DaCoTA

Road Safety Data Collection, Transfer and Analysis

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1. INTRODUCTION

The overall objective of DaCoTA is to help develop knowledge-based road safety policies in European countries by continuing to develop a European Road Safety Observatory (ERSO) and providing methods to use ERSO data for policy development and implementation.

Road safety has been increasing in motorized countries now for 30 years and this increase shows that political willingness and efficient countermeasures can actually produce positive results. The last couple of decades have seen a promising increase in e-safety systems directly linked to technological progress. These systems are complementary to traditional safety countermeasures (regulation, education, enforcement, advertising and information campaign, car crashworthiness, infrastructure improvements, etc.) E-safety systems address accident prevention (preventive safety), accident avoidance (active safety), injury mitigation (passive safety) and rescue and health care improvement. These systems are intended to assist, inform or alert the driver by addressing one or several driving tasks (e.g. a navigation system helps the driver in his search for the right direction), by amplifying driver actions (e.g. the emergency brake assist reduces the time necessary to reach ABS regulation), by correcting a problem (i.e. ESC recovers loss of control), by preparing and providing car occupant or external user protection in the case of a crash (e.g. seat belts, airbags and pre-crash systems), or even by relieving the driver of certain tasks (e.g. Intelligent Speed Adaptation systems can, to a certain extent, replace the driver for speed regulation). And of course some other systems are protecting the car occupants in combination with a stiffer and enhanced car structure (seat belts, load limiters, pretensioners, airbags, etc.)

eSafety is often regarded in its very limited viewpoint which is concerning only stand-alone car technologies. It is, however, actually embracing much more: road infrastructure safety, traffic, car-to-car communication, also car-to-car or user-to-user communication or any kind of countermeasures linked with the availability of new technology. To a certain extent, automatic speed cameras and automatic penalties can also be considered as e-safety systems.

The integrated safety program (FP6), the e-safety forum, the cars 21 initiative and other actions since the nineties have demonstrated that, as far as research or deployment issues are concerned, the automotive industry, the road building industry and the public authorities have increasingly paid attention to the potential of technology to save lives and reduce harm on European roads. Considerable investments and expectations have been put in technology as a promising way for crash and injury prevention.

A European Road Safety Observatory must then take the broad and extended e-safety issues into consideration by analysing what types of safety problems are addressed by technologies, and, if and how technologies are effectively and efficiently addressing these problems.

The consideration of e-safety as a potential means for accident and injury prevention encompasses four main aspects, in sequential order:

- The determination and/or the updating of accident and injury causation issues
- The identification and the update of the road users' needs in terms of accident and injury risk reduction based of this prior knowledge about causation (if, for example, accident causation analysis reveals a problem in driver's perception

of the pedestrian in unlit urban areas, the driver need could be an enhanced vision in unlit urban areas).

- The determination of whether current or future technology can address these needs (for example, do the current night vision applications, and the technology behind, really target, in its complexity, the needs for a better detection of pedestrian in unlit urban areas)
- The assessment of all the potential benefits, and not exclusively the safety benefits

With the progress of the electronics, the evolution of safety systems always more sophisticated in the automotive industry tends to develop more and more. This Technology which was formerly reserved in “luxury” vehicle begins to become more democratic on more popular vehicle thanks to the costs which decrease. In front of this myriad of solutions it is important to be able to estimate the effectiveness of these systems to select the most relevant, be able to prioritize them, even propose them in the regulations. 3 main challenges have to be taken into account:

- in an evolutionary context and multidisciplinary expectations to define relevant criteria;
- develop tools, strong methodologies to calculate these criteria;
- to have an effective and accessible common information system on the accidents in Europe

The basic research question of WP5 is “How does technology contribute to road safety?”
The objective is to develop methodologies and approaches that will enable future evaluation of the safety impact of emerging intelligent technologies.

To answer to this question we propose in this report to develop the following aspects:

1. The methodological point of view: The objective is to develop methodologies and approaches that will enable future evaluation of the safety impact of emerging intelligent technologies. This is done by:
   - Identifying and updating the user’s needs in term of accident risk prevention and injury risk prevention
   - Identifying and updating how current technology can address these needs
   - Providing methodology on assessing the potential benefits of the relevant safety applications (not only the safety benefits).
2. The technological point of view : the objective is to show the limits and the future challenges related to the technology;
3. Tools/support point of view: Previous assessment methods need data to estimate effectiveness or performance of the technology. We propose here in the third part to make a specific step on this important aspect.

ASSESSMENT METHODS

In road safety, develop technology for the technology does not offer a great interest. This technology so innovative it is must serve first safety and bring a real added value to the driver in case of problem that he was not able to anticipate. The question is to know how to measure this contribution?

Thanks to the help of the mathematics and the statistics, assessment methods did not stop evolving to estimate the effectiveness of the systems to solve certain problems of road safety. In spite of the considerable progress which were realized, the complexity of the context, the sophistication and the increasing number of the “driving assistances”, the diversity of assessment methods and supports used to perform them (such injury accident databases) make that it is necessary to pursue the researches.

Regarding assessment methods, several issues have to be reached:

- The evolution of the road safety context. There are many years road safety was one a main concerns only in some countries (such as Sweden, UK or the Netherlands), while in other countries it stayed a target, without any real whish, ambitions or means to succeed, or for the most of states others priorities (economic or social) were more significant. The most important is not to be the best student with “good” results but that this road safety feeling is shared by everyone, that every citizen feels concerned. However if this awareness is not well anchored, they remain very fragile in particular in a difficult economic and social environment as today. In EU27, the last decade showed that with an attainable target and a real commitment of every actor, progress is possible. The road safety context evolves in space and time: problems are different according to regions (Industrialized countries and emerging countries), evolvement of the mobility (electric/hybrid vehicles, priority to soft modes, etc.), vehicles safer and safer for everybody, new regulations, improvement and development of consumerist test (EuroNCap, LatinNCap, JNCap, etc.), bigger and bigger awareness by citizens, governments increasing the safety demand. All these components lead to changes in road safety context for which we have to be able to dread them. This can be done through a road safety observatory for example, allowing to update periodically the road safety diagnosis (in order to be able to have a statistical description of the road injury accidents, to handle evolution, the stakes, to define next priorities, to readjust road safety targets, to draw a realistic road map, to correct forecasting, etc.), or to update exposure data to know the change in the exposed population (travel patterns), to have a better idea of the new habits. A part of this issue has been developed in report D5.1 [1]
- The valuable notion: different values exist related to the human kind such as for example the health, eradication of starving, elimination of poverty, eradication of criminality, eradication of suicides, accident and injury prevention, ensure employment, avoidance of conflicts, wars, etc. and all of this for everyone, everywhere, now and in the future. For a long time, the road safety focused on the notion related to the Health and we mainly consider a road accident as an “illness”. In the road safety context, the question is what do we mean by illness healing? In other words, do we save lives? Do we mitigate injuries? Who takes benefits (what group) of the healing? Who pays and how much money do we save (e.g. in terms of price of life). Most of time we argue in terms of safety benefits and more precisely in terms of injury and fatality reduction. Others values exist depending on the domain of the stakeholder. Identity brand, consumerism rating, societal value,

environmental value, economical value, ethics, client value, citizenship, technological value, etc.

- A general framework of the assessment activity is missing. Today the evaluation of safety systems is realized from well-known and basic methods but which base on no formalization. These methods rely essentially to know how of evaluators and the data which are available. The definition of a framework would allow to base these assessment tools, to identify the lacks or the areas of research to be developed (as well the methods as the data), to better formalize the requests to have more adapted results.

- The existence of several evaluations with different results. In the literature, it is not rare to find several articles dealing with the efficiency of the same safety system with sometimes different estimations. The great majority of these differences result either the working hypotheses, the used method, the interpretation made it or the used data. Rather than to choose to realize an additional evaluation, it would be necessary to develop the meta-analysis.

- L’existence de plusieurs évaluations avec des résultats différents. Dans la littérature, il n’est pas rare de trouver plusieurs articles traitant de l’efficacité d’un même système avec des résultats parfois différents. La grande majorité de ces différences proviennent soit des hypothèses de travail, soit de la méthode utilisée, soit de l’interprétation qui en ai faite ou encore des données utilisées. Plutôt que de faire le choix de réaliser une évaluation supplémentaire, il faudrait développer les méta-analyses.

- The first role of active safety systems is to help us to manage (indeed to correct by itself in case of automatic system) critical situations and to avoid the accident. Most of the evaluation studies are interested only for that purpose and forget other effects. Among these, there are the side effects (for example the system can also have an influence on other typologies of accident), the effects not planned (the driver can use the system for other thing of why it was designed), the indirect effects which can modify the behavior of the driver (for example the driver can increase his risk taking believing that the system can compensate for his gap) or undesirable effects (for example the system can generate a new type of accident).

- The sophistication of the news and future technologies. For the last decades we got into a new area where the electronics rise sharply and became omnipresent. At first very expensive, its development and its advances made it gradually accessible and today every vehicles are equipped with. In a near future vehicles will be also communicating. They can so exchange information between them but also with the infrastructure and the environnment. The evaluation of the effectiveness of this type of very sophisticated system (many interactions, exchanges, information to be sorted out and to rank, the diversity of the technologies of communication which can be used, the interferences, etc.) cannot be only made with the current assessment tools.

- The increasing number of safety device in vehicles. That they are dedicated to protect occupants in case of crash (passive safety systems) or to avoid the accident (active safety systems), safety systems are today more and more numerous in our vehicles. This proliferation of these helps or assistants and the heterogeneousness of "packages" makes harder and harder the studies of evaluation to be able to measure the effectiveness of such or such system (or group of systems) independently of the others.

- The driver’s behaviour in the assessment loop. In regard to road safety, electronics allowed the development of ADAS (Advanced Driver

Assistance Systems) allowing to provide a “personal” assistance to the driver in case of problem(s). If some of these helps are automatic, others ask for an interaction with the driver (through an HMI[1] for example) so that he can decide on an adapted corrective solution and execute it.

Only a part of these issues have been studied in the WP5, and especially in task 5.2 and 5.3 respectively dedicated to the validation of the technology and the evaluation.

1.1. A general framework of the assessment activity

In order to improve the assessment activity we have to identify some issues that need to be handled. The current stakes of evaluation activity concern its objectives, the indicators, the tools/methods and the unpredictable changes.

Firstly, it is difficult for evaluators to identify what are the stakeholders’ expectations concerning evaluation. The diversity of actors and their domain implies diversity in their needs; they do not all want the same things. Some of them focus on the economic side, other on the public health or technological sides. The main issue for evaluators (who design and perform evaluations) is that no method or tools that could help them in identifying needs are available.

Secondly, the major media used in evaluation to deliver the results is the “indicator”. It is a mathematical object that gives factual information. Related to the first point, the conception of indicators is dependent of the expressed needs. Therefore, according to issues in identifying needs, evaluators have difficulties to offer relevant indicators. They mainly used indicators that they are in the habit to use and that they are able to calculate. Moreover, we do not identify methods/tools that allow designing new indicators.

Thirdly, evaluation is an activity that needs to be formalized in order to guide the evaluators’ work. We only identify some operational methods and tools but we do not know how they were build and if they are relevant according to the needs. We do not find a general evaluation model that could handle its definition, its realization, its valorization and its evolution.

Finally, the road system is a complex system that is usually represented by the triptych: vehicle, user and environment. One can understand its complexity by the unpredictable behavior of each of its component. For the evaluators, who need to understand what they evaluate, complexity is an obstacle. They cannot foresee all the unpredictable changes that could affect performances of a safety strategy. For instance, the implementation of a system that automatically regulates speed of the vehicle could lead to the appearance of new drivers’ behavior that could be dangerous. They can take advantage of it to perform other task like phoning or reading. Complexity also implies a dynamic vision of the evaluation activity; this is not always the same. It evolves according the changes of its context. However, how evaluators can make evolve evaluations?

Following these observations, we proposed in the report D.5.4 a framework of the evaluation activity. This report introduces the representation of this framework through a systemic paradigm. Various functional and descriptive models are proposed. Evaluators used them as guidelines in order to model knowledge on study case and to design evaluations. This general framework takes into account the various viewpoints of stakeholders and evaluators. It allows performing evaluations that are relevant for all the various stakeholders and that aim to assess performances

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[1] Human Machine Interface

according to various viewpoints (aggregation of various performances from road safety fields – accidentology, economy, biomechanics, etc.).
This approach allows to define a comprehensive and helpful framework on the assessment activity.

1.2. Assessing and improving vehicle safety

As we identified previously, the progress regarding electronics and its progressive accessibility in terms of cost are going to allow the development of new more adapted safety systems and the resolution of problems up to now technically inaccessible.

So beautiful, perfect and innovative is, the safety system has first to answer to a real need and to solve as indicates its name a problem of safety.

For that purpose, it is important to have a solid core relying mainly on the following actions:

- The implementation of an information system on road accidents, common at European level (at world scale would be fantastic but not realistic) and to built it to last (this point has been tackled by WP2);
- Improve the knowledge of the road accidents by updating periodically the road safety diagnosis for be able to describe the stakes and identify the priorities according to the problems (causes, factors, etc.) remaining to solve;
- Improve the assessment methods in order to progress and estimate better the "real" safety contribution of the systems, which means to be able to estimate their effectiveness with the help of relevant criteria, but also of identifying their potential limitations in real situations, from technical point of view, or due to exogenous or endogenous factors from the driver point of view.

Today most of the assessment methods on the effectiveness of safety systems consider the device as a black box (it is the case for a posteriori evaluations where only input and output are needed). We only look at the effects of the system. It is not need to know its features, only its domain of functioning that generally means one or several types of accidents which it is supposed to solve. On the other hand, the system has to be enough spread in the motor vehicle fleet to be found and that this sample has a significant size.

When it is not the case (for example for new systems) these classic methods cannot be used any more. Then, it is necessary to use a priori evaluation methods. The simulation tools with case by case analysis on relevant injury accidents still remains one of the methods usually used, but others exist. In this type of study, it is necessary to know a little more on the system, in particular some of their technical characteristics. It is what we called the white box (see figure below). This more thorough knowledge of the system can open on of wider studies. So, if some of technical characteristics are available on a set of systems, we are able to realize comparative studies (benchmark test) between these systems.
In the same way, the availability of technical data would allow to work on the optimization of the functioning of the system by finding the best compromise between the parameters to adapt itself to the real accidents life.
Also another possibility would be to participate to the design development by the definition of the specifications of the device built on the accidents data.

To improve the assessment studies, it is necessary to be able to take into account all effects and not those directly connected to the system itself. Until now, most of the proposed safety systems are activated in a automatic way (airbags, ESC[2], etc.) or semiautomatic (need an activation by the driver such as ABS[3] or EBA[4]) and did not require a "interaction", an exchange with the driver.
The development of the new driving assistances (in particular alarm systems) are tending to attract more the driver through interface. Their effectiveness is going to depend not only on their functioning, but also on the one of the interface (HIM) and on the behaviour of the driver in the processing of the alert and the corrective action which he is going to undertake.
In other words, these systems cannot content themselves any more with an evaluation of the efficiency such as they were made up, and will have to take into account other aspects such as those connected to the human factor, which means to put the driver in the evaluation loop (Intelligent Box in figure 1). Today this knowledge still very poor, but thanks to the naturalistic driving studies (see DacoTA WP6) and/or field operational test (FOT), this gap can be filled as one goes along.

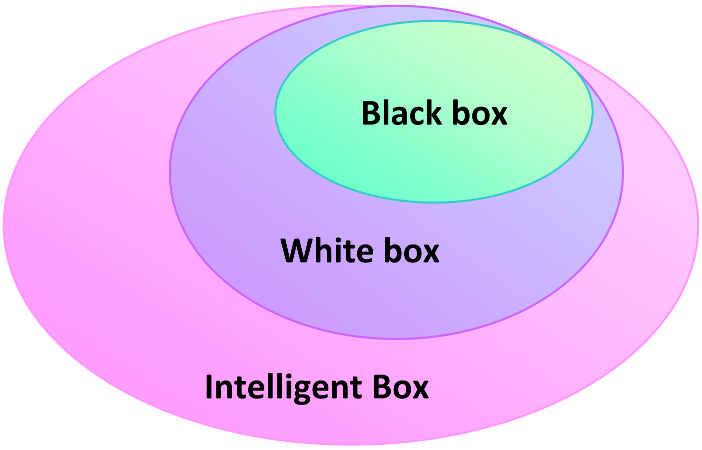


Figure 1: Global view of the assessment methods

1.2.1. Evaluation tools

The rapid growth of intelligent systems fitted to vehicles and the road infrastructure has raised the need to systematically evaluate the impact on safety and to give guidance on the most valuable functionalities of these systems.

Numerous assessment methods exist. They differ for most of them by the type of data that you have to have, by the scientific (mathematics) background that you need to perform them or also by the type of requests.

The safety benefits of systems can either be assessed on the basis of real-world accident data using epidemiological approaches or by a priori evaluation methods based on simulation tools or case-by-case analyses. The application of epidemiological methods necessitates that the system under investigation is on the market long enough to exert an influence visible in real-world accidents. Only then it is possible to gain information on its efficiency based on accident statistics. Many of these systems, however, take more than a decade to achieve a sufficient penetration

[2] Electronic Stability Control
[3] Anti-blocking Braking System
[4] Emergency Braking Assist

rate. As a rule it is not possible to wait e.g. 10 years until the assessment of a system is feasible. Thus, the application of simulation tools can be a helpful instrument. Quite naturally these tools require detailed accident analyses and are based on certain assumptions, e.g. on the extent the system reduces impact speed. In order to verify these assumptions and the resulting predicted efficiency it could be beneficial to assess the outcomes of the tools by a posteriori methods as soon as the system shows a sufficient market penetration.

When using a posteriori or epidemiological methods it has to be determined if the evaluation is based on routine data or if a special survey should be conducted. Although the usage of routine data generally cause less costs it is often not possible to perform the evaluation on this basis since information on the equipment of vehicles with the safety system under investigation are not available in these data. Thus, in many cases the best way to perform an (a posteriori) evaluation of vehicle safety systems is to conduct a cohort study, possibly under application of a matched-pairs concept (pairing an equipped vehicle with a - similar but unequipped - reference vehicle). In any case the accumulation of safety systems has to be thoroughly looked at when the efficiency of a certain system is to be assessed.

If the evaluation results shall be expanded from one or a few countries to the EU-27 the iterative proportional fitting procedure can be applied as far as some basic auxiliary information at EU-27 level are available. This is especially relevant for results coming from an a priori evaluation because here for each case it can be determined whether or not the presence of the system would have avoided or mitigated the accident. Thus, the distributions (regarding e.g. injury severity, light conditions, etc.) of both the affected and unaffected accidents are known and can be expanded to a wider accident population. However, one should be cautious when interpreting the estimation outcomes since differences between countries e.g. regarding vehicle fleet may be a limiting factor for validity of the results.

Concerning socio-economic evaluation of systems, the application of a cost-benefit-analysis should be aimed at. In order to estimate the benefits (cost reduction due to the mitigation or prevention of accidents) standard accident cost schemes can be used.

All these concepts are detailed in deliverable D5.6. The objective of this report is to give an overview on the state of art of evaluation tools and by this providing some kind of reference book for the application of these tools.

1.2.2. Drivers' needs analysis

This type of analysis has been conducted in the frame of the task 5.2 and constitutes a specific contribution to the studies dedicated to the evaluation of safety functions effectiveness. This contribution presents the specificity to be directed toward road user's needs, the particularity to be based on a methodology taking into account attested human safety difficulties (functional failures) an accident reality (context parameters).

Drivers' needs analysis allows to identify:

- Safety needs for different kinds of drivers, reflecting their accident-generating failures at the different stage of the process;
- The potential capacity of safety functions to meet these needs;
- The potential lacks in the functions efficiency.

Such results allow estimating the more or less appropriateness of the current safety systems, but also their weaknesses when considering real accident situations constraints. They also give some clues on the needs which are still not covered by the present devices. By such, these results can be considered as a contribution to the prospective ergonomics of safety systems, allowing their improvement for a better adequacy to the needs shown by drivers in accident situations and to the contextual constraints found in these situations.

Drivers' needs analysis is described with details in the deliverable D5.5 with the objective to evaluate the capacity of safety functions to compensate for drivers' needs as they can be diagnosed thought in-depth accident analysis.

Two main criteria are used in this purpose: 1) the ability of each function to meet the needs of the drivers (e.g. if the driver shows a need in detection or diagnosis, is the system considered devoted to give the information or diagnosis needed?); 2) their capacity to cope with the parameters of the situations in which these needs were found (e.g. time/space constraints, trigger threshold of the system, physiological state of the driver, behavioural considerations, etc.).

The study has been conducted on a sample of 445 road traffic in-depth accident studies involving passenger cars, two-wheelers and pedestrians. It has been applied to the e-safety functions addressed in details within the technical DaCoTa Deliverable D5.2 ("Catalogue of the current safety systems") plus some e-safety functions dedicated to powered-two wheelers and also functions infrastructure-based.

The results present in detail for each accident configuration (car versus car, car versus PTW, car versus pedestrian, single vehicle accidents) and for each phase of the accident (approaching phase, rupture phase, emergency phase) the potential capacity of the safety functions to meet driver's needs. They also give a precise indication on all the parameters that could act as a potential limitation to the effectiveness of the systems.

Such results allow estimating the more or less appropriateness of the current safety systems, but also their weaknesses when considering real accident situations constraints. They also give some clues on the needs which are still not covered by the present devices. By such, these results can be considered as a contribution to the prospective ergonomics of safety systems, allowing their improvement for a better adequacy to the needs shown by drivers in accident situations and to the contextual constraints found in these situations.

Of course, the sample on which this study is based should be extended in order to gain in representativeness. This could be one of the interests of a European in-depth accident database as developed within WP 2 of DaCoTa Project.

Other aspects are still to apprehend in further studies, notably dealing with the acceptance of safety systems and the capacity of their future users to master them appropriately.

1.2.3. Real world and Regulation

Another way of improving the vehicle safety can be realized through the regulations or the consumerist tests such as EuroNCap.

These improvements not have to first objective to incite the creation of new innovative systems but aim mainly at establishing a minimum required level of safety for all vehicles.

The main difficulty bases on the definition of the configurations of tests approaching as much as possible real conditions of what we observe in the accidents, on the definition of relevant criteria, and on the definition of threshold or corridor in which the criterion must be established.

These points have been partly tackled in task 5.4 and in deliverables D5.3 and D5.6.

Regarding regulation or consumerist test, accident data still remains a big challenge. To establish criteria it is indispensable to have available accident data to be able to estimate the real effectiveness of a safety system. Today, even with the same method the results can differ according to the support used. In front of the diversity of road accident databases and the lack of having a consensus at the European level, the tendency of these institutions relies on the qualification of certain support and the recommendation to use them to realize assessments.

1.3. Future challenges

WP5 has been mainly oriented to assessment methods.

Among different issues picked out during the different studies carried out in the project, some challenges

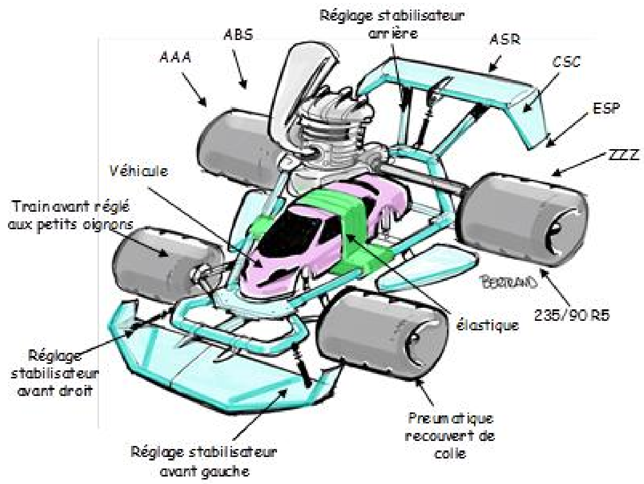
- We have to develop new criteria better adapted in new and future concerns. On one hand the gains in terms of human life will be more and more low because more we will get closer to the zero severe injuries or deaths on roads more this quest will be difficult, and on the other hand future safety systems will offer more than safety (example vehicle to vehicle communication) and these other values could be more significant in other future context (economic, societal, environmental, etc.).

- Assessment methods need to be improve to take into account the new challenge brought by future technology. These improvements will Identify the lacks of a methodological point of view and not content with making what we know how to make with the data that we have. They will go through the development and the availability of accident data (today one of the weak points of the methods), by the consideration of the human factor in the evaluation loop and the development of the statistical tools.

- Today it is not rare to find several studies of evaluation of the same safety system with sometimes results which can to be different even contradictory. These differences are understandable most of the time by the taken hypotheses, the used method or the selected sample. The development of the meta-analysis would be interesting because it is a statistical approach combining the results of a series of independent studies on a given problem. Meta-analysis would allow a more precise analysis of the data by the increase of the number of studied cases and to draw a global conclusion. This approach widely used in medicine for the global interpretation of clinical trials. She would also allow to detect the biases of method of the analysed studies.

2. TECHNOLOGY

The main difficulty when we speak about “technology” it is that behind this generic word can hide other meanings. In the context of the road safety, technology can be interpreted as a safety system or to a component of this device. For example, if we want to dread the characteristics of functioning of a safety countermeasure, we realize that for the same service it can exist various safety systems which can themselves differentiated by the used technologies or its features.



Here we see appearing several concepts which we are going to define:

Safety Service: a service is a help or assistance supplied with the aim of answering a general road safety problem (example visibility enhancement, help of vehicle control, detection of the collision, etc.).

A ***Safety System*** is a component of a service, a tool of application allowing to solve a specific problem. For example, the system of detection of the blind spot is a system allowing to enhance the visibility for the driver (the safety service). A system can also be included in several services (example, the AEBS[5] is a system answering the services of detection of a collision or still a help of vehicle control in emergency situation by the contribution of an automatic braking).

A ***Technology*** is a component of the safety system which assures a very precise function (for example acquisition, processing, execution, etc.). It refers to the technical aspect. A same technology can be used by various security systems.

Let us take an example: improvement of the braking efficiency.

The required service is to bring a solution which allows improving the performances of a braking in emergency situation.

Today, several safety systems answering this service exist (the following list is not exhaustive):

- ABS (Anti-Blocking System) which equips all the new vehicles and which avoids the blocking of wheels (loss of the efficiency of the friction) during a strong request of the braking by the driver.

[5] Automatic Emergency Braking System : this system scan the road in front of the vehicle and in case of detection of an obstacle activate an emergency braking.

- EBA (Emergency Braking Assist) which activates an optimal braking (ABS type) as soon as the driver requests an emergency braking. In fact the system is based either from an strong effort or a fast attack of the brake pedal.

- AEBS (Automatic Emergency Braking System) who activates an automatic braking as soon as an obstacle is identified in front of the trajectory of the vehicle.

Let us take now the example of the AEBS safety system and mainly those dedicated to the pedestrian. In this case, the system must be capable to detect a pedestrian in the trajectory of the vehicle and to stop the vehicle before the crash. Today, there are several technologies allowing to detect a pedestrian:

- The Radar: it is detection system which uses radio waves to determine the range, altitude, direction, or speed of objects. The radar dish or antenna transmits pulses of radio waves or microwaves which bounce off any object in their path. The object returns a tiny part of the wave's energy to a dish or antenna which is usually located at the same site as the transmitter.
- Infrared Detector: it is a system allowing to detect the presence of a pedestrian from the thermal radiation of the object.
- The camera: the road scene in front of the vehicle is filmed by a camera most generally placed behind the rear-view mirror and a program is in charge of identifying the pedestrian(s) but also of being able to plan if this pedestrian will become a potential obstacle.

In this report when we speak about technology, we shall refer mainly to the notion of safety system.

In the task 5.2 we tried to draw up a list (not exhaustive) of available safety systems. 21 safety systems were selected for the vehicle. For each system, we created a specific card on which we find the following information (deliverable D5.2):

- Its name
- A list of the problems solved by the service
- The covered features
- The identification of the phases of the accident where the service can intervene
- Its different operating modes (Informative, alert, cooperative or automatic)
- The list of existing devices equipping vehicles and their main technical characteristics
- The associated evaluations of effectiveness which have been published.

These characteristics have been chosen in order to serve the drivers' need analysis

So beautiful and so successful is, a safety system have to be effective and to solve a real need or a safety problem.

There are 2 kinds to make:

- The first one is the one that we could denominate the "engineer's method" which consists in developing a safety system from a vague idea of a problem that he thinks of being important. Once the device created, and only after, an evaluation study is made. Here we design first a system and we check a posteriori that it corresponds to a real need.

- The second consists to start from a need and then to create the system the most adapted to the researched problem. Naturally, here also it is important to check its effectiveness once the system is developed because the technical constraints can reduce its functioning.

We see that in every case it is indispensable to have evaluation tools.

2.1. Main issues

Regarding the “Technology” point of view several issues have to be reach:

- Is the technology addressing the right problems? To answer this question, it is necessary to have available safety diagnosis (as up to date as possible) and a common methodology on accident causation to identify and quantify the stakes. It requires mainly the implementation of an information system on the successful and accessible road accidents for every member state but also at the European level.
- Is the technology correctly solving the problem? It is important to check that the final product, first correspond to the initial request and because some technical limitations exist, what is its real effectiveness.
- How much does it cost? The cost is not the same following who we talk about. Even if the economic balance advocates its use and its development, the distribution between profits and the costs cannot be allocated to the same group.
- What is the value for the client? As useful and effective is the safety system, is the customer will want to pay to have the system in his car, or he will consider that it is a due. Today, the automotive industry is able to make a high safety technological vehicle but unsalable. The economic crisis which affects Europe also risks to change our priorities. The craze for the low-cost cars shows well this tendency.
- Is it reliable? The challenge is to find the best compromise between the detection of all the aimed situations and the false alarms.
- Assume a safety integrated level. The complexity and the sophistication of the electronic systems increase more and more their vulnerability in the failures. The electronics and the embarked software have to lean on mechanisms of operating safety to protect itself against these risks of dysfunctions.
- To be effective certain safety systems must be very wide-spread (example communication car-to-car or car-to-infrastructure)
- To know the safety equipment in vehicles. Today it is very difficult to have an exhaustive list of the safety equipment of a vehicle. This information is spread and most of the time their access is limited. The diversity of the systems for a same safety service adds some confusion (cf Deliverable D5.2).

2.2. The limits

Today the perfect system does not exist. The best safety system still remains the human but he can have failures (cf. deliverable D5.5). The machine (device) is made for correct these failures, but it has some limits too:

- Limitations due to the technical possibilities;

- Limitations due to environmental requirements met in the accidents. The environmental conditions of a road accident are not controlled as well as in a test scenario.
- Limitations due to the driver himself. He can badly interpret an alert, either be unfit to react correctly or to be inattentive to his driving task.
- Limitations due to the way the system is used by the driver
- Limitations due to the costs of components or technical solutions.
- Humans have failure, the technology too

2.3. Future challenges

The safety systems of tomorrow will be more and more sophisticated. They will interface at first with the driver to become then autonomous and to manage at first very simple situations (car park manoeuvres, movement in mastered zone or driving on highway) then harder and harder to manage critical situations.

Regarding technology several challenges exist for the next years. Among them, the most important could be:

- Make ADA more accurate. Often the scope of the safety systems mounted on vehicles is limited. In these technological limitations, come to add limitations due to the environmental conditions (meteorological, traffic, surface, etc.) and sometimes also those relative to the state of the driver. The problem of the acceptability also rises (should not the help be too intrusive) but also the one related to the trust made by the driver for the system.

- Communication V2X: behind the technical problems connected to the communication protocol, to the standardization of exchange formats, to the selection of the relevant information to deliver to the driver, to the HIM, raises the problem of the evaluation of a system so complex;

- Automation: this step will represent a real jump forward and will imply numerous changes in our relation with the car. The autonomous vehicle which will circulate on any road is not for tomorrow because it will require at first the acquisition of knowledge related to the travel, to the traffic and to the road environment. The first vehicles will circulate in a restricted and controlled environment or will make simple manoeuver such as the car park for example.

3. DATA SUPPORT

The data are located at the heart of the process of information. They represent measures (observations), attributes or variables of social or economic nature. No matter the subject, the data play an important role in the understanding of what surrounds us.

In road safety, the knowledge on the accidents and their mechanisms requires the implementation of a dedicated information system. This information system articulates around 4 types of data:

- The macroscopic accident data: they are based on aggregated information allowing to determine essentially stakes in terms of road safety or to make descriptive statistical analyses and only identify roughly the causes of accidents. Generally these databases contain the exhaustiveness of the accidents but with a low level of details. They correspond to the national accident census collected most of time by the police. They are for example databases such as CARE[6] or IRTAD[7] at the European level or BAAC[8] in France.
- The microscopic accident data: these collections are based on the constitution of a sample of accidents, analysed in detail and coded by experts. These analyses are going to allow to determine the accidental and injury mechanisms and to carry out studies on more complete and more adapted typologies of accidents. These analyses allow to determine the operational failures, in connection with the situational context of the driving (interaction between the drivers, infrastructure and the vehicle) and the context interns of the driving (status, intentions, motivations, etc.). This type of database includes generally a very big volume of information but about a number limited of cases. Unfortunately, these data collection are very expensive (experts team at full time) and ask a long time to have a consequent sample. One of their forces is to be able to adapt themself according to the new research questions. This type of data can be used for all type of evaluation, a priori evaluation too. Several such databases exist in Europe: EDA[9] in France or GIDAS[10] in Germany, CCIS[11] or OTS[12] in UK or INTACT[13] in Sweden.

➢ The exposure data. This type of collection allowing to characterize a particular population (for example the young drivers or pedestrians) and so allow to give indicators connected to the notion of risk by the identification of the exposed population. This type of data are not so spread except for traditional census like vehicle fleet, average km driven, habitants, age pyramid, etc.

➢ All the knowledge in road safety. This class gathers every tool and assessment methodologies as well as all the produced studies in road safety.

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[6] Community Road Accident Database. CARE is the European centralised database on road accidents which result in death or injury across the EU. CARE provides Member States access to this central database which is hosted by the European Commission at the Luxembourg data centre.
[7] International Road Traffic and Accident Database. The IRTAD database includes accident and traffic data and other safety indicators for 29 OECD countries.
[8] Bulletin d’Analyse des Accident Corporels (France)
[9] Etudes Détaillées d’Accidents (France)
[10] German In-Depth Accident Study (Germany)
[11] Co-operative Crash Injury Study (UK)
[12] On The Spot (UK)
[13] Investigation Network and Traffic Accident Collection Techniques (Sweden)

3.1. In-depth Accident databases

Since the mid 1990's a number of EU projects including STAIRS, PENDENT, RISER, MAIDS, EACS, ETAC and SafetyNet, have been commissioned to collect and devise methods to unify European data collection activities. This would then provide an in-depth database of comparable accidents allowing wide scale analysis and ultimately improving the understanding of the EU accident population.

In spite of these several attempts at European level, none has been perpetuated and there was no available common database structure which can be easily used by a new team wishing to go into this type of investigation.

However, some countries of the European Union (sometimes some private companies) developed their own in-depth accident database. It is the case of GIDAS in Germany, OTS in UK or the EDA in France, INTACT in Sweden for example.

If the strengths in terms of knowledge on the accidental and injury mechanisms brought by this type of investigation are not to be any more developed, there are numerous weaknesses which can slow down their development:

- The implementation of a specialised team at full-time remains very expensive, both at the level of the training and of the functioning;
- Need a long time to collect enough information to be correctly used;
- The necessary authorizations and the problems connected to the confidentiality of certain data (personal or medical) can be a real obstacle in certain countries;
- The harmonisation of variables is missing;
- The development of dedicate software to fill in information;
- No incitation from Europe to use a common dataset.

3.2. Vehicle safety equipment database

Information concerning vehicle safety equipment is more and more important especially for a posteriori evaluation. In order to be able to estimate the effectiveness of a device, we have to know which type of vehicles is equipped with.

Today the information on vehicles in terms of safety equipment can be obtained by various sources:

- Motor magazines or technical vehicle documentations. Most of these reviews give different type of information on vehicle such as technical characteristics or performance and today standard safety equipment. If documents are easily available, the implementation and the update of such a database can be time consuming and become quickly boring.
- The files of the registered vehicles. These files contain many information generally collected by a private company. Most of these files are not free and you have to pay to have it. The price depends on the requested information.
- Files manufacturers. These files are generally confidential and only the manufacturer can have access to the data.

3.3. Exposure data

There is no standard method for the collection of each exposure measure. In particular, different exposure measures may be derived from one collection method. For example, a travel survey may be used to collect vehicle kilometres, but may at the same time be used to obtain the number of trips, the time spent in traffic, vehicle ownership, or driver license holder ship. Accordingly, data collected by different methods may be used to produce an exposure estimate. For instance, passenger kilometres estimates may be obtained by using vehicle kilometres derived by traffic counts and vehicle occupancy rates obtained through surveys.

The usual exposure data that are most of time accessible are:

- Travel Surveys
- Traffic counts
- Vehicle fleet registers
- Driving licenses registers
- Road registers

However, the new technologies and the associated methods based on risk exposure ask to have information on specific target population such one linked to the driver behavior depending on some context.

3.4. Challenges

Regarding road safety, the accident data are the weak link. Without these data there are no observations, no understanding of the problems, no stakes, no statistical description, no risk estimation, no identification of the priorities, etc.

If the data macroscopic accident data are available in most of the countries of the European Union, the data microscopic accident data are much less numerous and do not have often the same level of information what makes very complicated concatenations.

The main issues regarding in-depth accident data rely on the existence, the availability and the necessity to have a common core structure.

From the exposure point of view, some new improvements will be brought by the development and the spread of naturalistic driving or field operational tests studies.

4. CONCLUSION & PERSPECTIVES

From evaluation point of view, the critical point still remains at European level where no common information system shared by all members states works.

Nevertheless the DaCoTA project showed that a common structure answering most of the researches questions could be organized at European level.
However without strong directive on behalf of Europe, the use of this structure is left free for each member states.
This lack of realization risks to be a brake for some countries to want to take a step forward and so to have “weapons” to fight better against the road insecurity and reach at the ambitious objectives fixed by Europe for 2020.
Certainly the question of the cost stays one of the main brakes because a complete information system on road accident must be carried out on the long term and needs experts. These Needs are not only for public institutions but are also shared by the industry.

The knowledge has to be shared and continuously improve in particular on the two following axes:

- Assessment tools and methodologies. The future security systems cannot be any more estimated correctly with the current methods. These will owe evolved to be more precise, quantify all the effects and take into account new concerns. Among the improvements which seem important to us today there are identification of new criteria (other been worth than injury reduction), the consideration of the human behaviour in evaluation loop and the development of the meta-analysis.

- Set up a common European information system. Whether it is for future decisions or orientations regarding road safety or for the identification of the priorities regarding development of the safety systems or anticipation of the future problems, the “sinews of war” will always be the accident data. If today in Europe most of the member states possess their own macroscopic accident data (more or less up to date), for example, the disaggregated accident data remain very scattered. From our point of view the future challenges as regards accident data will be:
    - The development and the spread of in-depth accident data collection on the model brought by DaCoTA (see WP2);
    - The implementation of a database gathering data regarding the list of the safety equipment by vehicle model;
    - The development of exposure data such as the one those that could be extracted from naturalistic driving (ND) or field operational test (FOT) studies.

European commission, members states authority, automotive industry, road maker and all other actor in road safety have to work together in order to reach the 2020 target and to anticipate what will be tomorrow.

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