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Deliverable D2.1

State of the art of level crossing safety: identification of key safety indicators concerning human errors and violations

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Consortium - List of partners

Partner No	Short name	Name	Country
1	UIC	International Union of Railways	France
2	VTT	Teknologian tutkimuskeskus VTT Oy	Finland
3	NTNU	Norwegian University of Science and Technology	Norway
4	IFSTTAR	French institute of science and technology for transport, development and networks	France
5	FFE	Fundación Ferrocarriles Españoles	Spain
6	CERTH-HIT	Centre for Research and Technology Hellas - Hellenic Institute of Transport	Greece
7	TRAINOSE	Trainose Transport – Passenger and Freight Transportation Services SA	Greece
8	INTADER	Intermodal Transportation and Logistics Research Association	Turkey
9	CEREMA	Centre for Studies and Expertise on Risks, Environment, Mobility, and Urban and Country planning	France
10	GLS	Geoloc Systems	France
11	RWTH	Rheinisch-Westfaelische Technische Hochschule Aachen University	Germany
12	UNIROMA3	University of Roma Tre	Italy
13	COMM	Commsignia Ltd	Hungary
14	IRU	International Road Transport Union - Projects ASBL	Belgium
15	SNCF	SNCF	France
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Executive summary

The aim of this Deliverable is to generate a descriptive framework in which existing and proposed level crossing systems and safety measures can be analysed from a user perspective. Using a methodology that combines literature review and expert opinion; key safety indicators concerning user requirements and human errors and violations have been identified. The results presented will be useful to the design of level crossings and safety systems according to the road and rail user's perspective, especially of vulnerable users.

Summary and reflection on data collection and analysis

In a first phase, all partners participated in creating a bibliographic database in *Google Drive* which gathered literature on human factors applied to level crossing safety. After selecting the most relevant sources of information, in a first stage, task partners reviewed the literature to identify user requirements and human errors and violations related to level crossings and safety systems. In order to facilitate the analysis and evaluation of the variables that had been identified in the documentation reviewed, a common template was developed, the *Project/ Study Form* (referred to in advance as *Review Form*). Also, other variables that had not been captured through the literature review and that might be of importance were identified.

Subsequently, FFE analysed the variables listed in the *Review Form*, grouping these under broad thematic categories classified as user requirement and human error and violation indicators. Following their classification, the indicators were subject to a validation exercise by Task partners using an *Indicators Rating Form*. Through this form, partners were consulted both to rate the relevance of the identified indicators and provide additional information or any "new" indicators not captured in the literature review.

In a final phase, the user requirement indicators were classified as human errors and violations in level crossings safety systems using the German in Depth Accident Study (GIDAS) human error categorization framework.

Summary of variables concerning user requirements analysed

The review of the literature revealed that most of the studies related to user requirements and human errors and violations at level crossings focus, on the one hand, on passive level crossings and automatically controlled active level crossings and on the other hand, on the car users and pedestrians. Almost all of these studies, even if not directly related to human factors, underline the relevance of these variables and the need to take them into account to better understand the safety performance of level crossing systems.

The documents reviewed also showed that the most studied variables related to human factors are (in 20 or more documents):

- Sight distances and signs (n=33).
- Setting of level crossings (e.g. urban or rural) (n=29).

- External distractions (n=25).
- Perception of train speed and distance (n=25).
- Crossing angle (n=22).
- Lack of understanding of the correct action that is required (n=22).
- Risk-seeking personalities (n=21).
- Lack of knowledge of signalling at level crossings (n=20).
- Frustration and impatience when delayed by approaching trains (n=20).

Variables linked to the personal conditions of level crossing users were also analyzed to identify risk groups. The results showed that, in recent years, the research has mostly focused on the analysis of behaviours by gender and age.

Key results of the connection between the variables in the database and the type of level crossing and type of user reveal the following:

- Type of level crossing:
  - Documents on passive level crossings focus on the variables of distraction and inattention, conspicuity, lack of knowledge, inaccurate risk perception and context information.
  - Documents on automatically controlled active level crossings are focused on the variables of gender, age, deliberate risk-taking behaviour, distraction and inattention, conspicuity, lack of knowledge, inaccurate risk perception and context information.
- Type of user:
  - Documents on car users at level crossings focus on the variables of gender, distraction and inattention, conspicuity, lack of knowledge, inaccurate risk perception and context information.
  - Documents on the pedestrians at level crossings are focused on the variables of age, gender, deliberate risk-taking behaviour, distraction and inattention, conspicuity, lack of knowledge, inaccurate risk perception and context information.

The systematic absence of significant associations among other variables can be explained by the low number of publications mentioning them.

In the review of the literature, Task partners identified new variables that had not been contemplated in the *Review Form*. New variables that appeared most frequently include: distraction in general, conspicuity, lack of knowledge in general, risk in general, second train coming, crossing time, traffic volume, the presence of police and time of day.

Summary of key safety indicators concerning user requirements and human error and violation

The following section presents the key safety indicators concerning user requirements and human error and violation identified from the literature and analysed against the error categories of the German in Depth Accident Study (GIDAS) human error categorization framework (Grippenkoven et al., 2012). The GIDAS framework classifies human errors according to the different stages of human information processing: information access, information admission, information evaluation, planning and operation. The following analysis focuses on the stages of information processing that are most obviously affected by the respective factor.

Indicators of personal conditions

The indicators of personal conditions are linked to errors of information access, errors of information admission, errors of evaluation and errors of operation. In this case, errors can occur due to not perceiving relevant information, experiencing interferences in and outside the car, making an incorrect interpretation of the information due to previous experience and knowledge of the place, and/ or taking wrong actions.

Main results (total survey responses=6):

- Two experts consulted considered the relevance of taking into account the potentially risky behaviour of men as very important in devising solutions to enhance safety at level crossings.
- The analysis of human factors must especially take into account young people that exhibit non-compliance at level crossings (extremely important according to two experts).
- Two survey responses judged physical disability as extremely important in the design of safety solutions at level crossings.
- According to two replies, it is considered extremely important to take into account the indicator on use of alcohol, drugs and/or medication within the analysis of human factors at level crossings.

Distraction and inattention

A road user´s attention may be diverted away from a level crossing due to 'external distractions' (e.g. traffic lights, give way signs, pedestrian traffic, etc.). Road users may also be presented with 'internal distractions' as a result of engaging in tasks secondary to driving, such as the use of media devices, conversing with passengers or fellow pedestrians, attending to children, or distracting mental processes, like daydreaming or worrying. These indicators are linked to errors of information admission.

Main results (total survey responses=6):

- Experts consulted highlighted the importance of the indicator related to tiredness in the analysis of human factor. Four replies rated it as very important in providing solutions to improve safety at level crossings.
- External distractions, internal distractions, distractions in general and non-compliances due to overload by other stimuli were considered extremely important in one case respectively.

Conspicuity of crossings and trains

The conspicuity at level crossings can be diminished due to weather conditions that reduce visibility, night-time conditions, sun glare, vegetation overgrowth, sight distance, etc. These indicators are linked to errors of access information and errors of admission.

Main results (total survey responses=6):

- Experts consulted considered that the indicator of crossing angle leading to non-compliance at the level crossing is the most relevant indicator. Two experts considered the crossing angle to be extremely important for human factor analysis and three responses judged it as very important.

Lack of knowledge

A human factor leading to the unintentional misuse of level crossings is lack of knowledge regarding the rules that apply and a lack of awareness of the risks associated with the rail environment. These indicators are linked to errors of information evaluation because the information can be interpreted incorrectly.

Main results (total survey responses=6):

- The indicator related to lack of understanding of the correct action leading to non-compliance at the level crossing is considered to be the most relevant indicator for the human factor analysis (one survey response rated it extremely important and three survey responses rated it as very important).

Inaccurate risk perception indicators

In general, inaccurate risk perception is related to familiarity with level crossing leading to the low expectancy of encountering trains at crossings and misjudgement of train speed and distance. These indicators are linked to errors of information evaluation. The information can be misunderstood due to previous experience and knowledge of the place and lack of awareness and knowledge of railways and related risks at level crossing infrastructures.

Main results (total survey responses=6):

- According to the survey responses, the indicator of user's familiarity with the place must be taken into account in the human factor analysis. This indicator was considered as extremely important in two survey responses and as very important in other two survey responses in the design of safety solutions at level crossings.

Deliberate risk-taking behaviour indicators

Deliberate risk-taking behaviour indicators fall into two main categories: risk-taking due to the frustration and impatience of the user having to wait at the level crossing and, risk-taking due to the risk-seeking personality of the user. These indicators are linked to voluntary unsafe behaviour or violations.

Main results (total survey responses=6):

- Experts consulted reported that the indicator of frustration and impatience leading to non-compliance at the level crossing is the most relevant indicator to consider within an analysis of human factors and level crossing safety (one survey response rated frustration and impatience as extremely important for the human factor analysis framework and three survey responses evaluated it as very important).

Information about the context indicators

The indicators regarding information about the context are linked to errors of information access, errors of information admission, errors of evaluation and errors of operation. In this case, errors can occur due to not perceiving relevant information, experiencing interferences in and outside the car, making an incorrect interpretation of the received information due to experience and familiarity with the place, and/ or taking wrong actions.

Main results (total survey responses=6):

- According to the results, experts highlighted the relevance of the level crossing setting indicator in the design of safety solutions at level crossings. The setting of the level crossing was considered extremely important in two survey responses and as very important in three survey responses.

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1. INTRODUCTION

1.1. Objectives of SAFER-LC project

The main objective of SAFER-LC is to improve safety and minimise risks at and around level crossings by developing a fully integrated cross-modal set of innovative solutions and tools for the proactive management and design of level crossing infrastructure. These tools aim to:

- Enable road and rail decision makers to achieve better coherence between both modes.
- Detect potentially dangerous situations leading to collisions at level crossings as early as possible.
- Prevent incidents at level crossings through innovative design and predictive maintenance methods.
- Mitigate the consequences of incidents and disruptions due to accidents or other critical events.

The main output of the SAFER-LC project is a toolbox which will be accessible through a user-friendly interface which will integrate all the project results and solutions to help both rail and road stakeholders to improve safety at level crossings. Within the framework of SAFER-LC, the objective of Work Package 2 is to enhance the safety performance of level crossing infrastructures from a human factor perspective, making them more self-explaining and forgiving.

1.2. Purpose of the document

The purpose of Task 2.1 is to provide a descriptive framework in which existing and proposed level crossing systems and safety measures can be analysed from a user perspective. The framework proposed is based on key safety indicators concerning user requirements, human errors and violations identified from the literature and expert opinion. This work represents the first stage in the development of a human factor methodological framework and constitutes one of the main inputs for Task 2.2.

1.3. Structure of the document

Following the introductory section (Section 1) of this report which sets out the objective of the SAFER-LC project and purpose of Task 2.1, this deliverable is presented under the following four sections:

- Section 2 introduces background information related to the analysis of human factors in level crossing safety systems with the aim to support understanding of the key safety indicators concerning human errors and violations at level crossings presented in the results section of this report.

- Section 3 describes the sources of data and methodology used in the process of developing key safety indicators concerning user requirements, human errors and violations at level crossings.
- Section 4 presents the results of the analysis of variables identified in the literature review and the key safety indicators concerning user requirements and human errors and violations at level crossings.
- Section 5 provides a final summary, discussion and conclusions of the findings from Task 2.1 along with proposals for the continuing work of WP 2.

2. BACKGROUND: HUMAN FACTOR APPLIED LEVEL CROSSING SAFETY ANALYSIS

This task seeks to understand the human factor contributors to level crossing accidents and non-compliant behaviour, in addition to some of the environmental or contextual factors that increase the risk of train-pedestrian and train-vehicle collisions. This analysis will help understand how technological and non-technological measures can be better adapted from a user perspective and therefore make crossings more self-explaining and forgiving. This background section introduces a number of key concepts that will support the analysis of human factors in level crossing safety systems addressed in this task. Most notably, it aims to elucidate the human factor categories presented in the results section. The information presented in this section is based on a review of a selection of studies that discuss a human factor´s approach to level crossing safety. Whilst this does not cover all of the literature reviewed as part of this task, it has drawn from some of the same sources and therefore there is coherence with the human factor categories found in both the survey tool used in this task (literature *Review Form*) and the results section of this deliverable.

Human factors and 'safe systems' approach (forgiving and self-explaining infrastructure)

A human factor is a theoretical approach concerned with the understanding of interactions among people and other elements of a system. This approach applies theory, principles, data and methods to design, in order to optimize human well-being and overall system performance (International Ergonomics Association web). It considers the presence of system wide latent conditions and their role in shaping the context in which operators make errors (UNECE, 2017). In this way, human error is no longer seen to be the primary cause of accidents rather a consequence of latent failures of the system.

According to the 'safe systems' approach, whilst humans are fallible and make errors, level crossing accidents result from the complex interaction between level crossing users (e.g. pedestrians, older drivers), vehicles (e.g. heavy vehicles, high-speed trains), level crossing infrastructure (e.g. sight distances, signage) and the broader environment (e.g. weather conditions). In this way, the key to safer level crossings arises from shared responsibility between road users, transport industries and governing bodies. Countermeasures adopted through the safe systems approach seek to make the characteristics of level crossings more forgiving of human error, and to minimise the level of unsafe road user behaviour (Searle et al., 2012).

The concept of forgiving and self-explaining infrastructure has been applied most commonly to the road safety context. From this perspective, a forgiving road is one that is designed and built in such a way as to interfere with or block the development of driving errors and to avoid or mitigate negative consequences of driving errors, allowing the driver to regain control and either stop or return to the travel lane without injury or damage. On the other hand, a self-explanatory road is designed and built to evoke correct expectations from road users and proper driving behaviour (either due to its layout or through adequate signing), thereby reducing the probability of driver errors and enhancing driving comfort (Bekiaris et al., 2011).

There is an increasing body of research and information on the subject of human factors at level crossings (albeit to date the studies have focused more on train and vehicle collisions as opposed to pedestrian-train collisions). Some common themes appear in the literature in relation to the user perspective at level crossings which are presented on continuation. Given the focus of the task, it is important to first distinguish between two broad categories of non-compliance at level crossings: human error and deliberate violation. The study of these two categories of behaviour constitutes the main focus and principal outcome of this deliverable.

Most level crossing users inadvertently engage in risky behaviour (Searle et al,. 2012) and these examples of unintentional non-compliance are referred in the literature as human error. Examples of human error include: failing to notice approaching trains and misjudging the risk of approaching trains and can involve various cognitive factors including inattention, distraction, poor knowledge, misjudgement, limited sight distance, etc. (Freeman et al., 2013). On the other hand, there are level crossing users that intentionally defy the crossing rules. These events are known as level crossing violations. Various factors have been cited in the literature as influencing a users´ tendency to comply with rules including: individual factors such as age, gender, personality, and attitudes; social factors such as norms, enforcement, and behaviour of nearby others; and situational factors such as waiting time, weather, distraction and mood (Edquist, 2011). Some more specific reasons reported for intentionally violating traffic or level crossing rules include being in a hurry; maximizing convenience; familiarity; deliberate risk-taking, fatigue, alcohol and drugs (Freeman et al., 2013). According to the literature, there are fewer examples of level crossing violations compared to non-compliance due to human error.

A further point that should be taken into account when analysing human factors in level crossing safety systems is the type of level crossing (passive, active and pedestrian) and level crossing user (motorized, non-motorized, vulnerable users), as these variables can influence the nature of the risk and human factors at play. For example, crashes at passively controlled level crossings involving unintentional driver non-compliance are more likely to be influenced by human factors than factors related solely to technical or equipment failures (Rudin-Brown et al., 2014) and certain human factors may be more prevalent in one road user group than another (Searle et al., 2012). These factors are taken into account in the following analysis of human factors at level crossings.

The two sets of human factors (human error and violations) defined above will now be explored in more detail. This analysis is principally based on the work of Searle et al. (2012), together with evidence from other sources of literature where relevant. The aforementioned study sets out a clearly defined set of human factor categories applied to level crossing safety which is based on a range of relevant literature and scientific evidence. Specifically, it explores high-risk level crossing users and their motives, encompassing different types of level crossing (active and passive) and user groups (motorised and non-motorised, including vulnerable users). The human factor categories set out in Searle´s analysis were also used to inform the development of the literature *Review Form* (survey tool used in this task) and therefore provide background on these variables and further facilitate understanding of the results of this deliverable.

Human factors related to human error at level crossings

- **Conspicuousness of crossings and trains**

In order to safely negotiate a level crossing, as a first step, the user needs to successfully detect the presence of a crossing or a train. Their ability to do this can depend greatly on the visual contrast of these objects against their broader environment. The contrast can be diminished due to weather conditions that reduce visibility, night-time conditions and sun glare that can temporarily blind the road users (Searle et al., 2012). The small perceived size and often dark colour of trains approaching from a distance may also contribute to poorer detection and recognition by drivers (Rudin-Brown et al., 2014).

Limited sightlines along the track are another important perceptual factor that can affect the road user´s ability to detect an approaching train at a passive crossing. Sight distance must allow road users not only to become aware of a train but also to be able to stop safely before the crossing. Previous research has highlighted that inadequate sight distances may be due to vegetation or buildings located alongside the track, curvature in the road or track, or the road and railway tracks intersecting at an acute angle (Searle et al., 2012).

- **Distraction and inattention**

A road user´s attention may be diverted away from a level crossing due to 'external distractions' (e.g. traffic lights, give way signs, pedestrian traffic, shops etc.). This is a problem experienced most commonly at active crossings, these being most frequently found in urban environments and often forming part of visually and mentally complex traffic systems (Searle et al., 2012). When overloaded with other stimuli, the situational awareness of the road user can be compromised and attention is taken away from the level crossing. In this situation, stimuli such as trains or flashing lights may be fully visible but unnoticed, a phenomenon referred to as 'attentional blindness', or 'looked but failed to see' (Searle et al., 2012).

Road users may also be presented with 'internal distractions' as a result of engaging in tasks secondary to driving, such as the use of media devices, conversations with passengers or fellow pedestrians, attending to children, or distracting mental processes like daydreaming or worrying. Rudin-Brown et al. (2014) argue that non-visual driver distractions that arise as a result of cognitive (thought) stimuli, can negatively impact on driver visual scanning behaviour. This factor could be present amongst users of both active and passive crossings and could apply to both motorized and non-motorised users.

On the other hand a further potential inattention issue experienced by drivers at passive crossings can be low states of arousal and inattentive to the broader environment, due to the rural isolation of passive crossings and their low train and road traffic, meaning that the user may fail to notice either crossings or approaching trains (Searle et al., 2012).

The issue of the presence (and awareness) of a second train appearing shortly after the first has passed, is receiving increasing focus within the literature (Freeman et al., 2013). Various authors, cited in Searle et al. (2012), report how approaching trains can act as a distraction affecting both pedestrian and motorized users. First, pedestrians may be focused on catching a train that is entering a railway station, and in doing so, run into the path of a second approaching train. Second, motorists may similarly have their attention focused on a train that is either approaching, stopped at an adjacent station, or just passed, and presume that it is safe to cross, when in fact a second unseen train is approaching.

- **Lack of knowledge**

A further human factor leading to the unintentional misuse of level crossings is lack of knowledge regarding the rules, particularly for passive crossings. This is often coupled with a general lack of awareness regarding the risks associated with the rail environment, such as the long stopping distances of trains and their inability to stop or slow to avoid a collision. This lack of knowledge can extend to users not being aware of the illegality of their behaviour and existence of penalties.

As suggested in the above point, there is a particular issue with understanding the correct way to act at passive level crossings. A number of studies referenced in Searle et al. (2012) have pointed to the fact that many drivers do not look for trains at passive crossings. It is suggested that this may be due to the fact that drivers not distinguish between active and passive crossings and therefore expect to be informed if a train is approaching.

Various experts agree on the need to address education within a wider programme of risk management to increase safety at pedestrian (and vehicular) rail level crossings (one of the five E´s). This involves increasing public awareness of dangers of crossings and educating pedestrians, road vehicle drivers and other users how to use them correctly (Metaxatos et al., 2015).

- **Inaccurate risk perception**

Some users are unaware of the real risks involved in misusing a level crossing. This can be due to lack of knowledge as explained above, but according to Searle et al. (2012) there are two key factors related to inaccurate risk perception: familiarity with level crossing leading to low expectancy of encountering trains at crossings; and misjudgement of train speed and distance.

- **Familiarity and expectation**

Drivers who use level crossings regularly come to develop expectations about train frequency and the likelihood of encountering a train, based on their previous crossing experience. Expectations and knowledge about a given situation are often referred to as schemas or mental models. Familiarity with a particular level crossing or type of crossing, together with a reinforced expectancy of no trains, leads to a ‘no trains’ schema being activated on future level crossing approaches (Rudin-Brown et al., 2014). Crossing familiarity and an expectation that a train will not be present have the potential to lull drivers into complacency or poor looking habits (Caird et al., 2002). This can be particularly true for frequent passive crossings users due to the low daily train volumes of this type of crossing.

- **Misjudgement of train speed and distance**

It is difficult for road users to judge the speed and distance of approaching trains and therefore the time it takes for trains to arrive at the crossing. Searle et al. (2012) point out two main perceptual issues that can affect one's ability to accurately judge train speed, leading them to underestimate train speed and be overconfident in their ability to 'beat the train': the Leibowitz effect and the looming effect. The Leibowitz effect describes the phenomenon where larger objects appear to be moving slower than smaller objects that are actually travelling at the same speed. The looming effect, on the other hand, means that despite travelling great distances there is virtually no change in apparent size of the train until it is quite close by. This situation can be acuter at rural crossings and at night.

Human factors related to level crossing violations

- **Deliberate risk-taking behaviour**

Deliberate risk-taking behaviour falls into two main categories: risk-taking due to the frustration and impatience of the user having to wait at the level crossing for the passing of an approaching train(s); and the user having a risk-seeking personality. In the first case, the user may decide to violate the crossing rules because they judge that the benefits of reducing waiting time outweigh the perceived risks of infringing the rules. Various studies cited in Searle et al. (2012) have observed that violations tend to increase significantly when the time between warning activation and train arrival exceeds 20–30 seconds. Impatience with delays at level crossings may arise when road users are in a hurry to reach their destination which may be accentuated at specific moments of the day, such as morning rush hour. Road users may also deliberately violate crossing controls if they consider them to be unreliable or if they perceive the consequences of their actions to be unlikely in terms of being penalized or a train arriving.

On the other hand, it has been identified that a user may deliberately violate the rules due to having a risk-taking personality. In this case, the user´s defiance of crossing rules and activated level crossing safety controls may be just one example of various risky behaviours.

3. SOURCES OF DATA AND METHODOLOGY

Task 2.1 was developed based on secondary information sources (literature review) and expert opinions, over a five phase data collection and analysis process. This section of the report first describes the data collection process and how the information was collected and analysed for the development of key safety indicators concerning user requirements, human errors and violations at level crossings. It then goes on to present a descriptive analysis of the information sources used in the literature review.

All phases of the work were supported by working documents prepared by FFE which outlined the methodology and instructions to complete the subtasks. Task partners were actively involved in providing feedback on the methodology which led to further refinement of the tools employed.

3.1. Data Collection

Phase I: Construction of a bibliographical database regarding human factors at level crossings and safety systems

All task participants (6 partners) were involved in constructing a bibliographical database regarding human factors at level crossings and safety systems. Each partner contributed documents to a shared spread sheet and folder hosted on *Google Drive*. Partners were asked to identify documents with a focus on human factors at level crossings including level crossing user requirements; incorporation of the user perspective in safety systems and measures; human factor level crossing accident and incident contributors; perception and acceptance of risk; errors, lapses and violations; vulnerable level crossing users (not exhaustive). There were no limits to the geographic scope or type of literature to be included (e.g. scientific articles; research papers; projects; communications; analytical tools etc.).

The documents were collected from online scientific databases and web tools (e.g. RSSB Spark web tool), *ResearchGate*, websites of related research projects and cited references listed in the bibliography of other publications. As a way of validating the documents identified, the database included a “Partner validation” column where the task partners had to indicate their awareness of the publication and confirmation of its usefulness for the review. A total of 131 documents were included in the database by partners, of which 125 were finally included in the analysis. The original list of documents was reduced due to the fact that four documents were repeated, one had not been uploaded and one was out of scope.

This database represents a valuable source of bibliographic information regarding human factors at level crossings and can be accessed on the SAFER-LC extranet.

Phase II: Literature review

This stage of the task involved the review of documents to summarise the findings and identify user requirement variables related to level crossings and safety systems. The literature in the database was distributed between task partners. Given the large volume of documents to be reviewed and the involvement of different partners in this task, a *Review Form* (originally entitled *Project/Study Form*) was developed by the task lead partner (FFE). This *Review Form* was designed to facilitate the identification and analysis of relevant information on user requirements and human factors to ensure that comparable data and details were provided by partners from the literature reviewed. In order to inform the categories contained in the *Review Form*, particularly those related to human factors, a preliminary review of a sample of documents contained in the bibliographic database was carried out (Caird et al., 2002; Ngamdung and DaSilva. 2013 ; Read et al., 2013; Rudin-Brown et al., 2014; Searle et al., 2012). From this brief review, a synthesis of human factor related variables was compiled and included in the form. The design of this form was based on the methodological principles of content analysis, a research technique for making replicable and valid inferences from texts (or other meaningful matter) to the contexts of their use (Bengtsson, 2016).

The form was created in Excel and was structured around six key information fields that needed to be completed by the reviewer (see Annex A for a copy of the review form):

- **Bibliographical information** (basic reference details of the reviewed document: title, author, year...).
- **Study information** (including the focus of the study, its objective and approach).
- **Classification items** (encompassing the type of level crossing [active and passive] and level crossing users [motorised users and vulnerable users] studied in the publication).
- **Variables related to human factors** (requiring the reviewer to indicate if the following variables were studied in the document: personal conditions; distraction and inattention; conspicuity of crossings and trains; lack of knowledge; inaccurate risk perception, deliberate risk-taking behaviour, information about the context).
- **Human factor translated to safety measure** (referring to evidence in the document that the human factors studied have been incorporated into the design of safety measures and whether this has measure been tested). The results of this information have been included within the final section of this report in order to support the discussion regarding the most relevant indicators to take forward in Task 2.2.
- **Information on countermeasures** (identification of information on countermeasures in the document to be included in the review of counter measures in Task 2.3).

In all of the categories, an additional information field was provided in order to capture any variables not listed on the form and observations that would support the analysis. A form was completed for each document reviewed, with a total of 125 completed *Review Form*s. Please note that several people were involved in the review process and thus filled in the study forms. In this way, variation is likely to exist in the way that individual reviewers filled in the template and whether they considered it important to mark specific variables in the form.

Phase III: Definition of user requirement indicators

This phase of the task sought to analyse the results of the literature review as captured in the *Review Form*s (most notably the results of the variables related to human factors identified in the document) in order to define a set of user requirement indicators. In order to do this, a frequency analysis was performed on the identified variables.

The content of all *Review Form*s was included in one SPSS file in order to analyse the results regarding human factor variables received through the document *Review Form*. The received data was then cleansed for inconsistencies and work to define, recode, label and standardize some of the variables in the SPSS file was carried out.

A descriptive univariate analysis was performed, in order to explore the data and characteristics of the sample. Specifically, an analysis was performed on type of level crossing and user studied; personal conditions of level crossing user (sex, age, type of disability and consumption of substances); type of distraction and inattention at level crossing; conspicuity of crossing and trains; knowledge regarding correct action required at level crossings; risk perception at level crossings; deliberate risk-taking behaviour; and variables related to the context (e.g. weather, setting, layout, time of day...). From this analysis the most frequently occurring variables (those listed in three or more documents) were grouped under seven broad user requirement indicator categories, as follows:

- Indicators related to personal conditions.
- Indicators related to distraction and inattention.
- Indicators related to conspicuity of crossings and trains.
- Indicators related to lack of knowledge.
- Indicators related to inaccurate risk perception.
- Indicators related to deliberate risk-taking behaviour.
- Indicators related to information about the context.

The specific indicators (n=35) are presented in the results section (chapter 4). A small number of the indicators are based on 'new' variables. These refer to variables that had not been listed in the *Review Form* but were detected in the literature reviewed. It was considered of interest to include all additional variables in order to gain the fullest analysis of human factors possible based on the literature reviewed. In a few other cases, following the feedback given in the *Review Form*s by some respondents, the variables related to human factor listed in the form have been grouped together as one indicator.

In order to explore possible associations between the human factor variables in the database and the type of level crossing and type of user, a bivariate analysis was also carried out on some of the variables (based on all *Review Form*s). In order to see the statistical association between the variables Pearson's chi-squared test (x^2) was used with a p-value significance level < 0.05.

Phase IV: Validation of user requirement indicators and identification of 'new' indicators

In order to validate the user requirement indicators identified in the previous phase and capture further observations and other variables not identified through the literature review, an *Indicator Rating Form* was developed (see Annex B for a copy of the *Indicators Rating Form*). Each task partner was asked to rate the relevance of measuring a specific indicator in terms of safety at level crossings from a human factors perspective. Each indicator was assigned a rating on a five point Likert scale (from 'extremely important' to 'not at all important'). A brief definition of each indicator was provided to facilitate a common understanding.

According to the information provided in the completed forms the decision to assign the score, ratings was based on evidence in scientific articles and research papers and in some cases also in-depth accident data and local knowledge from the survey respondent's country.

Phase V: Identification of key safety indicators concerning human error and violations

In a final phase and as the key outcome of Task 2.1, key safety indicators concerning human errors and violations have been identified. The user requirement indicators (identified in Phase III) created from the variables identified in the literature review (Phase II) have been classified as human errors and violations in level crossings safety systems using the German in Depth Accident Study (GIDAS) human error categorization framework (Grippenkoven et al., 2012). The GIDAS categorization framework classifies human errors and violations in categories according to the different stages of human information processing: information access; information admission; information evaluation; planning and operation.

GIDAS was originally designed for automobile users, though it has also been applied to the study of level crossing accidents. As an established tool used to describe the underlying mechanisms of human error in road traffic accident analysis, this framework offers a coherent way of classifying the set of indicators identified from the review of 125 documents, in terms of underlying mechanisms of human error applied to level crossing accidents. The violation of rules is also taken into account within this framework. This task has applied the GIDAS classification of errors and violations to all types of level crossing users because this framework does not discriminate between the human information processing of motorized road users or vulnerable road users.

Figure 1 below presents a schematic representation of the methodology followed in Task 2.1 for the identification of key safety indicators concerning human error and violations.

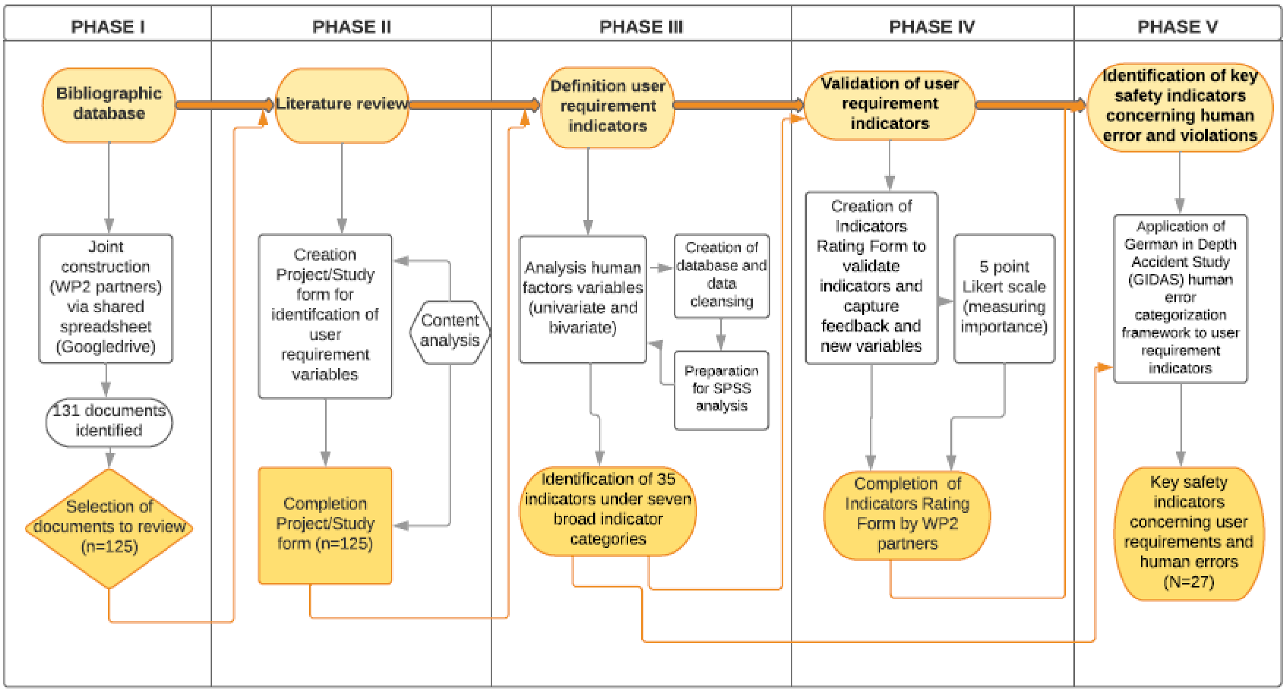

Figure 1. Task 2.1 methodology overview

3.2. Description of reviewed literature

A descriptive analysis of the information sources (125 documents) reviewed in the development of indicators on human errors and violation is presented on continuation, including a summary of the document type; temporal and spatial scope; study focus; and approach and methodology employed. A frequency analysis has been conducted on the data available. Please note that in some cases there was no information provided in the information field of the *Review Form* or the information provided did not allow for an adequate analysis. For this reason, there is some variation in the universe of the information analysed on continuation.

The full bibliographic database and completed *Review Forms* can be accessed by project partners through the SAFER-LC extranet.

3.2.1. Document type, temporal and spatial scope of study

Four types of documents were analysed as part of the literature review (125 documents), distributed as follows:

- Scientific articles (n=72).
- Research paper from a public entity e.g. European Commission, public foundation, ministry, etc. (n=24).
- Research paper from a private entity e.g. private foundation, organization, etc. (n=5).
- Other results/ reports (n=22).
- No information provided (n=2)

Furthermore, as indicated in the Description of Work, some analytical tools were also included in the analysis of the literature (RESTRAIL toolbox; TARVALC evaluation tool) in order to provide information on variables related to human factors.

Over half (n=72) of the documents reviewed were published in the last three years (2015-2017) and 102 of the publications are from the last ten years (2007-2017). One document had a publication date from 2018. There are some individual papers from the 80s (n=2), 90s (n=10) and early 2000s (2000–2006) (n=8) in addition to one study from 1978.

Just over half of the reviewed documents had a national remit (n=67) followed by local studies (n=26). Seventeen of the documents were international and just eight of them had a European scope. Most of the publications are from English speaking countries, most notably Australia and United States of America (but also the United Kingdom and New Zealand), closely followed by European countries and a smaller number of studies from other parts of the world.

3.2.2. Study focus

A brief thematic analysis of the literature has been performed, based on the key words contained in the bibliographical database and some supporting information from the *Review Form*s. The results of this analysis reveal the following key subject areas dealt with in the literature:

- Level crossing accidents (characteristics and causation).
- Non-compliance at level crossing (characteristics and causation).
- Design and evaluation of level crossing safety countermeasures.

Those documents that studied level crossing accidents (characteristics and causation) cover:

- Perception factors in level crossing collisions: size and speed of approaching train, motion, detection distance, etc.
- Accident analysis and risk management: accident causation, accident modelling, accident investigation, accident costs, safety evaluation, and risk management.

In terms of non-compliance at level crossing (characteristics and causation) the literature studied:

- Human factor contributors to non-compliance: human errors, distractions, attention, knowledge, perception, understanding, eye tracking, checking behaviour, sight distance, level crossing conspicuity, etc.
- Characteristics and behaviour of high risk level crossing users (both motorised and non-motorised road users).
- Analytical approaches to the study of level crossing user behaviour: situation awareness, decision making, systems theory, modelling driver behaviour, etc.

Those documents that dealt with the subject of design and evaluation of countermeasures covered issues such as:

- User design requirements including vulnerable level crossing users: people with disabilities, cyclists, pedestrians, etc.
- Human factors good practice.

- Theories and approaches applied to the design of level crossings and safety systems: cognitive work analysis, systems analysis, sociotechnical theory, system design, systems thinking design toolkit, constraints systems approach, etc.
- Design, testing and evaluation of measures (level crossing infrastructure, new technologies and intelligent transport systems).

3.2.3. Study approach and methodology

Many of the studies adopt a mixed study approach, encompassing one or a combination of the following: data analysis (n=63); test/pilots (n=57); theoretical/bibliographical approach (n=51); or other study approaches (n=8). A more detailed analysis of the methodology used, as described in the *Review Form*s, has been carried out. This shows the use of a wide range of information sources and data collection methods, encompassing: literature review, data modelling, user consultation, expert consultation, user observation, data analysis (accident and incident), driving simulator study, on-road test drives, questionnaire, experiments, and other methods (e.g. diary study). A brief summary of these methods and their study objectives is presented on continuation.

Literature review

Fifteen studies gathered information based on a review of relevant literature, often as part of a wider methodology.

Study objectives:

- To identify potential solutions and countermeasures that address target group behaviour and benchmarking best practice.
- To study characteristics of pedestrian accidents and risky crossing behaviour, including a taxonomy of human factors accident contributors.

Data modelling

Fourteen studies have applied analytical models to understand level crossing behaviour and develop and evaluate effective countermeasures. The most commonly cited model in the literature reviewed is Cognitive Work Analysis (CWA), applied principally to the development of novel level crossing design concepts. Some other models include mixed logit and binary logit prediction models; technology acceptance model and theory of planned behaviour; vehicle dynamic simulation model: path analysis and spatial modelling; and information processing model.

Study objectives:

- To study the contributing factors to various types of safety occurrences.
- To develop and evaluate effective countermeasures.

Level crossing user consultation

In thirteen of the studies level crossing users were consulted using various qualitative techniques such as interview, focus groups and surveys (face to face, site survey and postal). These techniques were sometimes employed as part of a wider consultation exercise or experiment.

Study objectives:

- To study user perception and attitudes to risk and safety at level crossings, reported behaviour and decision-making strategies.
- To evaluate the effect of countermeasures on target group behaviour.
- To ascertain user demographic information and factors that influence human behaviour at level crossings.

Consultation with experts and practitioners (rail professionals)

In twelve studies experts and professionals from the field were consulted through workshops, face to face and telephone interviews and online surveys.

Study objectives:

- To support the development of countermeasures and analyse the potential effect on target group behaviour, side effects or constraints for use.
- To identify research needs.

User observation in situ (e.g. railway stations, level crossing sites, overpasses)

Eleven documents included observations as part of the study methodology. These observations were conducted at identified black spot locations often using cameras, traffic surveillance systems and naturalistic covert observations.

Study objectives:

- To collect qualitative data on the characteristics of individuals observed engaging in both noncompliant and compliant behaviour.
- To study user behaviour (both pedestrians and drivers) under different combinations of level crossing equipment. The behavioural characteristics studied included: looking behaviour (looked one way, looked both ways or neither); the presence of distractions (phone, eating, talking to passenger, etc.); most commonly adopted trajectories; and differential stopping/crossing behaviour during activation of flashing red lights.

Analysis of level crossing accident and incident data

Eleven studies analysed level crossing accident and incident data, taken from a range of different sources: police accident reports, investigation reports, level crossing crash databases, etc.

Study objectives:

- To analyse human behaviour to determine potentially risky situations, including the development of a classification of human factor accident contributors and identification of decision/actions/failures related to the incident.
- Data was also collected and analysed to evaluate the economic efficiency of an investment/project.

Driving simulator study

Nine advanced driving simulator studies were carried out and one computer-based choice task. Participants were often unaware of the study's level crossing focus.

Study objectives:

- To examine visual and cognitive behaviour on approach to level crossings (active and passive), including looking behaviour (head movements, gaze patterns, eye tracking, approach speed, stopping compliance, safety distance, heart rate monitoring and knowledge of signage).
- To evaluate level crossing design concepts and safety systems/measures (e.g. the effect of advance signage with different levels of salience on drivers' stopping compliance, approach speed and safety margins).
- Assess knowledge of level crossing signage.
- To gather data to develop a binary logistic regression model to predict driver behaviour.

On-road test drives

Eight studies collected data from test drives conducted in real traffic with an instrumented vehicle and use of ‘think aloud’ protocols. The research participants were often unaware of the study's level crossing focus.

Study objectives:

- To collect vehicle-related data, driver-related data and eye tracking data.
- To study driver behaviour, including reasons for compliance or non-compliance at stop-controlled level crossings.

Questionnaire

A questionnaire was used in seven of the studies as part of a wider methodology (e.g. a NASA Task Load Index (NASA-TLX) questionnaire was used as part of a driver simulator study).

Study objectives:

- To assess level crossing usage, knowledge, experiences and behaviour (including violations and errors amongst pedestrians and car drivers).
- To provide demographic information on the subjects of an experiment or consultation.
- To assess driver acceptance of intelligent transportation system (ITS) intervention.

- To develop a logistic regression model to predict deliberate violations and assess the contribution of participants' age, gender, intentions to violate rules in the future, and perceptions of formal and informal sanctions on past crossing rule violations.

Experiments

Six of the studies discuss the use of experiments, laboratory based tests and controlled field testing to investigate visual attention and perception related effects on level crossing users.

Study objectives:

- To study size-speed illusion.
- To study eye movements.
- To compare time-to-arrival and speed judgement.
- To measure the effect of selected locomotive alerting light systems on observers.

Other methods

Diary study

In two studies, participants kept a daily diary regarding the level crossings they encountered during a two-week period.

Study objectives:

- To analyse differences in decision making (e.g. goals, information used, situational goals, perceived options) between compliant and non-compliant decisions and between road user groups.

Installation of pneumatic tubes before and after level crossings

In one study, a set of pneumatic tubes composed of a unit that records movements, including two pneumatic tubes (1 metre apart) that covered both lanes of traffic on each side of the crossing.

Study objectives:

- To evaluate crossing compliance rate (cars only), including vehicle speed, vehicle type, the direction of travel and road traffic volumes.

3.3. Methodological reflections

Performing a literature review on 125 publications has allowed the identification of relevant information from a broad range and number of studies. The joint construction of a bibliographic database facilitated a more rigorous identification of relevant literature which drew on the knowledge and expertise of all task partners and permitted the inclusion of some non-English texts and those only accessible by the author. Furthermore, the construction of a database that can be accessed and continually updated on the SAFER-LC extranet represents a rich source of human factors data for other Work Packages.

However, whilst a good range of largely current literature was included in the analysis, it does not represent an exhaustive review of the available literature. It should also be taken into account that some of the literature used the same bibliographic sources and in a few cases, the database contained duplicated documents (although these had been omitted in the final review). On the other hand, as mentioned above, the database will be accessible on the project extranet and therefore has scope to be updated and further expanded.

The analysis of the data sources reveals that the information regarding human factors and level crossing safety is largely taken from recent scientific articles and research papers. The majority of the studies have been carried out in English speaking countries, a factor to be taken into account when considering the representativeness of the information collected. In terms of the methodology employed in the different studies, a wide range of quantitative and qualitative information sources (both primary and secondary) have been used. These often account for the user's perspective and experience of level crossings, both in real life situations and under experimental conditions. In this way, the literature reviewed constitutes a rich source of information for the development of key safety indicators concerning human errors and violations as part of this task.

Basing the identification of user requirement indicators on a review of the existing literature does, however, raise some potential concerns about the objectivity of the information obtained. To address this issue a *Review Form* was developed based on the principals of content analysis, which facilitated the analysis of 125 documents by different reviewers to obtain comparable data. Even so, there is still scope for variation to exist in the ways that individual reviewers filled in the *Review Form* template and whether they considered it important to mark specific variables in the form.

A further potential weakness of basing the analysis on secondary data sources analysed by different people is the scope for missing relevant variables. This may be due to the fact that certain issues may not have been detected and reported in the existing literature by the person reviewing the document and/or a variable has been studied to a small degree or was not considered important in terms of frequency. In response to this issue, the *Indicator Rating Form* was developed in order to capture further observations on the variables identified and any new or other indicators that are not currently reflected in the literature.

It should be noted that only one *Indicator Rating Form* was filled in by each partner organisation. One *Indicator Rating Form* was filled in by each partner organisation. The exercise was based on the subjective evaluation and expertise of the expert(s) completing the form which according to survey respondents drew on: evidence from scientific literature and in some cases in-depth accident data and local knowledge from the respondent's country. There was no communication between task partners during the rating process, although the additional comments and observations by partners included in the form could support later debate on these indicators and the building of consensus in Task 2.2.

The outcome of this deliverable represents a first set of indicators that can be further refined and developed throughout Work Package 2, most notably in Task 2.2. It is proposed this could be done through a group evaluation of the indicators between WP2 partners and potentially wider expert consultation (if needed) in order to reach a consensus on which indicators to take forward into the human factor methodological framework in Task 2.2.

4. RESULTS

4.1. Analysis of variables concerning user requirements

This section presents a descriptive framework of the most relevant variables concerning user requirements and human errors and violations at level crossings by type of level crossing and user. This information is based on the analysis of variables in the *Review Form*s carried out in Phase III of the study (*Definition of user requirement indicators*).

4.1.1. Classification items

The reviewed literature covered three types of level crossing (Figure 2). The results reveal that passive level crossings (n=57) and the active level crossings with automatically controlled protection (n=53) are the most commonly studied types of level crossing.

In 52 documents there was no information regarding the type of level crossing. In 12 of the documents reviewed all types of level crossings were studied.

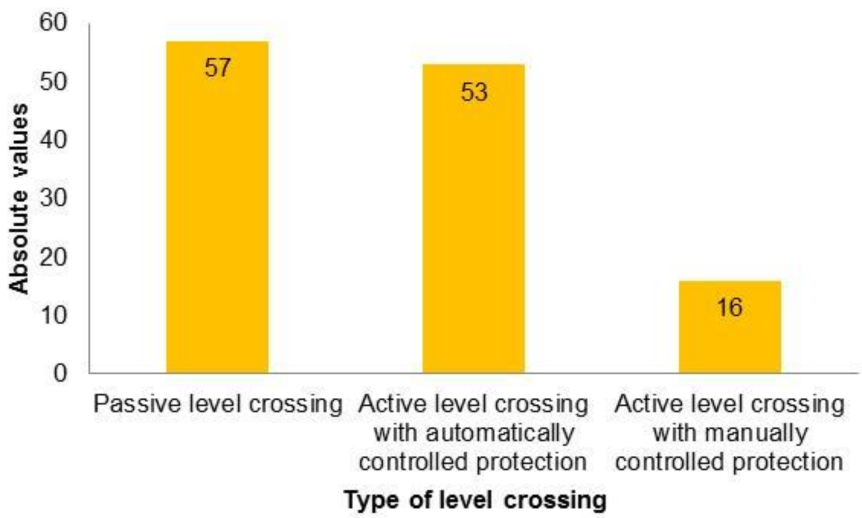

Figure 2. Type of level crossing in the literature reviewed

Figure 3 presents information regarding the type of user as indicated to be covered in the reviewed studies. The most important user cited by the literature reviewed are the car users (n=59) followed by pedestrians (n=40), cyclists (n=16) and heavy vehicles users (n=14). In *others* category, partners collected information from other types of users not included in the previous categories (e.g. dog walkers). In addition, a new category has been included: people with disabilities in general. According to the review of the literature, in some documents, it is not possible to determine the type of disability of the users of the level crossing. In 42 documents there was no information on to the type of user. All types of users were studied in one document.

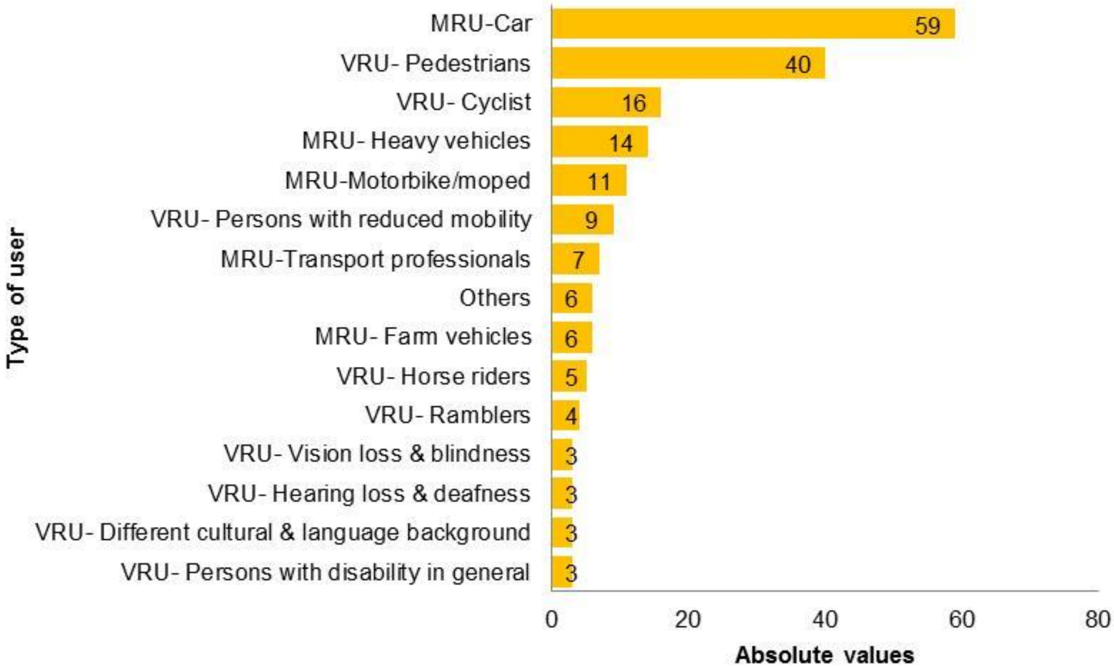

Figure 3. The indicated prevalence of type of user variable in the literature reviewed
VRU: Vulnerable Road User; MRU: Motorized Road User.

4.1.2. Variables related to human factor

4.1.2.1. Personal conditions

Table 1 presents results on variables related to personal conditions of the level crossing user (sex, age, type of disability and consumption of substances).

Table 1. Variables related to personal conditions in the literature reviewed

Variables	Frequencies	Percentage (of 125 revised documents)	Percentage (of the total of each category)
Age			
Young	34	27,2	32,1
Adults	28	22,4	26,4
Children	27	21,6	25,5
Seniors	11	8,8	10,4
Age non specified	6	4,8	5,7
Total	106	84,8	100,0
Sex			
Man	37	29,6	74,0
Woman	13	10,4	26,0
Total	50	40,0	100,0
Type of disability			
Intellectual	9	7,2	34,6
Hearing loss	8	6,4	30,8
Visionloss	5	4,0	19,2
Other physical disability	4	3,2	15,4
Total	26	20,8	100,0
Consumption of substances			
Alcohol	8	6,4	40,0
Medications	5	4,0	25,0
Others	4	3,2	20,0
Drugs	3	2,4	15,0
Total	20	16,0	100,0

The variables found indicate the importance of age in the study of user requirements related to level crossings and safety systems. In this regard, the most analysed age group in the literature are young people (n=34).

Men behaviour are more studied than women behaviour, with the man variable appearing in 37 documents and only 13 documents including the variable of woman.

Results show that the other variables related to personal conditions are less relevant. The most frequently cited type of disability in the literature reviewed is intellectual disability (n=9) followed by hearing loss and deafness (n=8). In the case of the consumption of substances, the most commonly reported is alcohol (n=8).

4.1.2.2. Distraction and inattention

Figure 4 presents information regarding the type of distraction and inattention at level crossings according to the literature reviewed. Results reveal that external distraction (e.g. traffic, noise, etc.), overloaded with other stimuli (e.g. signalling) and internal distraction (e.g. media devices, conversations with passengers or fellow pedestrians, etc.) are the most frequently studied as human factors related to level crossings and safety systems.

As part of *other* category, partners collected information from other types of distractions not included in the previous categories (e.g. risk approach; ‘attentional blindness’, or ‘looked but failed to see’; carrying objects; etc.). In addition, a new category has been included: distractions in general. According to the review of the literature, in some documents, it is not possible to determine the type of distraction of the users of the level crossing.

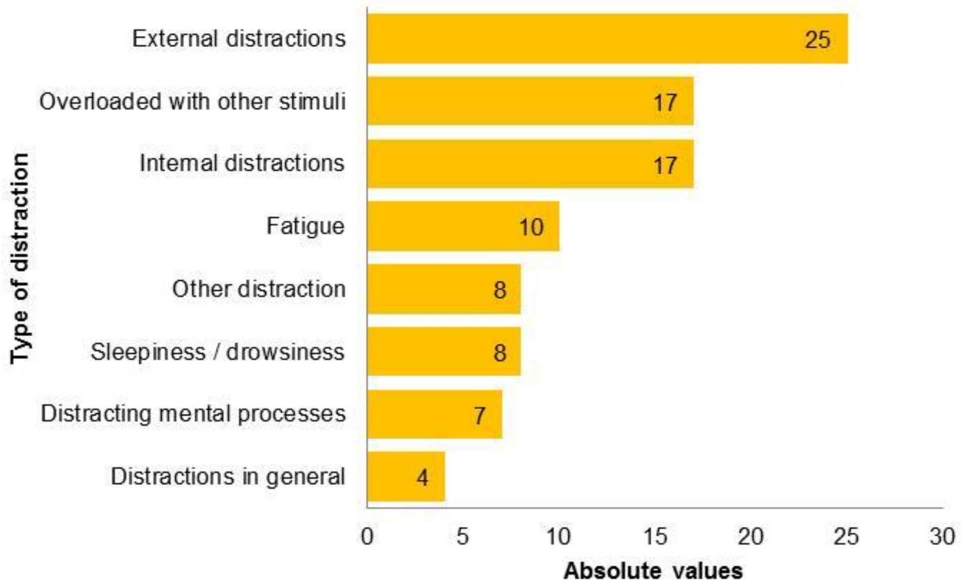

Figure 4. The indicated prevalence of variables related to distraction and inattention in the literature reviewed

4.1.2.3. Conspicuity of crossing and trains

Figure 5 presents information regarding conspicuity variables in the literature. The variables found indicate the importance of sight distances and signs (n=33) in the study of user requirements related to level crossings and safety systems followed by crossing angle (n=22).

The additional conspicuity variables indicated by the partners (not previously included in the *Review Form*) were added under *Other* category (n=13) (e.g. crossing trajectory and level crossing angle; the number of tracks crossed; audibility of an oncoming train or another vehicle; parallel rail-highway crossing; visibility; pedestrian location; etc.). In addition, in some documents, it is not possible to determine the type of conspicuity. For this reason, a new category has been included: conspicuity (n=5).

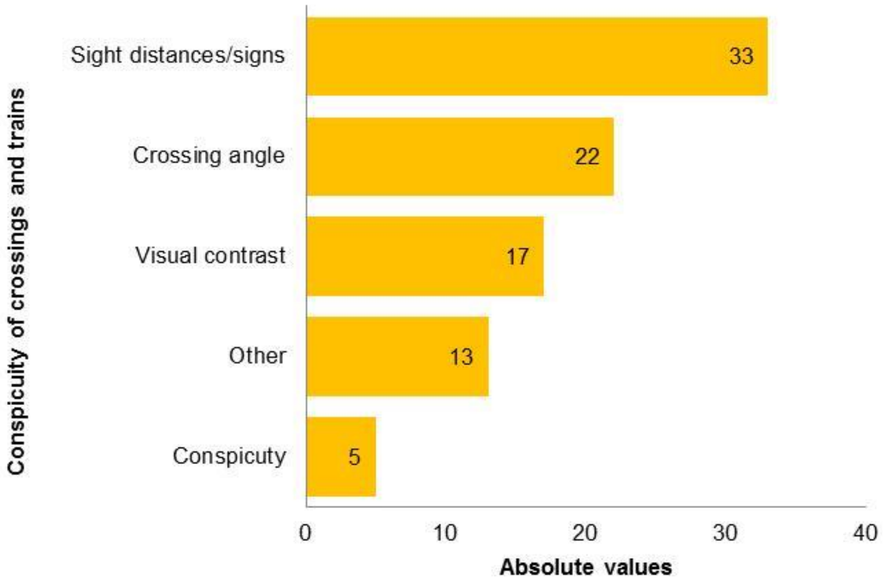

Figure 5. The indicated prevalence of variables related to conspicuity in the literature reviewed

4.1.2.4. Lack of knowledge

Figure 6 presents information on the variables regarding lack of knowledge. The most frequently cited variable in the documents is lack of knowledge of the correct action that is required to take in the level crossings (n=22) followed by not knowledge of signalling at level crossings (n=20) and no knowledge of traffic rules (n=19).

The additional lack of knowledge variables indicated by the partners (not previously included in the *Review Form*) were added under *Others* category (n=9), for example: not paying attention to the signs; learned misbehaviour; etc.

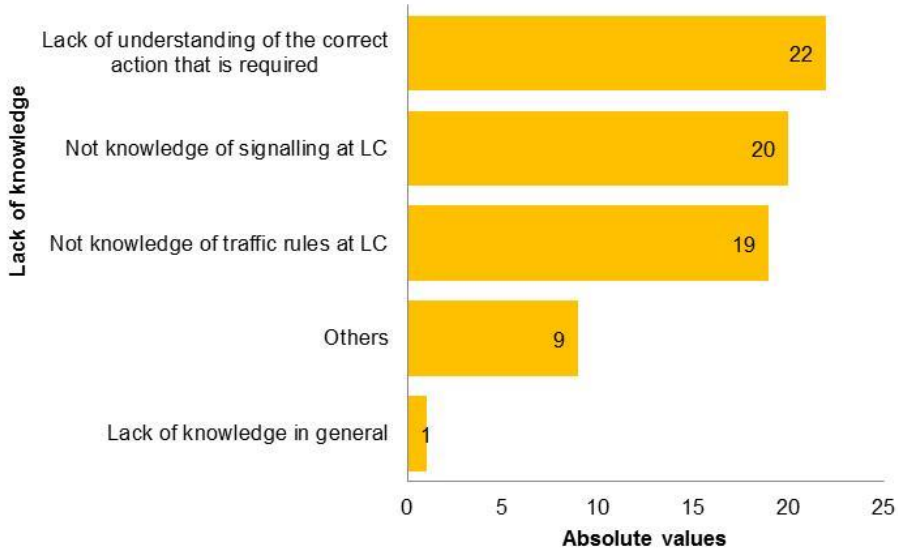

Figure 6. The indicated prevalence of variables related to lack of knowledge in the literature reviewed

4.1.2.5. Inaccurate risk perception

Figure 7 presents results on variables related to inaccurate risk perception. The variables found indicate the importance of the perception of train speed and distance in the study of user requirements related to level crossings and safety systems (n=25). Frequent level crossing user (e.g. professional driver) (n=18) and familiarity with the place (e.g. neighbours) (n=17) have also been highlighted.

Partners collected information from another inaccurate risk perception category in the documents reviewed (n=7): train position/trajectory; low expectancy of encountering trains at crossings; drivers do not differentiate passive and active crossings; lack of awareness of the potential hazards (e.g. confidence to "beat the train"); etc.

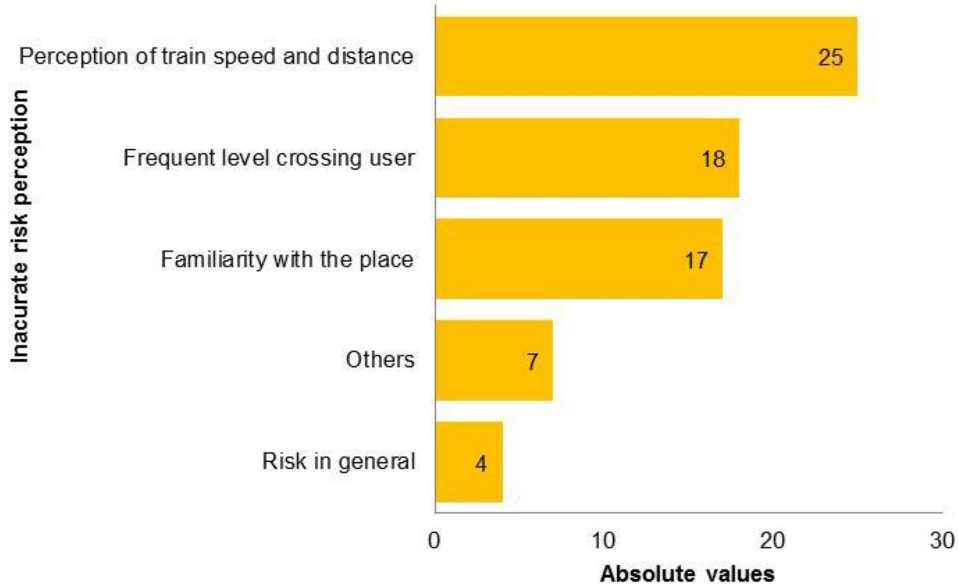

Figure 7. The indicated prevalence of variables related to inaccurate risk perception in the literature reviewed

4.1.2.6. Deliberate risk-taking behaviour

Figure 8 presents information regarding the type of deliberate risk-taking behaviour at level crossings according to the literature reviewed. Results reveal that the risk-seeking personalities (e.g. young people) and frustration and impatience are the most frequently cited variables.

Partners collected information from another deliberate risk-taking behaviour not previously included in the *Review Form* (n=10), for example, social norms, trespasses, gate-violations; etc.

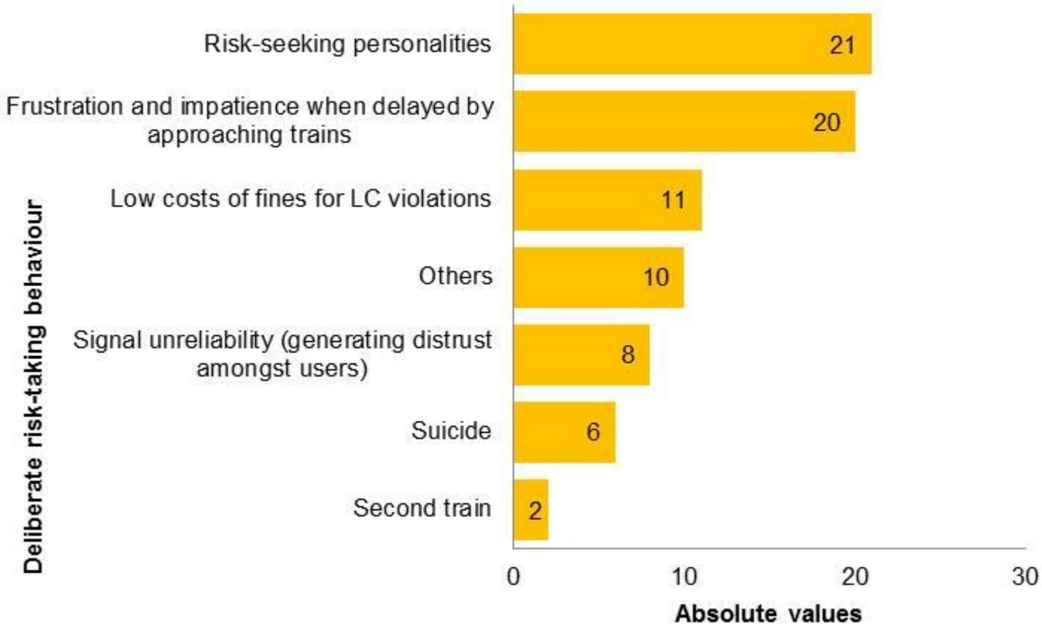

Figure 8. The indicated prevalence of variables related to deliberate risk-taking behaviour in the literature reviewed

4.1.2.7. Information about the context

Figure 9 presents results on variables related to the context (e.g. weather). The variables found indicate the importance of the level crossing setting in the study of user requirements related to level crossings and safety systems (n=29).

Partners collected information from others variables in the literature not included in the previous categories: time of day (n=5); the presence of the police in the level crossings (n=2); traffic volume (n=1); and crossing time (n=1).

In *others*, partners collected information about the context not included in the previous categories (e.g. status of the controls, opened or not, in the moment of transgression; the number of pedestrians present; etc.) (n=14).

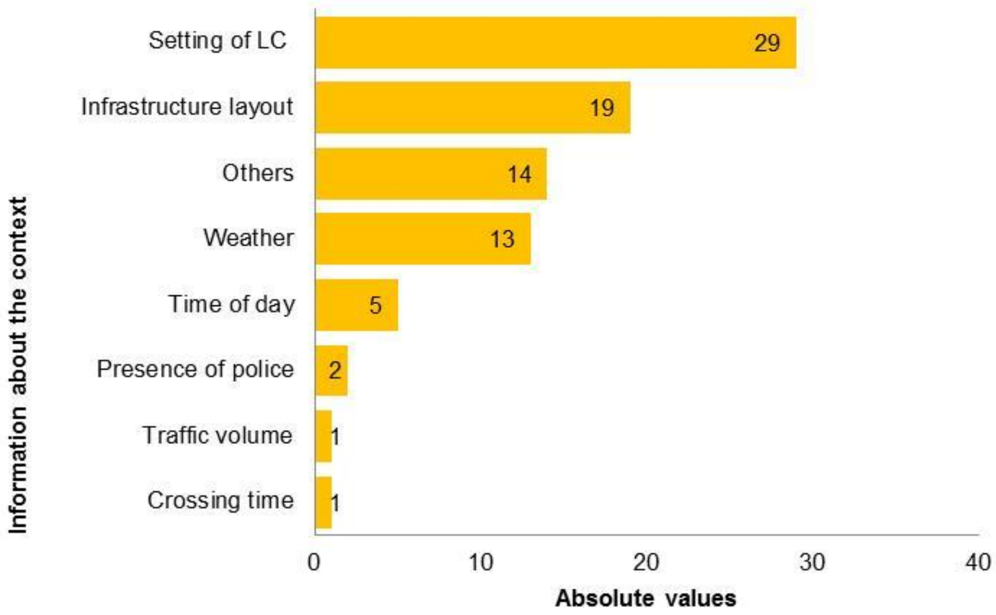

Figure 9. The indicated prevalence of variables related to information about the context in the literature reviewed

4.1.3. Variables related to human factor by type of level crossing

Table 3 (see in Annex C) presents results on variables related to human factor (personal conditions; distraction and inattention; conspicuity of crossing and trains; lack of knowledge; inaccurate risk perception; deliberate risk-taking behaviour; and information about the context) by type of level crossing according to the literature reviewed. Below, variables that have a statistically significant association are presented (p value<0.05):

- **Passive level crossing**: external distractions; internal distractions; sight distances and signs; no knowledge of signalling at level crossing; no knowledge of traffic rules at crossing; lack of understanding of the correct action that is required; perception of train speed and distance; setting of level crossing; and other information about the context.
- **Active level crossing with automatically controlled protection**: man; children; external distractions; internal distractions; sight distances and signs; crossing angle; frequent level crossing user; perception of train speed and distance; risk-seeking personalities; and setting of the level crossing.

There is no significant association for **active level crossing with manually controlled protection** possibly due to low case numbers.

4.1.4. Variables related to human factor by type of user

Table 4 (see in Annex D) presents results on variables related to human factor by type of motorized road user. Below, variables that have a statistically significant association are presented (p value<0.05):

- **Car**: man; external distractions; internal distractions; overloaded with other stimuli; visual contrast; sight distances and signs; not knowledge of signalling at level crossing; lack of understanding of the correct action that is required; frequent level crossing user; perception of train speed and distance; setting of level crossing; and infrastructure layout.

There is no significant association for **motorbike/ moped**, **transport professionals**, **heavy vehicles** and **farm vehicles**, possibly due to low case numbers.

Table 5 & Table 6 (see in Annex E) present results on variables related to human factor by type of vulnerable road user according to the documents reviewed. Below, variables that have a statistically significant association are presented (p value<0.05):

- **Pedestrian**: man; children; young; adults; visual contrast; sight distances/signs; crossing angle (p=0.013); no knowledge of signalling at level crossing; no knowledge of traffic rules at level crossing; lack of understanding of the correct action that is required; familiarity with the place; frequent level crossing user; perception of train speed and distance; frustration and impatience when delayed by approaching trains; risk-seeking personalities; and infrastructure layout.

There is no significant association for **cyclist**, **ramblers**, **horse riders**, **persons with reduced mobility**, **users with vision loss and blindness**, **users with hearing loss and deafness** and **users with different cultural and language background**, possibly due to low case numbers.

4.2. Analysis of indicators concerning user requirements

This section of the report presents the findings of the consultation exercise carried out with human factor and railway transport experts (Task partners) regarding the most relevant indicators concerning the study of user requirements. Specifically, survey respondents were asked to validate a list of indicators which had been identified through the literature review via an *Indicators Rating Form*. Survey respondents provided additional comments about the indicator ratings as well as suggesting other indicators that had not been captured through the literature review. Where possible, information provided in the literature *Review Form* regarding human factors incorporated into the design of safety measures[1] has been added to further support this analysis.

[1] This refers to the information extracted from the information field related to Human factor translated to safety measures in the *Review Form*.

4.2.1. Personal conditions

Figure 10 presents gender indicators (in terms of differences in the behaviour of men and women) related to user requirements and the proportion of survey responses (n=6) which considered each one to be most relevant.

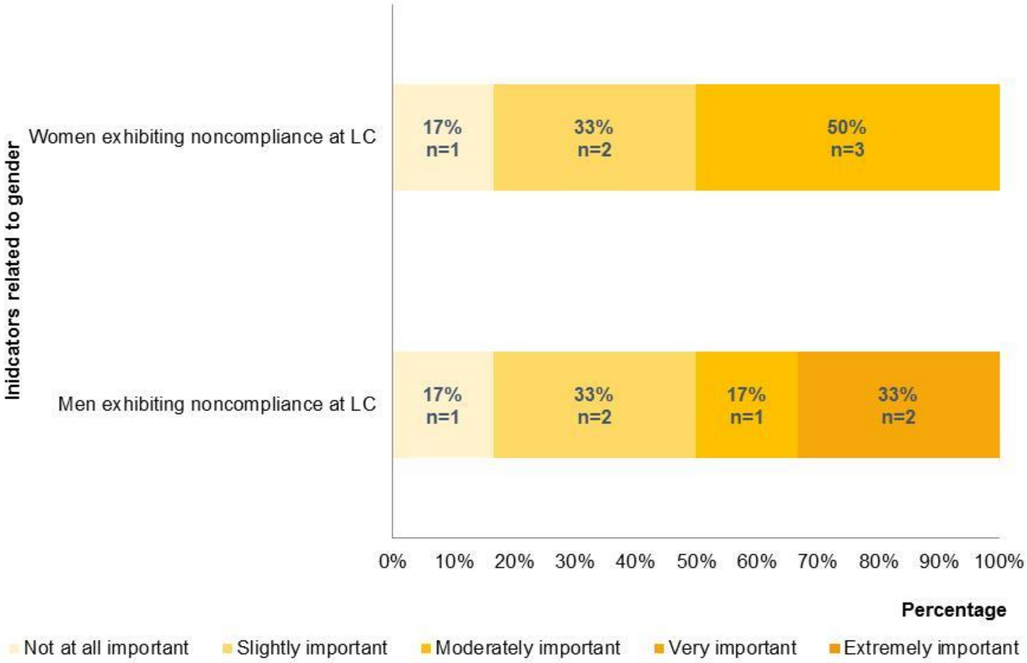

Figure 10. Perceived importance of indicators related to gender of the level crossings users

According to the results, overall, respondents consider the inclusion of the behaviour of men in the human factor analysis framework to be more important than that of women. However, there was general questioning about the relevance of distinguishing between the sexes when deciding to implement a safety measure. Some responses did though point out the relevance of tailoring specific measures (e.g. campaigns) to be directed at a particular audience. One observation, based on in-depth accident data from the survey respondent´s country, highlighted that a greater proportion of male drivers are responsible for road accidents than women, together with results from the literature that indicate that female drivers are significantly less likely to violate warnings than male drivers.

Figure 11 presents information related to age indicators and the proportion of survey responses (n=6) which considered each age group to be most relevant.

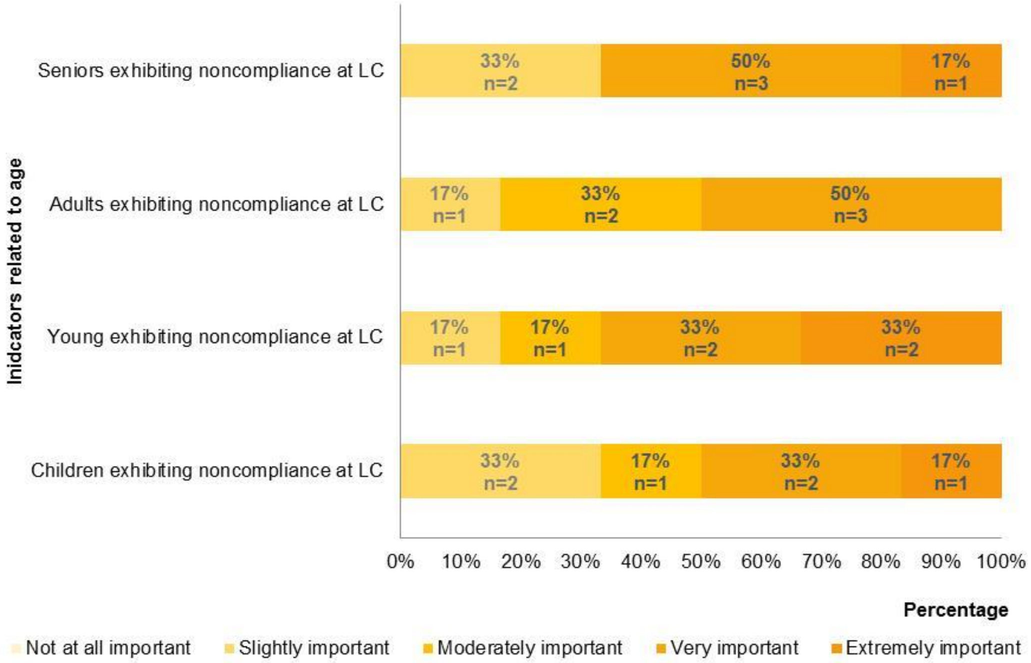

Figure 11. Perceived importance of indicators related to age of the level crossings users

According to the survey responses (n=6), in the analysis of human factors, special attention should be given to young people that exhibit non-compliance at level crossings (this indicator was considered extremely important in two experts; 33%).

Two respondents made additional comments which highlighted the need to consider all road user groups irrespective of age, whilst one response specifically highlighted the importance of age together with disability, due to the effects of these on the fitness or cognitive abilities of the user. In two cases, the need to attend specific age groups is emphasized. For example, one response points out that children are not seen as a risk group according to the accident data, however it is still moderately important to consider them, via early education and awareness actions, with a view to influencing later behaviour. Another observation pointed to youngsters and adults as the two age groups exhibiting non-compliance at level crossings most frequently.

One study referred to in the *Review Form* (regarding human factors in the design of safety measures) states age, in addition to gender and other demographic variables as an important personal conditions to take into account when investigating behaviours and perception (Freeman & Rakotonirainy, 2016).

Figure 12 presents disability indicators related to user requirements (physical and intellectual disabilities) and the proportion of survey responses (n=6) which considered each one most relevant.

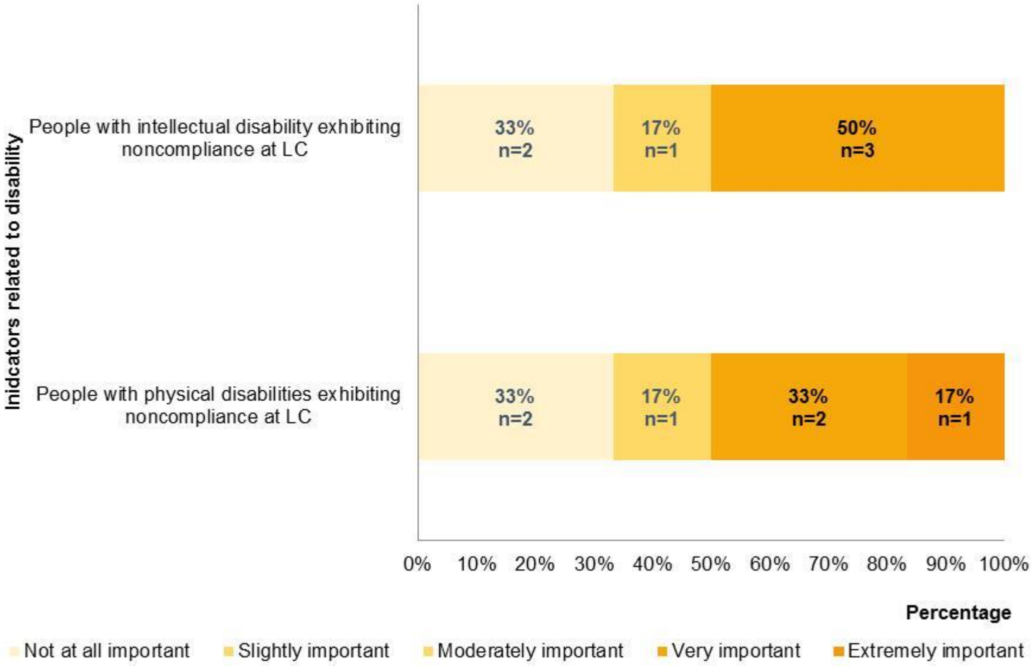

Figure 12. Prevalence of indicators related to disability of the level crossings users

According to the results, experts considered that the indicator of people with physical disabilities exhibiting non-compliance at the level crossing is more important to consider than that of indicator of people with intellectual disabilities. Two survey responses judge physical disability extremely important for the human factor analysis framework (17%). It should be noted that in the case of the physical disability indicator and the intellectual disability indicator both were considered to be not important at all in two cases (33%).

Observations made in the *Indicator Rating Form* (in 3 cases) pointed out the need to consider users with disabilities when planning level crossings and the possible safety measures implemented. In one case, as mentioned above, disability is considered important due to its potential effect on the fitness and cognitive ability of the user and another comment mentioned eyesight and the ability to see contrast as an important personal factor.

Figure 13 presents the results regarding the perceived importance of indicators related to use of addictive substances by level crossings users.

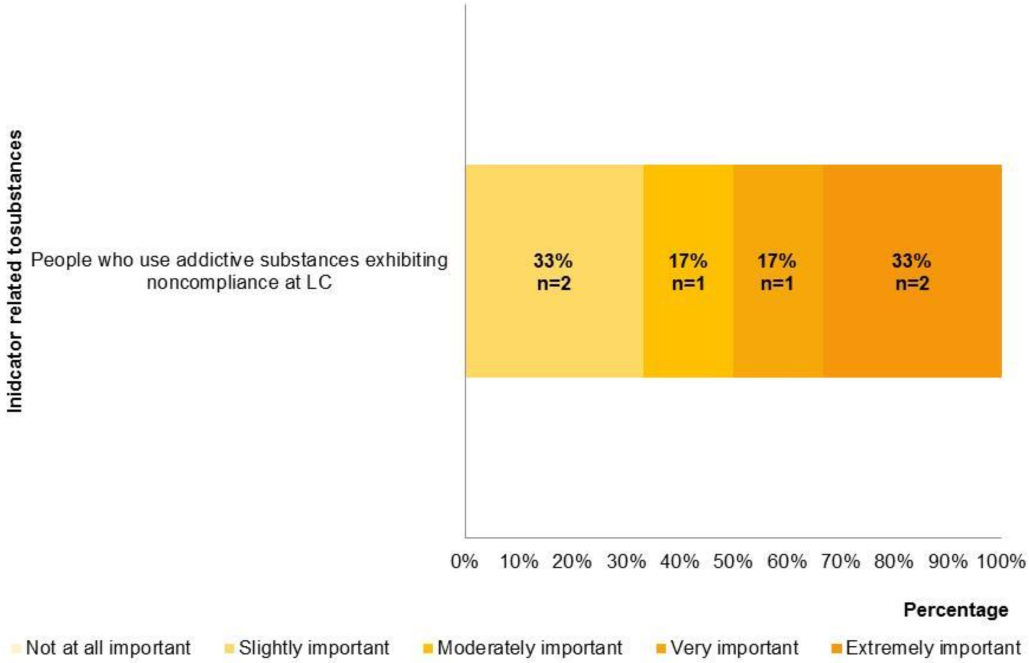

Figure 13. Perceived importance of indicators related to use of addictive substances by level crossings users

According to two replies, the indicator on alcohol, drugs and/or medication use was considered as extremely important (33%) and according to one reply as very important (17%) to be taken into account within an analysis of human factors (Figure 13).

One survey response observes that the use of alcohol, drugs and/or medications is always a safety issue in traffic and therefore there is a logical link to its importance within the level crossing context. However, the respondent goes on to highlight the need to focus on the consequences of substance use and how it changes the road user behaviour at level crossings. For example, the use of alcohol can increase distraction and therefore the indicator should be considered similarly to one regarding distraction.

A general observation regarding the group of indicators related to personal condition, made in three survey responses, point to the importance of considering all road users when designing a countermeasure (not prioritizing one group over another), whilst not losing sight of the needs of particular groups and making the corresponding modifications.

4.2.2. Distraction and inattention

Figure 14 presents the results regarding the perceived relevance of tiredness as a personal condition related to distraction and inattention at level crossings.

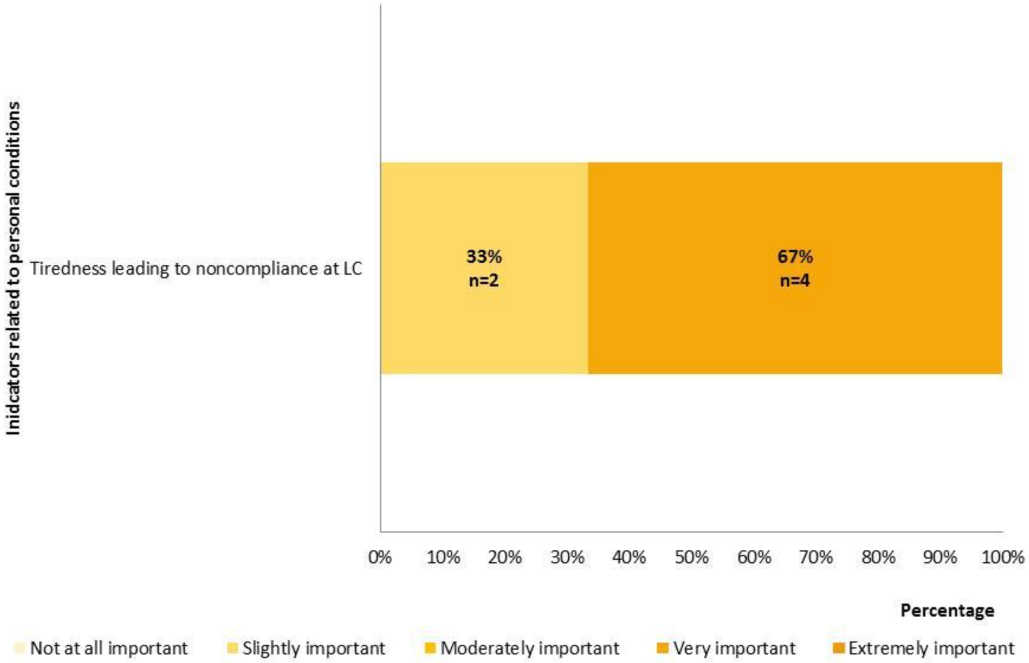

Figure 14. Perceived importance of indicators related to tiredness of level crossings users

Experts highlighted the importance of the personal condition of tiredness as a distraction related factor to consider in the analysis of human factor. Four replies rated it as very important (67%) (Figure 14).

Figure 15 presents results of indicators related to different distractions at level crossings: external distractions, internal distractions, distractions in general and non-compliances due to overload by other stimuli and the proportion of survey responses in which each indicator was considered relevant.

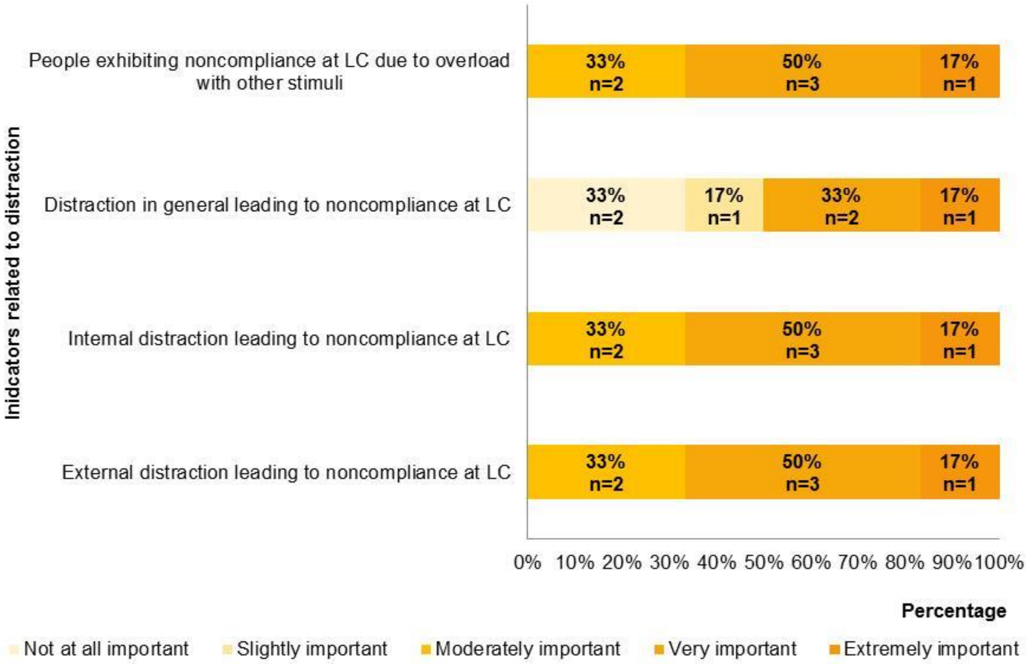

Figure 15. Perceived importance of indicators related to distraction at level crossings

All these indicators were considered as extremely important by one reply (17%). However, indicators of external distractions, internal distractions and non-compliance due to overload are considered very important. These indicators were rated as very important in half of the survey responses (n=3).

Where most disagreement lies is in the indicator of distraction in general leading to non-compliance at level crossing. Half of the responses consider this indicator either extremely or very important, whilst the other half rate it as slightly or not important at all. According to two of the survey responses, the reason for questioning the importance of distraction in general lies in the need to identify the different and real cause or source of distraction. It is argued that in order to effectively target safety measures for each situation and improve the approach to the level crossing, it is necessary to define the type of distraction experienced: is it a visual or mental distractor or one caused by multi-tasking etc.? In the same way, one response indicates the need to specify the type of stimuli (e.g. visual, auditory…) in relation to overload with other stimuli indicator.

The reason given by one respondent for rating external distraction and overload *with other stimuli* as important indicators is due to the possibility for the railway stakeholders to tackle the issue, through removing the source of distraction in the level crossing environment. One respondent also observes that even though the overload of stimuli may not be as relevant at level crossings with low traffic volumes, it continues to be an indicator that should be considered. Indeed, information given in the *Review Form* regarding human factors in the design of safety measures focuses on various measures to avoid external distraction and overload of stimuli on the approach to the level crossing. Examples include minimising the variety of signs that road users are required to see, read, interpret and respond to and using one universal level crossing advance warning sign (RSSB, 2011).

Observations made in two survey responses point out other human factors related to distraction and attention (not captured in the *Indicator Rating Form*). On the one hand, the close relationship between attention and knowledge is highlighted. For example, the knowledge of signs announcing a level crossing will lead to an endogenous shift of visual attention to relevant elements on the approaching to the crossing. In other words, previous knowledge of level crossing (e.g. signage) can lead to attention being drawn towards to those safety elements at the level crossing.

On the other hand, a reflection regarding attention at a level crossing and expectancy regarding train traffic is made. It is commented that at level crossings with low daily train volumes there is a risk that local people may not pay enough attention to the arrival of unexpected trains. This puts them at risk in the event that there is deviation from the regular timetable and expected running of trains.

4.2.3. Conspicuity of crossings and trains

Figure 16 presents the conspicuity indicators: sight distances and signs, crossing angle, visual contrast and conspicuity in general, and the proportion of survey responses (n=6) which considered each one to be most relevant.

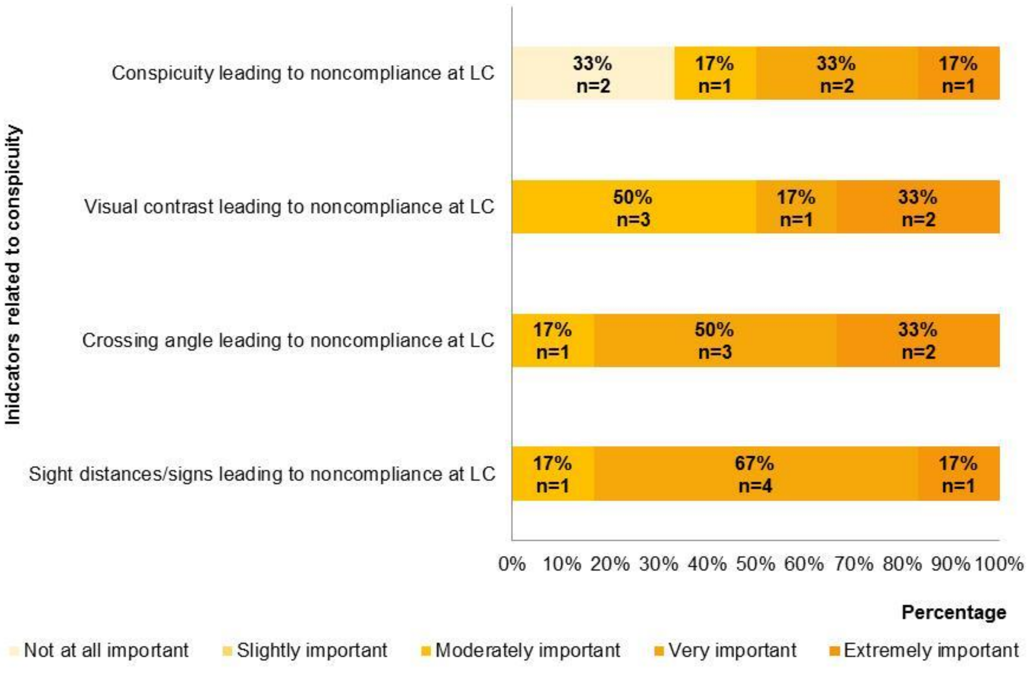

Figure 16. Perceived importance of indicators related to conspicuity at level crossings

According to these results, survey respondents considered that the indicator of crossing angle leading to non-compliance at the level crossing is the most relevant indicator. Two responses considered the crossing angle to be extremely important for the human factor analysis framework (33%) and three responses judged it as very important (50%).

Two responses proposed other indicators related to conspicuity that had not been captured through the literature review and that might be of importance: rolling stock colour, train lighting, street lighting and orientation of street/driving direction with reference to the sun.

There is most agreement regarding the relevance of sight distances and signs and the crossing angle, as factors that can lead to non-compliance at level crossings. According to one observation, sight distances and signs are important indicators of the condition and environment of level crossing with good sight distances and appropriate crossing angle representing factors that enhance safety. One respondent draws on national incident data when citing the importance of poor visibility, inadequate road signage and difficulty to manoeuvre for safety.

The greatest variation in results relates to the indicator of conspicuity leading to non-compliance at level crossings, where half of the respondents consider it extremely or very important whilst the other half rate it as slightly or not important at all. Observations made in three survey responses highlight the need to clarify the definition of this indicator by specifying the aspects of conspicuity that need to be addressed and measured (e.g. does this conspicuity refer to the level crossing or train and how does it differ from sight distances and crossing angle?). Furthermore, in its current "general" form, half of the partners question the possibility of measuring this indicator and do not rate it as relevant.

There is also a degree of variation in how respondents rated the importance of visual contrast, with half viewing it as extremely or very important and the other half considering it as only moderately important. Again, there are comments that point to a connection between a low relevance scoring and the need to clarify the meaning of the indicator. One partner poses the question of whether visual contrast refers to the condition of traffic signs (e.g. the colours used in traffic signs that warning road user of approaching level crossing or colours used in level crossing devices).

Some new user requirements related to conspicuity of crossings and trains were proposed. One of the survey responses highlighted train lighting, street lighting (at night), orientation of street or driving direction with reference to sun as further factors to take into account in relation to conspicuity and a further comment indicated the need to consider rolling stock colour.

4.2.4. Lack of knowledge

Figure 17 presents indicators related to lack of knowledge leading to non-compliance at the level crossing and the proportion of survey responses in which each indicator was considered relevant.

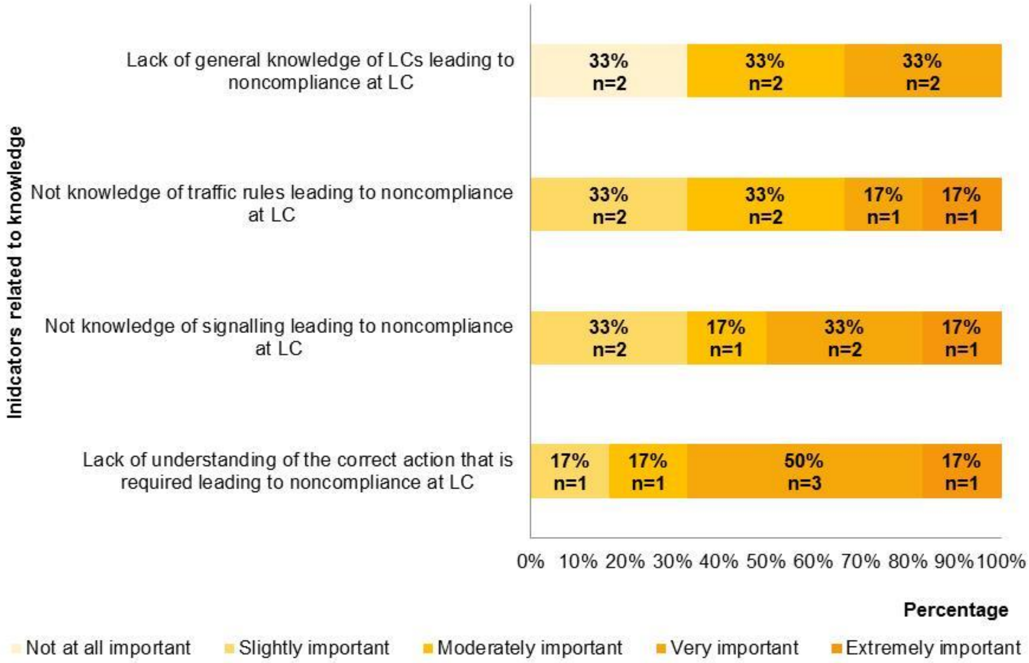

Figure 17. Perceived importance of indicators related to lack of knowledge

According to the experts (n=6), the indicator of lack of understanding of the correct action that is required leading to non-compliance at the level crossing is the most relevant indicator. One survey response considered this indicator to be extremely important for the human factor analysis framework (17%) and in three survey responses it was as very important (50%).

The observations made by half of the survey responses suggest an overlap of understanding between the four indicators related to knowledge. This is particularly the case for the indicator: lack of understanding of the correct action that is required leading to noncompliance at level crossings as it might be considered to encompass the indicators: not knowledge of signalling leading to noncompliance at level crossings; and not knowledge of traffic rules leading to noncompliance at level crossings. In this sense a clearer definition of each indicator has been requested.

According to one response understanding of the correct action is important since it is the responsibility of the road user to behave correctly at level crossings. A number of measures to support correct actions cited in the *Review Form* also support this point. Some examples of these measures include: campaigns to raise consciousness on safe behaviour at level crossing; provision of explicit warnings at active level crossing when more than one train will pass during one closure; complementary warnings in special situations (e.g. where road is running parallel to tracks in advance to level crossing); impeding driving around closed half barriers (e.g. by traffic islands between lanes, posts, rods); installing hanging bars / grids / chains to boom to prevent pedestrians from crossing below the boom when closed (Bahloul et al., 2012).

The greatest difference of opinion however lies in relation to the indicator: lack of general knowledge of level crossings leading to noncompliance at level crossings. This indicator has been rated equally across three categories (33% of responses in each case): very important; moderately important; and not important at all. Observations made by respondents regarding the lack of general knowledge indicator suggest a difference in understanding of this indicator. In two cases, further specification is requested because the indicator is not considered to be relevant "in general". In one case, the respondent understands it to refer to general knowledge and awareness of the risks inherent in the level crossing and rail environment (e.g. level crossing users need better awareness of the huge forces in heavy trains moving with high speed through level crossings). Three other respondents understand lack of general knowledge to refer to knowledge of particular user groups, such as children and young people, as early learners of traffic and safety rules or refugees coming from other countries, with potentially different knowledge and cultural references.

One survey response questions whether the correct understanding of signage by road users is the actual problem, rather the presence of errors (people fail to see the signage) or violation (people intentionally disregard the signage). However, examples given in the *Review Form* regarding human factors in the design of safety measures, point to the importance of gaps in user´s knowledge regarding level crossing signage. For example, one study shows that the meaning and behavioural implications of St. Andrew’s cross are represented with more uncertainty in user's knowledge than for that of the Stop sign. Thus, for level crossings with passive protection - at which stopping or strong slowing is necessary - safe behaviour would benefit from using a combination of St. Andrew's cross with the Stop sign (Bahloul et al., 2012). A further example is focused on using more self-explaining signs and road side signalling through the replacement of red flashing lights for yellow-red or green-yellow-red traffic lights due to higher familiarity from the road traffic context (Grippenkoven, 2017).

4.2.5. Inaccurate risk perception

Figure 18 presents information related to inaccurate risk perception indicators and the proportion of survey responses in which each indicator was considered relevant.

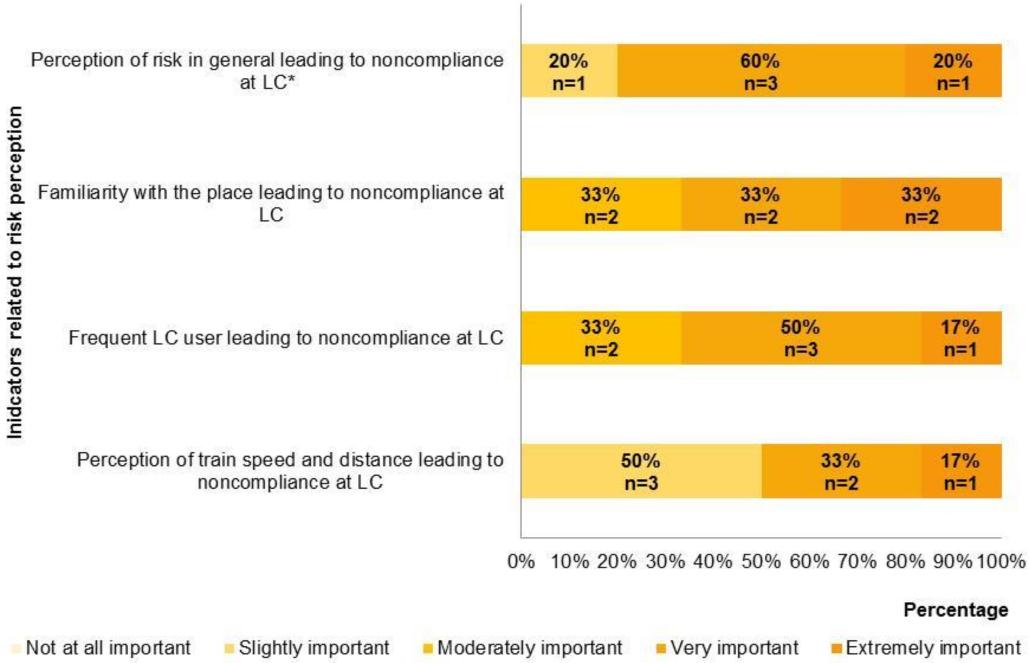

Figure 18. Perceived importance of indicators related to risk perception
*One expert did not answer this question.

According to the survey responses, the analysis of human factors must take into account the user's familiarity with the place (this indicator was considered as extremely important in two survey responses and as very important in other two survey responses). An additional comment made by one survey respondent indicates that, in general, a person who is a frequent level crossings user has a good experience and knowledge of level crossings operation but it could be different for a person who is familiar with the place, as it may lead to them underestimating the risk of approaching an extra train. However, they both could underestimate a risk situation so it is difficult to distinguish between these users except for the definition of a sample in an experimental simulation. One factor that can affect whether a driver looks for a train is the driver's expectation of seeing a train. A person's perception of the probability of a given event is strongly influenced by past experience, and the frequency with which the driver encounters a train at a level crossing will influence the likelihood of that driver stopping.

Regarding the indicator of perception of the train speed and distance, two survey respondents emphasized that the most important thing is to identify the presence of the train, therefore, the conspicuity. The thesis is that the users should not cross a level crossing based on perceptions. However, although conspicuity is a very important indicator (it was considered in another category of analysis), the misperception is related to the lack of knowledge, an aspect that has proven to be relevant in the analysis of safety in level crossings.

Regarding the indicator of perception of risk in general, the partners contributed different reflections. On the one hand, it is necessary to identify the cause of the risk situation. Thus it is an indicator that should not be taken into account, despite having been identified in the literature. On the other hand, the indicator of perception of risk, in general, is referring to a personality feature and thus rate it as highly important as risk-seeking behaviour. It has to be considered that risk perception is only one side of the psychological cost-benefit analysis done by users at level crossings. Thus, the benefits of misbehaviour have to be considered at the same time and reduced to enhance compliance (e.g. by avoiding overly long waiting times). The disagreement in this indicator recommends further reflection.

4.2.6. Deliberate risk-taking behaviour

Figure 19 presents the deliberate risk-taking behaviour indicators: frustration and impatience, risk-seeking personalities, low costs of fines, signal unreliability and suicide, and the proportion of experts who considered each one to be most relevant.

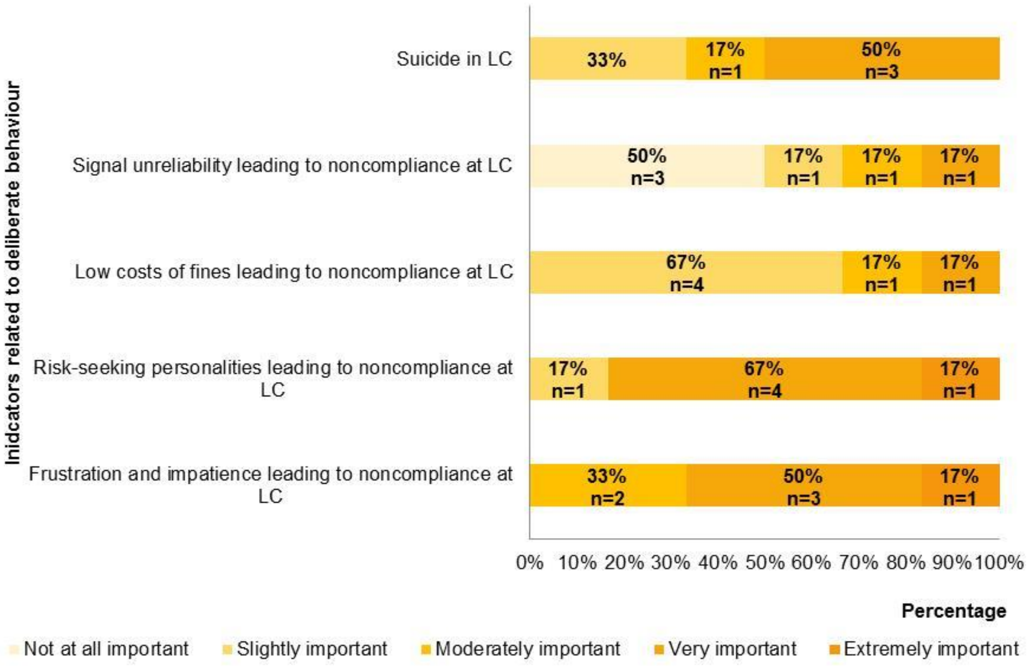

Figure 19. Perceived importance of indicators related to deliberate risk-taking behaviour

Experts considered that the indicator of frustration and impatience leading to non-compliance at the level crossing is the most relevant indicator to consider within an analysis of human factors and level crossing safety. One survey response rated frustration and impatience as extremely important for the human factor analysis framework (17%) and three survey responses evaluated it as very important (50%). In three survey responses, the indicator of the unreliability of the signal was considered as not all important for the human factor analysis framework (50%).

In relation to frustration and impatience, survey responses indicate that long waiting times at level crossings could influence drivers' behaviour and increase risk situations. In this way it could be interesting to measure these indicators at different level crossings (active or passive). According to one survey respondent, in their country cyclists and pedestrians are especially susceptible to risk at level crossings since they underestimate the risk perception because of impatience and frustration.

Another survey respondent pointed out the importance of this indicator although it is difficult to be measured. For example, how do you measure the share of drivers or road users who exhibit noncompliant behaviour at level crossings because of being frustrated and impatient?

One survey respondent asked what risk-seeking personalities really mean. Is it a permanent feature of a person who has been identified as having a risk personality? According to this survey response, deliberate risk-seeking behaviour could be measured via speed profiles or the number of barrier zigzagging. Also, the link to suicides was proposed. In this way, perhaps risk-seeking personalities could be measured with a methodology that combines technical and psychological aspects.

Another indicator was signal unreliability (generating distrust amongst users). One survey respondent indicates that signal failure is not often a problem causing accidents in their country. The assumption should be that level crossings equipment work reliably (100% functionality). In general, it is difficult to evaluate the relevance of this indicator. It should take into account that signal unreliability, is sometimes not related to a good operation but a perception or belief. There may be personalities who distrust the proper functioning of the level crossing.

The importance of the user´s expectation of a level crossing is also gathered in the *Review Form* regarding human factors in the design of safety measures. Specifically, there is an example given of drivers not differentiating between active or passive level crossings and expecting to be told that a train is approaching a passive level crossing, instead of checking it for themselves (Wigglesworth, 2001).

Evidence in the *Review Form* also points to the importance of previous experience in terms of right-side failures. That is to say a failure which does not result in the protection provided by the signalling (RSSB, 2004). It argues that frequent or prolonged right-side failures may cause road users to lose confidence in the warning which can influence their driving performance. This situation potentially facilitates the creation of mental models of when the train approach warning is credible based on other factors such as known train schedules, resulting in a mismatch between real risk and perceived risk (Rongfang Liu, 2010)

According to one survey response, level crossings could represent an easy "gateway" into rail facilities in the case of suicides. Level crossings could be designed to avoid that. However, in order to effectively prevent suicide, the protection would have to be gapless along the track which seems nearly impracticable. On the other hand, in the case of suicides, the intentionality of the event is not relevant due to the difficulties in preventing a suicide.

One respondent to the survey proposed changing the indicator of low costs of fines leading to noncompliance at level crossings to the indicator of the perceived improbability of being detected and fined. Concerning the fines, the problem is not the cost (fines are not too low), rather the low probability of getting caught. Countermeasures directed to this should thus work on enhancing the probability of being penalized for misbehaviour.

Another survey respondent noted that in the beginning, fines are good measures to reduce deliberate behaviour but in the medium-long term as the conduct of the people persists. In this regard, the recommendations should focus on designing educational and awareness programs for safety at level crossings.

One survey response proposed another indicator related to deliberate risk-taking behaviour that had not been captured through the literature review and that might be of importance: perceived improbability of being detected and fined.

4.2.7. Context information

Figure 20 presents the results of the context information indicators and the proportion of survey responses in which each indicator was considered relevant.

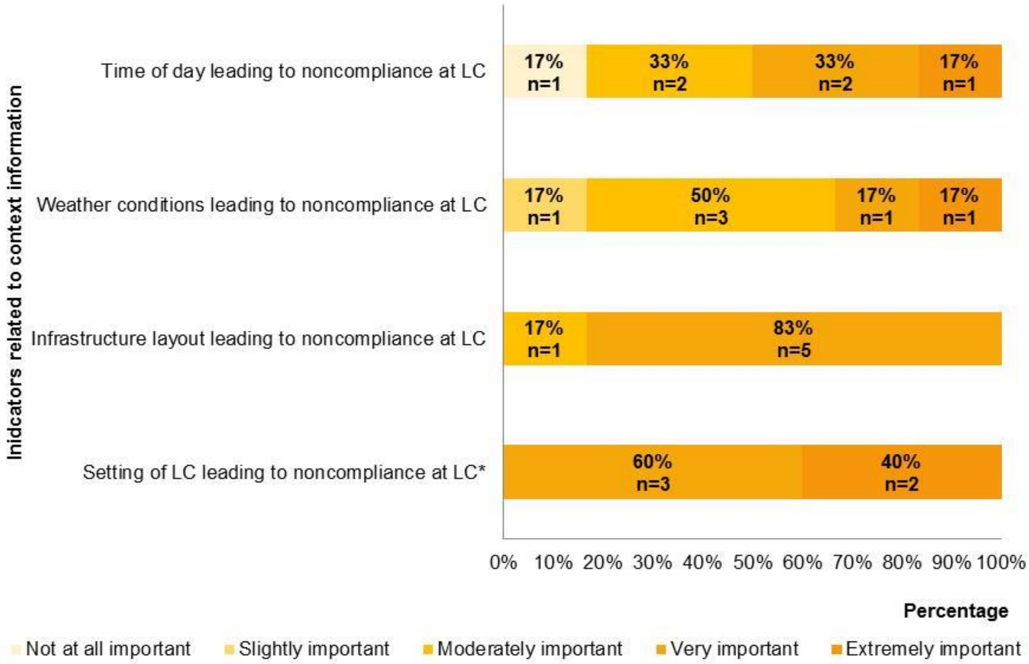

Figure 20. Perceived importance of indicators related to context information
*One expert did not answer this question.

According to these results, experts highlighted the importance of the indicator of the setting of the level crossing. The setting of the level crossing for the human factor analysis framework was considered extremely important in two survey responses (40%) and as very important in three survey responses (60%).

A comment made in one of the survey responses reported unfavourable location of the level crossing to be one of the main causes of accidents in their country. The setting of the level crossing is, in general, a very important factor, but needs to be broken down into its components. For example, road features such as crossing angle and/ or slope; features affecting the visibility of the tracks as vegetation and/ or buildings; traffic density, speed...).

Regarding the indicator of infrastructure layout, the partners contributed different reflections. On the one hand, accidents and incidents can occur even though we have a perfect infrastructure layout. In this sense, one survey response proposed to rename the indicator as condition (or status) of level crossings. On the other hand, another survey respondent indicated that problems in an infrastructure's layout are reported as one of the main causes of accidents in the respondent's country. For example, when a trajectory of a driver includes a curve it is more difficult to determine the speed and distance of another vehicle.

Regarding the indicator of weather and safety measures, one respondent to the survey indicated that it is important to know whether some weather conditions (e.g. ice, snow, hard wind, etc.) cause any possible problems with the functioning and maintenance of level crossings. Another survey respondent commented that maybe it is important to distinguish the different weather condition to identify the safety measures and prevent the main causes of accidents at that type of level crossings.

Finally, regarding the time of day's indicator this is a useful indicator if it refers to lighting conditions or road volumes. At night, drivers' judgment is usually worse, because they may have difficulty comparing train movement against a dim background with indistinct landmarks. It is possible that the indicator of time of day is an indicator that combines aspects such as traffic density, lighting, hurry, fatigue, etc. For the following Tasks, it would be useful to develop the definition of this indicator.

One survey response proposed other indicators related to context information: road and rail traffic volumes, and lighting conditions.

4.3. Human errors and violations at level crossings

Since the aim of this deliverable is to identify contributing human factors in level crossing accidents, the GIDAS categorisation was deemed to provide the most suitable approach to classify the indicators identified in this task. GIDAS (*German in Depth Accident Study*) permits to analyse the error causation and identify the violation, and it is specifically tailored to the application in road traffic accident analysis.

Taking into account the sequential procedure of the human information processing the GIDAS categories are information access, information admission, information evaluation, planning and operation (Grippenkoven, Giesemann & Dietsch, 2012). Table 2 includes a description of the influence and indicators identified within this task and classified according to the error categories of the GIDAS human error categorization framework. Table 2 focuses on the stages of information processing that are most obviously affected by the respective factor. However, this does not exclude influences to other stages (i.e. due to feedback loops from "later" stages to "earlier" ones e.g. if one does not expect a danger they will not look out for it and have a smaller chance to detect it).

Table 2. GIDAS error categorisation and indicators identified in the literature reviewed

SAFER-LC indicator category	Description of influence	Error category
Indicators related to personal conditions	*Relevant information cannot be perceived* *Interfering information and influences in and outside the car* *Information interpreted in a wrong way* *Wrong actions taken*	**Information access** **Information admission** **Information evaluation** **Operation**
Indicators related to conspicuity of crossings and trains	*Relevant information cannot be perceived* *Interfering information and influences in and outside the car*	**Information access** **Information admission**
Indicators related to information about the context	*Relevant information cannot be perceived* *Interfering information and influences in and outside the car* *Information interpreted in a wrong way* *Wrong actions taken*	**Information access** **Information admission** **Information evaluation** **Operation**
Indicators related to distraction and inattention	*Interfering information and influences in and outside the car*	**Information admission**
Indicator related to substances abuse	*Interfering information and influences in and outside the car* *Information interpreted in a wrong way* *Violation of rules/ wrong decisions due underestimation of the event's probability* *Wrong actions taken*	**Information admission** **Information evaluation** **Planning** **Operation**
Indicators related to lack of knowledge	*Information interpreted in a wrong way*	**Information evaluation**
Indicators related to inaccurate risk perception	*Information interpreted in a wrong way*	**Information evaluation**

It must be taken into account in the analysis of user requirements and human factor concerning safety measures, that there are involuntary unsafe behaviours (errors and failures) and voluntary unsafe behaviour (violations). Indicators related to deliberate risk-taking behaviour and suicide identified in the literature reviewed are voluntary unsafe behaviour or violations.

5. SUMMARY, DISCUSSION AND CONCLUSIONS

The aim of this Deliverable is to generate a knowledge base based on existing data sources and analytical tools that will allow enhancing the safety performance of level crossing infrastructures from a human factor perspective. Using a methodology that combines literature review and expert opinion, key safety indicators concerning user requirements and human errors and violations have been identified.

The introduction of these indicators aims to support the planning and evaluation of level crossing safety actions from a user perspective, so that technological and non-technological measures can be better adapted from a human factors perspective, making level crossings more self-explaining and forgiving. Specifically, the identification of these key safety indicators will feed into the development of the human factors framework which will in turn help to measure the extent to which human factor variables are taken into account within the design and evaluation of level crossing safety measures.

5.1. Summary and discussion on data collection and analysis

A set of key safety indicators concerning human error and violations has been developed based on the review of relevant human factors literature (125 documents), expert opinion and the German in Depth Accident Study (GIDAS) human error categorization framework (Grippenkoven et al., 2012). The methodology applied in the development of this task comprised five key phases which are reviewed on continuation.

Phase I: Construction of a bibliographical database regarding human factors at level crossings and safety systems

The joint construction of a bibliographic database facilitated a more thorough identification of relevant literature, drawing on the knowledge and expertise of task partners. The hosting of a shared file on Google Drive represented an open and user-friendly way to build the document and store a large number of documents (for their later review).

The human factors bibliographic database contains a good range of largely current literature (125 validated documents) principally comprising scientific articles and research papers. The documents offer a rich source of information regarding human factors at level crossings based on a wide range of quantitative and qualitative information sources, including empirical evidence regarding the level crossing user perspective and experience. The current selection of documents in the database is not exhaustive and it is proposed to keep this tool as a live document, hosted on the SAFER-LC extranet so it can be accessed and further updated by project partners.

Phase II: Literature review

Task partners reviewed a total of 125 documents (contained in the bibliographic database). Relevant and comparable information was sought using a *Review Form* template. This form, created in Excel, comprised six key information fields which had to be filled out for each document reviewed, including variables related to human factors. In all of the categories, an additional information field was provided in order to capture any variables not listed on the form and observations that would support the analysis. Despite the fact that this form aimed to make the literature review exercise as objective as possible, there is still scope for variation in the way that individual reviewers completed the form and whether they considered it important to mark specific variables.

More generally, a potential weakness of basing the analysis on secondary data sources is the possibility of missing relevant variables because they are not well represented in the current literature due to not yet having been studied or only being examined to a small degree. Furthermore, the information captured is limited to the sources identified which, as indicated above, is not exhaustive.

Gathering a qualitative review of information within an Excel template supported the subsequent analysis of the collected data. It should be noted however, that the limited level of detail provided regarding the identified variables has not allowed a more in-depth definition of indicators developed in the following Phase III.

Phase III: Definition of user requirement indicators

This phase of the task analysed the results of the *Review Forms* in order to identify a set of user requirement indicators, based on the most frequently cited variables in the literature. Following the prior treatment and cleansing of the information gathered in the *Review Forms* (in Excel), the data was included in one SPSS file for a descriptive univariate analysis to be undertaken. A bivariate analysis was also carried out on some of the variables in order to explore possible associations between the human factor variables in the database and the type of level crossing and type of user.

A selection of the most frequently occurring variables (including ones detected in the literature though not originally included in the template form) formed the base for the definition of a set of user requirement indicators. The main challenge faced in this phase was to turn the identified variables into measurable indicators, especially given the general nature of the variables identified.

Phase IV: Validation of user requirement indicators and identification of 'new' indicators

The user requirement indicators identified in the previous phase underwent a validation exercise through the completion of an *Indicator Rating Form*. The task partners rated the relevance of the indicators on five-point Likert scale (from 'extremely important' to 'not at all important') in terms of measuring safety at level crossings from a human factors perspective. This form also sought to capture other variables not identified through the literature review and observations about the rationale behind the ratings.

One *Indicator Rating Form* was filled in by each partner organisation. The exercise was based on the subjective evaluation and expertise of the expert(s) completing the form which according to survey respondents drew on: evidence from scientific literature and in some cases in-depth accident data and local knowledge from the respondent's country. There was no communication between task partners during the rating process, although the additional comments and observations by partners included in the form could support later debate on these indicators and the building of consensus in Task 2.2.

Phase V: Identification of key safety indicators concerning human error and violations

In a final phase and as the key outcome of Task 2.1, key safety indicators concerning human errors and violations were identified. This was achieved applying the German in Depth Accident Study (GIDAS) human error categorization framework (Grippenkoven et al. 2012) to the user requirement indicators (identified in Phase III). The GIDAS framework is an established tool used to describe the underlying mechanisms of human error in road traffic accident analysis. It classifies human errors and violations in categories according to the different stages of human information processing: information access; information admission; information evaluation; planning and operation. In this way it offers a coherent way of classifying the indicators identified from the review of 125 documents (Phase II), in terms of underlying mechanisms of human error applied to level crossing accidents. The violation of rules is also taken into account within this framework.

Furthermore, by mapping the key safety indicators to the critical steps in information processing established in the GIDAS framework, it may facilitate understanding of the relation between the stages in information processing and the self-explaining and forgiving criteria to be applied at level crossings.

5.2. Summary and discussion on variables concerning user requirements analysed

The review of the literature has revealed that most of the studies and projects related to user requirements and human errors and violations at the level crossings focus, on the one hand, on passive level crossings and automatically controlled active level crossings and, on the other hand, on car users and pedestrians. Almost all of these studies, even if not directly related to human factors, underline the relevance of these variables and the need to take into account them to better understanding safety system performance of level crossings.

The documents reviewed also show that the most studied variables related to human factors are (in 20 or more documents):

- Sight distances and signs (n=33).
- Setting of level crossings (n=29).
- External distractions (n=25).
- Perception of train speed and distance (n=25).
- Crossing angle (n=22).

- Lack of understanding of the correct action that is required (n=22).
- Risk-seeking personalities (n=21).
- Not knowledge of signalling at level crossings (n=20).
- Frustration and impatience when delayed by approaching trains (n=20).

Finally, the variables linked to personal conditions of the users of level crossings were analysed to identify risk groups, according to the literature reviewed. The results show that, in recent years, the research has focused commonly on the analysis of behaviours by gender and age.

The results of the association between the variables in the database and the type of level crossing and type of user are consistent with the results of the analysis of the classification items (the type of level crossing and user). It should take be into account that the systematic absence of significant associations for other variables can be explained by the lack of publications mentioning them. However, some differences can be noted between the variables of interest according to the type of level crossing and user. For example, documents on passive level crossings focused on the variables of distraction and inattention, conspicuity, lack of knowledge, inaccurate risk perception and context information. Documents on automatically controlled active level crossings are furthermore focused on the variables of gender, age and deliberate risk-taking behaviour. Regarding the type of user, documents on car users at level crossings focused on the variables of gender, distraction and inattention, conspicuity, lack of knowledge, inaccurate risk perception and context information. Documents on pedestrians at level crossings are focused on the age and deliberate risk-taking behaviour variables.

The differences found should be taken into consideration when addressing a descriptive framework to make level crossings more self-explaining and forgiving, wish keeping in mind the limitations of the selection of the literature reviewed. In addition, there are other variables that may be of interest that have not been studied or have not been studied to a large degree in the research literature, due to difficulties in the analysis or other impediments.

In this regard, it should be noted that in the review of the literature the Task partners identified new variables that had not been contemplated in the *Review Form*. The following are new variables that have appeared more frequently: distraction in general, conspicuity, lack of knowledge in general, risk in general, second train, crossing time, traffic volume, the presence of police and time of day. These new variables indicate, on the one hand, the need to include general variables because sometimes it is not possible to determine for example the type of conspicuity or distraction. On the other hand, several new variables are linked to context information. One recommendation would be to explore more variables related to these kinds of items.

5.3. Summary and discussion on indicators concerning user requirements

The following conclusions and discussion regarding the indicators concerning user requirements have been enriched by the additional comments provided by the survey respondents in the *Indicator*

Rating Form, together with information provided in the literature *Review Form* regarding human factors incorporated into the design of safety measures[2], where possible. Each set of user requirement indicators is explored on continuation, with recommendations to be considered in the further development of this work in Task 2.2.

Indicators related to personal conditions

Overall, there is some variation in the rating of the different categories of indicators related to personal conditions. In general terms though, age and disability are considered to be more relevant indicators than sex, in the study of user requirements at level crossings. These indicators are linked to errors in access, admission and evaluation of information and errors in operation (i.e. wrong actions taken).

A general observation regarding this group of indicators made in three survey responses, point to the importance of considering all road users when designing a countermeasure (not prioritizing one group over another), whilst not losing sight of the needs of particular groups and making the corresponding modifications. A closer examination of the different sets of personal condition indicators is presented on continuation.

Indicators related to sex

Overall, respondents consider the inclusion of the behaviour of men in the human factor analysis framework to be more important than that of women. However, there was general questioning about the relevance of distinguishing between the sexes when deciding to implement a safety measure. Some responses did though point out the relevance of tailoring specific measures (e.g. campaigns) to be directed at a particular audience. One observation, based on in-depth accident data from the survey respondent´s country, highlighted that a greater proportion of male drivers are responsible for road accidents than women, together with results from the literature that indicate that female drivers are significantly less likely to violate warnings than male drivers.

Indicators related to age

There is quite a wide spread of responses with regards to the level of relevance assigned to the different age indicators, with most consensus in relation to the consideration of adults and seniors. Two respondents highlight the need to consider all road user groups irrespective of age, whilst one response specifically highlights the importance of age together with disability, due to the effects of these on the fitness or cognitive abilities of the user. In two cases, the need to attend specific age groups is highlighted. For example, one response points out that children are not seen as a risk group according to the accident data, however it is still moderately important to consider them, via early education and awareness actions, with a view to influencing later behaviour. Another

[2] This refers to the information extracted from the information field related to *Human factor translated to safety measures* in the *Review Form*.

observation highlights youngsters and adults as the two age groups exhibiting non-compliance at level crossings most frequently.

One study referred to in the *Review Form* (regarding human factors in the design of safety measures) states age, in addition to gender and other demographic variables as an important personal condition to take into account when investigating behaviours and perception (Freeman & Rakotonirainy, 2016).

Indicators related to disability

There is some variation in the level of importance assigned to considering indicators related to disability. Whilst overall, both physical and intellectual disability is considered quite relevant, in two cases they are rated not at all important.

Observations pointing out the need to consider this group when planning level crossings and the possible safety measures implemented were made in three of the survey responses. In one case, as mentioned above, disability is considered important due to its potential effect on the fitness and cognitive ability of the user and another comment mentioned eyesight and the ability to see contrast as an important personal factor.

Indicators related to addictive substances

Overall, use of addictive substances (alcohol, drugs and/or medication) and non-compliance at level crossings is considered a relevant indicator, with half of the survey responses rating it as extremely or very important and the other half as moderately or slightly important. One survey response observes that the use of alcohol, drugs and/or medications is always a safety issue in traffic and therefore there is a logical link to its importance within the level crossing context. However, the respondent goes on to highlight the need to focus on the consequences of substance use and how it changes the road user behaviour at level crossings. For example, the use of alcohol can increase distraction and therefore the indicator should be considered similarly to one regarding distraction.

Indicators related to distraction and inattention

In general, the indicators related to distraction and inattention are considered relevant to the study of user requirements in level crossing safety systems. These indicators are linked to errors in information admission.

There is relatively little variation between the ratings attributed by partners on this set of indicators, though significant disagreement occurs in regards to the distraction in general indicator and whether or not it may lead to non-compliance at level crossings. Half of the responses consider this indicator either extremely important or very important, whilst the other half rate it as slightly or not important at all. According to two of the survey responses, the reason for questioning the importance of distraction in general lies in the need to identify the different and real cause or source of distraction. It is argued that in order to effectively target safety measures for each situation and improve the approach to the level crossing, it is necessary to define the type of distraction experienced: is it a visual or mental distractor or one caused by multi-tasking etc.? In the same way, one response indicates the need to specify the type of stimuli (e.g. visual, auditory…) in relation to overload with other stimuli indicator.

The reason given by one respondent for rating external distraction and overload *with other stimuli* as important indicators is due to the possibility for the railway stakeholders to tackle the issue, through removing the source of distraction in the level crossing environment. One respondent also observes that even though the overload of stimuli may not be as relevant at level crossings with low traffic volumes, it continues to be an indicator that should be considered. Indeed information given in the *Review Form* regarding human factors in the design of safety measures focuses on various measures to avoid external distraction and overload of stimuli on the approach to the level crossing. Examples include minimising the variety of signs that road users are required to see, read, interpret and respond to and using one universal level crossing advance warning sign (RSSB, 2011).

Observations made in two survey responses point out other human factors related to distraction and attention (not captured in the *Indicator Rating Form*). On the one hand, the close relationship between attention and knowledge is highlighted. For example, the knowledge of signs announcing a level crossing will lead to an endogenous shift of visual attention to relevant elements on the approaching to the crossing. In other words, previous knowledge of level crossing (e.g. signage) can lead to attention being drawn towards to those safety elements at the level crossing.

On the other hand, a reflection regarding attention at a level crossing and expectancy regarding train traffic is made. It is commented that at level crossings with low daily train volumes there is a risk that local people may not pay enough attention to the arrival of unexpected trains. This puts them at risk in the event that there is deviation from the regular timetable and expected running of trains.

Conspicuity of crossings and trains

There is a general level of consensus regarding the relevance of the indicators related to conspicuity of crossings and trains. These indicators are linked to errors in information access and admission. There is most agreement regarding the relevance of sight distances and signs and the crossing angle, as factors that can lead to non-compliance at level crossings. According to one observation, sight distances and signs are important indicators of the condition and environment of level crossing with good sight distances and appropriate crossing angle representing factors that enhance safety. One respondent draws on national incident data when citing the importance of poor visibility, inadequate road signage and difficulty to manoeuvre for safety.

The greatest variation in results relates to the indicator of conspicuity leading to non-compliance at level crossing, where half of the respondents consider it extremely or very important whilst the other half rate it as slightly or not important at all. Observations made in three survey responses highlight the need to clarify the definition of this indicator by specifying the aspects of conspicuity that need to be addressed and measured (e.g. does this conspicuity refer to the level crossing or train and how does it differ from sight distances and crossing angle?). Furthermore, in its current "general" form, half of the partners question the possibility of measuring this indicator and do not rate it as relevant. Feedback on this indicator suggests the need to further debate its value in the study of human factors at level crossing and how it is defined.

There is also a degree of variation in how respondents rated the importance of visual contrast, with half viewing it as extremely or very important and the other half considering it as only moderately important. Again, there are comments that point to a connection between a low relevance scoring and the need to clarify the meaning of the indicator. One partner poses the question of whether visual contrast refers to the condition of traffic signs (e.g. the colours used in traffic signs that warning road user of approaching level crossing or colours used in level crossing devices).

Some new user requirements related to conspicuity of crossings and trains were proposed. One of the survey responses highlighted train lighting, street lighting (at night), orientation of street or driving direction with reference to sun as further factors to take into account in relation to conspicuity and a further comment indicated the need to consider rolling stock colour.

Indicators related to lack of knowledge

In general terms, the respondents have rated the set of indicators related to lack of knowledge leading to non-compliance at the level crossings as relevant. This set of indicators is linked to errors in information evaluation.

The observations made by half of the survey responses suggest an overlap of understanding between the four indicators related to knowledge. This is particularly the case for the indicator: lack of understanding of the correct action that is required leading to noncompliance at level crossings as it might be considered to encompass the indicators: not knowledge of signalling leading to noncompliance at level crossings; and not knowledge of traffic rules leading to noncompliance at level crossings. In this sense a clearer definition of each indicator has been requested. Further discussion regarding these indicators is needed and to consider whether understanding the correct action indicator is sufficient or whether to maintain all three (including lack of knowledge of signalling or traffic rules).

According to one response the understanding of the correct action is important since it is the responsibility of the road user to behave correctly at level crossings. A number of measures to support correct actions cited in the *Review Form* also support this point. Some examples of these measures include: campaigns to raise consciousness on safe behaviour at level crossing; provision of explicit warnings at active level crossing when more than one train will pass during one closure; complementary warnings in special situations (e.g. where road is running parallel to tracks in advance to level crossing); impeding driving around closed half barriers (e.g. by traffic islands between lanes, posts, rods); installing hanging bars/ grids/ chains to boom to prevent pedestrians from crossing below the boom when closed (Bahloul et al., 2012).

The greatest difference of opinion however lies in relation to the indicator: lack of general knowledge of level crossings leading to noncompliance at level crossings. This indicator has been rated equally across three categories (33% of responses in each case): very important; moderately important; and not important at all. Observations made by respondents regarding the lack of general knowledge indicator suggest a difference in understanding of this indicator. In two cases, further specification is requested because the indicator is not considered to be relevant "in general". In one case, the respondent understands it to refer to general knowledge and awareness of the risks inherent in the level crossing and rail environment (e.g. level crossing users need better awareness of the huge forces in heavy trains moving with high speed through level crossings). Three other respondents understand lack of general knowledge to refer to knowledge of particular user groups, such as children and young people, as early learners of traffic and safety rules or refugees coming from other countries, with potentially different knowledge and cultural references.

One survey response questions whether the correct understanding of signage by road users is the actual problem, rather the presence of errors (people fail to see the signage) or violation (people intentionally disregard the signage). However, examples given in the *Review Form* regarding human factors in the design of safety measures, point to the importance of gaps in user´s knowledge regarding level crossing signage. For example, one study shows that the meaning and behavioural implications of St. Andrew’s cross are represented with more uncertainty in user's knowledge than for that of the Stop sign. Thus, for level crossings with passive protection - at which stopping or strong slowing is necessary - safe behaviour would benefit from using a combination of St. Andrew's cross with the Stop sign (Bahloul et al., 2012). A further example is focused on using more self-explaining signs and road side signalling through the replacement of red flashing lights for yellow-red or green-yellow-red traffic lights due to higher familiarity from the road traffic context (Grippenkoven, 2017).

Inaccurate risk perception indicators

In general, inaccurate risk perception is related to familiarity with level crossing leading to the low expectancy of encountering trains at crossings and misjudgement of train speed and distance. These indicators are linked with errors of information evaluation. The information can be misunderstood due to previous experience and knowledge of the place, and lack of awareness and knowledge of railways and related risks at level crossing infrastructures.

According to the survey responses, the indicator of user's familiarity with the place must be taken into account in the human factor analysis. According to one survey respondent, in general, a person who is a frequent level crossings user has a good experience and knowledge of level crossings operation but it could be different for a person with a familiarity with the place underestimating the risk of approaching an extra train. However, they both could underestimate a risk situation so it is difficult to distinguish these users except for the definition of a sample in an experimental simulation. One factor that can affect whether a driver looks for a train is the driver's expectation of seeing a train. A person's perception of the probability of a given event is strongly influenced by past experience, and the frequency with which the driver encounters a train at a level crossing will influence the likelihood of that driver stopping.

Regarding the indicator of perception of the train speed and distance, two survey respondents emphasized that the most important thing is to identify the presence of the train, therefore, the conspicuity. The thesis is that the users should not cross a level crossing based on perceptions. However, although conspicuity is a very important indicator (it was considered in another category of analysis), the misperception is related to the lack of knowledge, an aspect that has proven to be relevant in the analysis of safety in level crossings.

Regarding the indicator of perception of risk in general, the partners contributed different reflections. On the one hand, it is necessary to identify the cause of the risk situation. Thus it is an indicator that should not be taken into account, despite having been identified in the literature. On the other hand, the indicator of perception of risk, in general, is referring to a personality feature and thus rate it as highly important as risk-seeking behaviour. It has to be considered that risk perception is only one side of the psychological cost-benefit analysis done by users at level crossings. Thus, the benefits of misbehaviour have to be considered at the same time and reduced to enhance compliance (e.g. by avoiding overly long waiting times). The disagreement in this indicator recommends further reflection.

Deliberate risk-taking behaviour indicators

Deliberate risk-taking behaviour indicators fall into two main categories: risk-taking due to the frustration and impatience of the user having to wait at the level crossing and the user having a risk-seeking personality. These indicators are linked to voluntary unsafe behaviour or violations.

Survey responses considered that the indicator of frustration and impatience leading to non-compliance at the level crossing is the most relevant indicator to consider within an analysis of human factors. The long waiting times at level crossings could influence drivers' behaviour and increase risk situations, so it could be interesting to measure these indicators in different level crossings (active or passive). According to one survey respondent, in their country cyclists and pedestrians are especially susceptible to crossing level crossings since they underestimate the risk perception because of the impatience and frustration.

Another survey respondent pointed out the importance of this indicator although it is difficult to be measured. For example, how do you measure the share of drivers or road users who exhibit noncompliant behaviour at level crossings are frustrated and impatient? As a recommendation for other project tasks, it is necessary to evaluate aspects such as frustration and impatience in the development of technological and non-technological solutions. These results will allow the construction of more self-explaining and forgiving infrastructures.

Another recommendation would be to reflect on risk-seeking personalities. One survey respondent asked what does risk-seeking personalities really mean. Does a person identified with a risk personality always have it? According to this survey response, the deliberate risk-seeking behaviour could be measured via speed profiles or the number of barrier zigzagging. Also, the link to suicides was proposed. Perhaps risk-seeking personalities could be measured with a methodology that combines technical and psychological aspects.

Another indicator was signal unreliability (generating distrust amongst users). One survey respondent indicates that signal failure is not often a problem causing accidents in their country. The assumption should be that level crossings equipment work reliably (100% functionality). In general, it is difficult to evaluate the relevance of this indicator. It should take into account that signal unreliability, is sometimes not related to a good operation but a perception or belief. There may be personalities who distrust the proper functioning of the level crossing.

The importance of the user´s expectation of a level crossing is also gathered in the *Review Form* regarding human factors in the design of safety measures. Specifically, there is an example given of drivers not differentiating between active or passive level crossings and expecting to be told that a train is approaching a passive level crossing, instead of checking it for themselves (Wigglesworth, 2001).

Evidence in the *Review Form* also points to the importance of previous experience in terms of right-side failures. That is to say a failure which does not result in the protection provided by the signalling (RSSB, 2004). It argues that frequent or prolonged right-side failures may cause road users to lose confidence in the warning which can influence their driving performance. This situation potentially facilitates the creation of mental models of when the train approach warning is credible based on other factors such as known train schedules, resulting in a mismatch between real risk and perceived risk (Rongfang Liu, 2010)

According to one survey response, level crossings could represent an easy "gateway" into rail facilities in the case of suicides. Level crossings could be designed to avoid that. However, in order to effectively prevent suicide, the protection would have to be gapless along the track which seems nearly impracticable. On the other hand, in the case of suicides, the intentionality of the event is not relevant due to the difficulties in preventing a suicide.

One respondent to the survey proposed changing the indicator of low costs of fines leading to noncompliance at level crossings to the indicator of the perceived improbability of being detected and fined. Concerning the fines, the problem is not the cost (fines are not too low), rather the low probability of getting caught. Countermeasures directed to this should thus work on enhancing the probability of being penalized for misbehaviour.

Another survey respondent noted that in the beginning, fines are good measures to reduce deliberate behaviour but in the medium-long term as the conduct of the people persists. In this regard, the recommendations should focus on designing educational and awareness programs for safety at level crossings.

Information about the context indicators

The indicators related to the information about the context are linked with errors of information access, errors of information admission, errors of evaluation and errors of operation. In this case, errors can occur by not perceiving the relevant information, having interferences in and outside the car making an incorrect interpretation due to experience and knowledge of the place, and/ or taking wrong actions.

Survey responses considered that the indicator of the setting of level crossing is the most relevant to consider within an analysis of human factors. For example, an unfavourable location of the level crossing is reported as one of the main causes of accidents in one respondent´s country. The setting of the level crossing is, in general, a very important factor, but needs to be broken down into its components. For example, road features such as crossing angle and/ or slope; features affecting the visibility of the tracks as vegetation and/ or buildings; traffic density, speed...).

Regarding the indicator of infrastructure layout, the partners contributed different reflections. On the one hand, accidents and incidents can occur even though we have a perfect infrastructure layout. In this sense, one survey response proposed to rename the indicator as condition (or status) of level crossings. On the other hand, another survey respondent indicated that problems in an infrastructure's layout are reported as one of the main causes of accidents in their country. For example, when a trajectory of a driver includes a curve it is more difficult to determine the speed and distance of another vehicle.

Regarding the indicator of weather and safety measures, one respondent to the survey indicated that it is important to know whether some weather conditions (e.g. ice, snow, hard wind, etc.) cause any possible problems with the functioning and maintenance of level crossings. Another survey respondent commented that maybe it is important to distinguish the different weather condition to identify the safety measures and prevent the main causes of accidents at that type of level crossings.

Finally, regarding the time of day's indicator this is an useful indicator if it refers to lighting conditions or road volumes. At night, drivers' judgment is usually worse, because they may have difficulty comparing train movement against a dim background with indistinct landmarks. It is possible that the indicator of time of day is an indicator that combines aspects such as traffic density, lighting, hurry, fatigue, etc. For the following Tasks, it would be useful to develop the definition of this indicator.

5.4. Conclusions

There is no clear overall consensus between partners regarding the key safety indicators that should be considered in the human factor analysis framework going forward. Whilst there is agreement regarding the relevance of some indicators, others have provoked considerable discussion. The ratings and reflections made by partners regarding the key safety indicators captured in this Deliverable can feed the discussion towards the further refinement of the indicators in Task 2.2. A brief summary of the main findings and discussion on the user requirement and human error and violation indicators is presented on continuation.

Indicators related to personal conditions

- There is some variation in the rating of the different categories of indicators related to personal conditions. In general terms, age and disability are considered to be more relevant indicators than gender in the study of user requirements at level crossings. Use of addictive substances is also considered relevant for the study of human factors at level crossings.
- A general observation regarding this group of indicators point to the importance of considering all road users when designing a countermeasure (not prioritizing one group over another), whilst not losing sight of the needs of particular groups and making the corresponding modifications.

Indicators related to distraction and inattention

- In general, the entire set of indicators related to distraction and inattention are considered relevant for the study of user requirements in level crossing safety systems. Most disagreement lies though with regards to the indicator of distraction in general leading to non-compliance at level crossing, where different meanings have been attributed. An exploration into the definition of this indicator is recommended as a next step.

Indicators related to conspicuity of crossings and trains

- There is a general level of consensus regarding the relevance of the indicators related to conspicuity of crossings and trains with most agreement regarding the relevance of sight distances and signs and the crossing angle, as factors that can lead to non-compliance at level crossings.
- Comments made by survey respondents regarding the more general indicator of “conspicuity leading to non-compliance at level crossing” suggest the need to clarify the definition of this indicator, specifying the aspects of conspicuity that need to be addressed and measured.

Indicators related to lack of knowledge

- In general terms, the set of indicators related to lack of knowledge leading to non-compliance at the level crossings is rated as relevant to consider within the analysis of human factors at level crossings.
- However, feedback suggests an overlap of understanding between the four indicators related to knowledge. In this sense, a clearer definition of each indicator should be explored and further discussion as to whether the indicator “understanding the correct action” is sufficient or whether to also maintain the indicators “lack of knowledge of signalling” or “lack of knowledge of traffic rules”.

Indicators related to inaccurate risk perception

- In general, inaccurate risk perception is regarded as relevant for the study of human factors at level crossings. Of particular interest is the user’s familiarity with the level crossing, due to the links with low expectancy of encountering trains and misjudgement of train speed and distance.
- There is a certain amount of debate around the cause of misperception at level crossings. Some comments point to the importance of lack of knowledge, whilst others emphasize the relation with the risk-seeking behaviour personality trait.

Deliberate risk-taking behaviour indicators

- The most relevant of the deliberate risk-taking behaviour indicators fall into two main categories: risk-taking due to the frustration and impatience of the user having to wait at the level crossing and the user having a risk-seeking personality. These indicators are linked to voluntary unsafe behaviour or violations.
- As a recommendation for other project tasks, it is necessary to evaluate aspects such as frustration and impatience in the development of technological and non-technological solutions and their relation to self-explaining and forgiving infrastructures.

- In response to the question posed by one survey respondent as to what risk-seeking personalities really mean, another recommendation would be to reflect on risk-seeking personalities.

Indicators related to information about the context

- From the set of indicators related to information about the context, the indicator of the setting of level crossing (e.g. whether it is rural or urban) is considered most relevant to consider within an analysis of human factors.

A general observation made with respect to a number of the indicator groups discussed above is the need to clarify the indicator definitions. This is likely to help focus the discussion about which indicators to adopt moving forward. A more general and related suggestion concerns the use of the term “safety indicator” in the deliverable. It has been suggested that "key safety factors" or "factors influencing the interaction of users with the level crossing" may offer a more appropriate description the factors discussed in this Task. In this way, the factors can be seen as independent variables that influence safety, rather than dependent variables (a criterion of safety) as they stand in their current terminology as indicators. This proposed change in terminology could be introduced within the debate about the further development of the identified factors in Task 2.2.

In conclusion, the outcome of this deliverable represents a first set of indicators that can be further refined and developed throughout Work Package 2, most notably in Task 2.2. It is proposed this could be done through a group evaluation of the indicators between WP2 partners and potentially wider expert consultation (if needed,) in order to reach a consensus on which indicators to take forward into the human factor methodological framework in Task 2.2.

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ANNEXES

Annex A. Review Form

INSTRUCTIONS

In order to capture relevant data regarding user requirements and human errors, an excel template has been created to guide the analysis of variables and other relevant information when reviewing the literature.

This template for collecting human factor variables contains a number of fields that need to be completed for each document reviewed. These encompass bibliographical data; methodology; human factor variables; other variables; and other contextual information.

The items appearing in the section "Variables related to human factors" should be ticked if appearing in the document reviewed. In case of additional variables mentioned, please write them down in section "others".

Some of the fields require you to respond to options given on drop-down menus and other fields require you to write in the response.

If you cannot find the information requested, leave the box/space blank.

Please note, the project/study form should be based only on the information contained in the document reviewed.

DEFINITIONS

General reflection on the difference between fatigue and sleepiness

Fatigue refers to a more general state of tiredness whilst sleepiness refers to the state before sleeping. One could be fatigued but not sleepy.

Fatigue: In general, fatigue affects task performance: a reduction in alertness, longer reaction times, memory problems, poorer psychometric coordination, and less efficient information processing (http://erso.swov.nl/knowledge/content/55_fatique/effects_of_fatigue_on_driving.htm). The major effect of driver fatigue is that he/she becomes gradually diverted from the road and road traffic, with the resultant poorer driving performance (https://www.ncbi.nlm.nih.gov/pubmed/21870418).

Sleepiness/drowsiness: Being sleepy or drowsy can result in the driver falling asleep at the wheel which is clearly dangerous. Being sleepy, however, affects your ability to drive safely even if you don't fall asleep. Even in the event of not falling asleep, it makes drivers less able to pay attention to the road; slows reaction time if you have to brake or steer suddenly, and affects a driver's ability to make good decisions (https://www.cdc.gov/features/dsdrowsydriving/index.htm).

SOURCES OF INFORMATION

Excel file with the database of documents, where the designated partner per document can be located here (check column “Responsible Partner”): https://docs.google.com/spreadsheets/d/1hxyeoTTi0wUoZmPabckqsN2k5_v1gGlmXz5O_wucZQI/edit?usp=sharing

Document repository: Where you will find and download the actual document to fill in this questionnaire https://drive.google.com/open?id=0B1qn9IeybcWnVnk5UDNhRmFHS1U

Bibliographical Information	
Number	Document number in the bibliographical database
Title	Project/ study/ paper/presentation… title
Author	Document author
Year	Year of the study/ project/ paper/ presentation…
Document type	Document type: Scientific article, research paper, PhD thesis… Click the cell and you can see the drop-down list on the right side of the cell
Study Information	
Abstract	Brief description of project/study
Spatial scope	Spatical scope: Local, national, European, international… Click the cell and you can see the drop-down list on the right side of the cell
	Countries (specify)
Study Approach	Theoretical/Bibliographical
	Data analysis
	Test/Pilots
	Other: specify
Methodology	Brief description of project/study methodology
Theoretical model (*if applicable*)	Brief description of project/study theoretical model
Sample	Sample of study and details where available
Classification items	
Type of level crossing *(check the option/s)*	Passive level crossing
	Active level crossing with automatically controlled protection
	Active level crossing with manually controlled protection
	Observations
Type of user *(check the option/s)*	Motorized road users-Car
	Motorized road users-Motorbike/moped
	Motorized road users-Transport professionals
	Motorized road users- Heavy vehicles
	Motorized road users- Farm vehicles
	Vulnerable road users- Cyclist
	Vulnerable road users- Pedestrians
	Vulnerable road users- Ramblers
	Vulnerable road users- Horse riders
	Vulnerable road users- Persons with reduced mobility
	Vulnerable road users- Users with vision loss and blindness
	Vulnerable road users- Users with hearing loss and deafness
	Vulnerable road users- Users with different cultural and language background
	Others *(specify)*
	Observations

Variables related to human factor		
Personal Conditions *(check the option/s)*	Sex-Man	☐
	Sex-Woman	☐
	Age-Children	☐
	Age-Young	☐
	Age-Adults	☐
	Age-Seniors	☐
	Age-non specified	☐
	Vision loss and blindness	☐
	Hearing loss and deafness	☐
	Other physical disability	☐
	Intellectual disability	☐
	Consumption-Alcohol	☐
	Consumption-Drugs	☐
	Consumption-Medications	☐
	Others (*specify*)	☐
	Observations	
Distraction and inattention *(check the option/s)*	Fatigue	☐
	Sleepiness / drowsiness	☐
	External distractions (*e.g. traffic, noise…*)	☐
	Internal distractions (*e.g. media devices, conversations with passengers or fellow pedestrians…*)	☐
	Overloaded with other stimuli (*e.g. signalling…*)	☐
	Distracting mental processes (*e.g. worry…*)	☐
	Others (specify)	☐
	Observations	
Conspicuty of crossings and trains *(check the option/s)*	Visual contrast	☐
	Sight distances/signs	☐
	Crossing angle	☐
	Other (*specify*)	☐
	Observations	
Lack of knowledge *(check the option/s)*	Not knowledge of signalling at LC	☐
	Not knowledge of traffic rules at LC	☐
	Lack of understanding of the correct action that is required	☐
	Others (*specify*)	☐
	Observations	
Inaccurate risk perception *(check the option/s)*	Familiarity with the place (*e.g. neighbours …*)	☐
	Frequent LC user (e.g. *professional drivers …*)	☐
	Perception of train speed and distance	☐
	Others (*specify*)	☐
	Observations	

Deliberate risk-taking behaviour *(check the option/s)*	Frustration and impatience when delayed by approaching trains	☐
	Risk-seeking personalities (*e.g. young people*)	☐
	Signal unreliability (generating distrust amongst users)	☐
	Low costs of fines for LC violations	☐
	Suicide	☐
	Others (*specify*)	☐
	Observations	
Information about the context *(check the option/s)*	Weather (*e.g. rain, fog, blinding sun…*)	☐
	Setting of LC (*e.g. rural, urban, city outskirts..*)	☐
	Infrastructure layout (*e.g. if the level crossing is on a slope or a curve*)	☐
	Others (*specify*)	☐
	Observations	
Human factor translated to safety measures		
Incorporation of study/project results regarding human factors in the design of safety measures	Incorporation of human factor variables in the design of safety measures. Click the cell and you can see the drop-down list on the right side of the cell	
	Specify	
Incorporation of study/project results regarding human factors in tested safety measures	Incorporation of study/project results in regard to human factors in the tested safety measures. Click the cell and you can see the drop-down list on the right side of the cell	
	Specify	

Information on countermeasures		
Is the document mentioning/including information on	Yes	☐
	No	☐
If yes, please name them and provide further details in the excel file located in Google Drive:	Please name them	
	Please describe them clicking the link below: https://docs.google.com/spreadsheets/d/1hxyeoTTi0wUoZmPabckqsN2k5_v1gGlmXz5O_wucZQI/edit#gid=1514565582	

Any remarkable information:

Annex B. Indicators Rating Form

INTRODUCTION TO THE TOOL

The rating tool presented herein has been developed to respond to the research objectives of **Task 2.1. Analysis of Human Factors in LC safety systems** which forms part of Work Package 2 of the SAFER-LC project.

The aim of Task 2.1. is to contribute to the creation of a state of art of the current knowledge concerning human factors in level crossings and safety systems and identification of key safety indicators concerning user requirements and human errors. For this, the following tasks were carried out:

- Analysis of a selection of different sources of information, studies and projects related to human factors in level crossings design and safety measures identified by partners.
- Study of one or several analytical tools identified by the partners: RAILSET Tool; DKCP method; TARVALC evaluation tool; the systematic problem-solving model from RESTRAIL toolbox; Level Crossing Risk Management Toolkit; etc.
- Identification of key safety indicators concerning user requirements and human errors.

After selecting the most relevant sources of information, task partners reviewed the literature to identify user requirement variables related to level crossings and safety systems.
Using frequency analysis as an indication of the most important variables (an indicator was classified as important if counted in 3 or more examples of literature), these have been grouped under broad thematic categories classified as user requirement indicators.

Drawing on your knowledge and experience we would like you/your organization to fill out this Indicators Rating Form in order to measure the relevance of the findings from our *Review Form*. Specifically, we would like you **to indicate those user requirements related to level crossings and safety systems you believe are most relevant and identify others that had not been captured through the literature review and that might be of importance**.

In order to facilitate the rating of the indicators that have been identified, a common template has been developed: **Indicators Rating Form**. You can find it below.

ORGANIZATION INFORMATION

Country:

Name of Organization:

USER REQUIREMENT INDICATORS

Please indicate with a tick the level of importance you assign to the following indicators in terms of safety at level crossings from a human factors perspective.

INDICATORS RELATED TO PERSONAL CONDITIONS			Extremely important	Very important	Moderately important	Slightly important	Not at all important
	Indicator	Definition					
Sex	**Men exhibiting noncompliance at LC**	*Number of men exhibiting noncompliant behaviours at LC*	☐	☐	☐	☐	☐
	Women exhibiting noncompliance at LC	*Number of women exhibiting noncompliant behaviours at LC*	☐	☐	☐	☐	☐
Age	**Children exhibiting noncompliance at LC**	*Number of children exhibiting noncompliant behaviours at LC*	☐	☐	☐	☐	☐
	Young exhibiting noncompliance at LC	*Number of young exhibiting noncompliant behaviours at LC*	☐	☐	☐	☐	☐
	Adults exhibiting noncompliance at LC	*Number of adults exhibiting noncompliant behaviours at LC*	☐	☐	☐	☐	☐
	Seniors exhibiting noncompliance at LC	*Number of seniors exhibiting noncompliant behaviours at LC*	☐	☐	☐	☐	☐
Disability	**People with physical disabilities exhibiting noncompliance at LC**	*Number of people with vision loss and blindness, hearing loss and deafness, and/or another type of physical disability exhibiting noncompliant behaviours at LC*	☐	☐	☐	☐	☐
	People with intellectual disability exhibiting noncompliance at LC	*Number of people with intellectual disability exhibiting noncompliant behaviours at LC*	☐	☐	☐	☐	☐
Substances	**People who use addictive substances exhibiting noncompliance at LC**	*Number of people who use alcohol, drugs and/or medications exhibiting noncompliant behaviours at LC*	☐	☐	☐	☐	☐

Please describe briefly if there any other user requirements related to personal conditions.

Additional comments on indicators related to personal conditions and the level of importance assigned.

INDICATORS RELATED TO DISTRACTION AND INATTENTION			Extremely important	Very important	Moderately important	Slightly important	Not at all important
	Indicator	**Definition**					
Personal conditions	**Tiredness leading to noncompliant at LC**	*Number of people with fatigue and/or sleepiness/drowsiness exhibiting noncompliant behaviours at LC*	☐	☐	☐	☐	☐
Distraction	**External distraction leading to noncompliance at LC**	*Number of people who exhibit noncompliant behaviour at LC due to external distraction*	☐	☐	☐	☐	☐
	Internal distraction leading to noncompliance at LC	*Number of people who exhibit noncompliant behaviour at LC due to internal distraction*	☐	☐	☐	☐	☐
	Distraction in general leading to noncompliance at LC	*Number of people who exhibit noncompliant behaviour at LC due to distraction in general*	☐	☐	☐	☐	☐
	People exhibiting noncompliance at LC due to overload with other stimuli	*Number of people who exhibit noncompliant behaviour at LC due to overload with other stimuli*	☐	☐	☐	☐	☐

Please describe briefly if there any other user requirements related to distraction and inattention.

Additional comments on indicators related to distraction and inattention and the level of importance assigned.

INDICATORS RELATED TO CONSPICUITY OF CROSSINGS AND TRAINS			Extremely important	Very important	Moderately important	Slightly important	Not at all important
	Indicator	**Definition**					
Conspicuity	**Sight distances/signs leading to noncompliance at LC**	*Number of cases of noncompliance at LC due to sight distances/signs*	☐	☐	☐	☐	☐
	Crossing angle leading to noncompliance at LC	*Number of cases of noncompliance at LC due to crossing angle*	☐	☐	☐	☐	☐
	Visual contrast leading to noncompliance at LC	*Number of cases of noncompliance at LC due to visual contrast*	☐	☐	☐	☐	☐
	Conspicuity leading to noncompliance at LC	*Number of cases of noncompliance at LC due to conspicuity in general*	☐	☐	☐	☐	☐

Please describe briefly if there any other user requirements related to conspicuity of crossings and trains.

Additional comments on indicators related to conspicuity of crossings and trains and the level of importance assigned.

INDICATORS RELATED TO LACK OF KNOWLEDGE			Extremely important	Very important	Moderately important	Slightly important	Not at all important
	Indicator	**Definition**					
Knowledge	**Lack of understanding of the correct action that is required leading to noncompliance at LC**	*Number of people who exhibit noncompliant behaviour at LC due to lack of understanding of the correct action that is required*	☐	☐	☐	☐	☐
	Not knowledge of signalling leading to noncompliance at LC	*Number of people who exhibit noncompliant behaviour at LC due to not knowledge of signalling*	☐	☐	☐	☐	☐
	Not knowledge of traffic rules leading to noncompliance at LC	*Number of people who exhibit noncompliant behaviour at LC due to not knowledge of traffic rules*	☐	☐	☐	☐	☐
	Lack of general knowledge leading to noncompliance at LC	*Number of people who exhibit noncompliant behaviour at LC due to lack of general knowledge*	☐	☐	☐	☐	☐

Please describe briefly if there any other user requirements related to lack of knowledge.

Additional comments on indicators related to lack of knowledge and the level of importance assigned.

INDICATORS RELATED TO INACCURATE RISK PERCEPTION			Extremely important	Very important	Moderately important	Slightly important	Not at all important
	Indicator	**Definition**					
Risk perception	**Perception of train speed and distance leading to noncompliance at LC**	*Number of people who exhibit noncompliant behaviour at LC due to problems perceiving train speed and distance*	☐	☐	☐	☐	☐
	Frequent LC user leading to noncompliance at LC	*Number of frequent LC users who exhibit noncompliant behaviour*	☐	☐	☐	☐	☐
	Familiarity with the place leading to noncompliance at LC	*Number of people who exhibit noncompliant behaviour at LC due to familiarity with the place*	☐	☐	☐	☐	☐
	Perception of risk in general leading to noncompliance at LC	*Number of people who exhibit noncompliant behaviour at LC due to problems perceiving risk in general*	☐	☐	☐	☐	☐

Please describe briefly if there any other user requirements related to inaccurate risk perception.

Additional comments on indicators related to inaccurate risk perception and the level of importance assigned.

INDICATORS RELATED TO DELIBERATE RISK-TAKING BEHAVIOUR			Extremely important	Very important	Moderately important	Slightly important	Not at all important
	Indicator	**Definition**					
Deliberate behaviour	**Frustration and impatience leading to noncompliance at LC**	*Number of people who exhibit noncompliant behaviour at LC due to frustration and impatience*	☐	☐	☐	☐	☐
	Risk-seeking personalities leading to noncompliance at LC	*Number of people who exhibit noncompliant behaviour at LC due to risk-seeking personality*	☐	☐	☐	☐	☐
	Low costs of fines leading to noncompliance at LC	*Number of people who exhibit noncompliant behaviour at LC due to low costs of fines for violations*	☐	☐	☐	☐	☐
	Signal unreliability leading to noncompliance at LC	*Number of people who exhibit noncompliant behaviour at LC due to signal unreliability*	☐	☐	☐	☐	☐
	Suicide in LC	*Number of suicides in LC*	☐	☐	☐	☐	☐

Please describe briefly if there any other user requirements related to deliberate risk-taking behaviour.

Additional comments on indicators related to deliberate risk-taking behaviour and the level of importance assigned.

INDICATORS RELATED TO INFORMATION ABOUT THE CONTEXT			Extremely important	Very important	Moderately important	Slightly important	Not at all important
	Indicator	**Definition**					
Context information	**Setting of LC leading to noncompliance at LC**	*Number of cases of noncompliance at LC due to unfavourable location of LC*	☐	☐	☐	☐	☐
	Infrastructure layout leading to noncompliance at LC	*Number of cases of noncompliance at LC due to infrastructure layout problems*	☐	☐	☐	☐	☐
	Weather conditions leading to noncompliance at LC	*Number of cases of noncompliance at LC due to presence of adverse weather conditions*	☐	☐	☐	☐	☐
	Time of day leading to noncompliance at LC	*Number of cases of noncompliance at LC due to information about time of day*	☐	☐	☐	☐	☐

Please describe briefly if there any other user requirements related to information about the context.

Additional comments on indicators related to information about the context and the level of importance assigned.

Annex C. Table 3. Variables related to human factor by type of level crossing

Table 3. Variables related to human factor by type of level crossing

Variables related to human factor		Type of level crossing																	
		Passive level crossing						Active level crossing with automatically controlled protection						Active level crossing with manually controlled protection					
		No		Yes		Statistics		No		Yes		Statistics		No		Yes		Statistics	
		n	%	n	%			n	%	n	%			n	%	n	%		
Man	No	52	76,5	36	63,2	X^2	2,637	58	80,6	30	56,6	X^2	8,404	77	70,6	11	68,8	X^2	0,024
	Yes	16	23,5	21	36,8	***p-value***	0,104	14	19,4	23	43,4	***p-value***	,004[*]	32	29,4	5	31,3	***p-value***	,877[a]
Woman	No	62	91,2	50	87,7	X^2	0,398	66	91,7	46	86,8	X^2	0,778	101	92,7	11	68,8	X^2	8,560
	Yes	6	8,8	7	12,3	***p-value***	0,528	6	8,3	7	13,2	***p-value***	0,378	8	7,3	5	31,3	***p-value***	,003[a,*]
Children	No	55	80,9	43	75,4	X^2	0,543	61	84,7	37	69,8	X^2	4,008	89	81,7	9	56,3	X^2	5,316
	Yes	13	19,1	14	24,6	***p-value***	0,461	11	15,3	16	30,2	***p-value***	,045[*]	20	18,3	7	43,8	***p-value***	,021[a,*]
Young	No	51	75,0	40	70,2	X^2	0,364	56	77,8	35	66,0	X^2	2,125	82	75,2	9	56,3	X^2	2,538
	Yes	17	25,0	17	29,8	***p-value***	0,546	16	22,2	18	34,0	***p-value***	0,145	27	24,8	7	43,8	***p-value***	,111[a]
Adults	No	51	75,0	46	80,7	X^2	0,580	58	80,6	39	73,6	X^2	0,853	87	79,8	10	62,5	X^2	2,407
	Yes	17	25,0	11	19,3	***p-value***	0,446	14	19,4	14	26,4	***p-value***	0,356	22	20,2	6	37,5	***p-value***	,121[a]
Seniors	No	62	91,2	52	91,2	X^2	0,000	66	91,7	48	90,6	X^2	0,046	100	91,7	14	87,5	X^2	0,313
	Yes	6	8,8	5	8,8	***p-value***	0,992	6	8,3	5	9,4	***p-value***	,830[a]	9	8,3	2	12,5	***p-value***	,576[a]
Age non specified	No	65	95,6	54	94,7	X^2	0,049	69	95,8	50	94,3	X^2	0,149	105	96,3	14	87,5	X^2	2,381
	Yes	3	4,4	3	5,3	***p-value***	,824[a]	3	4,2	3	5,7	***p-value***	,699[a]	4	3,7	2	12,5	***p-value***	,123[a,c]
Vision loss	No	66	97,1	54	94,7	X^2	0,435	70	97,2	50	94,3	X^2	0,661	106	97,2	14	87,5	X^2	3,452
	Yes	2	2,9	3	5,3	***p-value***	,509[a]	2	2,8	3	5,7	***p-value***	,416[a]	3	2,8	2	12,5	***p-value***	,063[a,c]
Hearing loss	No	64	94,1	53	93,0	X^2	0,067	68	94,4	49	92,5	X^2	0,202	103	94,5	14	87,5	X^2	1,140
	Yes	4	5,9	4	7,0	***p-value***	,796[a]	4	5,6	4	7,5	***p-value***	,653[a]	6	5,5	2	12,5	***p-value***	,286[a]
Other physical disability	No	67	98,5	54	94,7	X^2	1,440	70	97,2	51	96,2	X^2	0,098	107	98,2	14	87,5	X^2	5,123
	Yes	1	1,5	3	5,3	***p-value***	,230[a]	2	2,8	2	3,8	***p-value***	,755[a]	2	1,8	2	12,5	***p-value***	,024[a,*,c]
Intellectual disability	No	67	98,5	49	86,0	X^2	7,326	69	95,8	47	88,7	X^2	2,338	104	95,4	12	75,0	X^2	8,701
	Yes	1	1,5	8	14,0	***p-value***	,007[a,*]	3	4,2	6	11,3	***p-value***	,126[a]	5	4,6	4	25,0	***p-value***	,003[a,*]
Consumption Alcohol	No	68	100,0	49	86,0	X^2	10,196	70	97,2	47	88,7	X^2	3,719	105	96,3	12	75,0	X^2	10,597
	Yes	0	0,0	8	14,0	***p-value***	,001[a,*]	2	2,8	6	11,3	***p-value***	,054[a]	4	3,7	4	25,0	***p-value***	,001[a,*]
Consumption Drugs	No	68	100,0	54	94,7	X^2	3,667	72	100,0	50	94,3	X^2	4,176	108	99,1	14	87,5	X^2	7,991
	Yes	0	0,0	3	5,3	***p-value***	,056[a]	0	0,0	3	5,7	***p-value***	,041[a,*]	1	0,9	2	12,5	***p-value***	,005[a,*,c]
Consumption Medications	No	66	97,1	54	94,7	X^2	0,435	71	98,6	49	92,5	X^2	3,015	107	98,2	13	81,3	X^2	10,396
	Yes	2	2,9	3	5,3	***p-value***	,509[a]	1	1,4	4	7,5	***p-value***	,082[a]	2	1,8	3	18,8	***p-value***	,001[a,*,c]
Other consumption	No	62	93,9	55	100,0	X^2	3,447	67	94,4	50	100,0	X^2	2,913	102	96,2	15	100,0	X^2	0,585
	Yes	4	6,1	0	0,0	***p-value***	,063[a]	4	5,6	0	0,0	***p-value***	,088[a]	4	3,8	0	0,0	***p-value***	,444[a,c]
Social crossing new	No	1	50,0	2	50,0	X^2	0,000	1	100,0	2	40,0	X^2	1,200	2	66,7	1	33,3	X^2	0,667
	Yes	1	50,0	2	50,0	***p-value***	1,000[a,c]	0	0,0	3	60,0	***p-value***	,273[a,c]	1	33,3	2	66,7	***p-value***	,414[a]
Fatigue	No	65	95,6	50	87,7	X^2	2,609	66	91,7	49	92,5	X^2	0,026	102	93,6	13	81,3	X^2	2,881
	Yes	3	4,4	7	12,3	***p-value***	,106[a]	6	8,3	4	7,5	***p-value***	,873[a]	7	6,4	3	18,8	***p-value***	,090[a]
Sleepiness / drowsiness	No	65	95,6	52	91,2	X^2	0,984	68	94,4	49	92,5	X^2	0,202	103	94,5	14	87,5	X^2	1,140
	Yes	3	4,4	5	8,8	***p-value***	,321[a]	4	5,6	4	7,5	***p-value***	,653[a]	6	5,5	2	12,5	***p-value***	,286[a]
External distractions	No	62	91,2	38	66,7	X^2	11,642	64	88,9	36	67,9	X^2	8,386	88	80,7	12	75,0	X^2	0,287
	Yes	6	8,8	19	33,3	***p-value***	,001[*]	8	11,1	17	32,1	***p-value***	,004[*]	21	19,3	4	25,0	***p-value***	,592[a]
Internal distractions	No	65	95,6	43	75,4	X^2	10,714	66	91,7	42	79,2	X^2	4,009	95	87,2	13	81,3	X^2	0,414
	Yes	3	4,4	14	24,6	***p-value***	,001[*]	6	8,3	11	20,8	***p-value***	,045[*]	14	12,8	3	18,8	***p-value***	,520[a]
Overloaded with other stimuli	No	62	91,2	46	80,7	X^2	2,895	63	87,5	45	84,9	X^2	0,175	97	89,0	11	68,8	X^2	4,865
	Yes	6	8,8	11	19,3	***p-value***	0,089	9	12,5	8	15,1	***p-value***	0,676	12	11,0	5	31,3	***p-value***	,027[a,*]
Distracting mental processes	No	66	98,5	49	89,1	X^2	4,952	66	93,0	49	96,1	X^2	0,534	102	95,3	13	86,7	X^2	1,824
	Yes	1	1,5	6	10,9	***p-value***	,026[a,*]	5	7,0	2	3,9	***p-value***	,465[a]	5	4,7	2	13,3	***p-value***	,177[a,c]

Variables related to human factor		Type of level crossing																	
		Passive level crossing						Active level crossing with automatically controlled protection						Active level crossing with manually controlled protection					
		No		Yes		Statistics		No		Yes		Statistics		No		Yes		Statistics	
		n	%	n	%			n	%	n	%			n	%	n	%		
Other distractions	No	64	94,1	53	93,0	X^2	0,067	69	95,8	48	90,6	X^2	1,414	102	93,6	15	93,8	X^2	0,001
	Yes	4	5,9	4	7,0	*p-value*	,796[a]	3	4,2	5	9,4	*p-value*	,234[a]	7	6,4	1	6,3	*p-value*	,979[a]
Distractions in general	No	1	33,3	1	33,3	X^2	0,000	1	33,3	1	33,3	X^2	0,000	1	20,0	1	100,0	X^2	2,400
	Yes	2	66,7	2	66,7	*p-value*	1,000[a,c]	2	66,7	2	66,7	*p-value*	1,000[a,c]	4	80,0	0	0,0	*p-value*	,121[a,c]
Visual contrast	No	62	91,2	46	80,7	X^2	2,895	62	86,1	46	86,8	X^2	0,012	96	88,1	12	75,0	X^2	2,029
	Yes	6	8,8	11	19,3	*p-value*	0,089	10	13,9	7	13,2	*p-value*	0,913	13	11,9	4	25,0	*p-value*	,154[a]
Sight distances/signs	No	56	83,6	33	60,0	X^2	8,513	57	80,3	32	62,7	X^2	4,626	83	77,6	6	40,0	X^2	9,411
	Yes	11	16,4	22	40,0	*p-value*	,004[*]	14	19,7	19	37,3	*p-value*	,031[*]	24	22,4	9	60,0	*p-value*	,002[a,*]
Crossing angle	No	60	88,2	43	75,4	X^2	3,501	64	88,9	39	73,6	X^2	4,930	93	85,3	10	62,5	X^2	5,010
	Yes	8	11,8	14	24,6	*p-value*	0,061	8	11,1	14	26,4	*p-value*	,026[*]	16	14,7	6	37,5	*p-value*	,025[a,*]
Other conspicuity	No	60	88,2	52	91,2	X^2	0,298	65	90,3	47	88,7	X^2	0,084	98	89,9	14	87,5	X^2	0,087
	Yes	8	11,8	5	8,8	*p-value*	0,585	7	9,7	6	11,3	*p-value*	0,772	11	10,1	2	12,5	*p-value*	,768[a]
Conspicuty in general	No	0	0,0	1	33,3	X^2	1,200	0	0,0	1	33,3	X^2	1,200	0	0,0	1	50,0	X^2	2,400
	Yes	3	100,0	2	66,7	*p-value*	,273[a,c]	3	100,0	2	66,7	*p-value*	,273[a,c]	4	100,0	1	50,0	*p-value*	,121[a,c]
Not knowledge of signalling at LC	No	63	94,0	39	70,9	X^2	11,781	63	88,7	39	76,5	X^2	3,256	95	88,8	7	46,7	X^2	17,027
	Yes	4	6,0	16	29,1	*p-value*	,001[*]	8	11,3	12	23,5	*p-value*	0,071	12	11,2	8	53,3	*p-value*	,000[a,*]
Not knowledge of traffic rules at LC	No	63	92,6	43	75,4	X^2	7,124	62	86,1	44	83,0	X^2	0,226	97	89,0	9	56,3	X^2	11,603
	Yes	5	7,4	14	24,6	*p-value*	,008[*]	10	13,9	9	17,0	*p-value*	0,634	12	11,0	7	43,8	*p-value*	,001[a,*]
Lack of understanding of the correct action that is required	No	64	94,1	39	68,4	X^2	14,118	63	87,5	40	75,5	X^2	3,046	94	86,2	9	56,3	X^2	8,652
	Yes	4	5,9	18	31,6	*p-value*	,000[*]	9	12,5	13	24,5	*p-value*	0,081	15	13,8	7	43,8	*p-value*	,003[a,*]
Other not knowledge	No	64	94,1	52	91,2	X^2	0,387	66	91,7	50	94,3	X^2	0,326	103	94,5	13	81,3	X^2	3,663
	Yes	4	5,9	5	8,8	*p-value*	,534[a]	6	8,3	3	5,7	*p-value*	,568[a]	6	5,5	3	18,8	*p-value*	,056[a]
Lack of knowledge in general	No	0	0,0	0	0,0	X^2	…	0	0,0	0	0,0	X^2	…	0	0,0	0	0,0	X^2	…
	Yes	0	0,0	1	100,0	*p-value*	…	0	0,0	1	100,0	*p-value*	…	0	0,0	1	100,0	*p-value*	…
Familiarity with the place	No	61	89,7	47	82,5	X^2	1,387	64	88,9	44	83,0	X^2	0,895	95	87,2	13	81,3	X^2	0,414
	Yes	7	10,3	10	17,5	*p-value*	0,239	8	11,1	9	17,0	*p-value*	0,344	14	12,8	3	18,8	*p-value*	,520[a]
Frequent LC user	No	62	91,2	45	78,9	X^2	3,762	66	91,7	41	77,4	X^2	5,070	96	88,1	11	68,8	X^2	4,226
	Yes	6	8,8	12	21,1	*p-value*	0,052	6	8,3	12	22,6	*p-value*	,024[*]	13	11,9	5	31,3	*p-value*	,040[a,*]
Perception of train speed and distance	No	59	86,8	41	71,9	X^2	4,265	64	88,9	36	67,9	X^2	8,386	91	83,5	9	56,3	X^2	6,469
	Yes	9	13,2	16	28,1	*p-value*	,039[*]	8	11,1	17	32,1	*p-value*	,004[*]	18	16,5	7	43,8	*p-value*	,011[a,*]
Other inacuratte risk perception	No	66	97,1	52	91,2	X^2	1,994	69	95,8	49	92,5	X^2	0,660	103	94,5	15	93,8	X^2	0,015
	Yes	2	2,9	5	8,8	*p-value*	,158[a]	3	4,2	4	7,5	*p-value*	,417[a]	6	5,5	1	6,3	*p-value*	,904[a,c]
Risk in general	No	1	33,3	1	33,3	X^2	0,000	1	33,3	1	33,3	X^2	0,000	1	20,0	1	100,0	X^2	2,400
	Yes	2	66,7	2	66,7	*p-value*	1,000[a,c]	2	66,7	2	66,7	*p-value*	1,000[a,c]	4	80,0	0	0,0	*p-value*	,121[a,c]
Frustration and impatience when delayed by approaching trains	No	57	85,1	45	81,8	X^2	0,234	62	87,3	40	78,4	X^2	1,712	94	87,9	8	53,3	X^2	11,436
	Yes	10	14,9	10	18,2	*p-value*	0,629	9	12,7	11	21,6	*p-value*	0,191	13	12,1	7	46,7	*p-value*	,001[a,*]
Risk-seeking personalities	No	58	85,3	46	80,7	X^2	0,468	64	88,9	40	75,5	X^2	3,932	93	85,3	11	68,8	X^2	2,741
	Yes	10	14,7	11	19,3	*p-value*	0,494	8	11,1	13	24,5	*p-value*	,047[*]	16	14,7	5	31,3	*p-value*	,098[a]
Signal unreliability	No	66	97,1	51	89,5	X^2	2,978	68	94,4	49	92,5	X^2	0,202	104	95,4	13	81,3	X^2	4,672
	Yes	2	2,9	6	10,5	*p-value*	,084[a]	4	5,6	4	7,5	*p-value*	,653[a]	5	4,6	3	18,8	*p-value*	,031[a,*]
Low costs of fines for LC violations	No	65	95,6	49	86,0	X^2	3,578	68	94,4	46	86,8	X^2	2,227	103	94,5	11	68,8	X^2	11,523
	Yes	3	4,4	8	14,0	*p-value*	0,059	4	5,6	7	13,2	*p-value*	,136[a]	6	5,5	5	31,3	*p-value*	,001[a,*]
Suicide	No	66	97,1	53	93,0	X^2	1,128	70	97,2	49	92,5	X^2	1,520	105	96,3	14	87,5	X^2	2,381
	Yes	2	2,9	4	7,0	*p-value*	,288[a]	2	2,8	4	7,5	*p-value*	,218[a]	4	3,7	2	12,5	*p-value*	,123[a,c]

Variables related to human factor		Type of level crossing: Passive level crossing						Active level crossing with automatically controlled protection						Active level crossing with manually controlled protection					
		No		Yes		Statistics		No		Yes		Statistics		No		Yes		Statistics	
		n	%	n	%			n	%	n	%			n	%	n	%		
Other deliberate risk-taking behaviour	No	62	92,5	50	90,9	X^2	0,106	67	94,4	45	88,2	X^2	1,483	101	94,4	11	73,3	X^2	7,754
	Yes	5	7,5	5	9,1	*p-value*	,744[a]	4	5,6	6	11,8	*p-value*	,223[a]	6	5,6	4	26,7	*p-value*	,005[a,*]
Second train	No	0	0,0	0	0,0	X^2	…	0	0,0	0	0,0	X^2	…	0	0,0	0	0,0	X^2	…
	Yes	1	100,0	1	100,0	*p-value*	…	0	0,0	2	100,0	*p-value*	…	1	100,0	1	100,0	*p-value*	…
Weather	No	63	92,6	48	85,7	X^2	1,573	64	88,9	47	90,4	X^2	0,072	102	93,6	9	60,0	X^2	15,841
	Yes	5	7,4	8	14,3	*p-value*	0,210	8	11,1	5	9,6	*p-value*	0,788	7	6,4	6	40,0	*p-value*	,000[a,*]
Setting of LC	No	57	85,1	36	65,5	X^2	6,417	59	83,1	34	66,7	X^2	4,423	86	80,4	7	46,7	X^2	8,249
	Yes	10	14,9	19	34,5	*p-value*	,011*	12	16,9	17	33,3	*p-value*	,035*	21	19,6	8	53,3	*p-value*	,004[a,*]
Infrastructure layout	No	60	89,6	43	78,2	X^2	2,970	61	85,9	42	82,4	X^2	0,286	93	86,9	10	66,7	X^2	4,103
	Yes	7	10,4	12	21,8	*p-value*	0,085	10	14,1	9	17,6	*p-value*	0,592	14	13,1	5	33,3	*p-value*	,043[a,*]
Other information abou the context	No	63	94,0	45	81,8	X^2	4,434	63	88,7	45	88,2	X^2	0,007	97	90,7	11	73,3	X^2	3,885
	Yes	4	6,0	10	18,2	*p-value*	,035*	8	11,3	6	11,8	*p-value*	0,932	10	9,3	4	26,7	*p-value*	,049[a,*]
Police	No	0	0,0	0	0,0	X^2	…	0	0,0	0	0,0	X^2	…	0	0,0	0	0,0	X^2	…
	Yes	1	100,0	1	100,0	*p-value*	…	1	100,0	1	100,0	*p-value*	…	2	100,0	0	0,0	*p-value*	…
Time day	No	0	0,0	0	0,0	X^2	…	0	0,0	0	0,0	X^2	…	0	0,0	0	0,0	X^2	…
	Yes	3	100,0	2	100,0	*p-value*	…	3	100,0	2	100,0	*p-value*	…	4	100,0	1	100,0	*p-value*	…
Crossing time	No	0	0,0	0	0,0	X^2	…	0	0,0	0	0,0	X^2	…	0	0,0	0	0,0	X^2	…
	Yes	1	100,0	0	0,0	*p-value*	…	1	100,0	0	0,0	*p-value*	…	1	100,0	0	0,0	*p-value*	…
Traffic volume	No	0	0,0	0	0,0	X^2	…	0	0,0	0	0,0	X^2	…	0	0,0	0	0,0	X^2	…
	Yes	0	0,0	1	100,0	*p-value*	…	0	0,0	1	100,0	*p-value*	…	0	0,0	1	100,0	*p-value*	…

Note: *The chi-square (X^2) statistic is significant at the 0.05 level.

[a] More than 20% of the boxes in this sub-table have frequencies less than 5. X^2 results may not be valid.

[c] The expected frequencies in this sub-table are less than one. X^2 results may not be valid.

DF=1.

Annex D. Table 4. Variables related to human factor by type of motorized road users

Table 4. Variables related to human factor by type of motorized road users

Variables related to human factor		Motorized road users																													
		Car						Motorbike/moped						Transport professionals						Heavy vehicles						Farm vehicles					
		No		Yes		Statistics		No		Yes		Statistics		No		Yes		Statistics		No		Yes		Statistics		No		Yes		Statistics	
		n	%	n	%			n	%	n	%			n	%	n	%			n	%	n	%			n	%	n	%		
Man	**No**	52	78,8	36	61,0	X^2	4,721	80	70,2	8	72,7	X^2	,031	86	72,9	2	28,6	X^2	6,226	82	73,9	6	42,9	X^2	5,739	86	72,3	2	33,3	X^2	4,155
	Yes	14	21,2	23	39,0	***p-value***	,030[*]	34	29,8	3	27,3	***p-value***	,859[b]	32	27,1	5	71,4	***p-value***	,013[*,b]	29	26,1	8	57,1	***p-value***	,017[*,b]	33	27,7	4	66,7	***p-value***	,042[*,b]
Woman	**No**	57	86,4	55	93,2	X^2	1,572	103	90,4	9	81,8	X^2	,784	108	91,5	4	57,1	X^2	8,383	102	91,9	10	71,4	X^2	5,587	107	89,9	5	83,3	X^2	0,266
	Yes	9	13,6	4	6,8	***p-value***	0,21	11	9,6	2	18,2	***p-value***	,376[b]	10	8,5	3	42,9	***p-value***	,004[*,b,c]	9	8,1	4	28,6	***p-value***	,018[*,b]	12	10,1	1	16,7	***p-value***	,606[b,c]
Children	**No**	53	80,3	45	76,3	X^2	0,299	90	78,9	8	72,7	X^2	,229	96	81,4	2	28,6	X^2	10,872	91	82,0	7	50,0	X^2	7,509	95	79,8	3	50,0	X^2	3,002
	Yes	13	19,7	14	23,7	***p-value***	0,5845	24	21,1	3	27,3	***p-value***	,632[b]	22	18,6	5	71,4	***p-value***	,001[*,b]	20	18,0	7	50,0	***p-value***	,006[*,b]	24	20,2	3	50,0	***p-value***	,083[b]
Young	**No**	51	77,3	40	67,8	X^2	1,413	84	73,7	7	63,6	X^2	,511	88	74,6	3	42,9	X^2	3,357	83	74,8	8	57,1	X^2	1,952	87	73,1	4	66,7	X^2	0,120
	Yes	15	22,7	19	32,2	***p-value***	0,2346	30	26,3	4	36,4	***p-value***	,474[b]	30	25,4	4	57,1	***p-value***	,067[b]	28	25,2	6	42,9	***p-value***	,162[b]	32	26,9	2	33,3	***p-value***	,729[b]
Adults	**No**	51	77,3	46	78,0	X^2	0,009	90	78,9	7	63,6	X^2	1,353	94	79,7	3	42,9	X^2	5,149	88	79,3	9	64,3	X^2	1,608	93	78,2	4	66,7	X^2	0,433
	Yes	15	22,7	13	22,0	***p-value***	0,926	24	21,1	4	36,4	***p-value***	,245[b]	24	20,3	4	57,1	***p-value***	,023[*,b]	23	20,7	5	35,7	***p-value***	,205[b]	26	21,8	2	33,3	***p-value***	,510[b]
Seniors	**No**	60	90,9	54	91,5	X^2	0,015	106	93,0	8	72,7	X^2	5,128	109	92,4	5	71,4	X^2	3,612	102	91,9	12	85,7	X^2	0,591	110	92,4	4	66,7	X^2	4,727
	Yes	6	9,1	5	8,5	***p-value***	0,9034	8	7,0	3	27,3	***p-value***	,024[*,b,c]	9	7,6	2	28,6	***p-value***	,057[b,c]	9	8,1	2	14,3	***p-value***	,442[b]	9	7,6	2	33,3	***p-value***	,030[*,b,c]
Age non specified	**No**	62	93,9	57	96,6	X^2	0,486	109	95,6	10	90,9	X^2	,486	114	96,6	5	71,4	X^2	9,170	107	96,4	12	85,7	X^2	3,104	114	95,8	5	83,3	X^2	1,942
	Yes	4	6,1	2	3,4	***p-value***	,486[b]	5	4,4	1	9,1	***p-value***	,486[b,c]	4	3,4	2	28,6	***p-value***	,002[*,b,c]	4	3,6	2	14,3	***p-value***	,078[b,c]	5	4,2	1	16,7	***p-value***	,163[b,c]
Vision loss	**No**	63	95,5	57	96,6	X^2	0,108	110	96,5	10	90,9	X^2	,814	115	97,5	5	71,4	X^2	11,659	108	97,3	12	85,7	X^2	4,344	115	96,6	5	83,3	X^2	2,633
	Yes	3	4,5	2	3,4	***p-value***	,742[b]	4	3,5	1	9,1	***p-value***	,367[b,c]	3	2,5	2	28,6	***p-value***	,001[*,b,c]	3	2,7	2	14,3	***p-value***	,037[*,b,c]	4	3,4	1	16,7	***p-value***	,105[b,c]
Hearing loss	**No**	62	93,9	55	93,2	X^2	0,027	107	93,9	10	90,9	X^2	,146	112	94,9	5	71,4	X^2	6,085	106	95,5	11	78,6	X^2	5,944	112	94,1	5	83,3	X^2	1,109
	Yes	4	6,1	4	6,8	***p-value***	,870[b]	7	6,1	1	9,1	***p-value***	,703[b,c]	6	5,1	2	28,6	***p-value***	,014[*,b,c]	5	4,5	3	21,4	***p-value***	,015[*,b,c]	7	5,9	1	16,7	***p-value***	,292[b,c]
Other physical disability	**No**	64	97,0	57	96,6	X^2	0,013	112	98,2	9	81,8	X^2	8,740	116	98,3	5	71,4	X^2	15,410	109	98,2	12	85,7	X^2	6,255	116	97,5	5	83,3	X^2	3,690
	Yes	2	3,0	2	3,4	***p-value***	,909[b]	2	1,8	2	18,2	***p-value***	,003[*,b,c]	2	1,7	2	28,6	***p-value***	,000[*,b,c]	2	1,8	2	14,3	***p-value***	,012[*,b,c]	3	2,5	1	16,7	***p-value***	,055[b,c]
Intellectual disability	**No**	62	93,9	54	91,5	X^2	0,272	107	93,9	9	81,8	X^2	2,177	113	95,8	3	42,9	X^2	27,682	108	97,3	8	57,1	X^2	30,000	114	95,8	2	33,3	X^2	33,357
	Yes	4	6,1	5	8,5	***p-value***	,602[b]	7	6,1	2	18,2	***p-value***	,140[b,c]	5	4,2	4	57,1	***p-value***	,000[*,b,c]	3	2,7	6	42,9	***p-value***	,000[*,b]	5	4,2	4	66,7	***p-value***	,000[*,b,c]
Consumption Alcohol	**No**	63	95,5	54	91,5	X^2	0,803	108	94,7	9	81,8	X^2	2,795	114	96,6	3	42,9	X^2	31,873	109	98,2	8	57,1	X^2	34,980	115	96,6	2	33,3	X^2	38,213
	Yes	3	4,5	5	8,5	***p-value***	,370[b]	6	5,3	2	18,2	***p-value***	,095[b,c]	4	3,4	4	57,1	***p-value***	,000[*,b,c]	2	1,8	6	42,9	***p-value***	,000[*,b,c]	4	3,4	4	66,7	***p-value***	,000[*,b,c]
Consumption Drugs	**No**	65	98,5	57	96,6	X^2	0,467	113	99,1	9	81,8	X^2	12,825	117	99,2	5	71,4	X^2	21,683	110	99,1	12	85,7	X^2	9,508	118	99,2	4	66,7	X^2	25,746
	Yes	1	1,5	2	3,4	***p-value***	,494[b]	1	0,9	2	18,2	***p-value***	,000[*,b,c]	1	0,8	2	28,6	***p-value***	,000[*,b,c]	1	0,9	2	14,3	***p-value***	,002[*,b,c]	1	0,8	2	33,3	***p-value***	,000[*,b,c]
Consumption Medications	**No**	61	92,4	59	100,0	X^2	4,656	109	95,6	11	100,0	X^2	,503	113	95,8	7	100,0	X^2	0,309	107	96,4	13	92,9	X^2	0,406	114	95,8	6	100,0	X^2	0,263
	Yes	5	7,6	0	0,0	***p-value***	,031[*,b]	5	4,4	0	0,0	***p-value***	,478[b,c]	5	4,2	0	0,0	***p-value***	,578[b,c]	4	3,6	1	7,1	***p-value***	,524[b,c]	5	4,2	0	0,0	***p-value***	,608[b,c]
Other consumption	**No**	60	95,2	57	98,3	X^2	0,872	107	97,3	10	90,9	X^2	1,267	111	96,5	6	100,0	X^2	0,216	104	96,3	13	100,0	X^2	0,498	111	96,5	6	100,0	X^2	0,216
	Yes	3	4,8	1	1,7	***p-value***	,350[b]	3	2,7	1	9,1	***p-value***	,260[b,c]	4	3,5	0	0,0	***p-value***	,642[b,c]	4	3,7	0	0,0	***p-value***	,480[b,c]	4	3,5	0	0,0	***p-value***	,642[b,c]
Social crossing new	**No**	2	50,0	1	50,0	X^2	0,000	3	60,0	0	0,0	X^2	1,200	2	50,0	1	50,0	X^2	0,000	2	66,7	1	33,3	X^2	0,667	3	50,0	0	0,0	X^2	
	Yes	2	50,0	1	50,0	***p-value***	1,000[b,c]	2	40,0	1	100,0	***p-value***	,273[b,c]	2	50,0	1	50,0	***p-value***	1,000[b,c]	1	33,3	2	66,7	***p-value***	,414[b]	3	50,0	0	0,0	***p-value***	

Motorized road users

Car

Variables related to human factor		No n	No %	Yes n	Yes %	Statistics	
Fatigue	No	62	93,9	53	89,8	X^2	0,715
	Yes	4	6,1	6	10,2	p-value	,398[b]
Sleepiness / drowsiness	No	62	93,9	55	93,2	X^2	0,027
	Yes	4	6,1	4	6,8	p-value	,870[b]
External distractions	No	60	90,9	40	67,8	X^2	10,401
	Yes	6	9,1	19	32,2	p-value	,001[*]
Internal distractions	No	64	97,0	44	74,6	X^2	13,295
	Yes	2	3,0	15	25,4	p-value	,000[*]
Overloaded with other stimuli	No	63	95,5	45	76,3	X^2	9,756
	Yes	3	4,5	14	23,7	p-value	,002[*]
Distracting mental processes	No	62	96,9	53	91,4	X^2	1,699
	Yes	2	3,1	5	8,6	p-value	,192[b]
Other distractions	No	63	95,5	54	91,5	X^2	0,803
	Yes	3	4,5	5	8,5	p-value	,370[b]
Distractions in general	No	2	66,7	0	0,0	X^2	3,000
	Yes	1	33,3	3	100,0	p-value	,083[b,c]
Visual contrast	No	63	95,5	45	76,3	X^2	9,756
	Yes	3	4,5	14	23,7	p-value	,002[*]
Sight distances/signs	No	57	89,1	32	55,2	X^2	17,710
	Yes	7	10,9	26	44,8	p-value	,000[*]
Crossing angle	No	58	87,9	45	76,3	X^2	2,894
	Yes	8	12,1	14	23,7	p-value	0,0889
Other conspicuity	No	59	89,4	53	89,8	X^2	0,006
	Yes	7	10,6	6	10,2	p-value	0,9364
Conspicuty in general	No	1	20,0	0	0,0	X^2	0,240
	Yes	4	80,0	1	100,0	p-value	,624[b,c]
Not knowledge of signalling at LC	No	59	92,2	43	74,1	X^2	7,232
	Yes	5	7,8	15	25,9	p-value	,007[*]
Not knowledge of traffic rules at LC	No	59	89,4	47	79,7	X^2	2,289
	Yes	7	10,6	12	20,3	p-value	0,1303
Lack of understanding of the correct action that is required	No	60	90,9	43	72,9	X^2	6,981
	Yes	6	9,1	16	27,1	p-value	,008[*]

Motorbike/moped

Variables related to human factor		No n	No %	Yes n	Yes %	Statistics	
Fatigue	No	106	93,0	9	81,8	X^2	1,699
	Yes	8	7,0	2	18,2	p-value	,192[b,c]
Sleepiness / drowsiness	No	107	93,9	10	90,9	X^2	,146
	Yes	7	6,1	1	9,1	p-value	,703[b,c]
External distractions	No	91	79,8	9	81,8	X^2	,025
	Yes	23	20,2	2	18,2	p-value	,875[b]
Internal distractions	No	98	86,0	10	90,9	X^2	,209
	Yes	16	14,0	1	9,1	p-value	,648[b]
Overloaded with other stimuli	No	100	87,7	8	72,7	X^2	1,919
	Yes	14	12,3	3	27,3	p-value	,166[b]
Distracting mental processes	No	106	95,5	9	81,8	X^2	3,462
	Yes	5	4,5	2	18,2	p-value	,063[b,c]
Other distractions	No	107	93,9	10	90,9	X^2	,146
	Yes	7	6,1	1	9,1	p-value	,703[b,c]
Distractions in general	No	2	40,0	0	0,0	X^2	,600
	Yes	3	60,0	1	100,0	p-value	,439[b,c]
Visual contrast	No	100	87,7	8	72,7	X^2	1,919
	Yes	14	12,3	3	27,3	p-value	,166[b]
Sight distances/signs	No	85	76,6	4	36,4	X^2	8,202
	Yes	26	23,4	7	63,6	p-value	,004[*,b]
Crossing angle	No	96	84,2	7	63,6	X^2	2,928
	Yes	18	15,8	4	36,4	p-value	,087[b]
Other conspicuity	No	103	90,4	9	81,8	X^2	,784
	Yes	11	9,6	2	18,2	p-value	,376[b]
Conspicuty in general	No	1	20,0	0	0,0	X^2	,240
	Yes	4	80,0	1	100,0	p-value	,624[b,c]
Not knowledge of signalling at LC	No	97	87,4	5	45,5	X^2	12,840
	Yes	14	12,6	6	54,5	p-value	,000[*,b]
Not knowledge of traffic rules at LC	No	102	89,5	4	36,4	X^2	21,953
	Yes	12	10,5	7	63,6	p-value	,000[*,b]
Lack of understanding of the correct action that is required	No	98	86,0	5	45,5	X^2	11,352
	Yes	16	14,0	6	54,5	p-value	,001[*,b]

Transport professionals

Variables related to human factor		No n	No %	Yes n	Yes %	Statistics	
Fatigue	No	113	95,8	2	28,6	X^2	40,534
	Yes	5	4,2	5	71,4	p-value	,000[*,b,c]
Sleepiness / drowsiness	No	114	96,6	3	42,9	X^2	31,873
	Yes	4	3,4	4	57,1	p-value	,000[*,b,c]
External distractions	No	98	83,1	2	28,6	X^2	12,258
	Yes	20	16,9	5	71,4	p-value	,000[*,b]
Internal distractions	No	105	89,0	3	42,9	X^2	11,965
	Yes	13	11,0	4	57,1	p-value	,001[*,b,c]
Overloaded with other stimuli	No	104	88,1	4	57,1	X^2	5,402
	Yes	14	11,9	3	42,9	p-value	,020[*,b,c]
Distracting mental processes	No	111	95,7	4	66,7	X^2	8,885
	Yes	5	4,3	2	33,3	p-value	,003[*,b,c]
Other distractions	No	111	94,1	6	85,7	X^2	0,770
	Yes	7	5,9	1	14,3	p-value	,380[b,c]
Distractions in general	No	2	40,0	0	0,0	X^2	0,600
	Yes	3	60,0	1	100,0	p-value	,439[b,c]
Visual contrast	No	106	89,8	2	28,6	X^2	21,104
	Yes	12	10,2	5	71,4	p-value	,000[*,b,c]
Sight distances/signs	No	88	75,9	1	16,7	X^2	10,131
	Yes	28	24,1	5	83,3	p-value	,001[*,b]
Crossing angle	No	100	84,7	3	42,9	X^2	7,995
	Yes	18	15,3	4	57,1	p-value	,005[*,b]
Other conspicuity	No	107	90,7	5	71,4	X^2	2,628
	Yes	11	9,3	2	28,6	p-value	,105[b,c]
Conspicuty in general	No	1	20,0	0	0,0	X^2	0,240
	Yes	4	80,0	1	100,0	p-value	,624[b,c]
Not knowledge of signalling at LC	No	100	86,2	2	33,3	X^2	11,636
	Yes	16	13,8	4	66,7	p-value	,001[*,b,c]
Not knowledge of traffic rules at LC	No	105	89,0	1	14,3	X^2	28,605
	Yes	13	11,0	6	85,7	p-value	,000[*,b]
Lack of understanding of the correct action that is required	No	101	85,6	2	28,6	X^2	14,815
	Yes	17	14,4	5	71,4	p-value	,000[*,b]

Heavy vehicles

Variables related to human factor		No n	No %	Yes n	Yes %	Statistics	
Fatigue	No	108	97,3	7	50,0	X^2	37,786
	Yes	3	2,7	7	50,0	p-value	,000[*,b]
Sleepiness / drowsiness	No	107	96,4	10	71,4	X^2	12,937
	Yes	4	3,6	4	28,6	p-value	,000[*,b,c]
External distractions	No	95	85,6	5	35,7	X^2	19,325
	Yes	16	14,4	9	64,3	p-value	,000[*,b]
Internal distractions	No	102	91,9	6	42,9	X^2	25,439
	Yes	9	8,1	8	57,1	p-value	,000[*,b]
Overloaded with other stimuli	No	98	88,3	10	71,4	X^2	3,007
	Yes	13	11,7	4	28,6	p-value	,083[b]
Distracting mental processes	No	105	96,3	10	76,9	X^2	8,088
	Yes	4	3,7	3	23,1	p-value	,004[*,b,c]
Other distractions	No	105	94,6	12	85,7	X^2	1,637
	Yes	6	5,4	2	14,3	p-value	,201[b,c]
Distractions in general	No	2	40,0	0	0,0	X^2	0,600
	Yes	3	60,0	1	100,0	p-value	,439[b,c]
Visual contrast	No	101	91,0	7	50,0	X^2	17,777
	Yes	10	9,0	7	50,0	p-value	,000[*,b]
Sight distances/signs	No	84	77,1	5	38,5	X^2	8,771
	Yes	25	22,9	8	61,5	p-value	,003[*,b]
Crossing angle	No	95	85,6	8	57,1	X^2	6,935
	Yes	16	14,4	6	42,9	p-value	,008[*,b]
Other conspicuity	No	102	91,9	10	71,4	X^2	5,587
	Yes	9	8,1	4	28,6	p-value	,018[*,b]
Conspicuty in general	No	1	25,0	0	0,0	X^2	0,600
	Yes	3	75,0	2	100,0	p-value	,439[b,c]
Not knowledge of signalling at LC	No	95	87,2	7	53,8	X^2	9,403
	Yes	14	12,8	6	46,2	p-value	,002[*,b]
Not knowledge of traffic rules at LC	No	99	89,2	7	50,0	X^2	14,813
	Yes	12	10,8	7	50,0	p-value	,000[*,b]
Lack of understanding of the correct action that is required	No	97	87,4	6	42,9	X^2	16,999
	Yes	14	12,6	8	57,1	p-value	,000[*,b]

Farm vehicles

Variables related to human factor		No n	No %	Yes n	Yes %	Statistics	
Fatigue	No	113	95,0	2	33,3	X^2	29,473
	Yes	6	5,0	4	66,7	p-value	,000[*,b,c]
Sleepiness / drowsiness	No	113	95,0	4	66,7	X^2	7,632
	Yes	6	5,0	2	33,3	p-value	,006[*,b,c]
External distractions	No	97	81,5	3	50,0	X^2	3,545
	Yes	22	18,5	3	50,0	p-value	,060[b]
Internal distractions	No	105	88,2	3	50,0	X^2	7,107
	Yes	14	11,8	3	50,0	p-value	,008[*,b,c]
Overloaded with other stimuli	No	104	87,4	4	66,7	X^2	2,089
	Yes	15	12,6	2	33,3	p-value	,148[b,c]
Distracting mental processes	No	112	96,6	3	50,0	X^2	22,858
	Yes	4	3,4	3	50,0	p-value	,000[*,b,c]
Other distractions	No	111	93,3	6	100,0	X^2	0,431
	Yes	8	6,7	0	0,0	p-value	,512[b,c]
Distractions in general	No	2	33,3	0	0,0	X^2	
	Yes	4	66,7	0	0,0	p-value	
Visual contrast	No	106	89,1	2	33,3	X^2	15,104
	Yes	13	10,9	4	66,7	p-value	,000[*,b,c]
Sight distances/signs	No	87	75,0	2	33,3	X^2	5,019
	Yes	29	25,0	4	66,7	p-value	,025[*,b]
Crossing angle	No	101	84,9	2	33,3	X^2	10,463
	Yes	18	15,1	4	66,7	p-value	,001[*,b]
Other conspicuity	No	107	89,9	5	83,3	X^2	0,266
	Yes	12	10,1	1	16,7	p-value	,606[b,c]
Conspicuty in general	No	1	16,7	0	0,0	X^2	
	Yes	5	83,3	0	0,0	p-value	
Not knowledge of signalling at LC	No	98	84,5	4	66,7	X^2	1,321
	Yes	18	15,5	2	33,3	p-value	,250[b,c]
Not knowledge of traffic rules at LC	No	103	86,6	3	50,0	X^2	5,922
	Yes	16	13,4	3	50,0	p-value	,015[*,b,c]
Lack of understanding of the correct action that is required	No	101	84,9	2	33,3	X^2	10,463
	Yes	18	15,1	4	66,7	p-value	,001[*,b]

Motorized road users

Car

Variables related to human factor		No n	No %	Yes n	Yes %	Statistics	
Other not knowledge	No	62	93,9	54	91,5	X^2	0,272
	Yes	4	6,1	5	8,5	*p-value*	,602[b]
Lack of knowledge in general	No	0	0,0	0	0,0	X^2	
	Yes	1	100,0	0	0,0	*p-value*	
Familiarity with the place	No	60	90,9	48	81,4	X^2	2,420
	Yes	6	9,1	11	18,6	*p-value*	0,1198
Frequent LC user	No	61	92,4	46	78,0	X^2	5,283
	Yes	5	7,6	13	22,0	*p-value*	,022[*]
Perception of train speed and distance	No	60	90,9	40	67,8	X^2	10,401
	Yes	6	9,1	19	32,2	*p-value*	,001[*]
Other inacuratte risk perception	No	66	100,0	52	88,1	X^2	8,295
	Yes	0	0,0	7	11,9	*p-value*	,004[*,b]
Risk in general	No	2	50,0	0	0,0	X^2	1,500
	Yes	2	50,0	2	100,0	*p-value*	,221[b,c]
Frustration and impatience when delayed by approaching trains	No	57	89,1	45	77,6	X^2	2,924
	Yes	7	10,9	13	22,4	*p-value*	0,0873
Risk-seeking personalities	No	55	83,3	49	83,1	X^2	0,002
	Yes	11	16,7	10	16,9	*p-value*	0,9664
Signal unreliability	No	63	95,5	54	91,5	X^2	0,803
	Yes	3	4,5	5	8,5	*p-value*	,370[b]
Low costs of fines for LC violations	No	62	93,9	52	88,1	X^2	1,307
	Yes	4	6,1	7	11,9	*p-value*	0,2529
Suicide	No	62	93,9	57	96,6	X^2	0,486
	Yes	4	6,1	2	3,4	*p-value*	,486[b]
Other deliberate risk-taking behaviour	No	60	93,8	52	89,7	X^2	0,678
	Yes	4	6,3	6	10,3	*p-value*	,410[b]
Second train	No	0	0,0	0	0,0	X^2	
	Yes	0	0,0	2	100,0	*p-value*	
Weather	No	60	92,3	51	86,4	X^2	1,134
	Yes	5	7,7	8	13,6	*p-value*	0,2868
Setting of LC	No	57	89,1	36	62,1	X^2	12,235
	Yes	7	10,9	22	37,9	*p-value*	,000[*]

Motorbike/moped

Variables related to human factor		No n	No %	Yes n	Yes %	Statistics	
Other not knowledge	No	107	93,9	9	81,8	X^2	2,177
	Yes	7	6,1	2	18,2	*p-value*	,140[b,c]
Lack of knowledge in general	No	0	0,0	0	0,0	X^2	
	Yes	1	100,0	0	0,0	*p-value*	
Familiarity with the place	No	100	87,7	8	72,7	X^2	1,919
	Yes	14	12,3	3	27,3	*p-value*	,166[b]
Frequent LC user	No	100	87,7	7	63,6	X^2	4,720
	Yes	14	12,3	4	36,4	*p-value*	,030[*,b]
Perception of train speed and distance	No	94	82,5	6	54,5	X^2	4,884
	Yes	20	17,5	5	45,5	*p-value*	,027[*,b]
Other inacuratte risk perception	No	109	95,6	9	81,8	X^2	3,612
	Yes	5	4,4	2	18,2	*p-value*	,057[b,c]
Risk in general	No	2	33,3	0	0,0	X^2	
	Yes	4	66,7	0	0,0	*p-value*	
Frustration and impatience when delayed by approaching trains	No	96	86,5	6	54,5	X^2	7,450
	Yes	15	13,5	5	45,5	*p-value*	,006[*,b]
Risk-seeking personalities	No	95	83,3	9	81,8	X^2	,016
	Yes	19	16,7	2	18,2	*p-value*	,898[b]
Signal unreliability	No	108	94,7	9	81,8	X^2	2,795
	Yes	6	5,3	2	18,2	*p-value*	,095[b,c]
Low costs of fines for LC violations	No	105	92,1	9	81,8	X^2	1,323
	Yes	9	7,9	2	18,2	*p-value*	,250[b,c]
Suicide	No	109	95,6	10	90,9	X^2	,486
	Yes	5	4,4	1	9,1	*p-value*	,486[b,c]
Other deliberate risk-taking behaviour	No	102	91,9	10	90,9	X^2	,013
	Yes	9	8,1	1	9,1	*p-value*	,910[b,c]
Second train	No	0	0,0	0	0,0	X^2	
	Yes	1	100,0	1	100,0	*p-value*	
Weather	No	104	92,0	7	63,6	X^2	8,615
	Yes	9	8,0	4	36,4	*p-value*	,003[*,b]
Setting of LC	No	85	76,6	8	72,7	X^2	,082
	Yes	26	23,4	3	27,3	*p-value*	,775[b]

Transport professionals

Variables related to human factor		No n	No %	Yes n	Yes %	Statistics	
Other not knowledge	No	111	94,1	5	71,4	X^2	5,069
	Yes	7	5,9	2	28,6	*p-value*	,024[*,b,c]
Lack of knowledge in general	No	0	0,0	0	0,0	X^2	
	Yes	1	100,0	0	0,0	*p-value*	
Familiarity with the place	No	105	89,0	3	42,9	X^2	11,965
	Yes	13	11,0	4	57,1	*p-value*	,001[*,b,c]
Frequent LC user	No	105	89,0	2	28,6	X^2	19,565
	Yes	13	11,0	5	71,4	*p-value*	,000[*,b]
Perception of train speed and distance	No	98	83,1	2	28,6	X^2	12,258
	Yes	20	16,9	5	71,4	*p-value*	,000[*,b]
Other inacuratte risk perception	No	112	94,9	6	85,7	X^2	1,058
	Yes	6	5,1	1	14,3	*p-value*	,304[b,c]
Risk in general	No	2	40,0	0	0,0	X^2	0,600
	Yes	3	60,0	1	100,0	*p-value*	,439[b,c]
Frustration and impatience when delayed by approaching trains	No	99	85,3	3	50,0	X^2	5,200
	Yes	17	14,7	3	50,0	*p-value*	,023[*,b,c]
Risk-seeking personalities	No	101	85,6	3	42,9	X^2	8,634
	Yes	17	14,4	4	57,1	*p-value*	,003[*,b]
Signal unreliability	No	113	95,8	4	57,1	X^2	16,453
	Yes	5	4,2	3	42,9	*p-value*	,000[*,b,c]
Low costs of fines for LC violations	No	111	94,1	3	42,9	X^2	21,593
	Yes	7	5,9	4	57,1	*p-value*	,000[*,b,c]
Suicide	No	114	96,6	5	71,4	X^2	9,170
	Yes	4	3,4	2	28,6	*p-value*	,002[*,b,c]
Other deliberate risk-taking behaviour	No	106	91,4	6	100,0	X^2	0,563
	Yes	10	8,6	0	0,0	*p-value*	,453[b,c]
Second train	No	0	0,0	0	0,0	X^2	
	Yes	1	100,0	1	100,0	*p-value*	
Weather	No	108	92,3	3	42,9	X^2	17,210
	Yes	9	7,7	4	57,1	*p-value*	,000[*,b,c]
Setting of LC	No	90	77,6	3	50,0	X^2	2,396
	Yes	26	22,4	3	50,0	*p-value*	,122[b]

Heavy vehicles

Variables related to human factor		No n	No %	Yes n	Yes %	Statistics	
Other not knowledge	No	104	93,7	12	85,7	X^2	1,185
	Yes	7	6,3	2	14,3	*p-value*	,276[b]
Lack of knowledge in general	No	0	0,0	0	0,0	X^2	
	Yes	0	0,0	1	100,0	*p-value*	
Familiarity with the place	No	100	90,1	8	57,1	X^2	11,485
	Yes	11	9,9	6	42,9	*p-value*	,001[*,b]
Frequent LC user	No	100	90,1	7	50,0	X^2	16,210
	Yes	11	9,9	7	50,0	*p-value*	,000[*,b]
Perception of train speed and distance	No	95	85,6	5	35,7	X^2	19,325
	Yes	16	14,4	9	64,3	*p-value*	,000[*,b]
Other inacuratte risk perception	No	106	95,5	12	85,7	X^2	2,250
	Yes	5	4,5	2	14,3	*p-value*	,134[b,c]
Risk in general	No	2	40,0	0	0,0	X^2	0,600
	Yes	3	60,0	1	100,0	*p-value*	,439[b,c]
Frustration and impatience when delayed by approaching trains	No	94	86,2	8	61,5	X^2	5,170
	Yes	15	13,8	5	38,5	*p-value*	,023[*,b]
Risk-seeking personalities	No	96	86,5	8	57,1	X^2	7,658
	Yes	15	13,5	6	42,9	*p-value*	,006[*,b]
Signal unreliability	No	106	95,5	11	78,6	X^2	5,944
	Yes	5	4,5	3	21,4	*p-value*	,015[*,b,c]
Low costs of fines for LC violations	No	105	94,6	9	64,3	X^2	14,230
	Yes	6	5,4	5	35,7	*p-value*	,000[*,b]
Suicide	No	107	96,4	12	85,7	X^2	3,104
	Yes	4	3,6	2	14,3	*p-value*	,078[b,c]
Other deliberate risk-taking behaviour	No	102	93,6	10	76,9	X^2	4,282
	Yes	7	6,4	3	23,1	*p-value*	,039[*,b]
Second train	No	0	0,0	0	0,0	X^2	
	Yes	1	100,0	1	100,0	*p-value*	
Weather	No	102	92,7	9	64,3	X^2	10,705
	Yes	8	7,3	5	35,7	*p-value*	,001[*,b]
Setting of LC	No	86	78,9	7	53,8	X^2	4,023
	Yes	23	21,1	6	46,2	*p-value*	,045[*,b]

Farm vehicles

Variables related to human factor		No n	No %	Yes n	Yes %	Statistics	
Other not knowledge	No	110	92,4	6	100,0	X^2	0,489
	Yes	9	7,6	0	0,0	*p-value*	,484[b,c]
Lack of knowledge in general	No	0	0,0	0	0,0	X^2	
	Yes	1	100,0	0	0,0	*p-value*	
Familiarity with the place	No	104	87,4	4	66,7	X^2	2,089
	Yes	15	12,6	2	33,3	*p-value*	,148[b,c]
Frequent LC user	No	103	86,6	4	66,7	X^2	1,833
	Yes	16	13,4	2	33,3	*p-value*	,176[b,c]
Perception of train speed and distance	No	97	81,5	3	50,0	X^2	3,545
	Yes	22	18,5	3	50,0	*p-value*	,060[b]
Other inacuratte risk perception	No	114	95,8	4	66,7	X^2	9,170
	Yes	5	4,2	2	33,3	*p-value*	,002[*,b,c]
Risk in general	No	2	33,3	0	0,0	X^2	
	Yes	4	66,7	0	0,0	*p-value*	
Frustration and impatience when delayed by approaching trains	No	99	85,3	3	50,0	X^2	5,200
	Yes	17	14,7	3	50,0	*p-value*	,023[*,b,c]
Risk-seeking personalities	No	100	84,0	4	66,7	X^2	1,233
	Yes	19	16,0	2	33,3	*p-value*	,267[b]
Signal unreliability	No	113	95,0	4	66,7	X^2	7,632
	Yes	6	5,0	2	33,3	*p-value*	,006[*,b,c]
Low costs of fines for LC violations	No	110	92,4	4	66,7	X^2	4,727
	Yes	9	7,6	2	33,3	*p-value*	,030[*,b,c]
Suicide	No	114	95,8	5	83,3	X^2	1,942
	Yes	5	4,2	1	16,7	*p-value*	,163[b,c]
Other deliberate risk-taking behaviour	No	107	92,2	5	83,3	X^2	0,602
	Yes	9	7,8	1	16,7	*p-value*	,438[b,c]
Second train	No	0	0,0	0	0,0	X^2	
	Yes	2	100,0	0	0,0	*p-value*	
Weather	No	108	91,5	3	50,0	X^2	10,491
	Yes	10	8,5	3	50,0	*p-value*	,001[*,b,c]
Setting of LC	No	90	77,6	3	50,0	X^2	2,396
	Yes	26	22,4	3	50,0	*p-value*	,122[b]

Motorized road users

Variables related to human factor		Car No n	Car No %	Car Yes n	Car Yes %	Car Statistics		Motorbike/moped No n	Motorbike/moped No %	Motorbike/moped Yes n	Motorbike/moped Yes %	Motorbike/moped Statistics	
Infrastructure layout	No	59	92,2	44	75,9	X^2	6,167	98	88,3	5	45,5	X^2	13,966
	Yes	5	7,8	14	24,1	*p-value*	,013[*]	13	11,7	6	54,5	*p-value*	,000[*,b]
Other information abou the context	No	59	92,2	49	84,5	X^2	1,778	98	88,3	10	90,9	X^2	,068
	Yes	5	7,8	9	15,5	*p-value*	0,1824	13	11,7	1	9,1	*p-value*	,795[b]
Police	No	0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2	
	Yes	1	100,0	1	100,0	*p-value*		2	100,0	0	0,0	*p-value*	
Time day	No	0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2	
	Yes	2	100,0	3	100,0	*p-value*		5	100,0	0	0,0	*p-value*	
Crossing time	No	0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2	
	Yes	0	0,0	1	100,0	*p-value*		1	100,0	0	0,0	*p-value*	
Traffic volume	No	0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2	
	Yes	0	0,0	1	100,0	*p-value*		1	100,0	0	0,0	*p-value*	

Variables related to human factor		Transport professionals No n	Transport professionals No %	Transport professionals Yes n	Transport professionals Yes %	Transport professionals Statistics	
Infrastructure layout	No	101	87,1	2	33,3	X^2	12,529
	Yes	15	12,9	4	66,7	*p-value*	,000[*,b,c]
Other information abou the context	No	102	87,9	6	100,0	X^2	0,818
	Yes	14	12,1	0	0,0	*p-value*	,366[b,c]
Police	No	0	0,0	0	0,0	X^2	
	Yes	2	100,0	0	0,0	*p-value*	
Time day	No	0	0,0	0	0,0	X^2	
	Yes	5	100,0	0	0,0	*p-value*	
Crossing time	No	0	0,0	0	0,0	X^2	
	Yes	1	100,0	0	0,0	*p-value*	
Traffic volume	No	0	0,0	0	0,0	X^2	
	Yes	1	100,0	0	0,0	*p-value*	

Variables related to human factor		Heavy vehicles No n	Heavy vehicles No %	Heavy vehicles Yes n	Heavy vehicles Yes %	Heavy vehicles Statistics		Farm vehicles No n	Farm vehicles No %	Farm vehicles Yes n	Farm vehicles Yes %	Farm vehicles Statistics	
Infrastructure layout	No	95	87,2	8	61,5	X^2	5,797	100	86,2	3	50,0	X^2	5,688
	Yes	14	12,8	5	38,5	*p-value*	,016[*,b]	16	13,8	3	50,0	*p-value*	,017[*,b,c]
Other information abou the context	No	98	89,9	10	76,9	X^2	1,928	103	88,8	5	83,3	X^2	0,167
	Yes	11	10,1	3	23,1	*p-value*	,165[b]	13	11,2	1	16,7	*p-value*	,682[b,c]
Police	No	0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2	
	Yes	2	100,0	0	0,0	*p-value*		2	100,0	0	0,0	*p-value*	
Time day	No	0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2	
	Yes	4	100,0	1	100,0	*p-value*		4	100,0	1	100,0	*p-value*	
Crossing time	No	0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2	
	Yes	1	100,0	0	0,0	*p-value*		1	100,0	0	0,0	*p-value*	
Traffic volume	No	0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2	
	Yes	1	100,0	0	0,0	*p-value*		1	100,0	0	0,0	*p-value*	

Note: *The chi-square (X^2) statistic is significant at the 0.05 level.

[a] More than 20% of the boxes in this sub-table have frequencies less than 5. X^2 results may not be valid.

[c] The expected frequencies in this sub-table are less than one. X^2 results may not be valid.

DF=1.

Annex E. Tables 5 & 6. Variables related to human factor by type of vulnerable road users

Table 5. Variables related to human factor by type of vulnerable road users I

Variables related to human factor		Vulnerable road users I																							
		Cyclist						Pedestrian						Ramblers						Horse riders					
		No		Yes		Statistics		No		Yes		Statistics		No		Yes		Statistics		No		Yes		Statistics	
		n	%	n	%			n	%	n	%			n	%	n	%			n	%	n	%		
Man	No	79	72,5	9	56,3	X^2	1,763	66	77,6	22	55,0	X^2	6,695	85	70,2	3	75,0	X^2	,042	86	71,7	2	40,0	X^2	2,310
	Yes	30	27,5	7	43,8	p	,184[a]	19	22,4	18	45,0	p	,010[*]	36	29,8	1	25,0	p	,838[a]	34	28,3	3	60,0	p	,129[a]
Woman	No	103	94,5	9	56,3	X^2	21,900	84	98,8	28	70,0	X^2	24,251	109	90,1	3	75,0	X^2	,945	110	91,7	2	40,0	X^2	13,751
	Yes	6	5,5	7	43,8	p	,000[a,*]	1	1,2	12	30,0	p	,000[a,*]	12	9,9	1	25,0	p	,331[a,c]	10	8,3	3	60,0	p	,000[a,*,c]
Children	No	89	81,7	9	56,3	X^2	5,316	76	89,4	22	55,0	X^2	19,020	95	78,5	3	75,0	X^2	,028	96	80,0	2	40,0	X^2	4,535
	Yes	20	18,3	7	43,8	p	,021[a,*]	9	10,6	18	45,0	p	,000[*]	26	21,5	1	25,0	p	,867[a,c]	24	20,0	3	60,0	p	,033[a,*]
Young	No	83	76,1	8	50,0	X^2	4,817	69	81,2	22	55,0	X^2	9,412	88	72,7	3	75,0	X^2	,010	89	74,2	2	40,0	X^2	2,830
	Yes	26	23,9	8	50,0	p	,028[a,*]	16	18,8	18	45,0	p	,002[*]	33	27,3	1	25,0	p	,920[a]	31	25,8	3	60,0	p	,093[a]
Adults	No	89	81,7	8	50,0	X^2	8,041	77	90,6	20	50,0	X^2	25,779	94	77,7	3	75,0	X^2	,016	95	79,2	2	40,0	X^2	4,236
	Yes	20	18,3	8	50,0	p	,005[a,*]	8	9,4	20	50,0	p	,000[*]	27	22,3	1	25,0	p	,899[a,c]	25	20,8	3	60,0	p	,040[a,*]
Seniors	No	100	91,7	14	87,5	X^2	0,313	82	96,5	32	80,0	X^2	9,194	112	92,6	2	50,0	X^2	8,740	111	92,5	3	60,0	X^2	6,317
	Yes	9	8,3	2	12,5	p	,576[a]	3	3,5	8	20,0	p	,002[a,*]	9	7,4	2	50,0	p	,003[a,*,c]	9	7,5	2	40,0	p	,012[a,*,c]
Age non specified	No	106	97,2	13	81,3	X^2	7,814	84	98,8	35	87,5	X^2	7,632	116	95,9	3	75,0	X^2	3,690	115	95,8	4	80,0	X^2	2,633
	Yes	3	2,8	3	18,8	p	,005[a,*,c]	1	1,2	5	12,5	p	,006[a,*]	5	4,1	1	25,0	p	,055[a,c]	5	4,2	1	20,0	p	,105[a,c]
Vision loss	No	107	98,2	13	81,3	X^2	10,396	85	100,0	35	87,5	X^2	11,068	117	96,7	3	75,0	X^2	4,746	116	96,7	4	80,0	X^2	3,472
	Yes	2	1,8	3	18,8	p	,001[a,*,c]	0	0,0	5	12,5	p	,001[a,*]	4	3,3	1	25,0	p	,029[a,*,c]	4	3,3	1	20,0	p	,062[a,c]
Hearing loss	No	105	96,3	12	75,0	X^2	10,597	84	98,8	33	82,5	X^2	12,099	114	94,2	3	75,0	X^2	2,386	113	94,2	4	80,0	X^2	1,608
	Yes	4	3,7	4	25,0	p	,001[a,*]	1	1,2	7	17,5	p	,001[a,*]	7	5,8	1	25,0	p	,122[a,c]	7	5,8	1	20,0	p	,205[a,c]
Other physical disability	No	107	98,2	14	87,5	X^2	5,123	85	100,0	36	90,0	X^2	8,781	118	97,5	3	75,0	X^2	6,340	117	97,5	4	80,0	X^2	4,746
	Yes	2	1,8	2	12,5	p	,024[a,*,c]	0	0,0	4	10,0	p	,003[a,*]	3	2,5	1	25,0	p	,012[a,*,c]	3	2,5	1	20,0	p	,029[a,*,c]
Intellectual disability	No	104	95,4	12	75,0	X^2	8,701	82	96,5	34	85,0	X^2	5,356	113	93,4	3	75,0	X^2	1,959	112	93,3	4	80,0	X^2	1,277
	Yes	5	4,6	4	25,0	p	,003[a,*]	3	3,5	6	15,0	p	,021[a,*]	8	6,6	1	25,0	p	,162[a,c]	8	6,7	1	20,0	p	,258[a,c]
Consumption Alcohol	No	105	96,3	12	75,0	X^2	10,597	82	96,5	35	87,5	X^2	3,654	114	94,2	3	75,0	X^2	2,386	113	94,2	4	80,0	X^2	1,608
	Yes	4	3,7	4	25,0	p	,001[a,*]	3	3,5	5	12,5	p	,056[a]	7	5,8	1	25,0	p	,122[a,c]	7	5,8	1	20,0	p	,205[a,c]
Consumption Drugs	No	107	98,2	15	93,8	X^2	1,161	84	98,8	38	95,0	X^2	1,698	119	98,3	3	75,0	X^2	9,010	118	98,3	4	80,0	X^2	6,888
	Yes	2	1,8	1	6,3	p	,281[a,c]	1	1,2	2	5,0	p	,193[a,c]	2	1,7	1	25,0	p	,003[a,*,c]	2	1,7	1	20,0	p	,009[a,*,c]
Consumption Medications	No	106	97,2	14	87,5	X^2	3,452	85	100,0	35	87,5	X^2	11,068	116	95,9	4	100,0	X^2	,172	115	95,8	5	100,0	X^2	0,217
	Yes	3	2,8	2	12,5	p	,063[a,c]	0	0,0	5	12,5	p	,001[a,*]	5	4,1	0	0,0	p	,678[a,c]	5	4,2	0	0,0	p	,641[a,c]
Other consumption	No	104	97,2	13	92,9	X^2	0,729	82	96,5	35	97,2	X^2	0,045	113	96,6	4	100,0	X^2	,141	112	96,6	5	100,0	X^2	0,178
	Yes	3	2,8	1	7,1	p	,393[a,c]	3	3,5	1	2,8	p	,833[a]	4	3,4	0	0,0	p	,707[a,c]	4	3,4	0	0,0	p	,673[a,c]
Social crossing	No	1	50,0	2	50,0	X^2	0,000	0	0,0	3	50,0	X^2		3	50,0	0	0,0	X^2		3	60,0	0	0,0	X^2	1,200
	Yes	1	50,0	2	50,0	p	1,000[a,c]	0	0,0	3	50,0	p		3	50,0	0	0,0	p		2	40,0	1	100,0	p	,273[a,c]
Fatigue	No	104	95,4	11	68,8	X^2	13,476	81	95,3	34	85,0	X^2	3,916	112	92,6	3	75,0	X^2	1,623	111	92,5	4	80,0	X^2	1,019
	Yes	5	4,6	5	31,3	p	,000[a,*]	4	4,7	6	15,0	p	,048[a,*]	9	7,4	1	25,0	p	,203[a,c]	9	7,5	1	20,0	p	,313[a,c]
Sleepiness / drowsiness	No	105	96,3	12	75,0	X^2	10,597	83	97,6	34	85,0	X^2	7,263	114	94,2	3	75,0	X^2	2,386	113	94,2	4	80,0	X^2	1,608
	Yes	4	3,7	4	25,0	p	,001[a,*]	2	2,4	6	15,0	p	,007[a,*]	7	5,8	1	25,0	p	,122[a,c]	7	5,8	1	20,0	p	,205[a,c]
External distractions	No	90	82,6	10	62,5	X^2	3,512	67	78,8	33	82,5	X^2	0,230	97	80,2	3	75,0	X^2	,065	98	81,7	2	40,0	X^2	5,208
	Yes	19	17,4	6	37,5	p	,061[a]	18	21,2	7	17,5	p	0,632	24	19,8	1	25,0	p	,799[a,c]	22	18,3	3	60,0	p	,022[a,*,c]
Internal distractions	No	97	89,0	11	68,8	X^2	4,865	75	88,2	33	82,5	X^2	0,761	105	86,8	3	75,0	X^2	,457	104	86,7	4	80,0	X^2	0,182
	Yes	12	11,0	5	31,3	p	,027[a,*]	10	11,8	7	17,5	p	0,383	16	13,2	1	25,0	p	,499[a,c]	16	13,3	1	20,0	p	,670[a,c]
Overloaded with other stimuli	No	96	88,1	12	75,0	X^2	2,029	75	88,2	33	82,5	X^2	0,761	105	86,8	3	75,0	X^2	,457	105	87,5	3	60,0	X^2	3,089
	Yes	13	11,9	4	25,0	p	,154[a]	10	11,8	7	17,5	p	0,383	16	13,2	1	25,0	p	,499[a,c]	15	12,5	2	40,0	p	,079[a,c]
Distracting mental processes	No	102	94,4	13	92,9	X^2	0,058	80	94,1	35	94,6	X^2	0,011	112	94,9	3	75,0	X^2	2,837	111	94,9	4	80,0	X^2	1,961
	Yes	6	5,6	1	7,1	p	,810[a,c]	5	5,9	2	5,4	p	,917[a]	6	5,1	1	25,0	p	,092[a,c]	6	5,1	1	20,0	p	,161[a,c]
Other distractions	No	105	96,3	12	75,0	X^2	10,597	82	96,5	35	87,5	X^2	3,654	113	93,4	4	100,0	X^2	,283	112	93,3	5	100,0	X^2	0,356
	Yes	4	3,7	4	25,0	p	,001[a,*]	3	3,5	5	12,5	p	,056[a]	8	6,6	0	0,0	p	,595[a,c]	8	6,7	0	0,0	p	,551[a,c]

Variables related to human factor		Vulnerable road users I																							
		Cyclist						Pedestrian						Ramblers						Horse riders					
		No		Yes		Statistics		No		Yes		Statistics		No		Yes		Statistics		No		Yes		Statistics	
		n	%	n	%			n	%	n	%			n	%	n	%			n	%	n	%		
Distractions in general	No	1	50,0	1	25,0	X^2	0,375	0	0,0	2	40,0	X^2	0,600	2	33,3	0	0,0	X^2		2	33,3	0	0,0	X^2	
	Yes	1	50,0	3	75,0	p	,540[a,c]	1	100,0	3	60,0	p	,439[a,c]	4	66,7	0	0,0	p		4	66,7	0	0,0	p	
Visual contrast	No	97	89,0	11	68,8	X^2	4,865	78	91,8	30	75,0	X^2	6,506	105	86,8	3	75,0	X^2	,457	106	88,3	2	40,0	X^2	9,543
	Yes	12	11,0	5	31,3	p	,027[a,*]	7	8,2	10	25,0	p	,011[*]	16	13,2	1	25,0	p	,499[a,c]	14	11,7	3	60,0	p	,002[a,*,c]
Sight distances/signs	No	84	77,8	5	35,7	X^2	11,113	67	78,8	22	59,5	X^2	4,899	87	73,7	2	50,0	X^2	1,104	88	75,2	1	20,0	X^2	7,408
	Yes	24	22,2	9	64,3	p	,001[a,*]	18	21,2	15	40,5	p	,027[*]	31	26,3	2	50,0	p	,293[a]	29	24,8	4	80,0	p	,006[a,*]
Crossing angle	No	93	85,3	10	62,5	X^2	5,010	75	88,2	28	70,0	X^2	6,237	101	83,5	2	50,0	X^2	2,991	101	84,2	2	40,0	X^2	6,456
	Yes	16	14,7	6	37,5	p	,025[a,*]	10	11,8	12	30,0	p	,013[*]	20	16,5	2	50,0	p	,084[a,c]	19	15,8	3	60,0	p	,011[a,*,c]
Other conspicuity	No	102	93,6	10	62,5	X^2	14,461	84	98,8	28	70,0	X^2	24,251	108	89,3	4	100,0	X^2	,480	109	90,8	3	60,0	X^2	4,897
	Yes	7	6,4	6	37,5	p	,000[a,*]	1	1,2	12	30,0	p	,000[a,*]	13	10,7	0	0,0	p	,489[a,c]	11	9,2	2	40,0	p	,027[a,*,c]
Conspicuty in general	No	0	0,0	1	25,0	X^2	0,600	0	0,0	1	16,7	X^2		1	16,7	0	0,0	X^2		1	16,7	0	0,0	X^2	
	Yes	2	100,0	3	75,0	p	,439[a,c]	0	0,0	5	83,3	p		5	83,3	0	0,0	p		5	83,3	0	0,0	p	
Not knowledge of signalling at LC	No	96	88,9	6	42,9	X^2	19,160	78	91,8	24	64,9	X^2	13,610	99	83,9	3	75,0	X^2	,224	99	84,6	3	60,0	X^2	2,120
	Yes	12	11,1	8	57,1	p	,000[a,*]	7	8,2	13	35,1	p	,000[*]	19	16,1	1	25,0	p	,636[a,c]	18	15,4	2	40,0	p	,145[a,c]
Not knowledge of traffic rules at LC	No	99	90,8	7	43,8	X^2	23,988	82	96,5	24	60,0	X^2	28,068	103	85,1	3	75,0	X^2	,308	103	85,8	3	60,0	X^2	2,485
	Yes	10	9,2	9	56,3	p	,000[a,*]	3	3,5	16	40,0	p	,000[*]	18	14,9	1	25,0	p	,579[a,c]	17	14,2	2	40,0	p	,115[a,c]
Lack of understanding of the correct action that is required	No	95	87,2	8	50,0	X^2	13,282	76	89,4	27	67,5	X^2	9,005	100	82,6	3	75,0	X^2	,156	100	83,3	3	60,0	X^2	1,802
	Yes	14	12,8	8	50,0	p	,000[a,*]	9	10,6	13	32,5	p	,003[*]	21	17,4	1	25,0	p	,693[a,c]	20	16,7	2	40,0	p	,179[a,c]
Other not knowledge	No	102	93,6	14	87,5	X^2	0,771	83	97,6	33	82,5	X^2	9,340	112	92,6	4	100,0	X^2	,321	112	93,3	4	80,0	X^2	1,277
	Yes	7	6,4	2	12,5	p	,380[a]	2	2,4	7	17,5	p	,002[a,*]	9	7,4	0	0,0	p	,571[a,c]	8	6,7	1	20,0	p	,258[a,c]
Lack of knowledge in general	No	0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2	
	Yes	0	0,0	1	0,0	p		0	0,0	1	0,0	p		1	100,0	0	0,0	p		1	0,0	0	0,0	p	
Familiarity with the place	No	99	90,8	9	56,3	X^2	14,195	80	94,1	28	70,0	X^2	13,464	105	86,8	3	75,0	X^2	,457	105	87,5	3	60,0	X^2	3,089
	Yes	10	9,2	7	43,8	p	,000[a,*]	5	5,9	12	30,0	p	,000[*]	16	13,2	1	25,0	p	,499[a,c]	15	12,5	2	40,0	p	,079[a,c]
Frequent LC user	No	96	88,1	11	68,8	X^2	4,226	79	92,9	28	70,0	X^2	11,614	104	86,0	3	75,0	X^2	,377	104	86,7	3	60,0	X^2	2,769
	Yes	13	11,9	5	31,3	p	,040[a,*]	6	7,1	12	30,0	p	,001[*]	17	14,0	1	25,0	p	,539[a,c]	16	13,3	2	40,0	p	,096[a,c]
Perception of train speed and distance	No	93	85,3	7	43,8	X^2	15,070	75	88,2	25	62,5	X^2	11,259	98	81,0	2	50,0	X^2	2,324	98	81,7	2	40,0	X^2	5,208
	Yes	16	14,7	9	56,3	p	,000[a,*]	10	11,8	15	37,5	p	,001[*]	23	19,0	2	50,0	p	,127[a,c]	22	18,3	3	60,0	p	,022[a,*,c]
Other inacuratte risk perception	No	103	94,5	15	93,8	X^2	0,015	79	92,9	39	97,5	X^2	1,069	114	94,2	4	100,0	X^2	,245	113	94,2	5	100,0	X^2	0,309
	Yes	6	5,5	1	6,3	p	,904[a,c]	6	7,1	1	2,5	p	,301[a]	7	5,8	0	0,0	p	,621[a,c]	7	5,8	0	0,0	p	,578[a,c]
Risk in general	No	1	25,0	1	50,0	X^2	0,375	0	0,0	2	0,0	X^2	1,500	2	33,3	0	0,0	X^2		2	33,3	0	0,0	X^2	
	Yes	3	75,0	1	50,0	p	,540[a,c]	2	100,0	2	0,0	p	,221[a,c]	4	66,7	0	0,0	p		4	66,7	0	0,0	p	
Frustration and impatience when delayed by approaching	No	94	87,0	8	57,1	X^2	8,081	77	90,6	25	67,6	X^2	9,967	99	83,9	3	75,0	X^2	,224	98	83,8	4	80,0	X^2	0,049
	Yes	14	13,0	6	42,9	p	,004[a,*]	8	9,4	12	32,4	p	,002[*]	19	16,1	1	25,0	p	,636[a,c]	19	16,2	1	20,0	p	,824[a,c]
Risk-seeking personalities	No	96	88,1	8	50,0	X^2	14,469	80	94,1	24	60,0	X^2	22,651	101	83,5	3	75,0	X^2	,199	101	84,2	3	60,0	X^2	2,006
	Yes	13	11,9	8	50,0	p	,000[a,*]	5	5,9	16	40,0	p	,000[*]	20	16,5	1	25,0	p	,656[a,c]	19	15,8	2	40,0	p	,157[a,c]
Signal unreliability	No	106	97,2	11	68,8	X^2	18,915	83	97,6	34	85,0	X^2	7,263	114	94,2	3	75,0	X^2	2,386	113	94,2	4	80,0	X^2	1,608
	Yes	3	2,8	5	31,3	p	,000[a,*]	2	2,4	6	15,0	p	,007[a,*]	7	5,8	1	25,0	p	,122[a,c]	7	5,8	1	20,0	p	,205[a,c]
Low costs of fines for LC violations	No	105	96,3	9	56,3	X^2	27,927	83	97,6	31	77,5	X^2	13,757	111	91,7	3	75,0	X^2	1,351	110	91,7	4	80,0	X^2	0,814
	Yes	4	3,7	7	43,8	p	,000[a,*]	2	2,4	9	22,5	p	,000[a,*]	10	8,3	1	25,0	p	,245[a,c]	10	8,3	1	20,0	p	,367[a,c]
Suicide	No	105	96,3	14	87,5	X^2	2,381	83	97,6	36	90,0	X^2	3,481	115	95,0	4	100,0	X^2	,208	114	95,0	5	100,0	X^2	0,263
	Yes	4	3,7	2	12,5	p	,123[a,c]	2	2,4	4	10,0	p	,062[a]	6	5,0	0	0,0	p	,648[a,c]	6	5,0	0	0,0	p	,608[a,c]
Other deliberate risk-taking behaviour	No	99	91,7	13	92,9	X^2	0,023	81	95,3	31	83,8	X^2	4,539	108	91,5	4	100,0	X^2	,369	107	91,5	5	100,0	X^2	0,466
	Yes	9	8,3	1	7,1	p	,879[a]	4	4,7	6	16,2	p	,033[a,*]	10	8,5	0	0,0	p	,543[a,c]	10	8,5	0	0,0	p	,495[a,c]
Second train	No	0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2	
	Yes	1	0,0	1	100,0	p		1	100,0	1	100,0	p		2	100,0	0	0,0	p		1	100,0	1	100,0	p	

Variables related to human factor		Vulnerable road users I																							
		Cyclist						Pedestrian						Ramblers						Horse riders					
		No		Yes		Statistics		No		Yes		Statistics		No		Yes		Statistics		No		Yes		Statistics	
		n	%	n	%			n	%	n	%			n	%	n	%			n	%	n	%		
Weather	No	100	91,7	11	73,3	X^2	4,762	79	92,9	32	82,1	X^2	3,378	108	90,0	3	75,0	X^2	,928	108	90,8	3	60,0	X^2	4,837
	Yes	9	8,3	4	26,7	p	,029[a,*]	6	7,1	7	17,9	p	,066[a]	12	10,0	1	25,0	p	,335[a,c]	11	9,2	2	40,0	p	,028[a,*,c]
Setting of LC	No	85	78,7	8	57,1	X^2	3,180	69	81,2	24	64,9	X^2	3,785	90	76,3	3	75,0	X^2	,003	91	77,8	2	40,0	X^2	3,777
	Yes	23	21,3	6	42,9	p	,075[a]	16	18,8	13	35,1	p	0,052	28	23,7	1	25,0	p	,953[a,c]	26	22,2	3	60,0	p	,052[a]
Infrastructure layout	No	94	87,0	9	64,3	X^2	4,879	78	91,8	25	67,6	X^2	11,479	101	85,6	2	50,0	X^2	3,728	101	86,3	2	40,0	X^2	7,826
	Yes	14	13,0	5	35,7	p	,027[a,*]	7	8,2	12	32,4	p	,001[*]	17	14,4	2	50,0	p	,054[a,c]	16	13,7	3	60,0	p	,005[a,*,c]
Other information abou the context	No	96	88,9	12	85,7	X^2	0,123	78	91,8	30	81,1	X^2	2,896	105	89,0	3	75,0	X^2	,745	103	88,0	5	100,0	X^2	0,676
	Yes	12	11,1	2	14,3	p	,726[a]	7	8,2	7	18,9	p	,089[a]	13	11,0	1	25,0	p	,388[a,c]	14	12,0	0	0,0	p	,411[a,c]
Police	No	0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2	
	Yes	2	100,0	0	0,0	p		1	100,0	1	0,0	p		2	100,0	0	0,0	p		2	100,0	0	0,0	p	
Time day	No	0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2	
	Yes	4	100,0	1	100,0	p		2	100,0	3	0,0	p		5	100,0	0	0,0	p		5	100,0	0	0,0	p	
Crossing time	No	0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2	
	Yes	1	0,0	0	0,0	p		0	0,0	1	0,0	p		1	100,0	0	0,0	p		1	100,0	0	0,0	p	
Traffic volume	No	0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2	
	Yes	1	0,0	0	0,0	p		1	100,0	0	0,0	p		1	100,0	0	0,0	p		1	100,0	0	0,0	p	

Note: *The chi-square (X^2) statistic is significant at the 0.05 level.

[a] More than 20% of the boxes in this sub-table have frequencies less than 5. X^2 results may not be valid.

[c] The expected frequencies in this sub-table are less than one. X^2 results may not be valid.

DF=1.

Table 6. Variables related to human factor by type of vulnerable road users II

Variables related to human factor		Vulnerable road users II																							
		Persons with reduced mobility						Users with vision loss and blindness						Users with hearing loss and deafness						Users with different cultural and language background					
		No		Yes		Statistics		No		Yes		Statistics		No		Yes		Statistics		No		Yes		Statistics	
		n	%	n	%			n	%	n	%			n	%	n	%			n	%	n	%		
Man	**No**	84	72,4	4	44,4	X^2	3,135	86	70,5	2	66,7	X^2	,021	86	70,5	2	66,7	X^2	,021	87	71,3	1	33,3	X^2	2,027
	Yes	32	27,6	5	55,6	p	,077[a]	36	29,5	1	33,3	p	,886[a,c]	36	29,5	1	33,3	p	,886[a,c]	35	28,7	2	66,7	p	,155[a,c]
Woman	**No**	108	93,1	4	44,4	X^2	21,221	111	91,0	1	33,3	X^2	10,443	111	91,0	1	33,3	X^2	10,443	112	91,8	0	0,0	X^2	26,482
	Yes	8	6,9	5	55,6	p	,000[a,*,c]	11	9,0	2	66,7	p	,001[a,*,c]	11	9,0	2	66,7	p	,001[a,*,c]	10	8,2	3	100,0	p	,000[a,*,c]
Children	**No**	94	81,0	4	44,4	X^2	6,603	97	79,5	1	33,3	X^2	3,686	97	79,5	1	33,3	X^2	3,686	98	80,3	0	0,0	X^2	11,157
	Yes	22	19,0	5	55,6	p	,010[a,*]	25	20,5	2	66,7	p	,055[a,c]	25	20,5	2	66,7	p	,055[a,c]	24	19,7	3	100,0	p	,001[a,*,c]
Young	**No**	86	74,1	5	55,6	X^2	1,456	89	73,0	2	66,7	X^2	,058	89	73,0	2	66,7	X^2	,058	90	73,8	1	33,3	X^2	2,418
	Yes	30	25,9	4	44,4	p	,227[a]	33	27,0	1	33,3	p	,809[a,c]	33	27,0	1	33,3	p	,809[a,c]	32	26,2	2	66,7	p	,120[a,c]
Adults	**No**	94	81,0	3	33,3	X^2	10,933	97	79,5	0	0,0	X^2	10,648	97	79,5	0	0,0	X^2	10,648	97	79,5	0	0,0	X^2	10,648
	Yes	22	19,0	6	66,7	p	,001[a,*]	25	20,5	3	100,0	p	,001[a,*,c]	25	20,5	3	100,0	p	,001[a,*,c]	25	20,5	3	100,0	p	,001[a,*,c]
Seniors	**No**	108	93,1	6	66,7	X^2	7,273	112	91,8	2	66,7	X^2	2,305	112	91,8	2	66,7	X^2	2,305	112	91,8	2	66,7	X^2	2,305
	Yes	8	6,9	3	33,3	p	,007[a,*,c]	10	8,2	1	33,3	p	,129[a,c]	10	8,2	1	33,3	p	,129[a,c]	10	8,2	1	33,3	p	,129[a,c]
Age non specified	**No**	114	98,3	5	55,6	X^2	33,357	119	97,5	0	0,0	X^2	60,963	119	97,5	0	0,0	X^2	60,963	118	96,7	1	33,3	X^2	25,746
	Yes	2	1,7	4	44,4	p	,000[a,*,c]	3	2,5	3	100,0	p	,000[a,*,c]	3	2,5	3	100,0	p	,000[a,*,c]	4	3,3	2	66,7	p	,000[a,*,c]
Vision loss	**No**	115	99,1	5	55,6	X^2	41,312	120	98,4	0	0,0	X^2	73,770	120	98,4	0	0,0	X^2	73,770	119	97,5	1	33,3	X^2	31,435
	Yes	1	0,9	4	44,4	p	,000[a,*,c]	2	1,6	3	100,0	p	,000[a,*,c]	2	1,6	3	100,0	p	,000[a,*,c]	3	2,5	2	66,7	p	,000[a,*,c]
Hearing loss	**No**	113	97,4	4	44,4	X^2	39,119	117	95,9	0	0,0	X^2	44,954	117	95,9	0	0,0	X^2	44,954	116	95,1	1	33,3	X^2	18,637
	Yes	3	2,6	5	55,6	p	,000[a,*,c]	5	4,1	3	100,0	p	,000[a,*,c]	5	4,1	3	100,0	p	,000[a,*,c]	6	4,9	2	66,7	p	,000[a,*,c]
Other physical disability	**No**	114	98,3	7	77,8	X^2	11,329	120	98,4	1	33,3	X^2	39,970	120	98,4	1	33,3	X^2	39,970	120	98,4	1	33,3	X^2	39,970
	Yes	2	1,7	2	22,2	p	,001[a,*,c]	2	1,6	2	66,7	p	,000[a,*,c]	2	1,6	2	66,7	p	,000[a,*,c]	2	1,6	2	66,7	p	,000[a,*,c]
Intellectual disability	**No**	109	94,0	7	77,8	X^2	3,276	114	93,4	2	66,7	X^2	3,142	114	93,4	2	66,7	X^2	3,142	114	93,4	2	66,7	X^2	3,142
	Yes	7	6,0	2	22,2	p	,070[a,c]	8	6,6	1	33,3	p	,076[a,c]	8	6,6	1	33,3	p	,076[a,c]	8	6,6	1	33,3	p	,076[a,c]
Consumption Alcohol	**No**	110	94,8	7	77,8	X^2	4,053	115	94,3	2	66,7	X^2	3,722	115	94,3	2	66,7	X^2	3,722	115	94,3	2	66,7	X^2	3,722
	Yes	6	5,2	2	22,2	p	,044[a,*,c]	7	5,7	1	33,3	p	,054[a,c]	7	5,7	1	33,3	p	,054[a,c]	7	5,7	1	33,3	p	,054[a,c]
Consumption Drugs	**No**	114	98,3	8	88,9	X^2	3,142	120	98,4	2	66,7	X^2	12,556	120	98,4	2	66,7	X^2	12,556	120	98,4	2	66,7	X^2	12,556
	Yes	2	1,7	1	11,1	p	,076[a,c]	2	1,6	1	33,3	p	,000[a,*,c]	2	1,6	1	33,3	p	,000[a,*,c]	2	1,6	1	33,3	p	,000[a,*,c]
Consumption Medications	**No**	112	96,6	8	88,9	X^2	1,277	117	95,9	3	100,0	X^2	,128	117	95,9	3	100,0	X^2	,128	117	95,9	3	100,0	X^2	0,128
	Yes	4	3,4	1	11,1	p	,258[a,c]	5	4,1	0	0,0	p	,720[a,c]	5	4,1	0	0,0	p	,720[a,c]	5	4,1	0	0,0	p	,720[a,c]
Other consumption	**No**	110	96,5	7	100,0	X^2	0,254	115	96,6	2	100,0	X^2	,070	115	96,6	2	100,0	X^2	,070	115	96,6	2	100,0	X^2	0,070
	Yes	4	3,5	0	0,0	p	,614[a,c]	4	3,4	0	0,0	p	,792[a,c]	4	3,4	0	0,0	p	,792[a,c]	4	3,4	0	0,0	p	,792[a,c]
Social crossing	**No**	1	25,0	2	0,0	X^2	3,000	2	40,0	1	0,0	X^2	1,200	2	40,0	1	0,0	X^2	1,200	2	50,0	1	0,0	X^2	0,000
	Yes	3	75,0	0	0,0	p	,083[a,c]	3	60,0	0	0,0	p	,273[a,c]	3	60,0	0	0,0	p	,273[a,c]	2	50,0	1	0,0	p	1,000[a,c]
Fatigue	**No**	108	93,1	7	77,8	X^2	2,665	114	93,4	1	33,3	X^2	14,374	114	93,4	1	33,3	X^2	14,374	114	93,4	1	33,3	X^2	14,374
	Yes	8	6,9	2	22,2	p	,103[a,c]	8	6,6	2	66,7	p	,000[a,*,c]	8	6,6	2	66,7	p	,000[a,*,c]	8	6,6	2	66,7	p	,000[a,*,c]
Sleepiness / drowsiness	**No**	111	95,7	6	66,7	X^2	11,744	116	95,1	1	33,3	X^2	18,637	116	95,1	1	33,3	X^2	18,637	116	95,1	1	33,3	X^2	18,637
	Yes	5	4,3	3	33,3	p	,001[a,*,c]	6	4,9	2	66,7	p	,000[a,*,c]	6	4,9	2	66,7	p	,000[a,*,c]	6	4,9	2	66,7	p	,000[a,*,c]
External distractions	**No**	94	81,0	6	66,7	X^2	1,078	98	80,3	2	66,7	X^2	,342	98	80,3	2	66,7	X^2	,342	99	81,1	1	33,3	X^2	4,184
	Yes	22	19,0	3	33,3	p	,299[a]	24	19,7	1	33,3	p	,559[a,c]	24	19,7	1	33,3	p	,559[a,c]	23	18,9	2	66,7	p	,041[a,*,c]
Internal distractions	**No**	102	87,9	6	66,7	X^2	3,214	106	86,9	2	66,7	X^2	1,019	106	86,9	2	66,7	X^2	1,019	106	86,9	2	66,7	X^2	1,019
	Yes	14	12,1	3	33,3	p	,073[a]	16	13,1	1	33,3	p	,313[a,c]	16	13,1	1	33,3	p	,313[a,c]	16	13,1	1	33,3	p	,313[a,c]
Overloaded with other stimuli	**No**	101	87,1	7	77,8	X^2	0,614	106	86,9	2	66,7	X^2	1,019	106	86,9	2	66,7	X^2	1,019	107	87,7	1	33,3	X^2	7,367
	Yes	15	12,9	2	22,2	p	,433[a]	16	13,1	1	33,3	p	,313[a,c]	16	13,1	1	33,3	p	,313[a,c]	15	12,3	2	66,7	p	,007[a,*,c]
Distracting mental processes	**No**	109	94,8	6	85,7	X^2	1,003	114	95,0	1	50,0	X^2	7,365	114	95,0	1	50,0	X^2	7,365	114	95,0	1	50,0	X^2	7,365
	Yes	6	5,2	1	14,3	p	,317[a,c]	6	5,0	1	50,0	p	,007[a,*,c]	6	5,0	1	50,0	p	,007[a,*,c]	6	5,0	1	50,0	p	,007[a,*,c]
Other distractions	**No**	109	94,0	8	88,9	X^2	0,359	114	93,4	3	100,0	X^2	,210	114	93,4	3	100,0	X^2	,210	114	93,4	3	100,0	X^2	0,210
	Yes	7	6,0	1	11,1	p	,549[a,c]	8	6,6	0	0,0	p	,647[a,c]	8	6,6	0	0,0	p	,647[a,c]	8	6,6	0	0,0	p	,647[a,c]

Variables related to human factor		Vulnerable road users II																							
		Persons with reduced mobility						Users with vision loss and blindness						Users with hearing loss and deafness						Users with different cultural and language background					
		No		Yes		Statistics		No		Yes		Statistics		No		Yes		Statistics		No		Yes		Statistics	
		n	%	n	%			n	%	n	%			n	%	n	%			n	%	n	%		
Distractions in general	No	0	0,0	2	0,0	X^2	3,000	1	20,0	1	0,0	X^2	2,400	1	20,0	1	0,0	X^2	2,400	1	20,0	1	0,0	X^2	2,400
	Yes	3	100,0	1	0,0	p	,083[a,c]	4	80,0	0	0,0	p	,121[a,c]	4	80,0	0	0,0	p	,121[a,c]	4	80,0	0	0,0	p	,121[a,c]
Visual contrast	No	103	88,8	5	55,6	X^2	7,852	107	87,7	1	33,3	X^2	7,367	107	87,7	1	33,3	X^2	7,367	108	88,5	0	0,0	X^2	19,527
	Yes	13	11,2	4	44,4	p	,005[a,*]	15	12,3	2	66,7	p	,007[a,*,c]	15	12,3	2	66,7	p	,007[a,*,c]	14	11,5	3	100,0	p	,000[a,*,c]
Sight distances/signs	No	87	75,7	2	28,6	X^2	7,412	88	73,3	1	50,0	X^2	,543	88	73,3	1	50,0	X^2	,543	89	74,2	0	0,0	X^2	5,484
	Yes	28	24,3	5	71,4	p	,006[a,*]	32	26,7	1	50,0	p	,461[a,c]	32	26,7	1	50,0	p	,461[a,c]	31	25,8	2	100,0	p	,019[a,*,c]
Crossing angle	No	100	86,2	3	33,3	X^2	16,100	102	83,6	1	33,3	X^2	5,103	102	83,6	1	33,3	X^2	5,103	102	83,6	1	33,3	X^2	5,103
	Yes	16	13,8	6	66,7	p	,000[a,*]	20	16,4	2	66,7	p	,024[a,*,c]	20	16,4	2	66,7	p	,024[a,*,c]	20	16,4	2	66,7	p	,024[a,*,c]
Other conspicuity	No	106	91,4	6	66,7	X^2	5,474	110	90,2	2	66,7	X^2	1,735	110	90,2	2	66,7	X^2	1,735	111	91,0	1	33,3	X^2	10,443
	Yes	10	8,6	3	33,3	p	,019[a,*,c]	12	9,8	1	33,3	p	,188[a,c]	12	9,8	1	33,3	p	,188[a,c]	11	9,0	2	66,7	p	,001[a,*,c]
Conspicuity in general	No	0	0,0	1	0,0	X^2	2,400	1	20,0	0	0,0	X^2	,240	1	20,0	0	0,0	X^2	,240	1	20,0	0	0,0	X^2	0,240
	Yes	4	100,0	1	0,0	p	,121[a,c]	4	80,0	1	0,0	p	,624[a,c]	4	80,0	1	0,0	p	,624[a,c]	4	80,0	1	0,0	p	,624[a,c]
Not knowledge of signalling at LC	No	98	85,2	4	57,1	X^2	3,794	101	84,2	1	50,0	X^2	1,676	101	84,2	1	50,0	X^2	1,676	102	85,0	0	0,0	X^2	10,370
	Yes	17	14,8	3	42,9	p	,051[a]	19	15,8	1	50,0	p	,196[a,c]	19	15,8	1	50,0	p	,196[a,c]	18	15,0	2	100,0	p	,001[a,*,c]
Not knowledge of traffic rules at LC	No	101	87,1	5	55,6	X^2	6,435	105	86,1	1	33,3	X^2	6,317	105	86,1	1	33,3	X^2	6,317	106	86,9	0	0,0	X^2	17,148
	Yes	15	12,9	4	44,4	p	,011[a,*]	17	13,9	2	66,7	p	,012[a,*,c]	17	13,9	2	66,7	p	,012[a,*,c]	16	13,1	3	100,0	p	,000[a,*,c]
Lack of understanding of the correct action that is required	No	97	83,6	6	66,7	X^2	1,655	101	82,8	2	66,7	X^2	,525	101	82,8	2	66,7	X^2	,525	102	83,6	1	33,3	X^2	5,103
	Yes	19	16,4	3	33,3	p	,198[a]	21	17,2	1	33,3	p	,469[a,c]	21	17,2	1	33,3	p	,469[a,c]	20	16,4	2	66,7	p	,024[a,*,c]
Other not knowledge	No	108	93,1	8	88,9	X^2	0,222	114	93,4	2	66,7	X^2	3,142	114	93,4	2	66,7	X^2	3,142	115	94,3	1	33,3	X^2	16,268
	Yes	8	6,9	1	11,1	p	,637[a,c]	8	6,6	1	33,3	p	,076[a,c]	8	6,6	1	33,3	p	,076[a,c]	7	5,7	2	66,7	p	,000[a,*,c]
Lack of knowledge in general	No	0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2	
	Yes	1	100,0	0	0,0	p		1	100,0	0	0,0	p		1	100,0	0	0,0	p		1	100,0	0	0,0	p	
Familiarity with the place	No	103	88,8	5	55,6	X^2	7,852	107	87,7	1	33,3	X^2	7,367	107	87,7	1	33,3	X^2	7,367	107	87,7	1	33,3	X^2	7,367
	Yes	13	11,2	4	44,4	p	,005[a,*]	15	12,3	2	66,7	p	,007[a,*,c]	15	12,3	2	66,7	p	,007[a,*,c]	15	12,3	2	66,7	p	,007[a,*,c]
Frequent LC user	No	100	86,2	7	77,8	X^2	0,481	105	86,1	2	66,7	X^2	,894	105	86,1	2	66,7	X^2	,894	106	86,9	1	33,3	X^2	6,812
	Yes	16	13,8	2	22,2	p	,488[a]	17	13,9	1	33,3	p	,344[a,c]	17	13,9	1	33,3	p	,344[a,c]	16	13,1	2	66,7	p	,009[a,*,c]
Perception of train speed and distance	No	95	81,9	5	55,6	X^2	3,622	98	80,3	2	66,7	X^2	,342	98	80,3	2	66,7	X^2	,342	99	81,1	1	33,3	X^2	4,184
	Yes	21	18,1	4	44,4	p	,057[a]	24	19,7	1	33,3	p	,559[a,c]	24	19,7	1	33,3	p	,559[a,c]	23	18,9	2	66,7	p	,041[a,*,c]
Other inacuratte risk perception	No	109	94,0	9	100,0	X^2	0,575	115	94,3	3	100,0	X^2	,182	115	94,3	3	100,0	X^2	,182	115	94,3	3	100,0	X^2	0,182
	Yes	7	6,0	0	0,0	p	,448[a,c]	7	5,7	0	0,0	p	,669[a,c]	7	5,7	0	0,0	p	,669[a,c]	7	5,7	0	0,0	p	,669[a,c]
Risk in general	No	0	0,0	2	0,0	X^2	6,000	1	20,0	1	0,0	X^2	2,400	1	20,0	1	0,0	X^2	2,400	1	20,0	1	0,0	X^2	2,400
	Yes	4	100,0	0	0,0	p	,014[a,*,c]	4	80,0	0	0,0	p	,121[a,c]	4	80,0	0	0,0	p	,121[a,c]	4	80,0	0	0,0	p	,121[a,c]
Frustration and impatience when delayed by approaching	No	97	84,3	5	71,4	X^2	0,804	101	84,2	1	50,0	X^2	1,676	101	84,2	1	50,0	X^2	1,676	101	84,2	1	50,0	X^2	1,676
	Yes	18	15,7	2	28,6	p	,370[a]	19	15,8	1	50,0	p	,196[a,c]	19	15,8	1	50,0	p	,196[a,c]	19	15,8	1	50,0	p	,196[a,c]
Risk-seeking personalities	No	100	86,2	4	44,4	X^2	10,421	103	84,4	1	33,3	X^2	5,468	103	84,4	1	33,3	X^2	5,468	103	84,4	1	33,3	X^2	5,468
	Yes	16	13,8	5	55,6	p	,001[a,*]	19	15,6	2	66,7	p	,019[a,*,c]	19	15,6	2	66,7	p	,019[a,*,c]	19	15,6	2	66,7	p	,019[a,*,c]
Signal unreliability	No	112	96,6	5	55,6	X^2	23,433	116	95,1	1	33,3	X^2	18,637	116	95,1	1	33,3	X^2	18,637	116	95,1	1	33,3	X^2	18,637
	Yes	4	3,4	4	44,4	p	,000[a,*,c]	6	4,9	2	66,7	p	,000[a,*,c]	6	4,9	2	66,7	p	,000[a,*,c]	6	4,9	2	66,7	p	,000[a,*,c]
Low costs of fines for LC violations	No	109	94,0	5	55,6	X^2	15,353	113	92,6	1	33,3	X^2	12,825	113	92,6	1	33,3	X^2	12,825	113	92,6	1	33,3	X^2	12,825
	Yes	7	6,0	4	44,4	p	,000[a,*,c]	9	7,4	2	66,7	p	,000[a,*,c]	9	7,4	2	66,7	p	,000[a,*,c]	9	7,4	2	66,7	p	,000[a,*,c]
Suicide	No	112	96,6	7	77,8	X^2	6,442	117	95,9	2	66,7	X^2	5,476	117	95,9	2	66,7	X^2	5,476	117	95,9	2	66,7	X^2	5,476
	Yes	4	3,4	2	22,2	p	,011[a,*,c]	5	4,1	1	33,3	p	,019[a,*,c]	5	4,1	1	33,3	p	,019[a,*,c]	5	4,1	1	33,3	p	,019[a,*,c]
Other deliberate risk-taking behaviour	No	105	91,3	7	100,0	X^2	0,663	110	91,7	2	100,0	X^2	,182	110	91,7	2	100,0	X^2	,182	110	91,7	2	100,0	X^2	0,182
	Yes	10	8,7	0	0,0	p	,415[a,c]	10	8,3	0	0,0	p	,670[a,c]	10	8,3	0	0,0	p	,670[a,c]	10	8,3	0	0,0	p	,670[a,c]
Second train	No	0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2	
	Yes	2	100,0	0	0,0	p		2	100,0	0	0,0	p		2	100,0	0	0,0	p		1	100,0	1	0,0	p	

Variables related to human factor		Vulnerable road users II											
		Persons with reduced mobility						Users with vision loss and blindness					
		No		Yes		Statistics		No		Yes		Statistics	
		n	%	n	%			n	%	n	%		
Weather	No	105	90,5	6	75,0	X^2	1,920	109	90,1	2	66,7	X^2	1,710
	Yes	11	9,5	2	25,0	p	,166[a,c]	12	9,9	1	33,3	p	,191[a,c]
Setting of LC	No	90	78,3	3	42,9	X^2	4,564	92	76,7	1	50,0	X^2	,772
	Yes	25	21,7	4	57,1	p	,033[a,*]	28	23,3	1	50,0	p	,380[a,c]
Infrastructure layout	No	101	87,8	2	28,6	X^2	17,620	103	85,8	0	0,0	X^2	11,023
	Yes	14	12,2	5	71,4	p	,000[a,*]	17	14,2	2	100,0	p	,001[a,*,c]
Other information abou the context	No	102	88,7	6	85,7	X^2	0,058	106	88,3	2	100,0	X^2	,264
	Yes	13	11,3	1	14,3	p	,810[a,c]	14	11,7	0	0,0	p	,608[a,c]
Police	No	0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2	
	Yes	2	100,0	0	0,0	p		2	100,0	0	0,0	p	
Time day	No	0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2	
	Yes	4	100,0	1	100,0	p		5	100,0	0	0,0	p	
Crossing time	No	0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2	
	Yes	1	100,0	0	0,0	p		1	100,0	0	0,0	p	
Traffic volume	No	0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2	
	Yes	1	100,0	0	0,0	p		1	100,0	0	0,0	p	

Variables related to human factor		Vulnerable road users II											
		Users with hearing loss and deafness						Users with different cultural and language background					
		No		Yes		Statistics		No		Yes		Statistics	
		n	%	n	%			n	%	n	%		
Weather	No	109	90,1	2	66,7	X^2	1,710	110	90,9	1	33,3	X^2	10,340
	Yes	12	9,9	1	33,3	p	,191[a,c]	11	9,1	2	66,7	p	,001[a,*,c]
Setting of LC	No	92	76,7	1	50,0	X^2	,772	93	77,5	0	0,0	X^2	6,521
	Yes	28	23,3	1	50,0	p	,380[a,c]	27	22,5	2	100,0	p	,011[a,*,c]
Infrastructure layout	No	103	85,8	0	0,0	X^2	11,023	103	85,8	0	0,0	X^2	11,023
	Yes	17	14,2	2	100,0	p	,001[a,*,c]	17	14,2	2	100,0	p	,001[a,*,c]
Other information abou the context	No	106	88,3	2	100,0	X^2	,264	106	88,3	2	100,0	X^2	0,264
	Yes	14	11,7	0	0,0	p	,608[a,c]	14	11,7	0	0,0	p	,608[a,c]
Police	No	0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2	
	Yes	2	100,0	0	0,0	p		2	100,0	0	0,0	p	
Time day	No	0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2	
	Yes	5	100,0	0	0,0	p		5	100,0	0	0,0	p	
Crossing time	No	0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2	
	Yes	1	100,0	0	0,0	p		1	100,0	0	0,0	p	
Traffic volume	No	0	0,0	0	0,0	X^2		0	0,0	0	0,0	X^2	
	Yes	1	100,0	0	0,0	p		1	100,0	0	0,0	p	

Note: *The chi-square (X^2) statistic is significant at the 0.05 level.

[a] More than 20% of the boxes in this sub-table have frequencies less than 5. X^2 results may not be valid.

[c] The expected frequencies in this sub-table are less than one. X^2 results may not be valid.

DF=1.