rail property such as rail crossings. Because signs are relatively inexpensive, complete coverage of commuter rail systems should be possible in a relatively short time. Implementing surveillance, identification, and response systems could commence with a rail system that has a relatively high incidence of suicides. Platforms and rail crossings in densely populated areas could be identified for the purpose of implementing pilot projects, with different alternative components for surveillance, identification, and response. It will take a long time and several projects to determine the effectiveness in terms of suicide prevention because suicides are such rare events. Therefore, the initial focus should be on gaining experience and accumulating cost data. Based on this experience with costs, the coverage of the commuter rail systems with suicide prevention projects could then be systematically expanded. It should be noted that this systematic coverage must occur on the assumption that a “blanket” coverage of critical places, i.e. platforms and rail crossings, will be required starting with the densely

populated areas. Previous research in the U.S. has indicated that it would be difficult to identify individual “hot spots.” By “piggybacking” onto other functions already carried out on rail property, the cost of such a “blanket” strategy will likely not be too high. By more accurately estimating the monetary societal cost of rail suicides and the benefits of reducing them, a better sense could be made of whether the prevention measures are cost-beneficial. Monitoring the frequency of all suicides annually for all commuter rail systems, such as done in this and previous research, should not be difficult or very costly.

ENDNOTES

1. Baumert, J., N. Erazo, and K. H. Ladwig. "Mental Health: Ten-Year Incidence and Time Trends of Railway Suicides in Germany from 1991 to 2000." *European Journal of Public Health*, Volume 16, No. 2 (2005): 173-178.
2. Krysinska, Karolina, and Diego De Leo. "Suicide on Railway Networks: Epidemiology, Risk Factors and Prevention." *Australian and New Zealand Journal of Psychiatry*, Volume 42 (2008): 763-771.
3. Baumert, J., N. Erazo, and K. H. Ladwig. "Mental Health: Ten-Year Incidence and Time Trends of Railway Suicides in Germany from 1991 to 2000." *European Journal of Public Health*, Volume 16, No. 2 (2005): 173-178.
4. Krysinska, Karolina, and Diego De Leo. "Suicide on Railway Networks: Epidemiology, Risk Factors and Prevention." *Australian and New Zealand Journal of Psychiatry*, Volume 42 (2008): 763-771.
5. Lukaschek, Karoline, Jens Baumert, and Karl-Heinz Ladwig. "Behavior Patterns Preceding a Railway Suicide: Explorative Study of German Federal Police Officers' Experiences." *BMC Public Health*, Volume 11 (2011): 620.
6. Holdaway, Simon, Emily Evans, and Sarah Webb. *Operations and Management Research Program—Improving Suicide Prevention Measures on the Rail Network in Great Britain: Literature Review*. Rail Safety and Standards Board LTD, 2012. Web.
7. Andriessen, Karl, and Karolina Krysinska. "Railway Suicide in Belgium 1998—2009: Incidence and Prevention." *Crisis*, Volume 33 (2012): 39-45.
8. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
9. Clarke, R. V., and B. Poyner. "Preventing Suicide on the London Underground." *Social Science and Medicine*, Volume 38 (1994): 443-446.
10. Cox, Georgina R., Christabel Owens, Jo Robinson, Angela Nicholas, Anne Lockley, Michelle Williamson, Yee Tak Derek Cheung, and Jane Pirkis. "Interventions to Reduce Suicides at Suicide Hotspots: A Systematic Review." *BMC Public Health*, Volume 13 (2013): 214.
11. Law, C. K., Paul S. F. Yip, Wincy S. C. Chan, King-Wa Fu, Paul W. C. Wong, and Y. W. Law. "Evaluating the Effectiveness of Barrier Installation for Preventing Railway Suicides in Hong Kong." *Journal of Affective Disorders*, Volume 114 (2009): 254-262.
12. Law, C. K., and Paul S. F. Yip. "An Economical Evaluation of Setting Up Physical Barriers in Railway Stations for Preventing Railway Injury: Evidence from Hong Kong." *Journal of Epidemiology and Community Health*, Volume 65 (2011): 915-920.

13. Krysinska, Karolina, and Diego De Leo. "Suicide on Railway Networks: Epidemiology, Risk Factors and Prevention." *Australian and New Zealand Journal of Psychiatry*, Volume 42 (2008): 763-771.
14. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
15. World Health Organization. *Towards Evidence-Based Suicide Prevention Programmes*. Geneva: World Health Organization, 2010.
16. Krysinska, Karolina, and Diego De Leo. "Suicide on Railway Networks: Epidemiology, Risk Factors and Prevention." *Australian and New Zealand Journal of Psychiatry*, Volume 42 (2008): 763-771.
17. Holdaway, Simon, Emily Evans, and Sarah Webb. *Operations and Management Research Program—Improving Suicide Prevention Measures on the Rail Network in Great Britain: Literature Review*. Rail Safety and Standards Board LTD, 2012. Web.
18. World Health Organization. *Towards Evidence-Based Suicide Prevention Programmes*. Geneva: World Health Organization, 2010.
19. Cox, Georgina R., Christabel Owens, Jo Robinson, Angela Nicholas, Anne Lockley, Michelle Williamson, Yee Tak Derek Cheung, and Jane Pirkis. "Interventions to Reduce Suicides at Suicide Hotspots: A Systematic Review." *BMC Public Health*, Volume 13 (2013): 214.
20. World Health Organization. *Towards Evidence-Based Suicide Prevention Programmes*. Geneva: World Health Organization, 2010.
21. Krysinska, Karolina, and Diego De Leo. "Suicide on Railway Networks: Epidemiology, Risk Factors and Prevention." *Australian and New Zealand Journal of Psychiatry*, Volume 42 (2008): 763-771.
22. Federal Transit Administration. *2009 Rail Safety Statistics Report*. Prepared by the Office of Safety and Security.
23. Federal Transit Administration. *Office of the Inspector General Audit Report. Challenges to Improving Oversight of Rail Transit Safety and Implementing an Enhanced Federal Role*. January 31, 2012.
24. Centers for Disease Control and Intervention. Suicide and Self-Inflicted Injury. <http://cdc.gov/nchs/fastats/suicide.htm> (Accessed November 11, 2013).
25. Clarke, R. V., and B. Poyner. "Preventing Suicide on the London Underground." *Social Science and Medicine*, Volume 38 (1994): 443-446.
26. Andriessen, Karl, and Karolina Krysinska. "Railway Suicide in Belgium 1998—2009: Incidence and Prevention." *Crisis*, Volume 33 (2012): 39-45.

-
27. Law, C. K., Paul S. F. Yip, Wincy S. C. Chan, King-Wa Fu, Paul W. C. Wong, and Y. W. Law. "Evaluating the Effectiveness of Barrier Installation for Preventing Railway Suicides in Hong Kong." *Journal of Affective Disorders*, Volume 114 (2009): 254-262.
 28. Ibid.
 29. Swissinfo.ch. "After Switzerland's Troubling Record of Suicide." International Service of the Swiss Broadcasting Corporation (2010). Web. 16 Aug. 2013. http://www.swissinfo.ch/eng/specials/switzerland_for_the_record/european_records/Switzerland_s_troubling_record_of_suicide.html?cid=8301804
 30. Ibid.
 31. Ibid.
 32. Ibid.
 33. Krysinska, Karolina, and Diego De Leo. "Suicide on Railway Networks: Epidemiology, Risk Factors and Prevention." *Australian and New Zealand Journal of Psychiatry*, Volume 42 (2008): 763-771.
 34. Baumert, J., N. Erazo, and K. H. Ladwig. "Mental Health: Ten-Year Incidence and Time Trends of Railway Suicides in Germany from 1991 to 2000." *European Journal of Public Health*, Volume 16, No. 2 (2005): 173-178.
 35. Lukaschek, Karoline, Jens Baumert, and Karl-Heinz Ladwig. "Behavior Patterns Preceding a Railway Suicide: Explorative Study of German Federal Police Officers' Experiences." *BMC Public Health*, Volume 11 (2011): 620.
 36. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
 37. Baumert, J., N. Erazo, and K. H. Ladwig. "Mental Health: Ten-Year Incidence and Time Trends of Railway Suicides in Germany from 1991 to 2000." *European Journal of Public Health*, Volume 16, No. 2 (2005): 173-178.
 38. Lukaschek, Karoline, Jens Baumert, and Karl-Heinz Ladwig. "Behavior Patterns Preceding a Railway Suicide: Explorative Study of German Federal Police Officers' Experiences." *BMC Public Health*, Volume 11 (2011): 620.
 39. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
 40. Baumert, J., N. Erazo, and K. H. Ladwig. "Mental Health: Ten-Year Incidence and Time Trends of Railway Suicides in Germany from 1991 to 2000." *European Journal of Public Health*, Volume 16, No. 2 (2005): 173-178.

-
41. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
 42. Ibid.
 43. Holdaway, Simon, Emily Evans, and Sarah Webb. *Operations and Management Research Program—Improving Suicide Prevention Measures on the Rail Network in Great Britain: Literature Review*. Rail Safety and Standards Board LTD, 2012. Web.
 44. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
 45. Holdaway, Simon, Emily Evans, and Sarah Webb. *Operations and Management Research Program—Improving Suicide Prevention Measures on the Rail Network in Great Britain: Literature Review*. Rail Safety and Standards Board LTD, 2012. Web.
 46. Clarke, R. V., and B. Poyner. "Preventing Suicide on the London Underground." *Social Science and Medicine*, Volume 38 (1994): 443-446.
 47. Ibid.
 48. Krysinska, Karolina, and Diego De Leo. "Suicide on Railway Networks: Epidemiology, Risk Factors and Prevention." *Australian and New Zealand Journal of Psychiatry*, Volume 42 (2008): 763-771.
 49. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
 50. Ibid.
 51. Baumert, J., N. Erazo, and K. H. Ladwig. "Mental Health: Ten-Year Incidence and Time Trends of Railway Suicides in Germany from 1991 to 2000." *European Journal of Public Health*, Volume 16, No. 2 (2005): 173-178.
 52. Ibid.
 53. Lukaschek, Karoline, Jens Baumert, and Karl-Heinz Ladwig. "Behavior Patterns Preceding a Railway Suicide: Explorative Study of German Federal Police Officers' Experiences." *BMC Public Health*, Volume 11 (2011): 620.
 54. Radbo, Helena, and Ragnar Andersson. "Patterns of Suicide and Other Trespassing Fatalities on State-Owned Railways in Greater Stockholm; Implications for Prevention." *International Journal of Environmental Research and Public Health*, Volume 9 (2012): 772-780.
 55. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.

-
56. Holdaway, Simon, Emily Evans, and Sarah Webb. *Operations and Management Research Program—Improving Suicide Prevention Measures on the Rail Network in Great Britain: Literature Review*. Rail Safety and Standards Board LTD, 2012. Web.
 57. Ibid.
 58. Ibid.
 59. Krysinska, Karolina, and Diego De Leo. "Suicide on Railway Networks: Epidemiology, Risk Factors and Prevention." *Australian and New Zealand Journal of Psychiatry*, Volume 42 (2008): 763-771.
 60. Holdaway, Simon, Emily Evans, and Sarah Webb. *Operations and Management Research Program—Improving Suicide Prevention Measures on the Rail Network in Great Britain: Literature Review*. Rail Safety and Standards Board LTD, 2012. Web.
 61. Ibid.
 62. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
 63. Ibid.
 64. Ibid.
 65. Ibid.
 66. Ibid.
 67. American Association of Highway and Transportation. *Highway Safety Manual*, 1st Edition. Washington D.C. 2010.
 68. Centers for Disease Control and Intervention. *Suicide and Self-Inflicted Injury*. <http://cdc.gov/nchs/fastats/suicide.htm> (Accessed November 11, 2013).
 69. Federal Transit Administration. *2009 Rail Safety Statistics Report*. Prepared by the Office of Safety and Security.
 70. Cox, Georgina R., Christabel Owens, Jo Robinson, Angela Nicholas, Anne Lockley, Michelle Williamson, Yee Tak Derek Cheung, and Jane Pirkis. "Interventions to Reduce Suicides at Suicide Hotspots: A Systematic Review." *BMC Public Health*, Volume 13 (2013): 214.
 71. Andriessen, Karl, and Karolina Krysinska. "Railway Suicide in Belgium 1998—2009: Incidence and Prevention." *Crisis*, Volume 33 (2012): 39-45.
 72. Ibid.

-
73. Ibid.
 74. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
 75. Holdaway, Simon, Emily Evans, and Sarah Webb. *Operations and Management Research Program—Improving Suicide Prevention Measures on the Rail Network in Great Britain: Literature Review*. Rail Safety and Standards Board LTD, 2012. Web.
 76. Ibid.
 77. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
 78. Ibid.
 79. Ibid.
 80. Botha, Jan L., Kristina A. Elmasu, and Philip J. Leitzell. *Suicides on Commuter Rail in California: Possible Patterns—A Case Study*. Mineta Transportation Institute, 2010.
 81. Krysinska, Karolina, and Diego De Leo. "Suicide on Railway Networks: Epidemiology, Risk Factors and Prevention." *Australian and New Zealand Journal of Psychiatry*, Volume 42 (2008): 763-771.
 82. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
 83. Lukaschek, Karoline, Jens Baumert, and Karl-Heinz Ladwig. "Behavior Patterns Preceding a Railway Suicide: Explorative Study of German Federal Police Officers' Experiences." *BMC Public Health*, Volume 11 (2011): 620.
 84. Holdaway, Simon, Emily Evans, and Sarah Webb. *Operations and Management Research Program—Improving Suicide Prevention Measures on the Rail Network in Great Britain: Literature Review*. Rail Safety and Standards Board LTD, 2012. Web
 85. Ibid.
 86. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
 87. Ibid.
 88. Radbo, Helena, and Ragnar Andersson. "Patterns of Suicide and Other Trespassing Fatalities on State-Owned Railways in Greater Stockholm; Implications for Prevention." *International Journal of Environmental Research and Public Health*, Volume 9 (2012): 772-780.

-
89. Lukaschek, Karoline, Jens Baumert, and Karl-Heinz Ladwig. "Behavior Patterns Preceding a Railway Suicide: Explorative Study of German Federal Police Officers' Experiences." *BMC Public Health*, Volume 11 (2011): 620.
 90. Clarke, R. V., and B. Poyner. "Preventing Suicide on the London Underground." *Social Science and Medicine*, Volume 38 (1994): 443-446.
 91. Botha, Jan L., Kristina A. Elmasu, and Philip J. Leitzell. *Suicides on Commuter Rail in California: Possible Patterns—A Case Study*. Mineta Transportation Institute, 2010.
 92. Clarke, R. V., and B. Poyner. "Preventing Suicide on the London Underground." *Social Science and Medicine*, Volume 38 (1994): 443-446.
 93. Krysinska, Karolina, and Diego De Leo. "Suicide on Railway Networks: Epidemiology, Risk Factors and Prevention." *Australian and New Zealand Journal of Psychiatry*, Volume 42 (2008): 763-771.
 94. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
 95. Ibid.
 96. Holdaway, Simon, Emily Evans, and Sarah Webb. *Operations and Management Research Program—Improving Suicide Prevention Measures on the Rail Network in Great Britain: Literature Review*. Rail Safety and Standards Board LTD, 2012. Web.
 97. Radbo, Helena, and Ragnar Andersson. "Patterns of Suicide and Other Trespassing Fatalities on State-Owned Railways in Greater Stockholm; Implications for Prevention." *International Journal of Environmental Research and Public Health*, Volume 9 (2012): 772-780.
 98. Andriessen, Karl, and Karolina Krysinska. "Railway Suicide in Belgium 1998—2009: Incidence and Prevention." *Crisis*, Volume 33 (2012): 39-45.
 99. Botha, Jan L., Kristina A. Elmasu, and Philip J. Leitzell. *Suicides on Commuter Rail in California: Possible Patterns—A Case Study*. Mineta Transportation Institute, 2010.
 100. Metrolink. All Line Timetable. N.p.: Metrolink, 2013. Print.
 101. U.S. Census Bureau (July 1, 2010), U.S Census Bureau: State and County Quickfacts, Retrieved September 2013.
 102. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
 103. World Health Organization. *Towards Evidence-Based Suicide Prevention Programmes*. Geneva: World Health Organization, 2010.

-
104. Ibid.
105. Ibid.
106. Ibid.
107. Ibid.
108. Krysinska, Karolina, and Diego De Leo. "Suicide on Railway Networks: Epidemiology, Risk Factors and Prevention." *Australian and New Zealand Journal of Psychiatry*, Volume 42 (2008): 763-771.
109. Holdaway, Simon, Emily Evans, and Sarah Webb. *Operations and Management Research Program—Improving Suicide Prevention Measures on the Rail Network in Great Britain: Literature Review*. Rail Safety and Standards Board LTD, 2012. Web.
110. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
111. Law, C. K., Paul S. F. Yip, Wincy S. C. Chan, King-Wa Fu, Paul W. C. Wong, and Y. W. Law. "Evaluating the Effectiveness of Barrier Installation for Preventing Railway Suicides in Hong Kong." *Journal of Affective Disorders*, Volume 114 (2009): 254-262.
112. Krysinska, Karolina, and Diego De Leo. "Suicide on Railway Networks: Epidemiology, Risk Factors and Prevention." *Australian and New Zealand Journal of Psychiatry*, Volume 42 (2008): 763-771.
113. Holdaway, Simon, Emily Evans, and Sarah Webb. *Operations and Management Research Program—Improving Suicide Prevention Measures on the Rail Network in Great Britain: Literature Review*. Rail Safety and Standards Board LTD, 2012. Web.
114. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
115. Law, C. K., Paul S. F. Yip, Wincy S. C. Chan, King-Wa Fu, Paul W. C. Wong, and Y. W. Law. "Evaluating the Effectiveness of Barrier Installation for Preventing Railway Suicides in Hong Kong." *Journal of Affective Disorders*, Volume 114 (2009): 254-262.
116. Krysinska, Karolina, and Diego De Leo. "Suicide on Railway Networks: Epidemiology, Risk Factors and Prevention." *Australian and New Zealand Journal of Psychiatry*, Volume 42 (2008): 763-771.
117. Ibid.
118. Holdaway, Simon, Emily Evans, and Sarah Webb. *Operations and Management Research Program—Improving Suicide Prevention Measures on the Rail Network in Great Britain: Literature Review*. Rail Safety and Standards Board LTD, 2012. Web.

-
119. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
 120. Law, C. K., Paul S. F. Yip, Wincy S. C. Chan, King-Wa Fu, Paul W. C. Wong, and Y. W. Law. "Evaluating the Effectiveness of Barrier Installation for Preventing Railway Suicides in Hong Kong." *Journal of Affective Disorders*, Volume 114 (2009): 254-262.
 121. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
 122. Ibid.
 123. Holdaway, Simon, Emily Evans, and Sarah Webb. *Operations and Management Research Program—Improving Suicide Prevention Measures on the Rail Network in Great Britain: Literature Review*. Rail Safety and Standards Board LTD, 2012. Web.
 124. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
 125. Andriessen, Karl, and Karolina Kryszynska. "Railway Suicide in Belgium 1998—2009: Incidence and Prevention." *Crisis*, Volume 33 (2012): 39-45.
 126. Holdaway, Simon, Emily Evans, and Sarah Webb. *Operations and Management Research Program—Improving Suicide Prevention Measures on the Rail Network in Great Britain: Literature Review*. Rail Safety and Standards Board LTD, 2012. Web.
 127. Ibid.
 128. Kryszynska, Karolina, and Diego De Leo. "Suicide on Railway Networks: Epidemiology, Risk Factors and Prevention." *Australian and New Zealand Journal of Psychiatry*, Volume 42 (2008): 763-771.
 129. Holdaway, Simon, Emily Evans, and Sarah Webb. *Operations and Management Research Program—Improving Suicide Prevention Measures on the Rail Network in Great Britain: Literature Review*. Rail Safety and Standards Board LTD, 2012. Web.
 130. Cox, Georgina R., Christabel Owens, Jo Robinson, Angela Nicholas, Anne Lockley, Michelle Williamson, Yee Tak Derek Cheung, and Jane Pirkis. "Interventions to Reduce Suicides at Suicide Hotspots: A Systematic Review." *BMC Public Health*, Volume 13 (2013): 214.
 131. Ibid.
 132. Ibid.
 133. Ibid.

-
134. Ibid.
135. Ibid.
136. Ibid.
137. Ibid.
138. Ibid.
139. Ibid.
140. Ibid.
141. Ibid.
142. Krysinska, Karolina, and Diego De Leo. "Suicide on Railway Networks: Epidemiology, Risk Factors and Prevention." *Australian and New Zealand Journal of Psychiatry*, Volume 42 (2008): 763-771.
143. Holdaway, Simon, Emily Evans, and Sarah Webb. *Operations and Management Research Program—Improving Suicide Prevention Measures on the Rail Network in Great Britain: Literature Review*. Rail Safety and Standards Board LTD, 2012. Web.
144. Cox, Georgina R., Christabel Owens, Jo Robinson, Angela Nicholas, Anne Lockley, Michelle Williamson, Yee Tak Derek Cheung, and Jane Pirkis. "Interventions to Reduce Suicides at Suicide Hotspots: A Systematic Review." *BMC Public Health*, Volume 13 (2013): 214.
145. Ibid.
146. Holdaway, Simon, Emily Evans, and Sarah Webb. *Operations and Management Research Program—Improving Suicide Prevention Measures on the Rail Network in Great Britain: Literature Review*. Rail Safety and Standards Board LTD, 2012. Web.
147. Ibid.
148. Ibid.
149. Zara, Christopher. "After New York Post Subway Death Story, A Safety Question Remains: Why No Platform Barriers?" *International Business Times* (2012). Web. 3 Mar. 2013.
150. Wikipedia. Platform Screen Doors. (Accessed March 8, 2014).
151. World Health Organization. *Towards Evidence-Based Suicide Prevention Programmes*. Geneva: World Health Organization, 2010.

-
152. Krysinska, Karolina, and Diego De Leo. "Suicide on Railway Networks: Epidemiology, Risk Factors and Prevention." *Australian and New Zealand Journal of Psychiatry*, Volume 42 (2008): 763-771.
 153. Radbo, Helena, and Ragnar Andersson. "Patterns of Suicide and Other Trespassing Fatalities on State-Owned Railways in Greater Stockholm; Implications for Prevention." *International Journal of Environmental Research and Public Health*, Volume 9 (2012): 772-780.
 154. Andriessen, Karl, and Karolina Krysinska. "Railway Suicide in Belgium 1998—2009: Incidence and Prevention." *Crisis*, Volume 33 (2012): 39-45.
 155. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
 156. Clarke, R. V., and B. Poyner. "Preventing Suicide on the London Underground." *Social Science and Medicine*, Volume 38 (1994): 443-446.
 157. Cox, Georgina R., Christabel Owens, Jo Robinson, Angela Nicholas, Anne Lockley, Michelle Williamson, Yee Tak Derek Cheung, and Jane Pirkis. "Interventions to Reduce Suicides at Suicide Hotspots: A Systematic Review." *BMC Public Health*, Volume 13 (2013): 214.
 158. Law, C. K., Paul S. F. Yip, Wincy S. C. Chan, King-Wa Fu, Paul W. C. Wong, and Y. W. Law. "Evaluating the Effectiveness of Barrier Installation for Preventing Railway Suicides in Hong Kong." *Journal of Affective Disorders*, Volume 114 (2009): 254-262.
 159. Ibid.
 160. Coats, T. J., and D. P. Walter. "Effect of Station Design on Death in the London Underground: Observational Study." *British Medical Journal*, Volume 319 (1999): 957.
 161. Cox, Georgina R., Christabel Owens, Jo Robinson, Angela Nicholas, Anne Lockley, Mich Williamson, Yee Tak Derek Cheung, and Jane Pirkis. "Interventions to Reduce Suicides at Suicide Hotspots: A Systematic Review." *BMC Public Health*, Volume 13 (2013): 214.
 162. Law, C. K., Paul S. F. Yip, Wincy S. C. Chan, King-Wa Fu, Paul W. C. Wong, and Y. W. Law. "Evaluating the Effectiveness of Barrier Installation for Preventing Railway Suicides in Hong Kong." *Journal of Affective Disorders*, Volume 114 (2009): 254-262.
 163. World Health Organization. *Towards Evidence-Based Suicide Prevention Programmes*. Geneva: World Health Organization, 2010.
 164. Law, C. K., Paul S. F. Yip, Wincy S. C. Chan, King-Wa Fu, Paul W. C. Wong, and Y. W. Law. "Evaluating the Effectiveness of Barrier Installation for Preventing Railway Suicides in Hong Kong." *Journal of Affective Disorders*, Volume 114 (2009): 254-262.

-
165. Ibid.
166. World Health Organization. *Towards Evidence-Based Suicide Prevention Programmes*. Geneva: World Health Organization, 2010.
167. Law, C. K., Paul S. F. Yip, Wincy S. C. Chan, King-Wa Fu, Paul W. C. Wong, and Y. W. Law. "Evaluating the Effectiveness of Barrier Installation for Preventing Railway Suicides in Hong Kong." *Journal of Affective Disorders*, Volume 114 (2009): 254-262.
168. Ibid.
169. Krysinska, Karolina, and Diego De Leo. "Suicide on Railway Networks: Epidemiology, Risk Factors and Prevention." *Australian and New Zealand Journal of Psychiatry*, Volume 42 (2008): 763-771.
170. Law, C. K., Paul S. F. Yip, Wincy S. C. Chan, King-Wa Fu, Paul W. C. Wong, and Y. W. Law. "Evaluating the Effectiveness of Barrier Installation for Preventing Railway Suicides in Hong Kong." *Journal of Affective Disorders*, Volume 114 (2009): 254-262.
171. Goldmark, Alex. "NY MTA Criticized for Considering Anti-Suicide Platform Barriers." *Transportation Nation* (2011). Web. 3 Mar. 2013.
172. Zara, Christopher. "After New York Post Subway Death Story, A Safety Question Remains: Why No Platform Barriers?" *International Business Times* (2012). Web. 3 Mar. 2013.
173. Coats, T. J., and D. P. Walter. "Effect of Station Design on Death in the London Underground: Observational Study." *British Medical Journal*, Volume 319 (1999): 957.
174. Holdaway, Simon, Emily Evans, and Sarah Webb. *Operations and Management Research Program—Improving Suicide Prevention Measures on the Rail Network in Great Britain: Literature Review*. Rail Safety and Standards Board LTD, 2012. Web.
175. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
176. Clarke, R. V., and B. Poyner. "Preventing Suicide on the London Underground." *Social Science and Medicine*, Volume 38 (1994): 443-446.
177. Goldmark, Alex. "NY MTA Criticized for Considering Anti-Suicide Platform Barriers." *Transportation Nation* (2011). Web. 3 Mar. 2013.
178. Ibid.
179. Zara, Christopher. "After New York Post Subway Death Story, A Safety Question Remains: Why No Platform Barriers?" *International Business Times* (2012). Web. 3 Mar. 2013.

-
180. Ibid.
181. Coats, T. J., and D. P. Walter. "Effect of Station Design on Death in the London Underground: Observational Study." *British Medical Journal*, Volume 319 (1999): 957.
182. Holdaway, Simon, Emily Evans, and Sarah Webb. *Operations and Management Research Program—Improving Suicide Prevention Measures on the Rail Network in Great Britain: Literature Review*. Rail Safety and Standards Board LTD, 2012. Web.
183. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
184. Clarke, R. V., and B. Poyner. "Preventing Suicide on the London Underground." *Social Science and Medicine*, Volume 38 (1994): 443-446.
185. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
186. Law, C. K., Paul S. F. Yip, Wincy S. C. Chan, King-Wa Fu, Paul W. C. Wong, and Y. W. Law. "Evaluating the Effectiveness of Barrier Installation for Preventing Railway Suicides in Hong Kong." *Journal of Affective Disorders*, Volume 114 (2009): 254-262.
187. Ibid.
188. Law, C. K., and Paul S. F. Yip. "An Economical Evaluation of Setting Up Physical Barriers in Railway Stations for Preventing Railway Injury: Evidence from Hong Kong." *Journal of Epidemiology and Community Health*, Volume 65 (2011): 915-920.
189. Ibid.
190. Lukaschek, Karoline, Jens Baumert, and Karl-Heinz Ladwig. "Behavior Patterns Preceding a Railway Suicide: Explorative Study of German Federal Police Officers' Experiences." *BMC Public Health*, Volume 11 (2011): 620.
191. Ibid.
192. Ibid.
193. Ibid.
194. Holdaway, Simon, Emily Evans, and Sarah Webb. *Operations and Management Research Program—Improving Suicide Prevention Measures on the Rail Network in Great Britain: Literature Review*. Rail Safety and Standards Board LTD, 2012. Web.
195. Radbo, Helena, and Ragnar Andersson. "Patterns of Suicide and Other Trespassing Fatalities on State-Owned Railways in Greater Stockholm; Implications for Prevention."

International Journal of Environmental Research and Public Health, Volume 9 (2012): 772-780.

196. Ibid.
197. Ibid.
198. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
199. Ibid.
200. Ibid.
201. Ibid.
202. Holdaway, Simon, Emily Evans, and Sarah Webb. *Operations and Management Research Program—Improving Suicide Prevention Measures on the Rail Network in Great Britain: Literature Review*. Rail Safety and Standards Board LTD, 2012. Web.
203. Lukaschek, Karoline, Jens Baumert, and Karl-Heinz Ladwig. "Behavior Patterns Preceding a Railway Suicide: Explorative Study of German Federal Police Officers' Experiences." *BMC Public Health*, Volume 11 (2011): 620.
204. Ibid.
205. Ibid.
206. Ibid.
207. Clarke, R. V., and B. Poyner. "Preventing Suicide on the London Underground." *Social Science and Medicine*, Volume 38 (1994): 443-446.
208. Lukaschek, Karoline, Jens Baumert, and Karl-Heinz Ladwig. "Behavior Patterns Preceding a Railway Suicide: Explorative Study of German Federal Police Officers' Experiences." *BMC Public Health*, Volume 11 (2011): 620.
209. Holdaway, Simon, Emily Evans, and Sarah Webb. *Operations and Management Research Program—Improving Suicide Prevention Measures on the Rail Network in Great Britain: Literature Review*. Rail Safety and Standards Board LTD, 2012. Web.
210. Ibid.
211. World Health Organization. *Towards Evidence-Based Suicide Prevention Programmes*. Geneva: World Health Organization, 2010.
212. Ibid.

-
213. Holdaway, Simon, Emily Evans, and Sarah Webb. *Operations and Management Research Program—Improving Suicide Prevention Measures on the Rail Network in Great Britain: Literature Review*. Rail Safety and Standards Board LTD, 2012. Web.
214. Ibid.
215. Ibid.
216. Ibid.
217. Ibid.
218. Ibid.
219. Ibid.
220. Ibid.
221. Mishara, Brian L. “Railway and Metro Suicides: Understanding the Problem and Prevention Potential.” *Crisis*, Volume 28 (2007): 36-43.
222. FTA. “Security Cameras/Systems fact Sheet: Rail Transit.” Federal Transit Administration, Research and Innovative Technology Administration. Web. 3 Mar. 2013. http://www.pcb.its.dot.gov/factsheets/security/secRai_print.htm
223. Mishara, Brian L. “Railway and Metro Suicides: Understanding the Problem and Prevention Potential.” *Crisis*, Volume 28 (2007): 36-43.
224. FTA. “Security Cameras/Systems fact Sheet: Rail Transit.” Federal Transit Administration, Research and Innovative Technology Administration. Web. 3 Mar. 2013. http://www.pcb.its.dot.gov/factsheets/security/secRai_print.htm
225. Clarke, R. V., and B. Poyner. “Preventing Suicide on the London Underground.” *Social Science and Medicine*, Volume 38 (1994): 443-446.
226. Ibid.
227. Holdaway, Simon, Emily Evans, and Sarah Webb. *Operations and Management Research Program—Improving Suicide Prevention Measures on the Rail Network in Great Britain: Literature Review*. Rail Safety and Standards Board LTD, 2012. Web.
228. Clarke, R. V., and B. Poyner. “Preventing Suicide on the London Underground.” *Social Science and Medicine*, Volume 38 (1994): 443-446.
229. Ibid.
230. Ibid.

-
231. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
232. Clarke, R. V., and B. Poyner. "Preventing Suicide on the London Underground." *Social Science and Medicine*, Volume 38 (1994): 443-446.
233. Ibid.
234. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
235. Honeywell. "Rail Track Safety." Honeywell International Inc., 2013. Web. 3 Mar. 2013. <https://cip.honeywell.com/sol/Pages/RailTrack.aspx>
236. Ibid.
237. Ibid.
238. Ibid.
239. Ibid.
240. Ibid.
241. World Health Organization. *Towards Evidence-Based Suicide Prevention Programmes*. Geneva: World Health Organization, 2010.
242. Ibid.
243. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
244. World Health Organization. *Towards Evidence-Based Suicide Prevention Programmes*. Geneva: World Health Organization, 2010.
245. Ibid.
246. Lukaschek, Karoline, Jens Baumert, and Karl-Heinz Ladwig. "Behavior Patterns Preceding a Railway Suicide: Explorative Study of German Federal Police Officers' Experiences." *BMC Public Health*, Volume 11 (2011): 620.
247. Radbo, Helena, and Ragnar Andersson. "Patterns of Suicide and Other Trespassing Fatalities on State-Owned Railways in Greater Stockholm; Implications for Prevention." *International Journal of Environmental Research and Public Health*, Volume 9 (2012): 772-780.
248. FTA. "Security Cameras/Systems fact Sheet: Rail Transit." Federal Transit

-
- Administration, Research and Innovative Technology Administration. Web. 3 Mar. 2013. http://www.pcb.its.dot.gov/factsheets/security/secRai_print.htm
249. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
250. Ibid.
251. FTA. "Security Cameras/Systems Fact Sheet: Rail Transit." Federal Transit Administration, Research and Innovative Technology Administration. Web. 3 Mar. 2013. http://www.pcb.its.dot.gov/factsheets/security/secRai_print.htm
252. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
253. Ibid.
254. FTA. "Security Cameras/Systems Fact Sheet: Rail Transit." Federal Transit Administration, Research and Innovative Technology Administration. Web. 3 Mar. 2013. http://www.pcb.its.dot.gov/factsheets/security/secRai_print.htm
255. Ibid.
256. Ibid.
257. Ibid.
258. Ibid.
259. Ibid.
260. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
261. FTA. "Security Cameras/Systems Fact Sheet: Rail Transit." Federal Transit Administration, Research and Innovative Technology Administration. Web. 3 Mar. 2013. http://www.pcb.its.dot.gov/factsheets/security/secRai_print.htm
262. Ibid.
263. Ibid.
264. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
265. Ibid.

-
266. Ibid.
267. Ibid.
268. Coats, T. J., and D. P. Walter. "Effect of Station Design on Death in the London Underground: Observational Study." *British Medical Journal*, Volume 319 (1999): 957.
269. Ibid.
270. Krysinska, Karolina, and Diego De Leo. "Suicide on Railway Networks: Epidemiology, Risk Factors and Prevention." *Australian and New Zealand Journal of Psychiatry*, Volume 42 (2008): 763-771.
271. Coats, T. J., and D. P. Walter. "Effect of Station Design on Death in the London Underground: Observational Study." *British Medical Journal*, Volume 319 (1999): 957.
272. Andriessen, Karl, and Karolina Krysinska. "Railway Suicide in Belgium 1998—2009: Incidence and Prevention." *Crisis*, Volume 33 (2012): 39-45.
273. Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
274. Law, C. K., Paul S. F. Yip, Wincy S. C. Chan, King-Wa Fu, Paul W. C. Wong, and Y. W. Law. "Evaluating the Effectiveness of Barrier Installation for Preventing Railway Suicides in Hong Kong." *Journal of Affective Disorders*, Volume 114 (2009): 254-262.
275. Radbo, Helena, Inge Svedung, and Ragnar Andersson. "Suicide Prevention in Railway Systems: Application of a Barrier Approach." *Safety Science*, Volume 46 (2008): 729-737.
276. Coats, T. J., and D. P. Walter. "Effect of Station Design on Death in the London Underground: Observational Study." *British Medical Journal*, Volume 319 (1999): 957.
277. Ibid.
278. Ibid.
279. Krysinska, Karolina, and Diego De Leo. "Suicide on Railway Networks: Epidemiology, Risk Factors and Prevention." *Australian and New Zealand Journal of Psychiatry*, Volume 42 (2008): 763-771.
280. Coats, T. J., and D. P. Walter. "Effect of Station Design on Death in the London Underground: Observational Study." *British Medical Journal*, Volume 319 (1999): 957.

281. Clarke, R. V., and B. Poyner. "Preventing Suicide on the London Underground." *Social Science and Medicine*, Volume 38 (1994): 443-446.
282. Ibid.
283. Caltrain Installs New Suicide Prevention Signs. [www.Caltrain .com](http://www.Caltrain.com) (Accessed March 18, 2014).
284. Centers for Disease Control and Intervention. Suicide and Self-Inflicted Injury. <http://cdc.gov/nchs/fastats/suicide.htm> (Accessed November 11, 2013).
285. American Association of Highway and Transportation. Highway Safety Manual, 1st Edition. Washington D.C. 2010.

BIBLIOGRAPHY

American Association of Highway and Transportation. Highway Safety Manual, 1st Edition. Washington D.C, 2010.

Andriessen, Karl, and Karolina Krysinska. "Railway Suicide in Belgium 1998-2009: Incidence and Prevention." *Crisis*, Volume 33 (2012): 39-45.

Baumert, J., N. Erazo, and K. H. Ladwig. "Mental Health: Ten-Year Incidence and Time Trends of Railway Suicides in Germany from 1991 to 2000." *European Journal of Public Health*, Volume 16, No. 2 (2005): 173-178.

Botha, Jan L., Kristina A. Elmasu, and Philip J. Leitzell. *Suicides on Commuter Rail in California: Possible Patterns—A Case Study*. Mineta Transportation Institute, 2010.

Caltrain Installs New Suicide Prevention Signs. [www.Caltrain.com](http://www.caltrain.com) (Accessed March 18, 2014).

Centers for Disease Control and Intervention. *Suicide and Self-Inflicted Injury*. <http://cdc.gov/nchs/fastats/suicide.htm> (Accessed November 11, 2013).

Clarke, R. V., and B. Poyner. "Preventing Suicide on the London Underground." *Social Science and Medicine*, Volume 38 (1994): 443-446.

Coats, T. J., and D. P. Walter. "Effect of Station Design on Death in the London Underground: Observational Study." *British Medical Journal*, Volume 319 (1999): 957.

Cox, Georgina R., Christabel Owens, Jo Robinson, Angela Nicholas, Anne Lockley, Michelle Williamson, Yee Tak Derek Cheung, and Jane Pirkis. "Interventions to Reduce Suicides at Suicide Hotspots: A Systematic Review." *BMC Public Health*, Volume 13 (2013): 214.

Federal Transit Administration. *2009 Rail Safety Statistics Report*. Prepared by the Office of Safety and Security.

Federal Transit Administration. *Office of the Inspector General Audit Report. Challenges to Improving Oversight of Rail Transit Safety and Implementing an Enhanced Federal Role*. January 31, 2012.

FTA. "Security Cameras/Systems fact Sheet: Rail Transit." Federal Transit Administration, Research and Innovative Technology Administration. Web. 3 Mar. 2013. http://www.pcb.its.dot.gov/factsheets/security/secRai_print.htm

Goldmark, Alex. "NY MTA Criticized for Considering Anti-Suicide Platform Barriers." *Transportation Nation* (2011). Web. 3 Mar. 2013.

- Holdaway, Simon, Emily Evans, and Sarah Webb. Operations and Management Research Program—Improving Suicide Prevention Measures on the Rail Network in Great Britain: Literature Review. Rail Safety and Standards Board LTD, 2012. Web.
- Honeywell. "Rail Track Safety." Honeywell International Inc., 2013. Web. 3 Mar. 2013. <https://cip.honeywell.com/sol/Pages/RailTrack.aspx>
- Krysinska, Karolina, and Diego De Leo. "Suicide on Railway Networks: Epidemiology, Risk Factors and Prevention." *Australian and New Zealand Journal of Psychiatry*, Volume 42 (2008): 763-771.
- Law, C. K., and Paul S. F. Yip. "An Economical Evaluation of Setting Up Physical Barriers in Railway Stations for Preventing Railway Injury: Evidence from Hong Kong." *Journal of Epidemiology and Community Health*, Volume 65 (2011): 915-920.
- Law, C. K., Paul S. F. Yip, Wincy S. C. Chan, King-Wa Fu, Paul W. C. Wong, and Y. W. Law. "Evaluating the Effectiveness of Barrier Installation for Preventing Railway Suicides in Hong Kong." *Journal of Affective Disorders*, Volume 114 (2009): 254-262.
- Lukaschek, Karoline, Jens Baumert, and Karl-Heinz Ladwig. "Behavior Patterns Preceding a Railway Suicide: Explorative Study of German Federal Police.
- Metrolink. All Line Timetable. N.p.: Metrolink, 2013. Print.
- Mishara, Brian L. "Railway and Metro Suicides: Understanding the Problem and Prevention Potential." *Crisis*, Volume 28 (2007): 36-43.
- Radbo, Helena, and Ragnar Andersson. "Patterns of Suicide and Other Trespassing Fatalities on State-Owned Railways in Greater Stockholm; Implications for Prevention." *International Journal of Environmental Research and Public Health*, Volume 9 (2012): 772-780.
- Radbo, Helena, Inge Svedung, and Ragnar Andersson. "Suicide Prevention in Railway Systems: Application of a Barrier Approach." *Safety Science*, Volume 46 (2008): 729-737.
- Swissinfo.ch. "After Switzerland's Troubling Record of Suicide." International Service of the Swiss Broadcasting Corporation (2010). Web. 16 Aug. 2013. http://www.swissinfo.ch/eng/specials/switzerland_for_the_record/european_records/Switzerland_s_troubling_record_of_suicide.html?cid=8301804
- U.S. Census Bureau (July 1, 2010), U.S Census Bureau: State and County Quickfacts, Retrieved September 2013.
- Wikipedia. Platform Screen Door. (Accessed March 8, 2014).

World Health Organization. Towards Evidence-Based Suicide Prevention Programmes. Geneva: World Health Organization, 2010.

Zara, Christopher. "After New York Post Subway Death Story, A Safety Question Remains: Why No Platform Barriers?" International Business Times (2012). Web. 3 Mar. 2013.

ABOUT THE AUTHORS

JAN L. BOTHA, PhD

Jan Botha, PhD, is a professor at the Department of Civil and Environmental Engineering at San Jose State University. Dr. Botha has nine years' experience in transportation engineering practice and has been a faculty member at the University of Alaska, Fairbanks, and at SJSU for a total of 24 years. Dr. Botha received a PhD and M.S. in transportation engineering from University of California Berkeley, and a BSc and BSc. (Hons.) in civil engineering from the University of Pretoria, South Africa.

MARISSA K. NEIGHBOUR, BS

Marissa Neighbour, BS, graduated from San Jose State University with a Bachelor of Science in civil and environmental engineering in Spring 2014. She is continuing her education in the Master's program at the University of California, Davis with a concentration in structural engineering.

SATNAM KAUR

Satnam Kaur has been a research assistant at San José State University since Spring 2013. She will be graduating from SJSU in Fall of 2014 with a Bachelor's Degree in civil engineering. Her research interests pertain to transportation safety, more specifically the effects of bike sharing and bicycle safety.

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