Overview of the European Road Safety Decision Support System

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Abstract

Effective road safety policies need good information about crash risk factors and appropriate countermeasures. SafetyCube which is a European co-funded research project, addresses this gap by generating new knowledge about crash risk factors and measures' effectiveness relevant to Europe. Findings will be integrated in a European Road Safety Decision Support System (DSS) that will present for each suggested road safety measure: details of the risk factors tackled, measure, best estimate of casualty reduction effectiveness, cost-benefit evaluation and analytic background. The DSS is implemented in a modern web-based tool with a highly ergonomic interface, allowing users to get a quick overview or go deeper into the results of single studies according to their own needs. The development of the DSS will support decision making at local, regional, national and international level. In order to provide policy-makers and industry with well-structured comprehensive information about measures, it is essential that the links between risk factors and all relevant safety measures are made fully visible.

Keywords: *road safety, decision support system, road safety measures, evidence based policy making*.

Περίληψη

Οι αποτελεσματικές πολιτικές οδικής ασφάλειας χρειάζονται καλές πληροφορίες σχετικά με τους παράγοντες επικινδυνότητας ατυχημάτων και τα κατάλληλα μέτρα αντιμετώπισης. Το SafetyCube, ένα ευρωπαϊκό συγχρηματοδοτούμενο ερευνητικό πρόγραμμα, αντιμετωπίζει αυτό το υπάρχον κενό δημιουργώντας νέα γνώση χετικά με τους παράγοντες επικινδυνότητας ατυχημάτων και την αποτελεσματικότητα των μέτρων που αφορούν την Ευρώπη. Τα αποτελέσματα θα ενσωματωθούν σε ένα Ευρωπαϊκό Σύστημα Υποστήριξης Αποφάσεων Οδικής Ασφάλειας (DSS), που θα παρουσιάσει για κάθε προτεινόμενο μέτρο για την οδική ασφάλεια τα εξής: λεπτομέρειες για τους παράγοντες κινδύνου που αντιμετωπίζονται, μέτρα, καλύτερη εκτίμηση της αποτελεσματικότητας μείωσης των ατυχημάτων, αξιολόγηση κόστους-οφέλους και αναλυτικό υπόβαθρο. Το DSS υλοποιείται σε ένα σύγχρονο εργαλείο που βασίζεται στο διαδίκτυο με εργονομικό περιβάλλον, επιτρέποντας στους χρήστες μια γρήγορη επισκόπηση ή να εμβαθύνουν στα αποτελέσματα μεμονωμένων μελετών ανάλογα με τις ανάγκες τους. Η ανάπτυξη του DSS θα στηρίξει τη λήψη αποφάσεων σε τοπικό, περιφερειακό, εθνικό και διεθνές επίπεδο. Προκειμένου να παρέχονται στους φορείς χάραξης πολιτικής και στον κλάδο ολοκληρωμένες καλά δομημένες πληροφορίες σχετικά με τα μέτρα, είναι απαραίτητο να να διασφαλιστεί η σύνδεση μεταξύ των παραγόντων επικινδυνότητας ατυχημάτων και όλων των σχετικών μέτρων ασφαλείας.

Λέξεις κλειδιά: *οδική ασφάλεια, συστημα υποστηριξης αποφασεων, μέτρα οδικής ασφάλειας, τεκμηριωμένη πολιτική.*

1. Introduction

Although there has been substantial progress in improving road safety and reducing traffic fatalities, in 2012 the EU Member States with the highest road traffic crash rate by population had a rate nearly four times that of the best performing countries. To address the road safety burden a number of countries have adopted a coherent approach to road safety management which follows the Safe System Approach (Bliss and Breen, 2009).

Road safety policy-making is considered within the remit of governments and local/regional authorities. Nevertheless, all stakeholders who have an impact on road risks, including individual citizens, also have a responsibility to contribute to their reduction. The group of relevant stakeholders therefore includes not only publicly elected bodies but also industry groups including: insurance organizations, police, public health organizations, vehicle manufacturers, highway authorities and so on.

However, there are several gaps in the evidence base which constitute major challenges needing to be addressed. There is poor availability regarding the information relating to the causes of crashes and the estimation of the associated risks. There is also a lack of a clear and consolidated set of measure evaluations relevant to European road safety. Moreover, a priority setting for road safety measures within a systems approach cannot be fully supported due to lack of information. Lastly, there is an increased need for further detailed safety data analysis in support of some key road safety “hot topics”, including new technologies and other measures that have not yet been properly evaluated. The main objective of SafetyCube project (“Safety Causation, Benefits and Efficiency - www.safetycube-project.eu) is to address these gaps in the evidence base. More specifically, it is aimed to develop an innovative road safety Decision Support System (DSS) that will enable policy-makers and stakeholders to select and implement the most appropriate strategies, measures and cost-effective approaches to reduce casualties and crash severity for all road users. The core of the project includes a novel and comprehensive analysis of crash causation factors combined with newly estimated data on the effectiveness and cost-effectiveness of safety measures, not just in relation to reduction of fatalities but also the number of injured. An operational framework will be established to provide future access to the DSS once the project is completed.

The structure underlying the DSS consists of (1) a taxonomy identifying risk factors and measures and linking them to each other, (2) a repository of studies, and (3) synopses summarizing the effects estimated in the literature for each risk factor and measure, and (4) an economic efficiency evaluation (e3-calculator).

Overview of the DSS

The taxonomy consists of four parts; **(1) Road Users, (2) Infrastructure, (3) Vehicles and (4) Post Impact Care Measures.** The taxonomy is a main underlying structural component of the DSS. Within the DSS the taxonomy can be used as a search option, it creates a uniform structure over all domains and it is used as a basis for linking risk factors with their corresponding measures. The structure consists of three levels, which are topic, subtopic and specific topic.

The content of the DSS is derived from analysis of scientific literature. This takes the form of a repository data-base of coded studies. The most important challenge for coding studies for the repository is the big variety of topics addressed, which also means that the studies addressing the topics tend to have different designs. A flexible coding template has been developed to be able to include different kinds of quantitative evaluation studies, preserving the information about study-design and type of information collected, but also allowing comparison of the results.

On the basis of the studies coded in the repository, a synopsis is written for each risk factor and each countermeasure summarizing the existing effects of risk factors or measures by means of meta-analysis, vote-count analysis, or simply an overview. To address different types of DSS-users, each synopses consist of three parts: (1) Summary, (2) Scientific overview, (3) Supporting document.

The DSS will be implemented in a modern web-based tool with a highly ergonomic interface. The structure is determined by the taxonomy and will be complemented by a powerful search engine. The DSS will allow users to find synopses or single studies related to one or more risk factors or measures, to define their own search criteria (e.g. only studies from a particular country), to identify measures most appropriate to address risk factors, and to have a quick overview of the “riskiness” of risk factors or the effectiveness of measures.

The project outputs will be framed according to the specific policy and stakeholder areas – infrastructures, vehicles and road users – so that the measures developed in the project can be most readily applied. A systems approach will ensure effective coordination between these areas. The close involvement of road safety stakeholders of all types at national and EU levels, and wider will enable the DSS to be focused on the most appropriate policy-making procedures and ensure the project outputs have global reach.

This paper describes the background, methodology and design principles of the European DSS within the SafetyCube project. For the development of the European DSS a comprehensive common methodology is designed and applied in existing and new studies of road safety measures effectiveness evaluation. Moreover, extensive consultation of road safety stakeholders is carried out, by means of several workshops, in order to define the user needs for the DSS. The structure and the functioning of the DSS will be also presented, both in terms of back-end database and front-end user interface, together with the first results of the application of the common methodology for the evaluation of road safety measures effectiveness.

2. SafetyCube Methodology

The SafetyCube methodology is illustrated in this section and is based on two pillars; analysis of study designs and coding of the studies, in order to be used as input to the repository database of the Decision Support System (DSS).

2.1 Taxonomy of risks, measures and related analysis methods

The risk factors and the measures to be included in the DSS taxonomy were identified based on a systematic analysis of the road safety field. The risks and measures were assigned to one of four main areas:

- Road users
- Infrastructure
- Vehicles
- Serious injuries post impact care measures

General categories of the three main areas were firstly considered and then the specific risk factors and measures were assigned to the respective category. More than 90 risk factors and 95 measures in infrastructure areas, more than 115 risk factors and 250 measures for behaviour, more than 60 risk factors and 60 measures for the vehicle area have been identified by means of a thorough review of existing safety areas and taxonomies.

The main elements included in the SafetyCube taxonomy are presented in Table 1. In each element, several specific risk factors and measures are considered.

Table 1: *Example of taxonomy elements of risk factors and measures*

Road User	**Infrastructure**	**Vehicle**	**Post Impact care measures**
-speed choice -driving under the influence of alcohol -driving under the influence of drugs -risk taking -fatigue -distraction and inattention -functional impairment -insufficient skills -emotions and stress -age -diseases and disorders -traffic rule violations	-exposure -road type -road surface -road environment -infrastructure safety management -workzones -alignment features -lighting -traffic control	-crashworthiness -technical defects/maintenance -injury mechanism -vehicle design -visibility/conspicuity -active safety/ADAS -tertiary safety -passive safety(VRU) -passive safety on board -communication	-extraction from vehicle -first aid training -ambulance/helicopters -pre-hospital medical care -triage and allocation to trauma facilities

Literature Search

A detailed and recorded literature search is carried out so that key studies are identified (at each detailed level of the taxonomy, i.e. for each specific risk factor or measure). Several relevant literature databases were searched, e.g., Google scholar and Scopus, based on well-defined logical strings of keywords. The exact database used varied between topics depending on which database was deemed most relevant. The key-words, database used, and resulting number of studies found were documented separately for each considered risk factor and measure.

The resulting list of potentially relevant studies from each search was then screened to assess eligibility for further analysis. Generally, only studies with quantitative results were coded for the repository. Important qualitative results were, however, included in the Synopses. Moreover topic-specific inclusion and exclusion criteria were applied and documented. This was done first on the basis of the abstract, then on the basis of the full paper. If few relevant papers had been retrieved, the reference list of the selected papers were examined to identify any additional relevant papers.

There are different types of studies dealing with the safety effects of risks and measures. Study designs in road safety are closely related to those in epidemiology. Each study design is characterized by a number of principles (addressing exposure to risk/measure; experimental vs. observational; presence of control group; time dimension) and their principal application is mentioned. After the study design is appropriately categorized, the next step is to identify and record the estimators of effects, which may also very (e.g. Crash Modification Factor (CMF), Absolute difference, Regression coefficient / slope, Odds ratios and so on).

Within SafetyCube, a framework was created in order to systematically characterize a range of identified studies for each specific risk factor or measure of the taxonomy. Overall, studies can be classified in two categories, namely, experimental and observational. Observational studies are further classified into analytical and descriptive studies which can then be divided to cohort studies, case control, case cross-over and cross-sectional. Similarly, the experimental studies can be classified in randomized or non-randomized control trials, quasi-experimental studies, between group, before and after studies, and cross over.

A core characteristic of the approach is to identify the outcomes and the exposure for each study, and their relationship to each other within the study design. Outcomes typically concern accidents or injuries and in particular, their (absolute/relative) numbers, their types and severities. Exposure, in the context of road safety, either refers to exposure to risk factors or exposure to countermeasures. For a full description and details, the reader is referred to Elvik et al, 2015. Figure 1 provides an overview of the categorization of studies.

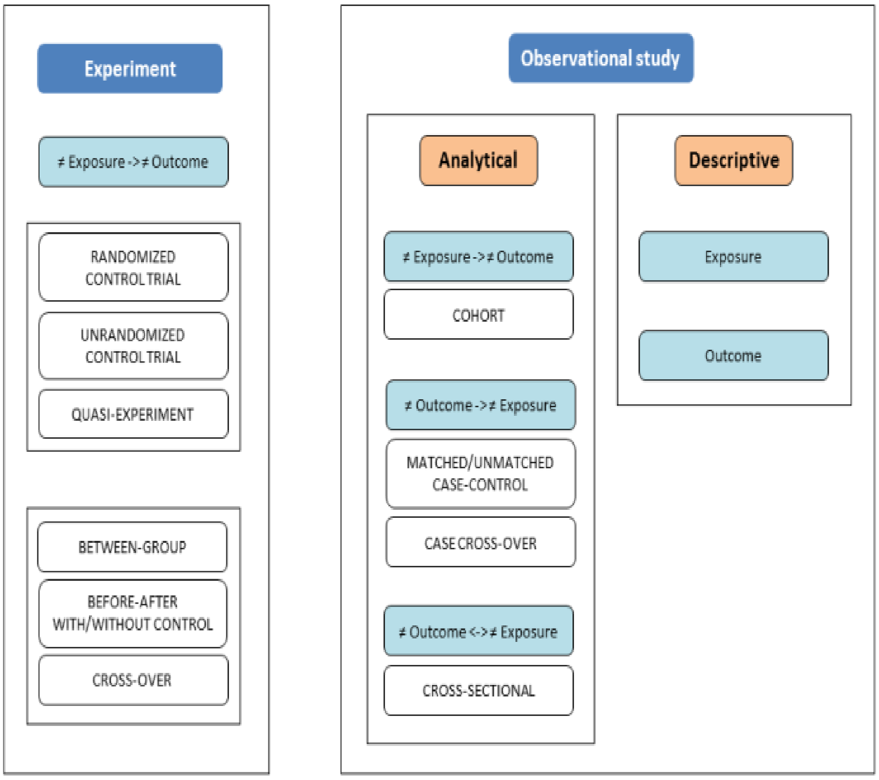

Figure 1: *Study design in analysis of risk factors and evaluation of countermeasures (source: Elvik et al. 2015).*

2.2 Coding studies

The study design and the corresponding estimator of effects of interest are entered in a template which was constructed in Microsoft Excel especially developed for coding research studies and existing results. The template includes information on the core elements of the study (study design, authors, year, abstract, road users profile, severities, potential sources of biases etc.), flexible elements (e.g. additional information that characterizes the study design), exposures (e.g. risk factors or countermeasures), outcomes (e.g. accident severity, accident frequency, accident reduction, other safety indicators, and so on), reported results (measure of effects, estimates, p-values, confidence intervals, etc.) and also a brief summary (critical overview of the study).

It is aimed to analyse and code a large number of studies for each specific risk factor or measure, and then draw the findings together into a neat "synopsis" for each topic. The SafetyCube approach is that the resulted summaries represent a complete synthesis of knowledge on the topic. Furthermore, a meta-analysis of existing studies on the topic will be included when this is possible (e.g. when there is an adequate number of studies, studies are not heterogeneous, etc.).

The collected studies investigated the effect on different outcome variables: crash-counts, simulated crash data, injury severity, on-road driving, driving in a simulator, crash simulations, and so on. They employed a large variety of research designs: before-after studies, cross-sectional designs, case-control, induced exposure, time-series; and statistical methods: simple comparisons of counts or means, different types of regression analyses, empirical Bayes, hazard rate, to name just a few. The enormous differences between studies constitute a big challenge for the creation of a joint data-base. The structure has to be general enough to allow coding different kinds of safety- or risk effects and flexible enough to capture all important details of different types of studies. For each study, the template therefore includes general information of the sampling frame and study conditions (e.g. road-user types, severity of crashes, road-types included), but also allows for the inclusion of conditions that are relevant to the specific area only (e.g. the differentiation between different injury types or details of the roadway design). Furthermore, for each estimated effect the following specifications were registered:

- what was compared to what
- analysis method/model
- measure of effect (often odds ratio but also many other less used measures of effect)
- statistical results (standard error, confidence interval)
- conclusion (significant effect on road-safety or not).

The selected studies were individually coded in a excel file coding template. The coding template consisted of several sheets, requiring the researcher to provide information, mostly in predefined categories. On the basis of the study features coded, a result tables shapes itself in which the results for all conditions that were coded could be entered. In Figure 1, an example of a result sheet in the excel template, completed for a study on the effect of a bicycle helmet.

Another important issue is the quality of research results. When comparing different studies one might wish to assign more value to good quality studies than to those that are likely to be flawed. However, the definition of a good quality study is very difficult and again varies strongly with the research area. Rather than rating the studies, it was therefore decided to indicate possible biases of a particular study and indicate how severe this possibility is believed to be. To this end, common biases for the major research designs were described and included into the coding template, so that these (or other) problems can be flagged if necessary.

☐ Differences between effects	Effect 1	Effect 2	Effect 3	Effect 4	Effect 5
Injury nature	Fracture; Internal; Open Wou	Fracture; Internal; Open Wou	Fracture; Internal; Open Wou	Fracture	Fracture
Injury severities	Moderate	AIS 3	AIS 4	AIS 3	AIS 3; AIS 4
Injury - Cases	Hospital; Head	Hospital; Head	Hospital; Head	Hospital; Head	Hospital; Head
Injury - Controls	Non-Head; Minor head	Non-Head; Minor head	Non-Head; Minor head	Non-Head; Minor head	Non-Head; Minor head
Measure of effect/association	Odds ratio	Odds ratio	Odds ratio	Odds ratio	Odds ratio
Specifications	Odds for wearing a helmet	Odds for wearing a helmet	Odds for wearing a helmet	Odds for wearing a helmet	Odds for wearing a helmet
Estimate	0.5060	0.3790	0.2570	0.4370	0.2170
Standard error of estimate					
Statistic [name(parameters)=x]					
p-value	<0.0001	<0.0001	<0.0001	0.1710	<0.0001
Sample size (x or n1=x1; n2=x2)	n (cyclist casualties)= 6745	n (cyclist casualties)= 6745	n (cyclist casualties)= 6745	n (cyclist casualties)= 6745	n (cyclist casualties)= 6745
Confidence level	0.9500	0.9500	0.9500	0.9500	0.9500
Lower limit	0.3880	0.2670	0.1480	0.1300	0.1320
Upper limit	0.6590	0.5360	0.4480	1.4660	0.3570
Adjustment variables/Covariates	Speed limit; Collision vehicle	Speed limit; Collision vehicle	Speed limit; Collision vehicle	Speed limit; Collision vehicle	Speed limit; Collision vehicle
Conclusion	Significant positive effect on	Significant positive effect on	Significant positive effect on	Non-significant effect on roa	Significant positive effect on

Figure 2: *Example of a coded study (results sheet).*

2.3 Summarizing studies

After having coded all of the selected studies, the researcher analyses the results. Three ways have been defined to analyse and summarize the results, in the decreasing order of priority:

- Meta-analysis, if there is a sufficiently large number of studies that are comparable in terms of both their scientific design features and the type of results they produced. A meta-analysis combines the numerical results of multiple studies and yields a weighted average from the results of the individual studies.
- Vote-count analysis, if a meta-analysis is not possible due to large differences between studies, but if there is a sufficient number of studies. A vote-count analysis compares the share of studies that showed a positive effect, no effect, or a negative effect.
- Review-type analysis, if the number of studies is small or if the studies are so heterogeneous that a vote-count analysis is not meaningful. In a review-type analysis the results are summarised in a more qualitative way, generally including a table of study descriptions (e.g. sample, method, outcome), the observed effects and their interpretation.

In each summarizing analysis, attention was dedicated towards the identification of modifying conditions (e.g. a counter-measure that works in urban, but not in rural settings or a risk-factor that is more dangerous for beginning drivers). In meta- or vote count analyses this was addressed by sub-group analyses.

For each of the studied risk factors and measures, a colour code was assigned to indicate the overall conclusion about the effect. Each colour code is supported by a short statement of two to three sentences.

***Table 2:** Colour code for risk factors and countermeasures.*

	Risk factor		Countermeasure
Red	Results consistently show an increased risk when exposed to the risk factor concerned.	**Green**	Results consistently show that the countermeasure reduces road safety risk.
Orange	There is some indication that exposure to the risk factor increases risk, but results are not consistent.	**Light green**	There is some indication that the countermeasure reduces road safety risk, but results are not consistent.
Grey	No conclusion possible because of few studies with inconsistent results, or few studies with weak indicators, or an equal amount of studies with no (or opposite) effect.		
Green	Results consistently show that exposure to the presumed risk factor does not increase risk.	**Red**	Results consistently show that the countermeasure does NOT reduce road safety risk and may even an increase it.

Finally, for each risk factor or road safety measure, a synopsis has been compiled. The synopsis provides a synthesis of the findings for a specific risk factor or road safety measure, including both quantitative information from the coded studies and more qualitative information from previous review studies. The synopsis aims to complement other output of the DSS, like a lists of available studies and direct access to the results of individual studies.

Each synopsis consists of three parts:

- Summary: In maximum two pages, the summary very briefly reports some background of the topic concerned, and the main results and conclusions based on the analyses.
- Scientific overview: In approximately four to five pages, the scientific overview describes the essence of the way the reported effects have been estimated, including a full analysis of the methods and results, and its transferability conditions in order to give the user all the necessary information to understand the results and assess their validity.
- Supporting documentation: The supporting documentation gives a more elaborate description of the literature search strategy, as well as the details of the study designs and methods, the analysis method(s) and the analysis results. Here, also a full list of coded studies and their main features is provided.

2.4 Database

The templates of coded studies will undergo a thorough checking and debugging process, in order to eventually be stored in a relational database, which will serve as the back-end of the DSS. The database includes numerous Tables, however the main ones concern the study details, and the safety effects details.

The database is designed and structured so that DSS user queries will be returning results in terms of key studies for each topic, safety effects reported in the studies, and SafetyCube synopses of the effects per topic. For each topic, the database will allow a customised search for results from specific countries, road user types, road types etc.

3. DSS Development

3.1 Analysis of user needs and identification of hot topics

Stakeholders play a crucial role in developing the DSS and in achieving excellence. The SafetyCube project had already identified a core group of stakeholders from government, industry, research, and consumer organizations covering the three road safety pillars: vehicle, infrastructure, road user. The future users of the DSS include Public Authorities (local, regional, national, European and international level), Industry (Infrastructure, Vehicle, Insurance, Technology), Research Institutes, Non-Governmental Organisations, and Mass media.

In order to identify user needs 3 workshops were carried out. The first workshop in June 2015 was carried out in Brussels in order to start a dialogue between the project participants and a number of key stakeholders for road safety in Europe. The workshop both introduced the audience to the SafetyCube project and also solicited input from the stakeholders that will form the structure and priorities of a DSS. An extensive list of “hot topics” was also created on the basis of feedback from stakeholders, enhancing the SafetyCube initial lists. A total of 30 delegates attended the event (Filtness et al., 2016).

A second workshop was organized on October 2015 in Ljubljana, Slovenia. The first part of the workshop was a plenary session with approximately 150 participants from the Slovenian Road Safety Councils and IRTAD meeting. The SafetyCube project was presented as well as the plans for the Road Safety Decision Support System (DSS) and the "hot topics" from previous workshop. All participants were asked to give their feedback to the DSS and "hot topics". Feedback was collected both in spoken and written form. The second part of the workshop was a breakout session continuing with participants from the IRTAD group. The breakout session started with a discussion where the 23 participants were giving more detailed feedback on their wishes and questions on the DSS. Thereafter the participants were asked to add, comment and prioritize the "hot topics". This was done on six posters showing the "hot topics" from previous stakeholder consultation.

A more dedicated workshop was carried out on February 2016, in Brussels (SafetyCube Stakeholder Workshop), where 12 road infrastructure stakeholders participated. The participants represented key road infrastructure stakeholders, including EC-INEA, EC-DG-MOVE, EURORAP, ASECAP, ETSC, POLIS network, FIA, BRRC and Belgian regional authorities. The objectives of the workshop were the analysis of infrastructure stakeholders' needs for the DSS, as well as ranking of infrastructure related "hot topics".

On the basis of the workshops results, it was indicated that the Decision Support System (DSS) should be suitable for use by a wide range of end users. It should not be limited to EU policy makers, but also be applicable for local authorities. It is intended that the system will help policy makers make an "informed decision". In addition, it has to be an impartial system, which will not advocate for specific measures – the intention is "to guide, rather than to dictate". Using this structured approach to policy making should eventually enhance public acceptance of measures by providing a solid evidence base for decisions.
Moreover, it was proposed that the DSS should have the following characteristics: include robust data which allows critical analysis and transparency, access to the studies used and to all generated results, information of the best quality studies and recommendations. A platform built in the project should be operational after the project.

3.2 DSS design principles and inclusion criteria

The DSS is created on the basis of the following design principles:

- A modern web-based tool
- High Ergonomic interface
- Simple structure
- Powerful Search Engines
- Fully Documented information
- Easily Updated

Regarding the SafetyCube DSS Website, a strong and easy to find web address is needed. Furthermore, the design should be consistent throughout all tools (e.g. unique visual identity, colours, design, messages, etc.). The design should be modern and ergonomic utilizing multimedia (photos and videos) wherever possible. As mentioned before, the system should allow for updates by receiving feedback not only from the users but also from visits traffic monitoring. Lastly, a robust promotion policy will be developed during and after the project via newsletters, social media and so on.

3.3 DSS development

Figure 3 illustrates the DSS development methodology. Firstly, the existing road safety DSS worldwide were analysed. At the same time, an analysis of User Needs (stakeholder workshops, on-line surveys) as well as the development of common methodology and contents collection was carried out. All these actions have lead to the design of the DSS, which will continue to undergo further development.

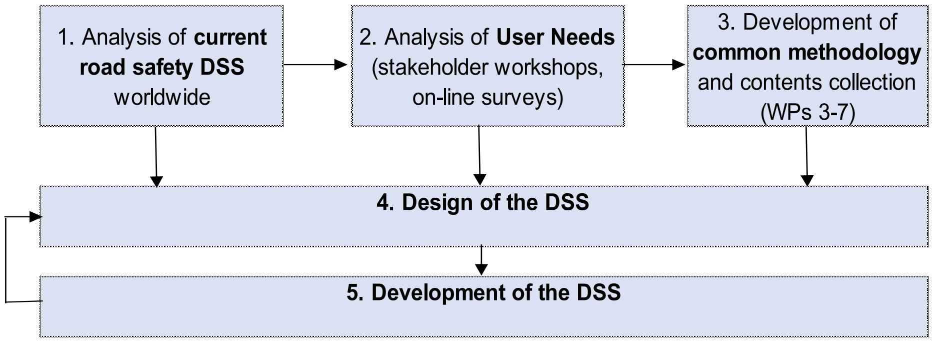

Figure 3: *DSS development methodology.*

The search engine is of critical importance for the DSS. The search will have the following characteristics:

- **Fully linked search**
  - Search a road safety problem alone or through the measures
  - Search a measure alone or through the road safety problems
- **Fully detailed search**
  - Search by any parameter in each data table (road safety problems, measures)
- **Fully flexible search**
  - Adjust search according to results
- **Fully documented search**
  - Access background information at any stage (links, etc.).

Consequently, the relational database of the back-end will be structured including the following: one main table with Road Safety Problems (including sub-Tables with meta-data and assessment results), one main Table with Road Safety Measures (including sub-Tables with meta-data and assessment results), as well as Links between the two Tables (including the sub-Tables). The links between risk factors and measures is of high importance as well. The DSS will be a fully hierarchical and interactive system full of tags and links:

- **For each road safety problem (risk factor)**
  - list of relevant measures
  - list of other relevant road safety problems
- **For each measure**
  - list of road safety problems addressed

- list of similar measures

Figure 4 demonstrates the DSS interface design. The heart of the DSS consistsof two main pillars and three levels. These two pillars represent: (A) the road safety problems (risk factors) and (B) road safety measures. There is also another pillar (C) dedicated to road safety tools, which will include more static outputs (reports, web-texts, glossary etc.).

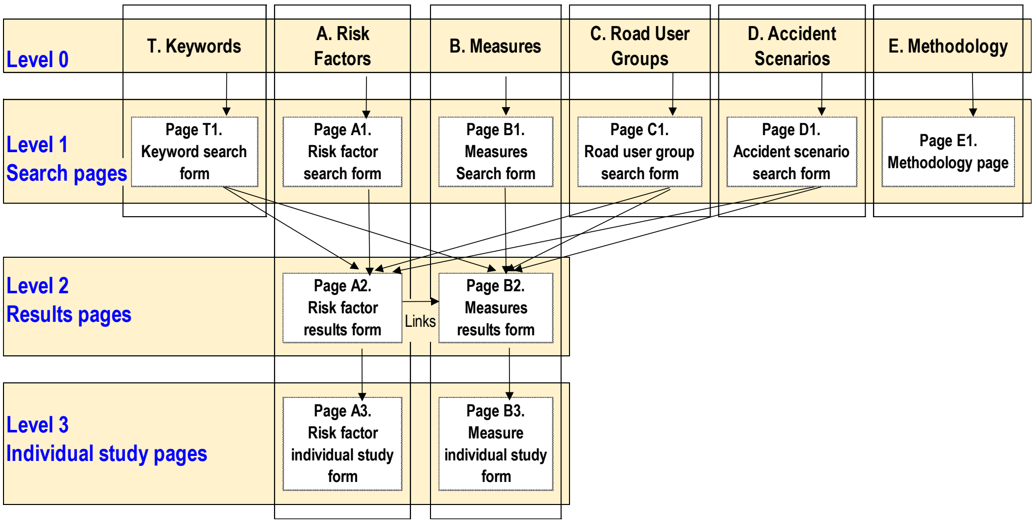

Figure 4: *DSS User Interface structure.*

The users will be able to select one of these five entry points depending on the type of search that they wish to conduct. More specifically, the text search allows the users to enter database key-words, the road safety risk factors/measures entry points allows them to seek specific risk factors or measures from the SafetyCube taxonomies respectively. On the other hand, the road user groups entry point enables a dedicated search of both risk factors and measures related to a selected group of road user (e.g. pedestrians, motorcyclists etc.). The same applies to accident scenarios as well, which is addressed to users looking for risks and measures related to specific crash configurations (e.g. single vehicle crashes, intersection crashes etc.). Figure 5 illustrates the Main Menu of the DSS as well as the entry points. The three levels of the DSS are briefly summarized as follows:

- Home Page - Level 0
- Level 1: Search Pages - Key-words / Risk Factors / Measures / Road User Groups / Accident Scenarios
- Level 2: Search Results - Provides the synopses and studies available for the selected search topic(s), the possibility to refine the search, and the related links between risk factors / measures
- Level 3: Individual study results - Provides the abstract, characteristics and main results of an individual study.

The Home Page (Level 0), provides a general description of the system and enables an initial selection of the element of interest (e.g. risk factor or measure, via one of the entry points). The main menu “Method” provides basic information about SafetyCube and the DSS, as well as background information, resources and methodology, including extensive glossary.

Figure 5: *Overview of the Main Menu and entry points of the DSS.*

Level 1 consists of the specific search that the user wishes to carry out on the basis of the five entry points. The philosophy of this search is as follows: at first the user has to select the keyword / risk / measure / road user group / accident scenario of interest, and then the related list of risk factors and / or measures is presented (for behaviour, infrastructure or vehicle). It is important to highlight that all entry points at Level 1 eventually lead to a selection of risk factors or measures of interest at Level 2. The more general level of the taxonomy is displayed and they can then choose for a general family of risks / measures (e.g. formal tools to address road network deficiencies, speed choice etc.). A more specific measure such as road safety audits, campaigns, lower speed limits and so on may be selected in the search refinement at Level 2.

Level 2 provides the results of the search. A list of studies available with their main features (author, year, design, country) in table form. The synopses of risk factors or measures are provided at this level, as well as the colour code. Two more search options are provided. The one is the refine search. The other is the link to related risk factors or measures as users will be able to find measures associated with each road safety problem, by means of links between risks results and measures results.

Finally, the user may select a specific study from the results page, and have the individual study results provided in Level 3, including the abstract, the related URL, and a table of all risk / measure safety effects available in the study containing:

- test and reference condition (e.g. helmet vs. not helmet)
- type of outcome (e.g. injury severity)
- type of estimate (e.g. odds ratio)
- statistical significance

3. Progress and Next Steps

A large number of studies examining safety risks and measures have been identified and coded according to the selection criteria mentioned earlier in the paper (meta-analyses, but also recent studies and high quality studies - prestigious journals preferred). So far, more than 500 studies have been analysed in the area of road risks and measures, and many more are in progress. In addition, more than 20 existing meta-analyses are updated and about 65 more are in progress. Summary reports (synopses) which will provide a critical synthesis of each risk factor and measure are under development.

The design of the DSS is finalised and the first static prototype of the DSS is available since late June 2016. The DSS testing phase (with test tables) is ready since August 2016, while the DSS Pilot Operation has started on September 2016. The final opening of the DSS will start on September 2017 and will be constantly updating from April 2018 and onwards.

The DSS is intended to become a major source of information for industry, policy-makers and the wider road safety community; it will incorporate the knowledge base of accident causation, risks and measures that will be developed in the project and the underlying methodological systems. It will be developed in a form that can readily be incorporated within the existing European Road Safety Observatory of the European Commission DG-MOVE. The development of the DSS presents a great potential to further support decision making at local, regional, national and international level, aiming to fill in the current gap of comparable measures effectiveness evaluation across Europe and worldwide.

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