European Road Safety and e-Safety

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Abstract

The objective of this research is to develop and describe a methodology that allows building the structure of a European Road Safety Observatory (ERSO) that addresses these e-safety issues, identify the nature of the data that has to be stored in such an observatory, in a way that it is easily interpretable and usable, and finally to implement suitable methods for appropriate e-safety data analyses that will assess the most promising technological counter-measures. For this reason, a five-step methodology is developed. The analysis revealed that a well matched statistical analysis model is necessary for quantitative assessment of the e-Safety systems, indicating whether they address the real users' needs revealed by the causation analysis. The expansion of the current benefits figures to an EU level and the analysis of the interactions between technology-based applications are considered to be the fundamental plinth upon which the relevant structure and data of ERSO are determined, allowing supplement other types of accident data and develop knowledge-based road safety policies at EU level.

Keywords: Safety; e-Safety; technologies; test procedures.

Résumé

L'objectif de cette recherche est de développer et de décrire une méthodologie qui permet de former la structure d'un Observatoire de la sécurité routière européenne (ERSO) qui aborde des questions de e-sécurité en ligne, d'identifier la nature des données qui doivent être inclus dans un tel observatoire, d'une manière qui est facilement interprétable et utilisable, et enfin de mettre en œuvre des méthodes appropriées pour des analyses de données de e-sécurité qui permettront d'évaluer les contre-mesures technologiques les plus prometteuses. Pour cette raison, une méthode avait ete développé en cinq étapes. L'analyse a relevé qu' un modèle d'analyse statistique bien adapté est nécessaire pour l'évaluation quantitative des systèmes de e-sécurité, indiquant si elles répondent aux besoins des utilisateurs réels révélés par l'analyse du lien de causalité. L'expansion d'avantages actuels au niveau de l'EU et de l'analyse des interactions entre les applications basées sur la technologie sont considérées comme un élément fondamental de la structure et les données de ERSO, et qui permet de compléter d'autres types de données sur les accidents et développer les politiques de sécurité routière basées sur la connaissance au niveau européen.

Mots-clé: sécurité; e-sécurité; technologies; les procédures d'essai.

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1. Introduction

The rapid growth of intelligent systems fitted to vehicles and the road infrastructure in the last decades, has raised the need to systematically evaluate their impact on safety and to give guidance on the most valuable functionalities of electronic based systems. e-Safety issues should be considered by analyzing what types of safety problems are addressed by technologies, and, if and how technologies are effectively and efficiently addressing these problems.

e-Safety is defined as vehicle-based intelligent safety systems which could improve road safety in terms of crash avoidance, crash severity mitigation and protection and post-crash phases or, integrated in-vehicle or infrastructure based systems, which contribute to one or more of these crash-phases. e-Safety is often regarded in its very limited viewpoint, concerning only stand-alone car technologies, whereas actually it embraces 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. Moreover, to a certain extent, automatic speed cameras and automatic penalties can also be considered as types of e-safety systems.

These systems are complementary to traditional road safety countermeasures (i.e. regulation, education, enforcement, advertising and information campaign, car crashworthiness, infrastructure improvements, etc.) The e-Safety systems address accident prevention (preventive safety), accident avoidance (active safety), injury mitigation (passive safety) and rescue and health care improvement. Furthermore, 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.)

Since these systems have an increasingly important role on road safety, ERSO, the European Road Safety Observatory, must take the broad and extended e-Safety issues into consideration by analysing the types of safety problems addressed by these technologies and if and how technologies are effectively and efficiently addressing these problems. The consideration of e-safety as potential means for accident and injury prevention encompasses four main aspects, in sequential order:

- The determination and/or the updating of injury and accident causation issues
- The identification and the update of the road users' needs in terms of accident and injury risk reduction based on this prior knowledge about causation
- The determination of whether current or future technology can address these needs

The objective of this study is to define the structure of the European Road Safety Observatory (ERSO) that addresses these e-safety issues, identify the nature of the data and information that has to be stored in such an observatory, in a way that it is easily interpretable and usable, and finally to implement suitable methods for appropriate e-safety data analyses that will assess the most promising technological counter-measures. In order to achieve this objective a five-step methodology is developed. Initially, the needs and expectations in ERSO are recorded allowing definition of the content, structure and format of the related data. An accident causation model that enables further identifying causes of crashes and causes of injuries is established and a catalogue of safety systems is provided. A general model for evaluating the safety and other benefits of technologies is further built and applied to a certain number of technologies identified. Recommendations explaining how evaluation results can be included in ERSO are formed, emphasizing on the estimation of benefit indicators generalisable to the wider European accident population. Finally, guidelines are proposed for future test procedures used for the evaluation of safety systems, to respond effectively to the real world conditions.

2. Drivers’ needs and the validation of technologies

When considering how safety systems fulfill drivers' needs, leading to an evaluation of overall benefit, it is important to understand the overall functionality of the system, taking into account as many design parameters as possible and considering previous evaluation work. On this purpose a list of 31 e-Safety systems was developed and a standardized template was defined to record all available information about each of the systems.

2.1. List of Safety Systems

e-Safety systems currently fall under four possible headings (Atalar et.al., 2012):

- Passive safety measures: reducing the consequences of an accident by managing the crash forces.
- Active safety measures: reducing the possibility of accidents occurring by taking preventative measures.
- Integrated safety measures: aiming at integrating active and passive safety systems within a vehicle to allow the vehicle to adapt to a pre-crash situation and either stop the crash from occurring or reducing the crash consequences by reacting to the crash appropriately.
- Rescue safety measures: also known as tertiary technologies. Optimising the rescue phase by supplying information on crash severity and location to rescue services.

As expected with such a wide range of safety systems, different functional modes are present, from systems that are completely automatic (i.e. electronic stability control) to those requiring driver reaction (i.e. lane departure warning). According to the literature review (Atalar et.al., 2012), there are 31 main safety relevant systems that are currently becoming established on vehicles or are likely to be realised in the near future.

In the following Table 1, the safety systems that were analysed within the framework of the DaCoTA project are put into generic descriptive categories, according to the service they provide, that could be used regarding drivers' needs and system effectiveness evaluation (Grömping et.al., 2007).

Table 1: Safety systems

Name	Abb.	Service
Advanced Adaptive Front Light System	AAFS	Visibility
ABS (Antilock Braking System)	ABS	Dynamic Control Longitudinal
Adaptive Cruise Control	ACC	Dynamic Control Longitudinal
Airbag Pedestrian Protection	PedPro	Protection
Alcolock Keys	AK	Driver Behaviour
Anti Whiplash Seat	AW	Protection
Automated Headlights	AutoLights	Visibility
Blind Spot Detection	BS	Visibility
Brake Assist	BA	Dynamic Control Longitudinal
Collision Avoidance and Automatic Emergency Braking (not pedestrian)	CA (AEB)	Dynamic Control Longitudinal
Collision Warning	CW	Warning
Drowsy Driver Detection System	DDS	Driver Behaviour
eCall	eCall	Localization/Prevention
Electronic Stability Control	ESC	Dynamic Control lateral
Event Data Recorder	EDR	Driver Behaviour
Intelligent Speed Adaptation	ISA	Dynamic Control Longitudinal and Speed / Warning
Intersection Control	IC	Communication
Lane Changing Assistant	LCA	Warning
Lane Keeping Assistant	LKA	Dynamic Control Lateral
LDW (Lane Departure Warning)	LDW	Dynamic Control Lateral
Low Friction Detection	LoFrctD	Localization/Prevention
Night Vision	NV	Visibility
Precrash (Presafe)	PreSAFE	Protection
Predictive Assist Braking	PBA	Dynamic Control Longitudinal
Rollover Detection	RollD	Dynamic Control Lateral
Speed Cameras	SpdCam	Localization/Prevention
Traffic Sign Recognition	TSR	Communication
Tyre Pressure Monitoring and Warning	TPMS	Warning
Vulnerable Road Users Protection	VRU	Dynamic Control Longitudinal
Youth Driver Monitoring	DrvMon	Driver Behaviour
Youth Key	YK	Driver Behaviour

2.2. Standard template for information collection- ACC example

The aim of developing a standard template for each safety system is to give a good representation of generic system functions and parameters whilst also describing the functionality of current technologies fitted to vehicles. The structure of this proposed standard template starts with a thorough description of the system's aim, along with pictures or figures that describe the system operation. Then, the intentional and unintentional functions covered by the system, as well as the phases of the accident sequence upon which the system is acting, are defined and subsequently, in each template the different levels of intervention that the examined safety system can provide are described. Furthermore, technical specifications are provided aiming to give a good representation for generic system functions and parameters whilst also describing the functionality of current technologies fitted to vehicles, giving examples of particular vehicles. Finally, previous evaluations in terms of both methodology and results are provided as links, in order to recognize previous evaluations of safety systems.

The standard templates are developed for each of the 31 safety systems presented above, allowing analysts to quickly acquire the necessary information to consider how safety systems fulfill driver's needs. For the purpose of this study, information collected through the proposed standard template is presented for the Adaptive Cruise Control (ACC) system, as an example.

<u>Aim of the system</u>
If a leading vehicle is travelling at a lower speed than the user's vehicle, or is located within the preset time or distance headway, the ACC system intervenes via braking pressure or throttle/engine torque control so that the headway increases. The system only intervenes if the current preselected speed or headway would lead to a likely collision or the speed would reduce the set headway. ACC may employ radar, laser or machine vision to continuously monitor the leading vehicle. Auxiliary detectors also monitor the speed, yaw and cornering rate of the vehicle to maintain tracking of the leading vehicle in the same lane when cornering.

<u>Functions covered by the system</u>
- Keeps a set distance to vehicle in front
- Detecting a fixed obstacle on the road
- Predicting that another user will stop or slow down
- Predicting that another user will move off or fail to stop
- Improved traffic flow

<u>Phases of the accident sequence upon which the system is acting</u>

Table 2: Phases of the accident sequence

Phases	Evaluation of actions
Driving Phase	ACC may employ radar, laser or machine vision (camera) to continuously monitor the leading vehicle
Rupture Phase	The system intervenes if the current preselected speed or headway would lead to a likely collision
Emergency Phase	The system decelerates the vehicle
Crash Phase	If a collision is inevitable the system may have been able to decrease speed and lower crash severity
Rescue Phase	ACC may employ radar, laser or machine vision (camera) to continuously monitor the leading vehicle

<u>Level of intervention</u>

Table 3: Level of intervention

		Specifications
Perceptive Mode		ACC may employ radar, laser or machine vision to continuously monitor the leading vehicle
Mutual Control	Warning Mode	The system warns if the current preselected speed or headway would lead to a likely collision
	Limit Mode	The system intervenes if the current preselected speed or headway would lead to a likely collision
	Corrective Mode	-
	Action Suggestion Mode	-
Delegation of function	Regulated Mode	-
	Prescriptive Mode	-
	Mediatised Mode	-
Automation		The system can decelerate or accelerate the vehicle if the current preselected speed or headway would lead to a likely collision. Or to maintain a safe headway.

Results revealed that although there are many different implementations of safety systems with different performance parameters, the development of a safety systems inventory can become a useful tool for analysts to establish a feel for a generic system, project the functionality of such a system onto available accident data and importantly to evaluate if the system really meets drivers' needs.

3. Review of evaluation procedures

Different organizations and bodies are involved to the development of safety systems' test procedures and several methodologies for testing and evaluation of preventive safety functions have been addressed in research projects in Europe and US during the last years. Although test methods for validation of e-Safety systems with drivers in the loop are not widely applied, there are certain methods for testing specific systems, mainly given by means of standards. Additionally, some research projects have already been carried out in the field of e-Safety systems testing and evaluation. Their focus was mainly on strategies and methodologies for testing active safety systems, allowing defining a minimum requirements for their functionalities. The ISO (International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees; each member body interested in a specific topic for which a technical committee is established, has the right to be part of that committee.

The SAE International (Society of Automotive Engineers) also has committees developing standards related to active safety systems. The most relevant committee is the Safety and Human Factors steering committee within the Vehicle Safety Systems group. Other relevant SAE groups and committees are: Safety Systems Component Advisory group, Truck and Bus Brake Systems committee and Highway Time Forum Steering committee.

The National Highway Traffic Safety Administration (NHTSA) in the US has proposed three test procedures for FCW, LDW and ESC systems which are related to US NCAP (New Car Assessment Programme) assessments. EuroNCAP has a specific test protocol for ESC systems and other active safety systems can be rewarded (Euro NCAP Advanced) by using the Beyond Euro NCAP Assessment Protocol. ESC systems are rewarded if fitted in the assessed vehicle in the Australasian NCAP (ANCAP). Other NCAP organizations are: Japan NCAP (JNCAP), China NCAP (C-NCAP) and Korea NCAP (KNCAP). The following Table summarizes which standards are used for the evaluation of the most widely used safety systems.

Table 4: Connection between different standards and systems

Standard / Report	ACC	FCW	BSD	LKA	LDW	ABS	ESC
ISO 3888-1:1999							●
ISO 3888-2:2002							●
ISO 6597:2005						●	
ISO 7401:2003							●
ISO 7975:2006						●	
ISO 15622:2002	●						
ISO 15623:2002		●					
ISO 17361:2007					●		
ISO.DIS 17387			●	●			
ISO 21994:2007						●	
ISO.DIS 22178	●						
ISO.DIS 22179	●						
SAE J2399	●						
SAE J2400		●					
SAE J2478				●			
SAE J2536						●	
FMCSA-MCRR-05-005					●		
FMCSA-MCRR-05-007	●	●					
FMVSS 126							●
GRRF-63-26							●

Through testing procedures, a significant amount of data is recorded. These data have to be processed and interpreted in an efficient way. The measured data can then be used to calculate safety performance indicators describing the performance of the safety function. Post-processing of measured data should be automatable and representative in a clear format and results should be understandable by different recipients and a fortiori for the customer. While experts are able to interpret precise measurements, end customers should be provided with abstracted values, e.g. by means of a rating.

However, the evaluation of a safety system for regulatory consideration is a complex procedure since different interests of various stakeholders need to be considered, but finally a decision is made whether to presently consider the system or to defer its consideration indefinitely. An evaluation that indicates present consideration requires full attention and further concrete steps. Such steps could involve educating consumers on the merits of a safety system, incentivizing automobile manufacturers to make the system readily available or further analyzing the system. As a future step the recommendation for new test procedures can be attempted, when necessary, enabling specific technological systems to approach as much as possible the real conditions and cover a wider part of the “real world” road safety problems.

4. Determination of a general evaluation model

In road safety we find many of actors having different interests and for which the word “evaluation” has no same meaning, understanding or does not include the same things. For these reasons, a dedicated study was carried out. In this study, a general knowledge on the evaluation activity is attempted, focused on a five steps model and provides a macroscopic definition of the evaluation activity that was used as a generic pattern. As a second step a systemic paradigm is described, providing the knowledge to handle modeling complexity in order to understand the road system and the evaluation. Finally, knowledge on the evaluation model design theories is described.

4.1 The Five Steps model of the evaluation activity

The five steps model (see the following figure) is the most macroscopic representation of the evaluation activity. It provides the steps that evaluators always have to execute during evaluations and though it is not restricted to road safety, it can be successfully applied to the evaluation procedure of all e-Safety systems. It is a synthesis of knowledge on evaluation that comes from road safety and other fields like engineering design, education, and economics. Initially, definitions were identified according to the state of the art, interviews with experts and workshops with stakeholders. Therefore, it was assumed that this representation is not completely relevant for all the areas. However, it is enough generic in order to be adapted to the needs. It describes all the activities to be performed, but evaluators can only execute some of them according to their evaluation context.

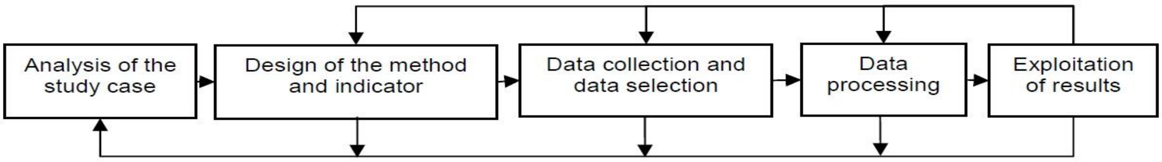

Fig. 1. The Five Steps model

This model aims to propose a definition of the evaluation activity that can be used by the evaluators. It is based on a central sequential process (composed by activities) and on feedback loops. These latter are used to allow asking for more knowledge on the evaluation case or to redo some steps when results are not validated. Two types of activities are cosidered. The first type is about the activities that focus on the upstream of the evaluation activity. These are the "analysis of the study case" and the "design of the methods and indicators", activities which are less time consuming and costly in comparison to the following three steps, but are very critical for the subsequent success of the evaluation activity. The second type concerns the operational activities. These include the "data collection", the "data processing" and the exploitation of the results".

"Analysis of the evaluation case": formalization of the evaluation case provides goals and contextual knowledge used by the evaluators to design and execute evaluations. Knowledge on the study case is significant to achieve an evaluation. For instance, this is knowledge on evaluation problems, on the evaluated safety strategy, on the context and on the stakeholders. The evaluators design and adapt their behavior in order to reach goals that they identify during this first step. This step is taken by the evaluators in relation to the stakeholder. The stakeholder expresses (but not automatically) his needs concerning the evaluation, his activity, his assumptions and his understanding of the evaluated safety strategy.

"Design of the evaluation method and indicator": this second step is about the design of the indicators and the evaluation methods. It focuses on the selection or/and the construction of the relevant indicators and methods that are used to answer to the declared problem(s). We speak of a design step because of the need to evaluate things that are in constant evolution. Evaluators can reuse methods and indicators that already exist, but sometimes they have to propose new ones.

"Data collecting and data selection", "data processing" and "exploitation of results" focus on the execution of the methods that were designed earlier (step N°2). These steps are geared to finding the relevant data, to process them and to exploit the results.

Certainly, the duration of each step and the related cost differs depending on the system that is evaluated.

One fundamental conclusion is related to the fact that the first steps of the evaluation activity are those that most need to be enhanced by providing new models. Accident data collecting and statistical methods are the most common fields of research in evaluation, however, a large lack in the formalization in the two first steps is noted while they directly influence the achievement of the three others. Firstly, it is difficult for evaluators to model knowledge on the study case since there is no formalization of stakeholders' needs. Evaluators do not have access to this information or/and stakeholders cannot clearly express their needs. Secondly, there is an issue concerning the communication between people from various areas and thirdly, some of the objects/systems to be modeled are complex. Moreover, concerning the design of the indicators and the methods, it is assumed that evaluators mainly use their habit with the risk being that the results may not be adapted to the needs, mainly due to the fact that evaluations are performed mostly according to the operational constraints (availability of the data and tools). Additionally, there is a need for tools that will fit the use of indicators and methods with the study cases, concerning the reuse and the enhancement of the design of new indicators and methods (construction step).

4.2 The Modeling Activity

Modeling activity aims to construct models that depict behavior and structure of systems. It also describes the way to perform an activity such as evaluation. Thereby, there is a need for another modeling paradigm that handles the complexity of road system. It will not replace the classical paradigm; it will be complementary. In this study, the systemic paradigm is analysed. In France, Le Moigne (1999) has formalized and enhanced this paradigm under the concept of "the general system". Le Moigne (1999) followed the research of Von Bertalanffy (1973) and he was inspired by Morin (2005) and Simon (1996).

Systemic paradigm was developed in order to provide answer to the limits of the classical modeling paradigm. It proposes a relative vision of the modeling activity when systems are dynamics objects. The general formulation of this paradigm is based on four axes: "a system is something that exists (ontological viewpoint), that operates (functional viewpoint), that evolves (genetical viewpoint) in a dynamic context by following some goals (teleological viewpoint)". The major differences with classical paradigm are on the genetical and the teleological axes. Complex changes of the systems can be understood by taking into account these two axes. Complex systems change its behavior according to the modifications of their context in order to achieve their intrinsic goals. In this paradigm, modelers are no longer external of the modeled reality; they directly interact with it. Each modeler has his own representation of the world. Thus, models are relative to the modelers.

Modeling activity does not only consider systems or objects, it also concerns activities. This epistemological reflection on modeling activity is usable for evaluation activity. This allows modeling the emergence of new indicators or methods. Evaluation is constructed gradually according to the evaluation context and the evaluators' capabilities.

4.3 The Design Theories

According to the identified issues on design of the methods and the indicators, we have looked for knowledge on this activity. An evaluation has to be done with the aim to propose indicators and methods that are relevant to the expectations and the needs. The continuous changes of these latter leads evaluators to propose new indicators and assessment methods. Nevertheless, we did not identify processes or approaches that allow handling such needs. From the analysis of the existing theories and the needs we identified the following issues:

- The designed indicators and methods have to be adapted to the evaluation problem(s). Therefore, the design activity has to be linked to the modeling of the evaluations study case. Evaluator performing the design needs to be aware of the expectations. The issue is that we do not have a method yet that allows expressing the expectations.
- Finding theory(s)/process(s) that are adapted to the current evaluators' activity. Indeed, it is impossible to impose new tasks on them if they are not adapted to their activity. This has to be an evolution of their job and not a radical change. For instance, the selected theory has to be understandable, usable and adapted to time constraints.

One has to consider design in terms of problem solving and/or creative processes. Indeed, this activity can be described as a methodological process (Pahl et.al, 1996) and (Gorti et.al., 1998) or as a cognitive process (Lawson, 2003). The first one considers design as a deterministic and linear process that begins at the specification level and goes to the desired result. The design is then fully described in terms of tasks. The second one considers design as a human cognitive activity. There are no deterministic processes. Design is an activity performed by persons according to their creative behaviour and theories.

5. Real world and procedures

Another way of improving the vehicle safety can be realized through the regulations or the consumerist tests such as EuroNCap. These improvements do not have as first objective to incite the creation of new innovative systems (i.e. the technology for the technology) but mainly aim at establishing a minimum required level of real (i.e. on the road) 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.

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.

6. Conclusion and discussion

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 two decades have seen a promising increase in e-Safety systems directly linked to technological progress.

From the evaluation point of view, the critical issue still remains at European level where no common information system shared by all members states works, despite some successful initiative as the one tested in DaCoTA. Nevertheless this study showed that a common structure answering most of the researches questions could be organized at European level, and the European Road Safety Observatory (ERSO) can be structured in a way that it addresses e-safety issues. The nature of the related data that could be stored in ERSO in a way that it is easily interpretable and usable was presented, but ERSO should also include suitable methods for appropriate e-safety data analyses that will assess the most promising technological counter-measures. A well matched statistical analysis model is necessary for quantitative assessment of the e-Safety systems, indicating whether they address the real users' needs that can be revealed by the causation analysis. These needs should also be recorded and organized in a structured way in ERSO. However without strong directive on behalf of Europe, the use of this structure is left free for each member state. This lack of realization risks to become a brake for some countries that aim to take a step forward, take appropriate measures against road insecurity and reach at the ambitious objectives set by Europe for 2020.

This study also proved that the knowledge has to be shared and continuously improved in particular on the two following axes: Firstly, regarding assessment tools and methodologies, the future safety systems cannot be any more estimated correctly with the current methods, since they will evolve to be more precise, quantify all the effects and take into account new concerns. Among the improvements which seem important to the road safety community today is the 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. Secondly, regarding setting 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 most critical 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.

Furthermore, this research highlighted the importance of human behavior in e-Safety studies, as well as the need for priority ranking of new technologies and dealing with legislative issues related to the implementation of safety systems identified. Moreover, it revealed that the development of a safety systems inventory such as ERSO, can become a useful tool for analysts to access necessary e-Safety data and information and importantly to evaluate if a safety system really meets drivers' needs. Analysis showed that like travel time and vehicle operation cost should also be considered as e-Safety effects, that may have impact on the economic growth.

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