PROTECTRAIL

HIGH PROBABILITY LOW IMPACT EVENTS WITHIN PROTECTRAIL

THE DEVELOPED COST & BENEFIT ANALYSIS

V.SICILIANO (ASTS)

The HPLI Context

The PROTECTRAIL project, following the RP2 review outcome, has agreed to expand its focus from the protection of railway from terrorist attack (that was the focus of the call) to the wider objective of protecting the railway from High Probability Low Impact (HPLI) security events.

The scope of the presentation is to reassume the results of the developed cost and benefit analysis for High Probability Low Impacts events (HPLI) taking into account that such events are very relevant for railway operators and, in most cases, could be contrasted using some of the technologies solutions proposed for the security objectives addressed by the PROTECTRAIL Project.

HPLI Conceptualization

High Probability Low Impact (HPLI) risk events naturally refer, as implied by the title, to a wide family of threat scenarios which are characterized by two features:

- **"Low Impact**" – The overall damage effect and negative consequences of any single occurrence of that type of events is non-critical to the operator and to the general public, and do not cause any major disturbance to public security, railway operations and business continuity of the operator;

- **"High Probability"** - The experienced frequency of that type of event may relate to the values of once in a couple of days or weeks.

Breakdown of the HPLI crimes by their possible location

Threat \ Place	Station	Rolling Stock	Tracks	Depot & Administrative Buildings
Graffiti	✓	✓		✓
Theft from passengers	✓	✓		
Verbal abuse against passengers & railway staff	✓	✓		✓
Physical aggression	✓	✓		✓
Sexual harassment	✓	✓		
Trespassing			✓	

Likelihood categories

Likelihood level	Definition	Frequency Guide *
"Frequent"	Continually occurs during operational life-cycle	100 /year
"Probable"	May occur several times during life-cycle	10 /year
"Occasional"	May occur a few times during operational life of system	1 /year
"Remote"	May occur at some time in the system life-cycle	1 / 10 years
"Improbable"	Unlikely to occur during operational life	1 / 100 years
"Incredible"	Extremely unlikely to occur	1 / 1000 years

Although the term "High probability" is not specifically defined in EN50216, it shall be included in that category all the events of which the likelihoods are:

Frequent or Probable

***** All frequency calculations shall be referred to a measuring unit e.g. per km of line

The CBA Process 1/4

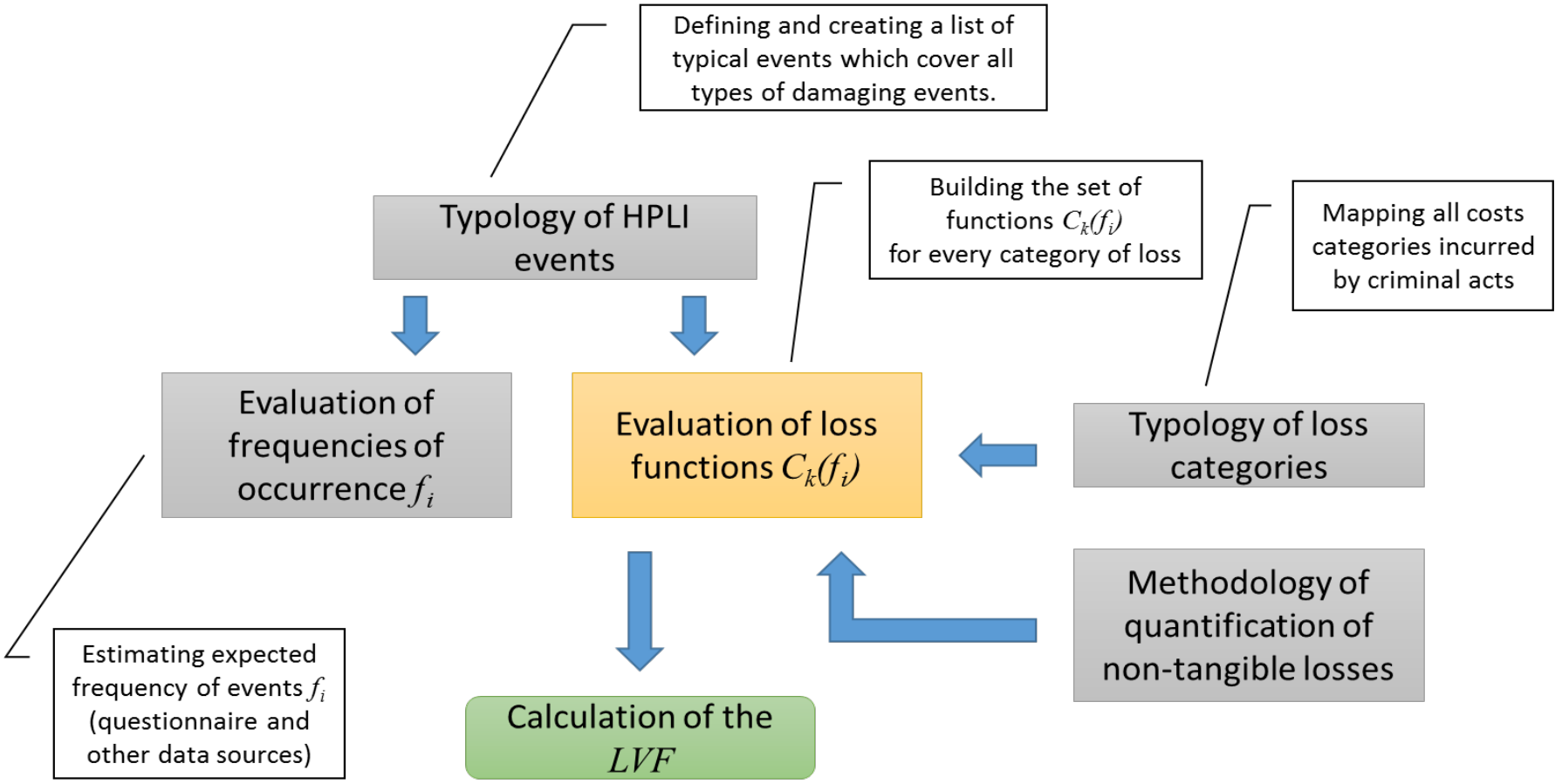
The developed CBA process is composed of the following steps:

1. Identifying and create a formal **mapping of all types** of events which have the potential to cause inconveniences to passengers, to the operating organization and to other members of the public;
2. Estimating the **frequency** at which each of those types of damage causing events occur.

3. Estimating the **overall annual cost (or "loss value")** associated with each type of event. This will be done by shaping a set of functions each of which expresses the dependency of the cost associated with a given category of loss on the frequency of occurrence of any type of event.

4. Calculating the Loss-Value-Function **(LVF)**.

The CBA Process 2/4



The CBA Process 3/4

The loss categories:

Inside the proposed approach it has been taken into account **6 loss categories** concerning:

- Human body damage;
- Capital loss;
- Quality of service reduction;
- Organizational reputation decrease;
- Negative customer experience;
- Income loss.

Just two of those six categories (capital loss and income loss) are tangible and thus are easily quantifiable in monetary terms.

Human body damage can be quantified by an estimate of the cost of illness made up of medical costs and lost income. The intangible part can be monetized by an estimate of the compensation awarded by the courts to the victims

.

The other three (quality of service reduction, organizational reputation decrease, and negative customer experience) are not attached with a natural and direct monetary value.

The CBA Process 4/4

Methodology of Quantification of the Non-Tangible Losses

On of the possible solutions to ascertain the value of an intangible benefit is by use of **shadow prices**, which represent monetary values. Shadow prices are typically estimated using revealed preference valuation or willingness to pay valuation.

- *Revealed preference valuation*

  Shadow prices are calculated inferring the value of an intangible benefit by examining empirical data.

- *Willingness to pay valuation*

  Shadow prices are calculated by asking people how much they are willing to pay for a specific benefit, for example how much the rail company management for a reduction in sexual assaults.

In the proposed approach it has been used the **willingness to pay valuation** to obtain a unique measure which will serve the quantitative valuation of service reduction, organizational reputation decrease and negative customer experience.

Case Study: Track protection against copper theft

In the next slides it will be shown a real case study in order to provide a real case application of the developed method and provide a complete example of the obtainable results. The data reported below are referred to a network of 20.000 km:

Threat	Theft of copper cables	
Year	2012	2013
Number of yearly incidents	2.137	2.056
Expected frequency of yearly incidents with the security system	214	206
Capital loss for yearly incidents (*)	10,6 M€	9,5 M€
Minutes of delay for yearly incidents	~ 147.000	~ 233.000
Willingness of management to pay to eliminate all the incidents due to quality of service reduction, organizational reputation decrease and negative customer service	very high	very high
Willingness of management to pay to eliminate half the incidents due to quality of service reduction, organizational reputation decrease and negative customer service	high	high

*The value of the euro is the sum of direct costs (material costs) and the cost of repair. The cost of repair, that is supported by the recovery of damages, it is certified, while the cost of the material is derived from the average annual price of copper on the website isoclima (http://www.isoclima.com/it/quotazione.asp).

Case Study: Track protection assumptions

For the study it as been reasonably assumed that , not all the tracks are at risk, only a fraction of them and more precisely 5000 km of the studied railway network. It has been assumed to protect those 5000 km with a security system made up with a well defined set of sensors and physical protections composed by Active fences, Optical cameras with IR illuminators and video-analysis, Thermal cameras with video analysis and a fiber-optic based protection system for signalling cable trenches.

The assumption is that the proposed security system will cause a reduction of 90% in the number of yearly incidents. The baseline assumed 2,000 yearly incidents of metal theft without the security system -approximate average of the yearly incidents in 2012 and 2013, and 200 incidents after the operational entrance of the security system; an efficiency of 90% for the security system.

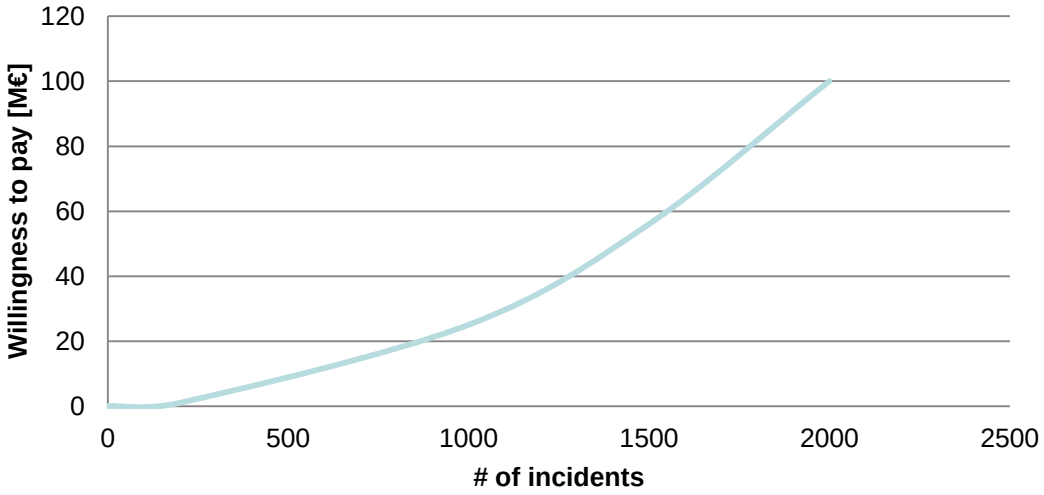
Another assumption is that the number of incidents is constant throughout the life cycle of the security system.

Case Study: Security System costs for 5000 km

Year	Security System Cost (k€)				TOTAL
	Procurement	Initial Installation	Personnel	Operations & Maintenance	
0	300.000	850.000	300.000	5.000	1.455.000
1			10.000	5.000	15.000
2			10.000	5.000	15.000
3			10.000	5.000	15.000
4			10.000	5.000	15.000
5			10.000	5.000	15.000
6			10.000	5.000	15.000
7			10.000	5.000	15.000
8			10.000	5.000	15.000
9			10.000	5.000	15.000
10			10.000	5.000	15.000
11			10.000	5.000	15.000
12			10.000	5.000	15.000
13			10.000	5.000	15.000
14			10.000	5.000	15.000
15			10.000	5.000	15.000
				Total	1.680.000

Case Study: Willingness to pay to eliminate the incidents

The graph below exhibits the willingness to pay to eliminate the incidents in each category (service reduction, organizational reputation decrease and negative customer experience) as a function on the number of incidents (created using the experience of several railway stakeholder).



The graph above shows that the willingness to pay for each of the three categories (service reduction, organizational reputation decrease and negative customer experience) is:
100 million € for 2,000 incidents of metal theft;
56 million € for 1,500 incidents of metal theft;
25 million € for 1,000 incidents of metal theft;
1 million € for 200 incidents of metal theft.

Case Study: Benefit-Cost Measures for Covering 5,000 km

Yearly Benefits (K€)	**306.000**
Total Benefits (K€)	3.940.000
Total Costs (K€)	1.680.000
Benefit – Cost (K€)	2.260.000
Benefit / Cost Ratio	2.3