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Current knowledge of railway suicides and trespassing accidents

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Table of contents

<u>1. EXECUTIVE SUMMARY</u>	<u>6</u>
<u>2. INTRODUCTION</u>	<u>8</u>
2.1 Purpose of the document	8
<u>3. DATA COLLECTION AND ANALYSIS</u>	<u>9</u>
3.1 Description of the corpus of papers considered for analysis	9
3.1.1 TIME AND SPATIAL DISTRIBUTION AND CONTEXT OF LITERATURE	9
3.1.2 TYPE OF DOCUMENTS	11
3.1.3 THEMATIC FOCI	11
<u>4. STATE-OF-THE-ART SUICIDES</u>	<u>12</u>
4.1 Definition of suicide	12
4.2 When (time of day, weekday, month)	12
4.2.1 TIME OF DAY AND WEEKDAY	12
4.2.2 MONTH OF THE YEAR	13
4.3 Where (typical places).....	13
4.4 Behavioural patterns and characteristics of railway suicide victims	13
4.4.1 BEHAVIOURAL PATTERNS OF RAILWAY SUICIDE VICTIMS	13
4.4.2 METHOD CHOICE	14
4.5 Who (gender, age, mean age)	14
4.5.1 SEX AND AGE DISTRIBUTION	14
4.5.2 METRO/UNDERGROUND.....	15
4.6 Drugs/alcohol	15
4.7 Illness	15
4.8 Railway suicides compared to national suicide rates.....	16
4.9 Railway suicide prevention (technical/physical and soft measures).....	16
4.10 The role of the media.....	18
<u>5. STATE-OF-THE-ART TRESPASS ACCIDENTS</u>	<u>20</u>
5.1 When most accidents occurred (time of day, weekday, month, year)	20
5.1.1 BASED ON TRESPASSING ACCIDENTS	20
5.1.2 BASED ON OBSERVATIONS OF TRESPASSING BEHAVIOUR	21
5.2 Where did trespassing occur (typical places)	21
5.2.1 TRESPASSING ACCIDENTS.....	21
5.2.2 TRESPASSING OBSERVATIONS AND INTERVIEWS.....	21
5.3 How (behaviour and intention with trespassing)	22
5.4 Who (gender, age, medium age).....	23
5.5 Drugs/alcohol	23
5.6 Trespassing accident prevention (technical/physical and soft measures)	24
5.6.1 TECHNICAL/PHYSICAL MEASURES	24

5.6.2	SOFT MEASURES	24
5.6.3	EVIDENCE FROM THE LITERATURE	25
5.6.4	LESSONS FROM CLOSELY-RELATED FIELDS THAT COULD APPLY TO RAIL TRESPASSING.....	28
6.	<u>TRAIN-PEDESTRIAN COLLISIONS</u>	<u>32</u>
6.1	Difficulties classifying train-pedestrian collisions.....	32
6.2	Annual ranges of documented railway suicides and fatalities related to railway trespassing in different countries.....	32
6.3	Mortality rates.....	33
6.4	Consequences.....	33
7.	<u>DISCUSSION AND CONCLUSION</u>	<u>35</u>
8.	<u>REFERENCES</u>	<u>37</u>
9.	<u>ANNEX</u>	<u>48</u>

1. EXECUTIVE SUMMARY

Purpose

The objective of this document is to provide a systematic and critical description of current knowledge concerning railway suicides and trespassing accidents, and to describe and review the methods and tools that have been used for the prevention of such incidents. The analysis is based on scientific literature and research reports and on reviews of planned and ongoing relevant projects at national, European and global level.

Method

We have searched through the main Publication Databases using keywords about suicide, rail trespassing, grade crossing, rail-pedestrian fatalities and potentially relevant themes in closely related fields (e.g. road safety campaign evaluations).

Around 170 publications (reports, conference proceedings, journals, papers) published between 1972 and 2012 have been identified and selected for inclusion in this review. The most represented countries in terms of data and numbers of references are, in decreasing order, the UK, USA, Germany, Sweden, Australia, the Netherlands, South Africa, Finland, Hong Kong, New Zealand, France, Turkey, Belgium, Canada, Denmark, India, Italy, Switzerland, Austria, Japan, Korea and Spain.

These publications focus mainly on suicide, or on fatalities at a more general level. Suicide was addressed in 2/3 papers compared with 1/3 for trespassing. Papers in the context of subways focus almost entirely on suicide issues, whereas in the context of railways the emphasis is on trespassing. A separate review has been carried out on suicide and trespassing issues and results.

Results

The review of articles and data gives a picture of when, where, how and who is involved in suicide and trespass accidents. We have also reviewed preventive measures against fatal accidents on railways.

The review has highlighted some differences and similarities between railway suicides and trespassing accidents. These are:

- Motivation of the person(s) involved in the event. As opposed to trespassing accidents with no suicidal intent, railway suicides involve persons intentionally putting themselves in a situation where they would be struck by a train. Railway trespassing can be motivated by several factors such as taking a short cut, using the railway area for recreational purposes (e.g. walking a dog, taking a walk along the tracks), using the railway area for specific group-related activities (e.g. playing, socialising, drinking alcohol, risk seeking), fare dodging and escaping or to conduct criminal activities (e.g. metal theft, vandalism etc.).
- Victim's profile in terms of mental health and intoxication. Specifically, the victims in trespassing accidents are more frequently intoxicated than in suicides. In contrast, suicide victims suffered from mental health problems much more frequently than victims in trespassing accidents.
- Behaviour of victims. Railway suicides are characterised by victims waiting for trains for some time in the vicinity of the track before the train arrived, whereas trespassing accidents occurred most often in situations where a person was crossing the track or walking in the wrong direction.

The main similarities between railway suicides and trespassing accidents relate to gender and location: the victims in railway suicides and trespassing accidents and observed trespassers were predominantly male, and most of the railway suicides and trespassing accidents occurred in densely populated areas.

There is a subset of common preventive measures, like fences, that can be used to prevent both railway suicides and trespassing accidents, even though their effectiveness may depend on the target group in view of the different motives. Indeed, the information that both railway suicides and trespassing accidents occur in densely populated areas means that the same measures can be used to prevent both railway suicides and trespassing accidents.

Other measures are specific to either one of the two targets, suicide and trespassing. For example, measures dedicated to suicide prevention are not expected to affect trespassing accidents and incidents. Similarly, some measures may essentially have an effect on trespassing accidents and incidents, e.g. the removal of attractions (abandoned buildings as potential playgrounds, metal warehouses that can incite theft etc.). Measures to prevent railway suicides include e.g. gatekeeper programmes (training of staff at stations to identify people at risk for railway suicide), informing local authorities on the risk of locating psychiatric institutions near railways, and design of announcement protocols in case of a railway suicide. Measures to prevent trespassing accidents include e.g. removal of unauthorised paths, installation of prohibitive and warning signs & posters and education at schools to increase awareness of risks related to crossing the tracks.

Some measures might have opposing effects on railway suicides and trespassing accidents. Examples are campaigns to raise awareness of the risks related to crossing the railway tracks or media reports on train-pedestrian collisions. These measures can potentially have a negative effect on the frequency of railway suicides by increasing the knowledge and attractiveness of railways as a means of suicide.

Limitations/implications

The review of existing literature on railway suicides and trespassing accidents revealed some limitations. In particular, most of the reviewed articles/studies have been conducted by individual railways or research institutes. The studies often include data from only one country and therefore the results are too limited or specific (to a certain railway environment) to be directly useful for other companies or countries. In addition, current studies lack accurate knowledge of motives (the underlying reasons for these actions) and behaviour. Earlier studies on railway trespassing, for example, have been mostly based on reported incidents and fatalities, which does not necessarily show the extent of the problem (i.e. frequency of trespassing) and characteristics of trespassing. Moreover, existing studies have suggested several countermeasures to prevent both railway suicides and trespassing accidents. However, there is little published research evaluating the efficacy of these interventions.

These limitations highlight the need to collect and analyse European-wide railway suicide and trespassing accident-related data, to collect information on potential measures to prevent railway suicides and trespassing accidents, and to estimate and demonstrate their effectiveness. Based on the literature, railway suicide and trespassing related behaviour tends to be specific to location and/or country and thus special attention should be paid to evaluating the applicability of identified measures to different railway and cultural environments.

2. INTRODUCTION

2.1 Purpose of the document

The objective of this document is to provide a systematic and critical review of current knowledge concerning railway suicides and trespassing accidents, and to describe and review the methods and tools that have been used for the prevention of such incidents. The analysis is based on scientific literature and research reports and reviews of planned and ongoing relevant projects at national, European and global level.

3. DATA COLLECTION AND ANALYSIS

In line with the RESTRAIL approach, the literature review has been carried in order to analyse both suicide and trespassing factors in the rail context, along with potential or evaluated measures in this context or in closely related fields.

3.1 Description of the corpus of papers considered for analysis

The current analysis has been conducted initially on the basis of around 170 papers accessed and referenced as dealing with suicide, rail trespassing, grade crossing, rail-pedestrian fatalities and potentially relevant themes. This literature deals mainly with the railway context (about 60%). There are also about 20 articles specifically focused on the subway context (Table 1 in Annex 1) and papers reported more general studies considering for example various methods of suicide including those in rail situations or papers dealing on closely related fields, e.g. suicide by jumping from a bridge or road safety campaigns. The full list of references is given in Annex 1.

3.1.1 Time and spatial distribution and context of literature

Data were usually specific to one country and/or a given area (regional area, city, part of a network etc.) within the considered country with the exception of about 20 international or European comparisons (Abbott et al., 2003; Beautrais, 2007; Clifton, 2011; Daigle, 2005; Hoekstra & Wegman, 2011; Lewis et al., 2007; Mishara, 2007; O'Donnell & Farmer, 1992; O'Donnell et al., 1993; Ratnayake et al., 2007; Reynders et al., 2011; Rådbo et al., 2008; Sarchiapone et al., 2011; Yip et al., 2012). They were published between 1972 and 2012, half of them after 2005.

As shown in from Table 1, the countries most represented in terms of data and numbers of references were the UK, USA, Germany, Sweden, Australia, the Netherlands, South Africa and New Zealand, Austria, Finland and France, Hong Kong and Turkey, Belgium, Canada, Denmark, India, Italy and Switzerland. Other countries represented by one paper were Japan, Korea and Spain.

Suicide has been addressed mostly in the USA, UK, Germany, Sweden, Australia, the Netherlands, Hong Kong and South Africa. Trespassing has been addressed mostly in the USA, UK, Sweden, Finland, South Africa, Australia, New Zealand and Turkey.

Table 1. Number of considered articles and reports by context and by country (briefly categorized from reading the document or the abstract when the document wasn't accessible).

Country	Railway context			Subway context			General, other field, level-crossing specific	Total Freq.
	Trespass	Suicides	Both	Trespass	Suicides	Both		
Australia	2	3	2				1	8
Austria					2		2	4
Belgium					1		1	2
Canada					2			2
Denmark		2						2
Finland	4							4
France		1	1		2			4
Germany	1	12	1		1		4	19
Hong Kong		1	1		1			3
India			2					2
International		5	1		2		13	21
Italy		1					1	2
Japan			1					1
Korea		1						1
the Netherlands		4			1		2	7
New Zealand	3		1				1	5
South Africa	1		3				1	5
Spain		1						1
Sweden	1	6	4			1	1	13
Swiss							2	2
Turkey			3					3
UK	3	8	4		2	2	8	27
US	4		9		3	1	8	25
European			1				3	4
Unknown		1					1	2
Total	19	46	34	0	17	4	49	169

3.1.2 Type of documents

From a methodological viewpoint, about 40% of the papers (65/169) are based on reports on intentional as well as unintentional fatalities and/or attempted suicides (more or less focused on a specific type and context), although three are focused on non-intentional fatalities (De Leo & Krysinska, 2008; Lindqvist et al., 2004; Silla & Luoma, 2011) and thus do not address suicide. The number of case reports involved in the analyses ranges from 1 single case in (Becker & Schmidt, 2001) and (Palanco, Lucas, Rojas, & Martinez, 1999) to a maximum of 145 865 cases of fatal suicides in Germany during ten years from 1991 to 2002 in (Baumert et al., 2008). The median number of reported cases is 175.

There are several reviews of the literature (e.g. Beautrais et al., 2009; Burrows & Laflamme, 2007; Farmer et al., 1992; Holdaway et al., 2012; Ladwig et al., 2009; Lerer & Matzopoulos, 1996; Lobb et al., 2003; Lobb, 2006; Lukaschek et al., 2011; Node et al., 2006; Rail Accident Investigation Branch (RAIB), 2011; Reisch & Michel, 2005; Sarchiapone et al., 2011; Beautrais et al., 2009; Cina et al., 1994; Lobb, 2006) and few empirical studies, evaluation or studies conducted in the field using interviews or questionnaires (Cina et al., 1994; Frisk, 1997; Ladwig et al., 2012; Law et al., 2009; Nixon et al., 1985; Ladwig & Baumert, 2004; O'Donnell et al., 1994; Reynders et al., 2011; Schmidtke, 1994; Shapiro et al., 1994; van Houwelingen & Kerkhof, 2008; Yum et al., 2006).

3.1.3 Thematic foci

From a thematic viewpoint, the literature is extensively focused on suicide, or on fatalities at a more general level. Whether or not it was central to the paper, suicide was treated in 127 papers whereas trespassing was treated in 58 papers and grade crossing was represented even less in 30 papers. Since both the themes could be found in a single paper, we have looked at their distribution: 87 papers were dedicated to suicide only, nine to trespassing (Rail Safety and Standards Board, 2005; Rail Safety and Standards Board., 2003; Silla & Luoma, 2009; Silla & Luoma, 2011; Silla & Luoma, 2012; Strauch et al., 1998; Thompson et al., 2012) and two to safety issues at level crossings (Evans, 2011; Rail Accident Investigation Branch (RAIB), 2011). Twenty papers dealt with the three issues, the rest with at least two of the three themes: 18 dealt with both suicide- and trespassing issues, eight with trespassing and level crossings, and none dealt with suicide and level crossings. Although the literature on level crossings has a predominant focus on drivers and train-vehicle collisions, some studies also dealt with train-pedestrian collisions.

One important issue concerns the differences and similarities between pedestrian-train collisions in the context of suicide and in the context of trespassing, in terms of adequate prevention, detection and mitigation of consequences. Rådbo et al., (2008) have proposed a detailed safety-oriented analysis of train-person collision where a person is fatally injured by a moving train. In the two next parts, chapter 4 and 5, we will concentrate on what characterize rail suicide and rail trespassing accidents. We will also provide a synthesis of factors and measures common or specific to suicide and trespassing that could help in deterring, preventing or mitigating the consequences of suicide and trespassing in the rail context.

4. STATE-OF-THE-ART SUICIDES

The following section reviews the articles that deal with railway suicides and railway trespassing accidents. It is based on papers for which the context is mainly the railway domain followed by the subway context. This review also includes some general papers about suicide statistics, means of suicide etc.

This literature provides considerable knowledge on how these events occur in different countries and the victims involved. Together, the articles describe the issue and phenomenon similarly and confirm each other's results. The specific situations are well-documented and in certain cases also describe how the victim acted before the accident. Henceforth in this summary the suicidal person, attempting, or completing the suicide attempt, is also termed the *victim*.

4.1 Definition of suicide

A definition of suicide, and the factors crucial to determining whether the death is a suicide, accident or homicide, is needed. Among others, Rosenberg et al., (1988) defines suicide as "death arising from an act inflicted upon oneself with the intent to kill oneself". Suicides on railway tracks are classified in the mortality recording in accordance with the tenth revision of the International Classification of Diseases (ICD-10) as "Intentional self-harm by jumping or lying in front of a moving object" (ICD 10 X81)." Driever et al., (2002) has use a classification of railway suicide from the criteria: "(i) logical suicide motive (hopeless situations caused by grave illness like cancer, psychical disorders like depressions, debts and long-time unemployment or separation, respective bereavement) in combination with (ii) farewell letter, announcement of suicide or preceding (multiple) suicidal attempts or (iii) sighting by the train driver in upright position standing in or stepping into the track".

4.2 When (time of day, weekday, month)

Studying time patterns is fundamental to understanding a suicide regardless of the means, and to find possible time patterns that may influence the victim. The exact time of suicidal or fatal accidents within rail networks can often be pinpointed due to schedules/timetables and train drivers attending, while exact times of other suicide methods are considerably harder to identify.

4.2.1 Time of day and weekday

From scientific articles concerning railway suicides, some trends in time of day are apparent, although there are also some differences. Studies show a pattern of railway suicides occurring during commuting hours (Meltem et al., 2011); Lerer & Matzopoulos, 1997) or in the evenings (Schmidtke, 1994; Silla & Luoma, 2012). Other studies indicate that train-person collisions occur during daytime (Emmerson & Cantor, 1993; Rådbo et al., 2005). A Dutch study has found a strong relationship between suicide rates and time of day, showing that the suicide rates increased 1.5–2 h after sunset (van Houwelingen & Beersma, 2001). In a large study of cases, the activity pattern shows victims jumping during daytime while during evenings they place themselves, lying or sitting, on the tracks (Dinkel et al., 2011). In some studies there is a description of the differences between men and women. Women usually commit suicide earlier in the day and men in late afternoon/evening (Erazo et al., 2004b; Kerkhof, 2003).

Concerning the weekly distribution, studies indicate a peak at the beginning of the week and a low on weekends (Erazo et al., 2004b; Schmidtke, 1994; van Houwelingen & Beersma, 2001). Apparently for subjects at risk the start of the working week triggers feeling of personal failure and isolation.

4.2.2 Month of the year

Circadian pattern peaks for the half-years covering summer and winter have clearly been shifting to earlier and later clock times, respectively, corresponding to time of sunrise and sunset (Erazo et al., 2004b; Andriessen & Kryszynska, 2011). Sex-specific interaction patterns of season and clock time for excess railway suicide risk have been reported by several studies (Erazo et al., 2004b; Schmidtke, 1994; van Houwelingen & Beersma, 2001. Ladwig et al. (2009) have observed from studying a large number of cases that most train-person collisions occur in April and the fewest in December. In a Turkish study a peak has been observed in summertime (Ozdoğan et al., 2006). In studies from Scandinavia, no clear monthly trend has emerged (Silla & Luoma, 2012; Rådbo et al., 2005).

4.3 Where (typical places)

Most railway suicides occur in densely populated areas with access to a railway (Rådbo et al., 2005; Silla & Luoma, 2012; van Houwelingen et al., 2010). There are clearer differences between urban and rural areas in the Nordic countries (Sweden, Finland) than in other European countries. In bigger cities the simplest way to reach the tracks seems to be via platforms, probably due to better fencing than in smaller cities (Rådbo & Andersson, 2012). In smaller communities and in rural areas, victims seek locations where they can easily step up onto the track, often in the vicinity of a level crossing, bridge, or tunnel – a known location, and place themselves on the track (Abbott et al., 2003; Rådbo & Andersson, 2012). In many cases the person tended to commit suicide close to their home (Rådbo et al., 2012b; Abbott et al., 2003; Kerkhof, 2003).

In densely populated areas it is common to find hotspots — specific locations where a high number of suicides take place. These are defined in one article as a section of 2-kilometre track where six or more suicides have occurred (Andriessen & Kryszynska, 2011). Hotspots seem to be easily accessible and often lack proper fencing. Also, they frequently develop close to level crossings and/or close to psychiatric hospitals or mental health facilities (Andriessen & Kryszynska, 2011; Emmerson & Cantor, 1993; van Houwelingen et al., 2010).

4.4 Behavioural patterns and characteristics of railway suicide victims

4.4.1 Behavioural patterns of railway suicide victims

Knowledge on railway suicide victims' pre-crash behaviour is sparse. Results from the few existing studies are consistent in reporting specific pre-crash behavioural patterns, e.g. the dropping or leaving behind of personal belongings (e.g. bags, suicide notes, ID cards), removal of shoes, possession of items that ordinarily would be left at home (e.g. framed family pictures), avoidance of eye contact, erratic gesture, mimic or movement, erratic communication patterns (e.g. loudly talking to oneself) and aimlessly wandering about (Lukaschek et al., 2011; O'Donnell et al., 1996; Clarke & Poyner, 1994; Gaylord & Lester, 1994). Furthermore, out-of-the-ordinary clothing (e.g. totally dressed in black, extremely bright colours, special items like a long, black coat, a Stetson or a uniform) might be an indicator (Lukaschek et al., 2011), although this feature seems to be more prominent in Hong Kong, where a departure from ordinary dress to traditional ethnic fashion alerts subway staff (Gaylord & Lester, 1994).

Additionally, information about suicide intention may also come from the location where suicide was committed in station areas, e.g. the head of a station platform (Clarke & Poyner, 1994; Lukaschek et al., 2011; Rådbo & Andersson, 2012).

Regarding suicidal behaviour on railway tracks, subjects might fall into one of the following four categories: jumpers, liers, touchers and wanderers (Guggenheim & Weisman, 1972). Accordingly, jumpers are those who leap or tumble directly in front of an oncoming train in the presence of passengers and other bystanders. Liars, seldom observed entering the pit, lie down across the

tracks, generally in a prone position, and await the approach of a train or for the train to start. Touchers make contact with an electrical source and are killed through electrocution from a high-volt electrical conductor. Wanderers walk along the pit and are hit by collision with the train in a walking position. Analysing suicide data for the German Railway Suicide Project, we further identified some rare cases of 'chaired suicides' (one incidence with wheelchair-bound persons, several incidences with couples). In one case, a young mother had committed suicide on the track with two infants in her arms (Ladwig et al., 2009). In a retrospective analysis of registry protocols of 4127 suicidal acts on the German Railway net in the period 2002 to 2006, 1004 cases could be classified as distinct behaviour pattern (jumping, lying, wandering) (Dinkel et al., 2011)). Neither in this study nor in a small Finnish study were age and sex associated with type of suicidal behaviour (Dinkel et al., 2011; Silla & Luoma, 2012). It has been hypothesised that the behaviour of the victim might allow conclusions to be drawn as to whether the incident was a suicide or an accident (Driever et al., 2002) but more evidence is needed.

4.4.2 Method choice

Key factors presumed to influence railway track method choice remain largely speculative. Intuitively, suicide death on the open track, accomplished by wanderers or liars and not witnessed by the public, point to a more thoughtful consideration of the effects on railway suicides on witnesses than is the case with a public death at a station with numerous bystanders (Ladwig et al., 2009; Guggenheim & Weisman, 1972).

Interviewing railway suicide attempters revealed that there is an omnipresent belief that suicide on the track results in a certain and painless death (Mishara, 2007). According to the SOVRN project, railway suiciders choose places near their vicinity—the 'proximity factor' (Abbott et al., 2003).

The choice-structuring concept presented by Clarke and Lester (Clarke & Lester, 1989) underscores the complexity of the cognitive progression from ideation to action (Silla & Luoma, 2012) and, by applying the concept to railway suicides, the fatal attractiveness of the method: easy opportunities, no knowledge or skills required to reliably produce the desired result, which might include not only one's own death but also inconvenience to others (through witnessing). Additionally, the certainty of death may be overestimated.

4.5 Who (gender, age, mean age)

4.5.1 Sex and age distribution

In the general population, substantially more men than women commit suicides with a male/female ratio of 3.2 within European countries (Schmidtke, 1994). Male victims are predominant in deaths due to self-immolation, railway collision, hanging, firearms, and electrocution. The most potentially painful/disfiguring methods of suicide — jumping from a height, self-immolation, and railway deaths, were favoured by the young (Cooper & Milroy, 1994). In Germany, 4003 fatal railway suicides over a 6-year period (1997–2002) were analysed and revealed a male/female ratio of 2.70 (Erazo et al., 2004b). After stratifying for open track and station area, the striking male preponderance of railway suicides decreased (Erazo et al., 2005). In a smaller sample from Germany, a comparable male/female ratio of 2.26 and a mean age of 41 years were found (Lukaschek et al., 2011). Additionally, an increasing time trend of the number of railway suicides for subjects aged ≤65 years was reported (Baumert et al., 2005). A study from Finland reported a male/female railway suicide ratio of 2.4 (Silla & Luoma, 2012). The excess railway suicide risk of males was also confirmed in the SOVRN Project (Abbott et al., 2003). Apparently, these figures mirror to some extent the general sex distribution of fatal suicides in Western societies. Data from the Netherlands show a male/female ratio of train suicides of about 2 and a mean age of 40 years. The male/female ratios of train suicides as well as of general population suicides have risen constantly within the last two decades in the Netherlands.

In a sample from Sweden dominated by railway victims the mean age was 42 years (Beskow et al., 1994). Male dominance in railway suicide victims was confirmed by another Swedish study where the majority of victims were in the age group 40-59 years (Rådbo & Andersson, 2012). In contrast, a study from Denmark showed that 44% of train suicide victims were in the age group 15-29 years. A study from Tokyo including platform incidents revealed a mean age of 44 years (Node et al., 2006).

A study from Queensland, Australia, reports a male/female ratio of 4, which is equal to the sex distribution of suicide by all methods in Queensland (De Leo & Krysinska, 2008). A third of railway suicide victims in the Australian study were in the age group 15-24 years (De Leo & Krysinska, 2008).

In a study from Cape Town, South Africa, the majority of victims were men between the ages of 25 and 44 years. However, the study sample includes all railroad related deaths, not only suicides (Lerer & Matzopoulos, 1997).

On the whole, evidence from studies conducted in a number of European countries, Australia, South Africa and Japan points to a greater incidence of railway suicides among men than women. Despite this, a review of international literature on the incidence of suicide on railway networks revealed conflicting data on the sex ratio of this type of suicide, but identified young adults (20-40 year of age) as those most exposed to train suicide (Krysinska & De Leo, 2008).

4.5.2 Metro/Underground

The sex ratio of suicide victims in subway systems might differ considerably. Here, male predominance is less pronounced (Ladwig & Baumert, 2004; Ladwig et al., 2009; Sonneck et al., 1994; O'Donnell & Farmer, 1994; O'Donnell et al., 1994; O'Donnell & Farmer, 1992). Victims tend to be younger than railway suicide victims (O'Donnell & Farmer, 1992; Sonneck et al., 1994; Abbott et al., 2003; Mishara, 1999; Ratnayake et al., 2007) with a peak in the age group 25 to 34 years (O'Donnell & Farmer, 1994; Ladwig & Baumert, 2004).

4.6 Drugs/alcohol

In railway suicides, deviant pre-crash behaviour may be accompanied by alcohol or drug intoxication. The proportion of subjects affected by alcohol/drug intoxication varies greatly between studies: Two studies reported only a few subjects with alcohol intoxication — 2% (Mohanty et al., 2007); and 10 % (Cocks, 1987), whereas two studies reported very high proportions of 70%, (Shapiro et al., 1994; Cooper & Milroy, 1994). Most studies reported proportions between 20% and 30% of intoxicated subjects (De Leo & Krysinska, 2008; Beskow et al., 1994; Lukasczek et al., 2011). Another study showed that about half of all victims were intoxicated by alcohol, medicines and/or drugs (Silla & Luoma, 2012). Regarding sex and age differences, alcohol was an important risk factor among the young (De Leo & Krysinska, 2008) and male subjects (Frisk, 1997), more precisely in single young men (Symonds, 1985).

Regarding subjects killed in train accidents as opposed to suicides, the proportion affected by alcohol intoxication is high, ranging from 35% (Lerer & Matzopoulos, 1997) to 69 % and above (Cina et al., 1994; Meltem et al., 2011; Silla & Luoma, 2012). A study on subway train-related fatalities in New York City reports that antidepressant medications were more frequently detected in suicides, whereas cocaine and ethanol were more frequent in accidents (Lin & Gill, 2009).

4.7 Illness

Evidence from retrospective psychological autopsy studies confirmed a substantial degree of psychiatric morbidity in railway suicide victims (Ladwig et al., 2009). The majority of SOVRN patients suffered from signs of mental disorders, where many of these had been present for over a year and some for more than a decade (Abbott et al., 2003). Data from the south of England

revealed that railway suicide victims appeared to have medical, mainly psychiatric, contributions to their death. Rail suicides included more cases of major psychosis and neurosis, but fewer and less severe alcoholics (Symonds, 1985). In the Netherlands, data of four published train suicide studies were combined with a study of 57 train suicides to investigate mental healthcare status and psychiatric disorders in train suicides. Fifty-three per cent of all train suicides received psychiatric care at the time of suicide, with 49% of them being inpatients. Compared to general suicides, functional non-affective psychoses were overrepresented (van Houwelingen & Kerkhof, 2008). However, loneliness and sudden ending of an intimate relationship are also possible triggers (O'Donnell et al., 1996).

In an Australian study, a psychiatric diagnosis was documented in 40.4% of railway suicide victims (De Leo & Krysinska, 2008). A study from Sweden reports that severe illness, mostly psychiatric, was detected in 57% of railway suicide victims (Beskow et al., 1994). Similar results came from a Danish study, where 81% of train suicide victims were classifiable as psychiatric patients (inpatient, outpatient, former inpatient). Of the 13 "psychiatric" suicides by train, nine (69%) had a psychosis diagnosis. As in other international investigations a correlation was demonstrated between increasing proportion of mentally ill and degree of violence and deliberateness of the suicide (Lindekilde & Wang, 1985). A reanalysis of patient records from 129 subjects who committed suicide in the Montreal metro found that 73% had received inpatient psychiatric treatment (e.g. major depression, schizophrenia) at the time of death (Mishara, 1999). A study from England on underground/metro suicide also revealed a certain percentage of victims who had been psychiatric inpatients at the time of the incident or had recently been discharged (Cocks, 1987). A review of the international literature on the incidence of suicide on railway networks revealed that documented psychiatric diagnoses were found in up to 83% of cases (Krysinska & De Leo, 2008; Lerer & Matzopoulos, 1997). A literature review involving epidemiology studies and studies relating to subway suicide showed that those attempting suicide on the subway appear to be affected by serious mental illness and have contact with mental health services before the suicidal behaviour (Ratnayake et al., 2007).

4.8 Railway suicides compared to national suicide rates

Krysinska (2008) has compiled a review of international studies on train-related suicides and presented a matrix of the percentage of railway suicides compared to all suicides in each country (Krysinska & De Leo, 2008). The review shows that the Netherlands has the highest proportion (12%) (Kerkhof, 2003) and the Hong-Kong mass transit railway has the lowest (1%) (Gaylord & Lester, 1994). Other countries that are included in the study are Spain (11.8%) (Palanco et al., 1999), Germany (7%) (Baumert et al., 2005) and Sweden (5%) (Rådbo et al., 2005). Other descriptive studies of railway suicide have shown rates of 5.3% in Belgium (Andriessen & Krysinska, 2011) and 2% in Australia (De Leo & Krysinska, 2008). In the Netherlands attempts have been made to find crucial circumstances that can explain increases or decreases in railway suicides, but only one is found to be significantly variable; "The incidents of train suicides parallels that of general population suicides" (van Houwelingen et al., 2010).

4.9 Railway suicide prevention (technical/physical and soft measures)

It is of great importance to work unremittingly with suicide prevention and means restriction. Daigle (2005) writes in the conclusion to his article that "*At the individual level, studies tend to demonstrate that many suicidal persons have a preference for a specific method. Similarly, the fact that suicidal crises are very often short-lived (and, what is more, influenced by ambivalence or impulsiveness) suggests that a given individual who has limited access to a given means will not put off his intentions to later or shift to another method*" (Daigle, 2005)

Technical/physical measures

Technical or physical preventative measures are discussed in a number of articles. A study from the London underground has shown that a pit under the tracks originally introduced to lead off surface water from the train stations reduces the number of suicides (Coats & Walter, 1999). In Japan, platform screen doors that eliminate access to tracks have been tested and evaluations show that this reduces suicides effectively (Law et al., 2009; Law & Yip, 2011).

Studies have also highlighted the importance of reducing public access to the track by different types of fences, and in discussions between infrastructure manager and railway operators, proper fencing is seen as one of the most important preventative measures (Clarke & Poyner, 1994; Rådbo et al., 2012). Within other suicide prevention areas, as well as studies on means restriction, it is clear that efforts to hinder suicidal persons are effective. By reducing the possibility to jump from high bridges by fencing, suicides decreased. Also, it has been shown that when fencing is removed, a noticeable increase in suicides occurred, followed by a decrease when the fence was replaced (Beautrais et al., 2009). Netting to stop the possibility of jumping from a terrace has also been shown to reduce the number of suicides (Reisch & Michel, 2005).

Theoretical derive and validation of railway suicide prevention strategies

Rådbo et.al (2008) have published a theoretically derived and categorised set of railway suicide prevention strategies, and converted them into proposed obstacles that may influence the event, such as: a) measures influencing perceived attractiveness and availability of rail traffic as a means to commit suicide, b) measures influencing accessibility and potential of collision, and c) measures influencing consequences of collision (Rådbo et al., 2008).

Different types of measures have also been discussed and validated in focus group interviews, where the participants had experienced railway accidents (suicide and trespass accidents) or had experience of accident investigation at operational and/or strategic level (Rådbo et al., 2012). The result from the interviews were divided into five barrier themes: 1) measures reducing the attractiveness of railways as a means of suicide, 2) measures obstructing accessibility to the track area, 3) measures influencing the victim's determination while awaiting the train, 4) early warning systems, enabling the train to break sufficiently or the victim to be removed before collision, and 5) measures to make the collision less violent and thereby less fatal and injurious. The discussions were based on results from earlier studies and the focus groups validated earlier strategic suggestions for barrier prevention. Available measures include, for example: informing the public of prohibited areas; relocating institutional homes and informing local authorities on the risk of locating institutions for vulnerable clients near railways; patrolling at critical sites (potential hotspots); promoting public awareness and emergency calls combined with enhanced response readiness among train dispatchers and rescue services; facilitating warning feedback from train drivers to train dispatchers and other train drivers when they observe trespassers so as to reduce speed and increase watchfulness at the actual spot; camera surveillance; maintenance and improvement of existing fences and noise barriers; and proper fencing (when lacking) in densely populated areas (Rådbo et al., 2012).

National plan for suicide prevention

Having and working towards a specific goal may be necessary to reduce the extent of railway suicide. In Sweden, for example, a rough activity plan has been drawn up and extensively discussed for suicide prevention as part of the national plan for the transportation system in 2010-2021. One proposed measure is good fencing and camera surveillance. The measures are well discussed in the document (Lindberg, 2012).

Announcements

Announcements at stations and on trains inform passengers and bystanders about a critical incident leading to a breakdown of railway traffic. In case of a railway suicide, announcement

protocols should be designed to inform about the delay/breakdown but avoid the subconscious promotion and eventual implementation of railway suicide in the minds of passengers.

Poster campaigns

Poster campaigns offering help for high-risk subjects may, under defined circumstances, be a prevention option. In order to avoid counterproductive promotion of suicidal ideation and fantasies dealing with the railway as a concrete means of suicide, nationwide poster campaigns at railway stations targeted at persons with increased suicidal risk should focus solely on offering concrete help (telephone hotline, Samaritans) for those who feel hopeless and desperate. Under no circumstances should the campaign address concrete means of suicide, and it should also avoid mentioning any understanding of the motives of suicidal plans.

Gatekeepers

Gatekeeper training is modelled on the fact that people at risk for (railway) suicide who do not actively seek help can be identified by certain risk factors and behavioural patterns. Gatekeeper programmes include a range of interventions focused on community or organisational gatekeepers (e.g. railway personnel, security staff, Samaritans) whose contact with potentially vulnerable populations provides an opportunity to identify at-risk individuals (Mann et al., 2005). Education covers awareness of risk factors, policy changes to encourage help seeking and availability of resources. Awareness programmes for railway staff have led to successful primary interventions resulting in a substantial number of people being intercepted before a possible suicide attempt (Mishara, 1999).

Suicide hotspot education

Previous international studies have shown that a considerable proportion of hotspots (railway stations or on-track locations with a significantly higher rate of suicide incidences) are in the vicinity of psychiatric centres (Emmerson & Cantor, 1993; Erazo et al., 2004a; Kerkhof, 2003; O'Donnell & Farmer, 1994). Once a psychiatric facility has been 'infected' with railway suicides by imitation, behaviour-specific approaches to avoid in-hospital psychiatric suicides are warranted (Hazell, 1993; Vogel et al., 2001). Chapter 4.3 gives further information about typical suicide spots.

The role of the media

The role of the media in influencing railway suicidal behaviour and the value of soft media guidelines has been extensively discussed. The following chapter is therefore devoted to this issue.

4.10 The role of the media

Most recently, media roles in suicide prevention have been systematically reviewed (Sisask & Värnik, 2012). Media effects on suicides have been convincingly evaluated by Schmidke and Häffner (1988), who demonstrated that a fictional television drama of the intentional death of a male student on a railway track had led to a substantial increase in subsequent incidences of railway suicides for male subjects in the same age group, generally known as the "Werther effect" (Schmidke, 1988).

Railway suicides have often led to extensive media coverage in the past. As shown in Vienna, it is possible to prevent imitative suicides by influencing mass media to limit reports and depictions of railway and metro suicides as much as possible (Sonneck et al., 1994; Etzersdorfer & Sonneck, 1998). Extensive media coverage of the suicidal death of a celebrity can trigger copycat suicides in the population (Kunrath et al., 2011; Ladwig et al., 2012; Stack, 2005; Niederkrotenthaler et al., 2009). Most recently, it has been suggested that the impact of suicide reporting may not be restricted to harmful effects, but may under certain circumstances have a protective influence, the so-called "Papageno effect" (Niederkrotenthaler et al., 2010).

A Dutch paper discusses how collaboration with the media should take place. The conclusions, after reviewing a number of different studies and sources, are as follows (Andriessen, 2011):

- *“There is a causal relation between media reports and suicidal behaviour*
- *The effect of non-fictional suicide is stronger than the effect of media coverage of fictional suicides, the latter still being equivocal*
- *The effect of reports of celebrity suicides is stronger than the effect of non-celebrity suicide reporting, a so-called vertical identification*
- *The suicidal person can potentially identify with the person who died by suicide e.g. similar age, gender and demographic group, a so-called “horizontal identification”*
- *The effect of daily newspaper reports is stronger than television covering of suicide*
- *There is a dose-response effect: the number of imitative suicides increases with the number of reports of the “example suicide”*
- *Some authors conclude that young people can be more vulnerable to imitative suicide, but rigorous review counter speaks this statement*
- *Media portrayals of suicide reflect cultural attitudes towards suicide and vice-versa, in the long term, media portrayals might influence cultural attitudes towards suicide” (Andriessen, 2011)*

In order to improve and strengthen the media’s role in responsible suicide reporting, media awards have been initiated in a number of countries (Andriessen, 2011; Dare et al., 2011).

5. STATE-OF-THE-ART TRESPASS ACCIDENTS

This section deals with trespassing accidents and incidents. The review is based on a subset of papers with trespassing as a theme, whether central or not. Trespassing has been mostly considered in the railway and scarcely in subway contexts. Fourteen papers focus essentially on the consequences of both suicide and trespasses on drivers, providing data about psychological consequences and approaches to mitigate these consequences (Bousfield, 1997; Briem et al., 2007; Burrows & Laflamme, 2007; Clifton, 2011; Tranah & O'Donnell, 1995; Yum et al., 2006; Farmer et al., 1992; Karlehagen et al., 1993; Limosin et al., 2006; Malt et al., 1993; Tang, 1994; Theorell et al., 1994; Tranah & Farmer, 1994).

Trespassing accidents are limited to cases where persons are crossing railway lines at places not marked for that purpose (outside level crossings) or are walking or loitering illegally on the railway tracks or in the railway area outside designated pedestrian areas. Trespassers also include persons driving or leading a bicycle or moped, pushing a pram or cart, skiing etc. It must be noted that when speaking about railway trespassing we refer to unauthorised persons and thus passengers, railway staff, level crossing users or persons attempting suicide are not considered. .

The aim of this review was to explore available information (articles, reports, projects etc.) concerning railway trespassers (both related to observed trespassing) and trespassing involved with injury and fatality. Trespassing is analysed both in terms of fatalities subsequent to trespassing and in terms of identified factors and contexts associated with trespassing. Finally, we review published evidence about anti-trespassing measures and lessons gleaned from potentially relevant closely related fields.

5.1 When most accidents occurred (time of day, weekday, month, year)

5.1.1 Based on trespassing accidents

In general it seems that trespasser fatalities occur most frequently at the end of the week. More specifically, Pelletier, (1997) found that fatality accidents typically occurred on Friday, Saturday and Sunday. The results from a Finnish study show that trespasser fatalities occur most frequently at the end of the week (from Friday to Sunday) (Silla & Luoma, 2012) and the British accident statistics show that over the past 10 years, the greatest number of trespasser fatalities has occurred on a Saturday (Railway Safety and Standards Board, 2011).

Findings on the relation between trespasser accidents and time of day are contradictory. Lerer & Matzopoulos, (1996) found that trespasser fatalities occurred at peak commuting times. This is slightly supported by findings from Finland and the UK. Particularly, the results from a Finnish study reveal that trespasser fatalities in Finland have occurred slightly more often during the afternoon rush hour (between 3 p.m. and 6 p.m.) than at other times of day (Silla & Luoma, 2012). According to the British accident statistics, trespass fatalities show a small peak in the pre-morning rush hour period and another peak in the evening (Railway Safety and Standards Board, 2011). In addition to the previous findings, other results indicate that fatal trespassing accidents occur typically in the evening (Rådbo et al., 2005) and at night (Pelletier, 1997; Rådbo et al., 2005; Railway Safety and Standards Board, 2011) or that the majority of killed and injured trespassers are reasonably evenly spread throughout the day (Patterson, 2004).

It is worth noting that local and nationwide studies might provide different pictures of these phenomena. For example, an analysis of 25 successive rail-pedestrian accidents in the Charleston area over a 10-year period (24) showed that more than 70% of trespasser decedents were killed between 11 a.m and 6 p.m. Furthermore, one third occurred during the months of July and August.

Concerning time of year, the results are also inconsistent. In a Finnish study, trespasser fatalities were fairly evenly distributed by time of year and month (Silla & Luoma, 2012). The months with the least fatalities were February, May and June. Pelletier, (1997) found that in North Carolina fatal trespassing collisions were most frequent during March through August (63%). In Great Britain, April and December are the months with the highest number of total trespass fatalities, with May and June having the lowest number (Railway Safety and Standards Board, 2011).

5.1.2 Based on observations of trespassing behaviour

The results in the previous section were based on analysis of accident statistics. However, as mentioned by (Savage, 2007) analysing the reported incidents and accidents gives only a partial picture of the profile of trespassers and thus consideration of studies investigating the behaviour of trespassers is important.

The results from Finnish trespasser observations (Silla & Luoma, 2009) show that trespassing was most common between 11 a.m. and 7 p.m. and the quietest phase was between 11 p.m. and 6 a.m., when only 2.3% of trespasses occurred. The observations were conducted in three selected sites in one city in Eastern Finland and the trespassers were counted with cameras equipped with motion detectors. The findings from a survey directed at people living close to a railway line showed that 40% of the respondents could not define any specific time of day when trespassing is frequent (Silla & Luoma, 2012). Other respondents had observed trespassing most frequently in the afternoon (38.7%), followed by morning (35.6%), evening (32.6%), noon (23.0%) and night (10.9%).

In a study by daSilva & Carroll, (2011), observations in Palm Beach showed that 70% of 176 trespassing events occurred after noon with the highest number observed during the period between 3 p.m. and 6 p.m followed by the periods 6–9 p.m, 12 a.m–3p.m and 6–9 a.m. The authors report hardly any events from 9 p.m. to 6 a.m.

5.2 Where did trespassing occur (typical places)

5.2.1 Trespassing accidents

Several studies suggest that train-pedestrian accidents occur in urban areas, often in or near a railway station (e.g. Lerer & Matzopoulos, 1996; Lobb et al., 2003; Pelletier, 1997; Savage, 2007; Silla & Luoma, 2012). In general, trespassing seems to concentrate in places where the population density is high and the train traffic is dense.

Pelletier (1997) found that 95% of trespassers were killed in incidents involving a single fatality, and the remaining deaths in incidents involving two.

5.2.2 Trespassing observations and interviews

Based on trespassing observations, most trespasses (70%) were conducted alone and 23.2% in groups of two (Silla & Luoma, 2009). Larger groups were rare. In addition, observations conducted in Finland showed that most trespassers (55,3%) were neither carrying nor having anything with them, 31.7% were carrying their bicycle, 11.3% were walking their dog(s), 1.6% were equipped with poles (i.e. Nordic walking), and a few trespassers had something else like a pram or scooter (Silla & Luoma, 2009).

In a study in the USA (daSilva & Carroll, 2011), the authors analysed video locomotive data from 613 15-minute trips through the city of Palm Beach, representing about 10% of all trips during a 4-month phase between March and July 2005. They observed 176 trespass events involving 230 trespassers. About 34% of trespassing events occurred at a level crossing before or after passage of a train while the gates were in the down position, the rest being observed along the right-of-way at a non-crossing location. Mapping the events with a geobrowser showed that at a general level the trespass problem was present almost everywhere on the line. However, zooming in made it

possible to identify a specific location where almost 40% of right-of-way events at a non-grade crossing occurred. In another observation at a different location, children or teenagers with backpacks were observed crossing the tracks, which the authors interpreted as possibly related to the catchment area of local schools and the substantial distance between grade crossings in that area.

Moreover, based on trespasser interviews the travelling deals with everyday life (Silla & Luoma, 2009). Specifically, most interviewed trespassers were going shopping or jogging or were on their way to school or work. The most frequent railway trespassing occurs especially in cities that are split by railway lines. Railway lines have always divided communities and sometimes more so over the years. The problem is that new developments within a city such as living areas, shopping areas and schools are often located on both sides of the railway line, increasing people's need to cross the tracks.

5.3 How (behaviour and intention with trespassing)

People trespass in the railway area for a variety of reasons (Railway Safety and Standards Board, 2011). Several studies have suggested that the main reason for trespassing is taking a short cut from point A to point B because the authorised route is assessed to be too far away (e.g. Lobb et al., 2001; Railway Safety and Standards Board, 2011; Robinson, 2003; Silla & Luoma, 2009). Specifically, the trespasser interviews conducted in Finland (A. Silla & Luoma, 2009) showed that 80% of trespassers explained that the route was the shortest and fastest alternative (although the official route was not more than 300 metres away). Other answers included ease of using the route because of an existing path (9%), and a developed habit of using a specific route (11%). Many trespassers had used the route for years, and according to them it was easy to use because there were already clear paths across the railway tracks (Silla & Luoma, 2009). Other reasons for trespassing are, for example, related to recreational purposes (walking the dog, taking a walk along the tracks), hanging around (socialising, drinking alcohol, smoking, applying graffiti) or even to committing vandalism or criminal activity (such as cable theft or fare evasion). In a paper dedicated to graffiti and vandalism on railway property, Thompson et al., (2012) reported that in the UK, published data suggest that up to 90% of offences on rail property have been conducted by young people, primarily on weekends or after school. They are committed mostly by males between the ages of 12 and 25. Areas with low socio-economic status are often the most targeted, although this does not reflect on the socio-economic background of the perpetrator (Thompson et al., 2012).

Based on several focus groups with children from 7 to 18 years old with an experience of trespassing, a study carried out in the UK (Rail Safety and Standards Board, 2006) has shown that for most of them, thrill seeking is not the motivation nor is trespassing a deliberate goal. In this study, the participants gravitated towards rails because it offered somewhere to go. For younger children, it represented a play area (especially when next to a park or woods, where it was simply seen as an extension of that space); for old teenagers, it offered the opportunity for some private space, away from adults. The authors also reported that the associated dangers and risk of the rail environment were largely unperceived, i.e. even if there was some perception of the severity of risk, there was little or no awareness of the extent to which they as an individual were themselves at risk.

Based on the studies no consensus exists on the pre-crash behaviour of railway trespassers. It is difficult to draw any conclusions on this issue due both to the contradicting results and to the different categories used to classify behaviours. In general, the most common behaviours are related to walking or crossing the railway tracks and lying/standing/sitting on the tracks. More specific findings from the previous studies are presented in the following. (Pelletier, 1997) reported that most trespasser fatalities involved pedestrians who were lying (31%), walking (20%), sitting (18%), crossing (8%), or standing (5%) on or adjacent to railway tracks. Among the 25 trespassing fatalities in a 10-year period in Charleston County (USA), most of the decedents were sitting or

lying on the tracks and three persons were killed trying to run across the tracks ahead of a train while intoxicated (Cina et al., 1994).

According to Silla and Luoma, (2012) trespasser fatalities occurred most frequently in situations when a person was crossing the tracks (38.5%) or lying/sitting (34.6%) on the tracks (Silla & Luoma, 2012). Rådbo et al., (2005) found that 53.3% of victims in trespasser fatalities were standing or walking on the tracks. Savage (2007) in turn found out that 29.8% of victims in casualties related to train-pedestrian collisions were walking or running, 22.9% were lying down or sleeping, 7.5% were standing, bending or stooping and 7.4% were sitting.

Davis et al., (1997) evokes more specifically the recent use of freight trains by illegal immigrants as transportation within the USA.

5.4 Who (gender, age, medium age)

Many studies have shown that trespassers involved in accidents are usually adults and males (e.g. Centers for Disease Control, 1999; George, 2007; Patterson, 2004). More specifically, many studies suggest that adults are the biggest trespassing group (e.g. Centers for Disease Control, 1999; Patterson, 2004; Pelletier, 1997; George, 2007). However, there are also results supporting that youngsters are a big group among trespassing victims (Lobb et al., 2003; Railway Safety and Standards Board, 2011; Savage, 2007). In addition, youngsters are considered as frequent trespassers based on the assessment of people living close to a railway line in one city in Finland (Silla & Luoma, 2011). The accident data from several countries suggest that peak ages for trespass fatalities are the late teens and early twenties (Railway Safety and Standards Board, 2011; Savage, 2007; Silla & Luoma, 2012). Trespasser fatalities involving children often receive a great degree of media attention and thus in public discussions children are often considered to be at particular risk. However, Savage, (2007) found that in the USA children under the age of 10 represented only 2.2% of trespasser casualties (including fatalities and injuries). The share of children in trespasser fatalities was 2.9% in Finland (share of children under the age of 10) (Silla & Luoma, 2012) and around 5% in Great Britain (share of children under the age of 16) (Railway Safety and Standards Board, 2011).

Concerning gender, based on collected trespassing data males trespass more frequently than females (e.g. Lobb et al., 2001; Rail Safety and Standards Board, 2005; Silla & Luoma, 2009). Men are also predominant among the victims of trespassing accidents (e.g. Centers for Disease Control, 1999; George, 2007; Patterson, 2004; Pelletier, 1997; Rådbo et al., 2005; Matzopoulos et al., 2006; Cina et al., 1994; Ozdoğan et al., 2006).

Based on collected data in the USA, George, (2007) found slightly different patterns of peak age for men and women. Men trespasser deaths exceed the population percentage after 20 until 54 whereas there appears to be an early peak for women between 15 and 19. Moreover, the highest peak for women is found between 35 and 39 whereas it observed between 39 and 44 for men.

5.5 Drugs/alcohol

Based on several studies many killed trespassers were intoxicated with alcohol or drugs (e.g. George, 2007; Lerer & Matzopoulos, 1996; Patterson, 2004; Pelletier, 1997; Silla & Luoma, 2012). Specifically, the amount of intoxicated accident victims was 56.7% in the USA (George, 2007), 69% in Finland (Silla & Luoma, 2012), 100% in Turkey (Matzopoulos et al., 2006) and 78% in North Carolina (Pelletier, 1997). In addition, Cina et al., (1994) reported based on the analysis of 25 consecutive train-pedestrian incidents that 87% of the decedents had ingested alcohol, and 80% had a blood ethanol level equivalent to or greater than 99mg/dl.

As indicated by Pelletier, (1997) the physical and mental impairment associated with alcohol use may increase the likelihood that a trespasser will be struck by an approaching train.

5.6 Trespassing accident prevention (technical/physical and soft measures)

Preventing trespassing accidents supposes the development of adequate strategies to address the various factors (both internal and external) that come into play at each step of the process of accident occurrence. Such strategies often involve the coordination of technical/physical measures (e.g. fences obstructing access to rail tracks, video-based monitoring systems), social measures (e.g. persons, organisations in the community), and behavioural measures (e.g. information campaign devoted to risks of crossing or playing on the tracks, electric shock, etc.).

There are a wide amount of measures proposed in the literature regarding trespassing with non-suicidal intent. These measures are often divided into the two simple following categories: technical measures and non-technical (or soft) measures (e.g. Thompson et al., 2012).

5.6.1 Technical/physical measures

Technical and physical measures correspond to physical or technological artefact dedicated to trespassing prevention. Typically, technical measures include:

- Enhancing train visibility/ conspicuity (Horton, 2009)
- Fences (e.g., Law & Yip, 2011; Silla & Luoma, 2011; Lobb et al., 2001; daSilva et al., 2006)
- Landscaping (Silla & Luoma, 2011; daSilva et al., 2006)
- Protected gates, cattle grids at potential point of entries
- Closed-circuit television (CCTV) possibly in association with other technologies like Video Motion Detectors (VMD), automatic triggered voice message (e.g. daSilva et al., 2006; daSilva & Carroll, 2011 see also technical reports from previous Rail Safety and Standards Board projects¹);
- Flashcam
- Public announcement and voice alarm systems (e.g. daSilva et al., 2006)
- Etc.

5.6.2 Soft measures

Soft measures are typically:

- Signage, posters (e.g. Rail Safety and Standards Board, 2006; Lobb et al., 2001)
- General mass media prevention campaigns (e.g. Lobb et al., 2003)
- Local targeted prevention campaigns (e.g. Lobb et al., 2001)
- Intervention at schools and provision of educational materials (e.g. Lobb et al., 2003)
- Reward or punishment (Lobb et al., 2003)
- Attendance of station staff or security personnel

As put by Offler et al., (2009) in the context of vandalism and graffiti prevention on railway property, “*Technical measures exist, however, within a social context through which they are made meaningful to individuals and groups*”. These authors report a clear illustration of this as the successful experience of a northern UK bus company in reducing vandalism by installing real and fake surveillance cameras in buses in conjunction with an education and media campaign. Consequently, it is often claimed that both technical and soft measures often have to be organised in order to mutually enforce their respective effect (Thompson et al., 2012; Hoekstra & Wegman, 2011). Despite this, there is heavy reliance on technical approaches whereas multi-faceted and

¹ In particular, see: Rail Safety and Standards Board (2004). T061b Getting the best use out of CCTV in Railways: Existing systems: Kingston University, Mott MacDonald, Ipsotek Limited; Rail Safety and Standards Board (2004). T061d Getting the best use out of CCTV in Railways: New and emerging CCTV technology: Kingston University, Mott MacDonald, Ipsotek Limited.

collaborative approaches with technical and non-technical (social) measures would be more effective because of their mutual reinforcements.

5.6.3 Evidence from the literature

Finally, many of these measures have been implemented in different countries, although few empirical evaluations of their effectiveness have been published so far. There is still little research published evaluating the efficacy of interventions targeting trespassing accidents (Clarke, 1994; Silla & Kallberg, 2012). Such a lack of empirical evaluations is however the case in several analogous domains, e.g. road safety (Hoekstra & Wegman, 2011).

Only four papers report on evaluation using observation or experimental design to assess the contribution of one or a set of measures dedicated to trespassing prevention² (see Table 2).

Table 2. On overview of measures tested in published field experimental studies

References	CCTV	Fences	Landscaping	Anti-trespassing signage, poster	Radio/TV/ newspaper campaign	At school/ at work educational intervention	Distribution of leaflets	Warning / walk-out vocal message	Punishment, fine	Design	Time span of data collection
Silla & Luoma (2011)		X	X	X						Independent testing	6 weeks
DaSilva, et al., (2006)	X							X		One single site	3 years
Lobb, et al., (2001)		X		X		X	X			Successive introduction	3 months
Lobb, et al., (2003)					X	X			X	Successive introduction	8 months

We have also found two studies that estimate the effectiveness of various measures based on reports and accident statistics (Horton, 2009; Savage, 2007).

The following section reports on the main results found in the current literature on rail anti-trespassing. Target factors and/or steps should be clearly identified to support both the design of the measures and their assessments, as well as the target audience and its characteristics. Measures can thus also be categorised according to the factors and/or step of actions leading to trespassing accidents they are supposed to influence.

Problem solving system/collaborative approaches

The seminal C.A.R.E (Community, Analysis, Response and Evaluation) approach developed in Canada is a step-by-step approach to trespass prevention and mitigation. This approach promotes stakeholders' involvement and commitment, the effective use of resources to identify root causes of trespassing in a community, and better communication to the right target audience. In the vein of this approach, several authors have argued for the adoption of a system and collaborative

² Studies on obstructive measures for suicide prevention are reported in the dedicated section.

approach to address rail and road safety issues (daSilva & Carroll, 2011; Offler et al., 2009; Delhomme et al., 2009; Rådbo et al., 2008). These approaches aim to disseminate good practices as well as evidence-based knowledge by way of guidelines and process models adapted to solving trespassing problems in a specific location and community³.

Technical and physical solutions

Although there is a plethora of technological propositions, there is in fact very little evidence about their effectiveness on trespassing.

The study by daSilva et al., (2006) sought to show the contribution of a stand-alone video-based trespass monitoring and deterrent system. The system was placed for 3 years on a railroad bridge known for frequent trespassing. The authors report at least four cases during this time when the intervention thus initiated prevented a train-pedestrian collision. Additionally, the system provided evidence about trespassers' profiles in contrast to *a priori* opinions by local stakeholders. A video system, beyond providing a potentially deterrent or reactive system to trespassing, also has the advantage of providing evidence about trespassing behaviour in the concerned area. For example daSilva et al., (2006) showed trespassing incidents involving mostly either adults or a combination of adults and small children using the bridge as a shortcut, whereas local opinion was that local teenagers used this particular site as a gathering place (daSilva et al., 2006).

Fencing and landscaping have been demonstrated to be the most effective ways to reduce trespasses in a field experiment carried out by Silla & Luoma, (2011). They report that trespassing was reduced by 94.6% by fencing and 91.3% by landscaping.

In addition, Horton, (2009) has shown that for a specific level crossing in the USA, measures related to enhancing the visibility of trains helped decrease the number of trespassing accidents.

Campaigns

Campaign measures can be defined as any purposeful attempts to inform, persuade and motivate a targeted subgroup of the population to change its attitudes and/or behaviour to improve rail safety, using organised communications, and involving specific media channels over a given time period. A campaign can thus have many purposes, e.g. informing the public of new or little known rules, increasing problem awareness or convincing people to refrain from hazardous behaviours and adopting safe ones. There are also possibly numerous approaches both in terms of message and format, e.g. humour, sensible argumentation or fear appeals. The Internet and news media are increasingly involved in campaigns dedicated to young people⁴. Examples of practical implementations of these kinds of campaigns are the *Stay Off the Tracks* and *Trains Move Faster Than You* campaigns implemented in Australia. The *Stay off the Tracks* campaign was implemented in 2006/2007 by the Public Transport Authority of Western Australia (PTA) to address the rising incidence of trespass and antisocial behaviour on Perth's Armadale train line. From the commencement of the programme in October 2006 through to the end of April 2007, the average number of incidents on the Armadale Line fell from 8.2 per week to as low as three per week before coming back up to 4.5 per week. Over the 28 weeks of the campaign, trespass averaged 5.3 incidents a week, 24% lower than the seven per week recorded in the previous corresponding

³ Examples of Guidelines are : Trespassing on Railway Lines : A Community Problem-Solving Guide: Direction2006 (www.direction2006.com/documents/pdf/en_TrespGuide2003.pdf); RSBB. (2005). Controlling trespass and access from the platform end : a guide to good practice (http://www.rssb.co.uk/SiteCollectionDocuments/pdf/reports/research/T322_guide_final.pdf); Rail Safety and Standards Board (2008) T062a Evaluation handbook for route crime and other initiatives. Evaluation Quick Guide (http://www.rssb.co.uk/RESEARCH/Lists/DispForm_Custom.aspx?ID=323).

⁴ See for example : France (<http://ww.jouepasaucon.com>), Australia (<http://stayoffthetracks.com.au>)

period. At the same time, trespass on Perth's entire rail network dropped by 14%, suggesting the broad media campaign also had an effect of other line users. Due to the campaign's success, it is now being rolled out on all other Perth rail lines. In 2012, a hard-hitting campaign to improve public awareness and safety on Transperth rail networks was launched by the Transport Ministry of Western Australia: The *Trains Move Faster Than You* campaign is aimed specifically at improving safety at pedestrian crossings and minimising the trauma for rail staff who witness a serious accident or near miss on the tracks. The campaign includes a dedicated Facebook page (<http://www.facebook.com/stayoffthetracks>), cinema advertising and educational resources (<http://www.righttrack.wa.gov.au>). Furthermore, the *Trains Move Faster Than You* campaign coincides with the establishment of a national rail safety foundation, known as trackSAFE, launched in Sydney.

Campaigns alone seem to have no effect and should be combined with other measures like enforcement and/or education, at least in the domain of road safety, as shown by several meta-analyses (Hoekstra & Wegman, 2011; Delhomme et al., 2009; Elvik et al., 2009). This result has also been reported in the domain of rail safety in a single study (Lobb et al., 2003). After the first phase of their intervention based on general communications about rail safety, they observed no significant decreases in unsafe crossing either in adults or children.

In the domain of rail safety, Operation Lifesaver is well known as a non-profit, international, public education programme (originally from the United States) to prevent collisions, deaths and injuries at highway-rail grade crossings and on railroad rights-of-way. Savage (2006, 2007) analysed annual data related to the number of collisions and fatalities at crossings in 46 US states from 1996 to 2002, and show that increasing the amount of educational activity (Operation Lifesaver) reduces the number of collisions, but the effect on the number of deaths cannot be concluded with statistical certainty. Horton (2009) showed globally that the Education & Enforcement factor (including the Lifesaver campaign) is one of the ten factors that have contributed to the decline of accidents in the USA from 2003 to 2007, while recognising that it is difficult to quantitatively analyse such factors.

It has been empirically demonstrated that the association of environmental intervention (fencing repairs), educational campaigns (talks in schools and factories, leaflet distribution) and new warning signs and posters has resulted in changing the occurrence of unsafe track crossing behaviour (instead of using an overpass) from 65% to 37% for adults and from 47% to 34% for children (Lobb et al., 2001).

Educational interventions and material

In addition to media campaigns, interventions are also carried out in schools or factories located near tracks or other places related to trespassing. They are usually performed by persons from the railway organisations, or by researchers interested in evaluating the effect of this type of measure. However, evaluations of the effect of these interventions remain scarce, although they have been studied in conjunction with other measures.

Lobb et al., (2003) have evaluated empirically the effect of several soft measures. The measures were introduced sequentially. Rail safety education in school, punishment for every unsafe crossing (continuous punishment), and occasional punishment for unsafe crossing (intermittent punishment) were associated with significant decreases in unsafe crossing compared with that observed prior to any intervention. Unsafe crossing was significantly reduced after the education phases, and even more so after continuous punishment. Although it is difficult to separate the individual effect of each measure, the authors concluded that punishment may be more effective in reducing unsafe behaviour in this type of situation than targeted education, and is much more effective than communication to heighten awareness.

It is worth noting that in some countries, railway safety educational resources are offered to schools and organisations working with children and young people. These resources are aimed at supporting classroom activities through the national curricula⁵.

Signage

We have found only two studies specifically dedicated to anti-trespassing signage. One study (Rail Safety and Standards Board, 2006) performed qualitative assessment of four platform-end signs as possible replacements for existing ones, and tested messages associated with them. The objective was to establish the effectiveness of anti-trespass signs and patterns of unauthorised access to the railway, especially by young people. The project sought to establish the extent to which the existing policy in regard to the placing and nature of 'Do Not Trespass' signs is effective, and to explore how the efficacy of these signs might be improved by alternative policies as to their placement and design. The method was based on focus groups and discussion in school classes. Several proposals for signage designs were realized based on improvements suggested during an initial focus groups study. Eight classes from different schools participated in the study. The tested images and messages were used by teachers to guide discussion with individuals and among groups in class concerning the meaning and effectiveness of the various symbols and messages. Although no quantitative data are reported, the feedback from teachers suggests that the new signs were no more effective than existing ones. A preference was found regarding one of the messages.

A more quantitative approach characterised the study by Silla & Luoma, (2011), which showed through a field experiment that prohibitive signs alone resulted in a decrease in trespassing of 30.7%.

5.6.4 Lessons from closely-related fields that could apply to rail trespassing

Road safety campaign effectiveness conditions

Research on the effectiveness of road safety campaigns can provide interesting insights for consideration when pondering the development of soft measures to address railroad trespassing issues. Some reports have addressed this issue by carrying out a review of existing evidence and/or best practices in closely related fields in order to establish possible transfer to railroad trespassing issues.

It has been shown (Hoekstra & Wegman, 2011; Elvik et al., 2009) that mass media campaigns have virtually no effect if they are not combined with other measures like enforcement and/or education. For example, the biggest effect on road accidents has been observed with local and personally directed campaigns, although the confidence interval – due to the very few number of these studies – provides uncertainty as to the real value of the result.

What can we learn from this field regarding the effectiveness of mass media campaigns?

Hoekstra & Wegman, (2011) underline that the effectiveness varies widely depending on the targeted safety behaviours, due to characteristics of the behaviour and of the audience:

1. The effectiveness depends on the current baseline of the target behaviour to be influenced, i.e. as the base measure of the behaviour increased, the expected impact and improvement as a result of a mass media campaign is reduced.
2. The effectiveness seems also to be strongly influenced by whether or not suitable alternatives to the target behaviour can be provided to the audience to deal with the dangers that a behaviour presents (as an illustration in the field of road safety, there is no

⁵ See for example: UK (<http://www.trackoff.org>), France (<http://www.sncf.com/education/sensibilisation-citoyennete-securite-cm1-cm2>), Australia <http://www.righttrack.wa.gov.au/Teachers/tabid/63/Default.aspx>).

suitable alternative to speeding except not to engage in this behaviour, whereas there are suitable alternatives to drinking, like having a non-drinking driver or using alternate modes of transport).

3. The combination of publicity with other measures such as enforcement, education, personal communication etc. also has different effects depending on the type of targeted behaviour.
4. The effectiveness of fear-appeal is not straightforward and remains controversial, because if it is correct that "Fear can motivate people, it can also have the opposite effect by leading people to employ so-called defensive responses (e.g: discounting the veracity of the claims, considering that the campaign bears no personal relevance to oneself or even avoiding exposure to the campaign." Individual and sociological characteristics can indeed mediate such effects, like:
 - Gender: Women tend to respond more favourably to fear-appeal than men. Young males, especially, seem to have little susceptibility to fear-appeal (Goldenbeld et al., 2008; Lewis et al., 2007).
 - Self-efficacy: When self-efficacy is low, people are usually more likely to show the defensive reactions to fear-appeal that render them ineffective.
 - Perceived threat: Refers to the extent to which people believe themselves to be in any danger of the shown consequences. Fear-appeal would have a chance to work if people felt that the consequences shown were relevant to themselves.
 - Cultural issues: Depending on the country, there can be a tradition of road safety advertising with emphasis on humour rather than fear (as in the Netherlands) or, by contrast, such as in Australia, New Zealand, the USA and the UK, explicit images of crashes, casualties, injuries and blood, and the related emotions of pain, sorrow and grief of victims and relatives.
 - Changing responses of population groups to campaigns: There are evolutions of behaviour or attitude among some groups of people which may imply changing responses to campaigns. In the domain of road safety, for example, some evidence has been found that underage female drivers have become more vulnerable to some risk-taking driving behaviours (Romano et al., 2008).

Furthermore, it has been shown that identifying the exact purpose as well as the target audience is thus critical to providing a clear basis for both the design of measures and their assessment (Hoekstra & Wegman, 2011; Delhomme et al., 2009). Also, careful pre-testing is required to determine what possible effects a particular approach or combination of approaches may have on the behaviour at hand, and for clearly specified target group(s).

Theories related to behavioural changes (references in this chapter are not currently included in the reference list

There is interesting literature on how to lead individuals to change their risky behaviour themselves. This field of research dedicated to behavioural changes has given rise to several theories that provide grounding and evidence to support the design of more efficient campaigns and communication strategies. These theories can be organised into three main types:

- 1) Theories that identify which variables can predict risky behaviour.
- 2) Theories that explain how information presented in a message is processed by the targeted individuals
- 3) Theories that explain at which stage in the behavioural changing process the targeted individuals are

A theoretical model can be both explanatory and descriptive, capturing the main variables that increase the chances of getting targeted individuals involved by capturing their motivations and modifying their risky behaviour.

Theories to identify which variables can predict the risky behaviour.

Different theories have been developed to try to predict behaviour with very few factors such as the Theory of Planned Behaviour, Interpersonal Behaviour, the Health Belief Model, and the Protection Motivation Theory. Among them, the Theory of Planned Behaviour (TPB) is the most often used. The TPB states that behavioural intentions can predict behaviours (Abraham et al., 1998; Gollwitzer & Moskowitz, 1996), while attitudes, subjective social norms, and perceived behavioural control are the moderators of the relationship between intention and behaviour (Ajzen & Madden, 1986). Attitudes toward a specific behaviour refer to a person's positive or negative evaluations about a targeted behaviour. Subjective social norms refer to perceived social pressure in terms of adopting or not the targeted behaviour. Perceived behavioural control refers to the individual's resources and abilities to perform the behaviour, but also the available opportunities and the importance of achieving one's objectives.

Evidence has shown that TPB offers good predictions (Ajzen, 1991) of behaviour and behavioural intentions. According to a meta-analysis by Armitage & Conner, (2001), of 185 studies, the TPB explains 27% of behaviour and 39% of behavioural intentions. To increase the prediction of behaviour and behavioural intentions, additional factors such as behavioural expectations (Sheppard et al., 1988), personal identity (Sparks & Guthrie, 1998), moral norm (Elliott & Thomson, 2010), and past behaviour (Aarts & Dijksterhuis, 2000) have been added to the TPB factors.

It is clear that these theories have been put forward to account for and predict human behaviour. The theories are generally very similar despite different terminology. What is important to know is that to increase the prediction of the behaviour or the intention — therefore to identify the main motivations for the risky behaviour — one has first to adapt the factors used in the models to the targeted individuals and to the context where the risky behaviour happens, and second to add supplementary factors specific to the context and/or the targeted individuals (perceived risk for themselves and others, affect, physiological measures, personality factors such as sensation seeking, habits, etc).

Theories that explain how information presented in a message is processed by the targeted individuals

Attitudes can be changed in many ways and some people are more susceptible to change than others. Persuasiveness can be described as the ability to induce in someone a belief with which they initially disagreed, and to convince them to do something different.

The previous theories have put forward an effort to identify the main motivations to attain to change the risky behaviour. However, these theories do not mention how to present the information or how to convince an individual to change his/her risky behaviour. To improve our understanding of how to proceed, one needs to refer to specific theories of information processing which refer to how the individual analyses the message, and what information the individual is capable of retaining and reproducing. The most often used model is the Elaboration Likelihood Model (Petty & Cacioppo, 1986). The probability that the individuals change their attitude mainly depends on the two following factors:

- The motivation to process the presented information
- The capacity to process the information (time and modality of information presentation, etc.)

If individuals are motivated and capable of processing the information, they will process it in a systematic or in-depth way (central route) and thus focus on the arguments linked to the content of the message.

Conversely, if individuals are not motivated and incapable of processing the information, they will process it in a superficial or unsystematic way (peripheral route) and focus on the arguments linked to the shape of the message (logo, source).

Overall, this model allows us to choose from among several messages the one that leads to a more systematic processing of its content. To identify it, the listing task of thoughts helps us to know which type of information processing has been involved.

Theories that explain at which stage in the changing process targeted individuals are situated

In addition to theories that try to explain and predict behaviour, as well as theories attempting to account for persuasion, there are theories accounting for the process of change itself. In order to change their risky behaviour and maintain their new behaviour, it is required that individuals go through different stages.

Thus before training to modify a behaviour, it is important to know whether this behaviour is adopted in a deliberate manner or not. According to the type of behaviour, it is possible that individuals are not aware of the fact that they are adopting a risky behaviour (so no intention to change = PRECONTEMPLATION stage).

They can be aware (CONTEMPLATION) and then decide to change their behaviour (planning, intention = PREPARATION), and adopt the new behaviour (change = ACTION). The behaviour is maintained, and can become a habit (MAINTENANCE) in order to stabilize itself (TERMINATION).

The Trans-theoretical Model of Change was developed by (Prochaska & DiClemente, 1982), who outlined six stages that individuals go through before a new behaviour can be firmly established. The approach clearly emphasises the importance of matching an intervention to the different needs of individuals. The stages are as follows:

- 1 **Pre-contemplation** – The individual has no intention to change his/her behaviour and may even resist change.
- 2 **Contemplation** – The individual starts to become aware of the problem, with the costs and benefits of the old behaviour being equal.
- 3 **Preparation** – The individual has begun preparations for change.
- 4 **Action** – Change has occurred but the risk is still high that the individual will return to previous behaviour patterns.
- 5 **Maintenance** – The new behaviour has started to become a habit.
- 6 **Termination** – The new behaviour is established and the individual is not likely to return to the old behaviour.

It is possible to go back to the previous stage. This model allows us to identify the change stage in which individuals are in order to act in a more appropriate way.

These models can be used to predict trespassing behaviours to act directly on violators. However, to prevent railway suicides, these models could be useful for the entourage (family, friends, colleagues...) to act indirectly.

These theories could be considered when a risky behaviour has been identified on railways. An important step is to establish whether the targeted behaviour is non-deliberate — that is to say that it can be due to a lack of knowledge about the encountered risks associated with the behaviour. In this case, a possible (and quite simple) response would be to bring the individual information on this problem in order to convince them to change their behaviour by themselves. However, in many other cases, the problem behaviour is volitional (intentional mistakes and/or violations), so the individual chooses to commit an unsafe act. It is then necessary to identify what motivates them to adopt such trespassing. The best way to identify this is to refer to theoretical models regarding the change of risky behaviour.

6. TRAIN-PEDESTRIAN COLLISIONS

6.1 Difficulties classifying train-pedestrian collisions

As stated in the task 1.3 working paper (*Plan for collection of data concerning railway suicides and trespassing accidents*) of the RESTRAIL project the classification of train-pedestrian collisions is frequently challenging. The challenge is that in many cases there is insufficient information to make a definitive classification (Mishara, 2007). In addition to practical issues (such as insufficient information), the accurate identification of railway suicides can be tricky due to the social, legal, financial or ethical implications of assigning suicide as a cause of death (Lobb, 2006). In Australia, for example, due to the social stigma associated with suicide and attempted suicide the coroners may prefer to assign the fatality as a suicide only if they have strong evidence of it (Bureau of Transport and Regional Economics, 2002). From the European Railway Agency, (2011) it is known that the Member States use different methods for establishing whether a fatality is a suicide or not. Because such a classification is needed for statistical purposes, the European Railway Agency, (2008) has developed guidelines for distinguishing suicides from trespassing accidents. The guidelines include the following issues: suicide note, clear statement of suicidal intent to an informant, previous suicide attempts, prolonged depressions or instability; that is, a marked emotional reaction to recent stress or evidence of failure to cope (such as a breakdown). Based on the guidelines, each of these mentioned issues, on its own, may be treated as evidence of suspected suicide.

6.2 Annual ranges of documented railway suicides and fatalities related to railway trespassing in different countries

Large differences appear to have emerged in the ratio of suicide relative to other trespassing accidents, depending on the moment and the country. In some countries the ratio of suicide remains quite low compared to other types of trespassing accidents.

Cina et al., (1994) reported one single case of suicide over 25 consecutive train pedestrian fatalities (i.e. 4%) in Charleston County between 1982 and 1992. George (2007) reported about 23% of suicide among all rail-pedestrians fatalities between 2002 and 2004 in the USA. These low levels can however be partially explained by the fact that "In the absence of historical or physical evidence suggestive of suicide or homicide, deaths are considered to be accidental, albeit victims are often at fault" (Cina et al., 1994).

Suicide represented about 9% of the 340 railway-related deaths with identified cause/intent between April 1992 and September 1994 in the Cape Town area of South Africa (Lerer & Matzopoulos, 1997), most of the cases being related to pedestrians or commuters who were hit by a train while crossing the track (i.e. 67%) but also violence (8%). Data from Turkey (Ozdoğan et al., 2006) show a similar pattern with train-pedestrian accidents identified as the leading cause of death (42% of fatalities) followed by level crossing accidents, with suicide in third place.

There are other countries with a high suicide ratio over other trespassing accidents. Rådbo & Andersson, (2012) report a ratio of suicide declaration by the police between 75% to 93% of all rail-pedestrian fatalities in Sweden. In France, 83% of fatalities related to rail-pedestrian accidents are suspected suicides for the period 2010 and 2011 (SNCF-DCF, cf. data collection annex A) In Finland, during a 5-year observation period, 84.9% of train-pedestrian fatalities were classified as suicides (Silla & Luoma, 2012).

6.3 Mortality rates

Train-pedestrian collisions often result in massive injuries and have a high mortality rate (Ozdoğan et al., 2006). According to a paper by Ozdoğan et al., (2006) this is due to the enormous amount of energy transferred to the body of a person when they are hit by a train. The consequences are massive since trains are heavy, frequently move fast and cannot stop quickly.

Reports from different European countries suggest that case fatality of railway suicides is extremely high, about 90% (Erazo et al., 2004a; Kerkhof, 2003; Ladwig et al., 2009; Schmidtke, 1994). On the other hand, the case fatality of metro/underground suicides is lower, ranging from 42% in Hong Kong to 55% in London or 66% in Munich, Germany (Gaylord & Lester, 1994; Ladwig & Baumert, 2004; O'Donnell & Farmer, 1994). Differences can likewise be seen with regards to mortality in terms of where railway suicides occur, i.e. whether the location is within an urban setting or on an open line (Erazo et al., 2005).

The severity of injury is also dependent on the location selected. On open lines, more severe injuries occur compared to events occurring closer to platforms and stations. This also correlates to a gender aspect, with men more often committing suicide on open lines and women within station areas (Schmidtke, 1994; Erazo et al., 2005). On open lines, 6% of the suicide attempters survived, while 16.2% survived within station areas (Erazo et al., 2005).

The results of a Turkish study (Ozdoğan et al., 2006) show a mortality rate for train-pedestrian accidents of 60.5%, and for railway suicides of 82.5% (similar to those reported in earlier mentioned studies). The results of a study conducted by Pelletier, (1997) show that 88% of victims in trespasser fatalities died at the scene of the collision and those who were transported for medical care lived for a median of 3 hours.

6.4 Consequences

The consequences of train-pedestrian collisions have been observed in some studies with regards to the effect on train drivers, other professional groups and witnesses (Abbott et al., 2003). A French study has, based on a large sample of 202 train drivers, (Limosin et al., 2006) shown that drivers felt unable to handle the situation and needed accompanying by another driver in order to continue. Two thirds of the drivers took days off work following the event. One to 15 days after an event, many of the drivers who “had experienced a ‘person-under-train’ accident experienced acute psychological disturbances” such somatic problems, anxiety, sleep disruption, and sometimes social disturbance problems (Limosin et al., 2006). Another French study (Cothereau et al., 2004) dealing with 186 train drivers concluded that most of the psycho-behavioural disorders in train drivers were observed in the immediate aftermath of the “person-under-train” accident and disappeared in less than 1 year. Due to these accidents nearly 70% of the drivers were given temporary sick leave. The average length of this leave was short (4.4 days). Based on the results of Cothereau et al., (2004), the occupational future of drivers does not seem affected by having experienced “person-under-train” accidents. Limosin et al., (2006) in turn found that after 15 days there were no significant differences observed between “person-under-train” drivers and control drivers. These different aspects also have consequences for IM and train operators with employed personnel, as to how the employer should deal with “person-under-train” train drivers.

Studies have also looked at drivers who experience more than one accident. Drivers with two or more previous accident experiences, as well as those who were worried about being involved in accidents, showed the greatest symptoms of distress at follow-up (Karlehagen et al., 1993). “Person-under-train” accidents are traumatic to engine drivers who in most cases see the victim alive before the accident and the body afterwards (Cothereau et al., 2004). In a UIC report,

comprehensive work is being done to inform about what a post traumatic event is, how it may trouble train drivers when witnessing a railway suicide and necessary factors to deal with in this specific situation (Clifton, 2011). This guide was prepared by a working group under the supervision of the UIC Safety Platform's Occupational Health and Safety Group (OHSG). The working group brought together psychologists, occupational physicians, ergonomists, safety experts, managers and safety directors. It is the fruit of interdisciplinary collaboration, marrying the concerns, needs and knowledge of railway undertakings and infrastructure managers from a variety of European countries (DB AG, Infrabel, SNCB, SNCF, Southeastern Railways) (Clifton, 2011).

In addition to train drivers, train-pedestrian fatalities can cause work-related stress and trauma for other railway staff and rescue employees, and trauma for families of the deceased and witnesses to the event (Mishara, 2007; Rådbo et al., 2005). Fatalities due to train-pedestrian collisions affect IM and/or railway operators also in other ways. The costs related to property such as damage to the train, rolling stock and tracks or to the railway environment are dealt with in this review. There is also a lack of information about the amount of delays (primary and secondary) and their costs to rail operators. Furthermore, train-pedestrian collisions (similar to all railway accidents) cause considerable costs to society in terms of human costs (such as value of lost life, lost labour, medical costs and lost quality of life) and other costs (such as value of lost time, emergency services costs, coronial costs and insurance administration and legal costs) (Bureau of Transport and Regional Economics, 2002).

7. DISCUSSION AND CONCLUSION

The purpose of this review was to provide a systematic and critical description of current knowledge concerning railway suicides and trespassing accidents, and to describe and review the methods and tools for the prevention of such incidents.

The review has highlighted some differences and similarities between railway suicides and trespassing accidents. The main differences are related to:

- Motivation of the person(s) involved in the event. As opposed to trespassing accidents with no suicidal intent, railway suicides involve persons intentionally putting themselves in a situation where they would be struck by a train. Railway trespassing can be motivated by several factors such as taking a short cut, using the railway area for recreational purposes (e.g. walking a dog, taking a walk along the tracks), using the railway area for specific group related activities (e.g. playing, socialising, drinking alcohol, risk seeking), fare dodging and escaping or to conduct criminal activities (e.g. metal theft, vandalism etc.). Railway trespassers fall roughly into two groups: (a) those who lack knowledge about encountered risks associated with trespassing and (b) those who choose to commit an unsafe act (even though aware of the risks).
- Victim's profile in terms of mental health and intoxication. Specifically, the victims in trespassing accidents are more frequently intoxicated than in suicides (e.g. Badiadka et al., 2010; George, 2007; Lerer & Matzopoulos, 1996; Patterson, 2004; Pelletier, 1997; Silla & Luoma, 2012)). In contrast, suicide victims suffered from mental health problems much more frequently than victims of trespassing accidents (e.g. Badiadka et al., 2010; Silla & Luoma, 2012).
- Behaviour of victims. Railway suicides are characterised by victims awaiting trains for some time in the vicinity of the track before the train arrives (De Leo & Kryszynska, 2008; Dinkel et al., 2011; Rådbo et al., 2005; Rådbo & Andersson, 2012; Silla & Luoma, 2012) whereas trespassing accidents occur most often in situations when a person is crossing the track (Rådbo & Andersson, 2012) (Silla & Luoma, 2012) walking in the wrong direction (Rådbo et al., 2012).

The main similarities of railway suicides and trespassing accidents are related to gender and location: the victims of railway suicides and trespassing accidents and observed trespassers are all mostly men, and most of the railway suicides and trespassing accidents occur in densely populated areas.

There is a subset of common preventive measures that can be used to prevent both railway suicides and trespassing accidents, even though their effectiveness may depend on the target group due to their different motives. In fact, knowing that both railway suicides and trespassing accidents occur in densely populated areas makes it possible to apply the same measures for preventing both railway suicides and trespassing accidents. An example of this is physical measures obstructing access to the tracks such as building a fence or landscaping. Physical measures have proven to be effective in preventing railway trespassing and might also have an effect on suicidal persons since such measures (i.e. barriers) make a suicide attempt more complicated. Of course, there is the possibility that a suicidal person will move to some other location with easier access to the railway tracks, but it is also possible that he/she will realise the irrationality of the act and decide not to commit it (e.g. Rådbo et al., 2005).

Other measures are specific to one of the two targets — suicide or trespassing. For example, measures dedicated to suicide prevention are not expected to affect trespassing accidents and incidents. Similarly, some measures may have essentially an effect on trespassing accidents and incidents, e.g. the removal of attractions (abandoned building offering potential playground, metal warehouse that can incite theft etc.). Measures to prevent railway suicides include e.g. gatekeeper programmes (training of staff at stations to identify people at risk for railway suicide), informing

local authorities on the risk of locating psychiatric institutions near railways, and design of announcement protocols in case of a railway suicide, whereas measures aimed at preventing trespassing accidents include e.g. removal of unauthorised paths, installation of prohibitive and warning signs & posters, and education in schools to increase awareness of risks related to crossing the tracks.

As indicated earlier in this review, some measures might have opposing effects to railway suicides and trespassing accidents. Examples are campaigns to raise awareness of risks related to crossing the railway tracks or media reporting on occurred train-pedestrian collisions. These measures can potentially have a negative effect on the frequency of railway suicides by increasing the knowledge and attractiveness of railways as a means of suicide (discussed further in Chapter 4.10).

The review of existing literature on railway suicides and trespassing accidents revealed some limitations. In particular, most of the reviewed articles/studies have been conducted by individual railways or research institutes. The studies often include data from one country only and therefore the results are too limited or specific (to a certain railway environment) to be directly useful for other companies or countries. In addition, the current studies lack accurate knowledge of motives (the underlying reasons for these actions) and behaviour. Previous studies, for example on railway trespassing, have been mostly based on reported incidents and fatalities, which does not necessarily show the extent of the problem (i.e. the frequency of trespassing) or its characteristics. Moreover, existing studies have suggested several countermeasures to prevent both railway suicides and trespassing accidents. However, there is little published research evaluating the efficacy of these interventions.

The mentioned limitations highlight the need to collect and analyse European-wide railway suicide and trespassing accident related data and to collect information on potential measures to prevent railway suicides and trespassing accidents and estimate and demonstrate their effectiveness. Based on the literature, railway suicide and trespassing related behaviour tends to be specific to location and/or country and thus special attention should be paid to evaluation of the applicability of identified measures to different railway and cultural environments.

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9. ANNEX

Table no 1: Scientific articles close related to the railway context.

Subway context	General studies	Various methods
Clarke & Lester, 1989	Altamura et al., 1999	Beautrais et al., 2009
Clarke & Poyner, 1994	Andriessen, 2011	Goldenbeld et al., 2008
Cocks, 1987	Baumert et al., 2008	Hoekstra & Wegman, 2011
Farmer et al., 1992	Beautrais, 2007	Lewis et al., 2007
Gaylord & Lester, 1994	Burrows & Laflamme, 2007	Lindqvist et al., 2004
Johnston & Waddell, 1984	Cantor & Baume, 1998	Reisch & Michel, 2005
Aouba et al., 2009	Clifton, 2011	Romano et al., 2008
Beck et al., 2011	Cohen et al., 2003	Rail Safety and Standards Board, 2003
Coats & Walter, 1999	Cooper & Milroy, 1994	
Guggenheim & Weisman, 1972	Daigle, 2005	
Ladwig & Baumert, 2004	Dare et al., 2011	
Lin & Gill, 2009	Hepp, et al 2012	
Mishara, 1999	Jobes et al 1991	
O'Donnell & Farmer, 1994	Sarchiapone et al 2011	
Ratnayake et al., 2007	Yip et al., 2012	
Sonneck et al., 1994		
van Houwelingen, 2011		
Rosenberg et al., 1988		
Clarke, 1994		