This practical contribution presents the main outcome of a successful research project coordinated by the International Union of Railways (UIC). RESTRAIL (REduction of Suicides and Trespasses on RAILway property; 2011-2014) was a three-year EU FP7 collaborative project which aimed to reduce railway suicides and trespassing fatalities as well as the costly service disruption caused by these events. The project provided the rail industry and researchers worldwide with an analysis and identification of the most cost-effective prevention and mitigation measures and the results are organised into a practical toolbox. The RESTRAIL toolbox is a free online tool with both practical and scientific aims. On the one hand it is a guide of best practice designed to lead railway undertakings and infrastructure managers through the process of selecting from the range of preventative and mitigation measures (through a systematic approach for analysing a problematic situation). It equally provides a wide list of cost-effective measures, implementation tips, examples, empirical evidence for effectiveness and other useful details which are important during the implementation phase. On the other hand, it is based on empirical evidence collected from the scientific literature and from the railway industry, as well as on data produced during 11 pilot tests which were implemented during the project. The RESTRAIL toolbox is a good example of exploitable results from EU-funded projects: the tool was developed during the project, it is currently easy to consult and available free of charge at www.restrail.eu/toolbox, and will continue to be maintained, updated and improved by the International Union of Railways (UIC) for the benefit of the entire railway community and society.

© 2016 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
Peer-review under responsibility of Road and Bridge Research Institute (IBDiM)
Keywords: Rail transport; safety; security; resilience; practical toolbox

1. Introduction

Fatalities on the railway caused by suicide and trespassing constitute a significant problem for the transport system and for society as a whole. At the EU level, railway suicide and trespassing accidents account for 88% of all fatalities occurring within the railway system and generate disproportionately high human, economic, psychological and emotional consequences (European Railway Agency, 2014). It has been shown that such incidents cause trauma and work-related stress to the railway staff and rescue employees, and discomfort to passengers and eye witnesses (Mishara, 2007; Rådbo et al., 2005). The consequences for train drivers are the most severe including somatic problems, anxiety, and sleep disruption (Limosin et al., 2006), with 70% of drivers needing a temporary sick leave of 4.4 days on average (Cotherneau et al., 2004). Notable financial costs include the expenses for emergency services, investigation, insurance administration, and legal procedures (Bureau of Transport and Regional Economics, 2002).

Beyond the human loss and suffering, suicide- and trespass-related incidents cause major disruptions to railway operations. In Europe, the average traffic shut-down time is around two hours when a train-person collision occurs (European Railway Agency, 2014). Even if the collision is avoided, the delays are imminent since trains typically have to stop or slow down if there is a trespasser in the track area. This severely impacts the transport schedules and many passengers especially in areas with frequent train services, causing additional costs for Railway Undertakings (RUs). These issues have grown more and more alarming for governments, local authorities and railway companies, for which a key objective has become to prevent suicides and trespassing accidents.

2. The RESTRAL project

RESTRAIL (REduction of Suicides and Trespasses on RAILway property; www.restrail.eu) was a three-year EU FP7 collaborative project coordinated by the International Union of Railway’s Security Division. The project benefited from multi-disciplinary expertise provided by a consortium of 17 partners from 12 countries (Belgium, Finland, France, Germany, Italy, Israel, the Netherlands, Poland, Spain, Sweden, Turkey and the United Kingdom). The project started in October 2011 and ended in September 2014 and provided the rail industry and researchers worldwide with an analysis of the most cost-effective measures to reduce the frequency and impact of suicide- and trespass-related incidents.

The project consisted of six work packages. The first work package (WP1) aimed to collect and analyse data related to railway suicides and trespassing accidents. The work resulted in a description of the state-of-the-art based on a literature review, up-to-date statistics on railway suicides and trespassing accidents compiled from different sources, information on possible countermeasures to prevent railway suicides and trespassing accidents, analysis of the consequences of railway suicides and trespassing accidents, and data on the behaviour of victims prior to the incident (see Havârneanu et al., 2015; Rådbo et al., 2012). The data were collected using forms or questionnaires that were completed by RESTRAIL partners, who typically acquired the requested data from documents or by interviewing national experts, and in some cases by organising workshops (e.g. Ryan, 2013). The survey among RESTRAIL partners indicated for example more than 40 different measures (partly overlapping) for the prevention of railway suicides and trespassing accidents have been implemented in EU Member States. Moreover, the literature review (Havârneanu et al., 2015) highlighted that many countermeasures can be applied to both events, while a few need to be carefully targeted to prevent either railway suicides or trespassing accidents.

In addition, accident investigation practices and processes vary between countries. The investigation process is not regulated at European level. The classification on whether the case was a suicide or accident is most often made by the police or a coroner and the organisations involved in the investigation and their roles vary between countries. In most countries the police are responsible for at least part of the investigation. Infrastructure managers (IMs) and railway undertakings (RUs) or specific investigation bodies can do their own investigations. Overall, the analysis revealed that the fatality data are rarely comparable between countries.

Work packages 2 and 3 assessed the measures targeted to reduce railway suicides (WP2) and trespassing accidents (WP3) in order to identify the most recommended ones. All measures identified in WP1 were reviewed and assessed...
using the same evaluation process, experts and criteria (Kallberg et al., 2012; Ryan and Kallberg, 2013). The assessment process took into account factors and information that could impact the success of measures if they were applied in different European environments, and drew conclusions on a list of measures defined as recommended and promising (Burkhardt et al., 2013).

Work package 4 evaluated the measures aiming to enhance the efficiency of the railway system by assisting it in responding to fatalities and trespassing accidents which jeopardise its reliability, punctuality and thus attractiveness to potential users. Work package 5 concerned the evaluation of some of the most promising measures through eleven pilot field tests implemented in various countries. Each pilot test was conducted according to a specific implementation plan in order to monitor the evaluation process and to provide additional empirical evidence for the effectiveness of measures (see Kallberg et al., 2014, for more information concerning the selection of the measures and their implementation in pilot test planning and execution). The main purpose of these evaluations was to quantitatively estimate the effect of single measures or combination of measures on a specific problem. Some field trials focused on measures to prevent suicides, others on means to prevent trespass, while others addressed only the mitigation of incident consequences. The results of the pilot tests provided altogether new recommendations to help reduce the number and consequences of suicide and trespassing fatalities (see Plaza et al., 2014, for more details about the results of the pilot tests and lessons learned during the trials). Those results which did not bring new recommendations were in line with the evidence from the literature, and provided new empirical support for the effectiveness of particular measures. Finally, work package 6 covered the results dissemination and the development of a toolbox for decision-makers which integrated all the practical information collected and produced during the project.

This paper aims to inform the railway and the scientific community about the final and main result of the project, specifically the RESTRAIL toolbox. The current synthesis presents an overview of the tool, its development process, its structure and contents, and its main advantages for the end-users. Eventually, we discuss its added value for the railway industry as well as its implications for the future research and practice.

3. The RESTRAIL toolbox

3.1. Overview

The RESTRAIL toolbox is a problem-solving guide for implementation of measures to prevent railway suicides and trespassing accidents and to mitigate the post incident consequences. It is the main output of the RESTRAIL research project and it aims to be a helpful, intuitive and user-friendly tool. It summarises practical information collected and produced during the project (synthesis, guidelines, best practice, lessons learned and empirical evidence for effectiveness). The content also makes links with scientific publications which support the recommended measures, providing a wide list of references (research papers, research reports, reviews, etc.).

The toolbox was designed as an online guide to best practice which is easy to disseminate, find, access and update even after the end of the project. Besides the online version, which is openly available at www.restrail.eu/toolbox, a synthesis of the toolbox was published in the final RESTRAIL official document (Bonneau and Havârneanu, 2014) publicly available for download on the project’s webpage.

3.2. The goal and development method

The aims of the RESTRAIL toolbox are threefold: (1) to lead decision-makers through the process of selecting from the range of preventative and mitigation measures; (2) to provide more detailed guidance on the implementation of those measures; and (3) to provide a framework for collecting and structuring information in order to feed an accessible and documented database on measures implementation and efficiency across the rail community and beyond.

The toolbox was developed through a systematic process which began with inputs from the first work packages: state-of-the-art reviews and the collection of international data and best practices (WP1), results of the assessment process (WP2 and 3), recommendations from WP4, and results from the field trials (WP5). The toolbox was drafted in several stages, with systematic evaluations after each draft. Each working version was reviewed by the RESTRAIL consortium. Additional evaluations were conducted through two joint workshops during the RESTRAIL Mid-term
conference held in Paris on 12 June 2013. These workshops provided external evaluations from experienced end-users and enabled further adjustments.

3.3. End-users

The toolbox is designed particularly for railway undertakings (RUs), infrastructure managers (IMs) and station managers, but can be used by all people involved in the process of choosing appropriate preventative or mitigation measures (e.g. decision-makers), as well as safety specialists working with the RUs and IMs or local authorities.

Before the development of this toolbox a number of assumptions were made about how decision-makers (e.g. RUs and IMs) may want to make decisions about the implementation of the measures. These helped to generate the basic requirements of the guidance materials included in this toolbox.

- RUs and IMs would make decisions based on a good understanding of the problem they are facing in order to save as many lives as possible on the railway networks and maintain a high standard of service punctuality.
- There may be different ways to approach the task of selecting the different preventative and post incident consequence mitigation measures. Therefore, any guidance or tools should be flexible, accounting for the fact that users may have different levels of expertise or experience in this area of work. The guidance and associated tools should therefore help the end-user by providing a structured approach to solve the problem at hand and provide clear options to select an appropriate preventative measure. The experts may wish to short-cut some parts of the process and have access to detailed data that they may want to use in helping them to make their decision.
- The effectiveness of measures is another key issue for RUs and IMs. In other words the Cost-Benefit Analysis (CBA) for a measure needs to be positive in order for it to be considered for implementation. Therefore, the preventative and mitigation measures included in the toolbox should be based on criteria on which a measure performs strongly or poorly or details of the likely effect of implementing a particular measure on the numbers of suicide or trespass events. Accordingly, the measures proposed in this toolbox are based on a detailed assessment process and expert ratings on different evaluation criteria: (1) durability of effects, (2) costs and benefits (based on expert judgment and not on calculation of the cost/benefit ratio), (3) integration with other policy measures, (4) impact on railway operations, (5) impact on people and jobs; (6) technological issues; (7) environment; (8) acceptance and (9) transferability issues. Total scores on the various evaluation criteria were computed for each measure separately in the context of suicide and of trespassing. According to the total score each measure was classified as recommended (best scores), or promising (good scores) in order to provide a user-friendly rating which may facilitate an effective decision.

3.4. Organisation of the content

Based on the previous assumptions, the toolbox includes two parts: (1) a general guidance and (2) a specific guidance. The former provides general guidance through a multistep approach which structures the analysis of a problematic situation. The question answered by the general guidance is “how to analyse a problem and choose the optimal preventative or mitigation measure(s)?” The systematic approach proposed in the general guidance consists of six steps (see Fig. 1): (1) describing and understanding the problem; (2) in-depth analysis of the target situation; (3) selection of the most suitable measures; (4) planning the implementation and evaluation; (5) implementation of the measures; and (6) evaluation of the outcomes. For each of these steps the toolbox provides a checklist of proposed actions and information to be collected in order to assist the user in the decision-making process. Depending on the context of the problem under analysis, some items from these checklists may be judged as more important than others, and only some subsets of items from these checklists might be relevant to be considered. Consequently, this part of the toolbox provides a systematic general guidance in order to help the end-users plan complex and effective interventions. Its strength is that it provides a detailed summary of what is generally considered to be a complete and useful approach to analysing a situation and providing step-by-step checklists of how to proceed and choosing suicide prevention activities, implementing them and evaluating their effectiveness. Even though the steps outlined, for the most part, are not railway-specific but constitute a classic model of developing, implementing and evaluating any prevention programme, the actions include railway-specific information and categories.
The second part includes specific guidance, providing details about the implementation of a variety of measures. The question answered by the specific guidance is “how to implement the selected measure(s) in order to minimise the shortcomings and enhance the expected effect?” This part of the toolbox provides the end-user with a wide list of preventative and mitigation measures, implementation tips, examples, empirical evidence for effectiveness and other useful details which may be important during the implementation phase.

So far, 70 different specific measures have been selected in the toolbox as recommended solutions for prevention or mitigation, and some of these have been pilot tested during the project. For clarity and pragmatic purposes, these measures were grouped into fewer subsets (i.e. 25 families of measures) sharing common typologies or common effect mechanisms to influence suicidal and trespassing behaviours (see Table 1). Consequently, families may include an unequal number of specific measures which varies between one and six. Both the families and the specific measures inside a family are cross-classified on four criteria. For example, according to their type and general mode of intervention, the measures are grouped in three broader categories: (1) organisational and procedural measures which are strategic, collaborative, enforcement and process related measures with cross-cutting effects on safety practice in general (e.g. risk assessment, collaboration between organisations, enforcement patrols, etc.); (2) physical and technological measures related to engineering or technology such as fencing, landscaping, detection systems and lighting devices, etc.; and (3) public awareness and educational measures which improve the knowledge or skills of various categories of people (communication campaigns, signage, education in and outside schools, media guidelines, training and exercises, etc.). Similarly, according to the problem they target, the measures are dedicated (1) to prevent suicide, (2) to prevent trespass, (3) to prevent both at the same time, and (4) to mitigate the consequences of an incident. Furthermore, according to their effect mechanism (Burkhardt et al., 2014), there are measures to (1) influence decision, (2) deter access, (3) influence behaviour in track area, (4) reduce consequences, and (5) improve practice and processes. The fourth and last criterion refers to the level of evidence associated with a particular measure: (1)
with study results in general, (2) field tested in RESTRAIL, and (3) with no study results to support it. In the online toolbox these criteria act as search filters which help the end-user reduce the list according to specific interests and limit the number of measures for which to explore the detailed guidance.

The presentation of each specific measure follows a standard structure: description, recommendations, warning points, observations, study results, and a gallery with examples and/or attached documents.

Table 1. The list of the 25 families of measures selected in RESTRAIL and included in the specific guidance of the toolbox.

<table>
<thead>
<tr>
<th>Type of measure</th>
<th>Family of measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Organisational and procedural measures</td>
<td>1. Risk assessment</td>
</tr>
<tr>
<td></td>
<td>2. Learning from best practice</td>
</tr>
<tr>
<td></td>
<td>3. Collaboration between organisations</td>
</tr>
<tr>
<td></td>
<td>4. Societal collaboration to prevent railway suicide</td>
</tr>
<tr>
<td></td>
<td>5. Information sharing at regional level</td>
</tr>
<tr>
<td></td>
<td>6. Patrols and enforcement</td>
</tr>
<tr>
<td></td>
<td>7. Cooperation of the police and legal entities</td>
</tr>
<tr>
<td>2. Physical and technological measures</td>
<td>8. Fences at stations</td>
</tr>
<tr>
<td></td>
<td>9. Fences outside stations</td>
</tr>
<tr>
<td></td>
<td>10. Landscaping</td>
</tr>
<tr>
<td></td>
<td>11. Detection and surveillance systems</td>
</tr>
<tr>
<td></td>
<td>12. Lighting devices to influence behaviour</td>
</tr>
<tr>
<td></td>
<td>13. Light to increase visibility at hotspots</td>
</tr>
<tr>
<td></td>
<td>14. Safety and emergency devices at stations</td>
</tr>
<tr>
<td></td>
<td>15. Incident management and information platform</td>
</tr>
<tr>
<td></td>
<td>16. Forward facing CCTV</td>
</tr>
<tr>
<td>3. Public awareness and educational measures</td>
<td>17. Campaigns to raise awareness</td>
</tr>
<tr>
<td></td>
<td>18. Mass media campaigns</td>
</tr>
<tr>
<td></td>
<td>19. Media guidelines</td>
</tr>
<tr>
<td></td>
<td>20. Posters and warning signs</td>
</tr>
<tr>
<td></td>
<td>21. Prohibitive signs</td>
</tr>
<tr>
<td></td>
<td>22. Education in and outside schools</td>
</tr>
<tr>
<td></td>
<td>23. Training to prevent suicide</td>
</tr>
<tr>
<td></td>
<td>24. Training to prevent trespass</td>
</tr>
<tr>
<td></td>
<td>25. Training and exercises to mitigate the consequences</td>
</tr>
</tbody>
</table>

As also discussed by Havârneanu et al. (2015) only three of all families of measures included the toolbox have evidence coming from multiple studies conducted in various countries: (a) fences at stations (b) fences outside stations and (c) media guidelines. For the rest of the measures, the level of evidence is much weaker because the results come from fewer or single studies, the studies were conducted in one country or limited contexts, and the effect of the measure was not quantified as the reduction in the number of suicide or trespass cases. It is thus important to note that the details provided in the toolbox vary considerably between measures. For some families and subsequent specific measures the information provided in the specific guidance is limited compared for example to the measures which were pilot tested during RESTRAIL. Readers are referred to the online RESTRAIL toolbox to search for empirical evidence supporting the various measures or to consult the recent systematic review on safety measures to prevent railway suicides and trespassing accidents (Havârneanu et al., 2015).
3.5. Evaluation and improvement

The development process of the toolbox has been iterative and user-tested so that its usefulness and usability improve. The working versions were periodically sent to partners for comments and feedback and the drafts were improved based on the results of systematic assessment procedures. During the project, the main evaluation was done through two joint dedicated workshops during the RESTRAIL Mid-term Conference held at UIC in Paris. Since the end of the project, other workshops were organised in Sweden (by Trafikverket), London (by UIC) and Copenhagen (by the Danish Transport and Construction Agency). Such evaluations have enabled us to make adjustments in accordance with the feedback of the safety experts of RUs and IMs, other stakeholders and policy makers, during and beyond the project’s lifetime.

3.6. Current and future versions

The RESTRAIL toolbox provides a systematic but flexible approach, allowing the end-users to adapt it to their specific needs and according to particular national or cultural problems. This toolbox is also an ongoing process. The content was developed and continuously improved during RESTRAIL. The official version of the toolbox was presented during the RESTRAIL Final Conference held in Paris on 18 September 2014. Since the end of the project the content has been updated under the responsibility of UIC. The toolbox will continue to be improved based on further information provided by RESTRAIL partners, examples of actions shared in international events and results published in scientific literature. New contributions and examples of good practice are also expected from railway stakeholders worldwide.

3.7. How to use the toolbox

The RESTRAIL toolbox is one of the few if not the only integrated approach to analyse and prevent a railway suicide/trespass problem and to implement post-incident mitigation measures. It should be used as a “guide to best practice” rather than a standard procedure or fixed framework.

This tool is not exhaustive, and neither was this its authors’ intention. It reflects the main results of the RESTRAIL project, including only the measures which emerged as recommended or promising during the project. This explains why some possible measures are not included in the toolbox (see Havârneanu et al., 2015 for a complete review of possible measures). However, the classification system used in this tool is flexible enough to allow new measures to be added in the future. The end-users are encouraged to use the online version of the toolbox as much as the short practical guide which is available in printable format.

3.8. Terms of use and copyright

The toolbox is open-access and its contents may be reproduced free of charge for research, private study or for internal circulation within an organisation. This is subject to it being reproduced and referenced accurately and not being used in a misleading context. The material must be acknowledged as the copyright of RESTRAIL consortium members and the title of the publication specified accordingly. For any other use of the material please apply to International Union of Railways (UIC) for permission.

4. Discussion

RESTRAIL “REduction of Suicides and Trespasses on RAILway property” (2011-2014) was the first EU FP7 project that specifically tackled railway suicide and trespassing in a comprehensive way. For the first time this project brought together information on railway suicides and trespasses, from a broad range of countries and multidisciplinary data sources, as well as piloting and evaluating prevention measures and developing a practical toolbox to help all relevant decision makers select and implement prevention measures. In summary, the RESTRAIL project has provided a unique toolbox which represents a major step forward for the railway safety, security and resilience.
4.1. The added value of the toolbox

Before RESTRAIL there was no integrated research about railway suicide and trespass prevention and no global classification of recommended or promising measures. The available resources included only limited evaluations of some measures (single studies specific to one railway network) and just a few country-specific guidance materials. Within RESTRAIL everything is integrated and available for the concerned stakeholders and researchers. Furthermore, the advanced knowledge achieved in the project has clear, practical implications for society.

The project produced innovative proposals, which could save lives, money and time for both railway companies and passengers. In this respect, the project has three major impacts. The first one is on safety, by helping reduce the number of deaths and injuries. In other words, it directly contributes to the reduction of life loss and human suffering, thus improving community well-being. The second implication is for the citizens who use the trains on a regular basis, for example for commuting. RESTRAIL helps reduce the traffic shut-down time after an incident improving the service punctuality. In this way, pedestrians and passengers will be less affected by traumatic events, will feel safer and more secure in the railway environment and will have a better perception of the train operating company. The third implication concerns the railway industry, which is seriously affected by suicides and trespassing accidents, in terms of economic costs, stress among train drivers and other railway staff, and negative public image conveyed by these incidents. RESTRAIL helps the industry significantly reduce the direct and indirect costs arising from these events.

4.2. Strengths and limitations

The RESTRAIL frame was very efficient in collecting and integrating international knowledge and examples of good practice, in developing an evaluation methodology and assessing the existing body of prevention and mitigation measures, developing field tests, and initiating a practical toolbox. However, there were some limitations mostly because of the inherent gaps which were impossible to overcome within the project’s time frame. For example, it was not possible to perform any preliminary economic analyses in the case of four pilot tests due to the lack of time to collect long-term data and the missing data or unavailability of measures of effectiveness and/or of other effects on the network at the time of the trials. As revealed in the RESTRAIL working steps, a large amount of data and evidence are still unavailable or difficult to obtain, thus requiring further relevant indicators from the field, improved collection procedures, and tools on a wider scale than was expected in the RESTRAIL context. Because of all these issues, the RESTRAIL toolbox is not yet a mature solution for the prevention practice, but it is an emerging new approach for more safe and secure railway operations with great potential for development and improvement.

4.3. The way forward

The RESTRAIL research team is keen to capitalise on the project’s findings. Partners in the consortium planned to continue working together. Possible follow-up research activities include developing more sound socio-economic evaluations of measures for preventing suicide and trespassing accidents. This will require a whole dedicated project focused on a smaller set of measures or combination of measures and on their evaluation in longer trials so as to collect more reliable data, leaving more time and more possibilities to implement several experimental and control situations in parallel. More thorough evaluations could employ controlled characteristics to select the different experimental sites and measurement tools that enable the collection of all relevant data, during longer periods, and testing several comparable measures and objectives.

Secondly, the elaboration of a theory-based framework (Weiss, 1997) is required to accurately support these evaluations and economic estimates. In other words, one can elaborate an explicit conceptualisation of the chosen prevention measures in terms of a theory that attempts to explain how it produces the desired effects (e.g. significantly decreasing the number of rail suicides, significantly reducing trespassing behaviours, etc.) as well as the various relevant impacts (e.g. in terms of time loss and delays). A further step could thus be verifying and sometimes modifying the assumptions of this theory-based framework. This would involve new studies and investigation whenever needed. The recently proposed model of suicide and trespass process (Burkhardt et al., 2014) and the updated knowledge and practice available in the RESTRAIL toolbox could provide the basis for initiating
such a theory-based approach as a follow-up of the project. Although such a theory-based framework is currently far from bringing actual help in directly saving lives or reducing the traffic shut-down time after an incident, it can act as a much needed top-down approach for interventions in absence of consistent empirical data about the effectiveness of measures. The RESTRAIL toolbox is the first attempt to close this gap between the top-down and bottom-up perspectives. It is an important starting point in proposing an integrated theory-based framework and integrating all the existing scientific evidence about the implemented interventions. The continuation of RESTRAIL and its subsequent toolbox will be supported by future dissemination actions targeted at various audiences. Dissemination tailored to specific audiences and readerships can help facilitate the translation of research results into action and policies. This article is meant to be a contribution to this dissemination strategy.

Acknowledgements

This work is an outcome of the research conducted in the project RESTRAIL which has received funding from the European Union’s Seventh Framework Programme for research, technological development and demonstration under grant agreement Nº 285153. On behalf of the International Union of Railways – UIC (project coordinator), the authors would like to thank the members of the RESTRAIL consortium for their efficient collaboration and valuable contributions.

References


