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Compilation of analyses of risks and measures

Deliverable 8.2

SafetyCube

Compilation of analyses of risks and measures

Work Package 8, Deliverable 8.2

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Table of contents

Executive summary

This deliverable provides information on how the information on road safety risks and measures that has been collected within SafetyCube, is processed, stored and made available to users through the SafetyCube Decision Support System (DSS).

SafetyCube focuses on road users, infrastructure, vehicles and injuries framed within a systems approach. Road safety stakeholders at the national level, EU and beyond having been involved at all stages. In contrast to all existing repositories, which cover measures only, SafetyCube also includes a comprehensive overview of risk factors.

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,
(3) synopses summarizing the effects estimated in the literature for each risk factor and measure,
(4) an economic efficiency evaluation tool ("E³ calculator") (which is discussed in other SafetyCube deliverables).

The taxonomy consists of four parts: Road Users, Infrastructure, Vehicles and Post Impact Care (only for measures). The taxonomy is a main structural part of the DSS: it can be used as a search engine in the DSS, it creates a uniform structure over all domains and it can be 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 repository is a data-base of coded studies. 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 etc. They used a wide array of research patterns: 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.

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. Based on the studies coded in the repository, a synopsis was 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 identify relevant studies for the inclusion into the DSS, a systematic scoping review was conducted for each item in the taxonomy. The aim of this approach was to represent the body of literature in a scientific way. Initially, several relevant literature databases were searched based on well-defined logical strings of keywords. The potentially relevant studies were then screened to assess their eligibility for further analysis. Generally, only studies with quantitative results were coded for repository. Important qualitative results were, however, included in the synopses. For several of the risk factors and measures, meta-analyses were already available. If this was the case, the most recent meta-analysis was used as the basis, and completed with additional studies published after, and conse-

quently not included in that meta-analysis. If there were too many other papers, they were listed in descending order of importance for the road safety DSS, based on outcome, transferability, recent publication date, language and source.

The collection of different types of studies, based on different underlying theories of crash causation, using different designs, analysis methods and variables constituted a big challenge for the creation of a joint database for all these studies. This database should be flexible enough to capture important details of different types of studies but should also allow to compare studies even across domains. The coding template was developed with the goal of creating such a database.

The data on the coded studies and the information in the synopses are stored in databases. The uploading process from the coded templates includes a thorough checking and debugging process. There are two databases: a development database (the "backend database"), and a production database (the "frontend database"). Users have access to the production database through the search facilities included in the front-end.

The DSS is implemented in a modern web-based tool with a highly ergonomic interface. The DSS allows 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 risk factors and the measures to be included in the DSS were identified based on a systematic analysis of the road safety literature. The report include tables which lists the main results for the risk factors and measures examined.

The DSS has the following components: (1) the Search tab: allows the user to query the DSS backend database and retrieve results; (2) the Knowledge tab: compiles the SafetyCube synopses as a knowledge library; (3) the Calculator tab: allows the user to retrieve one of the SafetyCube examples of cost-benefit analysis, edit it with own values or perform his/her own cost-benefit analysis of a road safety measures; (4) the Methodology tab: includes key background information and related documents on the SafetyCube methodology and related disclaimers; and (5) the Support tab: includes contact information, the guide to DSS users and possibility to send feedback or questions.

The SafetyCube DSS Search is structured in three operational levels (with Level 0 being the system Home Page): Level 1: Search Pages; Level 2: Results Pages; and Level 3 - Individual study pages. These are reachable through five entry points (keywords, risk factors, measures, road user groups, accident categories). More specifically, level 1 consists of the specific search methods which the user may want to use, based on five possible entry points (see Figure 4.2). The philosophy of this search is as follows:
- Keyword search: the system will let the user type in a keyword in free text and – as you type – will show all potential matches with keywords in the database. Once a keyword is entered (or selected from the dynamic pop-up list), the system will respond with the related subsets of risk and measure taxonomies for further selection.
- Risk factors: the user may search for a crash risk factor through the SafetyCube taxonomy
- Measures: the user may search for a road safety measure through the SafetyCube taxonomy
- Road user groups: if the user wishes to inquire about risks or measures specifically related to a particular road user group, he/she may enter the DSS via the road user groups' entry point. As for keyword search, the system will respond with the adequate subsets of risk and measure taxonomies – in relation to that road user group – for further selection.
- Accident categories: if the user wishes to inquire about risks or measures specifically related to a specific accident category.

1 Introduction

This chapter describes the project and purpose of the deliverable. A short description of the work package which produced the deliverable is also provided.

1.1   SAFETYCUBE

Safety CaUsation, Benefits and Efficiency (SafetyCube) is a European Commission supported Horizon 2020 project with the objective of developing 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 of all road user types and all severities.

SafetyCube aims to:
1. develop new analysis methods for (a) Priority setting, (b) Evaluating the effectiveness of measures (c) Monitoring serious injuries and assessing their socio-economic costs (d) Cost-benefit analysis taking account of human and material costs
2. apply these methods to safety data to identify the key accident causation mechanisms, risk factors and the most cost-effective measures for fatally and seriously injured casualties
3. develop an operational framework to ensure the project facilities can be accessed and updated beyond the completion of SafetyCube
4. enhance the European Road Safety Observatory and work with road safety stakeholders to ensure the results of the project can be implemented as widely as possible

As yet there is no systematic pan-European in-depth study of accident causation and it is very difficult for policy-makers and other road safety stakeholders to assemble a clear evidence base of the causation paths and associated risks. In a similar manner there is also no systematic catalogue of measures and their safety effects, although systems and documents exist which cover a range of measures, such as The Handbook of Safety Measures (Elvik e.a., 2009) and the CMF Clearinghouse (www.cmfclearinghouse.org).

There are many individual studies of well-established measures in the literature but the measured effectiveness, limitations and applicability can be highly varied. It is therefore difficult for road safety stakeholders to form conclusions over the most appropriate measures to be deployed.

SafetyCube addresses this gap by providing a comprehensive analysis of both crash risks as well the effectiveness and cost-benefit of safety measures. SafetyCube's objective to prepare a Decision Support System that will help countries to adopt the best possible approach to road safety is highly challenging, because it requires a comprehensive and consistent evaluation of crash causation factors and quantified risks as well as a clear presentation of the effectiveness of road safety measures – on which the information is currently highly diverse, unstructured and often incomplete. Even the best performing countries do not have available an evidence-base of the breadth and depth to which SafetyCube will work.

The data used for the project has been gathered for a variety of purposes using a range of protocols and selection criteria. It is therefore a significant challenge to bring this data together to form a single coherent analysis of crash causation mechanisms and risks. SafetyCube focuses on road users,

infrastructure, vehicles and injuries framed within a systems approach with road safety stakeholders at the national level, EU and beyond having been involved at all stages.

The SafetyCube team includes an impressive group of data analysts, researchers and policy advisors who are highly experienced in transferring the research results into well-founded policy-support information. To do this a series of new procedures has been developed to combine and analyse the safety effect of a wide range of measures, thereby extending the current level of knowledge and simplifying and making accessible what is currently a very large body of knowledge.

A further area where the project will develop the state of the art to a new level of understanding concerns analysis of the costs and benefits of measures. There is currently a lack of systematic information on the cost-effectiveness of measures when implemented in the European context. Cost information is scarce, particularly when concerning vehicle based measures. There is currently no method available that enables comparable calculations of cost-effectiveness for crash avoidance, crash mitigation and injury mitigation technologies.

SafetyCube will address each of these challenges within one compressive online tool, called the DSS (Decision Support System). This will further the state of the art in the understanding and access to information for informing evidence-based road safety policy making.

A systems approach provides a framework within which the work of other Work Packages is integrated into the DSS. A road collision is rarely the result of a single factor. Risk and problems from road user behaviour, infrastructure and vehicle deficiencies interact with each other resulting in environments within which a crash may occur. Understanding these risks and the most appropriate measures and solutions to mitigate them is central for evidence based policy making. In order to provide policy-makers and industry with comprehensive and well-structured information about measures, it is essential that a systems approach is used to ensure the links between risk factors and all relevant safety measures are made fully visible.

1.2   PURPOSE AND STRUCTURE OF THIS DELIVERABLE

This deliverable D8.2 is the second deliverable produced within work package 8. The main objectives of **work package 8** are to:
- Set up the European Decision Support System (DSS) for supporting evidence-based policy making.
- Co-ordinate the analyses undertaken in other work packages ensuring that the research outcomes integrate road user, vehicle and infrastructure factors.
- Compile the project outputs into a suitable form to be incorporated within the DSS and the European Road Safety Observatory.
- Develop the structure, operational procedures and business plan to enable the DSS to continue to support evidence based road safety policies beyond SafetyCube.

It is underlined that in addition to the deliverables under the form of report, the most important deliverable is actually the DSS itself.

The purpose of this deliverable is to summarize the work undertaken in Task 8.2. The aim of Task 8.2 is to examine the results relating to risks and measures for WP4, 5, 6 and 7 and describe how these have been made accessible for non-statisticians. Since the analyses of the risks and measures is described extensively in deliverables D4.1, D4.2, D5.1, D5.2, D6.1 and D6.2 the information from these deliverables will not be repeated here. The reader can also find information on the methodologies developed and used in the deliverables of WP3, in particular D3.1, D3.2 and D3.3. This report will give

an overview of the outputs produced, what they are based on and how these outputs are integrated into the DSS, as well as some detail about the operation of the DSS.

The structure of the remainder of this report is as follows:

- Chapter 2 describes the data collection and analysis process that is underlying the DSS. This has involved a rigorous process of first identifying, screening and selecting relevant studies then analysing, codifying and summarising the studies and finally storing the results in templates that could be fed in into the database of the DSS. Subsequently, the main results of the analyses conducted are presented in summary tables.
- Chapter 3 gives an overview of the structure and content of the "Back-end" database of the DSS, i.e. the development database which gathers and debugs the information gathered in the templates.
- Chapter 4 describes the front-end system. This system consists of a production database and a highly sophisticated user interface, that allows the user to search the DSS in a range of different ways, adapted to his/her interests and needs.
- Chapter 5 outlines the next steps in the finalisation of the DSS.
- The "References" section includes a reference to the DSS website and the documents that are referred to in this Deliverable.

2 The data collection and analysis process

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This Chapter describes how the data for the DSS has been collected and processed within the project to make it suitable for inclusion in the DSS.

2.1 INFORMATION ON RISKS AND MEASURES INCLUDED IN THE DSS[1]

The Road Safety DSS considers a ***road safety risk factor*** to be any situation or condition that increases road crash frequency or severity. ***Road safety measures*** are considered to be interventions that reduce road crash frequency or severity. Risk factors and safety measures can have a direct influence on the risk of a crash occurring, on the consequences of the crash (severity), or more indirectly by affecting a factor known to influence safe driving (Safety Performance Indicator; SPI) e.g. travel speed.

For selected risk factors and safety measure the Road Safety DSS contains:
1. A synopsis summarising the evidence from the scientific literature about the contribution of this factor to road crash frequency or severity.
2. Detailed information about each scientific study considered when developing the synopses.

In all cases information has been obtained from scientific literature. To be considered for inclusion, studies from the scientific literature had to clearly report on the influence of the risk/measure on crashes, injuries or, where appropriate, Safety Performance Indicators. This influence had to be quantifiable and to have been tested for statistical significance e.g. Odds Ratio. Studies also had to include a comparison or baseline group, for example, a group that was not exposed to the risk or crash data from before and after a measure was implemented. Therefore, many studies using alternative methodologies e.g. literature reviews without meta-analysis or those measuring change in attitudes were not included.

2.2 THE METHODOLOGY FOR DATA COLLECTION AND PROCESSING

2.2.1 Structure of the DSS

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,
(3) synopses summarizing the effects estimated in the literature for each risk factor and measure,
(4) an economic efficiency evaluation tool ("E³ calculator").

The methods for the economic efficiency evaluation are discussed in other deliverables such as D3.3.

The ***taxonomy*** consists of four parts:
(1) Road Users
(2) Infrastructure
(3) Vehicles

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[1] As will be illustrated in Chapter 4, the DSS includes also information on some other topics. In this chapter we limit the discussion to the data in relation to risks and measures.

(4) Post Impact Care (only for measures)

The taxonomy[2] is a main structural part of the DSS: it can be used as a search engine in the DSS, it creates a uniform structure over all domains and it can be 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 *repository* is a 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.

Based on the studies coded in the repository, a **synopsis** was 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 synopsis consists of three parts: (1) Summary, (2) Scientific overview, (3) Supporting document.

The DSS is implemented in a modern web-based tool with a highly ergonomic interface (see Chapter 4). The structure is determined by the taxonomy and is complemented by a powerful search engine. The DSS allows 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.

In the following sections the different components of the DSS are described, with a focus on which type of data they contain. We recall that the design and development of all these components was a lengthy, iterative and collaborative process in which many of SafetyCube experts as well as external stakeholders were involved. Numerous notes were produced and meetings organized in view of converging to the final structure and the characteristics of the DSS components. Some components, such as the taxonomy, evolved during the course of the process.

In order to ensure high quality and consistency in the data collection and analysis process, detailed guidelines were given, training workshops were organized and support was available at all times. Progress was monitored and work package leaders were responsible for the basic quality assurance. This is currently being complemented by a retrospective quality assessment process (see Chapter 5).

2.2.2 Taxonomy

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

- Road users
- Infrastructure
- Vehicles
- Post impact care (only measures).

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[2] The taxonomy was developed within SafetyCube. Other structuring methods for road safety risks and measures have been considered, such as the Haddon matrix, but were not finally not retained because they did not encompass the full range of risks and measures to be considered.

The draft taxonomy was systematically evaluated during four workshops, where stakeholders were asked to prioritise and indicate missing topics. Three workshops were directed to a general audience of road safety policy makers and practitioners, one was focused on infrastructure.

For each of the risk and measures areas, a three-level taxonomy was developed consisting of the main topic at level 1, several subtopics on level 2, and, if appropriate, specific topics at level 3. Table 2.1 is an example from the road users' area. The same approach was taken with all risk factors and measures. The level 1 main topics for each area are shown in Table 2.2.

Table 2.1 Example of the three levels of the taxonomy (part of Road users)

Level 1 – main topic	Level 2 – subtopic	Level 3 – specific topic
Speed choice	Excess speed	Built-up areas
		Rural roads
		Motorways
	Inappropriate speed	Too fast weather-related
		Too fast traffic related
		Too slow
Fatigue	Insufficient (good) sleep	Not enough sleep
		Sleeping disorders
	Long drives	--

Table 2.2: Level 1 topics of the taxonomy

	Risk Factor	Measure
Road Users	Speed Choice	Law and Enforcement
	Influenced Driving – alcohol	Education and Voluntary Training/programs
	Influenced Driving – drugs	Driver Training and Licensing
	Risk Taking	Fitness to Drive Assessment and Rehabilitation
	Fatigue	Awareness Raising and Campaigns
	Distraction and Inattention	
	Functional Impairment	
	Insufficient Knowledge	
	Emotion and Stress	
	Misjudgement and Observation Errors	
	Traffic Rule Violations	
	Personal Factors	
	Age	
	Disease and Disorders	
Infrastructure	Exposure	Exposure
	Road Type	Infrastructure Safety Management
	Road Surface	Road Type
	Road Environment	Road Surface
	Workzones	Lighting
	Alignment Deficiencies – Road Segments	Workzones
	Cross-section Deficiencies – Road Segments	Alignment – Road Segments
	Traffic control – Road Segments	Cross-section – Road Segments
	Alignment – Junctions	Traffic Control – Road Segments
	Traffic Control - Junctions	Alignment – Junctions
		Traffic Control - Junctions
Vehicles	Crashworthiness	Crashworthiness
	Injury Mechanism	Active Safety/ADAS
	Protective Equipment Design	Tertiary Safety
	Relevant Factors in Crash Data	
	Technical Defects/Maintenance	
	Vehicle Design	
	Visibility/Conspicuity	
Post impact care	-	Ambulances/Helicopters
		Extraction from Vehicle
		Pre-hospital Medical Care
		Triage and Allocation to Trauma Facilities
		First Aid Training for Drivers

2.2.3   Identification of relevant studies

To identify relevant studies for the inclusion into the DSS, a systematic scoping review was conducted for each item in the taxonomy. The aim of this approach was to represent the body of literature in a scientific way. While the criteria applied differed between research fields, there was a schematic approach followed for each review, consisting of initial search, screening, identifying additional papers, and prioritizing papers for coding.

Initially, several relevant literature databases were searched, e.g., Scopus, Medline, and Google Scholar based on well-defined logical strings of keywords (see Table 2.3, as an example). The keywords as well as the resulting number of studies were documented.

Table 2.3: Example of the search criteria for "Fatigue"

Fatigue	"fatigue*" OR "Sleep*" OR "Tired*" OR "drowsy" OR "drowsiness" OR "alert*" OR "monotony" OR "time on task"
AND	
Road Safety	"road safety" OR "driv*" OR "road" OR "transport" OR "crash" OR "accident" OR "incident" OR "traffic" OR "collision" OR "traffic safety" OR "risk" OR "measure OR "Road Casualties" OR "Road Fatalities"

2.2.4   Screening and prioritizing

The potentially relevant studies were then screened to assess their eligibility for further analysis. Generally, only studies with quantitative results were coded for repository. Important qualitative results were, however, included in the Synopses (see 2.2.7). 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 lists of the selected papers were examined to identify any additional relevant papers.

For several of the risk factors and measures, meta-analyses were already available. If this was the case, the most recent meta-analysis was used as the basis, and completed with additional studies published after, and consequently not included in that meta-analysis. Studies included in a meta-analysis were not included individually. If there were too many other papers, they were listed in descending order of importance for the road safety DSS, based on outcome, transferability, recent publication date, language and source. Note that these criteria were applied flexibly depending on how many studies were available and the field of research.

Papers that evaluated measures and risks in terms of observed crashes were considered more relevant than those based on observed road safety behaviour (e.g. speeding), which again were considered more relevant than studies that had other indicator variables as outcomes (e.g., self-reported behaviour, driving simulator data, simulated crash data, etc.). SafetyCube is focused on Europe, therefore prioritizing European studies above US/Australian/Canadian studies, which are prioritised above studies from other countries. Other criteria were publication date (recent studies before older studies, though older studies of particular relevance were included), language (papers in English before papers in other languages), and source (peer reviewed papers before non-peer reviewed papers).

2.2.5 Coding of studies

One of the main objectives of the SafetyCube project is to create a repository of estimates of risk factors and safety effects. While there are already a number repositories of safety effects around (CMF clearinghouse; Australian Clearinghouse), these are tailored to infrastructural measures. In SafetyCube a much broader scope is applied, comparable e.g. to the Handbook of Road Safety Measures [2], where measures directed towards infrastructure, vehicles, human behaviour and post impact care are evaluated.

In contrast to all existing repositories, SafetyCube includes a comprehensive overview of risk factors which makes the type of studies included into the repository even more diverse. 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 etc. They used a wide array of research patterns: 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 collection of different types of studies, based on different underlying theories of crash causation, using different designs, analysis methods and variables constituted a big challenge for the creation of a joint database for all these studies. This database should be flexible enough to capture important details of different types of studies but should also allow to compare studies even across domains. The coding template was developed with the goal of creating such a database.

The coding template, developed in Excel, consists of several sheets, requiring the researcher to provide information, mostly in predefined categories:
1. Core info
2. Results
3. Summary
4. Flexible info
5. Custom info
6. $exposure
7. $outcome

The variables contained in the "Core info" sheet are core variables that should be considered for every study. These concern referencing information (title, author, original publication, abstract) and also some very general sampling characteristics where the data are sampled, and which kind of collisions and / or road users are included. The "Flexible info" sheet contains a much more detailed list of variables that apply to some studies but certainly not to all (e.g., the location of injuries considered, information on infrastructure elements, the type of crashes included, or the type of drivers considered. These variables can be used flexibly for those studies to which they apply. A possibility to propose new variables or values which are not yet listed is given to the coder in the sheet "Custom info". Together, the variables indicated in Core info, Flexible info and Custom info identify the sampling frame. This means they give a complete picture where the data come from and which sampling criteria were applied. The coder can also indicate when different values of a particular variable are compared in the study (for example, it makes a difference whether fatal and injury crashes are included and simply treated together or whether separate analyses were done for fatal and for injury crashes).

The "Results" sheet in the coding template is used to provide the numerical and statistical details of **effects** that are reported in a given study. These effects always quantify a particular association be-

tween **exposure** (either to a risk factor or a countermeasure) and a road safety **outcome**. More info on exposure and effects is to provided in the $exposure and $outcome sheet.

The coder had to indicate whether the study compares road-safety outcomes under different conditions of exposure to a risk-factor or measure (-> exposure response study) or whether groups with or without a particular outcome (e.g., with and without a crash) are compared with respect to their exposure to a particular risk factor or measure (-> case-control study). Dependent on this and the definition of the different conditions that are compared to each other, the result table is built automatically, so that the result sheet is a table with all effects tested in the study and the definition of the conditions that are compared for each effect.

On the basis of the study features coded, a result table takes shape in which the results for all conditions that were coded can be entered. Figure 2.1 shows an example of a result sheet in the Excel template, completed for a study on the effect of a bicycle helmet

☐ 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 2.1: Example of a results sheet

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.

2.2.6   Analysis of coded studies and drafting of synopses

After having coded all selected studies, the researchers analyzed the results. Three ways had been defined to analyze and summarize the results, in a 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 sum-

marized 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 type of 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 novice drivers). In meta- or vote count analyses this was addressed by sub-group analyses.

For all risk factors and road safety measure for which sufficient coded studies were available, a **synopsis** was 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 outputs of the DSS, like 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 analysis.
- 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. A full list of coded studies and their main features is also provided in this section.

2.2.7 Keywords

The SafetyCube database includes thousands of keywords from the related studies (i.e. the original keywords of the study, as they appear on the publication). Since not all of them are useful for searching and several of them are synonyms, a particular processing of the database keywords was implemented in order to arrive at a consistent keyword list. First, the database keywords were classified into either "useful" or "irrelevant". "Irrelevant" keywords include very general terms (e.g. "road accident", "road safety") or terms not relevant for the purposes of the DSS users (e.g. "negative binomial model"). Subsequently, the database of "useful" keywords were further processed to identify synonyms (e.g. older / elderly / senior, curve / bend, HGV / truck etc.). On the basis of the "useful" keywords and the synonyms identified, a reduced Master keywords list was created, including all the terms that could be searchable by the DSS user. Finally, each database keyword was linked to all its synonyms in the Master keywords list, so that a search on "older drivers" will also bring the results related to "elderly" or "seniors".

Synopses also include keywords, which are based on the keywords of the studies that are discussed and used in the synopsis.

2.2.8 Colour coding of the extent of risk and effectiveness of measures

For each of the studied risk factors and measures, a colour code was selected on the results of the (majority of) the studies' outcomes to indicate the overall conclusion about the effect. Each colour code is supported by a short statement of two to three sentences.

Each synopsis was assigned one or more colour codes to indicate whether there was evidence that the factor was risky or whether a measure was found to be effective. It was occasionally necessary to assign two colour codes to a synopsis if the risk associated to the factor or effectiveness of the measure differed depending on the type of road user or its application.

For risks the colour codes Red (risky), Yellow (probably risky), Grey (unclear) and Green (probably not risky) were used:

- **Red:** (risky) was used when the study results were relatively consistent showing an increased risk upon exposure to the risk factor in question.
- **Yellow** (probably risky) was used when there was some indication that exposure to the risk factor increases the crash or injury risk, but the results were not consistent. This could either be due to conditions under which the risk factor has been shown not to be a problem, or because the study results are inconsistent (but with the majority of studies pointing to an increased risk).
- **Grey** (unclear) was used if there were few studies with inconsistent results, or few studies with weak indicators or an equal amount of studies with no (or opposite) results.
- **Green** (probably not risky) was used to indicate that studies suggest that the 'risk factor' was probably not risky or actually had a positive effect on road safety. The absence of a risk effect is a null-effect which is notoriously difficult to "prove", therefore this category was only chosen if there were a reasonably large number of studies with fair quality – such that one could expect a risk effect (if it existed) to become apparent in them.

For measures, Green (reducing risk), Light Green (probably reducing risk), Grey (Unclear) and Red (Not reducing risk) were used:

- **Green**: **Clearly reducing risk**. Consistent results showing a decreased risk, frequency and/or severity of crashes when this measure is applied.
- **Light Green:** **Probably reducing risk, but results not consistent**. Some evidence that there is a decreased risk, frequency and/or severity of crashes when this measure is applied but results are not consistent.
- **Grey:** **Unclear results**. Studies report contradicting effects. There are few studies with inconsistent or not verified results.
- **Red:** **Not reducing risk**. Studies consistently demonstrate that this measure is not associated with a decrease in crash risk, frequency or severity.

2.2.9   Limitations of the data collected

The following limitations apply to the data on risks and measures processed within SafetyCube:

- Every effort has been made to cover as wide a range of risks and measures as possible. However, some risks or measures may not be included. This may occur if there are too few studies identified as suitable for inclusion in the DSS. In some cases where details of a few studies for a particular risk/measure were provided, there was not sufficient information to develop a synopsis.
- When evaluating the impact of a risk/measure within a synopsis the intention was to undertake a meta-analysis. However, where the assumptions for meta-analysis could not be met (e.g. insufficiently similar studies) a vote count or literature review was completed. The evidence within a synopsis containing a meta-analysis should be considered more robust.
- All findings are limited by the individual studies identified from the scientific literature. The quality of considered studies is discussed within each individual synopsis.
- The Road Safety DSS methodology was applied to studies investigating a risk or measure outcome relating to crash frequency/rate/severity or outcomes in terms of changes in road safety relevant behaviour. Little (or no) information is presented for those risk factors and measures which are commonly investigated in terms of less tangible outcomes, like attitude changes.
- Considering crash severity and impact on injuries is a newer approach within road safety than considering fatalities. The relative newness of approaches for considering injury severities other than fatal, means that there may be limited evidence available compared to that for crash frequency/rate/risk or fatalities.
- Transferability of findings is limited by the range of countries from which scientific literature was identified. These limitations are discussed in the individual synopses for each risk and measure. Priority was given to studies from European and other countries with similar socioeconomic situations. Findings may not be transferable to developing countries.
- The number of studies considered within each synopsis is limited by the literature search process applied. The literature search process applied is provided in the supporting document of each synopsis. Limitations include, the search terms used, when the search was conducted and the range of databases in which the search was conducted.
- Due to resource constraints and the wide scope for risk/measure inclusion it was necessary to prioritise the scientific papers for inclusion in the synopses. Where possible all relevant studies were included, however, the details of prioritisation are provided in each synopsis.
- The absence of a safety measure is not considered as a risk factor. Instead, information about the presence and absence of a particular safety measure is contained within the measures analysis. For example, self-explaining roads are evaluated as an infrastructure related measure. The absence of self-explaining roads is not considered within the infrastructure related risks evaluation.

- Measures were assessed individually. Considering the potential effectiveness of implementing multiple measures at the same time is out of scope. However, in some specific cases where there are numerous scientific studies about the combined impact of measures often implemented together (e.g. education campaigns and enforcement) evaluation is provided within the relevant synopses. Details of the approach for each measure can be found in each individual synopsis.
- The starting point of many literature searches was the particular risk or measure of interest (full search process detailed in each synopsis). Subsequently, the implications for individual road user groups were identified only if relevant information was included in the scientific literature identified for that risk/measure. Because of the starting point of this approach for some risks and measures the overall impact on road safety is evaluated rather than for each individual road user group. For some risks (e.g. vehicle related) and measures (e.g. behaviour related) the literature search was conducted from the starting point of the road user group. Details of the approach taken for each risk and measure are included in the synopsis.

2.2.10 Other data collected and analysed within SafetyCube

In addition to the extensive data collected, analysed and synthesized on risks and measures, it is reminded that in the context of SafetyCube other data was also collected and transformed into useful information that will be incorporated in the DSS. This includes:
- information on serious injuries and their implications (reported on in the deliverables of work package 7)
- tools and results in relation to cost-benefit analyses (reported on in deliverables D3.3, D4.3, D5.3 and D6.3)
- accident categories factsheets (under development) and their links to risks and measures.

2.3 SUMMARY DESCRIPTION OF DATA COLLECTED (RISKS AND MEASURES)

The following tables report the main results for the risk factors and measures examined. These results are presented at the level of the taxonomy for which synopses are available, and for which a colour code has been assigned. The results for risks are given in the following tables, followed by those for measures.

Table 2.4: Colour codes of road user related risks. From Talbot et. al. (2016)

Risky	Probably risky	Unclear
• Influenced driving – alcohol • Influenced Driving – drugs (legal & illegal) • Speeding and inappropriate speed • Traffic rule violations – red light running • Distraction – cell phone use (hand held) • Distraction – cell phone use (hands free) • Distraction – cell phone use (texting) • Fatigue – sleep disorders – sleep apnea	• Risk taking – overtaking • Risk taking – close following behaviour • Insufficient knowledge and skills • Functional impairment – cognitive impairment • Functional impairment – vision loss • Diseases and disorders – diabetes • Personal factors – sensation seeking • Personal factors – ADHD • Emotions – anger, aggression • Fatigue – Not enough sleep/driving while tired • Distraction – conversation with passengers • Distraction – outside of vehicle • Distraction – cognitive overload and inattention	• Functional impairment – hearing loss (few studies) • Observation errors (few studies) • Distraction – music – entertainment systems (many studies, mixed results) • Distraction – operating devices (many studies, mixed results)

Table 2.5: Colour codes of road user related measures. From Theofilatos et al. (2017)

Effective	Probably effective	Unclear results	Ineffective or counterproductive
• Law and enforcement – General police enforcement, speeding • Law and enforcement – DUI checkpoints, selective and random breath testing • Law and enforcement – Laws and enforcement for seatbelt wearing • Fitness to drive assessment and rehabilitation – Alcohol interlock • Fitness to drive assessment and rehabilitation – Rehabilitation • Awareness raising and campaigns – Seatbelt • Law and enforcement – License suspension	• Law and enforcement – BAC limits, BAC limits for novice drivers • Driver training and Licensing – Formal pre-license training, graduated driver licensing and probation • Education and voluntary trainings and programmes – Child pedestrians • Awareness raising and campaigns – Aggressive and inconsiderate behavior • Awareness raising and campaigns – Campaigns in general • Awareness raising and campaigns – Child restraint • Awareness raising and campaigns – Speeding and inappropriate speed • Awareness raising and campaigns – Driving under the influence • Law and enforcement – Increasing traffic fines • Law and enforcement – Hours of service regulations for commercial drivers • Law and enforcement – Demerit point systems • Law and enforcement – Red light cameras • Fitness to drive assessment and rehabilitation – Medical referrals	• Law and enforcement – Laws and enforcement for mobile phone use (handheld, hands-free) • Education – None statutory training for novice drivers	• Fitness to drive assessment and rehabilitation – Age-based screening of elderly drivers

Table 2.6: Colour codes of infrastructure related risks. From Filtness and Papadimitriou (2016).

Risky	Probably risky	Unclear
• Effect of Traffic Volume on safety • Risks associated with Traffic Composition • Road Surface - Inadequate Friction • Workzone length • Alignment deficiencies - Low Curve Radius • Cross-section deficiencies - Number of Lanes • Shoulder and roadside deficiencies -Absence of paved shoulders	• Occurrence of Secondary crashes • Alignment deficiencies - Absence of Transition curves • Risk of Different Road Types • Adverse weather - Rain • Poor Visibility - Darkness • Cross-section deficiencies - Superelevation • Alignment deficiencies - High grade • Presence of Tunnels Cross-section deficiencies - Narrow lanes • Undivided road • Cross-section deficiencies - Narrow median • Shoulder and roadside deficiencies - Risks associated with Safety Barriers and Obstacles • Shoulder and roadside deficiencies - Sight Obstructions (Landscape,	• Congestion as a risk factor • Risks associated with the distribution of traffic flow over arms at junctions • Adverse weather - Frost and snow • Workzone duration • Alignment deficiencies - Frequent curves • Alignment deficiencies - Densely spaced junctions

• Shoulder and roadside deficiencies - Narrow Shoulders	Obstacles and Vegetation) • Interchange deficiencies - Ramp Length • At-grade junctions deficiencies - Number of conflict points • Risk of different junction types At-grade junction deficiencies - Skewness / Junction angle • At-grade junction deficiencies - Poor sight distance • At-grade junction deficiencies - Gradient • Uncontrolled rail-road crossing • Poor junction readability - Absence of road markings and crosswalks • Poor junction readability - Uncontrolled junction		• Interchange deficiencies - Acceleration / deceleration lane length

Table 2.7: Colour codes of infrastructure related measures. From Machata et. al. (2017).

Effective	Probably effective	Unclear results	Ineffective or counterproductive
• HGV traffic restrictions • Speed limit reduction measures to increase road safety • Dynamic speed display signs • Installation of section control & speed cameras • Installation of speed humps • Implementation of 30-zones • Installation of lighting & Improvement of existing lighting • Workzones: Signage installation and improvement • Implementation of rumble strips at centreline • Installation of chevron signs • Traffic sign installation; Traffic sign maintenance • Convert at-grade junction to interchange • Sight distance treatments • Automatic barriers installation	• Road safety audits & inspections • High risk sites treatment • Dynamic speed limits • Implementation of narrowings • School zones • Installation of traffic calming schemes • Road surface treatments • Creation of by-pass roads • Increase median width • Change median type • Shoulder implementation (shoulder type) • Increase shoulder width • Safety barriers installation; Change type of safety barriers • Create clear-zone / remove obstacles & Increase width of clear-zone • Road markings implementation • Implementation of edgeline rumble strips • Variable message signs • Convert junction to roundabout • Channelisation • Installation of rail-road crossing traffic sign • Traffic signal installation	• 2+1 roads • Implementation of woonerfs • Installation of median • Increase number of lanes • Increase lane width • Change shoulder type • Installation of cycle lane and cycle path • V2I schemes • Improve skewness or junction angle • Convert 4-leg junction to staggered junctions • STOP / YIELD signs installation / replacement • Implementation of marked crosswalk • Traffic signal reconfiguration	• Convert junction to roundabout (cyclists)

Table 2.8: Colour codes of vehicle related risks. Information extracted from https://www.roadsafety-dss.eu/#/knowledge , 6 Nov 17.

Risky	Probably Risky	Unclear	Probably not risky
• Bicycle Injury Level • Pedestrian: prevalence of factors in crash data • Passenger Car: Compatibility (self and part-	• PTW: Visibility, Conspicuity, sight obstruction and small size • Pedestrian - crashworthiness: low NCAP rating	• Bicycle: Accident characteristics • PTW Accident characteristics	• PTW Technical defects or maintenance

ner protection) and age • Passenger car: Side impact: risk to be injured following nearside/farside impacts • Passenger car: Risk of injury in frontal impacts: driver, front passenger and rear passengers • Light Goods Vehicle – visibility and Conspicuity – visible limitation due to design Light Goods Vehicle - crashworthiness - compatibility • HGV compatibility • HGV – Risks resulting from the blind spot issue by right turning trucks	• Pedestrian – vehicle design: vehicle shape • Passenger cars: Low star rating (Euro NCAP) • Passenger car: Risk to be injured in rear impact • Light Goods Vehicle :Prevalence of factors in crash data – accident characteristics	• Light goods vehicle – prevalence of factors in crash data – injury level	• PTW safety systems • Passenger car: Technical defect / maintenance

Table 2.9: Colour codes of vehicle related measures – Information taken from draft version of Hermitte, 2017 (Final version not available at the point of writing)

Effective	Probably effective	Unclear results
• Passenger car: Seatbelt incl. SRB and load limiter • Child restraint system (full seat) • Child restraint system – booster seats • Bicycle: Helmet, reflective equipment, lighting • Emergency braking Assistance • Passenger car: Autonomous Emergency Braking (city, interurban) • Autonomous Emergency Braking (pedestrian and cyclist protection) • Electronic Stability Control • Daytime running lights • Event Data Recorder	• Passenger car: Directive 96/79/CEE, ECE.R94 & EuroNCap (Frontal impact protection) • Passenger car: Directive 96/27/CEE, ECE.R95 & EuroNCAP (side impact protection) • Passenger car: Regulation UN R135 (Pole side-impact protection) • Passenger car: Side impact measure – EuroNCAP (MDB & Pole) • Pedestrian protection – Active technologies • Pedestrian protection – vehicle shape • Pedestrian regulation • PTW protective clothing • Intelligent Speed adaptation, speed limiter and speed regulator • Alcohol Interlock • HGV: blind spot detection • Vehicle inspection • HGV: Automatic Emergency Braking • Vehicle to Vehicle communication • E-Call • Rescue data sheet and Rescue code • ECE R100 (Battery electric vehicle safety)	• Passenger cars: Anti-submarining • Collision Warning system • Adaptive Cruise Control • Adaptive headlights • Night Vision

3 The Backend Database

3.1 THE BACKEND DATABASE

The data on the coded studies and the information in the synopses are stored in databases. There are two databases:

- a development database (the "backend database"), which is managed by Vias institute
- a production database (the "frontend database"), which is managed by NTUA

The frontend database and system is discussed in the next chapter.

The data stored in the study templates needs to be parsed into the development database. This is a relational database (MySQL) running under Ubuntu Linux. The structure of this relational database is shown on (Figure 3.1). The fields in the tables of the database correspond to the fields in the Excel templates. These fields have been described in Deliverable D3.1.

The database is in principle searchable for every value within every variable (e.g. studies concerning urban crashes or head injuries or elderly road users). However, users have only access to the production database through the search facilities included in the front-end (see Chapter 4), since interrogating the database requires expert knowledge of both the content of the template data and the relationships between the tables in the database.

The uploading process includes a thorough checking and debugging process. Python scripts have been developed to access the data in the Excel sheets and transfer these data to the appropriate tables in the development database. Whenever a data or consistency problem is encountered, the original template is checked to correct the error. Some errors are corrected centrally; for other errors the original coder is contacted and required to adapt the template.

At regular intervals the development database is "frozen" and a full copy is sent to the production database, where it replaces the previous version.

A similar, but simpler process, is undertaken for the synopses. The Word versions of the synopses are first converted to pdf-files, linked to the appropriate component of the taxonomy, and then uploaded to the DSS databases, together with a small linked Excel template that includes some elements of the synopsis, that will facilitate the use of the synopsis in the DSS.
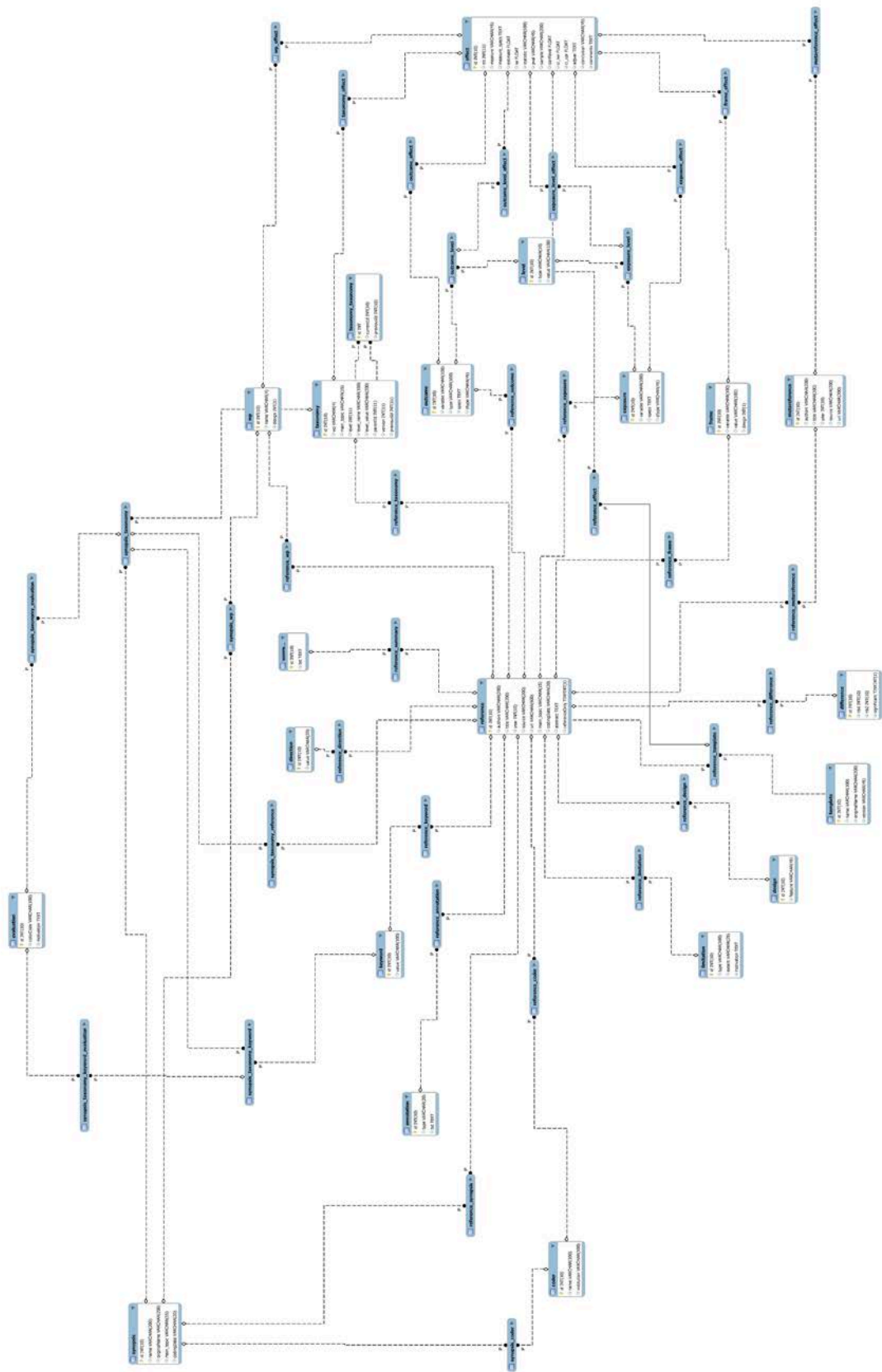
Figure 3.1: Structure of the database underlying the DSS

3.2 CONTENTS OF THE DEVELOPMENT DATABASE

The development data base captures all information that coders are able to provide in the coding template. The tables and linking tables are listed below.

reference

The data base is built around the **reference** table, which stores the bibliographic information for every coded study as well the main topic ("RISK FACTOR" or "COUNTERMEASURE"), coding date and abstract. The last column indicates whether it concerns a study with coded results (referenceOnly=0) or just a reference (linked to a synopsis; referenceOnly=1).

The content of the *reference* table looks like this:

id	authors	title	year	source	url	main_topic	codingDate	abstract	referenceOnly
1	CHARLTON	The role of attention in h...	2007	ACCIDENT ANALYSIS AND PRE...	HTTP://WWW.SCIENCED...	COUNTERMEASURE	17/12/2015	Horizontal curves have be...	0
4	TIM HORBERRY, JANET...	The possible safety bene...	2006	TRANSPORTATION RESEARCH...	DOI:10.1016/J.TRF.200...	COUNTERMEASURE	28/01/2016	A comparison of the relati...	0
7	M.R. BAMBACH, R.J. M...	The effectiveness of hel...	2013	ACCIDENT ANALYSIS AND PRE...	DOI:10.1016/J.AAP.201...	COUNTERMEASURE	08/12/2015	There has been an ongoin...	0
16	ADI RONEN, TAL ORON...	The combination of short...	2014	JOURNAL OF SAFETY RESEAR...	HTTP://DX.DOI.ORG/10...	COUNTERMEASURE	08/12/2015	One of the major concern...	0
10	ELVIK, R., BJøRN...	Safety-in-numbers: A sy...	2015	SAFETY SCIENCE (FORTHCOM...	DX.DOI.ORG/10.1016/J....	RISK FACTOR	11/12/2015	This paper presents a sys...	0
9	DE BRABANDER B, NUY...	Road safety effects of r...	2005	JOURNAL OF SAFETY RESEARCH	NULL	COUNTERMEASURE	09/12/2015	Introduction: This paper a...	0
12	HELS T, BERNHOFT IM, ...	Risk of injury by driving ...	2012	DRUID D2.3.5	HTTP://WWW.DRUID-PR...	RISK FACTOR	09/12/2015	The objective of this deliv...	0
1	CONNOR J., NORTON ...	Prevalence of Driver Slee...	2001	SLEEP, VOL. 24, NO.6	NULL	RISK FACTOR	27/04/2016	Study Objectives: To obta...	1

Figure 3.2: *reference* table

coder

Information on the coder of studies is stored in a separate table, which can be linked to the reference table through the linking table **reference_coder** (1 to 1).

A query linking both tables would yield the following output:

authors	title	name
CONNOR J., NORTON ...	Prevalence of Driver Slee...	KEVIN DIEPENDAELE
CHARLTON	The role of attention in h...	VANDEMEULEBROEK FÉLIX
M. KAHN; A. ABDEL-RA...	Potential crash reduction...	VANDEMEULEBROEK FÉLIX
TIM HORBERRY, JANET...	The possible safety bene...	JULIE MAES
T. GEHLERT, C. SCHUL...	Evaluation of different ty...	VANDEMEULEBROEK FÉLIX
F. LAI, O. CARSTEN, F....	How much benefit does I...	MAES JULIE

Figure 3.3: Linking *reference* and *coder* table

wp

This table stores the different work packages. Through **reference_wp**, each study is linked to one or more work packages (1 to many). Since work package entries can function as design variables (cf. "design" column in **wp**), they can also be linked to different effects using the **wp_effect** table.

taxonomy

The different taxonomies and their hierarchy are stored using a so-called adjacency list (cf. "parentId" column). Taxonomy entries are linked to individual studies through the **reference_template_taxonomy** table (1 to many). Since taxonomy entries can function as design variables (cf. "design" column in **reference_template_taxonomy**) and thus can assist in distinguishing

between different effects, they can also be linked to the **effect** table though **taxonomy_effect** (many to many).

It is important to note that the taxonomy table is read-in from a separate input file. Hence, all levels are represented, irrespective of whether links exist with the **reference** table.

There are different versions of the taxonomies. These different versions are *chained* (per wp and main_topic) through the "previousId" column. To retrieve all studies attached to earlier taxonomy versions, starting from the most recent version, the table **taxonomy_taxonomy** was created. The "currentId" column always provides the most recent taxonomy ids and the "previousId" shows *all* earlier ids for the given taxonomy level+value.

Level_values (i.e., display names) are only provided for the current taxonomy version per work package and topic (risk/countermeasure). By default, these are identical to the names that are used in the coding sheets (see column level_value_template). In some case, however, the level_value column provides a 'clean' version of the level_value_template entry.

keyword

Keywords are stored in a separate table. They can be linked with single studies through **reference_keyword** (1 to many).

masterkeyword

A list of "master keywords" was generated within the project. These are stored in a separate table with their 1 to many links to the original keywords defined in **masterkeyword_keyword**.

template

When a template file is parsed, it is copied to a separate folder with a new, structured file name. The new and original filename are stored the **template** table. This table also stores the template version info. They are linked to single studies through **reference_template** (1 to 1).

direction

The direction ("exposure2outcome" or "outcome2exposure") that was used to code a study is a critical variable for correctly querying study results (see below). **reference_direction** defines the direction for individual studies (1 to 1).

design

This stable stores all the different design characteristics that are identified in the template. **reference_design** defines the design characteristics for individual studies (1 to many).

summary

This table represents the study summaries as written by the coders (cf. "Summary" sheet in template). **reference_summary** provides the 1 to 1 mappings to the individual studies.

limitation

This table stores limitations / potential sources of bias, their extent (maybe/definitely a problem) and the motivation provided by the coder. **reference_limitation** defines the links with individual studies (1 to many).

annotation

This table stores input from the comment fields in the Sampling frame and Design sections in the template. **reference_anotation** stores the links with the studies (1 to many).

frame

This table captures all sampling frame variables and their values. These entries are collected from (a) the "Sampling frame" section on the "Core info" sheet in the template (b) the "Flexible info" sheet and (c) the "Custom info" sheet. The "design" column indicates whether the value is related to a subset of the reported effects (design=1) or not (design=0) – see table below.

id	variable	value	design
1	COUNTRIES	NEW ZEALAND	0
2	ADMINISTRATIVE LEVEL	LOCAL	0
3	ROAD USER PROFILE - MODES	CAR	0
4	ROAD USER PROFILE - TYPE	DRIVER	0
5	ROAD USER PROFILE - AGE	17-64	0
6	ROAD USER PROFILE - GENDER	ALL	0
7	ROAD NETWORK PROFILE - AREA	RURAL ROAD	0

Figure 3.4: Example of content of *frame* table

reference_frame allows to join the frame entries with the individual studies (1 to many relationship)

exposure and outcome

All exposure and outcome variable definitions in the "$exposure" and "$outcome" sheets of the template are stored in the corresponding tables. They are linked with the individual studies through **reference_exposure** and **reference_outcome** (1 to many).

For "exposure2outcome" (cf. **direction**) templates, effects deal with a contrast between different exposure variable levels (or a regression on exposure variables). In those cases, the **exposure_level** table allows to retrieve all corresponding levels from the **level** table and the **exposure_level_effect** table allows to retrieve the specific exposure variable – level combination for individual effects. Outcome variables can be linked through the **outcome_effect** table – in particular when different effects are influential on different outcome variables

For "outcome2exposure" templates, the roles are reversed; effects are influential on different outcome variable levels. In those cases, the **outcome_level** table allows to retrieve all corresponding levels from the **level** table and the **outcome_level_effect** table allows to retrieve the specific outcome variable – level combination for individual effects. Exposure variables can be linked through the **exposure_effect** table – in particular when different effects are influential on different exposure variables. The query is given below:

There are 3 types of levels (cf. **level.type**): "ctrl", "test" and "unit". In exposure2outcome templates the mapping is as follows: "ctrl"="Reference" and "test"="Test". For regressions (i.e., general numerical exposure variables), "unit"="Unit". In outcome2exposure templates the mapping is "ctrl"="Controls" and "test"="Cases".

effect

This table stores all individual coded effects. It includes all information of the "Results" sheet in the template, except the associated levels of the design variables, exposure variables and outcome variables. This information is retrieved through the **wp_effect**, **taxonomy_effect**, **frame_effect**, **outcome_effect** (direction=exposure2outcome), **outcome_level_effect** (outcome2exposure), **exposure_effect** (outcome2exposure) and **exposure_level_effect** (exposure2outcome) tables. **reference_template_effect** links individual effect to individual studies (1 to many).

difference

If differences between effects are coded, they are stored in this table. The format is simply: effect number 1; effect number 2; significant (0/1). They are linked to individual studies by **reference_difference** (1 to many).

metareference

When meta-analyses are coded, the "References" sheet in the template is intended to capture all the individual studies that are the subject of the analysis. This information is stored in the **metareference** table. **reference_metareference** provides the link between the coded meta-analyses and all the studies that are included in them. **metareference_effect** shows which studies in the meta-analysis are associates to which effects in the meta-analysis.

evaluation

This table stores colour codes and motivations (cf. synopses).

synopsis

This table stores the reference data for the synopses (title = title, filename = originalName, main topic and coding date). **synopsis_coder** provides the link with the author. **synopsis_wp** provides the link with the work package. **synopsis_taxonomy** provides the links with the taxonomy (1 to many). **synopsis_taxonomy_evaluation** provides the link with evaluations at the taxonomy level. Since some authors provide different evaluations for levels lower than the lowest taxonomy level (e.g., different road users) there is a 1 to 1 link with the evaluation table through **synopsis_taxonomy_keyword** and **synopsis_taxonomy_keyword_evaluation**. Finally, **synopsis_taxonomy_reference** contains the links between synopses and coded studies at the taxonomy level.

rug

This table contains the master road user group names; **taxonomy_rug** and **frame_rug** provide the links with the corresponding taxonomy levels and sampling frame values.

riskfactor_countermeasure

This table provides the consolidated links between the (most recent) risk factor and countermeasure taxonomy levels.

4 The Frontend System

The SafetyCube DSS (Decision Support System) is available at the following URL: http://www.roadsafety-dss.eu. Its pilot operation started early 2017; since then the system has been updated continuously and this process will continue until April 2018 (end of the SafetyCube project) and beyond. The system consists of the backend database which was described in the previous section, the front end database (and the related user interface) and the way they integrate (namely through the DSS Search Engine and the related database queries). These are described in the following sections.

In order to optimise and facilitate the use of the DSS, the design of the front end system was based on the following principles:

- **Search possibilities**: the user may search a road safety risk alone or through the measures, search a measure alone or through the risks, search for risks and measures related to specific road user groups or accident categories, and so on.
- **Fine level of detail**: the user may refine the search and filter the results with many parameters among those found in the database (e.g. road types, road user groups, countries etc.)
- **Flexibility**: the user may continuously adjust the search according to the results
- **Transparency**: the process is fully documented and the user may access background information at any stage (links, etc.)

4.1 STRUCTURE OF THE FRONTEND SYSTEM

4.1.1 System components

The DSS has the following components:

- The **Search** tab: allows the user to query the DSS backend database and retrieve results
- The **Knowledge** tab: compiles the SafetyCube synopses as a knowledge library
- The **Calculator** tab: allows the user to retrieve one of the SafetyCube examples of cost-benefit analysis, edit it with own values or perform his/her own cost-benefit analysis of a road safety measures
- The **Methodology** tab: includes key background information and related documents on the SafetyCube methodology and related disclaimers
- The **Support** tab: includes contact information, the guide to DSS users and possibility to send feedback or questions.

The Knowledge, Methodology and Support components have a simple one-level structure, with related text and links. Their interface and contents are presented in section 4.3.6.

The Calculator is currently under development and its structure will be finalised by December 2017.

The Search component has a distinct structure described in detail in section 4.1.2 below.

4.1.2 Structure of the search component

The SafetyCube DSS Search is structured in **three operational levels** (with Level 0 being the system Home Page), as shown in Figure 4.1:

- Level 1: Search Pages
- Level 2: Results Pages
- Level 3: Individual study pages

These are reachable through **five entry points** (keywords, risk factors, measures, road user groups, accident categories), as shown in Figure 4.1.
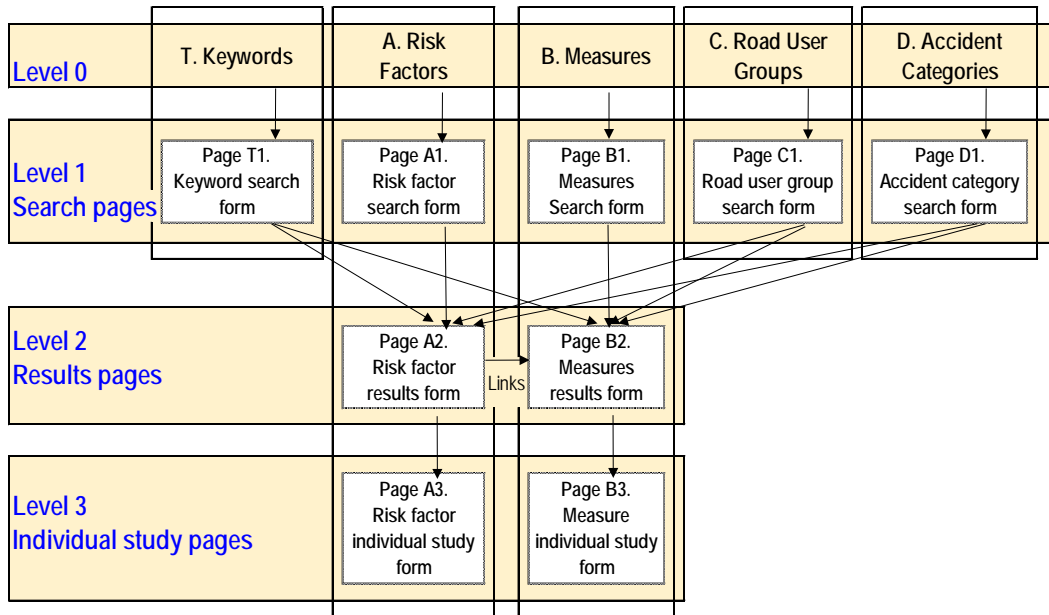
Figure 4.1 Design structure of the DSS

More specifically, level 1 consists of the specific search methods which the user may want to use, based on five possible entry points (see Figure 4.2).

Figure 4.2. SafetyCube DSS entry points

The philosophy of this search is as follows:

- **Keyword search**: the system will let the user type in a keyword in free text and – as you type – will show all potential matches with keywords in the database. Once a keyword is entered (or selected from the dynamic pop-up list), the system will respond with the related subsets of risk and measure taxonomies for further selection.
- **Risk factors**: the user may search for a crash risk factor through the SafetyCube taxonomy
- **Measures**: the user may search for a road safety measure through the SafetyCube taxonomy
- **Road user groups**: if the user wishes to inquire about risks or measures specifically related to a particular road user group, he/she may enter the DSS via the road user groups' entry point. As for keyword search, the system will respond with the adequate subsets of risk and measure taxonomies – in relation to that road user group – for further selection.
- **Accident categories**: if the user wishes to inquire about risks or measures specifically related to a specific accident cateh

It is important to highlight that the entire Search component is based on **two interlinked pillars**:

- **Risk Factors**
- **Road Safety Measures**

In fact, all entry points at Level 1 eventually lead to a selection of risk factors or measures of interest, and only by selecting one does the user retrieve the results at Level 2.

4.2 TECHNICAL SPECIFICATIONS OF THE FRONTEND SYSTEM

The DSS server is hosted in the Cloud, and running in Ubuntu Linux environment. The database queries used to retrieve information are MySQL.

The architecture stack of SafetyCube DSS is based on the following key technologies:

- *Node.js*: a software platform for creating a web server and building web applications on top of it. Node.js uses Google's open source V8 JavaScript engine at its core.
- *Express*: a minimal and flexible Node.js web application framework for web and mobile applications; it is used as a middleware between database and frontend. It is open source.
- Angular JS: a JavaScript framework for working with data directly in the frontend. Angular JS is open source.

The main strength of the chosen stack architecture lies in its centralization of JavaScript as the main programming language. Our solution has a representational state transfer (REST[3]) API feeding a single-page application. API is typically built with Express, and Node.js, with the Single Page Application being built in Angular JS.

4.3 THE USER INTERFACE RESPONDING TO USER NEEDS

4.3.1 Structure of the interface pages

Figure 4.3 gives an overview on the different screens the system will bring forward depending on the user choice – together with examples of further results from the system (Results Pages, Synopses, Individual Study Pages).

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[3] REST stands for REpresentational State Transfer, which is an architectural style rather than a strict protocol.

The Query Page

Accident Categories Search: Under construction

Road User Group Search

Keyword Search

Risk Factors Search

Measures Search

Related Risk Factors / Measures

The Results Page

Synopsis

The Individual Study Page
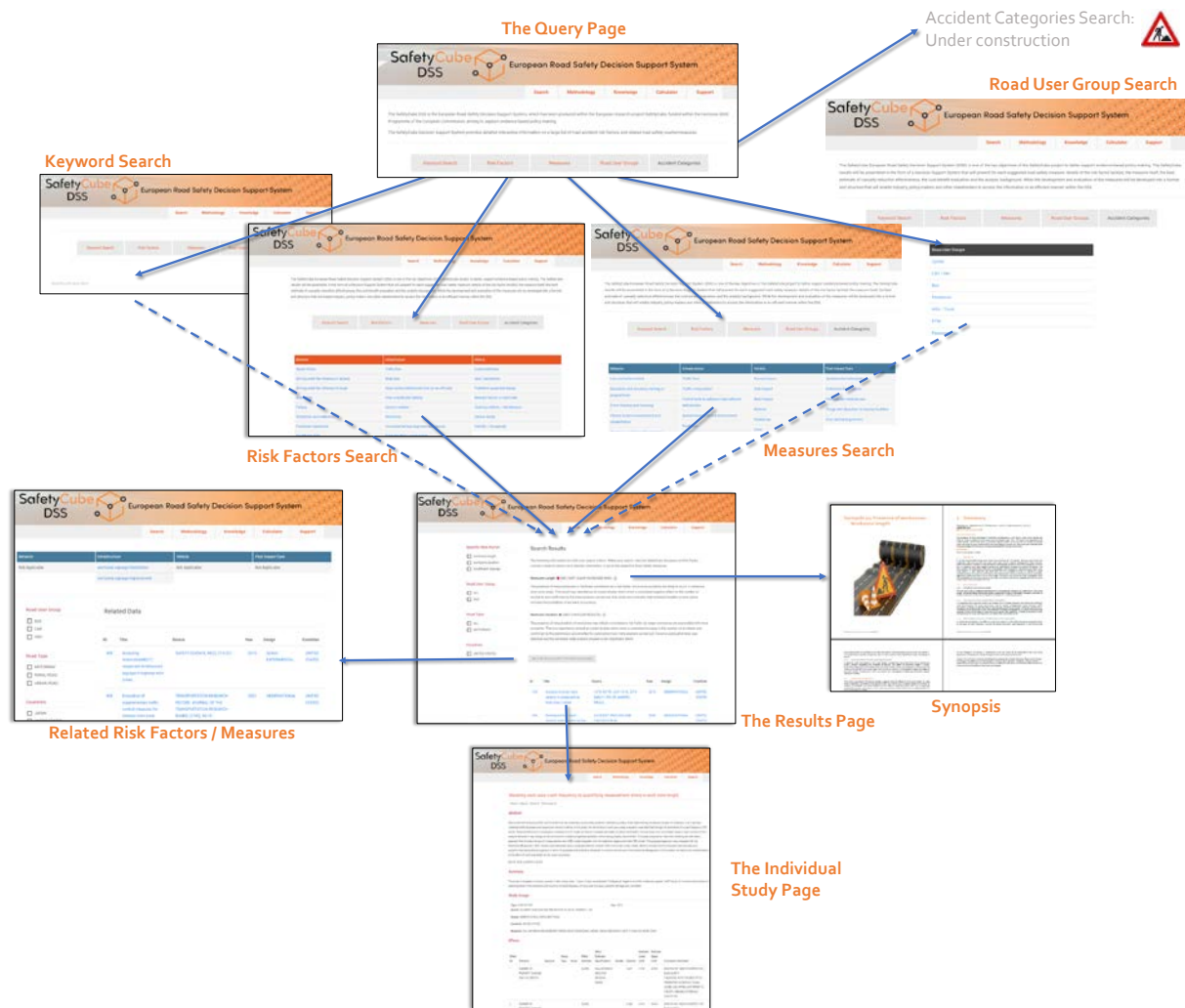
Fig. 4.3 Overview of the DSS structure and sequence of pages

4.3.2   The search pages

As mentioned above, the user may search on the basis of the five entry points of the system.

Option 1: Keyword search

Upon selecting **"Keyword Search"** the system will let the user type-in a keyword in free text and will show in auto-complete form all potential matches in the database master keywords (see Figure 4.4). Once a keyword is entered (or selected from the dynamic auto-complete list), the system will respond with adequate subsets of risk *and* measure taxonomies for further selection. The search system will search in both the keywords of the coded system as in the keyword list of the synopsis.

It is underlined that the results corresponding to synonyms of the typed keyword will also appear e.g. either one types "elderly" or "seniors", both terms will lead to the exact same search results.

Selecting one of the two taxonomies' entries (risk factors or measures) will take the user further to the respective results page. In this case, only the studies concerning the specific keyword will be retrieved for each risk factor or measure (and not all the studies available for the risk factor or measure).

Figure 4.4: An example for Keyword Search. Already as the word "pedestrians" was only partly typed in ("ped"), the system suggested various potential matches in the database; "PEDESTRIANS" was then selected from the list of suggestions.

Options 2 and 3: Querying Risk Factors and measures

When "Risk Factors" is selected as entry point, the SafetyCube taxonomy of crash risks will open, sorted by the domains "Road User", "Infrastructure" and "Vehicle" (see Figure 4.5). Likewise, if the entry point "Road Safety Measures" were selected, the SafetyCube taxonomy of measures would appear, including, in addition to the three domains, a fourth domain on "Post Impact Care".

Selecting one of the taxonomy's entries will take the user further to the respective results page (see next main chapter on Results Pages hereunder).

Option 4: Querying Road User Groups

As a shortcut to the results concerning crash risks or measures specifically related to a road user group, one may enter via the **road user groups** query (see Figure 6). As for keyword search, the system will respond with adequate subsets of risk *and* measure taxonomies – in relation to that road user group – for further selection. Selecting one of the two taxonomies' entries will take you further to the respective results page (see section 4.3.3). The results, as in the case of the "keyword" search, will include only the studies concerning the specific road user group (and not all the studies available for this risk or measure).

Figure 4.5: Risk Factors Search: the SafetyCube taxonomy of crash risks on the DSS.
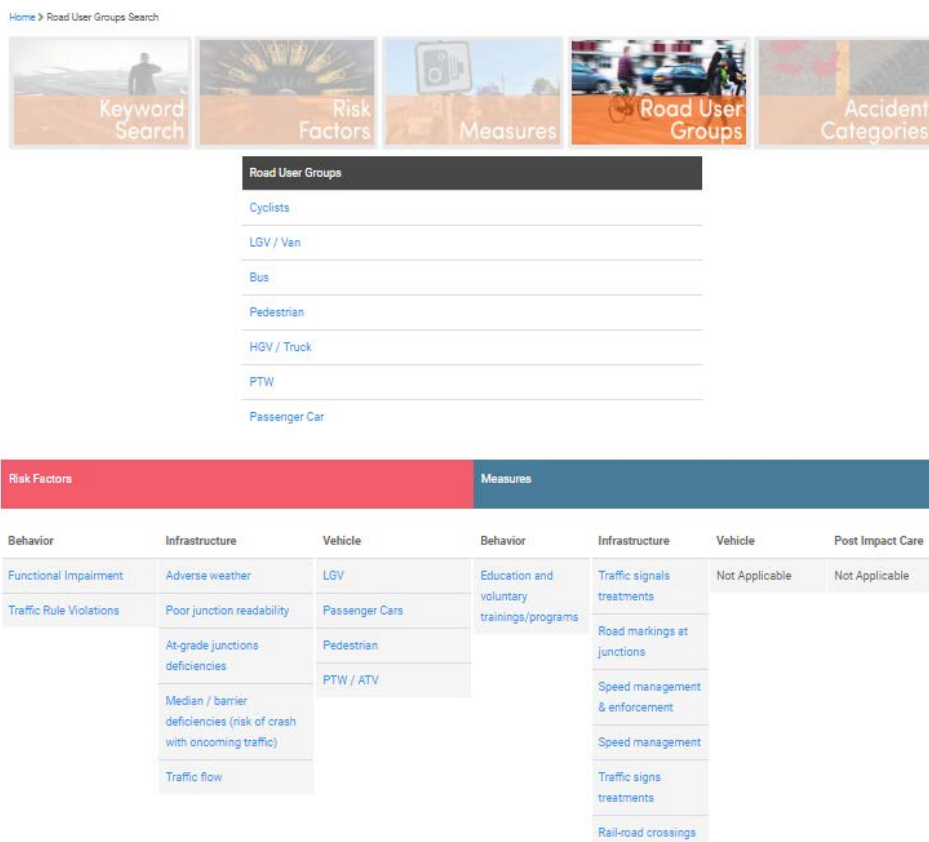
Figure4.6: Road User Group Search. As result from choosing 'pedestrian' from the list, the system responds with SafetyCube taxonomies on risk factors & measures specific to pedestrians.

Option 5: Querying Accident Categories

As a shortcut to the results concerning crash risks or measures specifically related to an accident category, one may enter via the **accident categories entry point.** Similarly to the road user groups entry point, by choosing an accident category:

- Bicycle accident
- Single vehicle accident - run off road
- Single vehicle - on roadway
- Head-on collisions / oncoming traffic
- Rear end collisions / same direction traffic
- Junction accident – no turning
- Junction accident – turning
- Railway level crossing

The system will respond with adequate subsets of risk *and* measure taxonomies – in relation to that accident category – for further selection. Selecting one of the two taxonomies' entries will take the user further to the respective results page (see section 4.3.3).

4.3.3   The DSS results page

Upon selecting an entry on one of the above lists (risk factors or measures), the main results page will appear. The results consist of (see Figure 4.7):

- Short **introductory texts and the colour code(s)**, describing the risks or the effectiveness of measures
- Links to one or more available **SafetyCube synopses** on the issue (pdf link button(s) next to the colour code)
- A **table listing the available meta-analyses and other coded studies** in the SafetyCube database together with their main characteristics such as design, country, and year of publication. Selecting a study from the Table will lead the user to the individual study page (see section 4.3.4).
- Depending on the selected domain, **adaptive search filters** are available on the left side of the results page. Filters include: keyword, specific risk factor (corresponding to the most detailed taxonomy level), road user group, road type, country. The keyword filter appears only when entering from the "keyword" or "road user group" entry point, and allows the user to "un-filter" the results and obtain all the studies related to the risk factor or measure (and not only those related to the keyword or road user group).
- A button which **links to related measures** (if the results page is in the risks domain) **or to related risk factors** (if the results page is in the measures domain).

Fig.4.7. The Results Page of risk factor "work zones"

Synopses

For all risk factors and measures where sufficient scientific evidence was available, the SafetyCube team produced a comprehensive synopsis to make the evidence accessible to a wide range of users with various backgrounds and professions.

The synopses are pdf documents (size between 10 and 70 pages), available for free download from the DSS's Results Pages of each topic (icon next to the risk factor or measure title), containing (see Figure 4.8):

- **Summary**: a two-page overview, including colour code (ranking the magnitude of a risk or the effectiveness of a measure), abstract, and overview of the scientific evidence,
- **Scientific overview**: a five-page document, with detailed background information and description of study results,
- **Supporting document**: with no page limit, including a full record of the literature search and study selection criteria, the full list of relevant studies, as well as detailed comparative tables of study designs and results (if applicable).

It is noted that not all synopses include information for all road user groups, and therefore these will not appear when entering from the "keyword" or "road user group" entry point. On the other hand, some synopses include separate information for different road user groups, and / or a different colour code for different road user groups, if applicable.

All the Synopses produced are also listed and available for download via the **Knowledge** tab of the SafetyCube DSS (see section 4.3.6).

Figure 4.8. Snapshot of SafetyCube Synopsis for risk factor "work zone length" (13 pages

Links between risks and measures

All risks are intended to be linked to measures that have the potential of reducing this risk, and vice versa. There is obvious added value in this feature, as it will assist DSS users in:
(a) knowing which risks can be remedied by which types of measures
(b) knowing which types of risks will be reduced by a particular measure.
These links are meant to reflect situations where a user of the system would be looking for effective measures. This means a measure (e.g. winter maintenance) could be linked to a risk-factor (e.g. snow) but in the end turn out not to be effective. The idea behind this is to give users access to an evaluation of the measure whenever they might consider the measure a solution to their problem.

The links between risks and measures are based on **a dedicated SafetyCube model under development** categorizing risks as to:
- generic ones, i.e. concerning the general state of the system (e.g. design of roads or vehicles, knowledge of the road users, etc.) or
- "circumstantial" ones, i.e. concerning the transient state of the system at the moment the crash occurred (e.g. defects, environmental conditions, road-user impairment, etc.).

Similarly, measures are categorized as:
- addressing generic risks, i.e. improving the general state of the system
- addressing "circumstantial" risks, i.e. preventing or mitigating circumstantial risks such as speeding, road user impairment, visibility etc.

Moreover, risks and measures are associated with:
- specific accident categories, namely those used in the respective DSS entry point.

- specific accident phases: pre-crash (typically, but not exclusively, including generic factors), crash (typically, but not exclusively, including circumstantial factors) or crash consequences (severity)

All these elements are integrated and taken into account when checking for measures that should be considered as remedies for a risk factor in question. Moreover, by linking risk factors to measures from different domains, a **systems approach** is emphasized for the user. As an example, when looking for measures linked to a road user related risk like "speeding", the user will be guided to measures that address road users (campaigns, demerit point systems) or infrastructure (speed humps, section control) or the vehicle (ISA, adaptive cruise control).

The **"related risk factors / measures" button** is activated only once a "Specific Risk Factor" or a "Specific Measure" is selected from the adaptive search filters on the Results Page on the left. Selecting one related risk factor / measure from the list, a table listing the available synopses and studies in the SafetyCube database for the related risk factor / measure appear (see Figure 4.9). **Adaptive search filters** are also available on the left side. Then, selecting an entry of the table will take you to the individual study page (section 4.3.3).

Figure 4.9. The Related Risk Factors / Measures: Choosing 'poor visibility - darkness' as a Specific Risk Factor from the "Poor visibility and lighting" risk factor and hitting the "Related Measures" button, the system responds with several related measures from the SafetyCube taxonomies. The results appear after selecting 'improvement of existing lighting'.

4.3.4   The individual study page

The individual study results (see Figure 4.10) provided in Level 3, includes the study abstract (as it appears in the original publication), 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. CMF, odds ratio)
- statistical significance.

The page also includes a summary of the main study features and findings written by the SafetyCube expert who analysed and coded the study, as well as an explicit outline of potential methodological issues or biases, as identified by the SafetyCube expert.

Estimating the relationship between accident frequency and homogeneous and inhomogeneous traffic flows.

Hiselius, L.

Abstract

This paper estimates the relationship between accident frequency and the traffic flow empirically treating the hourly traffic flow in two different ways, as consisting of homogenous vehicles and as consisting of cars and lorries. Rural roads in Sweden are studied using Poisson and Negative Binomial regression models. It is found that important information is lost if no consideration is taken to differences between vehicle types when estimating the marginal effect of the traffic flow. The accident rate decreases when the traffic flow is treated as if homogeneous. However, when cars are studied separately the result suggests that the accident rate is constant or increases. The result with respect to lorries is reversed, indicating a decreasing number of accidents as the number of lorries increases.

DOI:10.1016/J.AAP.2003.11.002

Summary

Data from 83 rural road sections in Sweden from 1989 to the middle of 1995 is analyzed. The traffic data is hourly based traffic flow (for each direction, but not per lane), separately for cars and lorries. Injury accidents, excluding intersection accidents and accidents involving animals, are analyzed, and daylight accidents are studied separately (showing the same results as all accidents, this analysis has not been coded). For the four road types analysed, approximately 160-600 accidents are in the dataset. In the poisson regression analysis, hours with similar traffic flows are aggregated. A negative binomial model was also used, but “Distributional assumptions do not seem to affect the results”, and poisson results are presented and coded. Generally, an increasing amount of lorries is found to be associated with lower accident frequency (controlling for car volume), while the opposite is found for volumes of cars. This tendency is found both for all accidents, single vehicle accidents and multi-vehicle accidents. The study analyzes four types of roads separately, and finds larger effects on for motorways and roads with speed limit 70 km/h and road width 6-9,7m, than for other road types (speed limit 90 km/h and road width 6–7,9 m; road type with speed limit 90 or 110 km/h and road width 8–13 m without separated road lanes). The author notes that a small sample size, and low volumes of lorries relative to cars may be an issue.

Limitations

Extent	Motivation	Type
MAYBE A PROBLEM	AS NOTED BY AUTHOR, LOW ACCIDENT FREQUENCY PER UNIT OF TRAFFIC FLOW INDICATES LOW POWER. THE AUTHOR ALSO NOTES THAT THE FLOW OF LORRIES IS A FRACTION OF THE FLOW OF CARS.	GENERAL: SMALL SAMPLE

Basic Study Information

Topic: RISK FACTOR   Year: 2004

Source: ACCIDENT ANALYSIS AND PREVENTION, 36, 985-992.

Design: OBSERVATIONAL CROSS-SECTIONAL

Countries: SWEDEN

Keywords: TRAFFIC: STATISTICS & NUMERICAL DATA FORECASTING MODELS RURAL POPULATION HUMANS REGRESSION ANALYSIS SWEDEN TRAFFIC TRAFFIC: PREVENTION & CONTROL BINOMIAL DISTRIBUTION ACCIDENTS THEORETICAL

Effects

Effect No	Outcome	Exposure	Group Type	Group	Effect Estimator	Effect Estimator Specifications	Sample	Estimate	Estimate Lower Limit	Estimate Upper Limit	Conclusion Comments
1	ACCIDENT				SLOPE	POISSON REGRESSION		-2.66			SIGNIFICANT POSITIVE EFFECT ON ROAD SAFETY
2	ACCIDENT				SLOPE	POISSON REGRESSION		3.62			SIGNIFICANT NEGATIVE EFFECT ON ROAD SAFETY
3	ACCIDENT				SLOPE	POISSON REGRESSION		-0.94			SIGNIFICANT POSITIVE EFFECT ON ROAD SAFETY

Figure 4.10 The Individual Study page for a study concerning "traffic flow" as a risk factor

4.3.5   The Calculator

The calculator for Economic Efficiency Evaluation (E3) of road safety measures, currently under development, allows to combine information about the effectiveness of a measure (i.e. the percentage of crashes or casualties prevented) with the costs of this measure. The calculator also integrates updated information of crash-costs in the European countries, allowing to express all costs and benefits of a measure in monetary values and conducting cost benefit analysis.

Three options will be available:
- **Select one of the SafetyCube cost benefit analyses examples**: if for a measure among those in the SafetyCube taxonomies, an input suitable for an economic efficiency evaluation was available, the user will be able to retrieve this example, as a form with the E3-calculator

prefilled according to the proper input values. Additional information on the assumptions behind the CBA-analyses is also provided.

- **Adapt one of the SafetyCube cost benefit analyses examples:** the user will be able to change the input (e.g. select another country, enter measure costs according to their own estimation, modify time horizon, change effect measures, etc.) to evaluate how this changes the results in comparison to the prefilled SafetyCube analysis.
- **Perform a cost benefit analysis with own input data**, by using the updated and standardised crash cost values developed in SafetyCube.

4.3.6 Other pages

The DSS includes the following additional tabs / pages (these are still under development and will include more elements than listed below):

- **Knowledge**: this page gives access to several units of knowledge developed within SafetyCube. In its current form (November 2017) it lists all risks and measures synopses developed in SafetyCube, initially sorted alphabetically, including the links to their pdf. files, and further allows the user to (see Figure 4.11) (1) filter the synopses by typing a "keyword" in a search bar, and (2) sort them on the basis of risk factor or measure tackled, area (road user behaviour, infrastructure, vehicle or post-impact care), and colour code. By the end of the project, other knowledge units will be added, such as information on serious injuries.

- **Methodology**: this page includes background information on the SafetyCube project, including the methodology, a disclaimer document with things to know when using the DSS, a glossary, as well as details on the Quality Assurance procedures.

- **Support**: this page presents contact information for user support, allows to download the Quick Guide that serves as the DSS manual, and to access a dedicated user feedback survey through which feedback can be sent to the SafetyCube partners.

Knowledge

The SafetyCube project synthesized existing knowledge on road safety risk factors and countermeasures in comprehensive Synopses; these are listed below per risk factor / measure, colour code (assigned to reflect the strength of evidence on the effect of the risk factor or measure), and the road safety area concerned (behaviour, infrastructure, vehicle).

🔍 Search…

ID	Title ▾	Topic	Domain	Color Code
12	2 + 1 roads	COUNTERMEASURE	Infrastructure	GREY (UNCLEAR RESULTS): ⬤ - 📄
83	Accident characteristics of bicycle accidents	RISK FACTOR	Vehicle	GREY (UNCLEAR RESULTS): ⬤ - 📄
1	Adverse weather conditions - Frost & Snow	RISK FACTOR	Infrastructure	GREY (UNCLEAR RESULTS): ⬤ - 📄
45	Adverse weather conditions - Rain	RISK FACTOR	Infrastructure	YELLOW (PROBABLY RISKY): ⬤ - 📄
128	Alcohol interlock	COUNTERMEASURE	Behavior	GREEN (EFFECTIVE): ⬤ - 📄
5	Alignment deficiencies - Absence of transition curves	RISK FACTOR	Infrastructure	YELLOW (PROBABLY RISKY): ⬤ - 📄
7	Alignment deficiencies - Densely spaced junctions	RISK FACTOR	Infrastructure	GREY (UNCLEAR RESULTS): ⬤ - 📄
6	Alignment deficiencies - Frequent curves	RISK FACTOR	Infrastructure	GREY (UNCLEAR RESULTS): ⬤ - 📄
8	Alignment deficiencies - High Grade	RISK FACTOR	Infrastructure	YELLOW (PROBABLY RISKY): ⬤ - 📄
4	Alignment deficiencies - Low curve radius	RISK FACTOR	Infrastructure	RED (VERY CLEAR INCREASED RISK): ⬤ - 📄
32	At-grade junction deficiencies - gradient	RISK FACTOR	Infrastructure	YELLOW (PROBABLY RISKY): ⬤ - 📄
30	At-grade junction deficiencies - skewness / junction angle	RISK FACTOR	Infrastructure	YELLOW (PROBABLY RISKY): ⬤ - 📄
28	At-grade junctions deficiencies - Number of conflict points	RISK FACTOR	Infrastructure	YELLOW (PROBABLY RISKY): ⬤ - 📄
31	At-grade junctions deficiencies - poor sight distance	RISK FACTOR	Infrastructure	YELLOW (PROBABLY RISKY): ⬤ - 📄
106	Awareness raising and campaigns – Aggressive and Inconsiderate Behaviour	COUNTERMEASURE	Behavior	LIGHT GREEN (PROBABLY EFFECTIVE): ⬤ - 📄
107	Awareness raising and campaigns – Child restraint	COUNTERMEASURE	Behavior	LIGHT GREEN (PROBABLY EFFECTIVE): ⬤ - 📄
108	Awareness raising and campaigns – Driving under the influence	COUNTERMEASURE	Behavior	LIGHT GREEN (PROBABLY EFFECTIVE): ⬤ - 📄
121	Awareness raising and campaigns – Seatbelts	COUNTERMEASURE	Behavior	GREEN (EFFECTIVE): ⬤ - 📄
109	Awareness raising and campaigns – Speeding	COUNTERMEASURE	Behavior	LIGHT GREEN (PROBABLY EFFECTIVE): ⬤ - 📄

Figure 4.11. The Knowledge tab of the SafetyCube DSS

5 Next Steps

5.1 COMPLETION OF THE DATABASE

As mentioned before, the database of studies and synopses is still being updated and extended. This will go on until the end of the project (April 2018). This updating process includes a final quality check of all synopses written and of the correctness of the information available on the individual study pages (see section 5.2) below.

In addition, over the next months the DSS will be extended with the following elements:
- additional studies and synopses on measures, in particular in relation to vehicles
- descriptions of accident categories, and their association with links and measures
- the integration of the E³ calculator tool and its associated files with exemplary Cost Benefit Analyses (CBAs)
- information, guidance and training materials
- further methodological background information.

5.2 FINAL STEPS IN THE QUALITY ASSURANCE PROCESS

Currently, the final step of the quality assurance process is being undertaken: a final review of all the synopses and all the individual study pages.

It is reminded first that this is the last step in an overall quality assurance approach that has included:
- explicit and detailed guidelines on the criteria for the literature search, the way different study designs should be processed and coded, how synopses should be written and how results should be documented (this has been documented in Milestone 13 and is also included in the future deliverable D3.3)
- a study coding template with a highly restrictive coding environment that for large parts forces coders to choose from a range of given values rather than to write something themselves
- trainings and a support function for all SafetyCube experts involved in coding studies and drafting synopses
- reviews by peers, task and work package leaders
- a debugging process when coded study templates are read into the data-base, requiring errors to be corrected before the template is entered into the data-base.

In the ongoing final step of the quality assurance process, experts within the SafetyCube team review systematically the following elements for each risk factor and measure analysed: inclusion of the most relevant search terms, inclusion of the most relevant databases, transparency about the selection of studies, inclusion of all obvious studies that should be included, consistency between the colour code and the main findings, adequacy of abstract, sufficiency of the background information, adequate overview of results, adequate description of analysis methods, identification of potential biases/limitations, inclusion of conditions for transferability, validity and logic of the results, and reflection of current state of the art.

A similar exercise in relation to the coding of studies is currently in a pilot phase. Coded studies will be checked systematically on whether the correct values have been entered into the system.
For both processes, when errors or omissions are detected, a process exists to remedy the problem and subsequently upload the final version of the synopsis or template, replacing the previous one.

5.3 FURTHER IMPROVEMENTS

In addition to the updating and extensions of the DSS, which were mentioned in sections 5.1 and 5.2, the DSS will undergo further improvements until the end of the project period (30th of April, 2018). These improvements will be based on the feedback and comments received through (1) users of the draft version of the DSS, which is currently on line, and (2) the quality assurance process itself. The improvements should further improve the quality and accessibility of the rich content of the DSS and should make sure that different types of users can find easily what they are looking for.

Currently, plans are also being developed on how the SafetyCube system could be maintained and improved after the lifetime of the project. This will be discussed in the future deliverable 8.5.

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