RESTRAIL

REduction of Suicides and Trespasses on RAILway property

Collaborative project

Evaluation of measures, recommendations and guidelines for further implementation

Pilot test #11

Forward Facing CCTV in trains – MTRS3

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RESTRAIL Consortium

	List of Beneficiaries		
No	**Beneficiary organisation name**	**Beneficiary short name**	**Country**
1	Union Internationale des chemins de fer	**UIC**	**FR**
2	Teknologian Tutkimuskeskus VTT	VTT	FI
3	Trafikverket - TRV	TrV	SE
4	Institut français des sciences et technologies des transports, de l'aménagement et des réseaux	IFSTTAR	FR
5	MTRS3 Solutions and Services LTD	MTR	IL
6	Fundación CIDAUT, Fundación para la investigación y Desarrollo en Transporte y Energia	CIDAUT	ES
7	Helmholtz Zentrum München Deutsches Forschungszentrum für Gesundheit und Umwelt (GmbH)	HMGU	DE
8	Karlstad University	KAU	SE
9	Fundación de los Ferrocarriles Españoles	FFE	ES
10	Turkish State Railway Administration	TCDD	TK
11	Deutsche Bahn AG	DB	DE
12	Instytut Kolejnictwa	IK	PL
13	ProRail B.V	PR	NL
14	Nice Systems Ltd	NICE	IL
15	Ansaldo STS	ASTS	IT
16	University of Nottingham	UNOTT	UK
17	INFRABEL	INFRABEL	BE

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Acronym	Meaning
ADIF	ADministrador de Infraestructuras Ferroviarias
ERA	European Rail Agency
BTP	British Transport Police
CAEX	CAPital Expenditure
CBT	Computer Based Training
CCTV	Close-Circuit TeleVision
CN	Canadian National
DOW	Description Of Work
FFCCTV	Forward Facing Closed-Circuit TeleVision
GDL	German Drivers Leasing
HMTreasury	Her Majesty's Treasury
IM	Infrastructure Manager
IP	Important Point
IT	Information Technology
NPV	Net Present Value
OPEX	OPeration Expenditures
OTDR	On Train Data Recorder
PIER	Program in Interdisciplinary Education Research
2RProtect	Rail and Road Protect
RAILPOL	European Network of RAILway POLice Forces
RSSB	Rail Safety and Standards Board
RU	Railway Undertaking
SMIS	Safety Management Information System
SPSS	Statistical Package for the Social Sciences
STS	SysTemS
SWOV	Institute for Road Safety Research
TCRP	Transit Cooperative Research Programme
VAS	Visual Analogue Scale
VPC	Values of Preventing a Casualty
VT	Value of Time
CBA	Cost Benefit Analysis
CEA	Cost Effectiveness Analysis

1.1 Forward Facing CCTV in trains – MTRS3

1.1.1 Overview of the piloted measure

A key need for railway undertakings (RU) and infrastructure managers (IM) is to minimise the service down time and disruption following suicides or trespassing fatalities on rail infrastructure. A principal benefit of Forward Facing CCTV (FFCCTV) systems is its ability to serve the three main entities involved in the investigation of these incidents - the RU, the IM and the police. Viewing the recorded images provides factual information, confirming witness information and enabling determination of the nature of the incident as either non suspicious or suspicious (potentially involving criminal activity). Knowing whether the circumstances are a suicide, accident or homicide is a key input for the police investigation of the circumstances and benefits the RU and IM as well as passengers, by helping minimise the incident investigation time, allowing resumption of operation as quickly as possible and reducing the associated costs. To gain the maximum benefit FFCCTV images need to be available to the police as quickly as possible after the incident to enable an assessment of the circumstances leading up to and the actual incident. In addition to rail fatality investigations the visual evidence provided by FFCTV is also utilised by many RUs, IMs and independent investigation bodies, e.g. RAIB and the BTP in GB.

A typical FFCCTV system includes four operating modes:

(1) **Active mode.** The camera and recorder are connected to a power supply, and the system is fully functional. In this mode, the status display panel shows that the system is operating properly.

(2) **Inactive mode.** The power supply to the camera and/or recorder is disconnected, or alternatively, the system is connected to the power supply and the camera, but is switched off.

(3) **Debriefing mode.** An external viewing device (PC, tablet or smartphone) is connected to the system for the purpose of viewing recorded images.

(4) **Malfunction mode.** The system is connected to the power supply and to the camera, but there is a malfunction in the system (whether power, communication, hardware, software), which is displayed in the status display LED and/or off-train equipment.

The **Figure 1.1-1** gives an example schematic overview of the application of FFCCTV to multiple unit rolling stock.

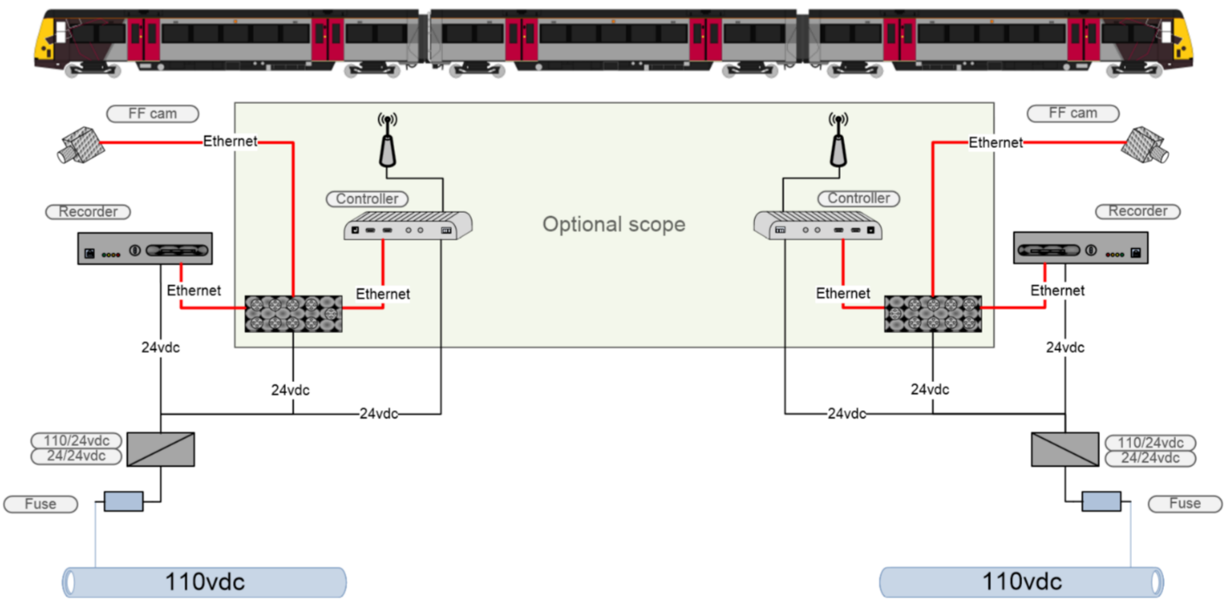

Figure 1.1-1: FFCCTV Schematic overview (Source: R2Protec GmbH)

In GB the RSSB Guidance document 'GM/GN2606 Guidance on the Fitment and Functionality of Forward and Rear Facing Cameras on Rolling Stock'[1] provides detailed guidance on the technical installation and operational aspects necessary for effective CCTV operation. The guidance is based on:

- Input from RUs already using FFCCTV and from the British Transport Police on evidential needs;
- Recognises the associated key safety & performance benefits that FFCCTV can provide.

Specific areas covered include:

- Camera systems requirements, positioning, file structure, recording and housing needs;
- Camera viewing envelope;
- Visual data storage capacity and use of hard drives on rail vehicles;
- Power supplies;
- Inputs e.g. date and time;
- Interfaces with other rail vehicle systems including other CCTV systems;
- Off-train equipment including portable access and data recording and viewing stations;
- Management of recorded data including downloading, viewing and access;
- Authorised personnel, on train and post incident data access
- Police evidential requirements.

[1] RSSB (http://rssb.co.uk/) . GM/GN2606 Guidance on the Fitment and Functionality of Forward and Rear Facing Cameras on Rolling Stock

1.1.2 Methodology to evaluate the piloted measures

As it was not possible to organise an FFCCTV trial, the review focused on GB arrangements, practices and experience of four RUs and the IM (Network Rail), also applicable legal requirements and police responsibilities, in particular the British Transport Police responsibility for policing the national GB rail system network as well as three FFCCTV equipment suppliers.

Information was obtained by surveys and questionnaires to determine:

- The numbers and costs to the rail industry of rail fatalities;
- The application, costs and effectiveness of FFCCTV;
- How, by whom and for what purpose the available information is used.

1.1.3 Reported costs for measure

Reported costs for this measure are given **Table 1.1-1.**

Table 1.1-1: Costs associated to the Forward Facing on train CCTV

Cost element	Sub components	value
Single cab FFCCTV costs		
In cab FFCCTV equipment	Video recorder	
	Removable storage (500GB)	
	Digital camera & housing	
	Power converter (110v to 24v)	
	Circuit breaker	
	19” tray	
	Materials - Cables, wires, cable binders, connectors	
	Total	3 000 €
Labor costs for on cab installation	Labor costs	2 000 €
Total per cab		5 000 €
Optional equipment	Embedded PC for remote access, health check and remote live video download	*2 750 €*
	Exterior antenna GPS/UMTS	
	SIM card	
Non-recurrence costs		
Software and related equipment	Software for reviewing of video footage	3 200 €
	USB docking station for HDD	
	Ruggedized storage case	
Remote sofware licence for video supervision	Remote supervision software license (excl. 15% for annual service)	25 000 €
Remote software licence per vehicle	Remote video supervision (Health & status monitoring)	25 €
Design review meetings	Total of 3 meetings	4 000 €
Meeting with the supplier	First article meeting (1day meeting in Germany)	900 €
SAT meeting	At the client premises (1 day)	900 €
Project management support	30 working days @ 900€	27 000 €
Documentation	10 working days	9 000 €

1.1.4 Evaluation results

The following items summarise the information obtained.

4.11.4.1. Rail fatalities – number and industry costs

The **Table 1.1-2** aggregates data collected relating to rail fatalities, the delays these cause and the associated industry costs. However there will be wide range of delays for each incident depending on the location, time of day and the service frequency with incidents in urban areas during peak traffic hours involving immediate and serious delays even when service shut down is minimised.

The largest elements of the identified costs are the service delay and cancellation costs paid by the IM to RUs as part of the GB performance regime intended to incentivise RUs and Network Rail to improve operational performance through operational decision making and investment appraisal. Over 4 years the payment from the IM to RUs has averaged over £17M a year. In addition the major direct costs for RUs arising from the impact of suicides on rail staff (particularly drivers), train cleaning and repairs, and compensation to passengers are estimated at approximately £12M a year. BTP annual costs for dealing with suicides are estimated to be £4.5M per annum[2].

The cost data given in **Table 1.1-2** is based on the average cost per minute used in GB[3]. The actual cost per minute for each incident depends on its location - those involving urban areas attracting a much higher cost than those in rural areas with low traffic volumes

Table 1.1-2: Fatalities - delays & costs

Year	Suicides	Minutes delay	Cost
2011/2012	242	422,067	£31M
2012/2013	239	333,920	£24.5M
2013/2014	277	290,752	Not available

In addition to the number of suicides identified in **Table 1.1-2**, there have also been between 38 and 60 other fatalities per year during the period 2010 – 2014. In the same period individual RUs have been involved in between 10 and 25 suicides and other fatalities annually.

4.11.4.2. FFCCTV Application

To gain an understanding of the extent to which FFCCTV is fitted to RU fleets four RUs provided information for their rolling stock fleets – whether owned or leased. This identified a wide variation in the % of rolling stock fitted with FFCCTV (31% - 100%) and recording times (7- 40 days).

4.11.4.3. FFCCTV Costs

FCCTV installation and management costs will depend on:

- whether the equipment is installed as part of the design of new rolling stock or fitted to existing stock.
- The installation of optional equipment providing a link to a shore based surveillance management system facilitating system management and data retrieval especially in large fleets **Table 1.1-3** to **Table 1.1-6** outline the costs involved.

[2] Costs data. RSSB ‘Improving suicide prevention measures on the rail network in Great Britain. T845- February 2014’

[3] Sources. Minutes delay BT2011/12 & 2012/13. RSSM 2013/2014 P. Cost data (£73.47/Min) National Audit Office 2008 Appendix 3.

FFCCTV Indicative costs tables (all prices excluding VAT)

Table 1.1-3: Non-recurring costs - project management

Item	Cost Element	Sub Components	Cost
1	Design review meetings	• Design review meetings - total of 3 meetings	€ 4,000
2	Meeting with the supplier	• First article I day meeting	€ 900
3	SAT meeting	• At client's premises - 1 day	€ 900
4	Project management support	• 30 working days @ € 900	€ 27,000
5	Documentation	• 10 working days	€ 9,000
	Total		**€ 41,800**

Table 1.1-4: Optional non-recurring costs - software & hardware

Item	Cost Element	Sub Components	Cost
6	Software and related portable equipment to review images	• Software for reviewing of video footage • USB docking station for HDD • Rugged storage case	€ 3,200
7	Shore based video supervision software license	Remote supervision software license - one off payment	€ 25,000
8	Design acceptance	Notified Body design acceptance – particular need for retrofits to unfitted stock	Application specific agreement

Table 1.1-5: Non recurring costs – single cab installation

Item	Cost Element	Sub Components	Cost
9	FFCCTV equipment	• Video recorder • Removable storage (500GB) • Digital camera & housing • Power converter (110v to 24v) • Circuit breaker • Mounting tray for DVR & PSU • Materials - Cables, wires, cable binders, connectors • Ethernet network switch	€ 3,000
10	Labour costs for one cab installation	Actual cost depends on type of vehicle	€ 2,000
11	Total per cab		€ 5,000
12	Optional equipment See Item 7	• Embedded PC for remote access, health check and remote live video download • Exterior antenna GPS/UMTS • SIM card	€ 2,750

13	Total per cab with optional equipment		€ 7,750

Table 1.1-6: Recurring costs

Item	Cost Element	Sub Components	Cost/Comments
14	See Item 7 Optional Shore based video - vehicle software license	Per vehicle and month	Application specific agreement
15	See Item 7 Optional Shore based video equipment – software service fee	X% per annum covering debugging and software updates for both rolling stock and RU software	Application specific agreement
16	See Item 7 Optional Vehicle license – health & status monitoring	Per vehicle and month	Application specific agreement
17	Operational costs (e.g. inspection, calibration., image retrieval etc.)	Staff to oversee shore based system and initiate maintenance, remove hard drives, copy footage for police or other investigations. This person would also cover similar requirements for any other on train CCTV covered by the same management system	One person full time – depending on fleet size
18	Maintenance costs	Based on predetermined expected failure rates for each item of equipment and periodic equipment operational checks. Agreed KPIs can provide a basis for determining likely costs.	Application specific agreement
19	Life expectancy	Based on life expectancy of individual items of equipment	Application specific agreement

1.1.5 Applicability of results to different circumstances

FFCCTV systems provide a number of significant safety and performance benefits in addition to those associated with the investigation of rail suicide and trespass fatalities. Images can provide retrospective information on the position before an incident occurred – useful for subsequent investigation and cost attribution. Benefits include:

- The investigation of many other types of incidents, accidents and near misses e.g. collisions, derailments, signals passed at danger, possible signalling system irregularities, trespass, incorrect use of crossings by individuals and vehicles, staff incidents;
- Undertaking infrastructure surveys e.g. overhead line condition, track conditions including flooding, lineside litter, encroaching vegetation, equipment and materials left on the line, security checks;
- Observing the condition of passing trains e.g. for loose fittings/equipment on freight vehicles;
- Facilitating train service recovery following an incident e.g. reducing time for asset testing;
- Crime prevention e.g. identification and subsequent arrest of individuals involved in trespass, vandalism, metal / cable theft and other criminal activities including off-rail crime investigation;
- Platform incidents – observing activity on platforms during station pass through;

- Input to driver route knowledge training and use in cab simulators for driver competence and performance;
- Input to rolling stock fleet management systems.

1.1.6 Discussion

The review confirmed that FFCCTV systems provide an important information source for the management of rail fatalities incidents and associated investigations, as well as other significant safety, security and performance benefits. Following a fatality quick access by key decision makers, e.g. the police, to the recorded images can provide an important input to the key decision which can help minimise the impact on services – i.e. are the circumstances suspicious or not. In many cases the installed technology does not provide immediate post incident access and the information available is used primarily as an input to subsequent investigation. However systems are available providing remote access to images recorded on stationary trains and if linked directly to the police could provide the essential quick decision making means, although the potential improvement in incident clear up time needs further consideration.

However, information concerning the effect of FFCCTV as a contributing factor to the investigation of suicides and fatal trespassing incidents is insufficient. This is mainly because RUs and IMs do not collect relevant data, which would enable a quantitative assessment of the extent of FFCCTV benefits.

Benefits

From an individual RU point of view the potential benefits of FFCCTV in relation to fatalities alone are arguably limited. An individual RU may only be involved in a limited number of fatalities and the cost of associated delays (in GB) is much less than the potential cost of fitting the remaining unfitted rolling stock of those RUs seen. However FFCCTV tends to be fitted as part of a package including on train CCTV and at least one of the RUs seen makes considerable use of on train CCTV images as an input to providing a safe and secure travel experience for their passengers. As previously mentioned there are of course the wider potential benefits to RUs and the IM in terms of e.g. safety management and reduced incident downtime, reduced investigation time and costs also as part of an RU's management system with remote access providing for aspects such as monitoring rolling stock condition and performance, optimising driving performance and timetable adherence.

Investment

The disaggregated rail industry adds a particular dimension to investment in projects such as FFCCTV fitted to rolling stock owned or leased by an RU. It is important to recognise that the actual and potential benefits of FFCCTV are not realised solely by one RU as there are considerable actual and potential benefits for other rail industry players – the Infrastructure Manager (IM) and other RUs using the same routes - and indirectly passengers. The reduction in incident time, hence costs, achievable by the police having direct access to FFCCTV images needs identification. A financial appraisal of these and other benefits and costs e.g. which rail organisation actually bears the costs of an incident, would be necessary to support equitable investment by the involved industry partners. For example with one RU seen the IM invests in the CAPEX and the RU the OPEX costs

However fitting FFCCTV now appears to be becoming the accepted way forward for new rolling stock builds e.g. for Crossrail and rolling stock for the Inter City Express Programme (IEP).

Police considerations

Police investigation decision making is a key element in reducing the period of disruption following a fatality. In GB development of this process has already resulted in a considerable reduction in the time involved when an incident is deemed to be non-suspicious. Fundamental to this reduction has moving from the risk averse approach previously applied by police officers responding to a fatality. This often involved fatalities being classified as unexplained i.e. no immediate cause explanation and no available information or intelligence to confirm the circumstances. This approach involved the (often unnecessary) deployment of significant police resources to site with extended disruption of rail services and attendant potential for harm to passengers and staff who may be stranded on a train for an unusually long time.

Following a review and consultation with involved industry and external stakeholders, BTP instituted a revised risk assessed approach based on incident classification guidelines and starting with a non suspicious mindset. This approach was supported by the education of BTP officers and reflecting the need:

- for diligent, professional investigations;
- to meet the expectations of external stakeholders e.g. Coroners and pathologists;
- to ensure the respect and dignity of the deceased.

If no suspicious circumstances are identified and death is declared the body may be covered by a 'forensic' sheet and/or moved. With this classification and after any site clean-up steps are taken to resume services - although the associated police investigation continues to ensure provision of a fully documented file for the Coroner/Procurator Fiscal.

The aspects considered in the classification of fatalities are as follows:

- Obtaining Train driver / eye witness accounts;
- Viewing FFCCTV / CCTV images;
- Identifying any vehicles found near scene;
- Assessing the fatality scene;
- Searching the body / assessing items found;
- Obtaining information from next of kin;
- Intelligence regards individual.

The revised approach has reduced the number of unexplained incidents considerably (2011/12 – 101, 2012/2013 – 30 and 2013/2014 – 10 to date) and the average time for conclusion of a fatality declared as non-suspicious (from the time reported to the BTP) is now 73 minutes. This has resulted in a 21% reduction in total delay minutes from the year 2011/2012 to 2012/2013.

Where the facility is provided a direct review by BTP officers on site on the involved train of FFCCTV images can assist site investigation in particular determination of the circumstances involved – suspicious or non-suspicious. The capability to remotely view recorded images immediately following an incident provides the most beneficial input possible to police decision making in term of speed. However BTP access to this facility is at present through RU or IM equipment and speed depends on the physical location of BTP officers in relation to the access equipment.

There are of course limitations on the extent to which the incident response time can be reduced. Specialists will always need to attend the site (e.g. IM and RU managers and support specialist staff, the police, the mortician and clean up contractors) and the time necessary to replace the involved driver will depend on driver availability, the location and access.

Suggested improvements

A standardised approach to considering what is necessary for effective fitment and functionality of FFCCTV systems, whether for new or retro-fit applications, would be of benefit to all potential users. An example of this approach is RSSB document GM/GN2606 appropriate to both new and retro-fit installations. Any industry guidance needs to reflect the fact that technology in this field is constantly developing both in terms of technological advances and to meet the emerging needs of IMs and RUs to exploit the benefits of these systems.

As FFCCTV becomes more widely used, with increased use of video surveillance management systems enabling remote access to data using wireless links, it is essential to ensure that data protection is maintained during access and transmission. Documented controls and procedures will need to reflect the development of FFCCTV systems and their application.

The use of desktop shore based video management systems enabling data to be automatically transferred from rolling stock to central location/s using wireless links are of particular benefit when large fleets are involved. These systems enable the application of KPIs (agreed by the supplier with the RU) to system and individual equipment availability and performance. They also make it much easier to access the relevant information when an incident occurs and to produce video and still images for investigation and evidential purposes. This is particularly the case with systems providing a live view connection with remote access and playback. Subject to any legal implications this approach provides the capability for future direct police access to images relating to any type of incident involving a train, including on train internal and door operation CCTV images. In the event of a rail fatality this type of system provides the quickest possible information for decision making - before a police officer is on site.

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