

TRUST Traffic Safety Culture | A Systematic Transition towards Shared
Responsibility for Safe and Sustainable Mobility in the EU

D3.1 | Models for Traffic Safety Culture

TRUST

Project identification

Acronym	TRUST
Full title	Traffic Safety Culture – A Systematic Transition towards Shared Responsibility for Safe and Sustainable Mobility in the EU
Project term	01.05.2025 – 30.04.2028

Document identification

Deliverable number	3.1
Deliverable title	Models for Traffic Safety Culture
Work package	3 Development of models, tools and interventions for TSC
Contractual due date	31.07.2026
Submission date	31.07.2026
Dissemination level	Public
Responsible author	Tor-Olav Nævestad TØI Alena Høye, Vibeke Milch, Ingeborg Storesund Hesjevoll TØI Susanne Kaiser, Anita Eichhorn, Eva Aigner-Breuss KfV Uta Meesmann, Mathias De Roeck VIAS
Contributions from	Alexandra Laiou, Dimitris Nikolaou NTUA Henriette Wallén Warner, Sonja Forward, Gunilla Björklund VTI Michael Schachner CFG Hanna Wennberg Lund University
Internal reviewer	Wouter van den Berghe Tilkon Research & Consulting
External reviewer	Nic Ward Safe System Culture

Citation

Nævestad, T.-O., Høye, A. K., Milch, V., Hesjevoll, I. S., Kaiser, S., Meesmann, U., De Roeck, M., Laiou, A., Nikolaou, D., Wallén Warner, H., Forward, S., Björklund, G., Schachner, M., Wennberg, H., Eichhorn, A., & Aigner-Breuss, E. (2026). Models of Traffic Safety Culture Deliverable 3.1 of the EC Horizon Europe project TRUST.

Funding note



This project has received funding from the European Union's Horizon Europe research and innovation programme under the Grant Agreement number 101197992

Disclaimer

The content of this publication is the sole responsibility of the publishers, and it does not necessarily represent the views expressed by the European Commission or its services. While the information in the document is believed to be accurate, the authors or any other participant in the TRUST consortium makes no warranty of any kind regarding this material. Neither the TRUST Consortium nor any of its members, their officers, employees or agents shall be responsible or liable in negligence or otherwise however in respect of any inaccuracy or omission herein. Without derogating from the generality of the foregoing, neither the TRUST Consortium nor any of its members, their officers, employees or agents

shall be liable for any direct or indirect or consequential loss or damage caused by or arising from any information advice or inaccuracy or omission herein.

Copyright

© TRUST Consortium, 2025-2028. This deliverable contains original unpublished work except where indicated otherwise. Acknowledgement of previously published material and work of others has been made through appropriate citation. Reproduction is authorized provided the source is acknowledged.

Statement on the use of AI

AI-powered language tools, including ChatGPT, were used to support grammar correction, translation, editorial consistency and adaptation across different language versions of this report. AI tools were also used to support content structuring, summarisation of text into shorter versions, development of illustrative figures and summary tables, reformulation, readability improvements, consistency checks and conceptual clarification. No evidence, analysis or interpretation was included solely on the basis of AI output. All AI-supported outputs, including adapted text, figures and tables, were reviewed, critically assessed and adapted by the authors to ensure accuracy, consistency with project terminology, and sensitivity to context-specific nuance.

Table of Contents

Glossary & abbreviations	7
Executive summary	8
1. Introduction	10
1.1. Background	10
1.2. Aims	12
1.3. Previous research	12
1.3.1. Analytical point of departure	12
1.3.2. What is theory? A mechanism-based approach.	14
2. Method	16
2.1. Scoping review	16
2.1.1. Search strategy and keywords	16
2.1.2. Criteria for excluding or including studies	17
2.1.3. Selection of relevant studies	17
2.1.4. Analysis of the studies	18
2.2. Development of the conceptual model	19
2.2.1. What is a conceptual model and why is it needed?	19
2.2.2. How did we develop the conceptual model?	19
2.2.3. Alignment of the conceptual model with TRUST researchers and Advisory Board	20
3. Traffic safety culture among private road users	21
3.1. Key characteristics of the studies	21
3.1.1. When were the studies published?	21
3.1.2. Which countries do the studies include?	21
3.1.3. Transport modes included in the studies	22
3.1.4. Methods used in the studies	22
3.1.5. Causal chain: system, traffic safety culture, behaviour, crashes	23
3.1.6. Cultural group level that is studied	24
3.1.7. Concepts used by the studies	24
3.2. Operationalisation of traffic safety culture across cultural group levels	25
3.3. Aspects that are particularly important for safety outcomes	27
3.4. Mechanisms between Traffic Safety Culture and safety performance	30
3.5. Methodological strengths and weaknesses of the reviewed studies	33
3.6. Summary	35
4. Development of a conceptual model	36
4.1. The core components of the conceptual model	36
4.2. Social ecological model	36
4.3. Causal chain and behavioural pathway	39

4.4.	How can the model be tested?	43
4.4.1.	Concrete hypotheses that can be used to test the model	43
4.5.	How to use the model to measure national Traffic Safety Culture?	46
4.6.	Planned application of the conceptual model in TRUST	48
4.7.	Summary	48
5.	Discussion	49
5.1.	The role of mechanisms	49
5.1.1.	When cultural elements function as mechanisms	49
5.1.2.	Mechanisms between other parts of the causal chain	50
5.2.	Is it reasonable to say that all the TSC studies focus on TSC?	50
5.3.	Policy implications	51
5.3.1.	Mechanism-based approach to interventions	51
5.4.	Issues for future research	52
5.4.1.	Future research is needed on intervention mechanisms	52
5.4.2.	Mechanisms between system level factors and traffic safety culture	53
5.4.3.	Further development of the social ecological model	53
5.4.4.	The relationship between other sustainability goals and traffic safety in the conceptual model	53
6.	Conclusion	55
	References	56
	Reviewed studies TSC	56
	Reviewed studies OSC	62
	Additional references	67
	Appendix 1 Additional information from the TSC review	72
	A1 Operationalisation of traffic safety culture across cultural group levels	72
	A1.1 Studies of traffic safety culture at the continent level	72
	A1.2 Studies of traffic safety culture at the national level	73
	A1.3 Studies of Traffic Safety Culture at the regional or local level	80
	A1.4 Studies of Traffic Safety Culture at the family level	81
	A1.5 Studies of Traffic Safety Culture at the peer level	83
	Appendix 2 Scoping review of research on organisational safety culture among road users at work	85
	A2.1 Introduction	85
	A2.1.1 Background	85
	A2.1.2 Aims	85
	A2.2 Method	85
	A2.2.1 Search strategy and keywords	85
	A2.2.2 Criteria for excluding or including studies	86
	A2.2.3 Selection of relevant studies	86
	A2.2.4 Analysis of the studies	87
	A2.3 Results	88

A2.3.1 Key characteristics of the studies	88
A2.3.2 Description of the different lines of research	90
A2.3.3 Aspects that are particularly important for safety outcomes	96
A2.3.4 Mechanisms between organisational safety culture and safety performance	98
A2.3.5 Methodological strengths and weaknesses of the studies	103
A2.4 Discussion	104
A2.4.1 Comparison of OSC and TSC research	104
A2.4.2 Adaptation of the TSC conceptual model to OSC	105
A2.4.3 How can we test the model?	107
A2.4.4 How can the OSC model be used to measure OSC safety culture?	108
A2.4.5 Issues for future research	111
A2.4.6 Policy recommendation based on the OSC review	113
A2.5 Conclusion	115
Appendix 3 Culture measurement and most common survey tools	116
A3.1 National level	116
Hofstede dimensions	116
Schwartz' values (in Hofstede-studies, cross-country comparisons)	116
Road traffic culture as symbol exchange	117
Fatalistic attributions / Destiny orientation	118
Vertical and horizontal individualism and collectivism (country level)	118
Traffic Climate Scale (TCS)	120
Nævestad modified-DBQ-studies – descriptive norms	121
A3.2 Family level	123
Family Climate for Road Safety Scale (FCRSS)	123
A3.3 Peer level	125
Safe Driving Climate among Friends (SDCaF)	125

Glossary & abbreviations

Term / abbreviation	Explanation
AB	Advisory Board
EU	European Union
n.a.	Not applicable
OSC	Organisational Safety Culture
RSC	Road Safety Culture
SC	Safety Culture
SDG	Sustainable Development Goal
SMS	Safety Management System
TSC	Traffic Safety Culture

Executive summary

This deliverable develops a conceptual model of traffic safety culture (TSC), based on scoping and conceptual reviews of existing research on TSC. The point of departure is that TSC is important for understanding traffic safety, but that the research literature is fragmented, with different concepts, methods, cultural levels and theoretical approaches. As illustrated in Figure 1, road users are embedded in several cultural groups, including nations, regions, local communities, families, peer groups and organisations, which may each influence how road users interpret traffic situations and behave in traffic.

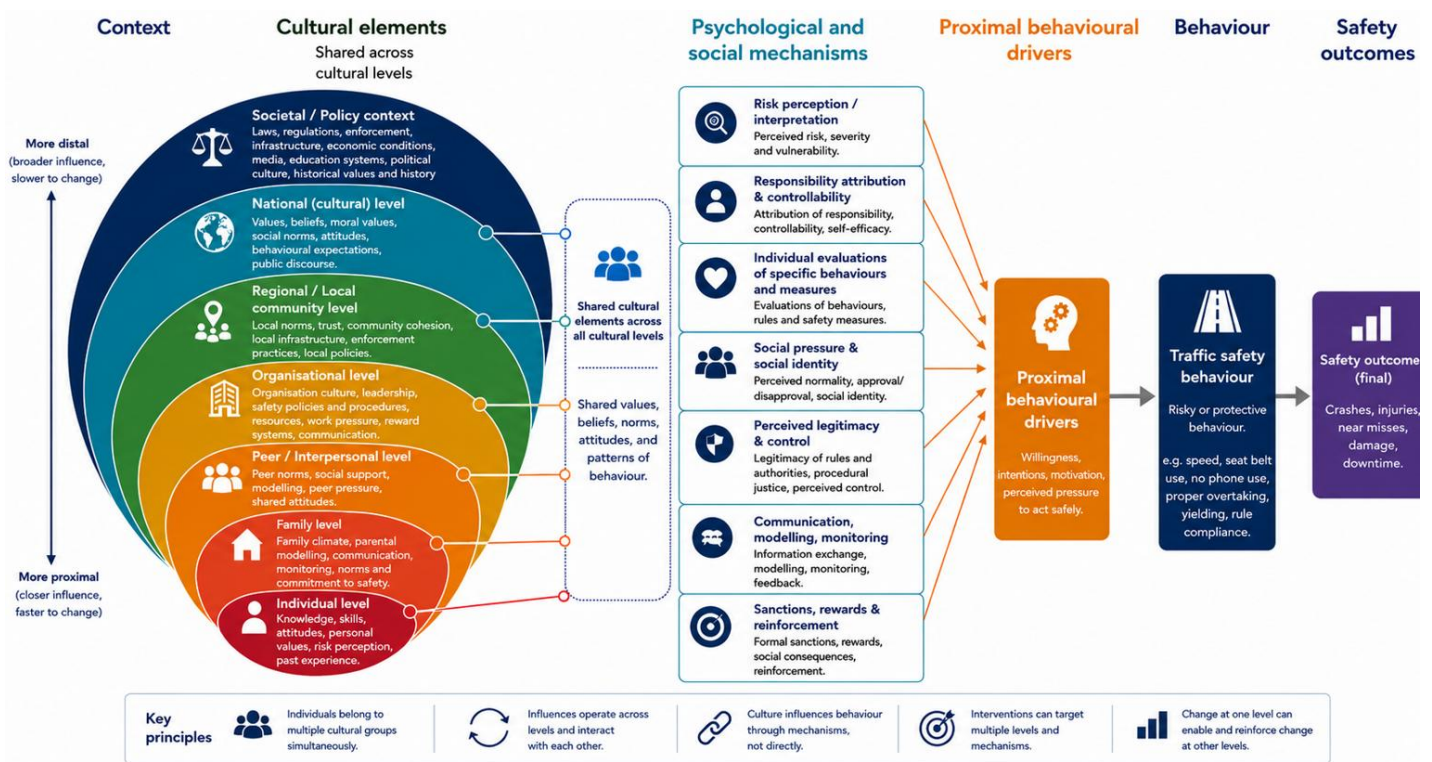
The main analytical contribution of the deliverable is to identify and explicate the mechanisms linking TSC to traffic safety behaviour. The review indicates that these mechanisms are crucial, but often underdeveloped, in TSC research. Making them explicit is important both for theory development and for designing more targeted interventions. On this basis, the study identifies a common analytical core across the diverse TSC literature and organises it into a multi-level, mechanism-based conceptual model. A second contribution is to embed this mechanism-based model within a social ecological framework, thereby showing how cultural influences at different levels may interact and shape traffic safety behaviour.

The review shows that TSC research at different group levels (e.g. national, regional, local, family, peer) shares a basic causal logic: safety culture influences safety behaviour, and safety behaviour influences safety outcomes. However, culture does not influence behaviour in a simple or direct way. Rather, it operates through psychological and social mechanisms, including social pressure, risk perception, responsibility attribution, perceived legitimacy, social identity, modelling, communication, monitoring, willingness, and intentions. These mechanisms explain how shared cultural elements are translated into concrete traffic safety behaviour.

A central finding is that group membership is the common core across the different lines of research. Road users are embedded in several cultural groups, including nations, regions, local communities, families, peer groups, and organisations. These groups exert a “social force” by shaping what road users perceive as normal, acceptable, legitimate, risky, or responsible behaviour. The social ecological model developed in this deliverable captures this multi-level structure, while the behavioural pathway specifies how cultural influence is translated into action.

Overall, the review provides moderate support for the assumption that safety culture is related to safety behaviour and, indirectly, to crashes, injuries, near misses, and other safety outcomes. The strongest evidence concerns the relationship between cultural elements and behaviour. The full causal chain from system-level factors, through culture and mechanisms, to behaviour and safety outcomes is less often tested directly. This is a key knowledge gap.

The conceptual model developed in this deliverable addresses this gap by integrating system factors, cultural elements, mechanisms, behaviour, and outcomes into one common framework. It shows that TSC should not be understood merely as a set of attitudes or behaviours, but as a socially embedded process through which shared meanings, norms, values, and practices shape road users’ behaviour. The central contribution of the deliverable is summarised in Figure 1, which presents the social ecological model of TSC developed in the TRUST project. The figure illustrates how road users are embedded in multiple cultural groups, and how these groups may influence behaviour through shared cultural elements and psychological and social mechanisms. It is important to remember that the figure is a simplification, and that hierarchical grouping logic (shown in the left) is a simplification and that in reality the lines between the subsets could be different (e.g. organisational level could be larger than national).



Mechanism-based behavioural pathway in traffic safety culture.

FIGURE 1 | Social ecological model of traffic safety culture, developed in the TRUST project. Inspired by Bronfenbrenner (1979) and Ward et al. (2019). Figure developed with assistance from ChatGPT-5.4.

The model also provides a basis for intervention development. Instead of aiming vaguely to “change culture”, interventions can target specific mechanisms, such as descriptive norms, parental modelling, peer pressure, perceived legitimacy, safety communication, reporting, learning, or organisational work pressure. In this way, the model provides a mechanism-based foundation for designing TSC interventions.

The deliverable therefore represents a step toward theoretical consolidation in a still-developing research field. It provides a common language for comparing TSC studies, clarifies the mechanisms through which culture matters, and identifies key hypotheses for future empirical testing. Future research should use longitudinal, multi-method, and mechanism-focused designs to test the full causal chain and to identify which cultural mechanisms are most relevant for different road users, behaviours, and cultural and economic contexts. Ultimately, the value of the conceptual model lies in its ability to support more precise research and more targeted interventions aimed at improving TSC and reducing road casualties.

1. Introduction

1.1. Background

Every year, some 20,000 people die on roads in the EU and at least 100,000 are severely injured (European Commission 2025). Despite the progress over the last decades, these numbers are still unacceptably high and a key challenge for all European countries. There are even signs that the trend of decreasing road fatalities is stagnating or reversing in some countries, and most European countries face great challenges with a large number of seriously injured pedestrians and cyclists. Whilst progress can still be expected from improved infrastructure, (vehicle) technology and traffic laws and enforcement, many road safety experts believe that a change in the beliefs, values, social norms of all stakeholders in road safety and road users is needed (Nævestad et al 2019a). These changes imply the need for a cultural change, which does not only apply to road user groups, but also, if not more, to those who are responsible for shaping the traffic system through their roles in organisations. This focus on safety culture and the crucial role of all stakeholders influencing the road traffic system is also underlined by the Academic Expert Group (AEG) of the Fourth Global Ministerial Conference on Road Safety, in Marrakech 2025 (STA 2025).

The concept of organisational safety culture (OSC) was first coined about forty years ago, and it has been applied to road users at work for over 20 years. These are generally part of work organisations, and the concept is therefore well suited to this context. In recent years, the concept of safety culture has been applied to road safety among non-professional road users. As these are not analysed based on their work organisation membership, Nævestad (2021) argues that this requires that the safety culture concept is linked to other group memberships than organisations, e.g. nations, regions, local communities, peer groups. It has been suggested that differences in national traffic safety culture (TSC) can contribute to explaining differences in road safety records and in road safety behaviours between countries (Van den Berghe et al., 2020).

The TSC concept to leverage improvement of road safety emerged in the US and evolved out of OSC and its application in high-risk industries (e.g., aviation, nuclear energy) (AAA 2007; Ward et al., 2010; Nævestad and Bjørnskau 2012). The TSC concept is important, as it denotes shared ways of thinking and acting that are relevant to traffic safety. Previous research indicates that such shared ways of thinking and acting are related to individual road safety behaviour, and thus crash involvement (Nævestad et al., 2025). Thus, there is great promise in the TSC concept, both as an analytical tool and as a basis for interventions.

Despite the growing interest in recent years, the field of TSC is still young and fragmented. There is no current state of the art overview of the field, and no common theoretical frameworks. In spite of this, TSC has been a key topic in several studies. It seems, however, that it is used in several different ways; lending itself to a range of different methods, conceptualisations and research traditions, e.g. TSC as descriptive norms at a national level (Nævestad et al., 2019a), TSC at a regional level (Luria et al., 2014), TSC among peer groups (Ma et al., 2024), family safety climate etc. (Taubman-Ben-Ari et al., 2014). This indicates that TSC is a boundary concept, which researchers may interpret and define differently, based on their background. Thus, although we intuitively understand what TSC is, referring to shared ways of acting and thinking related to road safety, researchers may define it differently, as the concept is flexible, lending itself out to several different definitions, specifications and operationalisations.

Additionally, the link to effective interventions currently seems to be relatively weak. TSC studies often repeat old recommendations and conclusions, suggesting that culture can be changed through well-known methods for individual behavioural change such as enforcement, education and infrastructure

(cf. Nævestad et al., 2019a). If TSC is related to road safety outcomes, knowledge about this relationship may help inform interventions aimed at reducing crashes. However, TSC is still a relatively new and heterogeneous research field. We therefore lack a clear overview over the extent to which studies have examined links between TSC and crashes among private road users, how well this relationship is documented, and which mechanisms or cultural elements may be most relevant.

Fourteen years ago, Nævestad and Bjørnskau (2012) published a conceptual paper termed: "How can the safety culture perspective be applied to road traffic?". Their point of departure was that the field of OSC research for drivers at work is relatively well established. The reason is that drivers at work are part of organisations, where we can draw on the more established OSC research to understand their cultural environment.

Applying the safety culture perspective to private drivers, however, is something different. Nævestad and Bjørnskau (2012) state that if we are to apply the safety culture concept to non-professional drivers in the road transport system, we have to examine how the concept can be applied to analytical units other than organisations (cf. Wiegman et al., 2007). The reason for this is that non-professional drivers do not use the road as members of organisations, but as private citizens. Nævestad and Bjørnskau (2012) therefore discuss whether the concept of TSC can be applied to the following analytical units: local communities, nations, and peer groups. They conclude that there are relatively few studies within these analytical units, and a wide range of unanswered questions. However, today fourteen years have passed, and we may assume that several studies focusing on these cultural units have been conducted, especially since the TSC concept seems to have gained popularity in recent years. In section 5.2, we conclude that this assumption indeed is correct.

The growing use and recognition of the TSC concept indicates that it would be interesting to make a systematic scoping review of all studies on the topic in recent years, to see how the term is used and in what contexts. It seems relevant to study, for example: What is the status of TSC research today? Which social groups do TSC studies typically focus on, at which analytical levels (e.g. national, regional, local, peer), which methods are used, what is the identified relationship with traffic safety behaviours and crashes? It also seems relevant to describe the knowledge status, knowledge gaps, and questions for future research within the different lines of TSC research. Such a scoping review, mapping the research field quantitatively and qualitatively is useful to get a full overview of an emerging, uncharted and promising research field.

It is also relevant to examine what types of theories TSC studies use to explain the relationship between TSC and traffic safety behaviour, and how theoretically mature or well-developed these theories are. It is also important to assess whether there is a common theoretical core across studies focusing on different cultural group levels, and to what extent different conceptualisations of TSC can explain traffic safety behaviour and crash involvement.

In addition, there is a need to examine how well-developed the policy implications are in existing studies. Do they provide specific and theoretically grounded recommendations, or do they mainly repeat established road safety measures such as education, enforcement, and infrastructure improvements? More broadly, it is important to assess whether TSC research offers new insights for policy and intervention, beyond what is already addressed in previous road safety research.

A main limitation with current research on TSC is that the field of research is multifaceted and heterogeneous, and that a common terminology, a common conceptual model and a common language for such a model are lacking. TSC is closely linked to behaviours and crashes, and research on the topic has increased in recent years. However, the field remains very diverse and theoretically underdeveloped,

highlighting the need to systematically map existing research, identify key findings, and determine common denominators. To address this, a step-by-step approach is required to build a conceptual framework that can guide future research. This is the aim of the TRUST project, where work has already been done on defining TSC (Nævestad et al., 2026), and is now focused on developing a comprehensive conceptual model.

Moreover, if the concept of TSC is to be used by researchers, authorities and stakeholders to improve traffic safety around the world, we need a well-developed conceptual model of what TSC is; how it is influenced by different factors, and how it influences traffic safety behaviour, which in turn is related to safety outcomes like crashes. This is needed to understand how TSC is related to traffic safety behaviours and crashes. Specific knowledge about the analytical mechanisms between culture behaviours and crashes is required to effectively use TSC as a tool in both analyses and interventions. This also concerns the factors influencing TSC; knowledge about this might inform targeted interventions to influence TSC.

1.2. Aims

The aims of the study underlying this Deliverable 3.1 are to:

1. **Conduct a scoping review of traffic safety culture research**, focusing on: a) what year, where the studies are from, transport modes included, methods used, cultural group levels studied, and concepts used to describe culture, b) how safety culture is operationalised, c) identification of the cultural aspects which seems to be most important for traffic safety outcomes and d) assumed mechanisms between safety culture and safety outcomes (e.g. traffic safety behaviours, crashes).¹
2. Based on these reviews, focusing on safety culture mechanisms, **develop a conceptual model** of traffic safety culture.

This study is part of the EU-project TRUST: “Traffic safety culture a systematic transition towards shared responsibility for safe and sustainable mobility in the EU” (Grant agreement ID: 101197992).

1.3. Previous research

1.3.1. Analytical point of departure

Scoping reviews are sometimes described as systematic approaches to map uncharted landscapes, where different research paradigms or lines of research are equalled with different valleys with different ways of doing things and views of the world. Thus, conducting scoping reviews can be equalled with making maps of such terrains, describing the different valleys and their concepts, results and ways of doing things. However, when this charting is done, or through the analytical process of describing the different valleys, a more general and higher order language of categories also emerges. This analytical process can be described as inductive analysis, where we start off with some basic categories, further developing these as well as introducing new categories and concepts through a bottom-up process, where categories emerge through comparing differences and similarities within different TSC valleys. Thus, virtually travelling through the valleys of the TSC country provides an overview and a higher order language that can be used for a general description of the concept.

We already start our journey with some conceptual tools for charting terrain. The first is the TRUST definition of TSC, which was developed through a three-step process of: 1) systematic literature review,

¹ We conduct a similar scoping review of OSC research, where we also adapt the conceptual model to OSC. The full scoping review is provided in Appendix 2.

2) Delphi surveys with experts and 3) Focus group discussions with experts (Nævestad et al., 2026). The TRUST definition of TSC says that:

Traffic safety culture encompasses shared values, beliefs, attitudes, norms, and patterns of behaviours that shape how traffic safety is understood and enacted within a meaningfully defined group of actors in the transport system. This meaningfully defined group of actors can refer to road users, organisations, authorities, or other actors within the transport system. (Nævestad et al., 2026).

This definition already provides two building blocks for a conceptualisation of TSC, as it distinguishes between **elements** and **aspects** of TSC (Nævestad et al., 2026). **Elements** refer to the underlying, abstract cultural constructs that characterise how safety is collectively understood and prioritised within a group, such as shared values, beliefs, norms, attitudes, and patterns of behaviour. Aspects refer to more concrete, observable, and potentially measurable features through which these elements are expressed in practice, such as e.g. management commitment, communication, safety systems, and employee involvement (Nævestad et al 2026). This distinction allows us to differentiate between the conceptual building blocks of safety culture and their operational manifestations, thereby supporting both theoretical clarity and empirical applicability. Thus, elements can be viewed as underlying cultural constructs that are manifested through different aspects across groups and contexts, with some manifestations supporting road safety and others undermining it.

Another building block is provided by a causal chain indicated in Nævestad et al. (2021) and Nævestad (2021). Based on this research, we can state that a conceptual model for TSC includes a causal chain of (at least) four analytical levels: 1) System level factors influencing TSC, 2) Culture level factors; i.e. TSC aspects, and the mechanisms (e.g. descriptive norms) through which they influence traffic safety behaviours, 3) Behaviour level factors: i.e. specific road safety behaviours that are related to different aspects of TSC, 4) Outcome level: crashes or other traffic safety outcomes that are related to the mentioned road safety behaviours (Nævestad 2021; Nævestad et al 2021). This is illustrated in Figure 2.

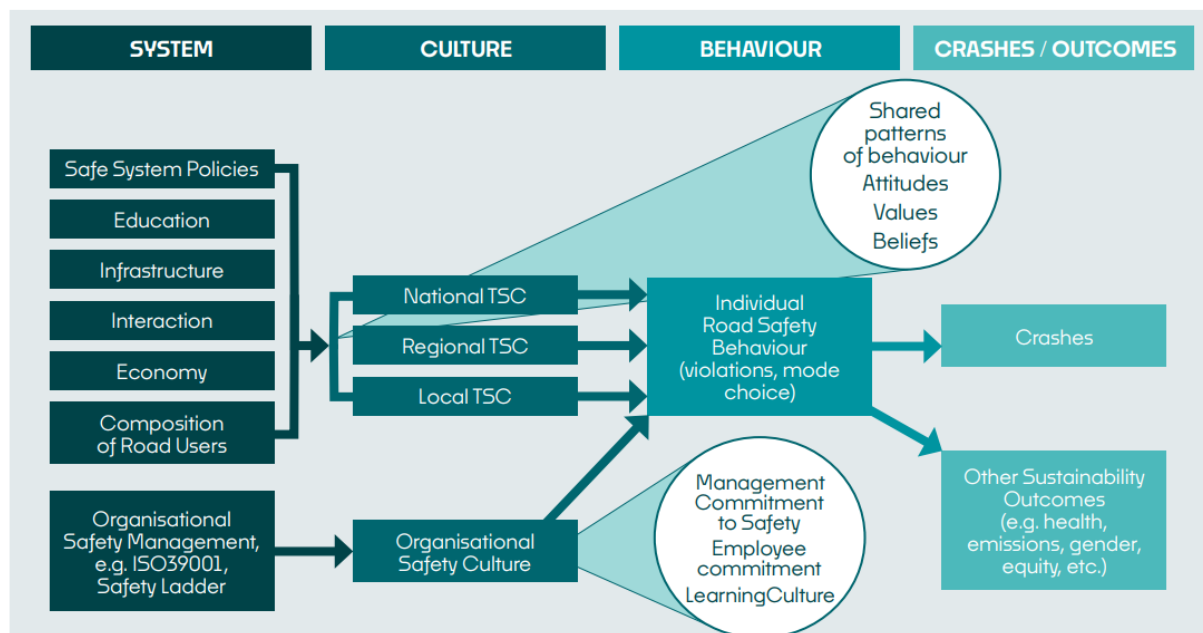


FIGURE 2 | Causal chain of (at least) four analytical levels for traffic safety culture analyses. Based on Nævestad & Bjørnskau (2012), further elaborated in Nævestad et al (2019) and Nævestad 2021.

A third already existing building block that is relevant and indicated in the figure is different types of cultural groups at different level, e.g. at the national level, regional level, local level and peer level (cf. Nævestad and Bjørnskau 2012; Nævestad 2021). The conceptualisation in Figure 2 is based on Nævestad and Bjørnskau's (2012) conceptual exploration of how the concept of safety culture can be applied to road traffic, further elaborated in Nævestad et al. (2019) and Nævestad (2021).²

1.3.2. What is theory? A mechanism-based approach.

According to Mjøset (2007), theory refers to a way of organising knowledge for explanation, ranging from highly general, abstract logics to more context-bound approaches with concrete explanatory power. High-level theories are often oriented toward generalisation through formal models or law-like relationships, while lower-level theories are grounded in empirical contexts and aim to explain specific cases. These approaches differ in their strategies of generalisation rather than simply in terms of deductive versus inductive methods or quantitative versus qualitative techniques.

In addition, theories can be understood as systems of concepts and classifications that structure how phenomena are described, analysed, and related to one another. That is, theories do not only explain relationships between variables or phenomena, but also define the key analytical categories and distinctions that make such explanations possible. In the context of TSC, this involves identifying and systematising central concepts; such as values, beliefs, attitudes, norms, patterns of behaviours, and crashes and sustainability outcomes, and clarifying how these are related across different analytical levels.

Thus, developing a conceptual model for TSC entails both specifying explanatory relationships (e.g. causal chains between system factors, culture, behaviour, and outcomes) and constructing a coherent set of concepts and classifications that capture the essential dimensions of the phenomenon. In line with Mjøset's (2007) emphasis on context-bound theory, such conceptual models should be grounded in empirical research and sensitive to variation across contexts, while still aiming to provide a systematic and generalisable analytical framework.

Thus, we see that theory ranges on a continuum from well-developed high level formal models with law-like relationships to merely sets of concepts and distinctions. In relatively immature research fields like TSC research, bottom-up approaches, nurturing from existing studies are needed, to build concepts and distinctions that can be used to make sense of the research terrain. Thus, the conceptual model is a theory, or a first step in the process of developing a TSC theory, as language and nuances are needed to describe the valleys of TSC research.

In his paper on sociological theories of the middle range, Merton (1949) characterises theory as sets of logically interconnected propositions that explain relationships between social phenomena. Such theories are abstract enough to allow generalisation, yet sufficiently close to empirical data to be testable. Building on this perspective, Elster (2007) emphasises the role of mechanisms in explanation, arguing that to explain a phenomenon is to identify the causal processes that generate it. This aligns with a middle-range approach, which rejects "black box" correlations and instead focuses on specifying the causal chains linking variables. In this perspective, theories can be understood as collections of mechanisms that explain how and why relationships between variables occur.

² It is evident that several factors can be added to the model, for instance "religion" or "morality" could be added at the system level (cf. Van den Berghe 2026, Nævestad et al 2025). In the present deliverable, the figure is updated based on systematic review of the literature.

We can provide an example of what this means, based on TSC research. In more individualistic cultures, people may place greater value on personal freedom and autonomy. This can lead to weaker social expectations to comply with rules (norms), which in turn reduces perceived social pressure to drive safely. As a result, individuals may be more likely to engage in risky behaviours such as speeding. In this case, the explanation provided is not just that individualism is associated with risky driving, but how values (individualism) shape norms (lower expectations for compliance, and less perceived social pressure), which in turn leads to a certain behaviour (i.e. higher levels of risk-taking in traffic). This is an example of what Elster (2007) means by a mechanism, i.e. a set of causal steps that explain why a relationship exists, rather than just showing that it exists. In this study, we focus on providing descriptions of the mechanisms involved in TSC research. It is important to note that what we identify are hypothesised mechanisms, which are often not explicated in studies, but rather hypothesised by us, in order to suggest testable hypotheses. We expand more on how we identify mechanisms in our review in section 3.4.

2. Method

2.1. Scoping review

We have conducted a scoping review approach, which applies a systematic literature review to fulfil the study aims. We label our approach a scoping review, as our main purpose with the review is to provide an overview of the current knowledge landscape within a given field and identify important knowledge gaps (Levac et al., 2010; Westphaln et al., 2021; Dwyer et al., 2023). Our presentation of the knowledge landscape is done through a theme-based content analysis of the identified studies (section 2.1.4). No reviews of study quality or methods are conducted. We describe the searches and analyses using the main elements of PRISMA: “Preferred Reporting Items for Systematic reviews and Meta-Analyses” (Page et al., 2021).

The main purpose of scoping reviews is to map existing literature on a broad topic, identify key concepts, types of evidence, and gaps in research. Unlike systematic reviews, scoping reviews do not usually assess the quality of the studies but aim to provide an overview of the current knowledge landscape within a given field and identify important knowledge gaps (Levac et al., 2010; Westphaln et al., 2021; Dwyer et al., 2023). Scoping reviews comprise six steps. The first step is to define the scope of the review, i.e. which types of research that is to be included in the review and which types of research that is to be excluded. In this study, we search for peer-reviewed studies in scientific journals. The second step is to determine the aims of the review. These are the same as the study aims. The third step is to choose a search strategy. This involves choosing the scientific databases to search in, and which search strings to use (i.e. combination of search words). This is described in section 2.1.1. The fourth step is article screening, which is described in section 2.1.2 and 2.1.3. The fifth step is data extraction, which is described in section 2.1.4. The sixth step is synthesis of the literature, which involves identifying and summing up the observed main tendencies in the reviewed studies, based on the extracted data (cf. Chapter 3 and Appendix 1).

2.1.1. Search strategy and keywords

The literature searches were conducted in March 2026 in two scientific databases: Science Direct and Scopus. The main search terms are presented in Table 1. The search combined terms related to culture or climate with traffic and road user descriptors and with safety and outcome-related concepts, including crashes, incidents, violations, and driver behaviour. As this is a relatively new research field where several different concepts are used, we relied on several different concepts and synonyms to identify traffic safety culture studies, involving climate, only culture etc. It is well known that culture and climate are used interchangeably in studies of OSC (e.g. Haukelid 2008), and we presuppose that the same is the case for studies of traffic safety culture.

Searches were performed in titles, abstracts, and keywords and were adapted to the indexing structure of each database. The searches were restricted to peer-reviewed journal articles and reviews published in English. To limit retrieval of healthcare-focused safety culture studies outside the scope of this review, nursing-related subject classifications were excluded using database-specific filters.

Theme	Key words
Traffic and road user	((traffic OR road OR highway OR pedestrian* OR cyclist* OR bike OR bicyclist* OR car* OR moped* OR motorcycle* OR "road user*" OR passenger*))
Safety	AND (safety OR crash OR accident* OR incident* OR violation* OR "driver behavior*")
Culture, climate	AND (culture OR climate))
Complete terms	OR ("traffic safety culture" OR "traffic safety climate" OR "road safety culture" OR "road safety climate" OR "traffic culture" OR "traffic climate")

TABLE 1 | Simplified overview of search terms used in the literature search.

2.1.2. Criteria for excluding or including studies

The following criteria applied at all screening stages:

1. Relevant sector (road transport)
2. Empirical study (including review studies, but not opinion pieces or purely theoretical publications)
3. Traffic safety culture or climate was a main focus or topic, and explicitly stated (i.e. studies focusing only on some elements, such as attitudes, or not explicitly addressing culture/climate, were excluded)
4. Focus on road users not acting in a professional capacity (i.e. studies of professional drivers and other road users at work were excluded)

2.1.3. Selection of relevant studies

The review aimed to identify empirical studies of traffic safety culture among groups of private road users (e.g. car drivers, motorcycle riders, pedestrians), conducted at any analytical level and including measures of safety performance.

Study screening was conducted in four successive steps. At each stage, publications were excluded if they clearly did not meet the inclusion criteria, and any unclear cases were forwarded to the next screening step. Overall, the search resulted in 2001 publications (excluding duplicates). Figure 3 shows results of the screening procedure for each step.

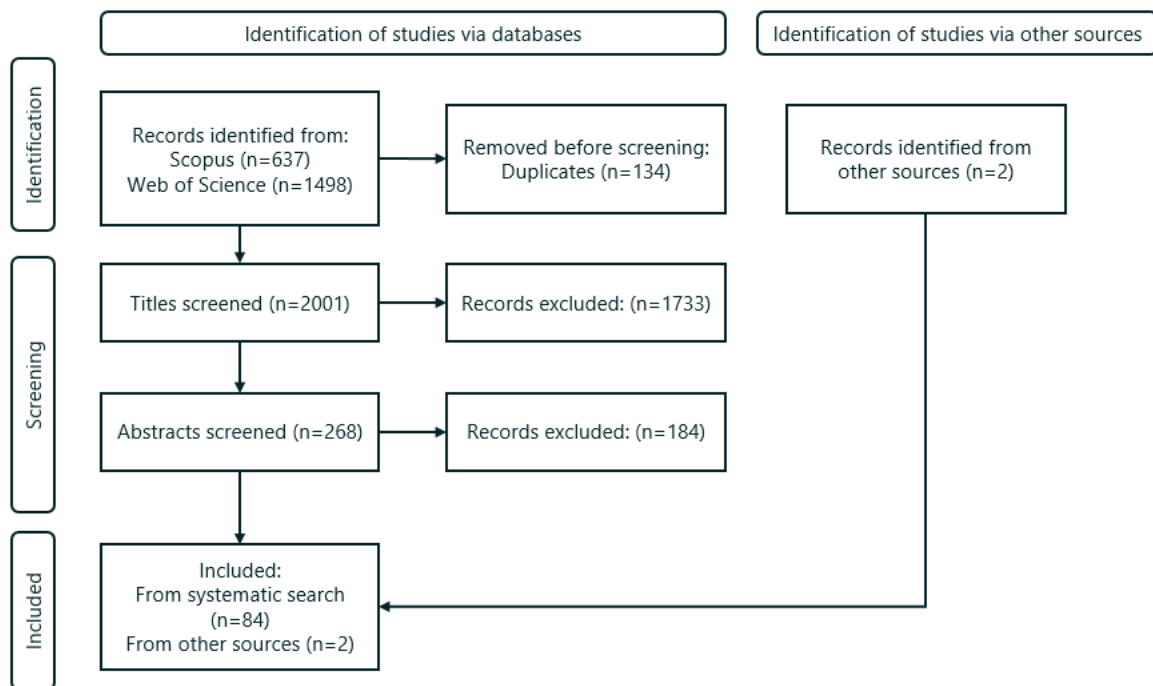


FIGURE 3 | Flow chart. Search on traffic safety culture.

In the first step, duplicates were removed after comparing the search results from the two databases. In the second step, titles were screened against the formal inclusion criteria, including English language and publication in a peer-reviewed journal. In the third step, abstracts were screened to assess whether traffic safety culture or traffic safety climate was a main focus or topic of the study. Studies focusing only on isolated elements, such as attitudes, or studies that did not explicitly address culture or climate, were excluded. In the fourth step, full texts were consulted where eligibility could not be determined from the abstract alone. This step was also used to assess whether the study focused on road users not acting in a professional capacity. Studies of professional drivers and other road users at work were generally excluded, as these are covered in the review of OSC. However, some studies represented grey zones, for example studies including professional drivers but focusing mainly on national traffic safety culture rather than OSC. These studies were included when the main analytical focus was national traffic safety culture, since the purpose of excluding road users at work was to avoid overlap with the OSC review. After applying all inclusion criteria, 86 studies were included in the review.

2.1.4. Analysis of the studies

The reviewed studies were analysed both quantitatively and qualitatively. Based on the coding of the 86 studies, we prepared a data file, where the following variables were registered for each study:

1. Author
2. Publication year
3. Country
4. Methods
5. Key concepts used for culture
6. TSC levels (e.g. community: national, regional, local, peer, family)
7. Transport mode included (car driver, MC, pedestrian)
8. TSC elements included (e.g. values, beliefs, norms, attitudes, patterns of behaviour)
9. TSC aspects included (e.g. aggression vs. cooperation, paternalism vs. freedom)
10. How are the elements and aspects measured?

11. Is individual road safety behaviour measured? How?
12. Are crashes (or other safety outcomes) measured?
13. Hypothesised relationships and results?
14. Factors influencing TSC included? (e.g. infrastructure, education, interaction, policies).
15. Other sustainability goals than Safety?

This information was analysed quantitatively. In addition, we also conducted more qualitative analyses, focusing on how safety culture operationalised across cultural group levels (national, regional, local, peer, family), assumed mechanisms between safety culture and traffic safety outcomes (e.g. traffic safety behaviours, crashes), the more general theoretical approaches that these mechanisms relate to, results regarding the relationship between safety culture and outcomes at each level, cultural aspects at each cultural group level which seems to be most important for traffic safety outcomes. This information is analysed for distinct lines of research within TSC and OSC studies.

As pointed out by Nævestad & Bjørnskau (2012), the most important basis for discerning between the studies is the level of cultural group membership that is the focus of each study, e.g. national level, regional level, local level, peer-group level, family level. This involved thematic analysis, which is a systematic method for identifying main themes in textual material (Braun & Clarke, 2006). This involves identifying themes that recur in descriptions of specific topics. Thus, the thematic analysis focused on identifying commonalities and differences within the studies at each cultural group-level: e.g. national level, regional level, local level, peer-group level, family level.

2.2. Development of the conceptual model

2.2.1. What is a conceptual model and why is it needed?

A common conceptual model can unite smaller lines of research into a larger and more comprehensive research field, suggesting its importance, and also facilitate learning across sub-paradigms. This may facilitate comparability across studies, and perhaps also increase the chances of cumulative knowledge development, and development of efficient prevention strategies building on TSC. A conceptual model of TSC may compensate for the theoretical heterogeneity, by contributing with a nuanced and precise language to describe the components of TSC. It seems especially important to develop a language and concepts and categorisations which can be used to describe the diversity across different types of TSC studies. Or in other words the purpose of the conceptual model is to provide a map or a tool to describe the TSC research, including its knowledge status and its knowledge needs.

A conceptual model can be defined as a systematic framework that organises key concepts, categories, and relationships within a research field. It provides a structured representation of a phenomenon by identifying its main components and specifying how these are related across different analytical levels. Conceptual models do not necessarily constitute full formal theories but represent an intermediate step in theory development, offering a coherent set of concepts and propositions that can guide empirical analysis and explanation.

2.2.2. How did we develop the conceptual model?

The conceptual model was developed through an inductive and integrative synthesis of the reviewed TSC literature. The starting point was the TRUST definition of TSC, which conceptualises TSC as shared values, beliefs, attitudes, norms, and patterns of behaviour within meaningfully defined groups of actors in the transport system. This definition provided the initial conceptual language for identifying the cultural content examined in the reviewed studies.

A second organising principle was the causal chain linking contextual or system-level factors, TSC, traffic safety behaviour, and safety outcomes. This causal chain was used from the start to structure the review and the coding of the studies. For each study, we examined whether it addressed factors influencing TSC, how TSC was conceptualised and measured, whether traffic safety behaviour was included, and whether safety outcomes such as crashes or near misses were measured. In this way, the causal chain functioned as an analytical framework for mapping the literature.

The next step was to organise the studies according to the cultural group level they addressed, including national, regional, local, organisational, family, and peer levels. This made it possible to compare how TSC was conceptualised and operationalised across different social contexts. For each level, we examined how culture was measured, which behaviours and outcomes were included, which mechanisms were assumed or tested, and which wider contextual factors were described as influencing TSC.

The model was then developed by identifying common patterns across the different lines of research. Although the studies used different concepts and measurement approaches, they shared a basic assumption: membership in a social group influences traffic safety behaviour through shared cultural elements and social influence. This common core was used as the basis for the multi-level structure of the model.

Finally, the conceptual model was refined by specifying the mechanisms and behavioural pathways within the broader causal chain. The review indicated that TSC does not influence behaviour directly, but through psychological and social mechanisms such as norms, attitudes, social identity, modelling, communication, monitoring, perceived legitimacy, responsibility attribution, and social pressure. In this way, the final model builds on the initial causal chain, but develops it further into a multi-level, mechanism-based conceptual model of TSC. Thus, the conceptual model builds on, refines and complements the analytical scheme that we developed to analyse and code the information in the studies we reviewed.

2.2.3. Alignment of the conceptual model with TRUST researchers and Advisory Board

This deliverable was made within WP3 in TRUST and several researchers were involved in the literature search and review. The researchers from TØI had the main responsibility for conducting the literature review and reporting it, while the other involved researchers contributed to the different stages of the literature review. KfV and NTUA researchers had particular responsibility for the initial versions of the TSC study review, while VTI and VIAS researchers had particular responsibility for the initial versions of the OSC study review. Wennberg from Lund University contributed to sustainability discussions and TSC and OSC discussions in general, while Schachner from CFG contributed to national TSC. Seventeen meetings were conducted in WP3, focusing on the stages of the literature review and discussions of the conceptual model and its operationalisations. A first draft of the conceptual model and its application to measure national TSC was also presented and discussed at the TRUST General Assembly in Oslo on 11.-12. May 2026. In this meeting several key advisory board members were present, most prominently Nic Ward, who also received a preliminary version of the current deliverable for feedback. (Follow-up discussions of the conceptual model were done per e-mail.) These discussions led to several important adaptations and adjustments, particularly its simplification and readability, also highlighting its concrete operationalisation and use. Thus, early and newer versions of the conceptual model were discussed both in meetings with Advisory board participants and in internal WP3 meetings.

3. Traffic safety culture among private road users

3.1. Key characteristics of the studies

This chapter relates to aim 1a, which is to describe what year, where the studies are from, transport modes included, methods used, cultural group levels studied, and concepts used to describe culture.

3.1.1. When were the studies published?

We identified 86 relevant studies on TSC. In Figure 4 we show which year the different studies are from. Note that the figure does not have a bar for each year, only for the years for which at least one article was identified.

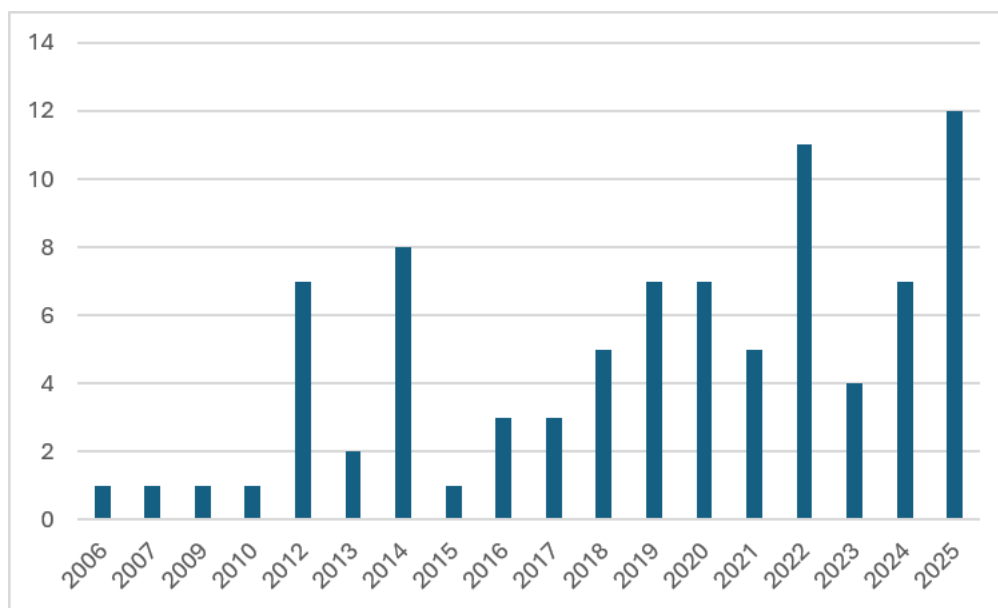


FIGURE 4 | What year the 86 different studies on traffic safety culture are from

Figure 4 shows that the number of studies on TSC has increased over time, particularly after 2015. Earlier years include only a small number of publications, while the period from around 2018 onwards shows a clear growth in research activity. The highest number of studies appears in the most recent years, with a peak in 2025. Overall, the figure indicates a growing and increasingly active research field.

3.1.2. Which countries do the studies include?

Table 2 shows which countries the various studies are from. Here we give percentages based on the country or countries that the studies focus on. Some studies focus on several countries, and the total number of countries is therefore higher than the total number of studies. Table 2 shows that the largest number of studies include the USA. Overall, the studies are distributed across a range of countries, but with a concentration in a few regions.

Country	Number
USA	23
Israel	19
Turkey	18
Norway	16
China	16
Greece	14
Iran	10

TABLE 2 | Overview of which country the various studies are from, focusing on the most frequently studied countries. Some studies focus on several countries, and the total number of countries is therefore higher than the total number of studies.

3.1.3. Transport modes included in the studies

Table 3 shows the transport modes included in the studies of TSC. The table shows that cars are the most frequently studied transport mode, included in 49% of the cases. Studies focusing on all road traffic account for 21%, while pedestrians (12%) and motorcycles (9%) are less commonly examined. Bicycles and professional drivers are each included in 5% of the studies. Professional drivers were only included in our review, if also private drivers were included in the study, or if a main focus was on national traffic culture. Overall, the literature is dominated by a focus on car use and general road traffic, with less attention to other specific transport modes.

Mode	Number	Per cent
Car	52	49%
Pedestrian	13	12%
Motorcycle	10	9%
All/road traffic	22	21%
Bicycle	5	5%
Professional	5	5%
Total	107	100%

TABLE 3 | Transport modes included in the 86 studies of traffic safety culture. Some studies focus on several modes, and the total number of modes is therefore higher than the total number of studies.

3.1.4. Methods used in the studies

Table 4 shows the methods used in the studies of TSC. The table shows that the majority of studies (70%) use survey methods. A smaller proportion employ other or miscellaneous methods (10%) and register-based studies (8%). Mixed-method approaches combining semi-structured interviews and surveys account for 7%, while 5% rely solely on semi-structured interviews. Overall, the literature is clearly dominated by quantitative survey-based approaches.

Method	Number	Per cent
Survey	60	70%
Other/Miscellaneous	9	10%
Register-based study	7	8%
Semi-structured interviews; survey	6	7%
Semi-structured interviews	4	5%
Total	86	100%

TABLE 4 | Research methods used in the 86 studies of traffic safety culture.

3.1.5. Causal chain: system, traffic safety culture, behaviour, crashes

As noted above, we understand TSC through a four-level causal chain: system factors may influence TSC, TSC may influence traffic safety behaviour, and traffic safety behaviour may influence crashes or other safety outcomes (Nævestad et al., 2021). This causal chain is an important part of the conceptual model, because it specifies why TSC matters for road safety: culture is assumed to shape behaviour, and behaviour is in turn linked to safety outcomes.

Table 5 shows how often the studies in the review include these different parts of the causal chain. The table should therefore be read as a map of analytical coverage in the literature. It does not show that all studies test the full causal chain statistically. Rather, it shows whether studies include, mention, or measure the different levels of the chain. Please note that the percentages in Table 5 should not be read row by row. They summarise whether the reviewed studies include different analytical levels of the proposed causal chain. The table shows that most studies mention system-level influences and measure traffic safety behaviour, but fewer studies include crash outcomes. Thus, the literature most often examines parts of the causal chain rather than testing the complete pathway from system factors, through traffic safety culture and behaviour, to crashes.

The first column shows whether studies mention system-level factors that may influence TSC, such as education, policy, enforcement, infrastructure, broader cultural values (e.g. related to religion, morality), or other contextual conditions. A key finding is that 90% of the studies mention at least one such factor. However, these factors are often discussed as possible background influences rather than being empirically analysed in detail.

The second column shows the cultural group level studied. The studies most often focus on TSC at the national level. Other studies examine culture at more immediate social levels, such as the local, regional, peer-group, or family level. This distinction is important because TSC may operate differently depending on whether the relevant group is a nation, a local community, a family, or a peer group.

System		Culture		Behaviour	Crashes
None mentioned	10%	National	46%	Included in 81% of the studies	Included in 49% of the studies
Yes, larger cultural elements	12%	National, and other	10%		
Yes, education	13%	Regional	6%		
Yes, policy	10%	Local	18%	E.g. speeding, DUI, aggressive driving	11% of the studies also include other SDGs, e.g. active mobility
Yes, enforcement	10%	Peer	6%		
Yes, infrastructure	10%	Family	14%		

TABLE 5 | Causal chain elements included in the studies: system factors influencing culture, cultural levels, traffic safety behaviour and crashes.

The third column shows whether studies include traffic safety behaviour as an outcome. This is the most commonly measured outcome in the literature: 81% of the studies include some form of road safety behaviour, such as speeding, driving under the influence, aggressive driving, seat belt use, or other risky or protective behaviours. This indicates that the literature most often studies the link between TSC and behaviour.

The fourth column shows whether studies include crashes or other safety outcomes. Only 49% of the studies include crash measures. This means that while many studies assume that TSC is relevant for crash prevention, fewer studies follow the causal chain all the way to crashes, injuries, or other final safety outcomes.

The main point from Table 5 is therefore that the literature gives strongest empirical attention to the relationship between TSC and behaviour, while the links from system factors to culture and from behaviour to crashes are less often fully analysed. This suggests that TSC research has a clear causal logic, but that many studies only examine selected parts of this chain rather than the full pathway from system conditions to safety outcomes.

3.1.6. Cultural group level that is studied

Table 6 shows which cultural group level(s) for TSC the different studies focus on. Some studies focus on several levels. Table 6 shows that 45% of the studies (plus 10% also including other level) focus on TSC at the national level, making it the most commonly studied level. National and other involves studies focusing on the national level in addition to another level (e.g. local or regional). Overall, the literature shows a strong emphasis on broader societal levels, with less attention to more immediate social contexts.

	Number	Per cent
Continental	1	1%
National	39	45%
National, and other	9	10%
Regional	5	6%
Local	15	17%
Peer	5	6%
Family	12	14%
Total	86	100%

TABLE 6 | Overview of which cultural group level(s) for traffic safety culture the studies focus on

3.1.7. Concepts used by the studies

In Table 7 we show which terms the various studies use in their abstracts and titles.

Concept	Number	Per cent
Traffic safety culture	31	35%
Family climate for road safety	13	15%
Traffic climate	12	14%
Culture (national level) "values"	8	10%
Traffic safety climate	5	6%

Road safety culture	5	6%
Driving climate	4	5%
Miscellaneous	8	10%
Total	86	100%

TABLE 7 | Terms used in the various studies in the abstract and title. Number and share of publications.

Table 7 shows that most of the studies use the label TSC, followed by family climate for road safety and traffic climate. Miscellaneous are e.g. Road traffic culture, Traffic culture, Road safety climate, Safe driving climate, Safety culture.

3.2. Operationalisation of traffic safety culture across cultural group levels

This chapter relates to aim 1b, which is to describe how safety culture is operationalised. We compare this across cultural group levels (continental, national, regional, local, peer, family).

Table 8 summarises the main lines of TSC research identified in the review. The table shows that TSC has been operationalised differently across cultural levels, ranging from broad national cultural values and traffic climate to more specific descriptive norms, family climate and peer-group climate. Further details on the operationalisations in Table 8 are provided in Appendix 1.

Cultural level and line of research	Operationalisation of culture	References
Continental / cross-continental level	TSC is operationalised as shared values, attitudes, beliefs, descriptive norms and shared expectations about other road users' behaviour. The main aspects are descriptive norms for road user violations, fatalistic beliefs, values and attitudes related to freedom to take risk, and the social valuation of motorised transport compared with walking.	Nævestad et al. (2025)
National level: Hofstede dimensions	Culture is operationalised through national cultural dimensions, especially individualism–collectivism, power distance, masculinity–femininity, uncertainty avoidance, long-term orientation and indulgence–restraint. These dimensions are used as country-level cultural indicators and related to traffic fatality rates or traffic safety outcomes.	Atchley et al. (2014); Gaygisiz (2010); Melinder (2007); Van den Berghe et al. (2020); Arslan & Özkan (2024)
National level: Schwartz' cultural values	Culture is operationalised as shared value priorities, including embeddedness–autonomy, hierarchy–egalitarianism and mastery–harmony. These values are used to examine how broader societal value orientations may be related to road safety outcomes.	Atchley et al. (2014); Gaygisiz (2010); Arslan & Özkan (2024)
National level: road traffic culture as symbol exchange	Traffic culture is operationalised as dominant forms of communication and meaning-making in traffic, measured through dimensions such as extraverted, introverted, auditive, oral, visual and written culture. These dimensions are assumed to capture how road users interpret and respond to traffic-related meanings, rules and expectations.	Klempe et al. (2009); Rundmo et al. (2012); Nordfjærn et al. (2012a, 2012b, 2014)

Cultural level and line of research	Operationalisation of culture	References
National level: fatalistic attributions / destiny orientation	Culture is operationalised through beliefs about fate, destiny, religion, divine will and controllability. These items measure whether road users understand crashes as preventable events or as outcomes determined by fate, destiny or higher powers.	Nordfjærn et al. (2012a, 2012b, 2014); Nævestad et al. (2025); Van den Berghe (2026)
National level: vertical and horizontal individualism and collectivism	TSC is operationalised through four cultural orientations: horizontal individualism, vertical individualism, horizontal collectivism and vertical collectivism. These dimensions describe how people relate to autonomy, equality, competition, hierarchy and group membership.	Nordfjærn & Zavareh (2016)
National level: Traffic Climate Scale (TCS)	TSC or traffic safety climate is operationalised as road users' perceptions of the wider traffic system. The TCS measures external affective demands, internal requirements and functionality, capturing whether traffic is perceived as stressful, demanding, predictable, safe or well organised.	Gehlert et al. (2014); Chu et al. (2019); Üzümcüoğlu & Özkan (2019); Üzümcüoğlu et al. (2019, 2020); Feng et al. (2021); Atombó & Wu (2022); Öztürk et al. (2022, 2023, 2024); Kacan-Bibican et al. (2025)
National level: DBQ-based descriptive norms	TSC is operationalised as descriptive norms based on selected Driver Behaviour Questionnaire items. Respondents report both their own behaviour and their expectations about how often other drivers in their country commit violations such as speeding, aggressive driving, driving under the influence or non-use of seat belts. Some studies also include values and attitudes related to freedom to take risk and paternalism.	Nævestad, Laiou, et al. (2019); Nævestad, Phillips, et al. (2019); Nævestad et al. (2020, 2022a, 2022b, 2025); Abubakari et al. (2025)
Regional/local level: alcohol and risk-behaviour culture	TSC is operationalised through local or regional norms, values, attitudes and beliefs related to alcohol, cannabis, DUI, speeding and mobile phone use. Some studies use register-based proxies such as alcohol consumption, religious composition or presence of large football universities, while others use survey measures of perceived risk, acceptability and support for enforcement or legislation.	Stringer (2018); Islam et al. (2017); Otto et al. (2021); Benzaman et al. (2022)
Regional/local level: school traffic culture	Local TSC is operationalised as descriptive norms concerning driver behaviour around schools, especially in relation to the implementation of the Heart Zone concept. Culture is measured through shared expectations about how drivers behave in the school environment.	Milch & Nævestad (2024)
Regional/local level: regional safety climate	TSC is operationalised as regional or local safety climate, capturing shared perceptions and expectations within a geographically defined road traffic context.	Luria et al. (2014)
Family level: Family Climate for Road Safety Scale (FCRSS)	Family-level TSC is operationalised as family road safety climate, measured through young drivers' and/or parents' perceptions of modelling, feedback, communication, monitoring, non-commitment to safety, safety messages and, in some versions, limits. These dimensions capture how family interaction, parental	Taubman-Ben-Ari & Katz-Ben-Ami (2012, 2013); Taubman-Ben-Ari et al. (2014); Taubman-Ben-Ari (2015, 2016); Skvirsky et al. (2017); Burns et al. (2020, 2022); Doncel et al. (2023); Awad-Yassin & Taubman-Ben-Ari (2024); Cui

Cultural level and line of research	Operationalisation of culture	References
	behaviour and parental commitment shape young drivers' safety behaviour.	et al. (2024); Ma et al. (2024); Awad-Yassin & Ben-Ari (2025); Zhang et al. (2025)
Peer level: Safe Driving Climate among Friends (SDCaF)	Peer-level TSC is operationalised as safe driving climate among friends. The SDCaF measures friends' pressure while driving, social costs of driving with friends, communication between friends about driving, and shared commitment to safe driving. These dimensions capture direct peer influence, social pressure, communication and shared responsibility.	Guggenheim & Taubman-Ben-Ari (2018); Skvirsky et al. (2017); Feng et al. (2021); Padilla et al. (2023); Ma et al. (2024); Li et al. (2025)

TABLE 8 | Overview of the main lines of TSC research identified in the review of TSC research at different levels.

3.3. Aspects that are particularly important for safety outcomes

This chapter relates to aim 1c, which is identification of the cultural aspects which seems to be most important for traffic safety outcomes. Table 9 summarises the cultural aspects that appear most relevant for traffic safety behaviour and safety outcomes across the reviewed lines of TSC research. The table should be interpreted cautiously, because the studies differ in cultural level, operationalisation, method and outcome measures. Nevertheless, it provides an overview of which cultural aspects that are most consistently linked to behaviour, crashes or other safety-relevant outcomes.

Cultural level / line of research	Cultural aspects most clearly related to safety outcomes	Main findings regarding behaviour and safety outcomes	References
Continental / cross-continental level	Descriptive norms related to traffic violations, fatalistic beliefs, freedom to take risk, and valuation of motorised transport compared with walking	Descriptive norms related to traffic violations, fatalistic beliefs and freedom-to-take-risk attitudes are related to car drivers' road safety violations, and violations are related to crash involvement. The largest cultural differences between African and European country respondents are found for fatalistic beliefs and valuation of motorised transport over walking.	Nævestad et al. (2025)
National level: Hofstede dimensions	Power distance and individualism; long-term orientation in one study	Cross-country comparison studies suggest that national cultural differences can explain some differences in fatality rates. Power distance and individualism are the most consistently related dimensions, while long-term orientation is found to be relevant in one study.	Gaygisiz (2010); Van den Berghe et al. (2020); Arslan & Özkan (2024)
National level: Schwartz' cultural values	Embeddedness, hierarchy, egalitarianism, autonomy and mastery	Some Schwartz value dimensions are related to national fatality rates. Embeddedness, hierarchy and egalitarianism are related to fatality rates in more than one study, while autonomy and mastery are identified in individual studies.	Gaygisiz (2010); Arslan & Özkan (2024); Atchley et al. (2014)
National level: road traffic culture as	Written, oral and auditive culture in some studies;	The evidence is weak and inconsistent. Some relationships are found between culture and behaviour or crashes, but the pattern differs	Rundmo et al. (2012); Nordfjærn et

Cultural level / line of research	Cultural aspects most clearly related to safety outcomes	Main findings regarding behaviour and safety outcomes	References
symbol exchange	fatalistic attributions in related studies	across countries and studies. The practical implications are unclear.	al. (2012a, 2012b, 2014)
National level: culture as country background among immigrants	Country background, interpreted as partly reflecting cultural differences	Studies treating culture as country background find relationships between background, safety-relevant behaviour and crash involvement. These differences are assumed to be partly related to cultural differences.	Chen et al. (2012); Uzundu et al. (2020)
National level: Traffic Climate Scale (TCS)	External affective demands, internal requirements and functionality	TCS dimensions are generally related to driver behaviour, but relationships with crash involvement are weaker and less consistent. Two studies find statistically significant but weak direct relationships with crashes, one finds no relationship, and one indicates an indirect pathway through DBQ behaviour.	Gehlert et al. (2014); Chu et al. (2019); Atombo & Wu (2022); Öztürk et al. (2022)
National level: DBQ-based descriptive norms	Descriptive norms for aggressive violations and other violations; values/attitudes related to individual freedom to take risk	Descriptive norms for violations are related to self-reported violations, such as speeding, DUI and non-use of seat belts. Values and attitudes related to individual freedom to take risk are also related to risky behaviour. Behaviour is related to self-reported crash involvement. Descriptive norms for compliance and politeness show weaker or no relationships.	Nævestad et al. (2019a, 2019b, 2020, 2022a, 2022b); Abubakari et al. (2025)
Regional/local level: alcohol and cannabis-related culture	Alcohol culture, cannabis-related attitudes, values and beliefs, alcohol consumption, religious composition, local drinking contexts	Relationships are found between alcohol/cannabis-related cultural indicators and DUI behaviour or DUI fatalities. Register-based indicators such as alcohol consumption, religion and university drinking culture are used as proxies for local alcohol culture.	Stringer (2018); Islam et al. (2017); Otto et al. (2021)
Regional/local level: broader state/county-level indicators	Alcohol consumption, legislation, political voting patterns, rural road length, health-care capacity and other contextual indicators	Fatality rates are related to a broad set of state/county-level variables that may partly reflect traffic safety culture or contextual conditions. These should be interpreted cautiously, as they are proxy indicators rather than direct measures of TSC.	Benzaman et al. (2022)
Local level: school traffic culture	Descriptive norms for driver behaviour around schools; knowledge and implementation of the Heart Zone concept	Descriptive norms around schools are related to improved behaviour and fewer dangerous traffic situations. The relationship appears to be connected to implementation and knowledge of the intervention.	Milch & Nævestad (2024)

Cultural level / line of research	Cultural aspects most clearly related to safety outcomes	Main findings regarding behaviour and safety outcomes	References
Family level: Family Climate for Road Safety Scale	Parental modelling and parental non-commitment; to a lesser extent messages, feedback, monitoring and limits	Family climate is related to self-reported crash involvement in one study. Across behaviour studies, modelling and non-commitment are generally the most important FCRSS factors for young drivers' behaviour.	Taubman-Ben-Ari & Katz-Ben-Ami (2012, 2013); Taubman-Ben-Ari et al. (2014); Taubman-Ben-Ari (2015, 2016); Skvirsky et al. (2017); Burns et al. (2020, 2022); Doncel et al. (2023); Awad-Yassin & Taubman-Ben-Ari (2024); Cui et al. (2024); Ma et al. (2024); Awad-Yassin & Ben-Ari (2025); Zhang et al. (2025)
Peer level: Safe Driving Climate among Friends	Friends' pressure, shared commitment, social costs and communication	Peer-group TSC is related to self-reported PDO crashes, near misses and violations in one study, although not to injury crashes. Friends' pressure appears particularly important. Other studies find relationships between peer climate, risky driving, driving styles and resistance to peer pressure.	Guggenheim & Taubman-Ben-Ari (2018); Skvirsky et al. (2017); Feng et al. (2021); Padilla et al. (2023); Ma et al. (2024); Li et al. (2025)
Micro level: subcultures	Positive attitudes, norms and values related to speeding; "invulnerable and sensation-driven" profile	Subcultures with more positive attitudes, norms and values related to speeding have more speed-related crashes, especially when combined with an "invulnerable and driven by sensation" profile.	Coogan et al. (2014)

TABLE 9 | Traffic safety culture elements and aspects that are particularly important for safety outcomes in the review of TSC research at different levels.

Overall, the table shows that it is difficult to identify one single cultural aspect that is most important across all levels and lines of research. Moreover, in the studies, it is often not clear whether TSC is a predictor, mediator, or moderator variable. However, shared norms describing expected and acceptable traffic behaviour emerge as a recurring mechanism across several levels. At the national and continental levels, descriptive norms, broad values, fatalistic beliefs and attitudes toward freedom to take risk appear important. At the regional and local levels, alcohol-related norms, values and attitudes are central. At the family and peer levels, the most important mechanisms are more direct and interaction-based, including modelling, non-commitment, peer pressure and shared commitment. This supports the broader conclusion that TSC influences safety outcomes mainly through behaviour, but that the relevant cultural aspects and mechanisms vary across cultural group levels.

3.4. Mechanisms between Traffic Safety Culture and safety performance

This chapter relates to aim 1d, which is to describe assumed mechanisms between safety culture and safety outcomes (e.g. traffic safety behaviours, crashes). Thus, this section can shed light on and explain the relationships identified in the previous section. These relationships are also studied in TRUST Deliverable 2.2b (Nævestad et al., 2026), focusing on the relationship between TSC and safety performance.

As described in Section 2.1.4, the reviewed studies were coded for TSC elements, TSC aspects, measurement approaches, traffic safety behaviour, crashes or other safety outcomes, hypothesised relationships and results, factors influencing TSC, and assumed mechanisms. This was followed by a qualitative/thematic analysis across cultural group levels, including national, regional/local, family and peer levels. The identification of mechanisms in this section is therefore based on both the coding of the studies, and the subsequent thematic synthesis of how the studies explain, assume or imply relationships between TSC, behaviour and safety outcomes.

The starting point for the review was the causal chain in which system-level factors may influence TSC, TSC may influence traffic safety behaviour, and traffic safety behaviour may influence crashes or other safety outcomes. In this review, we define a mechanism as the assumed causal process through which a cultural element/aspect is translated into safety performance (e.g. traffic safety behaviour or crashes). It is important to have a general approach to mechanisms in the review of studies, defining it as something that may explain the relationship between TSC and safety performance in general, as not all the studies measure behaviour or crashes. Some studies focus on the individual level, examining individuals' perception of TSC, individual behaviours and individuals' crash involvement (e.g. Nævestad et al., 2019a). Other studies, on the other hand, focus on the macro level, relying only on TSC and crashes (e.g. Gaygisiz, 2010; Arslan & Özkan, 2024).

The mechanisms were identified in three ways. First, we registered mechanisms that were explicitly described in the reviewed studies, for example when studies referred to, perceived risk, social pressure, modelling, communication, parental monitoring or peer influence. Second, we inferred mechanisms from the way culture and behaviour were operationalised and related in the studies. For example, studies measuring expectations about other drivers' violations were interpreted as involving a descriptive-norm mechanism; studies of fatalistic beliefs were interpreted as involving perceived controllability and responsibility attribution; and family and peer climate studies were interpreted as involving socialisation, modelling, monitoring, communication and peer pressure. Third, we compared these inferred mechanisms across cultural group levels and organised them thematically, using the causal chain and the TRUST definition of TSC as analytical guides.

Thus, the mechanisms presented in Table 10 should be understood as hypothesised mechanisms. In some studies, they are explicitly formulated and empirically examined, while in others they are implicit in the study design, measurement instruments or interpretation of results. The table therefore does not claim that all mechanisms have been directly tested, but summarises the causal processes that are assumed, suggested or implied across the reviewed literature.

Level	Line of research within level	Assumed mechanism between Traffic Safety Culture and safety performance	References (author, year)
Continental	Descriptive norms (DBQ-based)	Perceived prevalence of behaviours, such as violations, creates social norms and expectations. These norms involve subtle normative pressure to conform to what is perceived as common or normal behaviour in traffic. If risky behaviours are perceived as common, road users may be more likely to engage in similar behaviours.	Nævestad et al. (2025)
Continental	Fatalistic beliefs	Fatalistic beliefs may influence behaviour by shaping road users' understanding of causality, responsibility and controllability. If crashes are perceived as caused by fate, destiny, luck or divine will, road users may experience lower personal responsibility and lower perceived control over safety outcomes. This may weaken motivation to engage in protective behaviour.	Nævestad et al. (2025)
Continental	Valuation of vulnerable road users	The social valuation of vulnerable road users may influence behaviour by shaping whose safety is regarded as important and legitimate in traffic. If pedestrians or other vulnerable road users are given low social status, drivers may be less likely to adapt their behaviour, yield, reduce speed or treat them as legitimate road users. Conversely, higher valuation of vulnerable road users may support more protective and considerate behaviour toward pedestrians and cyclists.	Nævestad et al. (2025)
Continental	Valuation of freedom to take risk	Values related to individual freedom to take risk may influence behaviour by legitimising risky road user choices and reducing acceptance of restrictive safety measures. If road users believe that individuals should be free to decide their own level of risk in traffic, they may be more likely to engage in violations or oppose measures such as speed limits, alcohol limits, seat belt requirements or enforcement. In this case the mechanism is that the values legitimise risky behaviour.	Nævestad et al. (2025)
National	Hofstede's cultural dimensions	National cultural dimensions are assumed to shape orientations toward authority, uncertainty, responsibility, risk and rule compliance, thereby influencing road-user behaviour and ultimately safety outcomes. The specific pathways differ between studies and are often inferred rather than directly tested; governance quality and income may condition the extent to which cultural characteristics influence behaviour and crashes.	Gaygisiz (2010); Van den Berghe et al. (2020); Arslan & Özkan (2024); Atchley et al. (2014); Melinder (2007)
National	Schwartz' cultural values	Schwartz's cultural values may influence road safety through perceived equality and legitimacy of rules, concern for others, and competitive versus cooperative orientations. Hierarchy may weaken rule compliance when laws and sanctions are perceived as status-dependent, while mastery may promote	Arslan & Özkan (2024); Gaygisiz (2010)

Level	Line of research within level	Assumed mechanism between Traffic Safety Culture and safety performance	References (author, year)
		self-assertion and competition in traffic. Embeddedness may also be related to speeding under particular governance and income conditions. Governance quality may constrain these cultural influences on behaviour and safety outcomes.	
National	Traffic culture as symbol exchange	Dominant communication/meaning systems (e.g. visual, oral) shape e.g. how rules are understood and transmitted, and how danger and safety is interpreted, plus fatalism affects perceived control, influences compliance and responsibility, and behaviour and crash risk.	Rundmo et al. (2012); Nordfjærn et al. (2012a); Nordfjærn et al. (2014)
National	Traffic Climate Scale (TCS)	Perceptions of traffic system (stress, skill demands, functionality) influence attitudes, perceived control, and behavioural intentions (TPB), shape driving behaviour, which in turn indirectly affect crashes.	Gehlert et al. (2014); Chu et al. (2019); Feng et al. (2021); Atombo & Wu (2022); Öztürk et al. (2022); Kacan-Bibican et al. (2025)
National	Descriptive norms (DBQ-based)	Perceived prevalence of behaviours (e.g. violations) creates social norms and expectations, which involves normative pressure to conform, and leads to increased or reduced risky behaviour, which in turn influences crash involvement.	Nævestad et al. (2019a,b); Nævestad et al. (2020); Nævestad et al. (2022); Abubakari et al. (2025)
Regional / Local	Alcohol and risk behaviour culture (register-based & survey)	Local norms, values, and environmental factors (e.g. alcohol culture, religion) shape acceptability of risky behaviours (e.g. DUI), influence individual attitudes and behaviour, which in turn affect local crash rates.	Stringer (2018); Benzaman et al. (2022); Otto et al. (2021)
Regional / Local	Attitudes, beliefs, and policy support (survey-based)	Perceived risk, acceptability, and support for enforcement influence intentions and compliance shape behaviours such as DUI, speeding, phone use, which in turn influence safety outcomes.	Schlembach et al. (2016); Otto et al. (2021)
Peer	Safe Driving Climate among Friends (SDCaF)	Peer norms operate via social pressure, shared responsibility, and communication, influence risk-taking or safe driving, which in turn affect violations and crash risk.	Li et al. (2025); Ma et al. (2024); Padilla et al. (2023)
Peer	Peer pressure & resistance mechanisms	Peer climate influences ability to resist pressure, which moderates impact of norms on behaviour, which in turn affects engagement in risky driving.	Li et al. (2025); Padilla et al. (2023)
Family	Family Climate for Road Safety (FCRSS)	Socialisation processes: modelling, communication, monitoring, feedback leads to internalisation of safety norms, shape attitudes and behaviour, which in turn influence crash risk.	Cui et al. (2024); Awad-Yassin & Taubman-Ben-Ari (2024); Awad-Yassin & Ben-Ari (2025)
Family	Parental commitment vs. non-commitment	Strong vs. weak safety orientation affects norm internalisation and behavioural regulation, influences risky vs. safe driving behaviour.	Cui et al. (2024); Awad-Yassin & Taubman-Ben-Ari (2024)

TABLE 10 | The different hypothesised mechanisms between traffic safety culture and crashes within the different lines of research at the different levels.

Across the different cultural group levels, the mechanisms linking TSC to crashes become increasingly direct and concrete. At the national level, relatively abstract cultural values shape general social norms, which in turn influence behaviour indirectly. At the peer and family levels, the mechanisms are most direct, operating through face-to-face interaction, socialisation, and interpersonal influence, where behaviour is shaped through modelling, communication, and direct social pressure. This is also related to the fact that the smaller social units are more tangible and well defined. Thus, mechanisms involving e.g. direct communication and modelling become more relevant for cultural influence.

3.5. Methodological strengths and weaknesses of the reviewed studies

Self-reported data versus register data. The review includes studies based on very different types of data, ranging from register-based analyses to self-reported survey studies. When it comes to self-reported data, many studies use questionnaires to assess culture, behaviour, and attitudes, and these are often not properly validated and are not always clearly defined theories and concepts. This is because this is a relatively new research field. When relationships between different concepts are investigated, self-reporting of behaviour, violations, and crashes may lead to systematic bias. Bias may arise from different sources, e.g. social desirability. Relationships between culture, subjective variables and behavioural variables can therefore be overestimated.

Studies that are based on register data yield more objective results than self-reported data, especially for crash involvement. However, register data cannot include subjective variables like perceptions, expectations, attitudes, or behavioural styles. Another weakness of most register-based studies is that the role of the measured variables often is very unclear, i.e. whether they are background variables, a part of TSC, or consequences of TSC (outcome variables). For example, in the study by Melinder (2007), Catholicism and economic factors were found to be important for road fatalities, but it is unclear if they are included in the definition of TSC, background variables, or moderator variables.

To sum up, while register-based studies typically provide more objective and reliable data on crashes, they often lack direct measurements of TSC and instead rely on proxy indicators. In contrast, survey-based studies offer more detailed and direct insights into TSC, including attitudes, norms and behaviours, but often depend on self-reported crash data, which may be subject to bias and reduced validity. This creates a methodological paradox: studies with high-quality crash data often lack robust measures of culture, whereas studies with strong cultural measures tend to rely on less reliable crash data. As a result, each approach has complementary strengths and weaknesses, complicating efforts to draw firm conclusions about the relationship between TSC and crash outcomes.

At the same time, proxy indicators should not be dismissed. Some proxies may be useful for measuring aspects of TSC, especially when they are theoretically well justified, objectively measured, geographically comparable, and available over time. This may apply, for example, to indicators related to alcohol culture, religion, alcohol consumption, enforcement, legislation, or other contextual factors, as in Stringer's (2018) study of alcohol-related culture and DUI fatalities. Identifying valid and theoretically grounded proxy indicators for TSC is therefore an important issue for future research.

Different types of crashes are included in the different types of data sources. The above-mentioned discussion also relates to the type of crash data that is measured across data sources, which has implications for comparisons. The reason is that the TSC aspects and behaviours that influence minor crashes are not necessarily the same as those influencing severe crashes. The latter are also included in the self-reported data, while the register data includes severe crashes. Self-reported survey data typically capture a broad range of incidents, including minor and property-damage-only crashes, partly because

fatal crashes are rare and individuals involved in fatal crashes cannot participate in surveys. In contrast, register-based studies often rely on officially recorded data, which more frequently emphasise fatalities or severe injuries. This discrepancy leads to inconsistencies in the types and severity of crashes being analysed across studies, introducing a systematic bias when comparing findings derived from different data sources. As a result, observed relationships between TSC and crash outcomes may not be directly comparable, and caution is required when interpreting or synthesising results across studies using self-reported versus register-based data.

Can we trust self-reported data (about behaviour)? Meesmann et al. (e.g. 2024) provide several different comparisons of self-reported data from the ESRA surveys, which are compared with different types of more objective data, e.g. observed behaviours (Key Performance Indicators) from projects such as Trendline and Baseline. In a recent study presented at the IRTAD 2026 conference, they compare observed behaviour (baseline KPIs) and self-reported behaviour, alongside attitudinal dimensions. The aim is to assess the validity of self-reported measures and to better understand how psychological factors relate to actual traffic behaviour. The results show that self-reported behaviour generally corresponds moderately to strongly with observed behaviour, particularly for speeding and drink driving. They therefore conclude that self-reports can serve as a useful, though imperfect, proxy for real-world actions. However, the strength of this relationship varies by context and behaviour, with weaker or absent correlations in some cases (e.g., urban speeding), indicating limitations in relying solely on self-reported data. Overall, while self-reported measures provide valuable insights, especially when combined with attitudinal variables, they should be interpreted with caution and ideally complemented by objective behavioural data to obtain a more accurate picture of traffic safety behaviour.

Can relationships between self-reported constructs be overestimated? Self-reported measures of behaviour and constructs such as attitudes and norms may lead to overestimated relationships between variables. This is partly due to several forms of bias inherent in self-report data. For example, the false consensus effect suggests that individuals tend to overestimate the prevalence of their own behaviours among others, which can serve to justify their actions (Cialdini et al., 1990). Likewise, according to the cognitive dissonance principle, people may adjust their reported attitudes or perceptions to align with their behaviour. This can create artificial consistency between variables. Thus, when both predictors (e.g., attitudes, norms) and outcomes (e.g., behaviour) are measured using the same methods, different types of bias can influence the results and observed associations. Consequently, studies relying exclusively on self-reported data may report stronger relationships between constructs than actually exist, because common method bias can inflate measured associations when both predictors and outcomes are collected through self-reports.

The importance of study design. Some studies have explicit or implicit assumptions about causality, but in almost all studies the study design does not allow the validation of assumptions about causality. In most studies, causal relationships can theoretically be in more than one direction. Different study designs can be used to investigate TSC, most notably longitudinal and cross-sectional designs. Longitudinal designs involve repeated measurements over time and are particularly valuable for examining causal relationships. For example, researchers can first measure TSC and subsequently follow participants to assess changes in traffic safety behaviour and crash involvement over time. Such designs strengthen causal inference, as they allow researchers to establish temporal order, i.e., whether cultural factors precede behaviour, and whether behaviour precedes crashes. By doing this, we might avoid some of the abovementioned methodological biases associated with self-reported data, such as “artificial” relationships between constructs, because of false consensus or cognitive dissonance.

In contrast, cross-sectional designs measure all variables at a single point in time, which limits the ability to determine what comes first. As a result, causal interpretations are uncertain. Moreover, cross-sectional

studies relying on self-reports are particularly vulnerable to biases. For instance, the false consensus effect may lead individuals to overestimate the prevalence of risky behaviour among other road users. Additionally, cognitive dissonance mechanisms may cause individuals, especially those who have been involved in crashes, to adjust their reported attitudes or behaviours to align with their experiences, potentially overestimating their own engagement in risky behaviour. This is at least some hypothetical mechanisms that may be relevant. There is only one longitudinal study in our review (Stringer 2018), indicating a need for more studies of this kind.

Many studies lack clear definitions and distinctions between constructs such as culture, perceptions, attitudes, behaviours, and habits. For example, it is often not clear whether certain types of driver behaviour are regarded as a part of TSC or affected by TSC (Jung et al., 2019). Also, most studies make no clear distinction between predictor, moderator, mediator, and outcome variables. Many studies investigate relationships between many different variables, often with the aim of finding clusters, factors or generally related concepts.

3.6. Summary

This chapter has mapped research on TSC among private road users across several cultural group levels, including continental, national, regional/local, family, and peer-group contexts. The reviewed studies differ considerably in how they define, operationalise, and measure TSC, ranging from broad national values to descriptive norms, traffic climate, local alcohol-related culture, family climate, and peer influence. Despite this heterogeneity, the studies share a common causal logic: TSC is generally assumed to influence crashes indirectly through road user behaviour. Culture matters because it shapes how road users interpret risk, attribute responsibility, evaluate rules and safety measures, perceive what others normally do, and decide how to behave in traffic. Shared norms emerge as a particularly important mechanism across levels. The evidence suggests that several cultural elements are related to safety-relevant behaviour, and in some studies also to crash involvement. However, the strength and consistency of the evidence vary. Many studies rely on cross-sectional survey data, self-reported behaviour, and self-reported crashes, while register-based studies often use indirect proxy measures of culture. Overall, the review provides moderate support for a relationship between TSC, behaviour, and crashes, but highlights the need for more longitudinal, multi-method, and theoretically explicit studies.

4. Development of a conceptual model

4.1. The core components of the conceptual model

The conceptual model has four core components:

1. **Cultural groups / social ecology:** Individuals simultaneously belong to multiple cultural groups, such as national, regional/local, organisational, family, and peer groups. We could also add e.g. religious groups.
2. **Cultural elements:** Each group possesses a TSC consisting of shared values, beliefs, norms, attitudes, and patterns of behaviour, in line with the TRUST definition (Nævestad et al., 2026). The specific aspects of TSC differ across cultural groups.
3. **Cultural mechanisms:** The review indicates that culture does not influence behaviour directly. Rather, it operates through mechanisms such as social pressure, social identity, modelling, communication, monitoring, perceived legitimacy, responsibility attribution, and risk perception. These mechanisms differ across levels, but they perform the same general function: translating group membership into individual behaviour.
4. **Causal chain and behavioural pathway:** The model is organised as a causal chain linking system factors, cultural elements, cultural mechanisms, behaviour, and safety outcomes. Within this broader causal chain, the behavioural pathway explains how TSC is translated into behaviour: cultural elements influence psychological and social mechanisms, which shape willingness and intentions. Behaviour then affects safety outcomes such as crashes, injuries, and near misses.

An important implication of the model is that it can be used to guide intervention development. Because the model specifies a causal chain linking social ecology, cultural elements, mechanisms, behaviour, and safety outcomes, it helps identify where interventions may be introduced and which mechanisms they should target. Interventions may therefore address:

- Broader system factors of the social ecology, such as legislation, enforcement, infrastructure, education, religion or policies, or
- Cultural elements, such as shared values, beliefs, norms, attitudes, and patterns of behaviour, or
- More proximal mechanisms, such as risk perception, perceived legitimacy, social pressure, modelling, communication, willingness, and intentions.

In this sense, the model provides a mechanism-based foundation for designing TSC interventions.

4.2. Social ecological model

Our review of TSC research shows that the importance of group membership is a common core across studies at different cultural levels. We refer to this as the “social force” of culture, whereby cultural membership shapes both behaviour and interpretation. Membership in a social group may influence individuals’ traffic safety behaviour, contributing to both safer and riskier patterns of behaviour in traffic. The reviewed studies identify several mechanisms linking safety culture to traffic safety behaviour at different cultural levels. What these mechanisms have in common is that they arise from membership in cultural groups and from the social influence exerted by these groups. This influence operates through different mechanisms at different analytical levels, such as social pressure, modelling, communication,

monitoring and social identity. However, these mechanisms are often assumed rather than explicitly measured in the studies.

This emphasis on group membership is consistent with the social ecological model, which views behaviour as the product of interacting influences across multiple social levels rather than solely as an individual characteristic. Our review indicates that road users belong to several cultural groups simultaneously, including national, regional/local, organisational, peer, and family groups. Some of these groups may vary in the course of a lifetime. These groups may each influence how road users interpret traffic situations and how they behave in traffic.

The social ecological perspective builds on Bronfenbrenner's ecological systems theory, which conceptualises human development and behaviour as shaped by nested and interacting social environments, ranging from immediate interpersonal settings to broader institutional, societal, and cultural contexts (Bronfenbrenner, 1979). This perspective has also been applied to TSC research by Ward et al. (2019), who argue that TSC should be understood within a social ecological framework. Their model emphasises that road users are embedded in multiple social groups and that traffic safety outcomes emerge from the combined actions and influences of stakeholders operating at different levels of the social ecology, including individuals, interpersonal relationships, organisations, communities, and broader societal and policy contexts.

Building on this perspective, we have developed our own social ecological model of TSC, based on the reviewed studies (Figure 5). The model illustrates how multiple cultural group memberships may influence traffic safety behaviour through shared cultural elements, such as values, beliefs, norms, attitudes, and patterns of behaviour, and through psychological and social mechanisms that translate these cultural influences into willingness, intentions, behaviour, and ultimately safety outcomes. It is important to remember that the figure is a simplification, and that hierarchical grouping logic (shown on the left) is a simplification and that in reality the lines between the subsets could be different (e.g. organisational level could be larger than national).

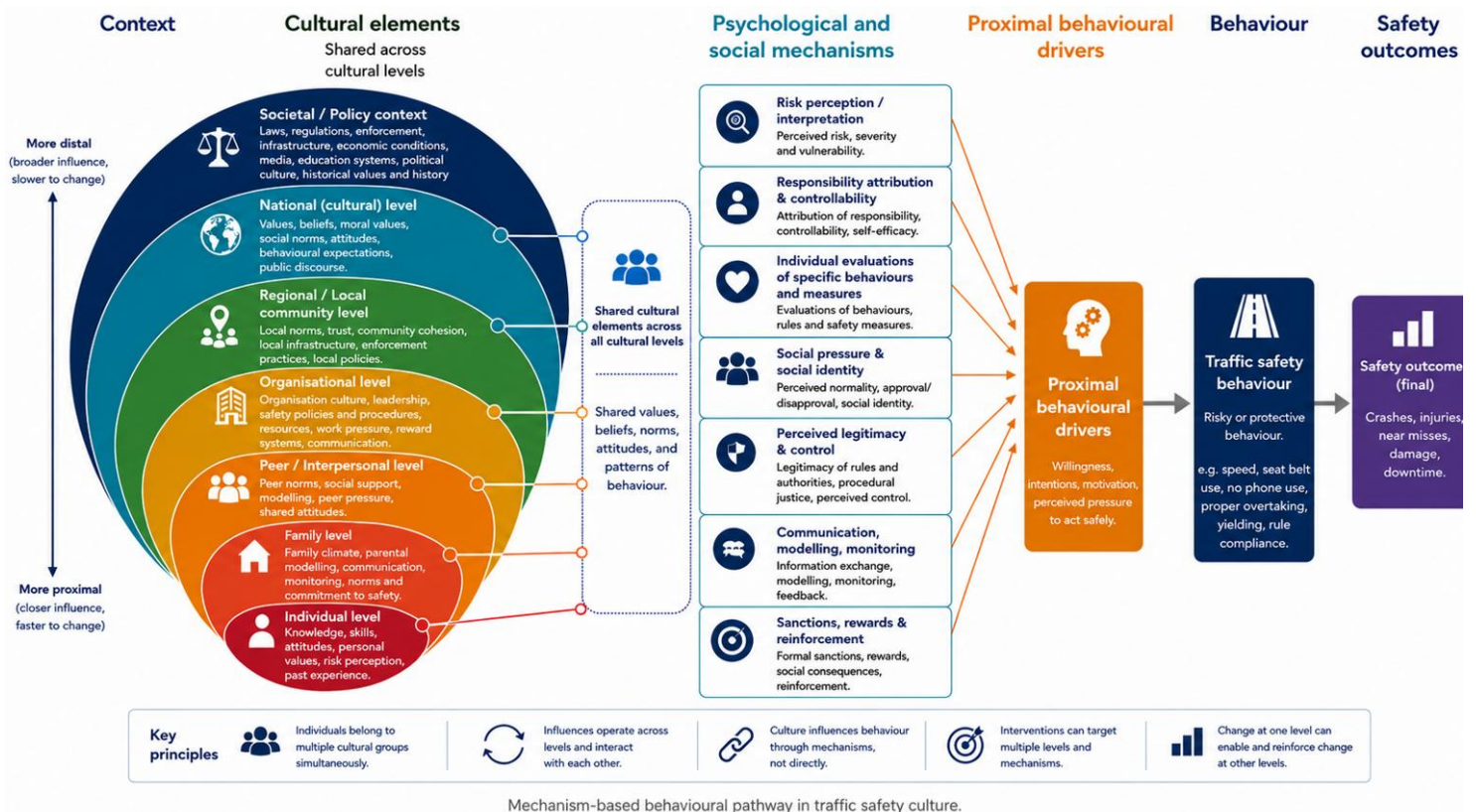


FIGURE 5 | Social ecological model of traffic safety culture, developed in the TRUST project. Inspired by Bronfenbrenner (1979) and Ward et al. (2019). Figure developed with assistance from ChatGPT-5.4.

Whereas a classical social ecological model primarily identifies where cultural influences originate, our model seeks to specify how these influences affect traffic safety behaviour. Ward et al. (2019) also address behavioural explanation, for example by combining the social ecological perspective with additional behavioural and cultural models (cf. Ward et al., 2023). However, the contribution of our review is to integrate the mechanisms identified across the reviewed TSC studies into one common mechanism-based framework. Across the reviewed studies, these mechanisms include social pressure, responsibility attributions, perceptions of legitimacy and control, social identity, modelling, communication and monitoring. The model therefore links different ecological levels to individual behaviour through explicit causal mechanisms.

This mechanism-based perspective represents the main conceptual contribution of our review. It integrates findings from previously fragmented lines of TSC research into a common causal framework, showing how cultural influences operating at different social levels may be translated into traffic safety behaviour and, ultimately, safety outcomes. Our conceptual model therefore complements Ward et al.'s (2019) social ecological framework by specifying the behavioural pathways through which cultural group membership may influence road users. We do this through a synthesis of the mechanisms found across the reviewed studies, using these to explain the relationships between TSC and traffic safety behaviour at different cultural levels.

4.3. Causal chain and behavioural pathway

Figure 6 elaborates the behavioural pathway presented on the right-hand side of Figure 5 by specifying the cultural elements and mechanisms involved.

Our conceptual model describes TSC as part of a broader causal chain, where system-level factors influence cultural elements, cultural elements influence traffic safety behaviour through mechanisms, and behaviour in turn influences safety outcomes. In this section, we specify this causal chain further by focusing on the behavioural pathway linking TSC to individual road user behaviour. Figure 6 illustrates this mechanism-based behavioural pathway.

Before presenting the model, it is necessary to clarify why the cultural part of the model is organised into three main categories: shared beliefs, shared moral values and attitudes, and shared social norms and patterns of behaviour. This distinction is based on both the TRUST definition of TSC (Nævestad et al., 2026) and the patterns identified in the review. The TRUST definition identifies shared values, beliefs, attitudes, norms and patterns of behaviour as core cultural elements. To simplify the behavioural pathway, Figure 6 groups these five elements into three broader categories: beliefs; moral values and attitudes; and social norms and patterns of behaviour. Social norms refer to shared expectations about appropriate and typical behaviour, whereas patterns of behaviour refer to the recurring and normalised practices observed within the group.

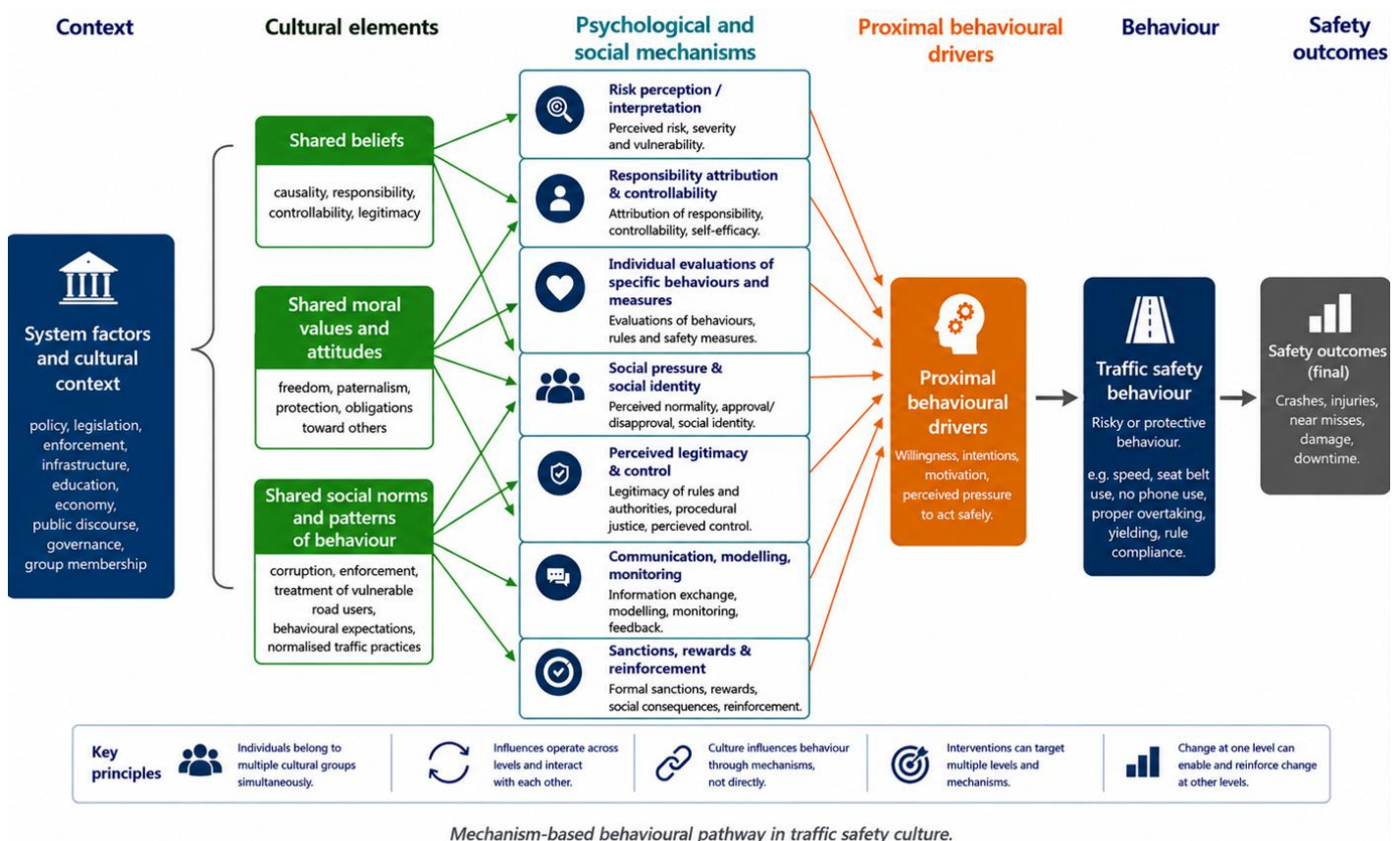


FIGURE 6 | Model of behavioural pathway in the conceptual model of traffic safety culture. This model is inspired by Ward et al.'s (2020) model of prosocial behaviour and traffic safety culture. Figure developed with assistance from ChatGPT-5.4. Figure 6 provides a detailed representation of the behavioural pathway included in the social ecological model in Figure 5

The behavioural model implicit in our framework can be described as a causal chain, with several different levels.

System-level factors, such as infrastructure, policy, enforcement, religion, education, legislation, governance quality, and economic conditions, may influence TSC by shaping the conditions under which road users interpret risk, rules, responsibilities, and acceptable behaviour. These system factors are identified across several lines of research as potentially important influences on TSC, although they are often discussed as contextual or background conditions rather than tested directly. Examples include studies linking national cultural values, governance quality, and economic conditions to road safety performance (Gaygisiz, 2010; Van den Berghe et al., 2020; Arslan & Özkan, 2024; Nævestad et al., 2025), studies discussing enforcement, education, and infrastructure as influences on national TSC (Nævestad et al., 2019a, 2020, 2022), and studies of continent-level differences where enforcement legitimacy, infrastructure, governance, and vehicle safety are treated as important contextual factors shaping **Traffic Safety Culture** (Nævestad et al., 2025; Van den Berghe, 2026). Studies also point to broader societal and cultural factors, such as religion, most clearly in Stringer's (2018) study of alcohol culture and DUI fatalities, and in cross-continental comparisons such as Nævestad et al. (2025). Benzaman et al. (2022) also includes broader contextual indicators, such as alcohol consumption, legislation, political voting patterns, rural road length, and health-care capacity, but these should be interpreted as contextual correlates rather than direct measures of TSC.

Traffic Safety Culture. Shared beliefs concern causality, responsibility, controllability, and legitimacy. These elements are visible in studies of fatalistic attributions and destiny orientation, where crashes may be understood as caused by fate, destiny, or divine will rather than by preventable risk factors (Nordfjærn et al., 2012a, 2012b, 2014; Nævestad et al., 2025). They may also be reflected in studies of traffic climate, where road users' perceptions of traffic as dangerous, stressful, unpredictable, functional, or safe are assumed to shape attitudes, intentions, and behaviour (Gehlert et al., 2014; Chu et al., 2019; Öztürk et al., 2022).

Shared moral values and attitudes refer to collective judgements about what is right, fair, acceptable or obligatory in traffic. They concern issues such as freedom, paternalism, protection, equity/non-discrimination, responsibility and obligations toward others. These issues are addressed in studies of national cultural values, including individualism, power distance, embeddedness, hierarchy and egalitarianism (Atchley et al., 2014; Gaygisiz, 2010; Van den Berghe et al., 2020; Arslan & Özkan, 2024), and in studies of freedom to take risk and acceptance of restrictive traffic safety measures (Nævestad et al., 2022; Van den Berghe et al., 2020). Values are generally measured through more specific attitudes, and we therefore group values and attitudes together. In the mechanism column, individual attitudes are labelled individual evaluations of specific behaviours and measures to distinguish them from attitudes that are shared at the cultural-group level.

Shared social norms concern enforcement, corruption, treatment of vulnerable road users, and behavioural expectations in traffic. These issues are central in DBQ-based descriptive norm studies, where perceived normal behaviour is assumed to influence respondents' own traffic behaviour (Nævestad et al., 2019a, 2019b, 2020, 2022; Abubakari et al., 2025). They are also addressed in studies of pedestrian safety and the valuation of vulnerable road users (Nævestad et al., 2025; Xu et al., 2018; Ward et al., 2020), and in studies where corruption and enforcement legitimacy are identified as important contextual or cultural aspects of TSC (Nævestad et al., 2025; Van den Berghe, 2026). Shared patterns of behaviour are closely related to, and may reinforce, shared norms; we therefore group these two elements together in the model. Patterns of behaviour refer to stable and normalised traffic practices, such as common speeding, drink-driving, seat belt use, mobile phone use, aggression, yielding or compliance.

Mechanisms. The central assumption in the model is that cultural elements do not influence behaviour directly in a simple or mechanical way.³ Rather, they influence behaviour through more specific psychological and social mechanisms, as described in Section 3.4, where we sum up the mechanism. For example, the DBQ-based descriptive norm studies point to perceived normality, social expectations and social pressure; studies of fatalistic beliefs point to risk interpretation, controllability and responsibility attribution; studies of national cultural values point to evaluations of specific measures and behaviours, legitimacy judgements and acceptance of regulation; Traffic Climate Scale studies point to e.g. risk perception, and perceived control; and family and peer studies point to modelling, communication, monitoring, social identity and direct social pressure.

Shared beliefs may shape risk perception and interpretation, as well as responsibility attribution. This is illustrated by studies of fatalistic beliefs, where lower perceived controllability and responsibility may reduce motivation for safe behaviour (Nordfjærn et al., 2012a, 2012b, 2014; Nævestad et al., 2025; Van den Berghe, 2026). Shared moral values and attitudes may shape evaluations of specific behaviours and safety measures, for example attitudes toward speeding, drink-driving, seat belt use, enforcement or restrictive policies (Nævestad et al., 2022; Van den Berghe et al., 2020; Islam et al., 2017; Otto et al., 2021). Shared social norms may influence behaviour when they are perceived by individuals as expectations, approval, disapproval, social pressure, sanctions or rewards. Descriptive norms are especially important in the DBQ-based studies, where expectations about other road users' violations are related to respondents' own self-reported violations (Nævestad et al., 2019a, 2019b, 2020, 2022; Abubakari et al., 2025). Social identity and social pressure are especially visible in studies of peer-group TSC, where friends' pressure, communication and shared commitment are related to risky or safe driving (Guggenheim & Taubman-Ben-Ari, 2018; Padilla et al., 2023; Ma et al., 2024; Li et al., 2025). Similar socialisation mechanisms are also central in family climate studies, where modelling, communication, feedback, monitoring and parental commitment shape young drivers' behaviour (Taubman-Ben-Ari & Katz-Ben-Ami, 2012, 2013; Taubman-Ben-Ari et al., 2014; Taubman-Ben-Ari, 2016; Cui et al., 2024; Ma et al., 2024).

Evaluations of specific traffic safety measures and policies. Individual evaluations of specific traffic behaviours and safety measures are included among the mechanisms in Figure 6. These evaluations may reflect broader shared values and attitudes, such as orientations toward freedom and paternalism. When the object of evaluation is a policy measure, acceptance of or support for that measure may also be treated as a very policy-relevant outcome. Thus, this is a crucial outcome measure in the figure, along with behaviours and accidents. Support for restrictive traffic safety measures is important because public acceptance may influence the political feasibility, introduction and implementation of such measures (Nævestad et al., 2022a; Van den Berghe et al., 2020). This creates a reciprocal relationship: TSC may influence traffic safety policy, while policies and their implementation may in turn influence TSC. For example, the literature has suggested that a relatively strong emphasis on individual freedom and comparatively low acceptance of restrictive safety measures may contribute to explaining both road safety policy and traffic safety outcomes in the United States (Nævestad et al., 2022a).

Proximal behavioural drivers (willingness, intentions etc). Some mechanisms, such as attitudes toward speeding, drink-driving, enforcement, or restrictive policies, fit well with intention-based models such as the Theory of Planned Behaviour, which explains behaviour through attitudes, subjective norms, perceived behavioural control, and intentions (Ajzen, 1991). Other mechanisms, such as peer pressure,

³ In the review, "mechanisms" is used broadly to capture how the reviewed studies explain relationships between TSC and safety performance, whether safety performance is measured as behaviour, crashes, or both. In the conceptual model's behavioural pathway, mechanisms are defined more precisely as the psychological and social processes through which cultural elements influence behaviour, with crashes and other safety outcomes positioned downstream of behaviour.

modelling, monitoring, communication, perceived norms, social identity, risk perception, and perceived legitimacy, may influence behaviour through willingness, situational interpretation, perceived social pressure, internalised norms, or more direct forms of social influence.

The distinction between intentions and willingness is nevertheless useful because traffic behaviour may be both planned and situational. The Prototype Willingness Model highlights more reactive and socially influenced behaviour, especially in situations where behaviour is shaped by social images, peer influence, and perceived norms. This distinction has also been applied in TSC research, for example in studies of prosocial driver behaviour (Ward et al., 2020). Thus, intentions and willingness should be understood as important proximal predictors within a broader behavioural pathway, rather than as mandatory steps in all pathways from TSC to behaviour.

Behaviour. Through these mechanisms, TSC influences individual traffic behaviour, including speeding, driving under the influence, aggressive violations, seat belt use, mobile phone use, yielding behaviour and interaction with vulnerable road users. These behaviours are then linked to safety outcomes such as crashes, injuries, conflicts and near misses. This final part of the causal chain is supported by several studies showing relationships between TSC, self-reported behaviour and crash involvement. DBQ-based studies, for example, find that descriptive norms are related to violations, and that violations are related to crash involvement (Nævestad et al., 2019a, 2020, 2022). Similarly, TCS studies indicate relationships between perceived traffic climate and driver behaviour, while some studies also link traffic climate and DBQ behaviour to crash involvement (Gehlert et al., 2014; Chu et al., 2019; Öztürk et al., 2022). Family and peer climate studies likewise show that social climate is related to driving style, violations, near misses or crashes (Taubman-Ben-Ari & Katz-Ben-Ami, 2013; Padilla et al., 2023; Cui et al., 2024). As noted, TRUST deliverable 2.2b (Nævestad et al., 2026) focuses specifically on the relationship between TSC and safety performance and OSC and safety performance.

The conceptual model conceptualises traffic behaviour as socially embedded. Behaviour is not treated only as an individual choice, but as the outcome of cultural meanings, social expectations and institutional conditions. This is important because it clarifies how TSC can be used as an explanatory concept: culture matters because it shapes how road users interpret risks, attribute responsibility, evaluate safety measures, perceive what others do and approve of, and judge whether rules and enforcement are legitimate. In this sense, the model brings together several research traditions in the review: national value studies, descriptive norm studies, Traffic Climate Scale studies, family climate studies, peer climate studies and studies of local DUI culture.

Safety outcomes. Finally, traffic safety behaviour influences safety outcomes, including crashes, injuries, conflicts and near misses. Several reviewed studies support this final part of the causal chain. DBQ-based studies find that road safety violations are related to crash involvement (Nævestad et al., 2019a, 2020, 2022; Nævestad et al., 2025). Traffic Climate Scale studies show relationships between perceived traffic climate and driver behaviour, and some also examine crash involvement (Gehlert et al., 2014; Chu et al., 2019; Öztürk et al., 2022). Family and peer climate studies likewise show that social climate is related to driving style, violations, near misses or crash involvement (Taubman-Ben-Ari & Katz-Ben-Ami, 2013; Padilla et al., 2023; Cui et al., 2024).

The conceptual model integrates safety culture and climate theory, social ecological and governance perspectives, layered theories of culture, social influence and learning perspectives, the Theory of Planned Behaviour, and mechanism-based middle-range theory to explain how system factors and shared culture shape traffic safety behaviour and outcomes.

The conceptual model in Figure 6 does not directly include aspects of TSC, as there are a wide range of TSC aspects, depending on the cultural group and issue. We provide, however, an example of how the model can be used to measure TSC at the national level in Chapter 4.5. TSC elements are the abstract cultural content, e.g. shared beliefs, moral values, attitudes, norms, patterns of behaviour. TSC aspects are the concrete manifestations or survey-measurable expressions of these elements, such as fatalistic beliefs, freedom to take risk, perceived legitimacy, descriptive norms for speeding, family modelling, peer pressure, monitoring, etc. Mechanisms are the processes through which these elements/aspects influence behaviour, such as risk perception, responsibility attribution, social pressure, modelling and perceived legitimacy.

4.4. How can the model be tested?

4.4.1. Concrete hypotheses that can be used to test the model⁴

The hypotheses below should not be understood as one single model to be tested in one study. Rather, they specify testable propositions derived from the conceptual model, which may be examined in different empirical designs, at different cultural levels, and for different types of road users, behaviours and safety outcomes.

4.4.1.1. Hypotheses to test the causal chain

First, to be able to explain traffic crashes by means of TSC, the causal chain between system factors, culture, behaviour and crashes is crucial. The same applies to the mechanisms between the different levels in the causal chain. Based on our review we can coin in the following hypotheses.

Hypotheses concerning the formation of safety culture

The basic assumption here is that what we call system factors, which are related to safety culture (Hypothesis 1-8).

Macro level formation of Traffic Safety Culture: National Traffic Safety Culture

H1. Cultural foundations. Traffic Safety Culture at the macro level is influenced by broader societal cultural values, such as individualism–collectivism, power distance, embeddedness, hierarchy, egalitarianism, religiosity, fatalism, and orientations toward freedom and authority. This hypothesis is supported by national value studies using Hofstede's and Schwartz' cultural dimensions, studies of fatalistic attributions and destiny orientation, and continent-level studies of fatalism and freedom to take risk (Gaygisiz, 2010; Atchley et al., 2014; Melinder, 2007; Nordfjærn et al., 2012a, 2012b, 2014; Van den Berghe et al., 2020; Arslan & Özkan, 2024; Nævestad et al., 2025).

H2. Institutional and structural foundations. Traffic Safety Culture is influenced by system-level factors such as policy, legislation, enforcement, infrastructure, education, governance quality, economic conditions and vehicle safety. This hypothesis is supported by studies linking governance quality, income level and legislation to road safety outcomes, by studies discussing enforcement, infrastructure and education as factors shaping descriptive norms, and by continent-level studies where enforcement legitimacy, infrastructure, governance and vehicle safety are treated as contextual conditions shaping

⁴ Having clear labels for each hypothesis is very important, to be able to describe and pinpoint them as clear as possible. We have used Chat GPT 5.2 to generate labels for each hypothesis, and for reviewing, revising and specifying suggested hypotheses. This has been helpful to ensure a consistent and precise language.

Traffic Safety Culture (Gaygisiz, 2010; Van den Berghe et al., 2020; Arslan & Özkan, 2024; Nævestad et al., 2019a, 2020, 2022, 2025; Van den Berghe, 2026; Uzundu et al., 2020).

H3. Policy–culture reciprocity. Traffic Safety Culture and traffic safety policy are reciprocally related: policies, enforcement and regulation may shape cultural acceptance of safe behaviour, while cultural values and legitimacy judgements influence support for restrictive measures. This hypothesis is supported by studies of policy support, enforcement legitimacy, support for legislation, paternalism, freedom to take risk and acceptance of restrictive safety measures (Van den Berghe et al., 2020; Nævestad et al., 2022, 2025; Islam et al., 2017; Otto et al., 2021; Arslan & Özkan, 2024).

Meso level formation of Traffic Safety Culture: Regional and local Traffic Safety Culture

H4. Local norm formation. Traffic Safety Culture at the regional and local levels is shaped by repeated interaction, shared practices and local environmental conditions, leading to shared norms and behavioural expectations. This hypothesis is supported by studies of local DUI culture, alcohol and cannabis-related culture, traffic safety around schools and regional/local safety climate (Stringer, 2018; Benzaman et al., 2022; Islam et al., 2017; Otto et al., 2021; Milch & Nævestad, 2024; Luria et al., 2014).

Micro level formation of Traffic Safety Culture: Family and peer Traffic Safety Culture

H5. Family socialisation. Traffic Safety Culture at the family level is shaped through social learning processes, including parental modelling, communication, monitoring, feedback, safety messages and commitment or non-commitment to safety. This hypothesis is supported by studies using the Family Climate for Road Safety Scale, which generally find relationships between family climate and young drivers' driving styles, risky behaviour and, in some studies, crash involvement (Taubman-Ben-Ari & Katz-Ben-Ami, 2012, 2013; Taubman-Ben-Ari et al., 2014; Taubman-Ben-Ari, 2015, 2016; Skvirsky et al., 2017; Burns et al., 2020, 2022; Doncel et al., 2023; Awad-Yassin & Taubman-Ben-Ari, 2024; Cui et al., 2024; Ma et al., 2024; Awad-Yassin & Ben-Ari, 2025; Zhang et al., 2025).

H6. Peer-group norm formation. Traffic Safety Culture in peer groups is shaped through repeated interaction among friends, leading to shared pressure, communication, social costs and shared commitment to safe or unsafe driving. This hypothesis is supported by studies using the Safe Driving Climate among Friends scale and studies of peer pressure and resistance to peer pressure (Guggenheim & Taubman-Ben-Ari, 2018; Skvirsky et al., 2017; Feng et al., 2021; Padilla et al., 2023; Ma et al., 2024; Li et al., 2025).

4.4.1.2. Hypotheses concerning mechanisms between Traffic Safety Culture and behaviour
The general assumption at this level is that TSC influences behaviour through various mechanisms.

H7. Normative mediation. Traffic Safety Culture influences behaviour through descriptive norms concerning what is typical and through injunctive norms and social pressure concerning what is expected, accepted or approved in traffic. Descriptive norms are particularly prominent in national-level studies, whereas injunctive norms are most clearly represented in family- and peer-level studies (Cialdini et al., 1990; Nævestad et al., 2019a, 2019b, 2020, 2022, 2025; Abubakari et al., 2025; Stringer, 2018; Islam et al., 2017; Otto et al., 2021; Milch & Nævestad, 2024; Guggenheim & Taubman-Ben-Ari, 2018; Padilla et al., 2023; Ma et al., 2024; Li et al., 2025; Taubman-Ben-Ari & Katz-Ben-Ami, 2013; Cui et al., 2024).

H8. Attitudinal mediation. Traffic Safety Culture influences behaviour through individual evaluations of specific traffic behaviours and safety measures; that is, attitudes toward speeding, drink-driving, seat-belt use, mobile-phone use, enforcement, alcohol limits and speed limits. (Nævestad et al., 2022, 2025;

Van den Berghe et al., 2020; Islam et al., 2017; Otto et al., 2021; Schlembach et al., 2016; Gehlert et al., 2014; Chu et al., 2019; Öztürk et al., 2022).

H9. Belief-based mediation. Shared beliefs influence behaviour by shaping risk perception, causal interpretation, responsibility attribution, perceived controllability and perceived legitimacy. This hypothesis is supported by studies of fatalistic attributions, destiny orientation, traffic climate and continent-level differences in fatalism, where beliefs about fate, God's will, controllability and danger are assumed to influence motivation for safe behaviour (Nordfjærn et al., 2012a, 2012b, 2014; Rundmo et al., 2012; Nævestad et al., 2025; Van den Berghe, 2026; Gehlert et al., 2014; Chu et al., 2019; Öztürk et al., 2022).

H10. Value-to-norm and value-to-attitude mediation. Abstract cultural values influence traffic behaviour indirectly through more specific norms and attitudes. This hypothesis is supported by Hofstede- and Schwartz-based studies, which assume that broad values such as individualism, power distance, embeddedness, hierarchy and egalitarianism influence compliance, risk-taking and fatality rates through intermediate mechanisms. It is also supported by studies of freedom to take risk and paternalism, where broader values are measured through specific attitudes toward risky behaviour or restrictive safety measures (Gaygisiz, 2010; Atchley et al., 2014; Melinder, 2007; Van den Berghe et al., 2020; Arslan & Özkan, 2024; Nævestad et al., 2022, 2025).

H11. Institutional legitimacy and enforcement norms. Traffic safety culture may influence behaviour through perceptions of institutional legitimacy, fairness and predictability. When traffic rules, enforcement and authorities are perceived as legitimate and fair, road users may be more likely to view compliance as appropriate and expected. Conversely, weak legitimacy, corruption or negotiable enforcement may weaken compliance by making rules appear less binding or less consistently applied. This hypothesis is consistent with studies of governance quality, enforcement, policy support, corruption and procedural legitimacy (Van den Berghe et al., 2020; Arslan & Özkan, 2024; Islam et al., 2017; Nævestad et al., 2025; Van den Berghe, 2026).

4.4.1.3. Hypotheses concerning behaviour and safety outcomes

H12. Behavioural effects on safety. Risky traffic behaviours, such as speeding, driving under the influence, aggressive violations, distraction and non-use of seat belts, are positively associated with crash involvement, near misses or other safety outcomes. This hypothesis is supported by DBQ-based studies, continent-level studies, TCS studies and family/peer studies linking behaviour to crashes, near misses or crash involvement (Nævestad et al., 2019a, 2020, 2022, 2025; Chu et al., 2019; Gehlert et al., 2014; Öztürk et al., 2022; Padilla et al., 2023; Cui et al., 2024; Abubakari et al., 2025).

H13. Culture-behaviour-outcome mediation. The relationship between TSC and safety outcomes is mediated by traffic behaviour. This hypothesis is supported by studies where TSC is related to behaviour, and behaviour is related to crash involvement, even if the full mediation pathway is not always tested in one statistical model. This applies particularly to DBQ-based descriptive norm studies, continent-level RSC studies, Traffic Climate Scale studies, and family and peer climate studies (Nævestad et al., 2019a, 2020, 2022, 2025; Chu et al., 2019; Gehlert et al., 2014; Öztürk et al., 2022; Taubman-Ben-Ari & Katz-Ben-Ami, 2013; Padilla et al., 2023; Cui et al., 2024).

4.5. How to use the model to measure national Traffic Safety Culture?

The hypotheses above specify how the conceptual model may be tested. To make such testing possible, the model also needs to be translated into measurable cultural elements. The next section therefore shows how the conceptual model can be used to operationalise national Traffic Safety Culture. We have developed a survey which uses the conceptual model to measure national TSC in four countries (Norway, Sweden, Serbia, Bulgaria). This survey includes all the operationalisations included in Table 11 below.

National TSC can be operationalised through five interrelated layers: shared beliefs, institutional beliefs, moral values measured through attitudes, social norms, and behavioural manifestations. These layers correspond primarily to the cultural elements in the conceptual model: shared beliefs, shared moral values, shared social norms, attitudes, and patterns of behaviour. They also correspond to several of the mechanisms in the model, including risk perception, responsibility attribution, perceived legitimacy, perceived norms, social pressure, and individual evaluations of specific behaviours or measures. Although Figure 6 groups social norms and patterns of behaviour for visual simplicity, Table 11 separates them analytically for measurement purposes. The table therefore covers the national-level cultural content of the model and several central mechanisms. The remaining parts of the model, e.g. wider system factors, proximal behavioural drivers, traffic behaviour, and safety outcomes should be measured through additional indicators, such as legislation, enforcement, infrastructure, willingness and intentions, self-reported or observed behaviour, and crash or injury data. The survey that we have developed to measure and test the conceptual model therefore includes several questions about such factors.

Layer	Cultural content	Example items	Reviewed studies
Shared beliefs / cognitive-cultural layer	Causality, fatalism, controllability, destiny orientation	"Crashes are God's will"; "Humans cannot do anything to prevent deaths in traffic"	Nordfjærn et al. (2012a, 2012b, 2014); Nævestad et al. (2025); Van den Berghe (2026)
Institutional beliefs	Responsibility, legitimacy, trust in authorities, perceived fairness of rules and enforcement	"Authorities are responsible for preventing crashes"; "Traffic rules and enforcement are fair and legitimate"	Van den Berghe et al. (2020); Arslan & Özkan (2024); Nævestad et al. (2025); Van den Berghe (2026); Islam et al. (2017)
Moral values, measured through attitudes	Freedom, paternalism, protection, obligations toward others, acceptance of restrictive measures	"Drivers should decide for themselves how much risk they take"; "Strict traffic safety measures are necessary to protect others"	Gaygisiz (2010); Atchley et al. (2014); Van den Berghe et al. (2020); Arslan & Özkan (2024); Nævestad et al. (2022, 2025)
Social norms	Descriptive and injunctive norms concerning speeding, DUI, aggression, enforcement, corruption and vulnerable road users	"Most drivers speed"; "Drivers are expected to stop for pedestrians"	Nævestad et al. (2019a, 2019b, 2020, 2022, 2025); Abubakari et al. (2025); Ward et al. (2020); Xu et al. (2018); Van den Berghe (2026)
Behavioural manifestations	Stable and normalised patterns of behaviour, such as DUI, speeding, aggression, distraction, yielding and seat belt use	"Drivers often drive without using a seat belt"; "Drivers often yield to pedestrians"	Nævestad et al. (2019a, 2019b, 2020, 2022, 2025); Abubakari et al. (2025); Gehlert et al. (2014); Chu et al. (2019); Öztürk et al. (2022)

TABLE 11 | Operationalisation of national traffic safety culture based on the conceptual model.

The first layer concerns shared beliefs about causality, fatalism, controllability and destiny orientation. These are cognitive-cultural assumptions about why crashes occur and whether crashes can be

prevented. Such beliefs are central in studies of fatalistic attributions, destiny orientation and perceived controllability. In the conceptual model, this layer corresponds to the shared beliefs component and is linked especially to the mechanisms of risk perception/interpretation, responsibility attribution and perceived controllability.

The second layer concerns institutional beliefs about responsibility, legitimacy, trust in authorities, and perceived fairness of rules and enforcement. These beliefs concern who is responsible for preventing crashes, whether traffic rules are perceived as fair and relevant, and whether enforcement and authorities are seen as legitimate. In the conceptual model, this layer links the wider societal and policy context to the mechanisms of perceived legitimacy and control, responsibility attribution and rule compliance.

The third layer concerns moral values, usually measured through attitudes. These include values related to freedom, paternalism, protection and obligations toward others. At the national level, this concerns whether road users prioritise individual freedom to take risks, or whether they accept restrictive measures designed to protect themselves and others. These issues are addressed in studies of individualism, collectivism, power distance, hierarchy, egalitarianism, freedom to take risk and acceptance of restrictive traffic safety measures. In the conceptual model, this layer corresponds to shared moral values and connects these values to attitudes toward specific behaviours and safety measures, such as speeding, drink-driving, enforcement or restrictive policies.

The fourth layer concerns shared social norms. These include both descriptive norms, referring to what people believe others normally do, and injunctive norms, referring to what people believe others approve of or expect. In national TSC, these norms may concern speeding, drink-driving, seat belt use, mobile phone use, aggressive violations, enforcement, corruption, and treatment of vulnerable road users. In the conceptual model, this layer corresponds to shared social norms and is linked to mechanisms such as perceived norms, social identity, social pressure, sanctions and rewards.

The fifth layer concerns behavioural manifestations of national TSC. These are stable and shared patterns of behaviour that express the underlying beliefs, values and norms of a group. Examples include common patterns of speeding, drink-driving, seat belt use, mobile phone use, aggressive driving, yielding to pedestrians, or adaptation to vulnerable road users. These behaviours should not be treated only as individual outcomes, because repeated and normalised behaviours may also become part of the culture itself. In the conceptual model, this layer corresponds to the behaviour component of the causal chain, while also reflecting the TRUST definition of TSC, where stable and normalised patterns of behaviour may be considered part of culture.

This operationalisation can be used to develop survey items, interview guides or comparative indicators for national TSC. We have used it to measure and test the conceptual model. The operationalisation makes it possible to test the conceptual model empirically by examining whether national-level beliefs, values and norms are related to specific mechanisms, such as risk perception, responsibility attribution, perceived legitimacy, perceived norms and attitudes, and whether these mechanisms are related to traffic safety behaviour and safety outcomes. To cover the full conceptual model, such cultural measures should ideally be combined with measures of system-level factors, such as legislation, enforcement, infrastructure and governance; proximal behavioural drivers, such as willingness and intentions; behavioural indicators, such as speeding, DUI, distraction and seat belt use; and safety outcomes, such as crashes, injuries or near misses.

4.6. Planned application of the conceptual model in TRUST

Measuring and testing the conceptual model. The first step in applying the conceptual model has been to use it in a survey examining national TSC in four countries: Norway, Sweden, Serbia and Bulgaria. The survey includes private road users, primarily car drivers, as well as road users at work, who are also embedded in organisational safety cultures (OSC). In addition, surveys will be conducted among employees of national road safety authorities and other national road safety stakeholders in the four countries.

To test as many of the relationships in the conceptual model as possible, the surveys include measures of TSC, traffic safety behaviour, crash involvement, system-level factors and relevant demographic background characteristics. Analysis of the survey data will be used to test H1–H3 concerning the formation of TSC at the national level, H7–H11 concerning the relationship between TSC and behaviour, H12 concerning the relationship between behaviour and safety outcomes, and H13 the mediated TSC–behaviour–outcome pathway. The conceptual model will subsequently be validated and, where necessary, adjusted based on the results from the four countries.

Informing subsequent activities and work packages in TRUST. The measurement and testing of the conceptual model will inform several subsequent activities in WP3. These include the development of measurement tools for TSC in Task 3.2, the development of measurement tools for OSC in Task 3.3, the further testing of the conceptual model and development of a TSC index in Task 3.4, and the development of TSC interventions in Task 3.5.

The results from WP3 will also inform later work packages. In WP4, they will contribute to the selection of intervention mechanisms for seven pilot interventions aimed at improving TSC and OSC. WP5 will examine the effectiveness of these interventions, including through pre- and post-intervention surveys. The conceptual model and the TSC assessment tools developed in WP3 will provide an important basis for these evaluations. Finally, WP6 will integrate the resulting assessment tools, intervention methods and guidance into a common set of resources intended to support cultural transformation towards TSC at community and organisational levels.

Informing TSC interventions. The conceptual model will provide a mechanism-based foundation for the development of TSC interventions. TRUST Deliverable 2.2c (Boets et al., 2026) develops an inventory of existing interventions and good practices that apply a cultural approach to improving road safety. It also identifies success factors, barriers and guidelines for developing, implementing and evaluating effective interventions. Building on the results from WP2 and the conceptual and empirical work undertaken in WP3, Task 3.5 will identify the intervention mechanisms to be applied in the seven pilots in WP4. The specific policy contribution of the present deliverable is therefore its mechanism-based approach to intervention development, as discussed further in Section 5.3.

4.7. Summary

Chapter 4 develops the conceptual model of TSC as a multi-level, mechanism-based model linking system factors, cultural elements, psychological and social mechanisms, behaviour and safety outcomes. The chapter also shows how the model can be tested through concrete hypotheses and operationalised for empirical measurement, especially at the national level.

5. Discussion

5.1. The role of mechanisms

In the conceptual model, we define a mechanism primarily as the assumed causal process through which a cultural element/aspect is translated into traffic safety behaviour. In the review of the studies on the other hand (cf. Table 10), we define mechanisms more broadly, as factors that may explain the relationship between TSC and safety performance (e.g. behaviour, crashes). This is done, because the focus in the review is to understand how the studies conceptualise the relationship between TSC and safety performance. Our review indicates that not all of the studies include specific data on both behaviour and crashes. Some studies focus on the individual level, examining individuals' perception of TSC, individual behaviours and individuals' crash involvement (e.g. Nævestad et al., 2019a). Other studies focus on the macro level, including mainly data on TSC and crashes (e.g. Gaygisiz, 2010; Arslan & Özkan, 2024). In the latter type of macro-level studies, more specific cultural elements, such as norms and patterns of behaviour, may function as intermediate mechanisms between broader cultural values and crashes. The reason is that these studies aim to explain relationships between TSC and crashes at the macro level, and that they may use mechanisms at the macro level to explain this (e.g. norms). The behavioural pathway in the conceptual model, on the other hand, focuses specifically on explaining how TSC is translated into behaviour, with crashes treated as downstream outcomes.

5.1.1. When cultural elements function as mechanisms

Gaygisiz (2010) provides an example of a macro study which indicates that norms or patterns of behaviour can explain the relationship between TSC (values) and crashes. The study assumes that macro-level cultural values influence road safety through road-user behaviour, and explicitly discusses general social norms, social interaction among road users, social norms of driving, and accepted driving habits as part of this pathway. Gaygisiz also states that social norms of driving and accepted driving habits can be expected to be related to national cultural norms and values, especially in societies with weak enforcement. However, Gaygisiz (2010) does not empirically test the full mediation pathway. Gaygisiz (2010) writes that:

In both cases, cultural values had stronger (negative) effect on traffic safety when the governance quality was low. Hence, the effects of a country's standing on values of hierarchy and mastery depend on the quality of governance: in countries with high levels of corruption and inefficiently governed institutions, the road users are more severely influenced by the failures of social interaction and culture while in countries with well governed institutions (e.g. road administration, traffic police and justice system, driver licensing, vehicle inspection) the road users are less free to deviate from the normative behavior described in the Highway Code. (p 1899).

Thus, we see that social norms and interaction are evoked as explanations as to why national values are related to national crash statistics, where certain values lead to "failures of interaction". Gaygisiz (2010) also writes that:

The hierarchy dimension in Schwartz's theory describes a society which relies on hierarchical systems of ascribed roles, and sees the unequal distribution of power, roles, and resources as legitimate. If the citizens perceive that the law and punishments for violations are not the same for everyone but depend on a citizen's social-economic status or social network, we can assume that traffic rules are seen as relativistic and, hence, not imperative in terms of safety. A good governance quality would reduce the effects of hierarchical values and treat all citizens equally (p. 1899).

Studies of values related to paternalism and freedom to take risk provide a related example (e.g. Nævestad et al., 2022a, 2022b). In these studies, broader cultural values are operationalised through individual evaluations of specific behaviours and policy measures. These evaluations therefore serve as indicators of broader values and may also function as more proximal mechanisms linking those values to behaviour or policy support.

5.1.2. Mechanisms between other parts of the causal chain

It is also important to note that we presuppose that mechanisms are important between all the different analytical levels in the causal chain between system factors, culture, behaviour and crashes. Mechanisms concern the hypothesised factors that may explain causal relationships, and thus they may be just as relevant to include to explain e.g. the relationship between system factors and TSC. This can e.g. relate to system factors like enforcement, education, Safe System policies, religion, economy, political factors (e.g. trust in and legitimacy of the national state etc.). (These mechanisms are also expressed in Hypotheses 1-3, in section 4.4.1.1). As noted in section 5.4, knowledge about these mechanisms may be crucial when it comes to developing policies to improve traffic safety. Likewise, mechanisms are important to explain the relationship between different types of road safety behaviours and drivers' crash involvement. DBQ based studies indicate that some types of behaviour (e.g. violations) are related to higher crash risk than e.g. lapses and errors (De Winter & Dodou, 2010). Thus, the mechanism concept should not be reserved for only the relationship between TSC and behaviour, although this is the relationship that we primarily apply it to in this study.

5.2. Is it reasonable to say that all the TSC studies focus on TSC?

TSC research is relatively new and fragmented, with great variation in operationalisations and little agreement on common dimensions. However, TSC research explicitly considers multiple social group memberships including nations, regions, communities, families, and peer groups. It is, however, relevant to ask whether it is reasonable to say that all the TSC studies focus on TSC? The observed heterogeneity and fragmentation within TSC research that we report in this review is a result of our inclusion of different types of studies in our literature search, which included studies ranging from the family level to the national level. A first relevant answer to the question of "Whether it is reasonable to say that all the TSC studies focus on TSC?" is that the inclusion of all these different lines of research is based on a line of argumentation put forward by Nævestad & Bjørnskau (2012), who stated that if we are to apply the safety culture concept to non-professional drivers in the road transport system, we have to examine how the concept can be applied to analytical units other than organisations (cf. Wiegman et al., 2007). The reason for this is that non-professional drivers do not use the road as members of organisations, but as private citizens. In that case, other types of social groups are relevant to include. Nævestad & Bjørnskau (2012) therefore discuss whether the concept of TSC can be applied to the following analytical units: local communities, nations, and peer groups. Our review indicates a considerable increase in studies on TSC at different levels (e.g. national, family, peer) in the last fourteen years since their 2012 paper, including studies of TSC in families.

We can also justify that all the included studies are studies of TSC conceptually. In this study, we define TSC as shared values, beliefs, attitudes, norms, and patterns of behaviour that shape how traffic safety is understood and enacted within a meaningfully defined group. This definition is deliberately inclusive and directs attention to studies focusing on different types of culture or climate related to road transport at different analytical levels. Moreover, TSC is a boundary concept, which lends itself to a range of different research traditions, theories, methods, and levels. Although the studies use different conceptual labels (e.g. traffic safety culture, family safety climate, traffic culture), they all examine shared (e.g., norms, attitudes, climate, values), related to traffic safety within social groups. This is precisely what defines TSC. Moreover, the common analytical core across all studies is that we find a social group (e.g. nation, region,

peer group, family, etc.) and shared cultural elements. So, instead of saying that these lines of research are different, we may also argue that they are studying the same phenomenon at different analytical levels and with different indicators. On the contrary, we can argue that the elements studied in the different groups are different layers of the same cultural system. Moreover, although some of the studies do not explicitly say that they are studies of "TSC", (but rather traffic culture, or family safety climate) they still study shared values, norms, attitudes and shared behaviours. That is why they were included in our literature review. Despite different conceptual labels, these studies analyse core cultural elements. Therefore, they can be interpreted as implicit studies of TSC. Moreover, in safety culture research, climate is generally treated as equivalent of culture (Flin et al., 2000).

Moreover, in our review, mechanisms explain why culture matters. Thus, what unifies these research traditions is not their terminology, but the mechanisms they propose; i.e., how shared cultural elements influence behaviour, through the social force of culture.

5.3. Policy implications

In the following, we will suggest preliminary policy implications, based on our reviews and the conceptual model. See also section 4.6, on planned application of the conceptual model.

Effective interventions require an understanding that TSC is formed and reproduced differently across cultural levels. Our review indicates that national TSC may be shaped by broader societal and institutional conditions, whereas family, peer and organisational cultures are more directly influenced by modelling, communication, monitoring and social interaction. Interventions should therefore be adapted to the relevant cultural group and to the mechanisms through which its culture is maintained and translated into behaviour.

5.3.1. Mechanism-based approach to interventions

When it comes to the specific policy implication of the present deliverable, it provides a mechanism-based approach to interventions. One of the purposes with the new focus on TSC as a new analytical concept was the hope that it could foster new prevention strategies which could lead to further reductions of road fatalities and severe injuries. As indicated in our review, most of the TSC studies seem to repeat well known individual behavioural change implications related to education, enforcement, infrastructure and so on. If these are the conclusions from TSC research, it is relevant to ask whether this perspective can facilitate new prevention perspectives?

Our review indicates that knowledge about mechanisms is crucial for developing TSC interventions. A mechanism-based approach to TSC interventions starts from the premise that effective interventions should target the causal processes that generate the phenomenon of interest, rather than merely addressing observed associations between variables. According to Elster (2007), explaining a social phenomenon requires identifying the mechanisms that produce it; that is, the sequence of causal processes linking causes to outcomes. Rather than asking only whether TSC is associated with safer behaviour, a mechanism-based approach asks *how* TSC influences behaviour and *through which processes* this influence occurs (Nævestad et al., 2026). Understanding these mechanisms provides a stronger basis for intervention design, because interventions can be directed at the factors that actually produce behavioural change. Such mechanisms can also be documented through logic models, which specify the assumed pathway from intervention activities, through mechanisms of change, to behavioural and safety outcomes. We can provide one example of such a logic model: Intervention: campaign showing that most drivers support lower speeds near schools. Mechanism: changes perceived descriptive and injunctive norms. Behavioural outcome: lower speeding near schools. Safety outcome: fewer conflicts, near misses or crashes involving children

Instead of simply reviewing whether TSC is associated with traffic safety outcomes, our review aims to identify the mechanisms that are assumed to connect TSC to behaviour at different cultural group levels (e.g. national, regional, family, peer levels). Across these different cultural group levels, results indicate that membership in cultural groups influences traffic safety behaviour through mechanisms such as social pressure, modelling, communication, monitoring, social learning, and peer influence. These mechanisms differ across the analytical levels. At the national level, abstract cultural values are translated into shared norms; at the regional and local levels, contextual norms influence behaviour; while at the family and peer levels, culture operates through direct social interaction, modelling, communication, and social pressure. The conceptual model that we have developed, synthesises these findings into a causal framework linking cultural groups, mechanisms, behaviour, and traffic safety outcomes.

This understanding provides a systematic basis for developing TSC interventions. Rather than designing interventions around broad concepts such as "improving safety culture," interventions can be targeted at the specific mechanisms that influence group behaviour within particular cultural groups. For example, if descriptive norms are found to maintain speeding within a community, interventions may focus on changing perceptions of what constitutes normal driving behaviour. If parental modelling is identified as the primary mechanism influencing novice drivers, interventions should target parents' own driving behaviour and communication practices rather than focusing exclusively on young drivers themselves. Similarly, interventions aimed at peer groups may seek to reduce peer pressure, strengthen positive group norms, or increase young drivers' resistance to social influence. Because different mechanisms operate at different analytical levels, the most effective interventions are likely to combine multiple approaches that address the mechanisms most relevant to the target group and behaviour.

The distinctive contribution of this approach is that it moves beyond describing TSC toward explaining how TSC produces safety outcomes. Previous TSC research has often identified associations between culture and behaviour but has rarely specified the causal mechanisms linking them. By explicitly identifying these mechanisms and organising them within a multi-level conceptual framework, the mechanism approach provides a stronger theoretical foundation for intervention development. It also allows interventions to be selected, designed, and evaluated according to whether they successfully modify the mechanisms that are expected to produce behavioural change. In this way, the mechanism-based approach offers a more transparent, theoretically grounded, and transferable framework for developing TSC interventions than approaches based solely on empirical associations or broad cultural concepts.

While traditional TSC research asks *whether* culture influences behaviour, the point of the mechanism-based approach is to ask *how* it does so, in order to provide a direct foundation for intervention design.

5.4. Issues for future research

5.4.1. Future research is needed on intervention mechanisms

As noted in section 5.3 future TRUST activities will focus extensively on TSC intervention mechanisms. Future research is needed to be able to fully grasp the effective mechanisms that national authorities can use to utilise TSC as an effective measure to improve traffic safety. We have mentioned the role of families, but peer groups are also an example of a cultural unit where culture is produced in the interaction between people (cf. Hypothesis 5-6, in section 4.4). Other relevant questions to ask when developing policies and interventions could be: If we need to change TSC, which elements should we target? Is it most effective to try to change the more underlying and abstract cultural elements like e.g. values, or should we try to change the more tangible cultural elements like norms and attitudes? Other relevant questions could be: do we need to change all the cultural elements in the model? How does traffic culture change? Do the changes always start at the more abstract value levels before the changes are transferred through mechanisms to the less abstract levels. If so, can we target the more basic levels

when we want to train TSC and assume that the other more concrete levels will follow. Another relevant question is: is it actually possible to change the most abstract level like values; can we change general cultural values like individualism, power distance, freedom to take risk and paternalism through campaigns some TSC interventions? This seems hard, as these are general and abstract cultural values. So, perhaps the most realistic TSC intervention approaches to target the more concrete and tangible attitudes and norms. It is evident that it is not easy to answer these questions, and that we must rely on increased theoretical maturity in the field of TSC research to be able to fully understand this. These issues will be examined in TRUST deliverable 3.3.

5.4.2. Mechanisms between system level factors and traffic safety culture

One of the most necessary areas to identify mechanisms is between systems level factors influencing TSC and behaviours. Although 90% of the studies in our review includes hints about factors influencing TSC (cf. section 3.1.5), these are generally just suggestions and not actually tested relationships. Establishing knowledge about the importance of different influencing factors for TSC is very important, because this knowledge can be used to design effective TSC interventions. It is also a need to start this across different cultural levels and compare differences and similarities and unique influencing factors at each level, as these cultural levels are different with different types of mechanisms and operationalisations. Hypothesis 1-3 in section 4.4 concern system factors influencing TSC, while Hypothesis 5-6 concern the family and peer level.

5.4.3. Further development of the social ecological model

The social ecological model indicates that we are members of nations and national TSC, we are members of regions, local communities, peer groups with friends and families, and many of us also work for organisations. In this study we have seen that these different types of group membership influence the traffic safety behaviour of road users. A very relevant question for future research, is the importance of these different types of group membership in different contexts. We might assume that the importance of the different group membership differs according to different situations, and also according to life phase, like age and gender. We might for instance assume that the importance of national TSC is especially important when we drive abroad in other countries, the importance of local TSC is perhaps most important when we're driving our local neighbourhoods and relate to the expectations of people living there, importance of micro level units might be especially relevant when we are together with these people and so on. Additionally, our work organisation membership is important when we are at work, and in this context, we may presumably act safer, because of the duties in the employment relationship. It seems that the central question for effective interventions is to reduce potential negative influence of some types of group membership, while utilising the positive effects of others. These are important issues for future research. In the TRUST project we will test the importance of different cultural group memberships through a survey examining of national TSC in four countries (Norway, Sweden, Serbia, Bulgaria), focusing on both private road users in society (car drivers) and road users at work, who also are part of organisational safety culture (OSC). Thus, we might test the importance of National TSC for private road users vs. road users at work.

5.4.4. The relationship between other sustainability goals and traffic safety in the conceptual model

The relationship between traffic safety and other sustainability goals is an important area for future research. In the conceptual model, other sustainability outcomes can be included on the outcome side alongside crashes, injuries, near misses etc. Relevant outcomes include public health, active mobility, emissions and energy use, gender equality, social inclusion, accessibility and attractive, liveable communities. This reflects the increasing integration of road safety into the broader sustainability agenda, particularly through SDG 3.6 and SDG 11.2, and the recognition of road safety as a precondition for achieving several other SDGs (Nævestad & Wennberg, 2026).

Such integration may create important synergies (Nævestad & Wennberg, 2026). For example, lower urban speeds may reduce crashes and injuries while also reducing noise, emissions and energy use and improving conditions for walking and cycling. Safe infrastructure for pedestrians and cyclists may support active mobility, public health, gender equality and social inclusion. Road safety can also be integrated into workplace safety, sustainable procurement, organisational sustainability reporting and urban mobility planning. The overview presented by Nævestad & Wennberg shows that these synergies occur primarily at the outcome level: an integrated measure or policy may contribute positively to several sustainability outcomes simultaneously.

However, the relationship is not necessarily positive in all cases. Sustainability policies may also create trade-offs or unintended safety consequences. For example, a modal shift from cars to walking and cycling may contribute to climate and public-health goals, but it may also increase the number of pedestrians falls and single-bicycle crashes unless it is accompanied by safe infrastructure, maintenance, speed management and other targeted measures. Urban densification, the reallocation of road space and other sustainability-oriented policies may likewise involve conflicts between different objectives. Future research should therefore examine both synergies and trade-offs rather than assuming that measures supporting one sustainability goal will automatically improve traffic safety.

Traffic safety culture provides a useful analytical perspective for understanding why such policies produce different outcomes in different contexts. Shared values, beliefs, attitudes, norms and patterns of behaviour may influence support for lower speeds, modal shifts, restrictions on motorised traffic, the protection of vulnerable road users and the distribution of responsibility between road users and system designers. The mechanisms included in the conceptual model, such as perceived legitimacy, responsibility attribution, risk perception, social pressure and attitudes towards specific measures, may explain why integrated policies are accepted and followed in some groups or communities but resisted in others.

The relationship may also operate in the opposite direction. Sustainability policies are system-level factors that may influence traffic safety culture by changing infrastructure, formal rules, interaction patterns and expectations about appropriate behaviour. For example, the introduction of 30 km/h areas or the redistribution of road space may gradually strengthen expectations that vulnerable road users should be protected and that motorised traffic should adapt accordingly. Conversely, measures perceived as unfair, poorly implemented or inconsistent may weaken their legitimacy and generate conflict between road-user groups. The relationship between sustainability policy and traffic safety culture should therefore be understood as reciprocal.

Future research should examine the mechanisms through which integrated sustainability policies affect traffic safety culture, behaviour and multiple outcomes over time. It should also investigate how conflicts between goals are managed, how responsibility and accountability are distributed across policy areas, and how traffic safety can retain its status as a fundamental value when included in broader sustainability frameworks. This is important because sustainability integration may provide road safety with access to new alliances, implementation arenas and funding, but it may also dilute road safety when it becomes one objective among many. As argued by Nævestad & Wennberg (2026), road safety may nevertheless be more likely to be “lost” without integration, since wider sustainability transitions in transport and society will proceed regardless. Future research should therefore focus on how road safety can be effectively integrated while maintaining explicit safety targets, indicators, responsibilities and Safe System principles.

6. Conclusion

This deliverable has developed a conceptual model of TSC based on a scoping and conceptual review of existing research. The starting point was that TSC is important for understanding traffic safety, but that the literature is fragmented, with different concepts, methods, cultural levels, and theoretical approaches. The main contribution of the deliverable is therefore to identify a common analytical core across this diverse literature and organise it into a multi-level, mechanism-based conceptual model.

The review shows that the different strands of TSC research share a basic causal logic: safety culture influences safety behaviour, and safety behaviour influences safety outcomes. However, culture does not influence behaviour in a simple or direct way. Rather, it operates through identifiable psychological and social mechanisms, including risk perception, responsibility attribution, perceived legitimacy, social identity, modelling, communication, monitoring, social pressure, willingness, and intentions. These mechanisms explain how shared cultural elements are translated into concrete traffic safety behaviour.

A central finding is that group membership is the common core across the different lines of research. Road users are embedded in several cultural groups, including nations, regions, local communities, families, peer groups, and organisations. These groups exert a “social force” by shaping what road users perceive as normal, acceptable, legitimate, risky, or responsible behaviour. The social ecological model developed in this deliverable captures this multi-level structure, while the behavioural pathway specifies how cultural influence is translated into action.

Overall, the review provides moderate support for the assumption that safety culture is related to safety behaviour and, indirectly, to crashes, injuries, near misses, and other safety outcomes. The strongest evidence concerns the relationship between cultural elements and behaviour. The full causal chain from system-level factors, through culture and mechanisms, to behaviour and safety outcomes is less often tested directly. This is a key knowledge gap.

The conceptual model developed in this deliverable addresses this gap by integrating system factors, cultural elements, mechanisms, behaviour, and outcomes into one common framework. It shows that TSC should not be understood merely as a set of attitudes or behaviours, but as a socially embedded process through which shared meanings, norms, values, and practices shape road users’ behaviour. The model also provides a basis for intervention development. Instead of aiming vaguely to “change culture”, interventions can target specific mechanisms, such as descriptive norms, parental modelling, peer pressure, perceived legitimacy, or safety communication.

The deliverable therefore represents a step toward theoretical consolidation in a still-developing research field. It provides a common language for comparing TSC studies, clarifies the mechanisms through which culture matters, and identifies key hypotheses for future empirical testing. Future research should use longitudinal, multi-method, and mechanism-focused designs to test the full causal chain and to identify which cultural mechanisms are most relevant for different road users, behaviours, and contexts. Ultimately, the value of the conceptual model lies in its ability to support more precise research and more targeted interventions aimed at improving TSC and reducing road casualties.

References

Reviewed studies TSC

- Abubakari, S., Mohammed, A.-R., & Alhassan, M. (2025). Risk perception, road safety culture, and aberrant riding behaviour among three-wheel motor vehicle riders in Ghana [Article]. *African Transport Studies*, 3, Article 100054. <https://doi.org/10.1016/j.aftran.2025.100054>
- Andrijanto, I., & Sianipar, F. S (2022). Behavioral aspects of safety culture: Identification of critical safety-related behaviours of motorcyclists in Indonesia's urban areas via the application of behavioural-based safety programs. *IATSS Research*, 46(3), 353-369.
- Andrijanto, Itoh, M., Sunardy, & Jonathan, M. (2025). Study of psychological aspects of the safety culture of motorcyclists' behaviours in Indonesia's urban road traffic: Construction of road users' belief systems. *IATSS Research*, 49(2), 137–154. <https://doi.org/10.1016/j.iatssr.2025.03.002>
- Arslan, B., & Özkan, T. (2024). Role of Culture, Income Level and Governance Quality on Driver Behaviours. *Journal of Road Safety*, 35(3), 10–24. <https://doi.org/10.33492/JRS-D-24-3-2319349>
- Atchley, P., Shi, J., & Yamamoto, T. (2014). Cultural foundations of safety culture: A comparison of traffic safety culture in China, Japan and the United States. *Transportation Research Part F-Traffic Psychology and Behaviour*, 26, 317-325.
- Atombo, C., & C. Z. Wu (2022). Traffic safety climate factors in explaining driving behaviours and traffic crash involvement: comparative study among male and female drivers. *Journal of Road Safety*, 33(1), 49-62.
- Awad-Yassin, M., & Ben-Ari, O. T. (2025). Navigating Risk: The contribution of family road safety climate and sense of community to driving styles of young Arab drivers in Israel. *Transportation Research Part F-Traffic Psychology and Behaviour*, 11, 343-353.
- Awad-Yassin, M., & Taubman-Ben-Ari, O. (2024). The transmission of driving styles from fathers to sons in Arab society in Israel: The contribution of parental attachment and family climate for road safety. *Transportation Research Part F-Traffic Psychology and Behaviour*, 104, 461-473.
- Banakar, R., & Fard, S. N. (2012). Driving dangerously: Law, culture and driving habits in Iran. *British Journal of Middle Eastern Studies*, 39(2), 241-257.
- Ben-Ari, O. T. (2015). Parents' perceptions of the family climate for road safety. *Accident Analysis and Prevention* 74, 157-161.
- Benzaman, B., Ward, N. J., & Schell, W. J. (2022). The influence of inferred traffic safety culture on traffic safety performance in US States (1994-2014). *Journal of Safety Research*, 80, 311-319.
- Burns, A. B., Garner, A. A., Chang, A., Becker, S. P., Kofler, M. J., Jarrett, M. A., ... & Burns, G. L. (2020). Factor structure of the family climate for road safety scale in emerging adults in the United States. *Accident Analysis and Prevention*, 142.
- Burns, A., Garner, A., Avion, A., Becker, S., Kofler, M., Jarrett, M., Luebbe, A., & Burns, G. (2022). ADHD and dangerous driving in emerging adults: The moderating role of family climate for road safety. *Accident Analysis and Prevention*, 178, 106819. <https://doi.org/10.1016/j.aap.2022.106819>

- Chen, C., Lin, H., & Loo, B. P. (2012). Exploring the Impacts of Safety Culture on Immigrants' Vulnerability in Non-motorized Crashes: A Cross-sectional Study. *Journal of Urban Health-Bulletin of the New York Academy of Medicine*, 89(1), 138-152.
- Chu, W. H., et al. (2019). Traffic climate, driver behaviour, and accidents involvement in China. *Accident Analysis and Prevention*, 122, 119-126.
- Coogan, M. A., Campbell, M., Adler, T. J., & Forward, S. (2014). Examining behavioural and attitudinal differences among groups in their traffic safety culture. *Transportation Research Part F-Traffic Psychology and Behaviour*, 26, 303-316.
- Cui, H., Yuan, X., Zhu, M., & Liu, S. (2024). The family climate for road safety scale in young Chinese drivers: An analysis of reliability and validity. *Transportation Research Part F-Traffic Psychology and Behaviour*, 103, 512-525.
- Doncel, P., Taubman-Ben-Ari, O., Ledesma, R. D., Blanch, M. T., Trógolo, M. A., Castro, C., & Padilla, J. L. (2023). Parenting in the context of driving: Spanish adaptation of the Family Climate for Road Safety (FCRSS) for parents and children. *Accident Analysis and Prevention*, 192.
- Feng, Z., Ji, N., Luo, Y., Sze, N. N., Tian, J., & Zhao, C. (2021). Exploring the influencing factors of public traffic safety awareness in China. *Cognition Technology & Work*, 23(4), 731-742.
- Gaygisiz, E. (2010). Cultural values and governance quality as correlates of road traffic fatalities: A nation level analysis. *Accident Analysis and Prevention*, 42(6), 1894-1901.
- Gehlert, T., Hagemester, C., & Özkan, T. (2014). Traffic safety climate attitudes of road users in Germany. *Transportation Research Part F-Traffic Psychology and Behaviour*, 26, 326-336.
- Girasek, D. (2013). Gauging popular support for traffic safety in the United States. *Accident Analysis and Prevention*, 50, 1112-1117. <https://doi.org/10.1016/j.aap.2012.09.001>
- Girasek, D. C. (2012). Towards operationalising and measuring the Traffic Safety Culture construct. *International Journal of Injury Control and Safety Promotion*, 19(1), 37-46.
- Guggenheim, N., & Taubman – Ben-Ari, O. (2018). Safe Driving Climate among Friends (SDCaF): A new scale. *Accident Analysis and Prevention*, 110, 78-85.
- Hoang, H., Bui, H. T., & Cools, M. (2025). Assessing the impact of traffic climate and risk-taking attitude on the risky riding behaviour of young motorcyclists in Vietnam. *Transportation Research Part F: Traffic Psychology and Behaviour*, 109, 336-353.
- Islam, M. T., Thue, L., & Grekul, J. (2017). Understanding Traffic Safety Culture Implications for Increasing Traffic Safety. *Transportation Research Record*, 2635(1), 79-89.
- Jadaan, K., Abojaradeh, M., Shaqadan, A., Abojaradeh, D., & Alshalout, I. (2022). Analysis of Human and Cultural Factors Causing Risk of Accidents in Jordanian Drivers. *International Journal of Safety and Security Engineering*, 12(5), 589-595.
- Jung, S., Xiao, Q., & Oh, C. (2019). Developing Targeted Safety Strategies Based on Traffic Safety Culture Indexes Identified in Stratified Fatality Prediction Models. *KSCE Journal of Civil Engineering*, 23(8), 3706-3713.

- Kaçan, B., Findık, G., Üzümcüoğlu, Y., Azık, D., Solmazer, G., Ersan, Ö., ... & Xheladini, G. (2019). Driver profiles based on values and traffic safety climate and their relationships with driver behaviours. *Transportation Research Part F-Traffic Psychology and Behaviour*, 64, 246-259.
- Kacan-Bibican, B., Özkan, T., & Taubman-Ben-Ari, O. (2025). Self-determined motivation and driving styles as dependent on the perception of traffic climate by Turkish and Israeli drivers. *Transportation Research Part F-Traffic Psychology and Behaviour*, 109, 1182–1196. <https://doi.org/10.1016/j.trf.2025.01.034>
- Li, Y., Zhang, X., Zeng, X., Qin, K., & Gao, Y. (2024). Influence mechanism of the urban traffic climate on prosocial driving behaviour: The combined role of rational, affective and moral factors. *Transportation Research Part F-Traffic Psychology and Behaviour*, 104, 118-135.
- Li, Y., Sun, L., & Guo, J. (2025). Psychometric properties of the peer pressure on risky driving scale in young Chinese drivers and its associations with risky driving behaviours and safe driving climate among friends. *Transportation Research Part F: Traffic Psychology and Behaviour*, 110, 118–127. <https://doi.org/10.1016/j.trf.2025.02.011>
- Luria, G., Boehm, A., & Mazor, T. (2014). Conceptualizing and measuring community road-safety climate. *Safety Science*, 70, 288–294. <https://doi.org/10.1016/j.ssci.2014.07.003>
- Ma, Y., Qiu, Y., & Sun, L. (2024). Chinese adaptation of the reckless driving behaviour scale: Testing its psychometric properties and links with safe driving climate among family and peers. *Heliyon*, 10(14), Article e34446. <https://doi.org/10.1016/j.heliyon.2024.e34446>
- Meesmann, U., Pires, C., Wardenier, N., & Cools, M. (2025). Exploring cross-national variations in traffic safety culture: Insights into mobile phone use and shared beliefs across 31 countries. *IATSS Research*, 49(3), 399–409. <https://doi.org/10.1016/j.iatssr.2025.09.004>
- Mehri, M., Khazaei-Pool, M., & Arghami, S. (2022). Exploring emergent latent themes of taxi drivers' safety culture: A grounded theory approach. *Safety Science*, 148, 105677. <https://doi.org/10.1016/j.ssci.2022.105677>
- Melinder, K. (2007). Socio-cultural characteristics of high versus low risk societies regarding road traffic safety. *Safety Science*, 45(3), 397–414. <https://doi.org/10.1016/j.ssci.2006.07.004>
- Milch, V., & Nævestad, T. O. (2024). Heart Zone as a measure to influence traffic safety culture: Which factors influence culture change? *Traffic Safety Research*, 6.
- Mirman, J. H., Roche, B., & Higgins-D'Alessandro, A. (2018). School safe driving climate: Theoretical and practical considerations for promoting teen driver safety in school settings. *Traffic Injury Prevention*, 19(6), 644–650. <https://doi.org/10.1080/15389588.2018.1476689>
- Mishra, S., & Mehran, B. (2022). Traffic safety culture of drivers in Canada: Implications for new traffic law implementation to enhance traffic safety. *IATSS Research*, 46(1), 82–92.
- Mozaffari, M. M., Taghizadeh-Yazdi, M., Nazari-Shirkouhi, S., & Asadzadeh, S. M. (2021). Measuring traffic safety culture toward achieving road safety performance: A DEA approach with undesirable inputs-outputs. *Cybernetics and Systems*, 52(7), 601–624. <https://doi.org/10.1080/01969722.2021.1914947>

- Mozaffari, M. M., Taghizadeh-Yazdi, M., Mohammadi-Balani, A., Nazari-Shirkouhi, S., & Asadzadeh, S. M. (2023). Modelling the effect of traffic safety culture on road fatalities: Linear and nonlinear stochastic frontier analysis. *International Journal of System Assurance Engineering and Management*, 14(3), 1049–1061. <https://doi.org/10.1007/s13198-023-01919-y>
- Muguro, J., Njeri, W., Matsushita, K., & Sasaki, M. (2022). Road traffic conditions in Kenya: Exploring the policies and traffic cultures from unstructured user-generated data using NLP. *IATSS Research*, 46(3), 329–344. <https://doi.org/10.1016/j.iatssr.2022.03.003>
- Nordfjærn, T., & Zavareh, M. (2016). Individualism, collectivism and pedestrian safety: A comparative study of young adults from Iran and Pakistan. *Safety Science*, 87, 8–17. <https://doi.org/10.1016/j.ssci.2016.03.005>
- Nordfjærn, T., Şimşekoğlu, Ö., Rundmo, T., & Jørgensen, S. H. (2014). Culture related to road traffic safety: A comparison of eight countries using two conceptualizations of culture. *Accident Analysis & Prevention*, 62, 319–328. <https://doi.org/10.1016/j.aap.2013.10.011>
- Nordfjærn, T., Jørgensen, S. H., & Rundmo, T. (2012a). Cultural and socio-demographic predictors of car accident involvement in Norway, Ghana, Tanzania and Uganda. *Safety Science*, 50(9), 1862–1872. <https://doi.org/10.1016/j.ssci.2012.05.003>
- Nordfjærn, T., Şimşekoğlu, Ö., & Rundmo, T. (2012b). A comparison of road traffic culture, risk assessment and speeding predictors between Norway and Turkey. *Risk Management*, 14(3), 202–221. <https://doi.org/10.1057/rm.2012.5>
- Nordfjærn, T., Şimşekoğlu, Ö., Zavareh, M. F., Hezaveh, A. M., Mamdoohi, A. R., & Rundmo, T. (2014). Road traffic culture and personality traits related to traffic safety in Turkish and Iranian samples. *Safety Science*, 66, 36–46. <https://doi.org/10.1016/j.ssci.2014.02.004>
- Nævestad, T.-O., Elvebakk, B., & Bjørnskau, T. (2014). Traffic safety culture among bicyclists: Results from a Norwegian study.
- Nævestad, T.-O., Laiou, A., & Yannis, G. (2020). Safety culture among car drivers and motorcycle riders in Norway and Greece: Examining the influence of nationality, region, and transport mode. *Frontiers in Sustainable Cities*, 2, 23.
- Nævestad, T.-O., Laiou, A., Phillips, R. O., Bjørnskau, T., & Yannis, G. (2019a). Safety culture among private and professional drivers in Norway and Greece: Examining the influence of national road safety culture. *Safety*, 5.
- Nævestad, T.-O., Laiou, A., Rosenbloom, T., Elvik, R., & Yannis, G. (2022a). The role of values in road safety culture: Examining the valuation of freedom to take risk, risk taking and accident involvement in three countries. *Transportation Research Part F: Traffic Psychology and Behaviour*, 84, 375–392.
- Nævestad, T.-O., Laiou, A., & Yannis, G. (2022b). The role of values in road safety culture: Examining the relationship between valuation of freedom to take risk and accident risk among motorcycle riders and car drivers. *Traffic Safety Research*, 3, 000010.
- Nævestad, T.-O., Phillips, R. O., Laiou, A., Bjørnskau, T., & Yannis, G. (2019b). Safety culture among bus drivers in Norway and Greece. *Transportation Research Part F: Traffic Psychology and Behaviour*, 64, 323–341.

- Nævestad, T.-O., Forward, S., Sam, E. F., Masaki, J., Mwamba, D., Miyoba, T., Francis, F., Fiangor, A., Hesjevoll, I. S., & Laureshyn, A. (2025). Road safety culture and the Safe System: Comparing beliefs and behaviours in African and European countries. *Traffic Safety Research*, 8, e000111, 1–21.
- Otto, J., Ward, N., Finley, K., Baldwin, S., & Grondel, D. (2021). The culture of driving under the influence of cannabis and alcohol in Washington State. *Journal of Applied Social Science*, 15(1), 29–46. <https://doi.org/10.1177/1936724420980405>
- Padilla, J., Sánchez, N., Doncel, P., Navarro-González, M., Ben-Ari, O., & Castro, C. (2023). The young male driving problem: Relationship between safe driving climate among friends, peer pressure and driving styles. *Transportation Research Part F: Traffic Psychology and Behaviour*, 98, 141–156. <https://doi.org/10.1016/j.trf.2023.09.006>
- Pires, C., Meesmann, U., Areal, A., Wardenier, N., Granie, M., Furian, G., Nikolaou, D., Jankowska-Karpa, D., Lyon, C., Møller, M., Surges, F., Nakamura, H., & Stelling, A. (2025). Measuring road safety performance and culture: A comparative study of 39 countries. *IATSS Research*, 49(3), 335–352.
- Rakauskas, M. E., Ward, N. J., & Gerberich, S. G. (2009). Identification of differences between rural and urban safety cultures. *Accident Analysis & Prevention*, 41(5), 931–937. <https://doi.org/10.1016/j.aap.2009.05.008>
- Rundmo, T., Nordfjærn, T., & Iversen, H. H. (2012). Traffic culture as symbol exchange: A cross-country comparison of Russia and Norway. *Safety Science*, 50(5), 1261–1267.
- Schlembach, C., Furian, G., & Brandstätter, C. (2016). Traffic (safety) culture and alcohol use: Cultural patterns in the light of results of the SARTRE 4 study. *European Transport Research Review*, 8(1), Article 7. <https://doi.org/10.1007/s12544-016-0194-8>
- Skvirsky, V., Ben-Ari, O., Greenbury, T., & Prato, C. G. (2017). Contributors to young drivers' driving styles: A comparison between Israel and Queensland. *Accident Analysis & Prevention*, 109, 47–54. <https://doi.org/10.1016/j.aap.2017.08.031>
- Stringer, R. J. (2018). Exploring traffic safety culture and drunk driving: An examination of the community and DUI related fatal crashes in the US (1993–2015). *Transportation Research Part F: Traffic Psychology and Behaviour*, 56, 371–380.
- Sujon, M., & Dai, F. (2021). Social media mining for understanding traffic safety culture in Washington State using Twitter data. *Journal of Computing in Civil Engineering*, 35(1).
- Taubman-Ben-Ari, O. (2016). Parents' perceptions of the family climate for road safety: Associations with parents' self-efficacy and attitudes toward accompanied driving, and teens' driving styles. *Transportation Research Part F: Traffic Psychology and Behaviour*, 40, 14–22.
- Taubman-Ben-Ari, O., & Katz-Ben-Ami, L. (2012). The contribution of family climate for road safety and social environment to the reported driving behaviour of young drivers. *Accident Analysis & Prevention*, 47, 1–10.
- Taubman-Ben-Ari, O., & Katz-Ben-Ami, L. (2013). Family climate for road safety: A new concept and measure. *Accident Analysis & Prevention*, 54, 1–14.

- Taubman-Ben-Ari, O., Musicant, O., Lotan, T., & Farah, H. (2014). The contribution of parents' driving behaviour, family climate for road safety, and parent-targeted intervention to young male driving behaviour. *Accident Analysis & Prevention*, 72, 296–301. <https://doi.org/10.1016/j.aap.2014.07.010>
- Taylor, C., Salmon, P., & Read, G. (2025). Applying systems thinking to understand the impacts of traffic safety culture on young driver speeding behaviour. *Journal of Traffic and Transportation Engineering (English Edition)*, 12(6), 1839–1854. <https://doi.org/10.1016/j.jtte.2024.08.002>
- Tekeş, B., Musselwhite, C., & Bıçaksız, P. (2025). Improving road safety in rural areas: An examination of the traffic safety climate in rural Wales. *Transportation Research Part F: Traffic Psychology and Behaviour*, 114, 864–872.
- Timmermans, C. P. M., Alhajyaseen, W. K. M., Ross, V., & Nakamura, H. (2020). Introducing a multi-variate classification method: Risky driving acceptance among different heterogeneous driver sub-cultures. *Journal of Safety Research*, 73, 81–91. <https://doi.org/10.1016/j.jsr.2020.02.009>
- Uzundu, C., Jamson, S., & Hibberd, D. (2020). Can infrastructure improvements mitigate unsafe traffic safety culture? A driving simulator study exploring cross cultural differences. *Transportation Research Part F: Traffic Psychology and Behaviour*, 73, 205–221. <https://doi.org/10.1016/j.trf.2020.06.022>
- Van den Berghe, W., Schachner, M., Sgarra, V., & Christie, N. (2020). The association between national culture, road safety performance and support for policy measures. *IATSS Research*, 44(3), 197–211. <https://doi.org/10.1016/j.iatssr.2020.09.002>
- Ward, N. J., Finley, K., Otto, J., Kack, D., Gleason, R., & Lonsdale, T. (2020). Traffic safety culture and prosocial driver behavior for safer vehicle-bicyclist interactions. *Journal of Safety Research*, 75, 24–31. <https://doi.org/10.1016/j.jsr.2020.07.003>
- Ward, N. J., Otto, J., Schell, W., Finley, K., Kelley-Baker, T., & Lacey, J. (2017). Cultural predictors of future intention to drive under the influence of cannabis (DUI). *Transportation Research Part F: Traffic Psychology and Behaviour*, 49, 215–225. <https://doi.org/10.1016/j.trf.2017.06.013>
- Xiao, D., Jin, X., Xu, X., Ma, C., & Yuan, Q. (2021). Exploring traffic safety climate with driving condition and driving behaviour: A random parameter structural equation model approach. *Transportation Safety and Environment*, 3(3), Article tdab015. <https://doi.org/10.1093/tse/tdab015>
- Xu, J., Ge, Y., Qu, W., Sun, X., & Zhang, K. (2018). The mediating effect of traffic safety climate between pedestrian inconvenience and pedestrian behavior. *Accident Analysis & Prevention*, 119, 155–161. <https://doi.org/10.1016/j.aap.2018.07.020>
- Üzümcüoğlu, Y., & Özkan, T. (2019). Traffic climate and driver behaviours: Explicit and implicit measures. *Transportation Research Part F: Traffic Psychology and Behaviour*, 62, 805–818. <https://doi.org/10.1016/j.trf.2019.03.016>
- Üzümcüoğlu, Y., Özkan, T., Wu, C., & Zhang, H. (2020). Traffic climate and driver behaviors: The moderating role of driving skills in Turkey and China. *Journal of Safety Research*, 75, 87–98. <https://doi.org/10.1016/j.jsr.2020.08.004>

- Üzümcüoğlu, Y., Özkan, T., Wu, C., & Zhang, H. (2019). How drivers perceive traffic? How they behave in traffic of Turkey and China? *Transportation Research Part F: Traffic Psychology and Behaviour*, 64, 463–471. <https://doi.org/10.1016/j.trf.2019.06.006>
- Zhang, Q., Ge, Y., Qu, W., Zhang, K., & Sun, X. (2018). The traffic climate in China: The mediating effect of traffic safety climate between personality and dangerous driving behavior. *Accident Analysis & Prevention*, 113, 213–223. <https://doi.org/10.1016/j.aap.2018.01.031>
- Zhang, Q., Yan, S., & Sun, L. (2025). Effects of safety attitudes on crossing behaviours of students aged 10–18 years: The moderating effects of family climate and social norms. *Behavioral Sciences*, 15(4), Article 415. <https://doi.org/10.3390/bs15040415>
- Özkan, T., Lajunen, T., Chliaoutakis, J. E., Parker, D., & Summala, H. (2006). Cross-cultural differences in driving behaviours: A comparison of six countries. *Transportation Research Part F: Traffic Psychology and Behaviour*, 9(3), 227–242. <https://doi.org/10.1016/j.trf.2006.01.002>
- Öztürk, İ., Wallén Warner, H., & Özkan, T. (2022). Traffic climate scale: Comparing samples from Turkey and Sweden. *IATSS Research*, 46(1), 130–137. <https://doi.org/10.1016/j.iatssr.2021.11.001>
- Öztürk, İ., Tümer, E., & Öz, B. (2024). Exploring the relationship between traffic resilience and driver behaviours through traffic climate. *Traffic Safety Research*, 6, 000039. <https://doi.org/10.55329/trjs3850>
- Öztürk, İ., Wallén Warner, H., & Özkan, T. (2023). Automation preferences by traffic climate and driver skills in two samples from countries with different levels of traffic safety. *Transportation Research Record*, 2677(2), 1701–1712. <https://doi.org/10.1177/03611981221109593>

Reviewed studies OSC

- Al-Mekhlafi, A. B. A., Isha, A. S. N., Chileshe, N., Abdulrab, M., Kineber, A. F., & Ajmal, M. (2021). Impact of safety culture implementation on driving performance among oil and gas tanker drivers: A partial least squares structural equation modelling (pls-sem) approach. *Sustainability*, 13(16), 8886.
- Anderson, N. J., Smith, C. K., & Byrd, J. L. (2017). Work-related injury factors and safety climate perception in truck drivers. *American Journal of Industrial Medicine*, 60(8), 711–723.
- Arboleda, A., Morrow, P. C., Crum, M. R., & Shelley, M. C. (2003). Management practices as antecedents of safety culture within the trucking industry: Similarities and differences by hierarchical level. *Journal of Safety Research*, 34(2), 189–197.
- Banks, T., Freeman, J., & Davey, J. (2016). An engineering or behavioural approach? A study into employees' perceptions regarding the effectiveness of occupational road safety initiatives. *Safety*, 2(1).
- Banks, T. D., Davey, J. D., & Brownlow, D. M. (2006). Driver education and safety climate in an emergency services fleet. *Journal of Occupational Health and Safety, Australia and New Zealand*, 22(4), 341–350.
- Batson, A., Kaviani, F., McDonald, H., Logan, D., Stefano, M. Di, & Koppel, S. (2025). Managerial insight towards enhancing road safety culture in the light commercial vehicle and gig economy

- transportation workforce in Australia. *Transportation Research Part F: Traffic Psychology and Behaviour*, 114, 171–181.
- Camden, M. C., Hickman, J. S., & Hanowski, R. J. (2022). Reversing poor safety records: Identifying best practices to improve fleet safety. *Safety*, 8(1),
- Chen, H. K., Chou, H. W., Su, J. W., & Wen, F. H. (2019). Structural interrelationships of safety climate, stress, inattention and aberrant driving behavior for bus drivers in Taiwan. *Transportation Research Part A: Policy and Practice*, 130, 118–133.
- Chiang, C.-H., & Chung, K.-C. (2025). Understanding the risks: Health and safety challenges for food delivery couriers. *Research in Transportation Business & Management*, 62, 101441.
- Douglas, M. A., Swartz, S. M., Richey, R. G., & Roberts, M. D. (2019). Risky business: Investigating influences on large truck drivers' safety attitudes and intentions. *Journal of Safety Research*, 70, 1–11.
- Fugas, C. S., Silva, S. A., & Meliá, J. L. (2012). Another look at safety climate and safety behavior: Deepening the cognitive and social mediator mechanisms. *Accident Analysis and Prevention*, 45, 468–477.
- Grinerud, K., Aarseth, W. K., & Robertsen, R. (2021). Leadership strategies, management decisions and safety culture in road transport organizations. *Research in Transportation Business and Management*, 41.
- Hagos, E., Brijs, T., Brijs, K., Wets, G., & Teklu, B. (2023). Safety Culture among Transport Companies in Ethiopia: Are They Ready for Emerging Fleet Technologies? *Sustainability*, 15(4).
- He, Y., Huang, Y. H., Lee, J., Lytle, B., Asmone, A. S., & Goh, Y. M. (2022). A mixed-methods approach to examining safety climate among truck drivers. *Accident Analysis and Prevention*, 164.
- Huang, Y.-H., He, Y., Lee, J., & Hu, C. (2021). Key drivers of trucking safety climate from the perspective of leader–member exchange: Bayesian network predictive modeling approach. *Accident Analysis & Prevention*, 150, 105850.
- Huang, Y. H., Lee, J., McFadden, A. C., Murphy, L. A., Robertson, M. M., Cheung, J. H., & Zohar, D. (2016). Beyond safety outcomes: An investigation of the impact of safety climate on job satisfaction, employee engagement and turnover using social exchange theory as the theoretical framework. *Applied ergonomics*, 55, 248–257.
- Huang, Y. H., Lee, J., McFadden, A. C., Rineer, J., & Robertson, M. M. (2017). Individual employee's perceptions of "Group-level Safety Climate" (supervisor referenced) versus "Organization-level Safety Climate" (top management referenced): Associations with safety outcomes for lone workers. *Accident Analysis and Prevention*, 98, 37–45.
- Huang, Y. H., Robertson, M. M., Lee, J., Rineer, J., Murphy, L. A., Garabet, A., & Dainoff, M. J. (2014). Supervisory interpretation of safety climate versus employee safety climate perception: Association with safety behavior and outcomes for lone workers. *Transportation Research Part F: Traffic Psychology and Behaviour*, 26, 348–360.

- Huang, Y.-H., Sinclair, R. R., Lee, J., McFadden, A. C., Cheung, J. H., & Murphy, L. A. (2018). Does talking the talk matter? Effects of supervisor safety communication and safety climate on long-haul truckers' safety performance. *Accident Analysis & Prevention*, 117, 357–367.
- Huang, Y. H., Zohar, D., Robertson, M. M., Garabet, A., Lee, J., & Murphy, L. A. (2013). Development and validation of safety climate scales for lone workers using truck drivers as exemplar. *Transportation Research Part F: Traffic Psychology and Behaviour*, 17, 5–19.
- Hussain, G., Batool, I., Kanwal, N., & Abid, M. (2019). The moderating effects of work safety climate on socio-cognitive factors and the risky driving behavior of truck drivers in Pakistan. *Transportation Research Part F: Traffic Psychology and Behaviour*, 62, 700–715.
- Kaviani, F., Batson, A., McDonald, H., Logan, D., Di Stefano, M., & Koppel, S. (2025). Enhancing workplace road safety for commercial and gig economy drivers in Australia. *Safety Science*, 192, 106994.
- Lee, J., Huang, Y. H., Sinclair, R. R., & Cheung, J. H. (2019). Outcomes of Safety Climate in Trucking: a Longitudinal Framework. *Journal of Business and Psychology*, 34(6), 865–878.
- Li, Y., & Itoh, K. (2014). Safety climate in trucking industry and its effects on safety outcomes. *Cognition, Technology and Work*, 16(2), 131–142.
- Mehri, M., Khazaee-Pool, M., & Arghami, S. (2022). Exploring emergent latent themes of taxi drivers' safety culture: A grounded theory approach. *Safety Science*, 148.
- Meyer, L., Louise Goedhals-Gerber, L., & de Bod, A. (2024). Safety climate and driving behaviour: Differential effects on truck drivers' violations and errors. *Transportation Research Interdisciplinary Perspectives*, 28.
- Mokarami, H., Alizadeh, S. S., Rahimi Pordanjani, T., & Varmazyar, S. (2019). The relationship between organizational safety culture and unsafe behaviors, and accidents among public transport bus drivers using structural equation modeling. *Transportation Research Part F: Traffic Psychology and Behaviour*, 65, 46–55.
- Murphy, L. A., Huang, Y. H., Robertson, M. M., Jeffries, S., & Dainoff, M. J. (2018). A sociotechnical systems approach to enhance safety climate in the trucking industry: Results of an in-depth investigation. *Applied ergonomics*, 66, 70–81.
- Murphy, L. A., Huang, Y.-h., Lee, J., Robertson, M. M., & Jeffries, S. (2019). The moderating effect of long-haul truck drivers' occupational tenure on the relationship between safety climate and driving safety behavior. *Safety Science*, 120, 283–289.
- Musicant, O. (2011). Measurement of company car drivers' aberrant behaviors, safety attitudes, and safety climate perceptions. *Transportation Research Record*, 2248, 21–29.
- Naveh, E., & Katz-Navon, T. (2015). A longitudinal study of an intervention to improve road safety climate: Climate as an organizational boundary spanner. *Journal of Applied Psychology*, 100(1), 216–226.
- Newnam, S., Lewis, I., & Watson, B. (2012). Occupational driver safety: Conceptualising a leadership-based intervention to improve safe driving performance. *Accident Analysis & Prevention*, 45, 29–38.

- Nguyen-Phuoc, D. Q., Truong, T. M., Ho-Mai, N. T., Mai, N. X., & Oviedo-Trespalacios, O. (2025). Safety climate and its contribution to safety performance in the food delivery industry. *Safety Science*, 181.
- Nævestad, T. O., & Phillips, R. O. (2023). The limits of soft safety regulation: Does successful work with safety culture require SMS implementation? *Transportation Research Interdisciplinary Perspectives*, 17.
- Nævestad, T. O., Blom, J., & Phillips, R. O. (2020). Safety culture, safety management and accident risk in trucking companies. *Transportation research part F: traffic psychology and behaviour*, 73, 325-347.
- Nævestad, T. O., Laiou, A., Phillips, R. O., Bjørnskau, T., & Yannis, G. (2019). Safety culture among private and professional drivers in Norway and Greece: Examining the influence of national road safety culture. *Safety*, 5(2), 20.
- Nævestad, T. O., Laiou, A., Rosenbloom, T., Elvik, R., & Yannis, G. (2022). The role of values in road safety culture: Examining the valuation of freedom to take risk, risk taking and accident involvement in three countries. *Transportation research part F: traffic psychology and behaviour*, 84, 375-392.
- Nævestad, T. O., Phillips, R. O., Laiou, A., Bjørnskau, T., & Yannis, G. (2019). Safety culture among bus drivers in Norway and Greece. *Transportation Research Part F: Traffic Psychology and Behaviour*, 64, 323–341.
- Qu, W., Luo, X., Wang, Y., & Ge, Y. (2022). Effects of personality on driving behaviors among professional truck drivers: The mediating effect of safety climate. *Transportation Research Part F: Traffic Psychology and Behaviour*, 89, 289–302.
- Sabar, M., Hammoumi, M. El, Ech-Chelfi, W., Bakraouy, H., & Fadil, M. (2019). Diagnosis of the Safety Culture of Carriers of Dangerous Goods by Road: A Case Study of Morocco. In *International Journal of Engineering Research and Technology*, 12.
- Seibokaite, L., & Endriulaitiene, A. (2012). The role of personality traits, work motivation and organizational safety climate in risky occupational performance of professional drivers. *Baltic Journal of Management*, 7(1), 103–118.
- Şimşekoğlu, & Nordfjærn, T. (2017). The role of safety culture/climate and social cognitive factors for driving behaviors of Turkish professional drivers transporting petroleum products. *Journal of Risk Research*, 20(5), 650–663.
- Strahan, C., Watson, B., & Lennonb, A. (2008). Can organisational safety climate and occupational stress predict work-related driver fatigue?. *Transportation research part F: traffic psychology and behaviour*, 11(6), 418-426
- Sullman, M. J. M., Stephens, A. N., & Pajo, K. (2017). Transport company safety climate—The impact on truck driver behavior and crash involvement. *Traffic Injury Prevention*, 18(3), 306–311.
- Swartz, S. M., Douglas, M. A., Roberts, M. D., & Overstreet, R. E. (2017). Leavin' on my mind: Influence of safety climate on truck drivers' job attitudes and intentions to leave. *Transportation Journal*, 56(2), 184–209.

- Swedler, D. I., Pollack, K. M., & Agnew, J. (2015). Safety climate and the distracted driving experiences of truck drivers. *American Journal of Industrial Medicine*, 58(7), 746–755.
- Varmazyar, S., Mortazavi, S. B., Arghami, S., & Hajizadeh, E. (2016). Relationship between organizational safety culture dimensions and crashes. *International Journal of Injury Control and Safety Promotion*, 23(1), 72–78.
- Wang, X., Jiao, Y., Huo, J., Li, R., Zhou, C., Pan, H., & Chai, C. (2021). Analysis of safety climate and individual factors affecting bus drivers' crash involvement using a two-level logit model. *Accident Analysis and Prevention*, 154.
- Washburn, C., Kueny, C., & Murray, S. (2023). Establishing links between safety culture, climate, behaviors, and outcomes of long-haul truck drivers. *Journal of Safety Research*, 85, 371–379.
- Wills, A., R., Watson, B., & Biggs, H. C. (2006). Comparing safety climate factors as predictors of work-related driving behaviour. *Journal of Safety Research*, 37, 375–385.
- Wills, A., Watson, B., & Biggs, H. (2009). An exploratory investigation into safety climate and work-related driving. *Work*, 32(1), 81–94.
- Wishart, D., Somoray, K., & Evenhuis, A. (2017). Thrill and adventure seeking in risky driving at work: The moderating role of safety climate. *Journal of Safety Research*, 63, 83–89.
- Xiong, J., & Chen, Z. (2024). Truck Driving Assessment for Chinese Logistics and Transportation Companies Based on a Safety Climate Test System. *Systems*, 12(5).
- Yan, M., Chen, W., Wang, J., Zhang, M., & Zhao, L. (2021). Characteristics and causes of particularly major road traffic accidents involving commercial vehicles in China. *International journal of environmental research and public health*, 18(8), 3878.
- Yılmaz, Ş., Özkan, T., & Öz, B. (2022). organizational Safety Climate, Professional Driver Behaviours, and Crashes Among a Mixed Group of Professional Drivers. *Journal of Road Safety*, 33(2), 5–16.
- Zohar, D., & Lee, J. (2016). Testing the effects of safety climate and disruptive children behavior on school bus drivers performance: A multilevel model. *Accident Analysis and Prevention*, 95, 116–124.
- Zohar, D., Huang, Y. H., Lee, J., & Robertson, M. (2014). A mediation model linking dispatcher leadership and work ownership with safety climate as predictors of truck driver safety performance. *Accident Analysis and Prevention*, 62, 17–25.
- Zohar, D., Huang, Y. H., Lee, J., & Robertson, M. M. (2015). Testing extrinsic and intrinsic motivation as explanatory variables for the safety climate–safety performance relationship among long-haul truck drivers. *Transportation research part F: traffic psychology and behaviour*, 30, 84–96.
- Öz, B., Özkan, T., & Lajunen, T. (2010). An investigation of the relationship between organizational climate and professional drivers' driver behaviours. *Safety science*, 48(10), 1484–1489.
- Öz, B., Özkan, T., & Lajunen, T. (2013). An investigation of professional drivers: Organizational safety climate, driver behaviours and performance. *Transportation Research Part F: Traffic Psychology and Behaviour*, 16, 81–91.

Öz, B., Özkan, T., & Lajunen, T. (2014). Trip-focused organizational safety climate: Investigating the relationships with errors, violations and positive driver behaviours in professional driving. *Transportation Research Part F: Traffic Psychology and Behaviour*, 26, 361–369.

Additional references

AAA Foundation for Traffic Safety. (2007). Improving traffic safety culture in the United States [Technical report]. AAA Foundation for Traffic Safety.

Ajzen, I. (1991). The theory of planned behaviour. *Organizational Behav. Hum. Decis. Processes* 50 (2), 179–211.

Amtrak Office of Inspector General. (2015). Safety and security: Opportunities exist to improve the Safe-2-Safer program (Report No. OIG-A-2015-007). Amtrak.

Bandura, A. (1977). *Social learning theory*. Englewood Cliffs, NJ: Prentice Hall.

Berger, P. L., & Luckmann, T. (1966). *The social construction of reality: A treatise in the sociology of knowledge*. Garden City, NY: Anchor Books.

Bjørnskau, T., & Longva, F. (2009). Sikkerhetskultur i transport: En sammenligning mellom forskjellige transportgrener [Safety culture in transport: A comparison of different transport modes] (TØI Report 1012/2009). Institute of Transport Economics.

Boets, S., de Séjournet, A., Moreau, N., Meesmann, U., Nævestad, T.-O., Storesund Hesjevoll, I., Sandin, J., Wallén Warner, H., Portolan, G., Brambati, F., Kaiser, S., Aigner-Breuss, E., & Machata, K. (2026). Inventory of current TSC measures and good practice (Deliverable 2.2c). TRUST: Traffic Safety Culture – A Systematic Transition towards Shared Responsibility for Safe and Sustainable Mobility in the EU.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. <https://doi.org/10.1191/1478088706qp063oa>

Bronfenbrenner, U. (1979). *The Ecology of Human Development: Experiments by Nature and Design*. Cambridge, MA: Harvard University Press.

Christian, M. S., Bradley, J. C., Wallace, J. C., & Burke, M. J. (2009). Workplace safety: A meta-analysis of the roles of person and situation factors. *Journal of Applied Psychology*, 94(5), 1103–1127. doi:10.1037/a0016172

Cialdini, R. B., Reno, R. R., & Kallgren, C. A. (1990). A focus theory of normative conduct: Recycling the concept of norms to reduce littering in public places. *Journal of Personality and Social Psychology*, 58(6), 1015–1026. <https://doi.org/10.1037/0022-3514.58.6.1015>

Clarke, S. (2006). The relationship between safety climate and safety performance: A meta-analytic review. *Journal of Occupational Health Psychology*, 11(4), 315–327. doi:10.1037/1076-8998.11.4.315

de Winter, J. C. F., & Dodou, D. (2010). The Driver Behaviour Questionnaire as a predictor of accidents: A meta-analysis. *Journal of Safety Research*, 41(6), 463–470. <https://doi.org/10.1016/j.jsr.2010.10.007>

- Desai, V. M., Roberts, K. H., & Ciavarella, A. P. (2006). The relationship between safety climate and recent accidents: Behavioral learning and cognitive attributions. *Human Factors*, 48(4), 639–650. <https://doi.org/10.1518/001872006779166361>
- Eagly, A. H., & Chaiken, S. (1993). The psychology of attitudes. Harcourt brace Jovanovich college publishers.
- Elster, J. (2007). Explaining social behavior: More nuts and bolts for the social sciences. Cambridge University Press.
- European Commission. (2025, March 18). EU road fatalities drop by 3% in 2024, but progress remains slow. Directorate-General for Mobility and Transport.
- Flin, R., Mearns, K., O'Connor, P., & Bryden, R. (2000). Measuring safety climate: Identifying the common features. *Safety Science*, 34(1–3), 177–192. [https://doi.org/10.1016/S0925-7535\(00\)00012-6](https://doi.org/10.1016/S0925-7535(00)00012-6)
- Gehlert, T., Hagemester, C., & Özkan, T. (2014). Traffic safety climate attitudes of road users in Germany. *Transportation Research Part F: Traffic Psychology and Behaviour*, 26, 326–336.
- Glendon, A. I., & Litherland, D. K. (2001). Safety climate factors, group differences and safety behaviour in road construction. *Safety Science*, 39(3), 157–188. [https://doi.org/10.1016/S0925-7535\(01\)00006-6](https://doi.org/10.1016/S0925-7535(01)00006-6)
- Global Aviation Information Network. (2001). Operator's flight safety handbook. Global Aviation Information Network.
- Griffin, M. A., & Neal, A. (2000). Perceptions of safety at work: A framework for linking safety climate to safety performance, knowledge, and motivation. *Journal of Occupational Health Psychology*, 5(3), 347–358. <https://doi.org/10.1037/1076-8998.5.3.347>
- Hale, A. R., Guldenmund, F. W., van Loenhout, P. L. C. H., & Oh, J. I. H. (2010). Evaluating safety management and culture interventions to improve safety: Effective intervention strategies. *Safety Science*, 48(8), 1026–1035. <https://doi.org/10.1016/j.ssci.2009.05.006>
- Haukelid, K. (2008). Theories of (safety) culture revisited—An anthropological approach. *Safety Science*, 46(3), 413–426. <https://doi.org/10.1016/j.ssci.2007.05.014>
- Hofstede, G. (2001). Culture's consequences: Comparing values, behaviours, institutions and organizations across nations (2nd ed.). Thousand Oaks, CA: Sage.
- Hudson, P. (2003). Applying the lessons of high-risk industries to health care. *Quality and Safety in Health Care*, 12(suppl. 1), i7–i12. <https://doi.org/10.1136/qhc.12.suppl.1.i7>
- Iversen, H. H., & Rundmo, T. (2004). Attitudes towards traffic safety, driving behaviour and accident involvement among the Norwegian public. *Ergonomics* 47, 555–572.
- Kaçan, B., Findık, G., Üzümcüoğlu, Y., Azık, D., Solmazer, G., Ersan, Ö., Özkan, T., Lajunen, T., Öz, B., Pashkevich, A., Pashkevich, M., Danelli-Mylona, V., Georgogianni, D., Berisha Krasniqi, E., Krasniqi, M., Makris, E., Shubenkova, K., & Xheladini, G. (2019). Driver profiles based on values and traffic safety climate and their relationships with driver behaviors. *Transportation Research Part F: Traffic Psychology and Behaviour*, 64, 246–259

- Klempe, H., Granskaya, J., Rundmo, T. (2009). Redefining culture in traffic safety. In: 11th European Congress of Psychology, 7–10 July, Oslo.
- Komisarof, A., & Akaliyski, P. (2025). New developments in Hofstede's individualism-collectivism: A guide for scholars, educators, trainers, and other practitioners. *International Journal of Intercultural Relations*, 107, 102200.
- Lappalainen, J., Kuronen, J., & Tapaninen, U. (2012). Evaluation of the ISM Code in Finnish shipping companies. *Journal of Maritime Research*, 9(1), 23–32.
- Levac, D., Colquhoun, H., & O'Brien, K. K. (2010). Scoping studies: *Advancing the methodology. Implementation Science*, 5, 69. <https://doi.org/10.1186/1748-5908-5-69>
- Merton, R. K. (1949). On sociological theories of the middle range. In *Social theory and social structure* (pp. 39–53). The Free Press.
- Mjøset, L. (2007). Om teori på høyt og lavere nivå. In J. Hjellbrekke, O. J. Olsen, & R. Saksind (Eds.), *Arbeid, kunnskap og sosial ulikhet: Festskrift til Olav Korsnes* (pp. 333–375). Oslo: Unipub.
- Nahrgang, J. D., Morgeson, F. P., & Hofmann, D. A. (2011). Safety at work: A meta-analytic investigation of the link between job demands, job resources, burnout, engagement, and safety outcomes. *Journal of Applied Psychology*, 96(1), 71–94. <https://doi.org/10.1037/a0021484>
- Neal, A., & Griffin, M. A. (2006). A study of the lagged relationships among safety climate, safety motivation, safety behavior, and accidents at the individual and group levels. *Journal of Applied Psychology*, 91(4), 946–953. <https://doi.org/10.1037/0021-9010.91.4.946>
- Nordfjærn, T., & Simsekoglu, Ö. (2013). The role of cultural factors and attitudes for pedestrian behaviour in an urban Turkish sample. *Transport. Res. Part F: Traffic Psychol. Behav.* 21, 181–193.
- Nævestad T.-O., Meesmann, U., Wallén Warner, H., Kaiser, S., Hesjevoll, I.S., Milch, V., Forward, S., De Roeck, M., Schachner, M., Nikolaou, D., Björklund, G., Laiou, A., Wennberg, H., Aigner-Breuss, E., & Eichhorn, A. (2026) Traffic safety culture within the safe system: developing a common definition of traffic safety culture. *Frontiers in Sustainable Cities*, 8, 1819840.
- Nævestad, T.-O., & Bjørnskau, T. (2012). How can the safety culture perspective be applied to road traffic? *Transport Reviews*, 32(2), 139–154. <https://doi.org/10.1080/01441647.2011.628131>
- Nævestad, T.-O., & Wennberg, H. (2026). Lost in sustainability? What happens to road safety when integrated in the broader sustainability agenda? In C. Bieder et al. (Eds.), *Living with the new safety landscape II*. Springer.
- Nævestad, T.-O., Blom, J., & Phillips, R. O. (2018). Sikkerhetskultur, sikkerhetsledelse og risiko i godstransportbedrifter på veg [Safety culture, safety management and risk in road goods transport companies] (TØI Report 1659/2018). Institute of Transport Economics.
- Nævestad, T.-O., Hesjevoll, I. S., & Elvik, R. (2021). How can regulatory authorities improve safety in organizations by influencing safety culture? A conceptual model of the relationships and a discussion of implications. *Accident Analysis & Prevention*, 159, 106228. <https://doi.org/10.1016/j.aap.2021.106228>

- Nævestad, T.-O., Meesmann, U., Pires, C., De Roeck, M., Björklund, G., Wallén Warner, H., Kaiser, S., Høye, A., Bjørnskau, T., Storesund Hesjevoll, I., Milch, V., Nikolaou, D., Laiou, A., & Wennberg, H. (2026). Link between traffic safety culture and road safety performance. TRUST EU project Deliverable 2.2b. TRUST project.
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., et al. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *Systematic Reviews*, 10, 89. <https://doi.org/10.1186/s13643-021-01626-4>
- Parker, D., Reason, J. T., Manstead, A. S., & Stradling, S. G. (1995). Driving errors, driving violations and accident involvement. *Ergonomics*, 38(5), 1036-1048.
- Reason, J. T. (1997). Managing the risks of organizational accidents. Ashgate.
- Reason, J., Manstead, A., Stradling, S., Baxter, J., & Campbell, K. (1990). Errors and violations on the roads: a real distinction?. *Ergonomics*, 33(10-11), 1315-1332.
- Rundmo, T., & Iversen, H. H. (2004). Risk perception and driving behaviour among adolescents in two Norwegian counties before and after a traffic safety campaign. *Safety Science* 42, 1–21.
- Schein, E. H. (2004). Organizational culture and leadership (3rd ed.). Jossey-Bass.
- Schwartz, S. H. (1977). Normative influences on altruism. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 10, pp. 221–279). New York, NY: Academic Press. [https://doi.org/10.1016/S0065-2601\(08\)60358-5](https://doi.org/10.1016/S0065-2601(08)60358-5)
- Schwartz, S. H. (1999). A theory of cultural values and some implications for work. *Applied Psychology: An International Review*, 48(1), 23–47. <https://doi.org/10.1111/j.1464-0597.1999.tb00047.x>
- Scott, W. R. (2014). *Institutions and organizations: Ideas, interests, and identities* (4th ed.). Thousand Oaks, CA: Sage.
- Singelis, T. M., Triandis, H. C., Bhawuk, D. P. S., & Gelfand, M. J. (1995). Horizontal and vertical dimensions of individualism and collectivism: a theoretical and measurement refinement. *Journal of Cross-Cult. Research*, 29, 240–275.
- Swedish Transport Administration. (2025). Saving lives beyond 2025: Taking further steps: Recommendations of the Academic Expert Group for the 4th Global Ministerial Conference on Road Safety (Trafikverkets publikationer 2025:007). Trafikverket.
- T. Özkan, & T. Lajunen (2011). Person and environment: Traffic culture B.E. Porter (Ed.), *Handbook of Traffic Psychology*, Elsevier, San Diego (2011), pp. 179-192
- Tajfel, H., & Turner, J. C. (1979). An integrative theory of intergroup conflict. In W. G. Austin & S. Worchel (Eds.), *The social psychology of intergroup relations* (pp. 33–47). Monterey, CA: Brooks/Cole.
- Taubman-Ben-Ari, O., & Katz-Ben-Ami, L. (2013). Family climate for road safety: A new concept and measure. *Accident Analysis & Prevention*, 54, 1-14.
- Turner, J. C., Hogg, M. A., Oakes, P. J., Reicher, S. D., & Wetherell, M. S. (1987). Rediscovering the social group: A self-categorization theory. Oxford: Blackwell.

- Van den Berghe, W. (2026). Differences in factors affecting traffic safety culture in Africa and Europe. In A. I. Attwood (Ed.), *Studies in cultural diversity for comparative and international contexts* [Online first]. IntechOpen.
- Ward, N. J. (2019). Ten principles of traffic safety culture. In N. J. Ward, B. Watson, & K. Fleming-Vogl (Eds.), *Traffic Safety Culture: Definition, Foundation, and Application*. Emerald Publishing Limited.
- Ward, N. J., Linkenbach, J., Keller, S. N., & Otto, J. (2010). White paper on traffic safety culture (White Paper No. 2, Toward Zero Deaths: A National Strategy on Highway Safety). Western Transportation Institute, Montana State University.
- Wasti, A., & Erdil, S. E. (2007). Bireycilik ve toplulukluk degerlerinin ölçülmesi: Benlik kurgusu ve indcol olceklerinin Turkce gecerlemesi (Measurement of individualism and collectivism values: Turkish validation of the self-construal and INDCOL scales). *Yönetim Araştırmaları Dergisi*, 7, 39–66.
- Westphaln, K. K., Regoeczi, W., Masotya, M., Vazquez-Westphaln, B., Lounsbury, K., McDavid, L., Lee, H., Johnson, J. A., & Ronis, S. D. (2021). From Arksey and O'Malley and beyond: Customizations to enhance a team-based, mixed approach to scoping review methodology. *MethodsX*, 8, 101375. <https://doi.org/10.1016/j.mex.2021.101375>
- Wills, A. R., Watson, B., & Biggs, H. C. (2005). Factor structure of a safety climate measure for occupational drivers. *Australian Journal of Psychology*, 57, 152–153.
- Wiegmann, D. A., von Thaden, T. L., & Gibbons, A. M. (2007). A review of safety culture theory and its potential application to traffic safety. In AAA Foundation for Traffic Safety, *Improving traffic safety culture in the United States: The journey forward*. AAA Foundation for Traffic Safety.
- Yule, S. J. (2003). Senior management influence on safety in the UK and US energy sectors. University of Aberdeen.
- Üzümcüoğlu, Y. (2020). A short scale of traffic climate across five countries. *Mustafa Kemal Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, 17(46), 673–702.
- Üzümcüoğlu, Y., Özkan, T., Wu, C., & Zhang, H. (2020). Traffic climate and driver behaviours: The moderating role of driving skills in Turkey and China. *Journal of safety research*, 75, 87–98.
- Zohar, D. (2010). Thirty years of safety climate research: Reflections and future directions. *Accident Analysis & Prevention*, 42(5), 1517–1522. <https://doi.org/10.1016/j.aap.2009.12.019>
- Zohar, D., & Luria, G. (2005). A multilevel model of safety climate: Cross-level relationships between organization and group-level climates. *Journal of Applied Psychology*, 90(4), 616–628. <https://doi.org/10.1037/0021-9010.90.4.616>
- Öztürk, İ., Wallén Warner, H., & Özkan, T. (2022). Traffic climate scale: Comparing samples from Turkey and Sweden. *IATSS Research*, 46(1), 130–137.
- Öztürk, İ., Warner, H. W., & Özkan, T. (2022). Traffic climate scale: Comparing samples from Turkey and Sweden. *IATSS research*, 46(1), 130–137.

Appendix 1 | Additional information from the TSC review

A1 | Operationalisation of traffic safety culture across cultural group levels

This appendix provides additional information on how TSC is operationalised (cf. aim 1b). We compare this across cultural group levels (continental, national, regional, local, peer, family). The information complements Chapter 3.2.

A1.1 | Studies of traffic safety culture at the continent level

Operationalisation of culture: There is only one empirical study of TSC at the continent level (Nævestad et al., 2025). We also mention Van den Berghe (2026), but this is a book chapter and not based on separate empirical data collection and is therefore not included as a review result. Nævestad et al. (2025) compare traffic safety culture in three European countries and three African countries. The study can be described as a cross-continental comparison based on selected country cases, rather than a representative comparison of Africa and Europe as whole continents. This distinction is important because continent-level comparisons may mask substantial variation between countries, although the framing is justified by the study's aim of identifying the largest differences between the African and European samples. The continent-level interpretation is further supported by Van den Berghe's (2026) scientific chapter on differences in factors affecting TSC in Africa and Europe.

Nævestad et al. (2025) operationalises traffic safety culture as shared values, attitudes, beliefs, descriptive norms and shared expectations regarding the behaviour of other road users. Four cultural elements/aspects are examined: descriptive norms related to road user violations, fatalistic beliefs about road safety, values and attitudes related to individual freedom to take risk in traffic, and the social valuation of motorised transport compared with walking. Descriptive norms are measured as respondents' expectations about how often car drivers in their country commit violations. Fatalistic beliefs are measured through statements concerning fate, God's will, spiritual intervention, punishment for bad deeds, and whether people can prevent their own death in road crashes. Freedom values are measured through attitudes concerning the individual right to take risks in traffic. The valuation of motorised transport over walking is measured through pedestrians' agreement with statements about the social status of car use and whether the road system is designed primarily for cars rather than pedestrians.

Assumed mechanisms between traffic safety culture and outcomes. The study of Nævestad et al. (2025) assumes that traffic safety culture influences safety outcomes through behaviour. Descriptive norms may influence behaviour by creating a subtle social pressure to act in accordance with what is perceived as normal in one's country or wider regional context. If road users expect violations to be common, such behaviour may become normalised and more likely to be reproduced. Fatalistic beliefs may influence behaviour by reducing perceived personal control and responsibility: if crashes are understood as predetermined, caused by fate, or controlled by divine will, individuals may be less motivated to act safely.⁵

⁵ Van den Berghe's (2026) chapter strengthens this interpretation by arguing that fatalism can also be understood as an interpretive response to environments where hazards are frequent and institutional protection is limited. In this sense, fatalism is not simply an irrational belief, but may reflect a cultural adaptation to structural insecurity.

Values related to freedom to take risk may legitimise risky behaviour and reduce acceptance of restrictive safety measures. The valuation of motorised transport over walking may reduce the perceived legitimacy and priority of pedestrians, potentially contributing to lower protection of vulnerable road users. Van den Berghe's chapter adds that when walking is culturally devalued, pedestrians may be treated as being "out of place" in traffic, and investment in pedestrian infrastructure may appear less politically attractive, even when pedestrians constitute a large share of road users and victims. This indicates how cultural valuation and material infrastructure can mutually reinforce each other.

Cultural aspects influencing outcomes: Nævestad et al. (2025) finds the largest differences between African and European respondents for fatalistic beliefs and the valuation of motorised transport over walking. Fatalistic beliefs were substantially higher among both car drivers and pedestrians in the African countries than in the European countries. The share agreeing with some fatalism-related statements was many times higher in the African sample. The study also found that the social valuation of car use compared with walking was considerably higher in the African sample. For example, the share agreeing that people who drive to work are more respected than those who walk was much higher among African pedestrians than among European pedestrians. Descriptive norms for violations were also higher in the African countries, while descriptive norms for speeding were higher in the European countries.

Results regarding behaviour and crash involvement: Nævestad et al. (2025) find that African car drivers report higher levels of road safety violations than European car drivers, especially aggressive violations, driving under the influence and lack of seat belt use. European drivers, however, report higher levels of speeding. Among pedestrians, aggressive violations are also higher in the African sample. Regression analyses show that descriptive norms, fatalistic beliefs, and freedom-to-take-risk attitudes are related to car drivers' road safety violations. Road safety violations are in turn related to crash involvement. This supports the general causal chain assumed in TSC research, where cultural elements influence behaviour, and behaviour influences safety outcomes. The study therefore provides empirical support for the assumption that traffic safety culture is relevant for understanding road safety behaviour and crash involvement at a cross-continental level.

A1.2 | Studies of traffic safety culture at the national level

A1.2.1 | Hofstede dimensions

Operationalisation of culture: Hofstede's cultural dimensions are in five studies used to classify countries according to the type of culture (Atchley et al., 2014; Gaygisiz, 2010; Van den Berghe et al., 2020; Arslan & Özkan, 2024; Melinder, 2007). Hofstede (2001) defines culture as "the collective programming of the mind that distinguishes the members of one group or category of people from another" (p. 9, as cited in Arslan & Özkan, 2024).

The studies based on Hofstede distinguishes between six dimensions of culture (Arslan & Özkan, 2024), although some of the studies only refer to the first four dimensions (e.g. Gaygisiz, 2010):

- **Individualism vs. collectivism** concerns whether people primarily see themselves as autonomous individuals or as members of a wider group, which may influence the balance between personal freedom and responsibility toward other road users.
- **Masculinity vs. femininity** concerns whether cultures emphasise competition, achievement, and assertiveness, or care, cooperation, and quality of life, which may be relevant for aggressive versus cooperative traffic behaviour.
- **Uncertainty avoidance** refers to tolerance of ambiguity and unpredictability, and may influence preferences for clear rules, predictability, and traffic regulation.
- **Power distance** concerns acceptance of hierarchy and unequal power, and may shape attitudes toward authority, enforcement, and traffic laws.

- **Short-term vs. long-term orientation** concerns whether cultures prioritise immediate outcomes or long-term planning, which may be relevant for preventive safety work.
- **Indulgence vs. restraint** concerns the extent to which cultures encourage gratification and personal enjoyment or emphasise self-control and regulation, which may be relevant for impulsive or risk-taking behaviours in traffic. (*not included in all studies, e.g. Atchley et al., 2014*)

The main element of culture according to this definition is social norms (Arslan & Özkan, 2024). However, the definitions of the dimensions of culture show that also values are a part of culture.

Assumed mechanisms between traffic safety culture and outcomes. Hofstede's cultural dimensions may hypothetically influence traffic safety through their effects on shared norms, attitudes, and behaviour (Hofstede, 2001; Arslan & Özkan, 2024). Individualism–collectivism and power distance are the dimensions most consistently linked to traffic fatality rates in the reviewed Hofstede-based studies, while long-term orientation is identified in one study (Gaygisiz, 2010; Van den Berghe et al., 2020; Arslan & Özkan, 2024). These dimensions may influence behaviour by shaping expectations about autonomy, responsibility, obedience to rules, and acceptance of authority. Collectivism may be associated with stronger concern for group welfare and greater rule compliance, while individualism may be linked to stronger emphasis on personal autonomy and potentially greater acceptance of risk-taking. High power distance may strengthen obedience to authority and traffic laws, although this relationship may also depend on institutional and governance conditions. Other dimensions, such as masculinity–femininity, uncertainty avoidance, and indulgence–restraint, are theoretically relevant for traffic behaviour. High uncertainty avoidance may support preferences for clear rules, predictability, and regulation, and may therefore be associated with safer and more rule-compliant behaviour. Masculine cultures may encourage more competitive and assertive behaviour, which could be relevant for aggressive or risky driving, whereas feminine cultures may place greater emphasis on care and cooperation. Long-term orientation may support preventive safety efforts, while indulgence may be linked to more impulsive or pleasure-oriented behaviour in traffic. Together, these cultural dimensions may shape traffic safety outcomes such as rule adherence, risky behaviour, and crash rates. The reviewed studies provide, however, less consistent evidence that masculinity–femininity, uncertainty avoidance, and indulgence–restraint are related to traffic safety outcomes. The assumed mechanism is that broad cultural values influence traffic safety through norms, attitudes, and behaviour, although this mechanism is often assumed rather than directly tested.

Cultural traits influencing outcomes: All of the Hofstede-based studies have collected information about crash rates, in addition to the cultural dimensions. Three of these have investigated relationships between the cultural aspects and fatality rates. The studies are based on 46, 29, and 65 countries, respectively (study (Gaygisiz, 2010; Van den Berghe et al., 2020; Arslan & Özkan, 2014). Culture dimensions related to fatality rates are:

- Power distance in all three studies
- Individualism in all three studies (but ns in Gaygisiz, 2010)
- Long-term orientation in one study (Arslan & Özkan, 2024) weaker relationship than for power distance and individualism).

The other dimensions (masculinity, uncertainty avoidance, long-term orientation, and indulgence vs. restraint) are less important.

A1.2.2 | Schwartz' values (in Hofstede-studies, cross-country comparisons)

Operationalisation of culture: Three of the studies that are based on Hofstede's cultural dimensions also refer to cultural values as defined by Schwartz (1999) (Atchley et al., 2014; Gaygisiz, 2010; Arslan & Özkan, 2024). Schwartz' framework conceptualises culture as shared value priorities, i.e. ideas about what is desirable, legitimate and important in a society. These values are described according to three dimensions:

- **Embeddedness vs. autonomy:** Embeddedness refers to cultures where individuals are strongly integrated into social groups, and where tradition, belonging, social order and commitment to the group are emphasised. Autonomy refers to cultures where independence, individual choice and self-expression are more highly valued.
- **Hierarchy vs. egalitarianism:** Hierarchy refers to cultures where unequal social roles, authority structures and differences in status are accepted as legitimate. Egalitarianism refers to cultures where individuals are regarded as moral equals, with shared basic interests and mutual obligations.
- **Mastery vs. harmony:** Mastery refers to cultures where achievement, ambition, control and the pursuit of personal or group interests are emphasised. Harmony refers to cultures where people are expected to fit into the social and natural environment, avoid conflict and maintain balance.

Based on these dimensions, specific values are described, e.g. by Atchley et al. (2014):

- **Embeddedness:** Collectivism, belonging, tradition and social order.
- **Intellectual autonomy:** Independent pursuit of ideas, curiosity and independent judgement.
- **Affective autonomy:** Independent pursuit of pleasurable experiences, enjoyment and excitement.
- **Hierarchy:** Hierarchical organisation of individuals and resources, and acceptance of unequal social roles.
- **Egalitarianism:** The degree to which individuals are seen as moral equals with shared basic interests and obligations toward each other.
- **Mastery:** The degree to which individuals value success, control, ambition and the pursuit of personal or group interests.
- **Harmony:** The degree to which individuals value fitting into, accepting and preserving their natural and social environment.

Assumed mechanisms between Traffic Safety Culture and outcomes: Schwartz' cultural values may influence traffic safety through their effects on norms, attitudes, responsibility attribution, acceptance of regulation and risk-taking in traffic. Embeddedness may support conformity to shared norms, although the safety effect depends on whether the dominant norms are safe or unsafe. Autonomy may support individual responsibility and independent judgement, but affective autonomy may also be related to sensation seeking or risk-oriented behaviour. Hierarchy may influence compliance with traffic rules and acceptance of enforcement, especially when authorities are perceived as legitimate. Egalitarianism may support mutual consideration and protection of vulnerable road users. Mastery may be associated with more assertive or competitive traffic behaviour, while harmony may support more cautious, cooperative and adaptive behaviour in traffic. Together, these value dimensions may shape traffic safety outcomes through their influence on behaviour, compliance and crash risk.

Cultural traits influencing outcomes: Values related to fatality rates are:

- Embeddedness, hierarchy, and egalitarianism in both studies
- Affective and intellectual autonomy in (Arslan & Özkan, 2024)
- Mastery in (Gaygisiz, 2010).

The two remaining studies (Atchley et al., 2014; Melinder, 2007) have compared countries with respect to culture and fatality rates, but they have not investigated relationships between the cultural aspects and fatality rates.

A1.2.3 | Road traffic culture as symbol exchange

Operationalisation of culture: Five studies are based on a view of culture as “Symbol exchange” (Rundmo et al., 2012; Nordfjærn et al., 2012a,b, 2014), which is quite different from other views of culture. All five studies are from the same group of authors from the Norwegian University of Science and Technology, Department of Psychology. All five studies are comparisons between countries. Road safety culture as symbol exchange refers to the forms of communication through which road users interpret and respond to safety-relevant meanings, reflected, for example, in taking oral corrections of one’s traffic behaviour seriously and reacting strongly to sounds signalling danger. These examples represent the study’s oral and auditive dimensions of traffic safety culture (Rundmo et al., 2012).

A questionnaire for measuring road traffic culture in terms of “symbol exchange” was developed by Klempe et al. (2009). The scale has been adjusted for measuring TSC on six dimensions (Rundmo et al., 2012):

- Extraverted culture
- Introverted culture
- Auditive culture
- Oral culture
- Visual culture
- Written culture

The dimensions extravert and introvert culture are not related to the definitions of extra- and introversion in personality psychology, i.e. the extent to which individuals are oriented toward external stimulation and social interaction (extraversion) versus internal thoughts and low-stimulation environments (introversion).

Fatalistic attributions / Destiny orientation. Three of the studies that are based on a view of Traffic Safety Culture as “Symbol exchange” have investigated Fatalistic attributions / Destiny orientation as an additional aspect of culture (Nordfjærn et al., 2012a,b, 2014). Fatalistic attributions / Destiny orientation is measured with items such as ‘if everyone were religious, there would be fewer traffic crashes’ and ‘all human beings have a destiny’.

Vertical and horizontal individualism and collectivism. One study has defined and measured TSC in terms of two dimensions, vertical and horizontal individualism and collectivism (INDCOL, Nordfjærn & Zavareh, 2016). Traffic safety culture on these two dimensions is measured on a self-report scale.

According to this definition, there are four general types of culture:

- Horizontal individualism: The self is considered as unique, low focus on competition and social status.
- Vertical individualism: The self is considered as unique, strong focus on competition and social status.
- Horizontal collectivism: Focus on the self in relation to others, low conformity to hierarchy and authorities.
- Vertical collectivism: Focus on the self in relation to others, strong focus on conformity to hierarchy and authorities.

Assumed mechanisms between Traffic Safety Culture and outcomes. The “symbol exchange” perspective conceptualises traffic culture in terms of dominant forms of communication and meaning-making, such as visual, written, oral, and auditive culture. It may therefore be interpreted as suggesting that traffic safety behaviour is influenced by how traffic-related meanings, rules, and expectations are communicated and internalised. However, the reviewed studies do not clearly specify or empirically test the precise mechanisms through which these cultural forms affect behaviour. Fatalistic attributions may reduce perceived personal control over safety outcomes, potentially leading to lower compliance with traffic rules. In contrast, weaker fatalistic beliefs may encourage a stronger sense of responsibility for safe behaviour. Finally, vertical and horizontal individualism and collectivism shape the balance between autonomy and conformity. Vertical forms may increase compliance with authority and regulations, while horizontal forms may emphasise equality and mutual consideration among road users. These traits may influence behaviour, risk perception, and ultimately traffic safety outcomes such as crash rates and rule adherence.

Cultural traits influencing outcomes: None of the studies found strong or consistent relationships between culture and behaviour or crashes. In two studies, culture and behaviour are generally unrelated (Nordfjærn et al., 2012b, 2014). In one study, different relationships between culture and crashes were found in different countries (Nordfjærn et al., 2012a). In the remaining two studies, some aspects of culture were found to be related to behaviour: “written culture” in both studies, “oral culture” in Nordfjærn et al. (2014), and “auditive culture” in Rundmo et al. (2012). However, the relationships are only reported for behaviour as one factor (not per type of behaviour). Moreover, it is unclear how the different types of culture are assumed to affect behaviour, or what practical implications the results might have.

A1.2.4 | Traffic Climate Scale (TCS)

Operationalisation of culture: Seventeen studies have used the Traffic Climate Scale (TCS) to measure TSC or traffic safety climate at the country level. In all studies, the TCS is answered by individuals, but the questions refer to the respondents’ perceptions of the wider traffic environment, for example the traffic climate in a country, region or city. Thus, the TCS measures individually reported perceptions of a shared traffic context, rather than individual driving behaviour alone.

The Traffic Climate Scale measures road users’ perceptions of the traffic safety climate in a given traffic system. It is based on the theory of planned behaviour (TPB), and on safety climate / safety culture theory from organisational safety research. The scale is relevant to TSC because it captures how road users perceive the traffic environment in which they participate, including whether traffic is experienced as stressful, demanding, predictable, safe or well organised. The TCS measures three dimensions of traffic climate (Öztürk et al., 2022):

- **External affective demands:** This dimension refers to the emotional and affective demands that road users experience in traffic interactions. It captures whether the traffic environment is perceived as stressful, annoying, tense, frustrating, threatening, or dependent on luck. A high level of external affective demands indicates that road users experience traffic as emotionally demanding or conflict-prone. In traffic safety terms, this may be important because stress, irritation and perceived unpredictability can reduce attention, increase impatience, and make risky or aggressive behaviour more likely.
- **Internal requirements:** This dimension refers to the skills, abilities and mental resources that road users perceive as necessary to manage the traffic environment. It includes perceptions that traffic requires skill, vigilance, concentration, alertness and the ability to anticipate other road users' actions. A high score on internal requirements may indicate that road users perceive traffic as complex and demanding. This can have two possible implications: it may encourage carefulness and vigilance, but it may also indicate that the traffic environment is difficult to navigate and places high demands on road users.
- **Functionality:** This dimension refers to road users' perceptions of how well the traffic system works. It captures whether the system is perceived as planned, predictable, safe, well organised, functional and supportive of safe behaviour. A highly functional traffic climate means that road users experience the traffic system as orderly and understandable. This is relevant because a predictable and well-organised traffic environment may support rule compliance, reduce uncertainty, and make safe behaviour easier.

The original version of the TCS consists of 44 items, although several shorter versions have also been developed and tested in different countries, including 16- and 38-item versions. These different versions reflect attempts to adapt the scale to different national contexts while retaining the same general conceptual structure.

Assumed mechanisms between Traffic Safety Culture and outcomes: The TCS dimensions may influence traffic safety outcomes indirectly through road users' perceptions, attitudes, intentions, behaviour, and interaction with the traffic system. A traffic climate characterised by high external affective demands may increase stress, annoyance, and perceived unpredictability, which may in turn contribute to risky behaviour, errors, or violations. Internal requirements may influence behaviour by shaping how much skill, vigilance, and effort road users believe traffic requires. This may support safer behaviour when it encourages attention and preparedness, but it may also reflect a traffic environment perceived as difficult or demanding. Functionality may influence behaviour by making the traffic system appear more predictable, organised, and understandable, thereby potentially supporting rule compliance and safer behaviour. Together, these dimensions describe how road users experience the traffic system, and how these experiences may shape traffic safety behaviour and, indirectly, safety outcomes.

Cultural traits influencing outcomes: Four studies have investigated the direct relationship between TCS and crash involvement. In two of these, statistically significant but very weak relationships were found (Atombo & Wu, 2022; Gehlert et al., 2014), and in the third study no relationship was found (Öztürk et al., 2022). In the fourth study (Chu et al., 2019) DBQ-behaviour is related to both crashes and TCS, i.e. TCS may affect crash involvement via behaviour, with the strongest relationships between External affective demands (TCS) and errors and violations (DBQ).

Among the studies that have investigated relationships between TCS and behaviour (16 studies), six are from the same group of authors (Üzümcüoğlu et al., 2020; Öztürk et al., 2022; Üzümcüoğlu & Özkan, 2019; Üzümcüoğlu et al., 2019; Öztürk et al., 2024 and study Öztürk et al 2023). Most of the 16 TCS-

behaviour studies have measured behaviour with the DBQ; other types of behaviour include self-reported driving styles, aggressive, risky, and drunk driving, and positive driver behaviour.

All studies found some relationships between TCS and behaviour, without any clear pattern of differences between the three factors of the TCS. About half of the studies found relationships between all three factors and behaviour, and the remaining studies found relationships with behaviour for one or two factors, but none of the factors is clearly more often among the relevant factors than the others. A general weakness with many of the TCS-studies is that they have investigated many bivariate relationships between survey-based variables, without clearly distinguishing between different types of variables (predictor, moderator, mediator).

A1.2.5 | Descriptive norms, based on selected DBQ questions (violations)

Operationalisation of culture: Some studies operationalise TSC as Descriptive norms, based on selected DBQ questions. These studies focus especially on violations, as these are especially critical to road safety. The Driver Behavior Questionnaire (DBQ) was developed by Reason et al. (1990) and Parker et al. (1995). It measures self-reported aberrant driving behaviours, i.e. deviations from safe driving, and distinguishes between three main categories:

- Violations (deliberate rule-breaking, e.g. speeding)
- Errors (unintentional mistakes, e.g. misjudging gaps)
- Lapses (attention/memory failures, e.g. forgetting where you parked)

The original DBQ-items are rated on frequency scales (e.g. “never” → “nearly all the time”).

Six studies have assessed TSC with questionnaires that are based on selected DBQ items (e.g. aggressive violations, speeding, lacking seat belt use, driving under the influence). These are the studies of Nævestad, et al. (2020), Nævestad, Laiou, et al. (2019), Nævestad et al. (2022a), Nævestad et al. (2022b) Nævestad, Phillips et al. (2019) and Abubakari et al. (2025), which used a scale from Nævestad et al. (2022a). These studies measure both behaviours based on the selected DBQ items and descriptive norms based on the selected DBQ items. Some of the studies also include additional operationalisations of TSC, like values and attitudes related to paternalism and individual freedom to take risk in traffic (Nævestad et al., 2022a, 2022b). It can also be mentioned that Nævestad et al. (2025) uses many of the same and additional behaviour and descriptive norms questions, as well as the value/attitude questions, in the study of TSC in three European and three African countries.

Traffic Safety Culture is in these studies regarded as a set of values, descriptive norms, attitudes, and behaviour patterns. All five studies have measured TSC with surveys filled out by individuals. These studies have also investigated differences between countries (e.g. Norway, Greece, Israel) and how country is related to culture and outcomes. However, their primary focus is on the relationship between culture and outcomes. The studies do, however, relate the findings on national TSC to Safe System policies, and the extent of restrictive road safety measures.

Assumed mechanisms between Traffic Safety Culture and outcomes. Descriptive norms derived from DBQ items influence traffic safety outcomes by shaping perceptions of typical driving behaviour (e.g. speeding, drinking and driving, aggressive violations). If different types of violations are perceived as common and normal, individuals may be more likely to adopt similar behaviours, increasing crash risk. Conversely, perceptions that safe driving is the norm may promote compliance and reduce risky behaviour. Descriptive norms create a subtle social pressure to act in certain ways, as it is perceived as the “normal” and expected way of acting in a certain area (Cialdini et al., 1990), and this in turn influences actual driving behaviour and safety outcomes (Nævestad et al., 2019). Nævestad et al. (2022a, 2022b) also includes freedom values, measured as attitudes. The assumed mechanisms relating the attitudes on

freedom to take risk in traffic to behaviour is that individuals who place greater value on the freedom to take risks are expected to hold more favourable attitudes towards risky driving, increasing the likelihood of engaging in risky behaviours that are associated with accident involvement.

Cultural traits influencing outcomes: Not all studies have reported results for relationships between all available combinations of norms, behaviours, and crashes or for specific themes. Therefore, the results cannot be used to draw conclusions about the relative importance of specific types of behaviours or norms related to specific behaviours. The main assumption in the studies is that TSC influences crashes through behaviour, but this is only tested in multiple separate regression analyses, and not e.g. structural equation models. With these limitations in mind, the results show the following:

- Descriptive norms for aggressive violations and other violations (speeding, drinking and driving etc.) are related to behaviour (e.g. speeding, alcohol, non-use of seat belts).
- Descriptive norms for compliance and politeness in traffic were investigated in two studies; one of them has not investigated how this is related to behaviour or crashes (Nævestad et al., 2019b), and the other found no relationship with behaviour (Nævestad et al., 2019a).
- Values/attitudes related to individual freedom to take risks are in the studies which examined this related to behaviour (aggressive violations and other violations, Nævestad et al., 2019b, Nævestad et al., 2022a, Nævestad et al., 2022b). None of the studies have investigated how values/attitudes related to individual freedom or paternalism are related to crash involvement.
- Behaviour is in all studies related to (self-reported) crash involvement.

A1.3 | Studies of Traffic Safety Culture at the regional or local level

Operationalisation of culture: The studies that have investigated TSC on a local or regional level are very heterogeneous. Looking at the regional level studies, these are explicitly or implicitly based on a definition of TSC in a context of values, norms, and attitudes, and all focus on specific behaviours. Most of these studies focus on DUI, some additionally on other high-risk behaviours like speeding and cell phone use, and one on driver behaviour near schools (e.g. Stringer 2018, Benzaman et al. (2022).

Stringer (2018) collected register-based information about many variables that are assumed to be related to alcohol culture in 446 counties in the US. Several variables that are assumed to be related to pro- or anti-alcohol norms, values, attitudes, and beliefs are associated with DUI-fatalities over time in a longitudinal analysis:

- Religions which may be more or less pro or against alcohol use (in interaction with the strength of religion)
- Alcohol consumption per capita
- Presence of a large football university (which may be related to pro-alcohol norms and alcohol-culture)

Otto et al. (2021) used self-reported measures of culture related to alcohol and cannabis, defined in terms of attitudes, values, and beliefs about alcohol / cannabis. The survey items in this study explicitly address attitudes, values, and beliefs. Drivers who reported of occasional or frequent DUI, had generally more positive attitudes towards alcohol and cannabis than other drivers.

Islam et al. (2017) used self-reported measures of culture related to alcohol, speeding and cell phone use, defined in terms of attitudes, values, and beliefs. The survey items in this study implicitly address beliefs, values, and attitudes. The survey consists of the following five factors, all including items that refer to cell phone use, DUI (alcohol and cannabis) and speeding:

- Perceived threats to personal safety
- Personal acceptability
- Support for enforcement
- Support for legislation and policy
- Self-reported behaviour

Milch and Nævestad (2024) investigated TSC around schools in the context of an evaluation study. The evaluated measure is the “Heart zone” concept that aims to improve safety around schools, especially during times when many parents drop off or pick up their children. Traffic Safety Culture is defined as descriptive norms related to driver behaviour around the school.

Assumed mechanisms between Traffic Safety Culture and outcomes. Regional and local TSC may influence traffic safety outcomes through shared norms, values, attitudes, and beliefs related to alcohol use and other high-risk behaviours, particularly driving under the influence. Cultural contexts characterised by strong religious norms and lower alcohol consumption may discourage impaired driving, whereas more permissive alcohol cultures may increase the acceptance of drinking and driving. Environmental and social factors, such as university culture, may further shape drinking patterns and associated road user behaviours. More generally, attitudes, values, and beliefs concerning alcohol and cannabis use, speeding, and mobile phone use may influence traffic safety by affecting the perceived acceptability of these behaviours, perceptions of risk, and support for enforcement and traffic safety policies. In local settings, descriptive norms regarding driver behaviour, for example around schools, may shape expectations about appropriate behaviour and thereby influence actual driving practices. Together, these mechanisms are assumed to influence traffic safety outcomes by shaping attitudes, perceived norms, compliance with traffic rules, and engagement in risky behaviours over time.

Cultural traits influencing outcomes. The percentage of the population never going to bars/taverns is related to DUI fatalities in a cross-sectional analysis, but not in the longitudinal analysis. However, alcohol legislation (dry/moist county) and the percentage of the population going to bars/taverns monthly are not related to DUI-fatalities. Benzaman et al. (2022) rated US-states on a scale of “positive” to “negative” TSC, based on register-data. The rating procedure is not described in detail, but among the variables used for this rating is alcohol consumption per capita. All measured variables are strongly related to fatality rates on county level: Population, employment, alcohol consumption, temperature, physicians per population, republican voters, fatal crash contributing factors (phone use, inattention), seatbelt laws, cellphone laws, hospital beds, and rural road length. Otto et al. (2021) found a relationship between culture and behaviours, as drivers who reported of occasional or frequent DUI, had generally more positive attitudes towards alcohol and cannabis than other drivers. Islam et al. (2017) found that practically all variables are related to each other and to self-reported behaviour (DUI). Milch and Nævestad (2024) found that results from surveys and interviews show that TSC (i.e. descriptive norms) is related to both improved behaviour and fewer dangerous traffic situations. The relationship between culture and behaviour can be attributed to the extent of implementation of the “Heart zone” and knowledge about the Heart zone. I.e. good implementation and knowledge about the Heart zone are related to both improved culture and improved behaviour.

A1.4 | Studies of Traffic Safety Culture at the family level

Operationalisation of culture: The Family Climate for Road Safety Scale (FCRSS) has been used in 16 studies. Eight of these are from Israel where the FCRSS has been developed by Taubman Ben-Ari and Katz Ben-Ami (2013), and one of these eight studies has also included young drivers from Australia (Skvirsky et al., 2017). The other studies are from China (3 studies), USA (2 studies), and Spain (one study).

The FCRSS refers to road safety climate within families, but the climate is assessed with a self-reporting scale that is applied individually. Most studies have used the FCRSS among young drivers, and investigated relationships between the young drivers' assessments of family climate and safety-relevant outcome variables (e.g. behaviour). However, in three studies the FCRSS was applied to young drivers and their parents, and these studies have additionally investigated relationships between the young drivers' and their parents' assessments of climate and outcome variables (Awad-Yassin & Taubman-Ben-Ari, 2024; Doncel et al., 2023; Taubman-Ben-Ari, 2016).

The FCRSS assesses seven aspects of the parent–child relationship (definitions from Taubman Ben-Ari et al., 2014):

- **Modelling:** The model that parents provide to their children by their own modes of driving and attitude to traffic laws, including planning ahead so that they will not be pressed for time, obeying traffic regulations, driving safely even when they are in a hurry, tired, or feeling stressed, etc.
- **Feedback:** Parents' positive feedback and encouraging comments to their offspring with regard to safe driving, and parents' ability to praise them for safe and considerate driving.
- **Communication:** Open and direct communication between parents and adolescents with respect to driving behaviour and risk taking, indicating parents' tendency to teach the young driver how to anticipate potential hazards on the road, to openly discuss anything related to driving, including risky driving, and to include the young driver in framing a family "contract" regarding their driving.
- **Monitoring:** Parental supervision and monitoring of their youngsters' driving habits, including making sure they do not drive recklessly and having them inform the parents of where they are taking the car, who is going with them, and when they intend to be home.
- **Noncommitment** (to safety): Parents' commitment to road safety, obeying traffic laws, demonstrating considerate driving, and investing time in safety education.
- **Messages:** Parents' verbal safety messages, indicating that parents deliver clear messages to their young drivers, and that their children understand these messages.

Safety climate describes how "individuals apprehend, perceive, and interpret the situation", and it is used to predict safety behaviour and crash involvement.

Assumed mechanisms between Traffic Safety Culture and outcomes. Family safety climate may influence traffic outcomes through socialisation processes involving parents and their children. Modelling may shape behaviour by exposing young drivers to parental driving practices, while feedback and communication reinforce safe attitudes and awareness of risks. Parental monitoring increases accountability and reduces opportunities for risky behaviour. Clear messages and strong parental commitment to safety may promote internalisation of safety norms, whereas noncommitment may weaken them. Together, these mechanisms may shape young drivers' attitudes, intentions, and behaviours, influencing crash risk and safety outcomes.

Cultural traits influencing outcomes: Only one study has investigated the relationship between FCRSS and (self-reported) crash involvement (Cui et al., 2024). In this study, six out of the seven factors of the FCRSS are related to crash involvement. Modelling and non-commitment have the lowest p-values, which suggests that they are most important. Monitoring is the only factor not related. The results refer to the self-reported family climate (i.e. climate rated by the drivers, not other family members).

Relationships between the FCRSS and behaviour were investigated in 14 studies (Awad-Yassin & Ben-Ari, 2025; Awad-Yassin & Taubman-Ben-Ari, 2024; Burns et al., 2020; Cui et al., 2024; Doncel et al., 2023;

Ma et al., 2024; Ben-Ari, 2015; Taubman-Ben-Ari, 2016; Taubman-Ben-Ari & Katz-Ben-Ami, 2012; Taubman-Ben-Ari & Katz-Ben-Ami, 2013; Zhang et al., 2025; Burns et al., 2022; Skvirsky et al., 2017 and Taubman ben ari et al., 2014). Several studies find statistically significant relationships between all, or most of the seven FCRSS-factors and driver behaviour (Cui et al., 2024; Ma et al., 2024; Ben-Ari, 2015; Taubman-Ben-Ari, 2016; Taubman-Ben-Ari et al., 2014).

However, other studies find clear differences between the FCRSS-factors (Awad-Yassin & Ben-Ari, 2025; Awad-Yassin & Taubman-Ben-Ari, 2024; Burns et al., 2020; Doncel et al., 2023; Taubman-Ben-Ari & Katz-Ben-Ami, 2012; Taubman-Ben-Ari & Katz-Ben-Ami, 2013; Skvirsky et al., 2017):

- Modelling is the most important, or at least among the most important factors of the FCRSS for behaviour in all six studies.
- Non-commitment is among the most important factors in six of the studies.
- Messages, Feedback, Monitoring, and Limits are important factors in two to four studies (varying between factors), but less important than Modeling and Noncommitment; however, all of these factors are unrelated to driving styles in one or two studies each.
- Communication is important in two studies, but not important or least important in two other studies.

In summary, Modeling and Noncommitment are the most important FCRSS-factors, for driver behaviour, in this order.

A1.5 | Studies of Traffic Safety Culture at the peer level

Operationalisation of culture: The Safe Driving Climate among Friends (SDCaF) has been used to measure TSC within peer groups in four studies (Li et al., 2025; Ma et al., 2024; Padilla et al., 2023; Guggenheim & Taubman-Ben-Ari, 2018). Two of the studies are from China, one from Israel, and one from Spain.

The SDCaF was developed by Guggenheim and Taubman Ben-Ari (2018). It consists of 19 items that belong to four factors:

- Friends' pressure while driving: The driver's perception that friends tend to push him to drive recklessly or break the law.
- Social costs of driving with friends: The driver's feelings of being uncomfortable, exhausted, or even scared when driving with friends.
- Communication between friends about driving: Open discourse among friends on driving issues, including their own driving.
- Shared commitment to safe driving with friends: Responsibility toward road safety, is shared by the drivers' friends in the car.

Assumed mechanisms between traffic safety culture and outcomes. Peer-group safety climate may influence traffic safety outcomes through social pressure and shared norms. Friends' pressure may encourage risky driving, increasing crash risk, while high social costs may reflect discomfort that either discourages unsafe situations or indicates exposure to risk. Open communication about driving may promote awareness and safer behaviour. A strong shared commitment to safe driving may support compliance with rules and mutual regulation among peers. Together, these factors may shape driving behaviour and thereby traffic safety outcomes.

Cultural traits influencing outcomes: One study has investigated the relationship between SDCaF and (self-reported) violations and crash involvement (Padilla et al., 2023). The results show that the SDCaF-

factor Pressure is related to both property damage only (PDO)-crashes, near-misses, and violations. However, it is not related to injury crashes. The latter are, however, fewer.

Three studies have investigated the relationship between SDCaF and (self-reported) behaviour (Ma et al., 2024; Padilla et al., 2023; Skvirsky et al., 2017). Two of these find that all four factors of the SDCaF are related to behaviour (reckless driving / driving styles). In Skvirsky et al. (2017), pressure is the most important factor, it is related to all driving styles except for the angry style. Moreover, peer commitment is related to reckless and angry driving styles, and social costs are related to the anxious driving style.

Relationships between the SDCaF and resistance to peer pressure were investigated in three studies (Padilla et al., 2023; Li et al., 2025; Feng et al., 2021). All three studies show that the SDCaF is related to the resistance to peer pressure. In two studies, all four SDCaF-factors are related to the resistance to peer pressure, and in the third (Li et al., 2025), all factors except for Communication are related to resistance to peer pressure.

Appendix 2 | Scoping review of research on organisational safety culture among road users at work

A2.1 | Introduction

A2.1.1 | Background

According to Zohar (2010) the relationship between safety culture and safety outcomes is well documented across industries and countries. And there exist several literature reviews and meta-analyses of safety culture/climate studies, including studies that have tried to link safety culture/climate to safety outcomes; safety behaviour, errors, incidents or crashes (Christian, Bradley, Wallace, & Burke, 2009; Clarke, 2006; Flin et al., 2000b; Nahrgang, Morgeson, & Hofmann, 2007; Yule, 2003). However, researchers studying road users at work were not among the first to apply the OSC concept. Arboleda et al. (2003) were among the earliest researchers to explicitly apply the concept of OSC to drivers at work, studying management practices as antecedents of safety culture within the trucking industry.

Now, more than 20 years after Arboleda et al. (2003) published their interesting article on safety culture in the heavy goods vehicle sector, it seems relevant to make up status for the research on OSC among drivers at work, examining questions like: Is the relationship between OSC and crashes well established? Are the relationships between OSC aspects and different types of safety performance (e.g. behaviours, crashes) studied systematically? What do we know about mechanisms between different aspects (e.g. safety commitment, learning) of OSC and different types of traffic safety behaviours (e.g. violations) among drivers at work? What are the most important OSC aspects for outcomes? Is there a common theoretical model in the OSC studies?

A2.1.2 | Aims

The aims of this study are therefore to:

1. **Conduct a scoping review of organisational safety culture research**, focusing on: a) what year, where the studies are from, transport modes included, methods used, cultural group levels studied, and concepts used to describe culture, b) how safety culture is operationalised, c) identification of the cultural aspects which seems to be most important for traffic safety outcomes, and d) assumed mechanisms between safety culture and safety outcomes (e.g. traffic safety behaviours, crashes).
2. Based on these reviews, focusing on safety culture mechanisms, **adapt the conceptual model** of Traffic Safety Culture to organisational safety culture.

A2.2 | Method

The searches and analyses were conducted and reported in accordance with the main elements of PRISMA: "Preferred Reporting Items for Systematic reviews and Meta-Analyses" (Page et al., 2021). The main purpose of the review is to gather systematic evidence about the relationship between OSC and safety performance (e.g. behaviour, crashes), to map: 1) whether such a relationship exists, 2) how well documented it is and on which methodological basis, 3) what mechanisms may link OSC and crashes, and 4) which elements and aspects of OSC are most closely related to crashes.

A2.2.1 | Search strategy and keywords

The literature searches were conducted in March 2026 in two scientific databases: Science Direct and Scopus. The main search terms are presented in Table 12. The search combined terms related to culture or climate with traffic and road user descriptors and with safety and outcome-related concepts, including

crashes, incidents, violations, and driver behaviour. We relied on several different concepts and synonyms to identify safety culture studies, involving both climate and culture-based terminology. Culture and climate are often used interchangeably in studies of OSC (e.g. Haukelid, 2008), and we presuppose that the same is the case for studies of safety culture among drivers at work.

Searches were performed in titles, abstracts, and keywords, and were adapted to the indexing structure of each database. The searches were restricted to peer-reviewed journal articles and reviews published in English. To limit retrieval of healthcare-focused safety culture studies outside the scope of this review, nursing-related subject classifications were excluded using database-specific filters.

Theme	Keywords
Complete terms	"safety culture" OR "safety climate" OR "road safety culture" OR "road safety climate" OR "traffic safety culture" OR "traffic safety climate" OR "organisational culture" OR "organizational culture" OR "workplace culture" OR "company culture" OR "corporate culture"
AND Safety terms	safety OR crash OR crashes OR accident* OR incident* OR violation* OR "driver behaviour*" OR "driver behavior**"
AND professional driver setting	"professional driver*" OR "work-related driving" OR "occupational driving" OR "driving for work" OR fleet* OR "long-haul" OR "long haul" OR delivery OR courier* OR "road transport" OR "road freight" OR truck* OR lorry* OR HGV OR LGV OR bus* OR taxi* OR cab* OR van* OR "goods vehicle**")

TABLE 12 | Simplified overview of search terms used in the literature search. Actual search included alternate spellings and adaptation to the specific databases.

A2.2.2 | Criteria for excluding or including studies

The following criteria applied at all screening stages:

- 1. Relevant sector (road transport)
- 2. Empirical study (including review studies, but not opinion pieces or purely theoretical publications)
- 3. Organisational safety culture or climate was a main focus or topic, and explicitly stated (i.e. studies not explicitly addressing culture/climate, were excluded)
- 4. Focus on road users at work.

A2.2.3 | Selection of relevant studies

The review aimed to identify empirical studies of OSC among groups of road users at work (e.g. truck, bus, other road user at work), conducted at any analytical level and including measures of crashes or other measures of safety performance.

Study screening was conducted in four successive steps. At each stage, publications were excluded if they clearly did not meet the inclusion criteria, and any unclear cases were forwarded to the next screening step. Overall, the search resulted in 1720 publications (excluding duplicates). Figure 7 shows results of the screening procedure for each step.

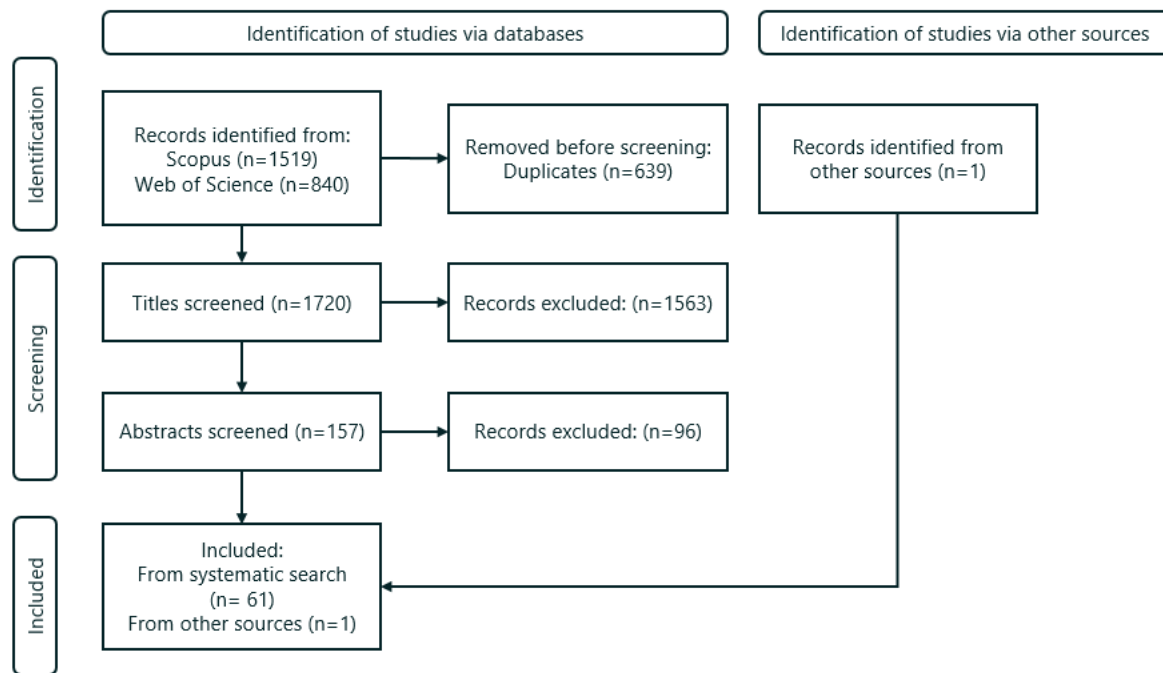


FIGURE 7 | Flow chart for the review of the studies of organisational safety culture.

In the first step, duplicates were removed after comparing the search results from the two databases. In the second step, titles were screened against the formal inclusion criteria, including English language and publication in a peer-reviewed journal. In the third step, abstracts were screened to assess whether the studies met the substantive inclusion criteria: relevance to road transport, empirical design, focus on organisations or road users at work, and explicit treatment of OSC or safety climate as a main topic. In the fourth step, full texts were consulted where eligibility could not be determined from the abstract alone. Studies were excluded if OSC or climate was only a peripheral issue, for example in studies mainly addressing driver fatigue or distraction where cultural factors were only mentioned or included as secondary variables. After applying all inclusion criteria, 62 studies were included in the review.

A2.2.4 | Analysis of the studies

The reviewed studies were analysed both quantitatively and qualitatively. Based on the coding of the 62 studies, we prepared a data file, where the following variables were registered for each study:

1. Author
2. Publication year
3. Country
4. Methods
5. Key concepts used for studying organisational safety culture
6. Subject sample
7. Type of organisation
8. Transport mode included (truck, bus, car etc.)
9. TSC elements included, e.g. values, beliefs, norms, attitudes, patterns of behaviour
10. TSC aspects included (e.g. aggression vs. cooperation, paternalism vs. freedom)
11. How are the elements and aspects measured?
12. Is individual road safety behaviour measured? How?
13. Are crashes (or other safety outcomes) measured?
14. Hypothesised relationships and results?
15. Other sustainability goals than Safety?

This information was analysed quantitatively. In addition, we also conducted more qualitative analyses, focusing on how safety culture operationalised across cultural group levels (national, regional, local, peer, family), assumed mechanisms between safety culture and traffic safety outcomes (e.g. traffic safety behaviours, crashes), the more general theoretical approaches that these mechanisms relate to, results regarding the relationship between safety culture and outcomes at each level, cultural aspects at each cultural group level which seems to be most important for traffic safety outcomes. This information is analysed for distinct lines of research within traffic safety culture and OSC studies. This involved thematic analysis, which is a systematic method for identifying main themes in textual material (Braun & Clarke, 2006). This involves identifying themes that recur in descriptions of specific topics.

A2.3 | Results

A2.3.1 | Key characteristics of the studies

This chapter relates to aim 1a, which is to describe what year, where the studies of OSC are from, transport modes included, methods used, cultural group levels studied, and concepts used to describe culture.

We identified 62 relevant studies on OSC. In Figure 8 we show which year the different studies are from. Note that the figure does not have a bar for each year, only for the years for which there is at least one article registered. Figure 8 shows that the number of studies on TSC has increased over time, particularly from 2014. The highest number of studies appears in the most recent years, with a peak in 2025. Overall, the figure indicates a growing and increasingly active research, field since 2012.

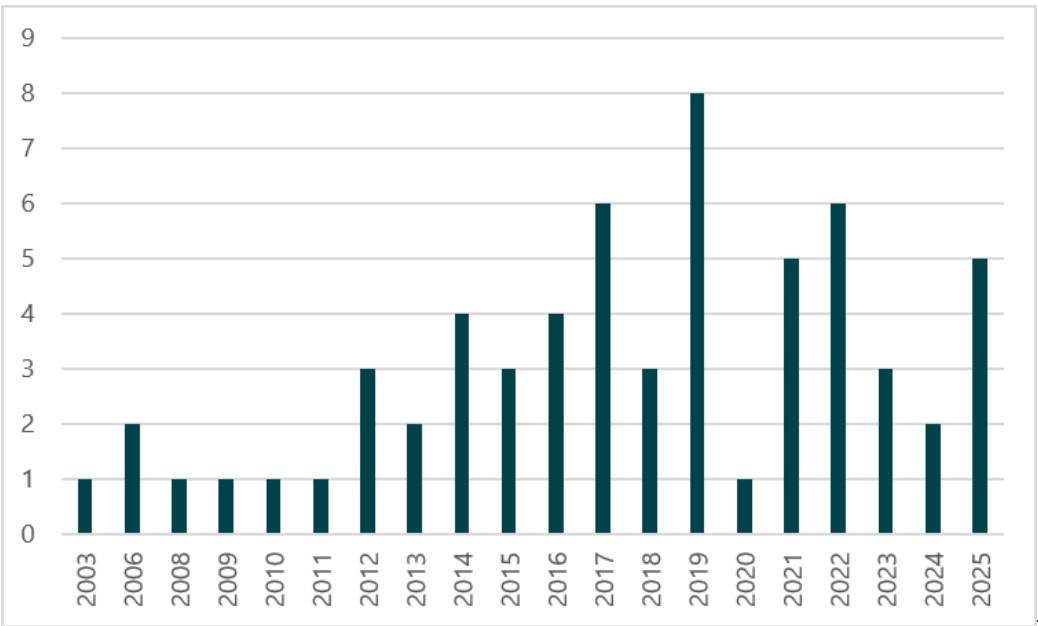


FIGURE 8 | What year the 62 different studies on organisational safety culture are from

Table 13 shows which countries the various studies are from. Here we give percentages based on the country or countries that the studies focus on. The table shows that the largest share of studies include the USA (28%), followed by Australia (13%). In the table, we give percentages based on the country or countries that the studies focus on. Some studies focus on several countries, and the total number of countries is therefore higher than the total number of studies. Some studies focus on several countries, and the total number of countries is therefore higher than the total number of studies.

Country	Number	Percentage
USA	19	28%
Australia	9	13%
Turkey	5	7%
China	4	6%
Iran	3	4%
Norway	6	9%
Israel	4	6%
Greece	3	4%
Taiwan	2	3%
Single countries	12	18%
Total	67	100%

TABLE 13 | Overview of which country the various studies are from.

TABLE 14 shows the transport modes included in the studies of OSC. The table shows that trucks/HGVs/tankers are the most frequently studied transport mode, included in 50% of the cases. Trucks, heavy goods vehicles, long-haul trucks, oil trucks, and tankers were grouped as Trucks/HGVs/tankers. Mixed road transport modes refers to studies including several types of road vehicles, such as passenger cars, light goods vehicles, buses, heavy goods vehicles, taxis, vans/pickups, and lorries. Other specific modes include less common single-mode categories, such as emergency vehicles, motorcycles, taxis, and mixed light road users.

Transport mode	Number	Per cent
Trucks/HGVs/tankers	31	50%
Bus/school bus	7	11%
Mixed road transport modes	8	13%
Light vehicles/cars/pickups	4	6%
Motor vehicles, unspecified	4	6%
Other specific modes	5	8%
Not specified/unknown	3	5%
Total	62	100%

TABLE 14 | Transport modes included in the 62 studies of organisational safety culture.

Table 15 shows the methods used in the studies of OSC. The table shows that the majority of studies (81%) use survey methods. Overall, the literature is clearly dominated by quantitative survey-based approaches.

Method	Number	Per cent
Survey	50	81%
Interviews	7	11%
Survey and interviews	3	5%
Analysis of systems/accidents	2	4%
Total	62	100%

TABLE 15 | Research methods used in the 62 studies of organisational safety culture.

In Table 16 we show which terms the various studies use in their abstracts and titles. The table shows that most of the studies use the climate, followed by culture. The studies use different labels for climate, e.g. the Trucking Safety Climate Scale, the Safety Climate Scale, the Safety Climate Questionnaire Modified for Drivers, and the Transportation Companies' Climate Scale (Zohar & Luria, 2005; Wills et al., 2005; Huang et al., 2013; Öz et al., 2013; Wang et al., 2021; Yilmaz et al., 2022; Xiong & Chen, 2024). This indicates that climate terminology dominates the OSC literature on road users at work.

Concept	Number	Per cent
Climate	43	69%
Culture	17	27%
Culture/climate	2	3%
Total	62	100%

TABLE 16 | Terms used in the various studies in the abstract and title. Number and share of publications.

A2.3.2 | Description of the different lines of research

This chapter relates to aim 1b, which is to describe how safety culture is operationalised. We compare this across the most widely used operationalisations of OSC research.

A2.3.2.1 | Trucking Safety Climate Scale (TSCS; Huang et al., 2013)

Operationalisation of culture: The Trucking Safety Climate Scale (TSCS) was developed by Huang et al. (2013) to measure safety climate among lone workers, using truck drivers as the exemplar. It treats safety climate as perceived safety priority and separates it into organisation-level and group/supervisor-level safety climate. The final scale has 40 items: 20 organisation-level items and 20 group-level items, answered on a 5-point Likert scale from strongly disagree to strongly agree. The scale has six dimensions/aspects. Three relate to the organisational level: 1) proactive practices, referring to organisational actions taken in advance to prevent safety problems (measures safety management system aspects like continuous improvement, driver training, use of information and feedback to improve); 2) driver safety priority, capturing the extent to which the organisation prioritises driver safety over competing demands such as productivity or delivery pressure; 3) supervisory care promotion, referring to the organisation's promotion of supervisor concern for drivers' well-being and safe working practices. Three dimensions relate to the group level: 1) safety promotion, referring to supervisors' active encouragement and reinforcement of drivers' safe behaviour; 2) delivery limits, capturing whether supervisors set limits on delivery demands when these may compromise safety; and 3) cell phone disapproval, referring to supervisors' discouragement of mobile phone use while driving.

Studies that used the Trucking Safety Climate Scale (Huang et al., 2013) measured OSC on organisational level and on group level among truck drivers, and most studies calculated one summary score for each level. Thus, the studies do not study the effects of the different dimensions/aspects separately (e.g. proactive practices), but summary scores of each group level (organisational and group level). Effects on crashes were investigated in five studies (Huang et al., 2013, 2014, 2018; Lee et al., 2019; Zohar et al., 2015). All five studies used registered lost workdays due to injury as the dependent variable (e.g. six months after the climate measurement, as done by Huang et al. 2013). Huang et al. (2013) also use the objective safety measure of hard braking. How OSC is related to behaviour was investigated in nine studies (Huang et al., 2014, 2017, 2018; Lee et al., 2019; Meyer et al., 2024; Murphy et al., 2019; Qu et al., 2022; Zohar et al., 2014, 2015). Most studies assessed self-reported behaviour, only one study had information about registered behaviour (near-misses, Murphy et al., 2019).

Cultural traits influencing outcomes. The results show consistently that both organisational and group-level OSC are related to both crashes and self-reported and registered behaviour. The relationship is stronger for group-level OSC than for organisational-level OSC (Huang et al., 2018: crashes and behaviour; Qu et al., 2022: behaviour). When OSC is rated by supervisors, no relationships were found between OSC and crashes / behaviour, indicating the need to rely on an employee perspective when trying to measure and improve OSC (Huang et al., 2014). Studies show that the relationship between OSC and crashes is mediated by behaviour, i.e. OSC is related to behaviour and behaviour to crashes (Huang et al., 2014; Lee et al., 2019).

A2.3.2.2 | Safety Climate Scale (SCS; Zohar & Luria, 2005)

Operationalisation of culture: The Safety Climate Scale / Multilevel Safety Climate Scale developed by Zohar and Luria (2005) measures safety climate as employees' perceptions of the priority given to safety in policies, procedures, and practices. It comprises two referent-specific scales: organisation-level safety climate, referring to top management, and group-level safety climate, referring to the direct supervisor. In the published retained version, each scale has 16 items, giving 32 items in total, although both scales were developed from larger 27-item pools. Zohar and Luria identified content themes, but because factor intercorrelations and cross-loadings supported a global safety-priority/managerial-commitment factor, the scales are commonly scored as overall mean scores rather than separate subscales. Later studies have sometimes used shortened versions and linked safety climate scores to safety behaviour and, in some transport contexts, injury or road-safety-related outcomes.

Cultural traits influencing outcomes. Studies that used the Safety Climate Scale (Zohar & Luria, 2005) calculated one summary score for OSC. Effects on crashes (registered by the organisation) were investigated by Wang et al. (2021) among bus drivers and effects on behaviour were investigated by Fugas et al. (2012) among employees in a transportation company. Wang et al. (2021) show that OSC is related to crashes. For behaviour, Fugas et al. (2012) found an indirect relationship, mediated by attitudes, perceived behavioural control, and norms (the direct relationship between OSC and behaviour is not reported). Additionally, Newnam et al. (2012) found that OSC among home care nurses is related to safety information exchange.

A2.3.2.3 | Safety climate questionnaire modified for drivers (SCQ-MD; Wills et al., 2005)

Operationalisation of culture: The SCQ-MD was adapted by Wills, Biggs and Watson (2005) for occupational/work-related vehicle drivers, drawing on Glendon and Litherland (2001) Safety Climate Questionnaire. It measures drivers' perceptions of how safety is managed and prioritised in the organisation, although the precise organisational level of reference can be somewhat ambiguous because the dimensions refer both to management and to the immediate work situation. The Wills et al. (2005) version contains 35 items across six factors: communication/procedures, work pressure, relationships, driver training, management commitment, and safety rules.

Based on Wills et al. (2005), the OSC aspect or factor Communication and Procedures refer to how clearly driver-safety policies, procedures, changes and expectations are communicated, documented and discussed between managers and employees, and whether these procedures correspond to how work is actually carried out. Work Pressure concerns whether drivers experience realistic schedules, manageable workloads, sufficient staffing and enough time to complete their work without compromising safety. Management Commitment reflects the extent to which management is perceived to prioritise driver and vehicle safety and to treat safety as an important organisational value. Relationships describe the broader social climate at work, including trust between employees and management, morale, job confidence and the quality of working relationships. This aspect by and large measures social capital. Driver Training refers to whether the organisation provides relevant and competent training that addresses vehicle-specific skills, risks and consequences. Finally, Safety Rules captures whether formal vehicle-safety rules are practical, compatible with everyday work demands and followed even when work is rushed and the driver operates under stress.

Cultural traits influencing outcomes. Four studies investigated relationships between the Safety climate questionnaire modified for drivers (SCQ-MD; Wills et al., 2005) and self-reported crashes (Banks et al., 2016; Seibokaite & Endriulaitiene, 2012; Swedler et al., 2015; Wills et al., 2009). The studies were conducted in different types of companies, and all studies calculated different sets of summary scores of the whole OSC construct. None of the studies found a relationship between OSC and crashes.

Eight studies that used the SCQ-MD investigated the relationship between OSC and behaviour. The behaviour is self-reported in most studies (Chen et al., 2019; Seibokaite & Endriulaitiene, 2012; Strahan et al., 2008; Wills et al., 2006, 2009; Wishart et al., 2017), one study has information about registered behaviour (Swedler et al., 2015: hard braking and swerving while distracted) and one study has information about violations (Banks et al., 2016: paid fines).

A relationship between OSC and behaviour was only found in two studies. Chen et al. (2019) found a relationship between OSC (summary score based on all subscales) and self-reported errors and violations, and Strahan et al. (2008) found a relationship between OSC (summary score based on all subscales) and self-reported fatigue-related near-misses. In the remaining studies, no relationships were found between OSC and behaviour.⁶

A2.3.2.4 | GAIN scale on organisational safety culture (GAIN, 2001) combined with questions measuring Safety Ladder implementation (Nævestad et al. 2018)

Operationalisation of culture: The organisational safety culture measure used in several road-transport studies is based on the GAIN safety culture index, originally developed in the aviation sector by the Global Aviation Information Network (GAIN 2001). The instrument was designed to assess safety culture at the company level, understood broadly as the organisation's attitude and commitment to safety. The original GAIN index consists of 25 items covering five aspects: management commitment, employee safety attitudes, reporting practices and reactions to unsafe behaviour, safety-related training and general safety issues.

Although responses are collected from individual employees, the items are normally aggregated into an overall organisational safety culture score. In road-transport research, the GAIN index has been adapted for settings such as bus and goods transport (e.g. Nævestad et al., 2019a, 2019b). These studies have

⁶ It is relevant to ask whether the relatively low level of relationship between OSC and behaviour be related to the fact that there are no questions focusing on organisational regulation of the driving task (policies/follow up), and/or that all the items are grouped together?

most often used the scale (or a shortened 10-item version of it) as a single overall indicator of organisational safety culture rather than as a set of separate subscales. In addition to the GAIN-based OSC index, the studies include self-developed questions on work-related and organisational factors, such as management focus on driving style and seat belt use, time pressure and stress, and sector focus on safety. These additional questions can be interpreted as covering several levels of the Safety Ladder for safety management (Nævestad et al., 2018), including management commitment, follow-up of driving behaviour, working conditions, and broader safety management practices, as used in Nævestad et al. (2025).

Cultural traits influencing outcomes. Among the studies that measured OSC with selected questions from the GAIN (2001) scale on organisational safety culture, two investigated the relationship between OSC and self-reported crashes (Nævestad et al., 2020, 2022), and three studies investigated the relationship between OSC and self-reported behaviour, measured with the DBQ (Nævestad et al., 2019a,b, 2022). All surveys were conducted among professional truck and/or bus drivers. All studies used one summary score of OSC, based on the 10 GAIN questions. One of the studies found a relationship between OSC and self-reported crashes that was mediated by behaviour (Nævestad et al., 2020), and another study found a relationship between OSC and self-reported aggressive violations (Nævestad et al., 2019b). None of the other studies found a relationship between OSC and crashes or behaviour.

A2.3.2.5 | Transportation Companies' Climate Scale (TCCS; Öz et al., 2013)

Operationalisation of culture: The Transportation Companies' Climate Scale (TCCS) measures organisational safety climate in transport companies (Öz et al., 2013). It consists of 31 items covering three aspects: General safety management, Specific practices and precautions, and Work and time pressure. General safety management captures drivers' perceptions of management commitment to safety and the organisational focus on safety versus efficiency. The aspect specific practices and precautions focuses on learning from accidents and violations, organisational efforts to improve safety and safety rules. The aspect work and time pressure focuses on production pressures that may conflict with safe driving. The scale was developed for professional drivers and has been used in studies of both passenger and freight transport companies.

Cultural traits influencing outcomes. Two studies that have measured OSC with the Transportation Companies' Climate Scale (TCCS; Öz et al., 2013) investigated the relationship between OSC and self-reported behaviour, measured with the DBQ (Öz et al., 2013; Yilmaz et al., 2022). The studies were conducted in different types of public and private transport companies, transporting both goods and people. Both studies calculated three summary scores of OSC, one for each factor. The results are mixed.

- The OSC-subscale Work and time pressure is related to errors and violations (Öz et al., 2013) and to speeding and tiredness (Yilmaz et al., 2022).
- The other two OSC-subscales (General safety management and Specific practices and precautions) are not related to neither errors and violations (Öz et al., 2013) nor to speeding and tiredness (Yilmaz et al., 2022).
- None of the subscales are related to inattention (Yilmaz et al., 2022).

Relationships with crashes were not investigated.

A2.3.2.6 | Safety Culture Dimensions (Varmazyar et al., 2016)

Operationalisation of culture: The Safety Culture Questionnaire/SCQ was developed by Varmazyar et al. for public transport bus drivers and published in 2016. It measures OSC, defined as shared values concerning organisational policies/regulations, safety-related behaviours, and how people feel. The final scale contains 29 items across five dimensions. The first is leadership styles and company values, which includes 10 items on supervisors', managers' and organisational safety information and training to

drivers. The second aspect is usage of crash information and preventive programmes, which includes 7 items on training, crash prevention programmes and sharing of information from accident investigations. The third aspect is management commitment and safety policy, which includes 6 items on management and organisational commitment to safety. The fourth aspect is participation, which includes three items on the organisations' use of drivers' experiences (e.g. from accidents) and viewpoints to improve safety. The fifth aspect is control, which includes three items focusing on organisational learning and continuous improvement, based on accident data, previous safety measures and regular vehicle and route inspections. Thus, we see that the second, fourth and fifth concern learning and continuous improvement.

Cultural traits influencing outcomes. Varmazyar et al. (2016) found a relationship with crashes only for the subscale control in multivariate analyses. Relationships with behaviour were not investigated. The survey developed by Varmazyar et al. (2016) was used in one more study by the same group of authors (Mokarami et al., 2019). Mokarami et al. (2019) found a relationship between a summary score for the whole scale and self-reported crashes.

A2.3.2.7 | Other OSC-scales

Other OSC-scales and crashes

Four studies that have assessed OSC with other tools than those described above have investigated relationships between OSC and crashes. The participants in all studies are bus or truck drivers.

Cultural traits influencing outcomes. Registered crashes: Two of the studies used information about registered crashes (i.e. as registered by the company). One of them found a relationship between two summary scores of OSC, one on organisational and one on fleet level, and registered crashes per 1000 kilometers (Xiong & Chen, 2024). The summary scores are based on relatively heterogeneous items, and each scale was found to consist of three factors. In the other study (Li & Itoh, 2014) the OSC-subscales Safety management/system and Teamwork were related to registered crashes, while other subscales were not (Communication and coordination, Competence-based view, Perception of stress/workload, Risk awareness). Safety management/system is a somewhat heterogeneous factor, which includes employee involvement, information exchange, reporting culture, training etc. (Li & Itoh, 2014) The factor Teamwork includes items focusing on being part of a group and being acknowledged (Li & Itoh, 2014).

Self-reported crashes: The other two studies found a relationship between OSC and self-reported crashes (Anderson et al., 2017; Sullman et al., 2017). Both studies have calculated overall summary scores of OSC that are based on thematically different items and subscales.

In summary, most results show that OSC is related to crash involvement. Most studies have calculated only one summary score of OSC, and two studies have only information about self-reported crashes. Among the two studies based on registered crashes, only two subscales of OSC were related to crashes, while other subscales were not.

Other OSC-scales and behaviour

Nine studies investigated relationships between other OSC-scales and behaviour. Behaviour is self-reported in most studies, mostly measured with the DBQ.

Registered behaviour: Two studies have register-information about behaviour (Naveh & Katz-Navon, 2015; Xiong & Chen, 2024). Naveh & Katz-Navon (2015) found a non-significant relationship between OSC and violations in a very heterogeneous group of employees in 12 different companies. Xiong and Chen (2024) used objectively registered in-vehicle risk behaviours from a telematics monitoring system, including phone use, smoking, non-use of seatbelt, vehicle deviation, yawning, and distracted driving.

Both organisational- and fleet-level safety climate scores were significantly related to these registered behaviours, with distracted driving and vehicle deviation emerging as the most important behavioural indicators. Although the scale included specific dimensions at each level, the analysis of registered behaviour was reported for the general OSC and FSC scores rather than for separate safety-climate subscales. In Xiong and Chen (2024), the organisational level refers to company-level safety management, monitoring, and safety priority, while the fleet level refers to the more immediate workgroup context, including communication, shared safety awareness, and drivers' self-regulation. Thus, OSC captures how safety is prioritised and managed by the enterprise, whereas FSC captures how safety is enacted in the daily fleet environment.

Self-reported behaviour and OSC by subscale: Three other studies investigated relationships between subscales of OSC and self-reported behaviour, measured with the DBQ. There are some differences between subscales of OSC in all three studies.

In the study by Şimşekoğlu & Nordfjærn (2017), who studied truck drivers in a Turkish oil company, there are four subscales of OSC with different relationships to behaviour, measured according to DBQ dimensions:

- Management commitment to safety was related to violations
- Priority of Safety, Communication, and Work environment were not related to violations
- None of the subscales were related to errors or lapses.

In the study by Öz et al. (2014), there are two subscales of OSC, and the participants are drivers in eight different companies transporting goods and/or people in Turkey. The first subscale of OSC is Trip safety monitoring and control (TSMC). Most items in the TSMC aspect focus on reporting culture, learning and information exchange. The second subscale is Tacit agreement to safety (TATS). The TATS subscale is comprised of heterogeneous items about safety-relevant attitudes and behaviour; some of them concern a lacking reporting culture and negative culture traits (e.g. lacking focus on safety):

- TSMC is related to positive driver behaviour, but not to errors or violations
- TATS is related to errors and violations, but not to positive driver behaviour.

The pattern in relationship is not surprising, given the negative culture traits in TATS.

Hussain et al. (2019) found relationships between all three subscales of OSC and self-reported behaviour among truck drivers in small companies in Pakistan. The OSC-tool is adapted from the concept family climate for road safety and has the following subscales: Communication between supervisors and drivers, Role modelling by supervisors, and Limits placed by supervisors on risky driving behaviour. Open communication includes eight items measuring whether supervisors and drivers can openly discuss risky driving. Role modelling includes six items measuring whether supervisors/truck owners set a safe example through their own driving and traffic-rule attitudes. The factor Limits includes five items measuring whether supervisors/truck owners set limits, discipline drivers, and control risky driving. The common denominator is that all three measure supervisor/truck-owner practices intended to reduce risky driving through dialogue, example-setting, or control. Risky driving behaviour was measured with eight items, e.g. reckless or illegal over-taking, signal breaking, tailgating, overloading, drunk driving, cell phone usage during driving and non-fastening the seat belts (Hussain et al., 2019).

Self-reported behaviour and OSC overall summary score: The remaining four studies investigated the relationship between a summary score of OSC and self-reported behaviour (Al-Mekhlafi et al., 2021; Nguyen-Phuoc et al., 2025; Sullman et al., 2017; Zohar & Lee, 2016). All studies found that OSC and behaviour are related. However, in the study by Zohar and Lee (2016) OSC is only related to short-cuts

(small deviations from standard practices to simplify a task or to save time), but not to near-misses or violations. Sullman et al. (2017) found that OSC is related to violations, but not to errors (or self-reported crashes).

A2.3.3 | Aspects that are particularly important for safety outcomes

This chapter relates to aim 1c, which is identification of the cultural aspects which seems to be most important for traffic safety outcomes. In our review, we have seen that most studies have reported relationships only between an overall summary score of organisational safety culture and crashes or safety-related behaviour. Consequently, these studies provide limited insight into which specific aspects of OSC are most strongly associated with safety outcomes. This may partly explain why some studies have found weak or non-significant relationships between OSC and crashes or behaviour. When multiple dimensions are combined into a single aggregate measure, dimensions that are unrelated to the outcome may dilute the effects of dimensions that are strongly related, thereby reducing the overall observed relationship. We have two types of results that allow some conclusions about the relevance of OSC-themes to crashes and behaviour:

1. Studies that have reported relationships between OSC and crashes / behaviour by subscale (and not only for overall scores of OSC)
2. Interview studies

An overview of results for specific subscales related and not related to safety outcomes is shown in Table 17.

Study	Subscales related to crashes / behaviour	Subscales not related to crashes / behaviour
Safety climate questionnaire modified for drivers (SCQ-MD, Wills et al., 2005)		
Swedler et al., 2015		Communications and procedures ≠ Crashes (self-reported) Management commitment ≠ Crashes (self-reported) Work pressure ≠ Crashes (self-reported)
Wills et al., 2006	Work pressure ⇒ Distraction Management commitment ⇒ Distraction, Errors Safety rules ⇒ Distraction, Errors, Violations	Communication ≠ Errors, Distraction, Violations Work pressure ≠ Errors, Violations Relationships ≠ Errors, Distraction, Violations Driver training ≠ Errors, Distraction, Violations Management commitment ≠ Violations
Transportation Companies' Climate Scale (TCCS, Öz et al., 2013)		
Öz et al., 2013	Work and time pressure ⇒ Errors and Violations	Work and time pressure ≠ Positive driver behaviour General safety management ≠ Errors, Violations, Positive driver behaviour Specific practices and precautions ≠ Errors, Violations, Positive driver behaviour
Yilmaz et al., 2022	Work and time pressure ⇒ Speeding, Violations, and Tiredness	Work and time pressure ≠ Inattention General safety management ≠ Speeding, Violations, Tiredness, Inattention

Study	Subscales related to crashes / behaviour	Subscales not related to crashes / behaviour
		Specific practices and precautions ≠ Speeding, Violations, Tiredness, Inattention
Safety Culture Dimensions (Varmazyar et al., 2016)		
Varmazyar et al., 2016	Control ⇒ Crashes (self-reported)	Leadership style and company values ≠ Crashes (self-reported) Use of accident information/prevention programs ≠ Crashes (self-reported) Management commitment and safety policy ≠ Crashes (self-reported) Participation ≠ Crashes (self-reported)
Self-developed tools		
Şimşekoğlu & Nordfjærn, 2017	Commitment ⇒ Violations Fatalism ⇒ Violations, Errors and lapses	Priority of safety ≠ Violations, Errors and lapses Work environment ≠ Violations, Errors and lapses Communication ≠ Violations, Errors and lapses Commitment ≠ Errors and lapses
Hussain et al., 2019	Open communication by supervisors ⇒ Risky behaviour Role modeling by supervisors ⇒ Risky behaviour Limits place by supervisors on risky behaviour ⇒ Risky behaviour	
Li & Itoh, 2014	Safety management/system ⇒ Crashes (registered) Teamwork ⇒ Crashes (registered)	Communication and coordination ≠ Crashes (registered) Competence-based view ≠ Crashes (registered) Perception of stress/workload ≠ Crashes (registered) Risk awareness ≠ Crashes (registered)
Öz et al., 2014	Tacit agreement to trip safety (TATS) ⇒ Errors, Violations Trip safety monitoring and control (TSMC) ⇒ Positive driver behaviour	Tacit agreement to trip safety (TATS) ⇒ Positive driver behaviour Trip safety monitoring and control (TSMC) ⇒ Errors, Violations

TABLE 17 | Subscales related and not related to crashes / behaviour in studies that have reported results by subscale.

Overall, there is no consistent pattern of subscales appearing more often in the “related” or “unrelated” columns. However, three types of subscales were related to crashes or behaviour in more than one study.

First, subscales concerning organisational policies for, and follow-up of, driving style were related to safety performance in several studies. These include Safety rules (Wills et al., 2006), Limits placed by supervisors on risky behaviour (Hussain et al., 2019), and Trip safety monitoring and control (Öz et al., 2014). The measures differ substantially in wording, organisational level, and item content. Wills et al. (2005) focus on the practicality and use of motor-vehicle safety rules. Hussain et al. (2019) focus on supervisor or truck-owner limits on risky driving. Öz et al. (2014) focus on trip-level monitoring, reporting, passenger feedback, control, and management-driver communication. Thus, the common denominator is organisational or supervisory regulation of driving safety, although the operationalisations vary considerably across studies.

Second, organisational learning and continuous improvement also appear in subscales related to safety performance. Examples include Control (Varmazyar et al., 2016) and Trip safety monitoring and control (Öz et al., 2014). Control was related to accidents in multivariate analyses and includes items on organisational learning and continuous improvement based on accident data, previous safety measures, and regular vehicle and route inspections. Trip safety monitoring and control includes several items on reporting, learning, and information exchange, and was related to positive driver behaviour.

Third, work and time pressure was related to safety behaviour in several studies, although the relevant outcome differed across studies. Work pressure was related to driver errors in Wills et al. (2006). Work and time pressure was related to errors and violations in Öz et al. (2013), and to speeding, violations, and tiredness, but not inattention, in Yilmaz et al. (2022). Thus, work/time pressure appears to be relevant, but its relationship with safety performance depends on the type of behavioural outcome examined.

The qualitative studies provide additional information about OSC themes that may be relevant for safety performance, although they generally provide less direct evidence about relationships between specific OSC themes and behaviour or crashes than the quantitative studies.

Camden et al. (2022) found that several safety-culture themes were perceived as relevant in companies that had improved their safety performance, including support, relationships, participation, and monitoring/feedback. Mehri et al. (2022), in a study of taxi drivers, identified organisational governance and administration, rule compliance, income-cost balance, cultural-societal traits, and traffic behaviours as central themes. Murphy et al. (2018), based on interviews with drivers and managers in trucking companies, identified themes such as maintenance, policy-practice gaps, sense of belonging, work-family balance, and supply-demand pressures.

Taken together, the qualitative studies suggest that relevant OSC themes may extend beyond the dimensions most often included in survey instruments. They point especially to maintenance, policy-practice gaps, social belonging, economic pressure, and work-life balance as potentially important aspects of safety culture among road users at work.

A2.3.4 | Mechanisms between organisational safety culture and safety performance

This chapter relates to aim 1d, which is to describe assumed mechanisms between safety culture and safety outcomes (e.g. traffic safety behaviours, crashes). Thus, this section can shed light on and explain the relationships identified in the previous section. These relationships are also studied in TRUST Deliverable 2.2b (Nævestad et al., 2026), focusing on the relationship between TSC and safety performance.

Based on Elster (2007), we may note that theories can be understood as collections of mechanisms that explain how and why relationships between variables occur, and that to explain a phenomenon is to identify the causal processes that generate it. To be able to examine hypotheses about mechanisms in empirical research about OSC, the studies should ideally examine relationship between specific aspects

of OSC and specific aspects of behaviour. This requires specific examinations of OSC and behaviour subscales.

However, as noted our review shows that most studies report associations only between an overall summary score of organisational safety culture and crashes or overall scales measuring safety-related behaviour. This limits what can be learned about the underlying mechanisms. Aggregating several aspects of OSC into one general score may obscure important effects, because aspects that are weakly or unrelated to the outcome can dilute the influence of dimensions that are more strongly related.

In Table 18, we sum up the different OSC aspects that are examined specifically in the reviewed studies which provide empirical investigations of specific aspects, including hypothesised mechanism between OSC aspect and crashes, as well as study results. We provide more information on our analytical identification of mechanisms in Chapter 2.2. It is important to mention that the hypothesised mechanisms not necessarily are made explicit in the studies; they may be more or less implicit. In addition, they are not recognised, or highlighted in several cases, as the focus is on general summary scores of OSC, which do not specifically examine the influence of safety training, reporting culture, management commitment etc. (e.g. GAIN 2001; Nævestad et al., 2019). It is also important to note that in many cases, the factor or subscale titles may be slightly misleading or general. This is because the factor titles often sum up the main items in the factors. If there are many different factors, the titles may be relatively abstract, e.g. General safety management (Öz et al., 2013). In such cases, we provide explanations in brackets behind the titles (e.g. commitment and safety vs. efficiency).

Aspect	Hypothesised mechanism between OSC aspect and crashes	Study results regarding relationships
Management commitment	Management commitment to safety will signal the importance of safety in the organisation, and make employees behave safer, leading to fewer accidents (cf. Schein 2004). This mechanism may be especially relevant for reducing driver violations, because violations are intentional behaviours and are therefore more likely to be influenced by perceived organisational priorities and norms.	⇒ Distraction, Errors (Wills et al., 2006) ⇒ Violations (Şimşekoğlu & Nordfjærn, 2017) ≠ Crashes (self-reported) (Swedler et al., 2015) ≠ Violations (Wills et al., 2006) ≠ Crashes (self-reported) (Varmazyar et al., 2016) ≠ Errors and lapses (Şimşekoğlu & Nordfjærn, 2017) General safety management (commitment and safety vs. efficiency) ≠ Errors, Violations, Positive driver behaviour (Öz et al., 2013) General safety management (commitment and safety vs. efficiency) ≠ Speeding, Violations, Tiredness, Inattention (Yılmaz et al., 2022)
Relationships/ Participation/ Teamwork	Positive social relationships between managers and employees, employee participation and sense of belonging, will lead to more trust and higher levels of reporting of incidents and better safety communication.	Teamwork ⇒ Crashes (registered) (Li & Itoh, 2014) Relationships ≠ Errors, Distraction, Violations (Wills et al., 2006) Participation ≠ Crashes (self-reported) (Varmazyar et al., 2016)
Work and time pressure	Work and time pressure will lead to higher levels of stress, which may lead to more violations (e.g. speeding, risk taking, aggression),	⇒ Speeding, Violations, and Tiredness (Yılmaz et al., 2022) ⇒ Distraction (Wills et al., 2006)

Aspect	Hypothesised mechanism between OSC aspect and crashes	Study results regarding relationships
	distractions, fatigue etc and subsequently more crashes.	≠ Crashes (self-reported) (Swedler et al., 2015) ≠ Errors, Violations (Wills et al., 2006) ≠ Positive driver behaviour (Öz et al., 2013) ≠ Inattention (Yilmaz et al., 2022) ≠ Crashes (registered) (Li & Itoh, 2014)
Communication	Positive communication between managers and employees, will lead to more effective signalling of company priorities, more trust and higher levels of reporting of incidents and better learning.	Open communication by supervisors ⇒ Risky behaviour (Hussain et al., 2019) ≠ Crashes (self-reported) (Swedler et al., 2015) ≠ Errors, Distraction, Violations (Wills et al., 2006) ≠ Violations, Errors and lapses (Şimşekoğlu & Nordfjærn, 2017) ≠ Crashes (registered) (Li & Itoh, 2014)
Driver training	Driver training will improve drivers' abilities to drive in manners which leads to fewer violations, errors and lapses.	≠ Errors, Distraction, Violations (Wills et al., 2006) Leadership style and company values ≠ Crashes (self-reported) (Varmazyar et al., 2016)
Organisational procedures for and control of driving style	Organisational procedures for, and control of driving style will clarify the organisations' policies for driving style, speed seat belt use and mobile phone use, and thus lead to fewer violations (cf. Schein 2004).	Role modeling by supervisors ⇒ Risky behaviour (Hussain et al., 2019) Limits place by supervisors on risky behaviour ⇒ Risky behaviour (Hussain et al., 2019) Trip safety monitoring and control (TSMC) ⇒ Positive driver behaviour (Li & Itoh, 2014) Tacit agreement to trip safety (TATS) ⇒ Errors, Violations (Li & Itoh, 2014) Safety rules ⇒ Distraction, Errors, Violations (Wills et al., 2006)
Safety management system (SMS) (reporting, learning, just culture)	Safety management system, with a reporting, learning, just culture will lead to a higher level of reported incidents and employee reporting of viewpoints on safety. The organisation can use this knowledge to learn and take measures against potential hazards at different level and make the overall working conditions safer, in manners that reduce the risk of accidents (cf. Reason 1997). If drivers report specific hazards related to e.g. certain routes or schedules, the organisation may change routes or schedules. If drivers report specific hazards related to e.g. physical delivery conditions, these reports can be used to improve these conditions etc.	Control (reporting culture, continuous improvement) ⇒ Crashes (self-reported) (Varmazyar et al., 2016) Trip safety monitoring and control (TSMC) ⇒ Positive driver behaviour (Li & Itoh, 2014) Safety management/system ⇒ Crashes (registered) (Li & Itoh, 2014) Tacit agreement to trip safety (TATS) ⇒ Errors, Violations (Li & Itoh, 2014) Tacit agreement to trip safety (TATS) ≠ Positive driver behaviour (Li & Itoh, 2014) Trip safety monitoring and control (TSMC) ≠ Errors, Violations (Li & Itoh, 2014) Competence-based view (factor covering items impeding reporting culture) ≠ Crashes (registered) (Li & Itoh, 2014) Specific practices and precautions (reporting culture) ≠ Errors, Violations, Positive driver behaviour (Öz et al., 2013)

Aspect	Hypothesised mechanism between OSC aspect and crashes	Study results regarding relationships
		Specific practices and precautions (reporting culture) ≠ Speeding, Violations, Tiredness, Inattention (Yılmaz et al., 2022) Use of accident information/prevention programs ≠ Crashes (self-reported) (Varmazyar et al., 2016)
Miscellaneous factors	Some of the factors are very heterogenous, and seems to include items covering all the other aspects. Thus, pointing to mechanisms is difficult.	Risk awareness (very heterogenous factor) ≠ Crashes (registered) (Li & Itoh, 2014)

TABLE 18 | Different OSC aspects that are examined specifically in the reviewed studies, hypothesised mechanism between OSC aspect and crashes and study result regarding relationships.

In the following, we will draw some main conclusions, based on the results in the table. Before doing so, it is important to note that the different OSC aspects are measured with factors which involves several different items that are grouped based on factor analysis, so they are not “clean” factors, in the sense that they only or primarily measure the aspect indicated in their title. This is why we cannot put decisive emphasis on the results in the tables.

When it comes to management commitment, the hypothesised mechanism is that this will signal the importance of safety in the organisation, and make employees behave safer, leading to fewer accidents (cf. Schein 2004). This mechanism may be especially relevant for reducing driver violations, because violations are intentional behaviours and are therefore more likely to be influenced by perceived organisational priorities and norms. Looking at the studies that have examined the relationship between commitment and safety performance, two studies have found significant relationships with behaviours. The relationship between commitment and safety performance has been tested seven additional times in other studies, not yielding significant results. This aspect is, however, one of the most crucial aspects of safety culture, as evidenced in previous systematic reviews (Flin et al., 2000), so the seemingly low importance of this aspect must be due to measuring issues.

When it comes to relationships, participation, teamwork, the hypothesised mechanism is that positive social relationships between managers and employees, employee participation and sense of belonging, will lead to more trust and higher levels of reporting of incidents and better safety communication. Looking at the studies that have examined the relationship between this aspect and safety performance, one study has found a significant relationship with the factor teamwork and registered crashes (Li & Itoh, 2014), another study did not find a relationship between employee participation and self-reported crashes (Varmazyar et al., 2016) and a third study did not find a relationship between Relationships (trust and cooperation in the workplace) and Errors, Distraction, Violations (Wills et al., 2006). A common denominator in these studies is the relationship, trust and communication between employees and managers. The outcome variable in these analyses could or should also be employee reporting and factors influencing reporting and just culture (cf. Reason 1997), safety knowledge, (unless the issue is managements’ communication about company procedures for safe driving) (cf. Schein 2004).

When it comes to work and time pressure, the hypothesised mechanism is that this will lead to higher levels of stress, which may lead to more violations (e.g. speeding, risk taking, aggression), distractions, fatigue etc. and subsequently more crashes. The studies examining these mechanisms have tested most

of these relationships and found support (two studies) and not support (four studies) for this hypothesis. Given the different ways of measuring this, we should consider this an important aspect to take into account in studies of OSC.

When it comes to communication, the hypothesised mechanism is that positive communication between managers and employees, will lead to more effective signalling of company priorities, more trust and higher levels of reporting of incidents and better learning. Looking at the studies that have examined the relationship between this aspect and safety performance, (Hussain et al., 2019) find a relationship between open communication by supervisors and risky behaviours, while four other studies do not find relationships between communication and risky driver behaviour or crashes. It is, however, important to note that the outcome variable in these analyses could also be employee reporting and factors influencing reporting and just culture (cf. Reason 1997), safety knowledge, (unless the issue is managements' communication about company procedures for safe driving) (cf. Schein 2004). Thus, we should not discard the importance of communication, based on our review results.

When it comes to driver training, the hypothesised mechanism is that driver training will improve drivers' abilities to drive in manners which leads to fewer violations, errors and lapses. Two studies examined the relationship between driver training and driving style, and did not find a significant relationship. The outcome variable in these analyses could also be related to behaviours that are related to the safety management system, e.g. employee reporting and factors influencing reporting and just culture (cf. Reason 1997). In that perspective, we could assume that driver training will improve drivers' knowledge about the safety management system and increase that level of reporting of incidents and safety issues. Thus, we should not discard the importance of driver training and information, based on our review results.

When it comes to organisational policies for and control of driving style, the hypothesised mechanism is that this will clarify the organisations' policies for driving style, speed seat belt use and mobile phone use, and thus lead to fewer violations (cf. Schein 2004). Looking at the studies that have examined the relationship between this OSC aspect and safety performance, they all find significant relationships between this aspect of OSC and different types of driver behaviours: risky behaviour, positive behaviour, errors, violations, distractions. Based on our reviewed studies, this is clearly the most important aspect of OSC for drivers at work.

When it comes to Safety management system (SMS) (reporting, learning, just culture), the hypothesised mechanism is that this will lead to a higher level of reported incidents and employee reporting of viewpoints on safety. The organisation can use this knowledge to learn and take measures against potential hazards at different level and make the overall working conditions safer, in manners that reduce the risk of accidents (cf. Reason 1997). If drivers report specific hazards related to e.g. certain routes or schedules, the organisation may change routes or schedules. If drivers report specific hazards related to e.g. physical delivery conditions, these can be improved etc. Looking at the studies that have examined the relationship between this OSC aspect and safety performance, four find a significant relationship with driver behaviours, while six do not. Considered the relatively heterogenous factors measuring this aspect, this might be considered relatively robust evidence. Moreover, based on e.g. the foundational research of Reason (1997), it can be argued that this aspect is tested against the "wrong types" of safety behaviours. It should rather be tested against employee reporting of incidents than violations, as the main purpose of SMS focusing on reporting, learning and just culture is to facilitate employee reporting and organisational learning, to prevent crashes.

A2.3.5 | Methodological strengths and weaknesses of the studies

Measuring OSC. Several methodological issues limit the practical interpretation of the reviewed OSC measures. First, the boundary between OSC, attitudes, values, norms, and behaviour is not always clear. Although most studies define OSC as perceptions of safety-related policies, practices, and priorities, many items refer implicitly or explicitly to attitudes, values, norms, or behaviour. This makes it difficult to determine whether behaviour is treated as part of OSC or as an outcome of OSC.

Second, the organisational level being measured is often unclear. Some instruments distinguish between organisation-level, group/supervisor-level, and individual-level perceptions. However, many items refer more generally to “management” or “the working situation” without specifying the relevant level. This limits conclusions about which organisational actors or practices shape OSC, and therefore also limits the identification of targeted interventions.

Third, many OSC instruments provide limited guidance for practical improvement. Subscales can be useful when they refer to concrete aspects of work, such as time pressure, feedback, training, monitoring, or communication. However, many subscales are broad and conceptually heterogeneous (e.g. “Management commitment” or “Safety management”), and some OSC-tools appear to operationalise OSC as a single overall dimension, reporting only one aggregate score. Tools with only one aggregate score are Al-Mekhlafi et al. (2021), Anderson et al. (2017), Arboleda et al. (2003), Swartz and Douglas (2009), Zohar and Luria (2005), and Naveh and Katz-Navon (2015). With such general subscales and tools with only one summary score it is difficult to link the results to concrete organisational practices or circumstances. The results are therefore of limited value for identifying relevant measures.

Finally, the reviewed studies rarely examine OSC at item level. This means that it is usually not possible to determine which specific items or practices are most strongly associated with safety behaviour, crashes, injuries, or near misses. Although many studies report acceptable or high internal consistency, reliability alone does not show whether a measure predicts relevant safety outcomes. Evidence of validity is mixed: some tools show consistent relationships with behaviour or crash-related outcomes, while others show weak or inconsistent associations. This suggests that future studies should use more clearly specified, level-sensitive, and practice-oriented OSC measures, and should report subscale- or item-level relationships with safety outcomes where possible.

Study design. Most studies in the review that have investigated how OSC affects behaviour and safety outcomes, are cross-sectional studies. Some of the reviewed studies apply prospective designs, which means that they measure OSC by survey and link it to later injury outcomes, for example Huang et al. (2014), where objective injury data were collected six months after survey administration. Lee et al. (2019) is the clearest example, with two waves of safety climate and behaviour data separated by two years, and later injury outcomes six months after the second wave. Naveh & Katz-Navon (2015) is also longitudinal/intervention-based, because it examined change in road safety climate and registered traffic violations over time.

The problem with cross-sectional studies is that it is not possible to draw conclusions about causality. Observed associations may reflect effects of OSC on behaviour (or other outcome variables), effects of behaviour on OSC perceptions, reciprocal relationships, or the influence of unmeasured third variables. For example, if a study finds, no or a negative relationship between OSC and safety performance, an alternative explanation may be that poor safety outcomes motivated the management to increase their focus on OSC.

Types of data. Only few studies have used other than self-reported information about behaviour or safety outcomes. Information about registered safety outcomes or behaviour is only used in these studies:

- Lost workdays as safety outcome was used in studies that have used the Trucking Safety Climate Scale by (Huang et al., 2013, 2014, 2018), Lee et al. (2019), and Zohar et al. (2015)
- Registered crashes were used in two studies using self-developed OSC-tools (Li & Itoh, 2014; Ziong & Chen, 2014)
- Registered violations were used in one study that has used the SCQ-MD (Banks et al., 2016) and in one study that has used a self-developed OSC-tool (Naveh & Katz-Navon, 2015)
- Registered behaviour was used in one study that has used the SCQ-MD (Swedler et al., 2015) and in one study that has used a self-developed OSC-tool (Xiong & Chen, 2024)

A major limitation of studies relying exclusively on self-reported data is common-method bias. Associations between self-reported OSC, behaviour, and safety outcomes may be affected by different kinds of bias, such as social desirability, recall bias, or respondents' general response tendencies. A second problem with conclusions about relationships between OSC and other variables is the often imprecise definition of concepts and conceptual overlap, i.e. a lack of clear distinctions between different concepts. In particular, behavioural norms and expectations are sometimes included as indicators of OSC while similar constructs are treated as behavioural outcomes in other studies. A third problem is related to assumptions about how different variables, such as OSC, attitudes, behaviours, and safety outcomes, are related to one another and about which variables serve as predictors, moderators, mediators, and outcomes. In some studies, such assumptions are empirically tested.

However, some studies report only the assumed relationships. For example, some studies assume that OSC affects crash outcomes indirectly via behaviour, and report only the relationships between OSC and behaviour and between behaviour and outcome, but not between OSC and outcome (e.g. Fugas et al., 2012; Huang et al., 2014). Without formally testing mediation, such results cannot be interpreted as evidence that behaviour mediates the relationship between OSC and safety outcomes. Moreover, when the direct relationship between OSC and outcome variables are not reported, the results cannot be included in a review of the effects of OSC on safety or behaviour. Other studies have simply reported correlations among all or most of the measured variables without distinguishing between predictor, moderator, mediator, and outcome variables. Such results can be included in reviews, but they do not allow conclusions about how the variables are related to each other.

A2.4 | Discussion

A2.4.1 | Comparison of OSC and TSC research

Similarities. When it comes to similarities, both TSC and OSC research are concerned with how shared cultural factors influence safety behaviour and, ultimately, crashes. Both fields often use survey methods, often measure behaviour as an intermediate outcome, and usually assume a causal chain where culture shapes behaviour and behaviour shapes safety outcomes. Both also rely heavily on mechanisms such as norms, attitudes, communication, modelling, management/supervisory influence, and social pressure. In both fields, many studies examine only parts of the causal chain rather than testing the full pathway from culture to behaviour to crashes.

Differences. When it comes to differences, TSC research is broader and more heterogeneous. It studies several cultural group levels, including continental, national, regional/local, peer, and family levels, and it uses very different concepts such as national values, descriptive norms, traffic climate, peer climate, and family climate. OSC research is more organisationally bounded and generally focuses on road users

at work, especially professional drivers, where culture is linked to management, supervisors, procedures, training, time pressure, reporting, and safety management systems. Thus, TSC often explains behaviour through broader social and cultural mechanisms, while OSC more often explains behaviour through more concrete and bonded organisational mechanisms such as management commitment, work pressure, safety rules, communication, and control of driving style.

A key difference is also theoretical maturity. OSC research is more established and has clearer recurring aspects, such as management commitment, safety communication, reporting/learning, training, and work pressure. TSC research is newer and more fragmented, with greater variation in operationalisations and less agreement on common dimensions. However, unlike OSC research, TSC research explicitly considers multiple social group memberships beyond organisations, including nations, regions, communities, families, and peer groups. This provides a broader perspective on the social influences that shape traffic safety behaviour across different contexts.

The causal chains in TSC and OSC research. Most of the reviewed OSC studies focus on climate, and they are therefore more oriented towards cultural aspects than elements, and less theoretically oriented than many of the TSC studies. The behavioural pathway model is therefore useful for OSC research, because it makes explicit what many OSC studies leave implicit: the mechanisms linking organisational culture to behaviour, such as perceived norms, legitimacy, attitudes, responsibility attribution, motivation, willingness, and intentions. This fits the mechanism-based approach of the study, since the model seeks to explain how safety culture influences safety performance, rather than only documenting associations. The main limitation with the reviewed OSC studies is that they often do not test such a detailed pathway. Many use overall OSC or safety climate summary scores rather than separate dimensions, which makes it difficult to identify which mechanisms that are actually operating.

A2.4.2 | Adaptation of the TSC conceptual model to OSC

As discussed in the previous section, the reviewed OSC literature shares the same fundamental assumptions as the TSC model. Both research traditions view safety culture as comprising shared beliefs, values, and norms that influence safety behaviour through psychological and social mechanisms. The main difference lies not in the underlying behavioural pathway, but in the content of the cultural elements and the contextual factors that shape them. In OSC research, these cultural elements are primarily influenced by organisational factors such as management commitment, safety communication, work organisation, and safety management systems, whereas the TSC model focuses on broader societal and group-level contexts. The example in Figure 9 illustrates how the conceptual pathway proposed for TSC can be translated to an organisational context using concepts that are well established in the OSC literature.

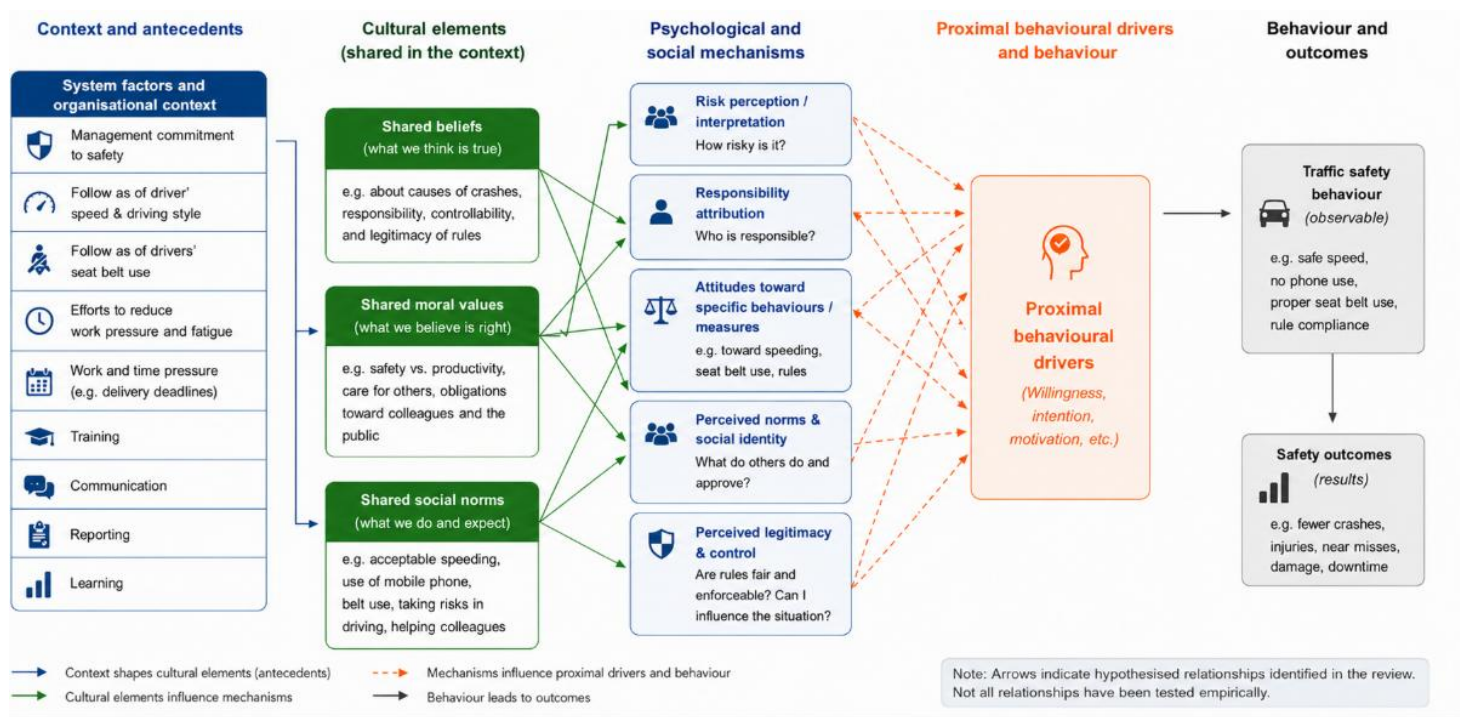


FIGURE 9 | Model of behavioural pathway in the conceptual model of organisational safety culture. This model is inspired by Ward et al.'s (2020) model of prosocial behaviour and Traffic Safety Culture. Figure developed with assistance from ChatGPT-5.4.

System level. In contrast to the TSC model, the OSC model mainly includes one specific cultural group level: the organisation or workplace. Thus, the mechanisms linking system-level factors to OSC are more organisational than societal. Organisational safety culture among road users at work is influenced by organisational system-level factors, which we often can refer to as formal aspects of safety management in organisations ("what we say that we do"), as described in routines, procedures. Safety culture denotes the informal aspects of safety management in organisations ("what we actually do"). Safety management systems describe formal routines and measures describing how the organisation should work systematically with safety. Safety management systems concern how risk should be identified and reduced through formal risk assessments, countermeasures such as procedures and training, roles and responsibilities, evaluation of safety outcomes, and adjustments when needed (Nævestad and Phillips 2023). The most comprehensive types of safety management are formal safety management systems like ISO:39001, with procedures for risk analysis, learning and improvement (Nævestad et al., 2025). In the Safety Ladder approach, which is a simplified and stepwise approach to safety management, Nævestad et al. (2025), discern between four levels: 1) Management and employee commitment to safety, 2) Follow up of drivers' speed, driving style, seat belt use, mobile phone use etc. 3) Focus on working conditions influencing road safety, e.g. factors influencing fatigue, stress, time pressure, 4) Safety management system with focus on risk assessment, learning, reporting (e.g. ISO:39001). Nævestad et al. (2025) find a tight relationship between the formal and informal aspects of safety in organisations; between system and culture. The lack of focus on organisational safety management in the road sector is particularly evident when compared to other transport sectors. There are legal requirements for safety management systems to contribute to a positive safety culture in aviation, maritime and rail (Amtrak, 2015; Hudson, 2003; Lappalainen et al., 2012). In contrast, companies that have employees who drive for work can choose whether to implement safety management systems, e.g. ISO:39001, ISO:45001 or not.

Our review indicates the importance of studies at different levels of the Safety Ladder for Safety culture. First, studies point to the importance of level 1 and 2: management commitment to safety; follow-up of

drivers' speed, driving style, and seat belt use (Wills et al., 2006; Hussain et al., 2019; Öz et al., 2014; Hussain et al., 2019). Second, the reviewed studies point to the importance of factors at level 3: efforts to reduce time pressure and fatigue; work and time pressure, such as delivery deadlines, and level 4: training; communication; reporting; and learning (Arboleda et al., 2003; Nævestad et al., 2025). Several of the latter factors denote safety management system elements, comparable to those addressed in standards such as ISO 39001 (Varmazyar et al., 2016; Li & Itoh, 2014; Nævestad et al., 2025). In the organisational context, system-level factors therefore primarily refer to safety management measures, organisational practices, and working conditions.

Organisational safety culture. These organisational system-level factors shape employees' shared beliefs, values, and norms about what the company actually prioritises in practice: safety, efficiency, delivery deadlines, rule compliance, reporting, learning, or other organisational goals. In this way, organisational structures and management practices form the context within which OSC develops and is maintained. This is consistent with the OSC literature, where management commitment, supervisor practices, safety communication, safety rules and procedures, work pressure, reporting systems, and safety management systems are repeatedly treated as central aspects, or precursors of OSC (Wills et al., 2006; Hussain et al., 2019; Öz et al., 2014; Varmazyar et al., 2016; Li & Itoh, 2014; Nævestad et al., 2025).

Psychological and social mechanisms. The middle column illustrates how organisational factors shape how drivers interpret risk, responsibility, legitimacy, norms, and behavioural expectations. For example, management commitment and supervisor behaviour may influence drivers' perceived legitimacy and control, attitudes toward safe driving, and perceived norms about whether speeding, mobile phone use, fatigue driving, or rule-breaking are acceptable. Work and time pressure may influence whether unsafe shortcuts are perceived as necessary, normal, or tolerated (cf. Zohar & Luria, 2005; Wills et al., 2005; Fugas et al., 2012). Similar effects may be observed for incentive systems, such as bonuses for safe driving or efficiency (e.g. Arboleda et al., 2003).

Proximal determinants of behaviour. The proximal determinants of behaviour in the OSC model include willingness to act safely, intentions to act safely, motivation, perceived pressure, and practical capacity to comply with safety requirements. For instance: a driver may intend to comply with speed limits, wear a seat belt, avoid fatigue driving, and report incidents, but these intentions may be weakened if delivery deadlines, time pressure, fatigue, or perceived managerial priorities signal that productivity is more important than safety (cf. Griffin & Neal, 2000; Neal & Griffin, 2006; Wills et al., 2006).

Behaviour. The behavioural part of the model refers to observable safety-related driving behaviour in work-related transport. This includes speed choice, driving style, seat belt use, mobile phone use, fatigue-related driving, compliance with rules and procedures, reporting of incidents, and participation in learning processes. Among the reviewed OSC studies, 17 studies have reported relationships between OSC and crashes, and 32 studies have investigated the relationship between OSC and behaviour.

A2.4.3 | How can we test the model?

A2.4.3.1 | System factors influencing OSC.

H1. Organisational system factors and OSC formation Organisational safety culture among road users at work is influenced by organisational system-level factors, including management commitment to safety, supervisor follow-up, safety rules and procedures, training, communication, reporting systems, learning processes, work and time pressure, and fatigue-related working conditions. These factors shape employees' shared beliefs, values and norms about what the organisation actually prioritises in practice: safety, efficiency, delivery deadlines, rule compliance, reporting or learning (Zohar & Luria, 2005; Wills et al., 2005; Huang et al., 2013; GAIN, 2001; Öz et al., 2013; Varmazyar et al., 2016; Nævestad et al., 2019a, 2019b, 2020, 2022; Yilmaz et al., 2022).

H2. Management commitment and safety priority. Management commitment to safety and organisational safety priority influence driver behaviour by signalling the relative importance of safety compared with productivity, efficiency and delivery demands. When management consistently prioritises safety, drivers are more likely to perceive safe driving, rule compliance, seat belt use, fatigue management and reporting as expected and legitimate. (Zohar & Luria, 2005; Huang et al., 2013, 2014, 2018; Wills et al., 2005, 2006; Şimşekoğlu & Nordfjærn, 2017; Varmazyar et al., 2016; Nævestad et al., 2019a, 2019b, 2020).

H3. Supervisor practices and group-level OSC. Supervisor practices and group-level safety climate influence drivers' safety behaviour through direct social influence, role modelling, communication, monitoring, feedback and reinforcement of safe or unsafe practices. Group-level OSC is expected to have a particularly strong relationship with driver behaviour because supervisors and immediate work groups are closer to drivers' everyday work situation than top management. (Huang et al., 2013, 2014, 2018; Lee et al., 2019; Zohar et al., 2014, 2015; Qu et al., 2022; Hussain et al., 2019).

H4. Work and time pressure as competing organisational priorities. Work and time pressure, including delivery deadlines, productivity demands, long working hours and fatigue, weaken OSC by making unsafe shortcuts appear necessary, tolerated or normal. Such pressure is expected to increase risky behaviours such as speeding, fatigue-related driving, mobile phone use, violations and other forms of non-compliance (Wills et al., 2005, 2006; Strahan et al., 2008; Öz et al., 2013; Yilmaz et al., 2022).

H5. Safety management systems, reporting and learning. Safety management practices, including training, communication, reporting systems, feedback, use of crash information, preventive programmes and organisational learning, influence safety behaviour by increasing drivers' safety knowledge, perceived control, trust, risk awareness and willingness to report safety problems (GAIN, 2001; Öz et al., 2014; Varmazyar et al., 2016; Mokarami et al., 2019; Li & Itoh, 2014; Nævestad et al., 2019a, 2019b, 2020, 2022).

A2.4.3.2 | Hypotheses concerning mediation and moderation effects

H6. Behavioural mediation between OSC and safety outcomes. The relationship between OSC and safety outcomes is mediated by driver behaviour. In other words, OSC influences crashes, injuries, near misses, vehicle damage and downtime primarily by shaping observable safety-related behaviour, such as speed choice, seat belt use, mobile phone use, fatigue management, rule compliance, reporting and unsafe shortcuts (Huang et al., 2013, 2018; Zohar et al., 2015; Wang et al., 2021; Xiong & Chen, 2024; Anderson et al., 2017; Sullman et al., 2017; Mokarami et al., 2019).

H7. Organisational constraints moderate the effect of OSC. The effect of OSC on driver behaviour is moderated by working conditions. A positive safety culture is expected to have weaker effects when drivers experience strong time pressure, fatigue, unrealistic schedules, conflicting productivity demands or insufficient organisational resources. (Wills et al., 2005, 2006; Huang et al., 2013; Öz et al., 2013; Yilmaz et al., 2022; Strahan et al., 2008).

A2.4.4 | How can the OSC model be used to measure OSC safety culture?

The hypotheses presented above specify how the OSC model may be tested. To make such testing possible, the model must be translated into measurable components. As in the TSC model, measurement should cover the full conceptual pathway: organisational context, shared cultural elements, psychological and social mechanisms, proximal behavioural drivers, safety-related behaviour and safety outcomes.

Our review indicates that the organisational context can be operationalised through four interrelated aspects, which we structure according to the Safety Ladder for safety management approach (Nævestad

et al., 2018; Nævestad et al., 2025). These aspects also relate to the aspects found to be most closely related to safety outcomes in our review.

1. **Management commitment and employee participation in safety.** This concerns the extent to which managers, supervisors and employees give safety priority over productivity, efficiency and delivery demands, and whether managers demonstrate this priority consistently in practice. Management commitment is one of the most consistently recurring aspects across the reviewed OSC instruments, although results regarding relationships with outcomes were a bit mixed. The Trucking Safety Climate Scale includes organisational safety priority, supervisory care and safety promotion, while the SCQ-MD includes management commitment, and the GAIN scale distinguishes between management and employee attitudes toward safety (Huang et al., 2013, 2014, 2018; Lee et al., 2019; Zohar et al., 2015; Qu et al., 2022).
2. **Policies for and follow-up of driving behaviour.** The review provides strong support for including organisational policies and supervisory follow-up related to concrete driving behaviours. Relevant studies examine safety rules, supervisory monitoring, driver-safety priorities, delivery limits and disapproval of mobile-phone use. Studies focusing on organisational policies and follow-up of driving style generally report relationships with risky driving, positive driver behaviour, errors, violations and distraction (Wills et al., 2006; Hussain et al., 2019; Li & Itoh, 2014). The reviewed evidence also suggests that policies are most likely to influence behaviour when they are communicated, monitored and consistently enforced by supervisors. This domain aspect includes management focus on speed, driving style, seat-belt use, mobile-phone use, fatigue-related driving and other relevant risky or protective behaviours.
3. **Working conditions influencing road safety.** Work and time pressure are recurring dimensions in several reviewed tools, including the SCQ-MD and the Transportation Companies' Climate Scale. The latter distinguishes work and time pressure from general safety management and specific safety practices. Importantly, work and time pressure was related to errors and violations in Öz et al. (2013), and to speeding and tiredness in Yilmaz et al. (2022), whereas the other two TCCS dimensions were not related to these behaviours. Other reviewed studies also indicate that delivery deadlines, long working hours, fatigue, unrealistic schedules and productivity demands may weaken the influence of a positive OSC by making unsafe shortcuts appear necessary or tolerated (Wills et al., 2005, 2006; Strahan et al., 2008; Öz et al., 2013; Yilmaz et al., 2022). This shows that it is important to measure scheduling, workload, fatigue, time pressure, incentives and competing productivity demands.
4. **Safety management systems, communication, reporting and learning.** The reviewed instruments repeatedly include training, communication, procedures, reporting, feedback, use of crash information, preventive programmes and organisational learning. The SCQ-MD includes communication and procedures, driver training and safety rules; the GAIN scale includes reporting and reactions, training and safety priority; and the Safety Culture Dimensions scale includes control, employee participation, use of crash information and preventive programmes. Some studies find relationships between safety-management-related dimensions and crashes or behaviour, including Li and Itoh (2014), Varmazyar et al. (2016) and Mokarami et al. (2019). However, the overall evidence is mixed. One likely reason is that safety management systems may influence safety indirectly: reporting and communication help the organisation identify hazards, revise routes or schedules, improve risk assessments and create safer working conditions, rather than directly changing driving behaviour. Relevant outcomes

should therefore include not only violations or crashes, but also reporting, communication of safety concerns, participation in risk assessment and organisational learning.

Management commitment, supervisor practices and concrete follow-up of driving behaviour appear to have the strongest and most direct relationships with driver behaviour and safety outcomes. Working conditions, particularly time pressure and fatigue, also show relatively clear relationships with unsafe behaviour. Safety management systems, communication, reporting and learning are well established in OSC measurement, but their effects may be more indirect and should therefore be assessed using organisational learning and hazard-management outcomes in addition to individual driving behaviour.

Finally, the assessment should include safety-related behaviour and outcomes. Behavioural indicators may include speed choice, driving style, seat-belt use, mobile-phone use, fatigue management, rule compliance, vehicle checks, reporting of incidents and participation in safety and learning activities. Safety outcomes may include crashes, injuries, near misses, vehicle damage and downtime. Including these indicators makes it possible to examine whether OSC influences outcomes through behaviour, as proposed in the conceptual model.

Component of the model	Measurement content	Examples of indicators or items
Commitment to safety	Management, supervisor and employee commitment; safety priority relative to productivity	"Management considers safety more important than meeting delivery deadlines"; "Managers respond consistently to unsafe driving"
Driving policies and follow-up	Rules, monitoring and feedback concerning speed, driving style, seat belts, mobile phones and fatigue driving	"Drivers' speed is systematically followed up"; "Non-use of seat belts is addressed by supervisors"
Management focus on work-related risk factors	Time pressure, fatigue, schedules, workload, resources, incentives and competing demands	"Delivery schedules can be completed without speeding"; "The organisation takes measures to prevent driver fatigue"
Safety management system	Training, communication, risk assessment, reporting, learning, feedback and preventive measures	"Employees receive relevant safety training"; "Reported incidents are analysed and followed up"; "Safety information is communicated effectively"
Safety-related behaviour	Speed, driving style, seat-belt and mobile-phone use, fatigue management, reporting and participation in learning	Self-reported or observed behaviour, fleet-management indicators, reporting and participation data
Safety outcomes	Crashes, injuries, near misses, damage and downtime	Organisational records and employee reports

TABLE 19 | Examples of OSC measurement content and items

The model can also be used diagnostically to support interventions. Measurement can identify where the pathway appears weakest: for example, limited management commitment, inadequate follow-up of driving behaviour, excessive time pressure, weak reporting and learning, low perceived legitimacy or insufficient willingness and capacity to act safely. Interventions can then be directed toward these specific factors and mechanisms rather than toward OSC in general. Repeated measurement before and after an intervention can be used to assess whether the targeted organisational conditions, cultural elements, mechanisms and behaviours have changed.

Thus, the OSC model should not be operationalised through one general safety culture score alone. A comprehensive assessment should distinguish between organisational antecedents, shared cultural elements, mechanisms, proximal behavioural drivers, behaviours and outcomes. This makes it possible

both to measure the state of OSC and to examine how organisational safety culture may influence safety performance.

A2.4.5 | Issues for future research

1) Need for broader measurement of safety behaviours. There is also a need to examine the relationship between OSC and other types of safety behaviour than driving behaviour. Relevant behavioural outcomes could include incident reporting, communication of safety concerns, sharing of safety ideas with management, participation in risk assessments, and engagement in organisational learning processes. At other analytical levels, such as organisational learning, the causal mechanisms may be different from those linking OSC directly to driver behaviour. For example, a safety management system may not primarily improve safety through direct effects on individual driving behaviour. Instead, it may improve the organisation's ability to identify new hazards, conduct risk analyses, learn from incidents, and create safer working conditions. Thus, the most relevant target behaviours for this type of safety culture may be reporting, safety communication, safety imagination, and learning. Other relevant types of safety behaviours related to OSC are e.g. checking the vehicles before trips, maintenance of vehicles, communication with internal transport planners before and during trips etc.

2) More focus on mechanisms in OSC research. Future studies should place less emphasis on the relationship between general organisational safety culture/climate scores and general behaviour scores. Our review indicates that studies focusing only on broad relationships between OSC and safety behaviour may conceal important relationships between specific aspects of OSC and specific types of behaviour. Rather than asking whether OSC in general is related to safety behaviour in general, it may be more useful to examine which aspects of OSC are related to which safety-related outcomes, and through which mechanisms.

There is therefore a need for more studies examining relationships between specific OSC subscales and specific behavioural subscales. This is important because the mechanisms linking different OSC aspects to behaviour may vary considerably. Overall OSC scores may show whether OSC is related to safety performance, but they provide limited insight into how this relationship operates.

This can be illustrated by comparing two aspects of OSC that may both be hypothesised to reduce crash risk, but through different mechanisms. The first is a culture with a strong focus on driver policies for safe driving, for example compliance with speed limits, seat belt use, and avoidance of mobile phone use while driving. The second is an informed, learning and just culture, which facilitates the reporting of incidents, hazards, and safety concerns.

Both aspects may be associated with fewer crashes, but the causal pathways are different. In the first case, the purpose of the culture is to regulate and support safe driving behaviour directly. Clear safety rules, supervisory monitoring, feedback, and follow-up may reduce deliberate violations such as speeding, non-use of seat belts, mobile phone use, or other intentional deviations from safe driving procedures. In the second case, the purpose of a reporting and learning culture is not primarily to influence a specific driving behaviour directly, but to generate safety-relevant information that the organisation can use for continuous improvement. For example, drivers may report dangerous schedules, problematic routes, unsafe delivery locations, vehicle malfunctions, fatigue-related problems, or other hazards. The organisation can then use this information to improve working conditions, adjust routines, and reduce risks before accidents occur.

This illustrates why different OSC aspects should not be expected to influence the same behaviours in the same way. Safety rules and supervisory monitoring may primarily influence deliberate violations, while work pressure, stress, and fatigue-related working conditions may be more closely related to

errors, lapses, tired driving, or speeding motivated by time pressure. Similarly, reporting culture and organisational learning may influence safety performance through mechanisms that differ from those linking safety rules to driver behaviour. Thus, the hypothesised mechanisms between OSC and crashes may be quite different across OSC dimensions, and existing studies do not always distinguish these mechanisms sufficiently. Future research should therefore examine specific OSC subscales in relation to specific behavioural outcomes, rather than relying mainly on overall OSC summary scores.

Future studies should also aim to develop more theoretically coherent and less heterogeneous OSC factors. One problem identified in the existing literature is that many studies are primarily empirically driven rather than theoretically or mechanism driven. A large share of studies use factor analysis to identify dimensions of OSC. As a result, several of the factors analysed in this review are heterogeneous, in the sense that they include items covering a wide range of topics and potential mechanisms. While this may be useful for measurement purposes, it can produce factors that are defined statistically rather than by clear theoretical mechanisms.

This creates several challenges. First, heterogeneous factors make it difficult to understand why specific OSC aspects are related to specific safety outcomes. Second, they make it harder to compare findings across studies, because apparently similar factors may include different types of items and mechanisms. Third, and most importantly from an applied perspective, heterogeneous factors make it harder to develop clear policy implications. When a factor measures “everything”, it becomes difficult to identify what organisations should actually change in order to improve safety. Future studies should therefore seek to develop theoretically cleaner OSC dimensions that correspond more clearly to specific mechanisms and intervention targets.

3) The importance of study design. A key methodological challenge in OSC research is that most studies are cross-sectional. The problem with cross-sectional studies is that they do not allow firm conclusions about causality. Observed associations may reflect effects of OSC on behaviour or safety outcomes on OSC perceptions, reciprocal relationships, or the influence of unmeasured third variables. For example, if a study finds no relationship, or even a negative relationship, between OSC and safety performance, one possible explanation may be that poor safety outcomes have motivated management to increase its focus on safety culture.

Several studies illustrate this problem. Desai et al. (2006) found that accident rates were positively correlated with safety culture scores. They argue that this result is consistent with the hypothesis that safety culture may improve after crashes or incidents occur, because the organisation responds by trying to learn from the event and strengthen its safety culture. Similarly, Hale et al. (2010) argue that an increase in reports of dangerous situations should not necessarily be interpreted as evidence of increasing danger. Rather, it may be positive evidence that awareness of danger and openness to reporting and addressing safety issues are increasing.

The use of self-reported data also makes it challenging to interpret causal relationships. In a study of safety culture in transport, Bjørnskau and Longva (2010) did not find a clear link between individual safety records and perceived safety culture. On the contrary, they found that drivers who had reported one serious incident or accident perceived the safety culture to be better than drivers who had reported no serious incidents or crashes.

According to Bjørnskau and Longva (2010), there are three possible explanations for this finding. First, safety culture questions usually concern how employees perceive the general safety culture in their company, not their own behaviour. Their study found a clear relationship between personal rule-following and incidents or crashes, but not between individual perceptions of safety culture and

individual safety records. Second, a key element of a good safety culture is that employees trust management enough to report their own errors, incidents and unsafe conditions. Thus, those who perceive the safety culture as good may also be more willing to report incidents. Third, drivers who have experienced an incident or crash may subsequently have experienced fair and just treatment from management, including a focus on identifying underlying causes rather than blaming individuals. This experience may lead them to perceive the safety culture as better than drivers who have not had such experiences.

These explanations may all be relevant. They show that the relationship between safety culture and actual safety performance is complex, and that cross-sectional studies may be difficult to interpret. Ideally, the relationship should be analysed using prospective designs, where safety culture is measured before safety outcomes are registered. This would provide a clearer temporal order and stronger evidence about whether OSC predicts later behaviour, crashes, injuries, near misses, or reporting practices.

Future studies should also include more objective measures of safety performance. In the reviewed literature, only a limited number of studies use objective indicators such as registered crashes, registered injuries, telematics data, or company-recorded safety events. Most studies rely on self-reported crashes or self-reported behaviour. Self-reports are valuable because they can capture behaviours and events that are not otherwise recorded, but they are also vulnerable to recall bias, social desirability bias, and common method bias when OSC and outcomes are measured in the same questionnaire. Objective indicators can reduce some of these problems and provide stronger evidence about the relationship between OSC and safety performance.

At the same time, objective indicators should be interpreted carefully. In organisations with a strong reporting culture, the number of reported incidents, near misses, or hazardous situations may increase, not because safety has deteriorated, but because employees are more willing to report. Thus, studies should distinguish between different types of safety outcomes, such as crashes, injuries, near misses, unsafe behaviours, and reporting activity. Increased reporting may be a positive sign of safety culture, whereas increased crashes or injuries may indicate poorer safety performance.

Overall, there is a need for more longitudinal and prospective studies of OSC among road users at work. Such studies should examine whether specific OSC aspects predict later changes in behaviour, crashes, injuries, near misses, reporting practices, or organisational learning. This would provide stronger evidence on causal mechanisms and would be particularly useful for evaluating organisational safety interventions.

A2.4.6 | Policy recommendation based on the OSC review

Based on the mechanism-oriented review, two broad pathways appear especially relevant for understanding how OSC may influence safety performance: direct behavioural-control mechanisms and more indirect safety management and learning mechanisms.

Organisational policies for driving style, speed, seat belt use and mobile phone use. Based on the reviewed studies, organisational policies for, and follow-up of, driving style appear to be among the most important OSC aspects for drivers at work. Studies examining this aspect generally find significant relationships with different types of driver behaviour, including risky behaviour, positive driver behaviour, errors, violations, and distraction (Hussain et al., 2019; Li & Itoh, 2014; Wills et al., 2006). This suggests that organisations with drivers at work should develop, implement, and systematically follow up policies for safe driving style, including speed compliance, seat-belt use, mobile-phone use while driving, and other forms of risky driving.

Such policies should not only exist formally, but also be communicated, monitored, and enforced in practice. The reviewed evidence indicates that rules, supervisory limits, monitoring, and control are particularly relevant when they are connected to concrete driving behaviours. Organisations should therefore ensure that supervisors and managers actively support these policies, provide feedback to drivers, and respond consistently to unsafe driving practices. This is important because policies that are not followed up may have limited practical influence on behaviour and may also contribute to a gap between formal safety policy and everyday practice.

Safety management system. Safety management systems represent a somewhat different OSC mechanism than organisational policies for driving style. For SMS-related aspects, such as reporting, learning, and just culture, the hypothesised mechanism is not necessarily a direct effect on individual driving behaviour. Rather, the expected mechanism is that a well-functioning SMS increases the reporting of incidents, hazards, and employee viewpoints on safety. The organisation can then use this information to identify risks, learn from incidents, and implement measures that make working conditions safer and reduce accident risk.

For example, if drivers report hazards related to specific routes, schedules, loading areas, delivery conditions, vehicles, or customer demands, the organisation may use this information to revise routes or schedules, improve delivery arrangements, adjust risk assessments, strengthen training, or improve communication with customers and transport buyers. In this way, SMS-related OSC aspects may influence safety performance indirectly by improving organisational learning and hazard control, rather than only by changing individual driver behaviour.

The reviewed studies provide mixed evidence for the relationship between SMS-related OSC aspects and driver behaviour. Some studies find significant relationships, while others do not. However, this should not necessarily be interpreted as weak evidence for the relevance of SMS. One reason is that several of the factors used to measure SMS-related aspects are heterogeneous, combining reporting, learning, control, communication, training, and management practices within the same factor. This makes it difficult to identify the specific mechanisms involved. Another reason is that SMS-related aspects may often have been tested against the wrong type of outcome. If the main purpose of reporting, learning, and just culture is to facilitate employee reporting and organisational learning, then the most relevant behavioural outcomes may not be violations, errors, or risky driving, but rather incident reporting, communication of safety concerns, participation in risk assessment, and contribution to organisational learning.

Thus, organisations should not limit their safety efforts to direct behavioural-control policies. They should also develop safety management systems that support reporting, learning, and continuous improvement. This includes creating a just culture in which drivers feel able to report incidents, hazards, and mistakes without fear of unfair blame, while still maintaining clear accountability for deliberate unsafe behaviour. In combination, concrete driving policies and well-functioning safety management systems may address different mechanisms: the former by directly influencing driver behaviour, and the latter by improving the organisation's ability to identify hazards and create safer working conditions.

A2.5 | Conclusion

This Appendix has mapped research on OSC among road users at work, especially professional drivers. Compared with TSC research, OSC research is more clearly bounded around one cultural group level: the organisation or workplace. The reviewed studies typically operationalise OSC through safety climate or safety culture scales focusing on management commitment, supervisor practices, safety rules, communication, training, work and time pressure, reporting, learning, and safety management systems. The studies share a common causal logic: organisational factors shape safety culture, safety culture influences driver behaviour, and driver behaviour influences safety outcomes such as crashes, injuries, near misses, vehicle damage, and downtime. Several studies indicate that OSC is related to safety behaviour and, in some cases, to crash involvement. The evidence also suggests that behaviour may mediate the relationship between OSC and safety outcomes. However, the review also identifies important limitations. Many studies use broad summary scores of OSC rather than analysing specific subdimensions, which makes it difficult to identify the mechanisms linking culture to behaviour. Moreover, several studies rely on self-reported behaviour and crashes, and many do not test the full causal chain. Overall, the OSC literature provides moderate support for a relationship between OSC, driver behaviour, and safety outcomes, but more mechanism-focused studies are needed.

Appendix 3 | Culture measurement and most common survey tools

A3.1 | National level

Hofstede dimensions

SUMMARY: Cross-country comparison studies show that differences in TS culture between countries can explain some of the differences in crash rates between countries. This has been shown specifically for alcohol-related culture and crashes and for driving styles (violations and errors). The most important cultural dimensions that contribute to differences between countries are power distance and individualism.

Hofstede's cultural dimensions are used in five studies to classify countries according to the type of culture (Atchley et al., 2014; Gaygisiz, 2010; Van den Berghe et al., 2020; Arslan & Özkan, 2024; Melinder, 2007). Hofstede (2001) defines culture as "the collective programming of the mind that distinguishes the members of one group or category of people from another" (p. 9, as cited in Arslan & Özkan, 2024).

The concept distinguishes between six dimensions of culture (Arslan & Özkan, 2024), although some of the studies only refer to the first four dimensions (e.g. Gaygisiz, 2010):

- **Individualism vs. collectivism:** Integration of individuals into primary groups
- **Masculinity vs. femininity:** Division of emotional roles between males and females, value placed on competitiveness, ambition, and the importance of wealth.
- **Uncertainty avoidance:** Individual tolerance for uncertain conditions and level of stress related to unknown future
- **Power distance:** Inequality between people
- **Short- vs. long-term orientation:** Quick vs. long-lasting solutions for problems.
- **Indulgence vs. restraint:** Value placed on the gratification of basic human needs and enjoyment in life (*not included in all studies, e.g. Atchley et al., 2014*)

The main element of culture according to this definition is social norms (Arslan & Özkan, 2024). However, the definitions of the dimensions of culture show that also values are a part of culture.

It should also be noted that recent revisions of Hofstede's model, sometimes referred to as the Minkov–Hofstede model, reduce the classic model mainly to two dimensions: individualism–collectivism and long-term orientation/flexibility–monumentalism. In this revised model, other dimensions, such as power distance, are interpreted as strongly related to individualism–collectivism rather than as fully independent cultural dimensions (Komisarof et al., 2025).

Schwartz' values (in Hofstede-studies, cross-country comparisons)

Three of the studies that are based on Hofstede's cultural dimensions, also refer to cultural values as defined by Schwartz (1999) (Atchley et al., 2014; Gaygisiz, 2010; Arslan & Özkan, 2024). These values are described on three dimensions:

- **Embeddedness vs. autonomy**
- **Hierarchy vs. egalitarianism**
- **Mastery vs. harmony**

Based on these dimensions, specific values are described, e.g. by Atchley et al. (2014):

- Embeddedness: Collectivism
- Intellectual autonomy: Independent pursuit of ideas
- Affective autonomy: Independent pursuit of affective experiences (e.g. pleasure, enjoyment of life)
- Hierarchy: Hierarchical organisation of individuals and resources
- Egalitarian: Degree to which individuals are seen as moral equals and share the same basic interests as
- Mastery: Degree to which individuals value success and pursue personal interests
- Harmony: Degree to which individuals are content be part of their natural and social environment

Road traffic culture as symbol exchange

Five studies are based on a view of culture as “Symbol exchange” (Rundmo et al., 2012; Nordfjærn et al., 2012a,b, 2014), which is quite different from other views of culture. All five studies are from the same group of authors from the Norwegian University of Science and Technology, Department of Psychology. All five studies are **comparisons between countries**.

A questionnaire for measuring road traffic culture in terms of “symbol exchange” was developed by Klempe et al. (2009 – not available). The scale has been adjusted for measuring traffic safety culture on six dimensions (Rundmo et al., 2012):

- Extraverted culture
- Introverted culture
- Auditive culture
- Oral culture
- Visual culture
- Written culture

The dimensions **extravert** and **introvert** culture are not related to the definitions of extra- and introversion in personality psychology, i.e. the extent to which individuals are oriented toward external stimulation and social interaction (extraversion) versus internal thoughts and low-stimulation environments (introversion).

The items, all of which are answered on 5-point scales from “Never” to “Very often” are:

Dimension	Items	Alternative interpretations of items
1: Written culture	What I read about dangers, I take seriously	Regulation awareness
	I consider a written request to be particularly serious	
	I prefer reading what the law says on right and wrong in traffic	
	I enjoy following press debates concerning traffic regulations	
2: Auditive culture	While in traffic, I'm especially aware of the sounds around me	Risk awareness
	I react strongly to sounds signalling danger	
	It is important to look for signs of danger	
3: Oral culture	I enjoy hearing about what others consider right or wrong in traffic	
	I take oral corrections of my behaviour in traffic seriously	

	I consider an oral request to be particularly serious	
4: Extravert culture	Prompt reaction to road signs is very important	Law abiding
	I act according to the image of traffic that I see	
	In traffic I usually behave as others are likely to expect me to	
	I'm especially aware of how other people behave in traffic	
5: Conscious culture	When someone honks their horn, I think I've done something wrong	?
	Few sounds indicate that traffic is running smoothly	
6: Introvert culture	If everyone followed their own convictions, traffic would run smoothly	?
	People's behaviour can change in dangerous situations	

TABLE 20 |

Fatalistic attributions / Destiny orientation

Three of the studies that are based on a view of TSC as "Symbol exchange" have investigated Fatalistic attributions / Destiny orientation as an additional aspect of culture (Nordfjærn et al., 2012a,b, 2014). Fatalistic attributions / Destiny orientation are measured with items such as 'if everyone were religious, there would be fewer traffic accidents' and 'all human beings have a destiny'.

Vertical and horizontal individualism and collectivism (country level)

One study has defined and measured TSC in terms of two dimensions, vertical and horizontal individualism and collectivism (INDCOL, Nordfjærn & Zavareh, 2016). TSC on these two dimensions is measured on a self-report scale.

According to this definition, there are four general types of culture:

- **Horizontal individualism:** The self is considered as unique, low focus on competition and social status.
- **Vertical individualism:** The self is considered as unique, low focus on competition and social status.
- **Horizontal collectivism:** Focus on the self in relation to others, low conformity to hierarchy and authorities.
- **Vertical collectivism:** Focus on the self in relation to others, strong focus on conformity to hierarchy and authorities.

The items of the INCOL-scale are, according to Nordfjærn and Zavareh (2016), and all rated on 5-point scales (which items belong to which scale is unspecified):

Items
My happiness depends very much on the happiness of those around me
Winning is everything
I usually sacrifice my self-interest for the benefit of my group
It annoys me when other people perform better than I do
It is important to maintain harmony within my group
It is important that I do my job better than others
I like sharing little things with my neighbours
The well-being of my co-workers is important to me
Competition is the law of nature
If a co-worker gets a prize, I would feel proud
I am a unique individual
When another person does better than I do, I get tense and aroused
I often "do my own thing"
It is important to me to respect the decisions of those around me
I trust myself rather than trusting others
Family members should be bunched up together whatever it requires
Parents and children should stay together as much as possible
I enjoy being unique and different from others in many ways
Even though I should sacrifice from my own interests, taking care of my family is my duty
My individual identity is so important to me
I am a unique individual different from others
I respect the wishes of my immediate surroundings
I enjoy being unique and different from others
Before taking a decision, it is important to consult with my close friends and take their suggestions
If a relative were in financial difficulty, I would help within my means
Without competition it is not possible to have a good society
One should live one's life independently of others
I would sacrifice an activity that I enjoy very much if my family did not approve of it
I feel good when I cooperate with others
I enjoy working in situations involving competition with others
I prefer to be direct and forthright when I talk with people
Children should be taught to place duty before pleasure
To me, pleasure is spending time with others
Success is the most important thing in life
When I succeed, it is usually because of my abilities
I hate to disagree with others in my group
In order to please my family I can do any act no matter if I hate it

TABLE 21 |

Traffic Climate Scale (TCS)

17 studies have used the TCS to measure safety culture at the **country level**. In all studies, TCS is applied individually, but it refers to the traffic climate in a whole country (may also refer to regions, cities, ...).

The Traffic Climate Scale (TCS) measures road users' perception of traffic safety of a country. It is based on theory of planned behaviour (TPB) and safety climate / safety culture theory in organisational safety climate research. The TCS measures three dimensions of traffic climate (Öztürk et al., 2022):

- **External affective demands:** Emotional engagement in traffic interactions (e.g. annoying, stressful, depends on luck)
- **Internal requirements:** Traffic related skills and abilities (e.g. requires skill, vigilance)
- **Functionality:** Characteristics of the traffic system (e.g. planned, safe, well-organised system).

The original version of the TCS consists of 44 items, but there are several versions of the TCS, for example 16- and 38-item versions, that have been developed and tested in different countries (for an overview, see Öztürk et al., 2022).

The items of the TCS contain statements or adjectives that are related to possible situations in traffic. Each item is rated on 6-point Likert scales from 1 (does not describe it at all) to 6 (describes it fully). The items of the TCS describe how the traffic system is perceived. None refer to norms, values, attitudes or expectations.

The items of the 38-item scale (Öztürk et al., 2022) are as follows (items in bold text are those included in the 16-item version of the TCS):

Factor	Items (Traffic Climate Scale, TCS)
External affective demands	Dangerous
	Exciting
	Makes one feel worthless
	Unpredictable
	Pressurizing (included in 16-item version)
	Depends on fate
	Risky
	Annoying (included in 16-item version)
	Aggressive (included in 16-item version)
	Stressful (included in 16-item version)
	Monotonous
	Depends on luck (included in 16-item version)
	Mobile
	Creates tension
	Chaotic (included in 16-item version)
	Makes irritated (included in 16-item version)
	Time consuming (included in 16-item version)
Functionality	Travel easily from place to place
	Planned (included in 16-item version)

Factor	Items (Traffic Climate Scale, TCS)
	Includes deterring rules
	Under enforcement
	Harmonious (included in 16-item version)
	Free flowing (included in 16-item version)
	Includes precautionary measures
	Requires mutual courtesy
	Forgives mistakes
	Egalitarian
	Safe (included in 16-item version)
	Functional (included in 16-item version)
Internal requirements	Demands cautiousness (included in 16-item version)
	Requires being quick
	Non-compliance is rewarding
	Directs one's behaviours
	Demands alertness (included in 16-item version)
	Requires experience
	Requires patience
	Requires vigilance (included in 16-item version)
	Requires skillfulness
Additional items in 44-item version (Üzümcüoğlu, 2020)	Dynamic
	Complicated
	Fast
	Requiring you obey rules
	Requiring knowledge of traffic rules
	Dense

TABLE 22 |

Nævestad modified-DBQ-studies – descriptive norms

The Driver Behavior Questionnaire (DBQ) was developed by Reason et al. (1990) and Parker et al. (1995). It measures self-reported aberrant driving behaviours, i.e. deviations from safe driving, and distinguishes between three main categories:

- **Violations** (deliberate rule-breaking, e.g. speeding)
- **Errors** (unintentional mistakes, e.g. misjudging gaps)
- **Lapses** (attention/memory failures, e.g. forgetting where you parked)

The original DBQ-items are rated on frequency scales (e.g. "never" → "nearly all the time").

Five studies have assessed Traffic Safety Culture with questionnaires that are based on the DBQ:

- Nævestad et al. (2020)
- Nævestad et al. (2019)

- Nævestad et al. (2022)
- Nævestad et al. (2019)
- Abubakari et al. (2025) (used scale from Nævestad et al., 2022)

In these studies TSC is regarded as a set of values, descriptive norms, attitudes and behaviour patterns. All five studies have measured TSC with surveys filled out by individuals, but TSC is mainly defined on country-level, and in one study (nr. 56) on a local level (all respondents are from the same city). The four country-level studies have also investigated differences between countries and how country is related to culture and outcomes. However, their primary focus is on the relationship between culture and outcomes and these studies are therefore treated as country-level (and not cross-country comparison) studies.

Some of these studies have additionally related culture to types of drivers (car or private drivers, professional drivers or bus drivers).

The answer format was modified to the general format in all studies : "For every ten trips, how often do you..."? Possible answers: "Never", "Once or twice", "Three or four times", "Five or six times", "Seven or eight times", "More than eight times but not always", "Always".

The items used in the questionnaires are:

	Item	Study ^a
Behavior - Speeding:		
	Disregard the speed limit on a residential road	(nr. 35, 36, 38)
	Disregard the speed limit on a motorway road	(nr. 35, 36, 38)
Behavior - Aggressive violations (modified from DBQ):		
	Disregard the speed limit on a residential road	(nr. 35, 36, 38)
	Disregard the speed limit on a motorway road	(nr. 35, 36, 38)
	Disregard the speed limit on a residential road	(nr. 35, 36, 38)
	Disregard the speed limit on a motorway road	(nr. 35, 36, 38)
	Disregard the speed limit on a residential road	(nr. 35, 36, 38)
Behavior – Other:		
	Drive without using a seat belt	(nr. 36)
	Drive when suspect you might be over the legal blood alcohol limit	(nr. 36)
Descriptive norms ("When driving in my country, I expect the following from other drivers..."):		
	That they sound their horn to indicate their annoyance to another road user	(nr. 35, 36, 37, 38)
	That they become angered by a certain type of driver and indicate their hostility by whatever means they can	(nr. 35, 36, 37, 38)
	That they overtake a slow driver on the inside	(nr. 35, 36, 37, 38)
	That they drive when they suspect they might be over the legal blood alcohol limit	(nr. 35, 36, 37, 38)
	That they drive without using a seatbelt	(nr. 35, 36, 37, 38)
	That they disregard the speed limit on a motorway road	(nr. 35, 36, 37, 38)
	That they disregard the speed limit on a residential road	(nr. 35, 36, 37, 38)
	That they respect and follow traffic rules	(nr. 36, 38)

	That they are polite to other road users	(nr. 36, 38)
--	---	--------------

^a 35: Nævestad et al. (2020); 36: Nævestad, Laiou et al. (2019a), 37: Nævestad et al., (2022); 38: Nævestad, Phillips et al. (2019b)

TABLE 23 |

A3.2 | Family level

Family Climate for Road Safety Scale (FCRSS)

The Family Climate for Road Safety Scale (FCRSS) has been used in 16 studies. Eight of these are from Israel where the FCRSS has been developed by Taubman Ben-Ari and Katz Ben-Ami (2013), and one of these eight studies has also included young drivers from Australia (Skvirsky et al., 2017). The other studies are from China (3 studies), USA (2 studies), and Spain (one study).

The FCRSS refers to road **safety climate within families**, but the climate is assessed with a self-reporting scale that is applied individually. Most studies have used the FCRSS among young drivers, and investigated relationships between the young drivers assessments of family climate and safety-relevant outcome variables (e.g. behaviour). However, in three studies the FCRSS was applied to young drivers and their parents, and these studies have additionally investigated relationships between the young drivers’ and their parents’ assessments of climate and outcome variables (Awad-Yassin & Taubman-Ben-Ari, 2024; Doncel et al., 2023; Taubman-Ben-Ari , 2016).

The FCRSS was developed by Taubman-Ben-Ali and Katz-Ben-Ami (2013). It assesses seven aspects of the parent–child relationship (definitions from Taubman Ben-Ari et al., 2014):

- **Modeling:** The model that parents provide to their children by their own modes of driving and attitude to traffic laws, including planning ahead so that they will not be pressed for time, obeying traffic regulations, driving safely even when they are in a hurry, tired, or feeling stressed, etc.
- **Feedback:** Parents’ positive feedback and encouraging comments to their offspring with regard to safe driving, and parents’ ability to praise them for safe and considerate driving.
- **Communication:** Open and direct communication between parents and adolescents with respect to driving behaviour and risk taking, indicating parents’ tendency to teach the young driver how to anticipate potential hazards on the road, to openly discuss anything related to driving, including risky driving, and to include the young driver in framing a family “contract” regarding their driving.
- **Monitoring:** Parental supervision and monitoring of their youngsters’ driving habits, including making sure they do not drive recklessly and having them inform the parents of where they are taking the car, who is going with them, and when they intend to be home.
- **Noncommitment (to safety):** Parents’ commitment to road safety, obeying traffic laws, demonstrating considerate driving, and investing time in safety education.
- **Messages:** Parents’ verbal safety messages, indicating that parents deliver clear messages to their young drivers, and that their children understand these messages.

Safety climate describes how “individuals apprehend, perceive, and interpret the situation”, and it is used to predict safety behaviour and crash involvement.

The FCRSS consists of 54 items, rated on a 5-point scale ranging from 1 (*not at all*) to 5 (*very much*).

Factor	Items (Family Climate for Road Safety Scale (FCRSS))
1: Modeling	(6) My parents set an example by obeying traffic laws
	(20) My parents drive safely even when they're in a hurry
	(50) My parents obey the traffic laws even when they're tired or feeling stressed
	(31) My parents talk about safe driving, but they don't drive so safely themselves [-]
	(47) My parents tell me to drive carefully even though they're not very careful drivers [-]
	(30) My parents serve as role models for safe driving
	(1) My parents plan their time well so they won't be pressed for time when they're driving
	(24) My parents aren't very committed to the issue of safe driving [-]
	(39) My parents take every traffic violation very seriously, even when it doesn't result in a crash
	(23) My parents don't like to admit it when they make a mistake on the road [-]
	(15) My parents only follow the rules for safe driving because they don't want to get caught [-]
2: Feedback	(49) I get positive feedback from my parents whenever they see me drive safely
	(26) My parents compliment me for driving safely
	(14) My parents praise me when I drive safely and carefully
	(35) My parents encourage me and applaud me when they see I make sure to drive safely
	(53) I feel that my parents are proud of me when I drive safely
3: Communication	(46) We talk at home about how to prevent or avoid dangerous situations on the road
	(4) In my family we talk openly about mistakes on the road or near accidents so I can learn from them
	(51) I tell my parents about dangerous situations I've been in on the road
	(8) In my family we talk openly about anything related to driving
	(2) My parents teach me how to anticipate potential problems on the road before they occur
	(33) My parents talk to me about possible hazards on the road
	(36) I can talk freely with my parents about different driving situations
	(34) I share in framing the family contract about my driving
	(38) My parents take an interest in how I drive
4: Monitoring	(21) Whenever I take the car, I have to call my parents and tell them if there's a change in where I'm going
	(18) I have to get my parents' permission every time I want to go out in the car
	(54) Whenever I take the car, I have to tell my parents when I'll be home
	(13) Whenever I take the car, I have to tell my parents where I'm going
	(7) Whenever I take the car, I have to call my parents and tell them if I'm going to be late
	(25) Whenever I take the car, I have to tell my parents who I'm taking with me wherever I go

Factor	Items (Family Climate for Road Safety Scale (FCRSS))
	(3) My parents make sure I don't fool around on the road
5: Noncommitment	(40) My parents will only pay attention to whether I'm driving safely if something like a car crash happens
	(10) In my family, it's considered a nuisance to have to obey all the traffic regulations
	(44) My parents ignore it when I drive dangerously
	(29) My parents don't spend time teaching me how to drive safely
	(42) My parents are willing to accept it if I get home late because I didn't want to speed [-]
	(41) The people in my family don't like it if someone complains that they're not driving safely
	(22) Sometimes my parents urge me to speed up when the light turns yellow
	(52) My parents make it clear that driving safely is more important than getting somewhere on time [-]
6: Messages	(16) My parents tell me when they think I'm driving dangerously
	(5) My parents tell me when I take unnecessary risks on the road
	(12) My parents really care that I drive safely
	(9) I know how my parents expect me to drive
	(28) My parents believe that driving safely is very important
	(11) My parents don't always say anything about my driving, even when I do something dangerous on the road [-]
	(48) My parents' expectations from me about driving safely are very clear to me
	(37) Sometimes my parents encourage me to ignore the traffic regulations [-]
7: Limits	(43) My parents made it clear to me that if I didn't obey the traffic regulations they would restrict my driving
	(19) My parents wouldn't let me take the car if I drove recklessly, even if it would make it easier for them if I drove (to go to the store, to pick someone up)
	(32) If my parents found out I wasn't driving safely, they would impose limits on my driving
	(27) There's an unwritten contract between me and my parents about my driving safely
	(45) My parents let me take the car more often when they feel I drive safely
	(17) My family has clear rules about driving carefully

TABLE 24 |

A3.3 | Peer level

Safe Driving Climate among Friends (SDCaF)

The Safe Driving Climate among Friends (SDCaF) has been used to measure TSC within **peer groups** in four studies (Li et al., 2025; Ma et al., 2024; Padilla et al., 2023; Guggenheim & Taubman-Ben-Ari, 2018). Two of the studies are from China, one from Israel, and one from Spain.

The SDCaF was developed by Guggenheim & Taubman Ben-Ari (2018). It consists of 19 items that belong to four factors:

- Friends' **pressure** while driving: The driver's perception that friends tend to push him to drive recklessly or break the law
- Social **costs** of driving with friends: The driver's feelings of being uncomfortable, exhausted, or even scared when driving with friends.
- **Communication** between friends about driving: Open discourse among friends on driving issues, including their own driving.
- Shared **commitment** to safe driving with friends: Responsibility toward road safety, is shared by the drivers friends in the car.

Factor	Items (Safe Driving Climate among Friends, SDCaF)
Pressure	(16) I have sometimes done dangerous or stupid things, such as running a red light or ignoring a stop sign, because my friends urged me to do so.
	(15) My friends can make me do almost anything when I'm driving.
	(17) I do stupid things while driving if my friends encourage me to do them.
	(13) If my friends ask me to do something when I'm driving, it's hard for me to refuse.
	(19) My friends often pressure me to drive faster, although I wouldn't do it on my own.
Costs	(10) When my friends are in the car, it makes me feel uncomfortable.
	(11) I feel scared when I'm driving and my friends are in the car.
	(12) I feel it's exhausting to drive when my friends are in the car.
	(9) I can't stand driving with my friends in the car.
	(8) When my friends are in the car, I feel that some of them look down on me.
Communication	(7) I share with my friends the dangerous situations I've been in on the road.
	(6) I can talk freely with my friends about different situations related to driving.
	(1) My friends and I talk openly about mistakes we've made when driving or near accidents we've had so we can learn from them.
	(14) My friends and I talk freely about how each of us drives.
	(18) When my friends are in the car, they tell me if they see hazards on the road before I do.
Commitment	(3) My friends set an example by obeying the traffic laws.
	(2) My friends drive safely even when they're in a hurry.
	(5) My friends and I all agree that we should drive safely.
	(4) I feel that my friends are proud of me when I drive carefully.

TABLE 25 |