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OPERATION AND SAFETY OF TRAMWAYS IN INTERACTION WITH PUBLIC SPACE: STATE OF THE ART

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This paper was submitted and validated for a presentation during this Conference in Brussels (Dec 2013). Something came up and we finally didn't achieved to attend the meeting.

OPERATION AND SAFETY OF TRAMWAYS IN INTERACTION WITH PUBLIC SPACE: STATE OF THE ART

ABSTRACT

The aim of the paper is to present the results of the first Working Phase of the COST Action TU1103 "Operation and safety of tramways in interaction with public space". This Project is funded by European Cooperation in Science and Technology (COST). It started on September 19th 2011 and will last until September 18th 2015.

The countries involved in the Action and that could give information in the moment that this abstract was written were the following: Belgium, Czech Republic, France, Germany, Hungary, Ireland, Italy, the Netherlands, Poland, Portugal, Spain, Switzerland and United Kingdom. Since then, Austria has joined the Action. Moreover, UITP (International Association of Public Transport) is also involved in the development of the Action.

This COST Action deals with the safety of tram and Light Rail Transit (LRT) systems through their insertion in urban spaces in order to minimize accidents and their impacts on both transport system and society. During the first Working Phase of the Action a state of the art context exploration has been made, related to institutional and regulatory aspects, to the evaluation of tramway accidents, and to infrastructure design.

In relation to the institutional and regulatory aspects, the main points that have been explored are: the legal basis and the technical requirements for LRT systems; operational, control and supervision practices; as well as operational measures aimed at increasing safety and users' awareness (considering social and cultural issues).

On the other hand, in relation to data collection on accidents, the following information has been collected from each country: tools and mechanisms for data collection and processing, criteria of analysis, indicators and results.

Finally, in relation to infrastructure design, a survey has been made in order to determine the best and worst practices that can be encountered in each country, when dealing with the interaction of the LRT with other street users (pedestrians, cyclist and road vehicle drivers). This survey will establish a common body of knowledge about a safe urban insertion of LRT systems and can be the basics for developing guidelines in relation to their design.

INTRODUCTION

The COST Action TU1103 "Operation and safety of tramways in interaction with public space" deals with the improvement of tram and Light Rail Transit (LRT) safety through a better management of their insertion into urban spaces, and therefore with the minimization of accidents and their impacts on both transport system and society.

The Action enables a better understanding of problems, solutions, and a shared feedback, at a European scale, about:

- LRT safety assessment, through a harmonized approach in order to facilitate comparisons.
- LRT running in various infrastructure configurations, through a shared analysis of advantages, drawbacks and impacts on transport system functioning.

At the beginning of this Action, the members have specified that safety, in the framework of the Action, deals with the risk and precautions taken to reduce level of risk related to accidents and injuries, such as the urban design insertion and measures which can be taken within the institutional framework. The Action will look at urban fully guided public transportation which shares public space with road/bike/pedestrian traffic and it will be focused in accidents and near-misses when they are registered. The whole tram system, including the infrastructure design and equipment management, is important for this purpose.

The Action focuses on the interaction between trams and other road users (pedestrians, car drivers, cyclists) in urban spaces, but does not include collisions between rail vehicles or with trackside equipment, or derailments. In the Action, only accidents that are a consequence of an urban insertion issue are considered. And therefore, accidents caused by track or signalling or rolling stock problems are not studied here.

The first Working Phase of the Action (WP1) deals with the state of the art and context exploration. During this WP an inventory of the current situation has been made, for every participating country, in relation to the three main subjects:

- Institutional and regulatory aspects: concerning the legal basis and the technical requirements for LRT systems; operational, control and supervision practices; as well as operational measures aimed at increasing safety and users' awareness (considering social and cultural issues).
- Data collection on accidents, at the national and local levels: tools and mechanisms for data collection and processing, criteria of analysis, indicators and results.
- Infrastructure design: practical aspects related to existing configurations, running handling signage and operational performance, as well as tools (guidelines, regulations) related to infrastructure design existing in each country.

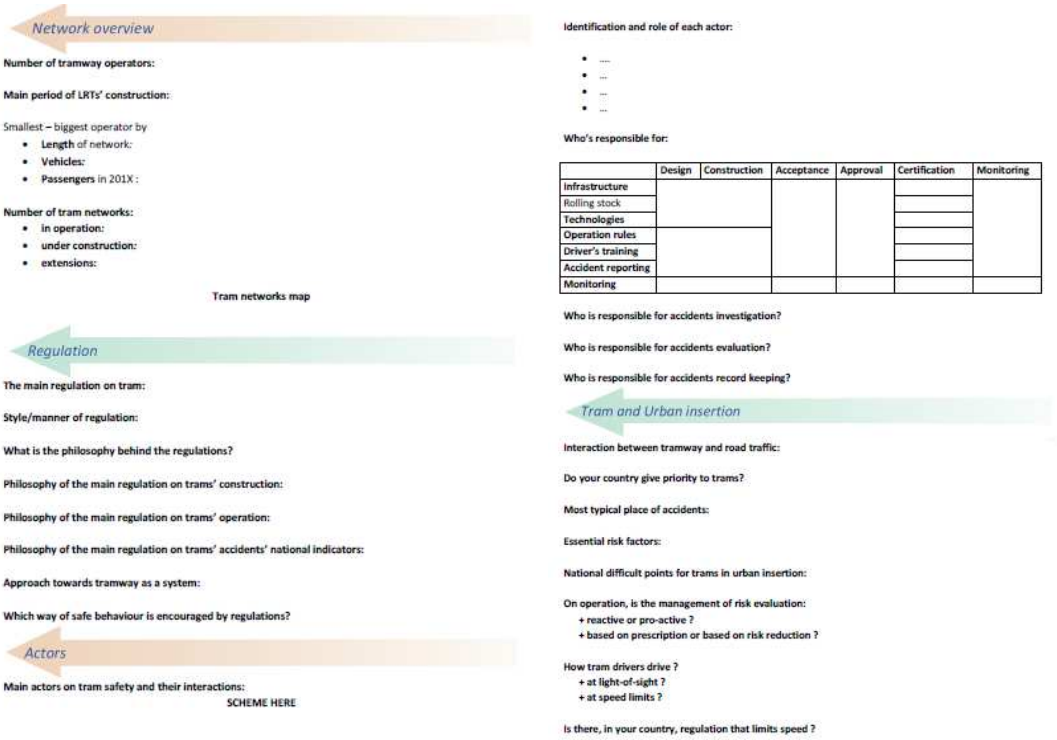
The methodology and conclusions of WP1 for each one of these subjects are going to be presented in the following sections.

INSTITUTIONAL AND REGULATORY ASPECTS

The main objective of this state of the art context exploration in relation to institutional and regulatory aspects has been the overview on national key points for each country, the identification of the regulations concerning trams and the establishment of a common vocabulary.

Global views

First of all, exploration has concerned a global view for each country participating to the Action. For this purpose, a template sheet was prepared in such a way that the group members from each country could fill it in with their information.



Network overview

Number of tramway operators:

Main period of LRTs' construction:

Smallest – biggest operator by
- **Length** of network:
- **Vehicles:**
- **Passengers** in 201X :

Number of tram networks:
- **in operation:**
- **under construction:**
- **extensions:**

Tram networks map

Regulation

The main regulation on tram:

Style/manner of regulation:

What is the philosophy behind the regulations?

Philosophy of the main regulation on trams' construction:

Philosophy of the main regulation on trams' operation:

Philosophy of the main regulation on trams' accidents' national indicators:

Approach towards tramway as a system:

Which way of safe behaviour is encouraged by regulations?

Actors

Main actors on tram safety and their interactions:
SCHEME HERE

Identification and role of each actor:
- ....
- ...
- ...
- ...

Who's responsible for:

	Design	Construction	Acceptance	Approval	Certification	Monitoring
Infrastructure						
Rolling stock						
Technologies						
Operation rules						
Driver's training						
Accident reporting						
Monitoring						

Who is responsible for accidents investigation?

Who is responsible for accidents evaluation?

Who is responsible for accidents record keeping?

Tram and Urban insertion

Interaction between tramway and road traffic:

Do your country give priority to trams?

Most typical place of accidents:

Essential risk factors:

National difficult points for trams in urban insertion:

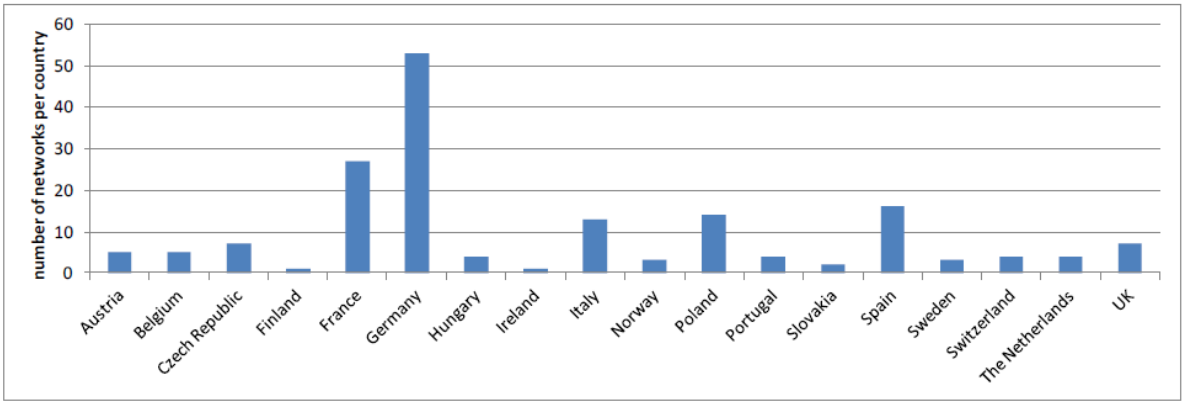
On operation, is the management of risk evaluation:
- **+ reactive or pro-active ?**
- **+ based on prescription or based on risk reduction ?**

How tram drivers drive ?
- **+ at light-of-sight ?**
- **+ at speed limits ?**

Is there, in your country, regulation that limits speed ?

Per country, the group has gathered information on networks, main regulation on tram safety and its philosophy, actors involved in tram construction and operation, and main urban insertion issues encountered in the country. A synthesis followed by an analysis of all situations has then been made. Each of these global views allows the Action's members to learn better how each country works on LRTs (technical tradition, projects, regulations, interactions with urban spaces, accidents, difficult points). But they also allow identifying common points and issues that cannot be met.

New tramway systems and lines are spreading all over Europe. After a period of gradual closure of this technology on their public transport urban networks, LRT systems are now growing with new vehicles and technology and the existing ones are extending in most medium and big cities of the EU countries. Germany has the greatest number with 58 operators and more than 20 extensions in progress, and Ireland two tram lines in Dublin. France has known the highest progression of new lines during the last decade. This diversity can be explained by national technological traditions, local and national politics, roles of various players, image of tram systems and policies towards sustainable mobility.



A wide variety of the main tram regulations has been observed across the countries. On the other hand, there is a need for a deeper understanding of the tramway safety issues, as urban mobility and transport safety are relevant issues of the European transport policy. The design regulations are functional, considering the system as a whole, but many components are regulated by technical standards. Construction and operation are largely affected by the urban design and by the operator experience, when existing.

There are different actors involved in operation and in the design of the system. Obviously, tram operators, local or regional transport authority and representatives of Transport Supervisory Authority are each time interacting. Constructors as rolling stock manufacturers or construction companies, and also project infrastructure managers are identified when presenting project actors. Street traffic authorities and independent safety assessors are also sometimes included. More indirectly, research bodies, police, insurance companies, as well as politicians (national, regional, local) can participate in a tram life. When an accident is concerned, operators and investigation agencies are directly concerned. Depending on the country, police participates for enforcement and registration of traffic incidents.

Safety management is mostly based on a reactive approach to reduce the frequency of undesired recurring events in black spots of the networks. Accident data are collected by the operator, but there is not an established practice to manage and analyse them in a national database according with common safety indicators, except in one country.

Generally there are not national databases for accidents' collection and analysis (except in the case of France) and some countries require the introduction of a Safety Management System (e.g. UK) to proactively reduce the risk of accidents, while others rely on a reactive approach based on the investigation of individual accidents to develop a corrective action plan. The minimum seems to be that operators need to comply with some form of risk based approach, reactive and/or pro-active, materialized in their own rule set and management of safety.

There are a lot of types of accidents; the big variety is linked to the different locations where the tram is inserted, to the degree of track segregation (fully separated, partially separated or in mixed traffic), and to the operation speed. There is not a typical accident though the majority of them is obviously connected to intersections - most typical places of conflicts, turn-left movements with tram in the back, which are quoted distinctively. Cars are the most implicated on collisions with trams. Pedestrian crossings are also an issue.

Other parameters are given as encountered problems: lack of attention from other space users, speed, restricted sightline/visibility, traffic jams, etc. Accidents tend to happen because road vehicle drivers are not aware of the presence of a tram or do not treat it with sufficient respect recognising its longer stopping distance or different path. Whatever the regulation, whatever different solutions, all countries face these problems.

Legal and the technical frameworks of LRT systems

Secondly, exploration has concerned the legal and the technical frameworks of LRT systems, and a complete list of regulations concerning tramway systems has been collected for EU level and for each country. All these regulations have been gathered in a sheet for each participating country:

National level

item	Name of Document (national language, link, English translation)	Legal Status (law, directive, technical standard, guideline etc.)	General description	Level of application		Responsible entities				Tramway references (details of regulation)	Safety references
				Geographically	Transit system	(design)	(approval)	(execution / operation)	(evaluation / assessment)		
Passenger transport	Passenger Transport Act	Law	regulating the condition of public passenger transport with buses, trolleybuses, taxis, and guided systems (tramways, metros and monorails).	National level	buses, trolleybuses and taxis + tramways, LRT, metros + monorails, other guided systems + NOT: Heavy Rail, ropeways and funiculars	transport ministry					no safety references
Tramway operation	BOStrab - Straßenbahnbau- und -betriebsordnung [Regulation on the construction and operation of tramways] of 11th December 1987	Law	This Decree describes the functional requirements for constructing and running a tramway system. All technical and operational components and requirements are regulated in a functional, purpose-related manner.	all tram and metro networks in Germany	tramway and metro systems. NOT S-Bahn and Heavy Rail systems	operator	TAB (Technical Supervisory Authority)	operator	TAB (Technical Supervisory Authority)	all	all
Guidelines to BOStrab	9 Guidelines on particular issues of tramway construction and operation: Alignment; Swept path and clearances; Guidance; Electrical installations; Tunnelling; Fire Protection; Rail-Road vehicles; automated operation; Brakes	Code	These guidelines specify particular issues which are vital for tramway operation in terms of interface design and system interaction.	National level	tramway and metro systems. NOT S-Bahn and Heavy Rail systems					all	all
Street traffic	Straßenverkehrsgesetz (Street Traffic Law)	Law	This law sets traffic rules and all legal and statutory measures governing the traffic(circulation) on public roads comprising pavements, roads, highways, intersections) of all means of use (pedestrians, two-wheelers with or without engine, automobiles, tramways etc.).	National level	all kinds of street traffic	transport ministry					
Street traffic	Straßenverkehrsordnung	law	Traffic rules for traffic on public streets, including level crossings	National level	all kinds of street traffic	transport authority	transport authority	street operating authority	transport authority		
road signalisation	RiLSA	Code	Guidelines on street traffic signalisation (traffic lights)	National level	traffic lights: planning and designing intersections and control programmes	street operating authority	transport authority	street operating authority	street operating authority		

Regional Level

item	Name of Document (national language, link, English translation)	Legal Status (law, directive, technical standard, guideline etc.)	General description	Level of application		Responsible entities				Tramway references (details of regulation)	Safety references
				Geographically	Transit system	(design)	(approval)	(execution / operation)	(evaluation / assessment)		
In technical respect: Not concerned - only national or local levels.											
contracting of Public Transport Services	Public Transport laws of the *Länder* (16 in all)	Law	these laws describe the responsibilities and procedures of attributing the legal concession to a bus or tram line to a particular concessionaire.	Federal Level	all rail-borne or street-borne public transport systems, not nation-wide transport (long-distance coaches, high-speed trains etc.). Administrative regulations, no safety issues.						

Operations regulations

item	Name of Document (national language, link, English translation)	Legal Status (law, directive, technical standard, guideline etc.)	General description	Level of application - geographically	Level of application - Transit system	responsible entities				Tramway references (details of regulation)	Safety references
						(design)	(approval)	(execution / operation)	(evaluation / assessment)		
operation	Operator internal procedures	related to BOStrab, set up by the enterprise (and their Operations Manager) and approved by the TSA	Internal Book of Rules, compulsory for every tramway operation	local	tramway, Metro	Operator	Technical Supervisory Authority (TSA)	Operator	Operator, TSA		

There is a wide variety of regulations across the countries. Talking about tramway as a system, in the majority of the cases, there is not a code, which collects all the laws concerning the tramway sector, but there are rather interpretations of the laws regarding railway and road sectors. On the contrary, the system components often have norms based on national technical standards, sometimes from European norms, which apply to LRT. Some of them are related to railways statistics and safety management, but most of them concern technical aspects (rolling stock, power supply, track).

To summarize:

- All countries have national regulations (for trams, for railways and/or for road);
- Spain, Switzerland and Germany have additional and detailed regional level regulations:
  - On specific items (funding, operation, concessions);
  - Or specific Railway Acts (definitions, design, priority, maintenance);
- Local operational rules: when existing (some at the operator's initiative), it's a goal-setting regulation which sets out what must be achieved without detailing how to achieve it;
- Moreover, UITP has proposed Fundamental Requirements.
- The design is mostly regulated by national laws, while the operation is regulated by local laws or operator’s laws

It is difficult to make a synthesis from all these regulations, and more difficult to make any comparison and evaluation, as juristic specialists would be necessary to identify common points and philosophy. Besides it does not seem possible to make meaningful correlations among type of regulations and accident occurrences. Neither global conclusion nor recommendations on which regulation is the best are possible and this is not the aim of this Action. The huge differences among the regulatory frame of each country can be pointed out as one of the main conclusions of this exploration: there is a wide range in the manner and level of regulation and standardization of each country. However, the main common point observed gathers five countries: Germany, Switzerland, UK, Ireland and France, since they have each a specific regulation for trams and its safety management. As urban public transport is a strategic issue of European transport policy, it seems that the same level of safety should be the goal of the regulations. Nevertheless the way to achieve is still today a matter for each country: the conclusion is that there is no need for a higher degree of standardisation - and the Action does not aim at standardising.

Glossary

Last objective, a common glossary has been established in order to check if there was any language issue and no potential misunderstandings or mistranslations. This glossary (not a dictionary) is on main terms in the original language and their descriptions in English (tramway, LRT, mixed zones, segregated lines, etc.), illustrated. A global table with all translations in each language represented and comments has also been made.

Globally, no complicated issue occurred but terms as “Metrobus” or “local authority” have appeared to mean slightly different ideas.

DATA COLLECTION ON ACCIDENTS

In this part of the COST Action’s state of the art exploration the objectives were: on the one hand, to study the kind of indicators used by each country to analyse light rail accidents; on the other hand, to study the harmonization of these indicators at the national level.

Indicators used by country

Regarding indicators, no major difference appears between the national level and the individual operators. Indicators were classified in 4 types: global indicators, geographical indicators, typological indicators and economic indicators.

Some definitions are similar from one country to another:

- The number of events often includes all the events that may occur on tramway network. Some differences appear in the level of severity of damages.
- Fatalities = persons died in 30 days after the accident (it is the OECD definition),
- Victims = fatalities + heavily injured + lightly injured,
- Passenger = person travelling in the tram.

In some cases, definitions may be different:

- the types of events – but they often distinguish collision with a third party, passenger accident, derailment, impact against obstacle,
- heavily injured: it is often considered as persons hospitalised more than 1 day (OECD definition), but in Czech Republic, the incapacity to work is also used.

The most common collected data in the studied countries are as follows:

- number of events (total);
- number of events (by types of events);
- number of fatalities;
- number of seriously injured people;
- number of lightly injured people;
- number of victims;
- number of victims (passengers);
- number of victims (3rd parties).

Global indicators

The indicators the most used are:

- events per km run (used in the 7 countries studied in this part of the Action: Portugal, France, Italy, Ireland, Spain, Switzerland, Czech Republic), even if the definition of the "km run" is not really clear, the differences between definitions are not essential. For Czech Republic, Portugal and Spain, it is all km run by vehicle, even those inside the depot or when running without passengers towards the terminus. For Ireland, it is only commercial journey.
- collisions per km run (5 countries – not in Switzerland and Spain). Portuguese operators count collisions between 2 tramway.
- number of accidents divided by number of road junction (4 countries – not in Italy, Spain and Switzerland),
- events per passenger x km (3 countries)

Geographical indicators

The indicators the most used are:

- Distribution of collisions by type of places (6 countries - not in Spain).
  But the definitions of the type of places are very different from one country to another. For some ones, it is the distinction between stations, intersections and running sections with several level of precisions. Others only consider major crossing (crossings road/ tram tracks and pedestrian crossings) or intersections. The last ones determine type of places in function of the types of accidents (accident caused by turning off the road, car drivers failing to stop or jumping the red lights, turn left before tram, etc.).
- Several indicators used by 3 countries (France, Ireland, Czech Republic) are the following:
  - distribution of victims of collisions by type of places
  - distribution of collisions with pedestrians by type of places
  - distribution of serious victims in collisions with pedestrians by type of places
  - risk of collision by type of places of collisions
  - risk of victims by type of places of collisions
  - risk of serious collision by type of places of collisions
  - spatial distribution of events

Typological indicators

The indicators the most used are:

- distribution of events by period of year (months) (7 countries). In France, the distribution of events is analysed by year. And 4 countries analyse distribution of events by type of day (Portugal, Italy, Switzerland and Czech Republic) or by period of day (Portugal, Ireland, Switzerland and Czech Republic).
- distribution of collisions by causes (5 countries – Portugal, France, Italy, Spain, Czech Republic). There is no precision about the causes taken into account. In France, it is the type of traffic light (stop, R24, R17).
- relative distribution of events by types (5 countries – Portugal, France, Italy, Spain, Czech Republic). There are several definitions for type of events but they often distinguish collision with a third party, passenger accident, derailment and impact against obstacle.
- distribution of collisions by 3rd parties (4 countries: France, Ireland, Spain and Czech Republic). Third parties are defined as other persons without passengers and tram staff.

Economical indicators

3 countries use the cost as an indicator (rolling stock repairing and infrastructure and equipment repairing): Portugal, Italy, Czech Republic. 3 countries record the disruption of operation due to accidents: Italy, Spain and Czech Republic. 2 countries analyse the duration of the immobilisation of rolling stock: Portugal and Czech Republic.

Indicators' harmonization

All operators make statistics with their indicators. 7 countries have harmonised their set of indicators at a national level and make statistical "reports" (Italy, Germany, Switzerland, Poland, Ireland, United Kingdom and France), generally with data provided by operators, and 5 of them give the indication that these reports have to be transmitted to national safety authority (Italy, Switzerland, Ireland, United Kingdom and France). The remaining four countries have no national indicators because their legislation does not ask for it (Czech Republic, Netherlands, Portugal and Spain), some because of no national regulation but strong regional level and others because tramway legislation is very old and does not provide for national indicators.

In most cases there is a general obligation to provide accident data to a control office, but there is not a required minimum set of indicators to perform the monitoring of the system safety.

The philosophy of the main regulation on tram accidents' national indicators tends to be not only a technical report but also mainly a tool that can help the legislator to be more careful with the operation of each system. Moreover, each technical sub-system of infrastructure or equipment is evaluated according to safety conditions.

There is an important question that should be answered: should it be a harmonization of tram safety indicators at a European level? The benefits of European wide harmonisation are difficult to determine and would probably be very difficult to achieve. This situation can be compared to what already exists:

- railways: trams are not railways. Trams are different, they operate in a street environment where the risks come from outside agencies (car drivers, pedestrians, highway authorities) over which the tramway operator has little or no control. All it can do is make sure his drivers and controllers are prepared for the risks and take action to reduce them. Of course, there are other ways of reducing risks related to the tramway design and urban insertion, that are going to be treated in the following point of this paper.
- road: another comparison has been proposed since tramway companies are generally public transport companies and they have also public transport systems like buses. But trams are specific, with long braking distances and various systems of priority.

INFRASTRUCTURE DESIGN AND URBAN INSERTION

The main work developed in relation to infrastructure design and urban insertion was the identification and gathering of information about common "Interaction points" in the LRT lines/networks from the different participating countries. Interaction points are the main points of the LRT's infrastructure whose design has to be properly studied in order to guarantee the safety of the system in its interaction with public space. It should be pointed out that the meaning of "interaction point" in this case is wide, including interaction locations but other interaction elements as well, as signalling and signage.

Interaction Points Identification

In relation to the Interaction Points identification, the first main conclusion made is the need to study separately the stations/stops and the rest of the infrastructure (called "between stations"). This distinction is made due to the important differences between those two kinds of zones, both in relation to the operation of the system and to the users/pedestrians behaviour.

In relation to LRT operation, the vehicles' speed when approaching stations/stops is usually low, as the vehicle needs to stop in the station for passengers to board and alight; the speed in between stations zones will be as high as it is allowed by the maximum operational speed of the infrastructure, the vehicle acceleration capability, and the circumstances of the track (as the LRT usually runs on line of sight, where the tram driver adjusts the vehicle speed depending on the situation: existence of pedestrians in the vicinity, cars crossing the tracks, etc.).

In relation to users/pedestrian behaviour, most people around stations/stops are the users of the system, so they are aware of the approaching vehicles as they want to board them. In consequence, it would seem that these zones would be safer because of this awareness.

Nevertheless, there are several circumstances that make the stops particularly troublesome points, which are the following:

- Users hurry to catch the vehicle coming, which can lead them to behave in a more risky way.
- The tendency to cross the tracks via inappropriate or non-organised paths, in order to get the more direct route to their final destination.
- The accumulation of users during rush hour in the limited space of the platform, with some of them trying to pass each other in the unsafe zone of the platform.
- The possible existence of stopped LRT vehicles, which restricts the visibility of other approaching LRT vehicles.

On the other hand, the other street users in "between stations" zones can be less aware of the existence of the LRT system, or, more commonly, of the approaching of a LRT vehicle. This fact can lead to additional different risks in these zones.

Once this distinction between different zones was made, the question about which main users of the streets would conflict with the system arose. This was a pretty simple question, as obviously its answer is that every one of the other users of the street is a candidate to conflict with the system, being them: road vehicles, pedestrians and cyclists.

Finally, a brainstorm was made among the participants in order to identify the interaction points, obtaining the following list of potential interaction points, as well as the potential conflicting users for every one of them:

Interaction point ID	selection		
	pedestrians	cars	cyclists
Road junctions (cars and cyclists) with tramway		x	x
Road junctions (cars and cyclists) with a left turn		x	x
Roundabouts		x	x
Tramway segregation along the street (lanes and sidewalks)	x	x	x
Tramway perception on mixed streets (cars and cyclists)		x	x
Tramway perception on pedestrians areas	x		
Pedestrians level crossings	x		x
Cyclists in segregated areas			x
Stops and its accesses	x	x	x
Interchange areas	x	x	x
Traffic (road & pedestrians) signals	x	x	x
Line signalling	x	x	x

During the second phase of the Action a questionnaire will be sent to operators of each country to get information about their more dangerous locations and design recommendations will be developed for these places.

Interaction Points Data Collection

Once the interaction points were identified, the next step was the gathering of information about good and bad design examples for these interaction points in the different countries participating in the Action.

For this purpose, a template sheet was prepared in such a way that the participants from each country could fill it in with their examples, in order to have a standardised source of information for the next phases of the Action.

The template sheet was as follows:

N	Network: Case			
Location	City	Network	Line	Section
Operation Mode	segregated tramway	mixed zone	banalized space	
Interaction Points between LRT and	pedestrians	cars	cyclists	
Landscape and surrondings context	Description			
Location	station	between stations		
Description	type of solution_configuration			
	advantages			
	disadvantages			
	innovation aspects			
Images + Plans				

The number of examples gathered for each interaction point is the following:

Entry	Interaction point ID *	number of examples	
		stations	between stations
pedestrians			
1	Tramway segregation along the street (lanes and sidewalks)	0	5
2	Tramway perception on pedestrians areas	0	8
3	Pedestrians level crossings	6	5
4	Stops and its acesses	10	0
5	Interchange areas	6	0
6	Traffic (road & pedestrians) signals	0	3
7	Line signalling	2	1
cars			
1	Road junctions (cars and cyclists) with tramway	1	13
2	Road junctions (cars and cyclists) with a left turn	0	5
3	Roundabouts	0	5
4	Tramway segregation along the street (lanes and sidewalks)	0	11
5	Tramway perception on mixed streets (cars and cyclists)	0	4
6	Stops and its acesses	0	0
7	Interchange areas	0	0
8	Traffic (road & pedestrians) signals	0	3
9	Line signalling	0	3
cyclists			
1	Road junctions (cars and cyclists) with tramway	0	3
2	Road junctions (cars and cyclists) with a left turn	0	0
3	Roundabouts	0	2
4	Tramway segregation along the street (lanes and sidewalks)	0	4
5	Tramway perception on mixed streets (cars and cyclists)	0	2
6	Pedestrians level crossings	0	2
7	Cyclists in segregated areas	0	3
8	Stops and its acesses	0	0
9	Interchange areas	0	0
10	Traffic (road & pedestrians) signals	0	1
11	Line signalling	2	1

First Conclusions about Interaction Points

After the compilation of all the examples gathered, first conclusions have been achieved in relation to good and bad practices for LRT design in interaction with public space. These conclusions are related to the following subjects:

- Stations:
  - Pedestrian pathways at stations
  - Platform design and stop/station location
- Between stations:
  - Pavement treatment: on shared channels and on segregated channels.
  - LRT separators on segregated channels: green separators and other kinds of separators.
  - Intersections: left-turn intersections; roundabouts; intersections of general streets with shared channels; pedestrian and cyclists crossings; and specific LRT signalling at intersections.
  - LRT channel differentiation and protection by means of pavement, marks, fences and barriers.
  - OCS (overhead contact system) poles location.

These first conclusions are the base for starting the second working phase of the Action, related to comparison, analysis and best practices. This working phase is starting now and its main output will be a design toolkit for getting a safe LRT urban insertion.

CONCLUSIONS

The first conclusions of the state of the art exploration in relation to LRT safety has been presented in this paper, in relation to three very different subjects: institutional and regulatory aspects; data collection on accidents; and infrastructure design:

- one of the main results achieved in relation to the institutional and regulatory frame is the knowledgeable improvement about similarities and dissimilarities among different European countries in this field: there is a wide range in the manner and level of regulation and standardization for light rail systems in each country.
- in relation to data collection on accidents, we have produced an overview of organisational options in terms of gathering and using data (safety, operation). But the harmonisation of accidents and operation's data collection and indicators cannot be achieved. The benefits of European wide harmonisation are difficult to determine and would probably be very difficult to achieve. There may however be some lessons to be learnt which could reduce risks on new systems. The common knowledge on safety issues (problems, levels, impacts, indicators, causes of accidents and incidents) will be continued during the second working phase of the Action.
- the main achievement about infrastructure design and urban insertion is the compilation and analysis of good and bad practices in relation to safety when interacting with other street users (pedestrians, cyclists and road vehicle users). Every country's systems face similar kinds of risky situations, and there are specific design solutions that may be generally considered as safe or dangerous.

The results of the analysis will be recommendations for safest tram insertion in urban spaces, through a guideline with risks, objectives and possible solution to cover them for example with design examples and additional measures aiming at a safe interaction of new and existing LRT systems with public space.

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