



**Conférence Européenne
des Directeurs des Routes**
**Conference of European
Directors of Roads**

**Stopped Vehicle Hazards – Avoidance, Detection and
Response (SHADAR)**

Results of the behavioural simulation study

Deliverable D4.1 Version 1.0
September 2022



Stopped Vehicle Hazards – Avoidance, Detection and Response (SHADAR)

D4.1 Results of the behavioural simulation study

Due date of deliverable (original): December 2021

Actual submission date (after work extension): September 2022

Start date of project: 01/10/2020

End date of project: 17/11/2022

This document is issued for the party which commissioned it and for specific purposes connected with the above-captioned project only. It should not be relied upon by any other party or used for any other purpose.

Mott MacDonald accepts no responsibility for the consequences of this document being relied upon by any other party, or being used for any other purpose, or containing any error or omission which is due to an error or omission in data supplied to us by other parties.

This document may contain confidential information and proprietary intellectual property. It should not be shown to other parties without consent from Mott MacDonald and from the party which commissioned it.

Author(s) of this deliverable:

Clemens Kaufmann (Factum)

Karin Ausserer (Factum)

Cedric Kwok (Mott MacDonald)

Sean Williamson (Mott MacDonald)

Julie James (Mott MacDonald)

Giovanni Huisken (Map Traffic Management)

Ian Cornwell (Mott MacDonald)

Version: 1.0

Executive summary

The project “SHADAR” (Stopped vehicle Hazards – Avoidance, Detection, And Response) addresses the objective of “Preventing collisions with stopped vehicles in a live traffic lane”. Stopped vehicles on the highway network present a significant hazard with impact on safety and the economy. The SHADAR project aims to improve detection, reporting and management of these events.

This report describes the results of research on drivers and their behaviour when encountering a stopped vehicle on a highway. This research was divided into three parts – interviews with drivers, and two sets of virtual reality (VR) studies: the first one in which the test persons encountered an incident with a stopped vehicle under various conditions without further information, and a second set in which different channels provided information about the incident before it was encountered. Within this research mainly qualitative methods were used to gather a wide range of different behaviour and statements regarding how such incidents are reported and how drivers want to be informed.

Interviews with car drivers

Interviews in three different countries (Austria, the Netherlands, United Kingdom) were undertaken with the aim to gather more information of how drivers inform themselves about the traffic information on highways, which information is considered as important and what their behaviour would be when facing incidents or problems. The sample was balanced in gender and age and included both frequent and occasional motorway drivers.

The results show that different kind of information channels, such as SatNav, navigation apps, traffic news, and gantries are used. The most desired information is: what happened, where the incident is located and how does one have to behave. In the event of an incident on motorways, people claim they drive more carefully and more attentively, keep a greater safety distance, do not overtake, and reduce speed if a speed limit is displayed on gantries. In general, stopped vehicles on a motorway were perceived to be rare events. The interviewees were very uncertain how to behave properly in such a situation.

1st VR-simulation study

Based on the results of the interviews and earlier research in the project, four different scenarios were developed. A stopped vehicle on a motorway was placed at different positions (1st/2nd lane, near an exit) under different weather conditions and traffic situations. The test person filled in pre-and post-questionnaires and were asked to comment on anything while driving through the four scenarios. Additionally, questions regarding the situation with the stopped vehicle and their possible behaviour were answered. The simulation study was carried out in Austria, the Netherlands and the United Kingdom and included 81 test persons balanced in gender and age.

A wide range of reactions and behaviours in a situation where one is unexpectedly confronted with a stopped vehicle on a motorway was found. Most of the test persons would try to pass by the stopped vehicle in a safe manner, but also some dangerous behaviour such as driving at walking speed and trying to get in contact with the person in the stopped car when passing by or stopping in front or next to the stopped vehicle was reported. There was no common knowledge about how to behave correctly if you encounter a stopped vehicle. There was no unanimous opinion on whether to call for help in the event of a stopped vehicle, or who to call in such a case.

2nd VR-simulation study

Based on the results of the interviews, the first simulation study and other research in the

SHADAR project, four new scenarios were developed. They again differed regarding the position of the stopped vehicle, weather, and traffic conditions. But the main difference was that the test persons received information about the incident beforehand. Four different information channels were used: Impact protection vehicle (IPV), gantries, traffic news via radio and information on a display in the middle of the dashboard. The information content differed and included general information about the incident, new speed limits, closed lanes and general recommendations, how to behave. The same procedure (pre- & post-questionnaires, commenting while driving, specific questions about the situation with the stopped vehicle) was used.

The results show that the information via the gantries was seen as the best information source followed by the radio news. Apart from advantages of each information source also disadvantages were reported (e.g. visual information has the potential to distract, radio news can easily be missed, information has to be received early enough). Nevertheless, within all four scenarios the test persons would mainly follow the information/recommendations given and alter their behaviour according to it. Stopping to help and reporting the incident was hardly mentioned during the second simulation as it was assumed that the incident has already been reported by someone.

Recommendations

Based on the results of the three parts of the driver behaviour research the following recommendations correspond to the opinions of the participants:

- Short and precise information should be given so that car drivers know where the incident is and how they should behave
- Information should be repeated as visual and audio information could be easily missed due to distraction
- Information should be multilingual and ideally not only in the language of the country. Symbols should be internationally valid and clear.
- Information should be given multisensory to appeal to as many senses as possible.
- Information should be given via as many channels as possible to get the attention of a wide range of road users.
- Topic should be included in the driver's education as drivers are unsure how to behave when coming to such a situation.
- Traffic safety campaign can make drivers aware of the danger of such a situation.
- Install/advertise a hotline so that drivers have more options to report such an incident

Table of contents

Contents

1	Introduction	8
2	Methods	9
3	Individual Interviews	12
3.1	Procedure.....	12
3.2	Sample.....	12
3.3	Results.....	13
3.3.1	Traffic information channels	13
3.3.2	Experienced incidents on motorways and reaction	13
3.3.3	Road users' behaviour in the event of a stopped vehicle.....	14
3.3.4	Useful information about stopped vehicles	14
3.3.5	Experience of eCall function.....	15
3.3.6	Suggestions for improvements	15
3.3.7	Summary.....	15
4	VR-Simulation	16
4.1	Simulation study first run	16
4.1.1	Procedure	16
4.1.2	Sample.....	18
4.1.3	Results.....	19
4.2	Simulation study second run	25
4.2.1	Procedure	25
4.2.2	Sample.....	27
4.2.3	Results.....	28
5	Conclusions.....	46
6	Literature.....	48
	Appendix A - Guideline single interviews.....	49
	Appendix B – Informed Consent.....	50
	Appendix C – Pre Questionnaire	51
	Appendix D – Final Questionnaire	52
	Appendix E – General VR-study guideline first run	53
	Appendix F – Interview Guide VR-study first run	54
	Appendix G –VR-study guide second run.....	55
	Appendix H – Interview guide VR-study second run	57
	Appendix I – Interview questions VR-study second run	58

List of Tables

Table 2: Advantages and disadvantages of various information channels	13
Table 3: Overview of the simulation scenarios.....	17
Table 4: Overview of the simulation scenarios.....	26
Table 5: Pros of the four information sources and suggestions for improvements	41
Table 6: Average scores for the assessment of the usage of the VR-glasses	42

List of Figures

<i>Figure 1: Country Gender and age distribution (n=81).....</i>	<i>18</i>
Figure 2: Driving Experience and motorway experience in % (n=81).....	18
Figure 3: Information Sources in % (n= 103)	19
Figure 44: Wished information Sources in % (n= 103).....	20
Figure 5: Reaction on the information, that there are problems ahead in % (n=103).....	20
Figure 6: Information needed in case of an incident ahead in % (n=103).....	21
Figure 7: Country Gender and age distribution (n=80).....	27
Figure 8: Driving Experience and motorway experience in % (n=80).....	28
Figure 9: IPV: Content recognised (n=80)	29
Figure 10: IPV: Behaviour after receiving information (n=80).....	30
Figure 11: IPV: Comment on the information (n=79).....	30
Figure 12: Gantry: Content recognised (n=80).....	32
Figure 13: Gantry: Behaviour after receiving information (n=80).....	32
Figure 14: Gantry: Comment on the information (n=80).....	33
Figure 15: Traffic News: Content recognised (n=80).....	35
Figure 16: Traffic News: Behaviour after receiving information (n=80).....	35
Figure 17: Traffic News: Comment on the information (n=80).....	36
Figure 18: Dashboard: Content recognised (n=80)	37
Figure 19: Dashboard: Behaviour after receiving information (n=80)	38
Figure 20: Dashboard: Comment on the information	38
Figure 21: Favourite information source (n=80)	39
Figure 22: Considering stopping to help after passing by the stopped vehicle	40

Figure 23: I found driving with VR glasses to be exhausting in % (n= 103).....	42
Figure 24: I experienced the trip as realistic in % (n= 103)	43
Figure 25:I was able to assess the distances well during the VR-ride in % (n= 103).....	43
Figure 26: I was able to assess the speeds well during the VR-ride in %.....	44
Figure 27:Assessment speeds of other car drivers well during the VR-ride in % (n= 103) ...	44
Figure 28:The situations with the stopped vehicle were realistic in % (n= 103).....	45

1 Introduction

The project “SHADAR” (Stopped vehicle Hazards – Avoidance, Detection, And Response) addresses the objective of “Preventing collisions with stopped vehicles in a live traffic lane”. Stopped vehicles on the highway network present a significant hazard with impact on safety and the economy. The SHADAR project aims to help reduce the risk of collisions with stopped vehicles on highway networks by improving detection, reporting and management of these events. The research has three inter-related strands – on detection and reporting technology, road user behaviour, and response from national road managers.

The present document reports on the road user behaviour research of SHADAR. To increase understanding of how road users behave around stopped vehicles and the resulting traffic management, we conducted studies using virtual reality simulations in multiple countries.

The aim of this research was to:

- analyse road users’ perspectives on the topic of stopped vehicles
- elaborate solutions for how to avoid collisions due to a stopped vehicle, how drivers want to be informed about incidents, and how to report them
- evaluate the effect on the driving behaviour produced by different kinds of communication about a stopped vehicle hazard.

2 Methods

The road user behaviour was investigated on various levels with different methods. In a first step, focus group interviews in Austria were planned to get a first impression of drivers' views on this topic as a preparation for the subsequent simulation study. Due to the Covid-19 pandemic and the restriction of gathering larger groups of people, the method was changed to individual interviews.

Individual interviews resemble focus groups and were considered a suitable replacement method. They differ only in some aspects. The interviewer talks to only one person at a time, but therefore has more time to discuss various topics in detail. The interviewer does not have to worry about the group dynamics, can give the interviewee his/her full attention and adjust the interviewing style to the interviewee's needs. Individual interviews allow us to probe individual's attitudes and experiences, and to get a deeper understanding where needed. They can take place face-to-face, by phone, or video conference. All three options were used in this work package. They helped to refine questions for the questionnaires used in the simulation study. The change from focus group interviews to individual interviews opened the opportunity to interview people from different countries - namely Austria, the Netherlands, and the United Kingdom - instead of conducting all focus groups in Austria.

The **Virtual Reality (VR) simulation study** aimed at finding out how the test subjects react to different situations related to stopped vehicles. The VR simulation turned out to be a useful way to present the situation with the stopped vehicles as these situations could not be tested in real world. The advantage compared to just showing a flat video is that the test persons had the possibility to watch around creating a more realistic test situation¹. Past research has shown that among different training systems (written manual, video-based, VR simulation), participants preferred the light VR system in terms of usefulness, ease of use and realism (Sportillo et al. 2018). With regard to performance Iryo-Asano et al. (2018) stated that "*the perception of distance and subjective danger from personal mobility vehicles are not different in VR and real spaces*". A possible disadvantage of "cyber sickness" (test persons getting uncomfortable using the VR-glasses) was not experienced during either simulation test. One reason for that might be that each scenario lasted only up to 5 minutes.

The participants wore VR glasses and experienced the ride from the driver's perspective. They were not able to control the movement of the vehicle nor the speed. The advantage of this method is that all participants encounter the stopped vehicle in the same way. Otherwise, if the participants could have influenced the driving themselves, there would be a risk that some may pass the stationary vehicle, for example in the outermost lane, without noticing it.

Demographic data of the participants, general questions on information gathering, and impressions on the quality of the VR-ride were collected by means of standardised questionnaires.

¹ Compare Chapter 4.2.3.3

To get impressions of the car ride, the method “thinking aloud” was applied. The thinking-aloud method is a research method used mainly in usability testing. The test person is asked to speak his or her thoughts aloud. In this way, the interviewer can better understand what the participant is currently dealing with, what he or she is thinking about, whether questions arise or what emotions he or she is currently feeling. What is said is recorded and taken down and then evaluated (Somerén et al. 1994).

The VR was developed using the Unreal Engine, with Blueprints as a visual scripting language and C++ where needed for special elements. A standalone executable was packaged from the Unreal Engine, so that the VR could be run on any suitable Windows computer.

Limitations

The VR simulation study is a qualitative survey. It provides an insight into the diverse behaviour of road users when confronted with a stopped vehicle on the motorway. No representative frequencies or percentages can be derived from the answers. This is not essential in the present empirical study. Rather, the aim was to understand what happens in such a situation, what are possible reactions, and how can road users be better prepared for stopped vehicle so that they can react adequately.

Interviewees experience the simulation from the driver’s perspective in VR, but they have no control of the actual movement of the vehicle. This is not only a limitation but a necessary feature, so that they have a consistent experience of the stopped vehicle.

VISSIM microsimulation software

Traffic behaviour is simulated using a microsimulation VISSIM traffic model. The models deployed are based on extensive research work carried out by R. Wiedemann in 1974 and 1991. The traffic flow model is a stochastic, time step based, microscopic model that treats driver-vehicle units as basic entities. As the model accounts for psychological aspects as well as for physiological restrictions of drivers’ perception, it is called psycho-physical car-following model. It contains a psycho-physical car following model for longitudinal vehicle movement and a rule-based algorithm for lateral vehicle movement.

A microsimulation model has been used to simulate driver behaviour in order to replicate the variable nature of traffic in reality. The VISSIM model uses a random seed variable for each model run with each seed resulting in changes to vehicle entry times with varying behaviour within the parameters of the driver behaviour model.

The traffic parameters used in the VISSIM model were as follows:

- 2 lanes – 700 vehicles per hour in each direction
- 3 lanes – 1400 vehicles per hour in each direction
- 4 lanes – 1400 vehicles per hour in each direction
- Traffic composition: 75% cars, 10% LGVs, 10% HGVs, 5% buses

The model has been run a number of times using different seed variables until a seed which meets the requirements of the study is identified (i.e. test vehicle approaching in same lane as stopped vehicle and must change lanes to avoid stopped vehicle). With the fixed seeds

identified, the location of all the vehicles in the model network were extracted from the model for use in the VR simulation.

3 Individual Interviews

This chapter summarizes the results of the qualitative individual interviews that served as preparation for the VR-study.

3.1 Procedure

The interviews were conducted in April 2021. They took place via phone and video conference and were carried out using a guideline. The guideline was developed based on literature and in cooperation with the work package partners.

The main topics of the interviews were:

- Kind of traffic information channels used on motorways
- Experienced incidents on motorways and reaction
- Behaviour in the event of stopped vehicles
- Useful information about stopped vehicles
- Experiences with eCall function and mobile apps
- Suggestions for improvements regarding traffic management on motorways

An interview lasted between 20 and 30 minutes. They were recorded, transcribed, and evaluated using the Froschauer and Lueger (2003) thematic analysis.

3.2 Sample

The sample was formed according to nationality (interviewees from each involved WP-partner Austria, United Kingdom, and the Netherlands), gender (at least two women from each country), age (at least one interviewee from the following age groups: 18-35, 36-50, over 50 in each country) and motorway experience (the interviewees should drive at least once a month on motorways).

A total of 17 interviews were conducted. 6 of the interviewees were female, 11 were male. Six people were in the 18-35 age group, 4 were between 36 and 50 years and 7 were over 50 years. Eight participants lived in Austria, five in the UK and four in the Netherlands.

The interviewees had different motorway experiences. Two were professional HGV-drivers and were on the motorway every day. Other interviewees used to drive on motorways every day on their way to work. Due to COVID-19 pandemic, the number of motorway trips was reduced up to twice a week. However, all interviewees stated that they drive on a motorway at least once a week.

3.3 Results

The results are presented according to the main topics of the interviews.

3.3.1 Traffic information channels

The interviewees were asked what kind of traffic information channels they use on motorway trips to inform themselves about the traffic situation.

On regular trips hardly anyone informs themselves about the traffic situation before the journey. During the ride all different kind of information channels are used: Traffic news, navigation apps, information on gantries, google maps. The HGV drivers were also informed by the control centre about problems on their route. Some stated that even during the ride they hardly turn on the radio or use any other information channel.

The advantages and disadvantages of the different channels mentioned by the interviewees are listed in the following table.

Table 1: Advantages and disadvantages of various information channels

Information channel	Pros	Cons
Traffic news	You get good overview of the motorway situation	Only every 30 minutes – information often comes too late
Navigation Apps	- Options for alternative routes - Information refers to route taken - Information is given on time - Information is transmitted in your own language	Distraction of driver
Gantry	- All drivers get the same information - All drivers must reduce speed	- Information is not always reliable or up to date - Depending on motorway, gantries are rare infrastructure - Information is given only in the national language

3.3.2 Experienced incidents on motorways and reaction

The interviewees were confronted with all different kind of incidents - traffic jams, broken cars standing on the hard shoulder, obstacles, such as tyres lying on the lane, road works or accidents. These incidents were observed from every day to rarely.

The reaction depends on the incident and on the consequences of the incident. Some change routes or take the next exit others prefer to stay on the motorway than to take a diversion. *“I do not mind if the car trip takes longer, I always have something to do in the car.”* (Interviewee No. 3)

Two interviewees reported on incidents they had directly experienced. Others had driven past an incident after it happened.

In one case, two cars in front of the interviewee, a car lost some of its load. The car behind collided with some of it. He, however, was able to change lane on time and drove on as no one was hurt.

Another interviewee encountered an incident where he was approaching a junction. On the inside lane was a stopped vehicle with hazards lights on. He managed just in time to get into the second lane. He had nowhere to go because there was just the inside lane and no hard shoulder where the vehicle could have pulled off.

"There are so many things in your head, because you tend to work out what vehicles are behind you, and what are they doing, you are assessing, how to get into the next lane out, there were big HGV vehicles on my side, that was making it even more difficult, it was a second to weigh up the options what I must do. I was not in the situation, what I was expecting." (interviewee No. 7)

In general people drive more carefully and more attentively, keep a greater safety distance, stay in one lane, and try to drive at a constant speed. If there is no traffic jam or no speed limit displayed on the gantries, the speed will not be reduced.

3.3.3 Road users' behaviour in the event of a stopped vehicle

The interviewees were asked how they would behave if they were driving on a motorway and a car stops in front of them on a live traffic lane. The supposed reactions were quite different. Some were especially concerned about the cars coming from behind. They would brake and turn the hazards lights on. Others would look in the rear-view mirrors and try to change lane. In case of a medical emergency, the interviewees would stop and call the police. Otherwise, most of the interviewees would drive on, assuming that the driver himself will inform the necessary service (e.g. police, motorist club...). Some, especially people from the Netherlands, would stop, even if no medical help is necessary. In case of rain or during night-time, however, they rather would call the police instead of stopping themselves to look if they could help the driver (also mostly that they would be suspicious in the night, fearing of a possible crime). Most of the interviewees knew the number of the police/emergency service by heart, but could not, for example, memorize the telephone number of the radio traffic news. They also considered it too dangerous to talk on the phone while driving on the motorway. One interview participant stated that he had notified the traffic news after an incident. All the others had never reported an incident on the motorway to anyone, as they had also not been the first to arrive at the "incident scene".

In general, the interviewees were rather uncertain about what the right behaviour would be in such a situation.

3.3.4 Useful information about stopped vehicles

The interviewees stated the following information would be useful to help them react in time if a car stops on a live traffic lane on a motorway:

- Time of the incident
- Name of the motorway on which the incident had happened
- Approximate location of the broken car

- On which lane the stopped vehicle is standing
- Alternative routes
- Recommended speed limit
- Any important aspects to consider when approaching the car – how to behave

The preferred channels for passing on information were different from traffic news, navigation apps, over gantries, dashboard screens to in-vehicle technology.

3.3.5 Experience of eCall function

We wanted to know from the interviewees if their car was equipped with the eCall function. Two interviewees answered this question in the affirmative, two others did not know, and the others negative. None of the interviewees, however, could tell how the eCall function works (when is someone informed, who is informed etc.).

3.3.6 Suggestions for improvements

The interviewees had a few suggestions on how to improve the management of disruptions on motorways.

- Information on gantries should be comprehensible – speed limits without recognisable causes lead to the limit not being adhered to the next time.
- Information should be on time
- More cars equipped with in-vehicle technologies will reduce the number of incidents
- Speed limits harmonise traffic
- More control with respect to lane change – some car drivers tend to constantly change lane, traffic flow is disrupted
- Every motorway should have a hard shoulder

3.3.7 Summary

The following aspects can be summarized regarding the interviews:

- Different kind of channels are used to inform oneself of the traffic situation on motorways like navigation apps, traffic news, gantries, etc.
- In the event of an incident on motorways people drive more carefully and more attentively, keep a greater safety distance, do not overtake, and reduce speed, if a speed limit is displayed on gantries.
- Stopped vehicles are perceived to be rare events. The interviewees are very uncertain how to behave properly in such a situation.
- Incidents without apparent personal injury seem to be hardly reported to road administrations, traffic news editors etc.
- Information about a stopped vehicle on a motorway should contain: what happened, where and how do I have to behave.

4 VR-Simulation

4.1 Simulation study first run

4.1.1 Procedure

The first run of the VR-simulation study took place in September 2021 in three countries: Austria, the United Kingdom, and the Netherlands. A total of 81 people took part in the study: 30 in Austria, 31 in the UK and 20 in the Netherlands. The participants were balanced in age and gender. They had to sign an informed consent for the use of the data collected including a disclaimer of liability. The test persons received €25 in the form of vouchers for participation, for which a confirmation of receipt had to be signed. The VR simulations were conducted in compliance with the prevailing COVID-19 regulations.

The study was divided into three parts:

- **Introduction and pre-questionnaire**, in which primarily socio-demographic data were asked for, as well as questions about driving on motorways (mileage, preparation etc.)
- **Survey during the virtual motorway trip**, to gather information about the test person's behaviour in relation to the research goal
- **Final questionnaire** that focuses on wishes and suggestions for improvement, as well as questions about the use of VR glasses and the general study design.

The pre- and final questionnaires were structured or partially structured questionnaires with closed and open questions. The during-survey was purely qualitative with open questions. Each test person needed one hour for the whole procedure.

4.1.1.1 The VR-Scenarios

The **virtual motorway trip** consisted of four VR-simulated rides. Due to differences in the countries' traffic regulations eight independent simulations were available: four simulations for driving on the right for Austria and the Netherlands, and four simulations for driving on the left for the tests in the United Kingdom. The scenarios differed with respect to the number of lanes, weather conditions, traffic volume, whether the stopped vehicle had the hazard lights on, and whether a driver was standing next to the stopped vehicle. Apart from these conditions, the scenarios were set up in the same way. The VR car drove along the motorway, overtook vehicles, and was suddenly confronted with a stopped vehicle to which it reacted.



The following table gives an overview of the eight different scenarios.

Table 2: Overview of the simulation scenarios

		Weather condition	Traffic volume	Stopped vehicle hazard lights on	Driver standing next to stopped vehicle	Simulation Reference
Left Hand Drive: Rural dual carriageway with 4 running lanes in each direction	Stopped Vehicle Event Scenario 1: Vehicle stopped at Lane 1 near exit	Good	Light	Yes	Yes	L1A
		Light rain	Medium	Yes	No	L1B
	Stopped Vehicle Event Scenario 2: Vehicle stopped at Lane 2	Light rain	Light	Yes	Yes	L2A
		Good	Medium	No	No	L2B
Right Hand Drive: Rural dual carriageway with 3 running lanes + hard shoulder in each direction	Stopped Vehicle Event Scenario 1: Vehicle stopped at Lane 1 near exit	Good	Light	Yes	Yes	R1A
		Light rain	Medium	Yes	No	R1B
	Stopped Vehicle Event Scenario 2: Vehicle stopped at Lane 2	Light rain	Light	Yes	Yes	R2A
		Good	Medium	No	No	R2B

To avoid study artefacts due to the order of the scenarios, the order of scenarios was varied for different test persons.

4.1.1.2 Overview of the VR-simulation ride procedure

In the following the test procedure is roughly summarized:

- **Welcome** of the test person
Explanations of the aim of the study and procedure, signing of the informed consent and filling in the pre-questionnaire.
- **VR-Simulation ride**
Before the actual study VR rides started, every test person had time to get used to the VR-glasses by a short accommodation ride. After the accommodation the test persons experienced four VR simulations. The head position of the VR-simulation corresponded to that of the driver of the car. They were told that they would have the freedom to look anywhere. However, they were not able to control the movement of the vehicle, nor the speed. The test persons had no information about the driven speed. We encouraged the test persons to feel and respond as if they were doing the driving.
During the actual VR-simulation scenarios the test persons were asked to comment out loud according to the think aloud method on driven speed (e.g. if one would drive faster or slower), lane choice (e.g. if the test person would change lane less or more often) and overall situation on the motorway (e.g. is it a stressful ride or a relaxed ride).
The simulation stopped in front of the stopped vehicle. The test person had to describe the situation, tell if he/she had ever been in such a situation, how he/she would act etc.
The simulation ride continued and stopped shortly after the VR-car had driven past the stopped vehicle. Again, questions were asked like how the situation was solved and if the test person had any other comments.

It was the same procedure for all four VR-rides. The comments during the rides were tape recorded and transcribed. After the last ride the final questionnaire was filled in.

4.1.2 Sample

The VR-Study was carried out in three countries: Austria, United Kingdom, and the Netherlands. It total 81 test person took part in the VR-study (31 United Kingdom, 30 Austria, 20 the Netherlands). 35 test persons were female and 46 male. In age, the participants were distributed as follows: 29 between 18-35, 27 between 36-50 and 25 over 50.

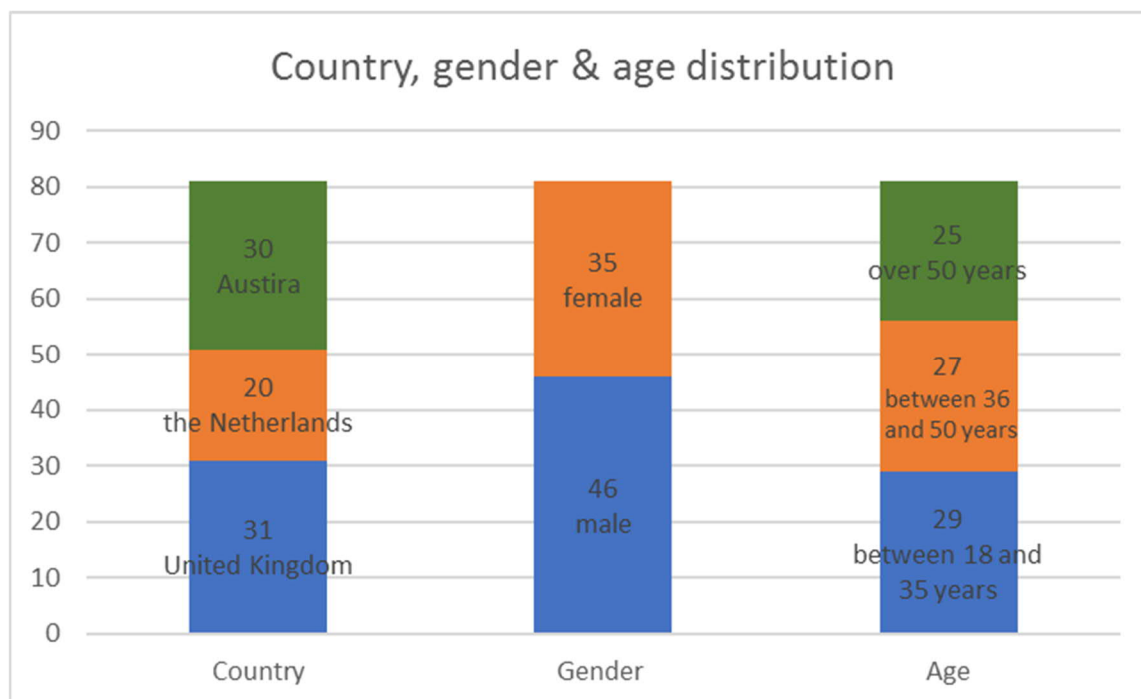


Figure 1: Country Gender and age distribution (n=81)

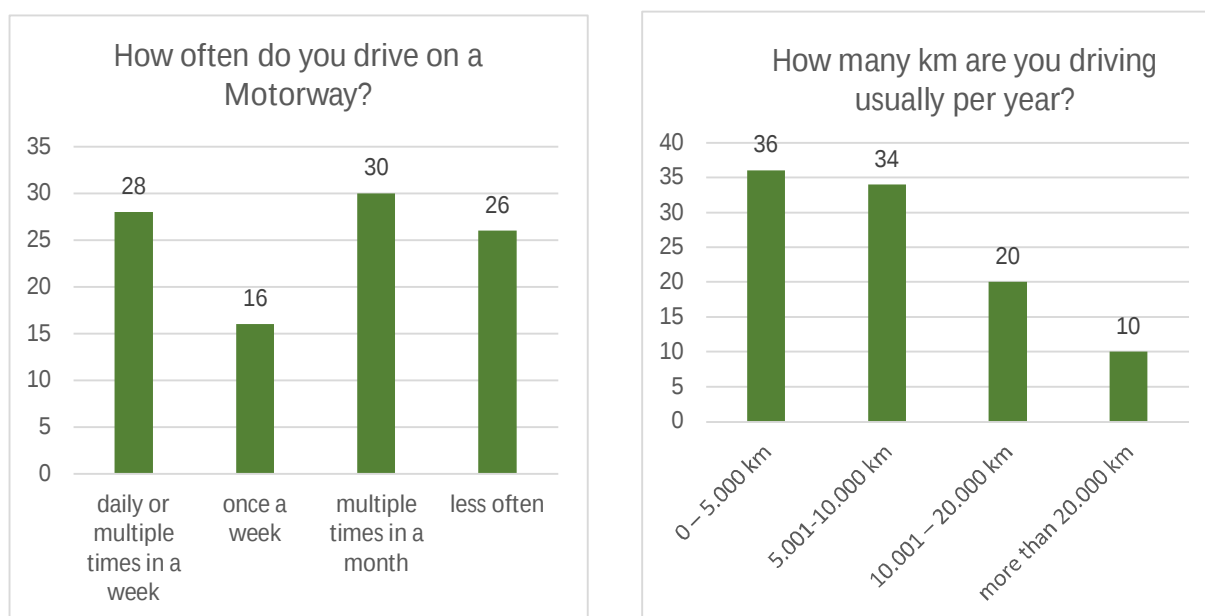


Figure 2: Driving Experience and motorway experience in % (n=81)

The sample consisted of both people who regularly travelled on the motorway and those who only used the motorway from time to time. Most participants travelled less than 10,000km a year.

Most of the participants did not have an e-call system in their car (59%) or did not know (26%), while a small number (15%) stated that their car was equipped with an e-call system.

4.1.3 Results

4.1.3.1 Pre-and Post- questionnaire

In the questionnaire, the test persons filled in how and whether they inform themselves about the traffic situation before or during a car journey, how they want to be informed about an incident and how they react when confronted with an unexpected incident on the motorway.

Information Sources

Before a journey, the main source of information about the traffic situation is the smartphone (41%) followed by the PC/Internet at home (33%).

While driving, participants are mainly aware of the information provided by gantries (63%). Radio traffic information is listened to by 51%, smartphones use 46% and navigation systems 36% for obtaining information. 4% of the participants do not inform themselves about the traffic situation at all.

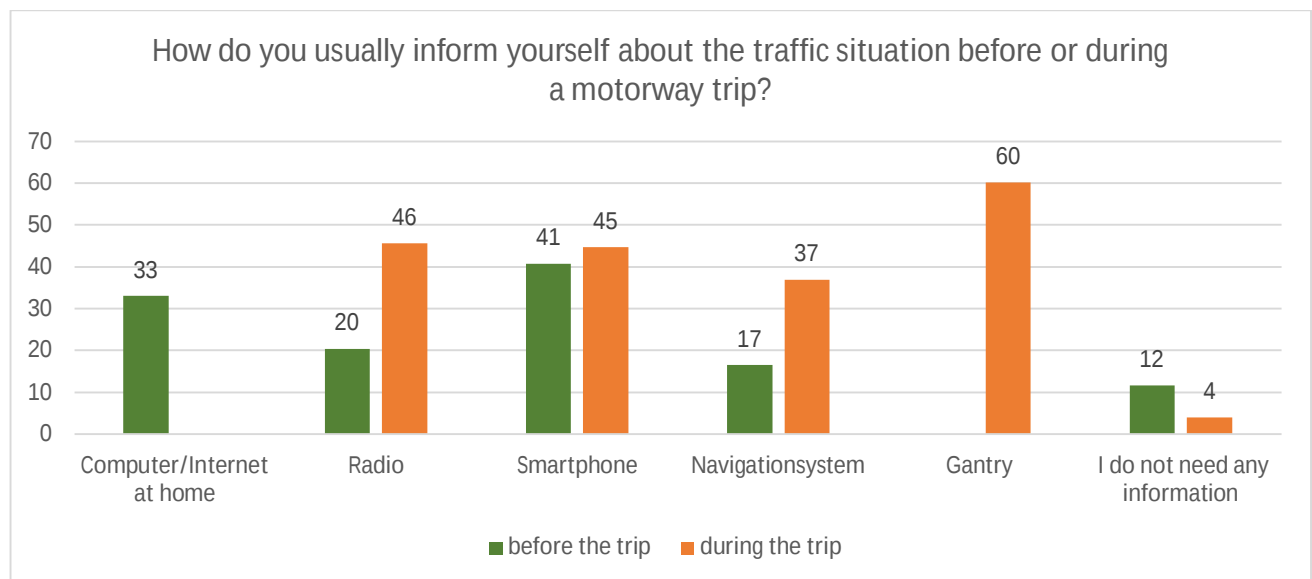


Figure 3: Information Sources in % (n= 103)

Most of the participants use more than one information source during a journey (68%). 26% consult one source of information.

A similar conclusion is reached when one asks how they want to be informed in the event of an incident. Gantries (77%) are the preferred information source during a journey, followed by navigation systems (63%), radio (54%) and smartphone (43%).

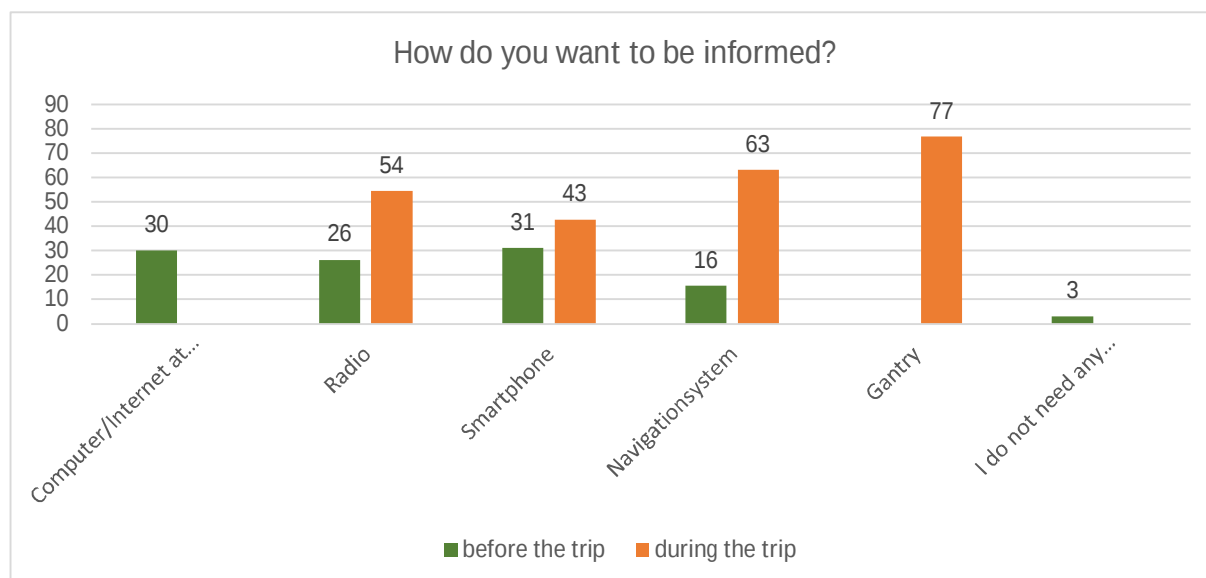


Figure 44: Desired information sources in % (n= 103)

Reaction on Incidents and information needed

If people are informed about an incident ahead during a car ride, most participants drive more carefully (69%) and reduce their speed (54%). Over half (53%) increase their distance between other cars. A little more than a quarter of the participants (26%) leave the motorway at the next exit, whilst 14% continue to drive without changing their driving behaviour.

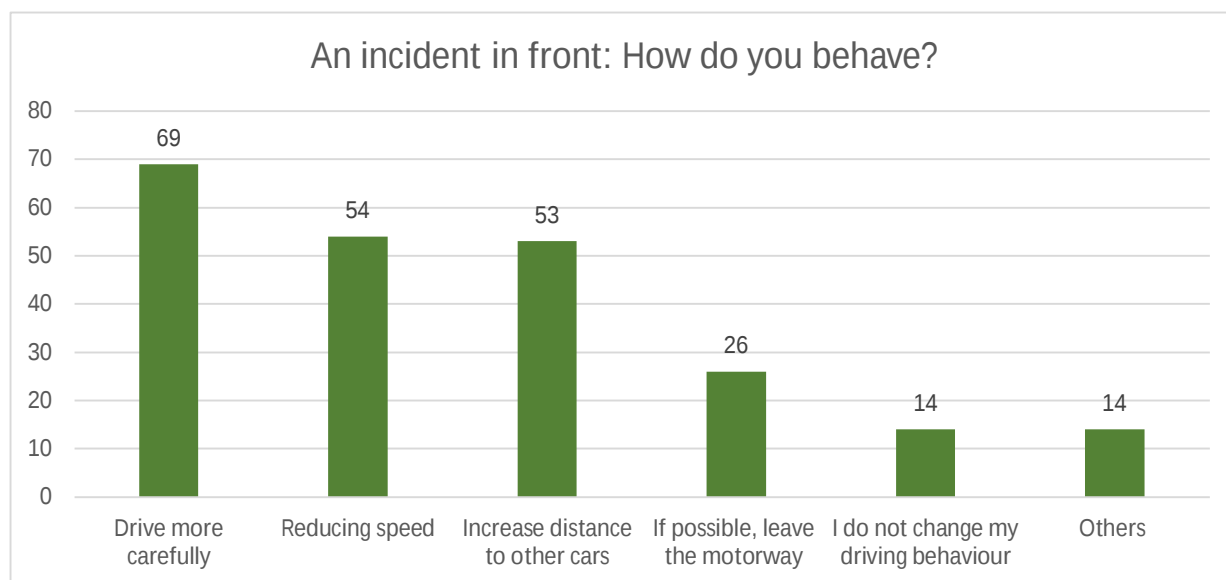


Figure 5: Reaction on the information, that there are problems ahead in % (n=103)

The survey found that participants appreciate detailed information on incidents ahead. Three quarters (75%) want to be informed about the exact position of the incident, and a similar amount want to know which lane is blocked. Over half of the participants would like to receive clear instructions on how to act in the situation and one third would like to have information about the name and number of the highway (35%).

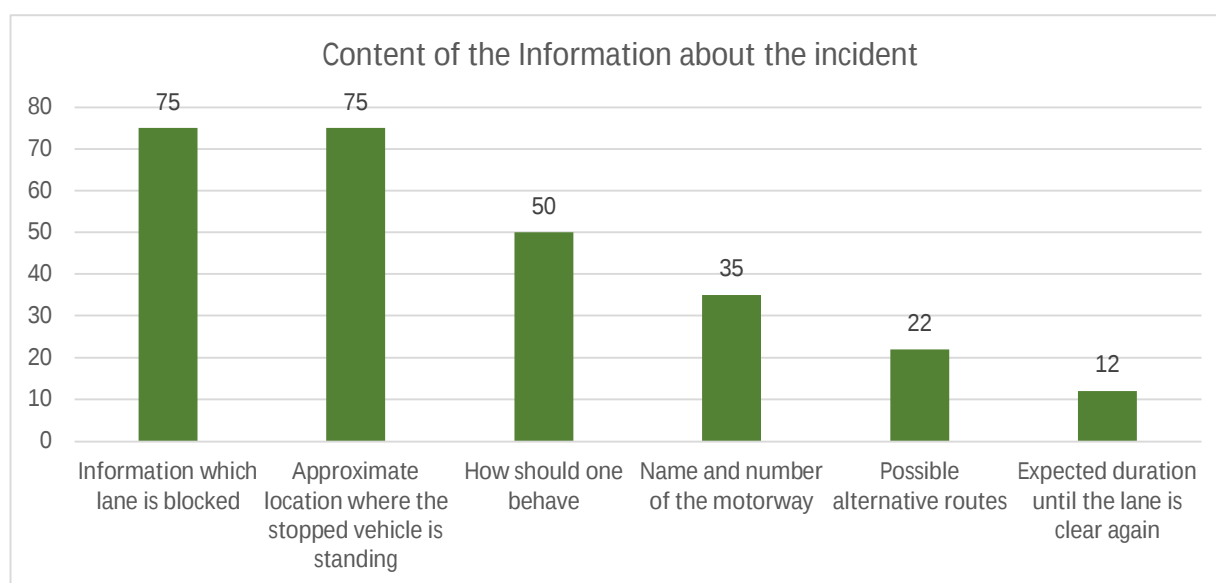


Figure 6: Information needed in case of an incident ahead in % (n=103)

Summary questionnaire

Different information sources are used to inform participants of the traffic situation ahead when driving a car on a motorway. Gantries seem to be the most used information sources. However, in-car navigation systems, obtaining information via radio and smartphone seem important too.

In the case of an incident on a motorway, most people adapt their speed to the situation and drive more carefully. Information on the incident is highly welcomed, such as which lane is blocked, approximate location or how one should behave.

4.1.3.2 Simulation rides

As described in 4.1, the test persons made four trips with slight changes in the driving situations with respect to weather conditions, traffic volume, person standing behind the stopped vehicle, and lane where the stopped vehicle was standing. As there were only small differences in the reactions between the different simulation rides and features, the scenarios are not described separately. There were hardly any differences between the countries; cases of difference are pointed out in the text. The results of the simulation ride are structured according to the following topics: reactions in this situation, information needed to react adequately, and if they would call someone for help.

Reactions on the scenarios

The reactions to the different scenarios were manifold. In all scenarios participants were surprised by the stopped vehicle. Hardly anyone had experienced such a situation.

In the following the main reactions are summarized, how people would behave in case of being confronted with a stopped vehicle on the motorway:

- Reduce speed and try to change lane
- Brake hard and try not to collide with the stopped vehicle

- Turn on hazard lights to warn the oncoming car drivers
- Drive onto the hard shoulder and continue journey
- Change lane, pass by, and continue driving
- Beep the horn, change lane, and drive on
- Change lane, pass slowly by, and ask via window if the person needs help
- Assess the situation when passing by and decide if help is necessary
- Use the next exit, stop as soon as possible, and report the incident
- Pass by and stop in front of the car and call rescue service
- Stop as soon as possible on the hard shoulder and help to get the car out of the road
- Stop on the hard shoulder and try to get the person behind the crash barrier
- Stop on a safe place, put on the safety waistcoat, and set up the warning triangle
- Stop on a safe place and call for help

Most of the test persons were overwhelmed with the situation. Some would call for help because someone was standing behind the car, others assumed that because the person was standing on the motorway, they had already called for help themselves. Most of those test persons who would call for help, would call the police, as they know the number by heart. Others mentioned that they would phone the emergency service, the national highway, the traffic control centre, or the break down service. Hardly anyone knew the phone number of these services and so that they would have to look it up on the Internet. The reactions also depended partly on how the other drivers behaved. If another motorist had already stopped, they would just drive on.

There was no uniformity in the reactions. Hardly anyone mentioned that the weather conditions had an influence on their reaction. Women mentioned that they would rather not stop at night but drive on. In the scenarios where the hazard lights were on, the car was noticed a little earlier, but the reactions were very similar, being overwhelmed by the situation, reducing speed, and trying to change lanes.

Depending on the traffic situation and the distance to the stopped vehicle, some would also swerve to the right (Austria, the Netherlands) respectively left (UK) to avoid an accident. Others could not imagine this at all.

The most unpleasant part of the scenarios for many was that a person was in the middle of the motorway and the vehicle was not on the hard shoulder. What if the person panics, what if more persons get out of the car, what if one is not able to brake in time and crashes into the person?

The stopped vehicle in the fast lane was felt more uncomfortable than in the slow lane. The situation was considered as more stressful, when there was a lot of traffic around and the test persons got the feeling they were boxed in and had hardly any space to manoeuvre.

Regarding other road users, the test persons expected similar behaviour that they themselves displayed, speed reduction and very attentive driving.

Information needed to react adequately

The test persons were asked, what kind of information they would need to react adequately

in such situations and what information channels they prefer.

Most important according to the test persons is the general information that there is an “obstacle ahead, congestions, vehicle on the road, dangerous situation etc.” and which lane is affected. “Reducing speed and slower speed limit” is another important information which was considered by the test persons. Less often the information about the location, the distance to the obstacle, and that it is near an exit, as well as recommendations how to behave (do not overtake, which lane to use etc.) and a warning that there is a pedestrian on the road, would be needed to be able to behave adequately. Other comments by a few test persons were about the colour of the stopped vehicle, whether somebody is injured, or that help is already on the way. Test persons also stated that they would need as much information as possible by as many channels as possible and that the information must be accurate and consistent.

By far most test persons mentioned that information is best provided by gantries or electric boards on the side of the road as this is the only way to reach all drivers. Other channels which were mentioned was in-vehicle-technology with warning sounds, information on the dashboard, information on the heads-up display or haptic information. In this respect it was also mentioned that this would work in two ways: 1) the sensors in the car would detect the stopped vehicle and warn the driver, or 2) that the information about the stopped vehicle is coming from another source. Furthermore, smartphone and special app such as Waze or Google maps, the car’s navigation system, and the radio were all mentioned as channels through which the test persons would like to be informed. Other sources of warnings would also be breakdown triangles, other cars’ hazard lights, pedestrians, and the police.

Most of the test persons stated the information should come at least 2km or 2 miles before the incident. The following can be summarised:

Content of information

- Dangerous situation ahead
- Stopped vehicle on the road
- Person on the motorway
- Which lane is affected?
- Reduction of speed necessary
- Location of the stopped vehicle
- How far away is the incident?
- Instructions what to do (stay right, do not stop, drive on etc.)

Information channels

- Gantries or electric boards on the side of the road
- Traffic news
- In-vehicle with warning sounds, information on the dashboard, information on the head-up displays or haptic would work in two ways. 1) the sensors in the car would detect or 2) information is coming from another source
- Smartphones and special apps such as Waze or Google maps
- Navigation systems

In addition, test persons suggested to install a hotline organized by the road administrations with an easy to remember number, and a “three-step plan” of what to do in such situations that is taught in driving schools and disseminated through other media channels (radio, social media, TV, etc.).

Would you consider passing by the stopped vehicle on the right (left) side?

Those test persons who have not specifically mentioned it before were asked if they would consider passing by the stopped vehicle on the right (left for the UK) side. Most of the test persons stated that they would not overtake on the right (respectively on the left in the UK)

on a motorway. It was mentioned that this would be illegal and dangerous. On the other hand, there were test persons who stated that they would do it in this situation as it was safer or that the traffic situation would lead to such a reaction. Others again would consider passing by on the right (left for the UK) depending on the traffic situation (car is coming from behind on the other lane), distance to the stopped vehicle, day/night-time etc. and therefore decide in the situation which side would be the safer one.

Would you get help? If so, how and whom would you notify?

The test persons were also asked if they would consider getting help and whom they would notify. Calling the police or considering calling the police was the most frequent answer. A few test persons mentioned that they would call either the emergency service, national highway, the traffic control centre, or a break down service. One test person stated that she would call her husband to get advice what to do.

Many of the test persons emphasised that it was dangerous to make a phone call on the motorway and would only call someone if they could stop somewhere safely (after taking the exit, or in a breakdown bay), or if they were travelling with a passenger who could make the call. Reporting the incident via an app was also considered by some test persons.

At the same time, however, test persons said that they would not inform anyone and had no idea who they should inform in such a case. They did not know any numbers by heart and had to look them up on the Internet. Others would perform an Internet search even to find out where to report the incident. They also stated that it would depend on the situation or that they would only call if it would be an emergency (injured people, fire). Some of the test persons would first try to contact the driver before calling someone else.

It was assumed by some that the incident was already reported (smart highway, cameras) or that nowadays everybody has a mobile phone and therefore the driver would have already called for help himself.

4.1.3.3 Summary

The following main aspects can be summarized with respect to behavioural aspects and stopped vehicles on motorways:

- There is a wide range of reactions and behaviours in a situation where one is unexpectedly confronted with a stopped vehicle on a motorway. Some of the mentioned reactions were dangerous, like driving at walking speed and trying to get in contact with person when passing by the stopped vehicle.
- In driving school people are told what to do if they have an accident, like “Stay calm” “Get yourself out of the danger zone”, “Secure the accident scene” etc. There is no common knowledge and there are no clear recommendations about how to behave correctly in case you are the following car of a stopped vehicle.

- There is no unanimous opinion on whether to call for help in the event of a stopped vehicle or who to call in such a case. The police were most likely to be mentioned as a contact person.
- With respect to a stopped vehicle event people seem not to behave differently in the case of rain or night-time conditions.
- People use different information channels to inform themselves about the traffic situation ahead. Thus, they appreciate multiple information channels to be informed about stopped vehicles on motorways.
- Information that is considered most important as a warning of an incident ahead is which lane is affected and the request to reduce speed.

4.2 Simulation study second run

4.2.1 Procedure

The second run of the VR-simulation study took place in May and June 2022 again in three countries: Austria, the United Kingdom, and the Netherlands. The procedure was very similar to the first run.

The aim of the second VR-simulation study was to investigate test persons' reactions when they are informed beforehand of a stopped vehicle in a live lane.

The main questions were:

- Do test persons perceive the additional information about the incident?
- Would the test persons behave according to the recommendations (change speed, change lane, drive more carefully etc.)?
- Is the information given sufficient and comprehensible?

The study was again divided into three parts: Introduction and pre-questionnaire; survey during the virtual motorway trip, and final questionnaire. The pre-questionnaire and the final questionnaire were the same as in the first run. The survey during the virtual motorway trip was based on the results of the first VR-simulation run standardized with some open questions. The questions considered: if the information given was noted by the test persons, how the test persons would react after the information was given, and whether the information was given early enough and was sufficient to respond to the incident.

The information sources in the four scenarios were:

- Mobile lane closure with an impact protection vehicle
- Electronic messages on gantries
- Traffic news and
- In-vehicle information on a dashboard

Again, eight independent simulations were available: four simulations for driving on the right for Austria and the Netherlands and four simulations for driving on the left for the tests in United Kingdom.

The following table gives an overview of the eight different simulations:

Table 3: Overview of the simulation scenarios

United Kingdom

Stopped Vehicle Scenario	Number of lanes	Weather conditions	Traffic volume	Stopped vehicle hazard lights on	Driver standing next to stopped vehicle	Additional information	Scenario nr.
Scenario 1 + 2: Vehicle stopped at Lane 1 near exit	2 + hard shoulder	good	light	yes	no	Mobile lane closure	S1
	4	light rain	medium	yes	yes	Electronic messages on gantries	S2
Scenario 3 + 4: Vehicle stopped at Lane 2	2 + hard shoulder	light rain	light	yes	no	Traffic radio	S3
	2 + hard shoulder	good	light	Yes	no	In-vehicle information	S4

Austria and the Netherlands

Stopped Vehicle Scenario	Number of lanes	Weather conditions	Traffic volume	Stopped vehicle hazard lights on	Driver standing next to stopped vehicle	Additional information	Scenario nr.
Scenario 1 + 2: Vehicle stopped at Lane 1 near exit	2 + hard shoulder	good	light	yes	no	Mobile lane closure	S1
	3 + hard shoulder	light rain	medium	yes	yes	Electronic messages on gantries	S2
Scenario 3 + 4: Vehicle stopped at Lane 2	2 + hard shoulder	light rain	light	yes	yes	Traffic radio	S3
	2 + hard shoulder	good	light	yes	no	In-vehicle information	S4

The order of the scenarios was altered by the study director to avoid study artefacts.

Where participants in the second run that were the same persons as in the first run, they received the same code number and did not have to fill in the pre-questionnaire a second time.

In contrast to the first study the questions during the VR-simulation ride were mainly standardized with some open questions.²

4.2.2 Sample

In the second study participated in total 80 test persons: 30 each from the United Kingdom and Austria and 20 from the Netherlands. In the Netherlands, the same 20 test persons took part as in the first VR study. In Austria, there were 13 new and in the UK 10 new test persons. As the goal was to have a similar distribution among gender and age there are hardly any differences between the sample of the first and second simulation study.

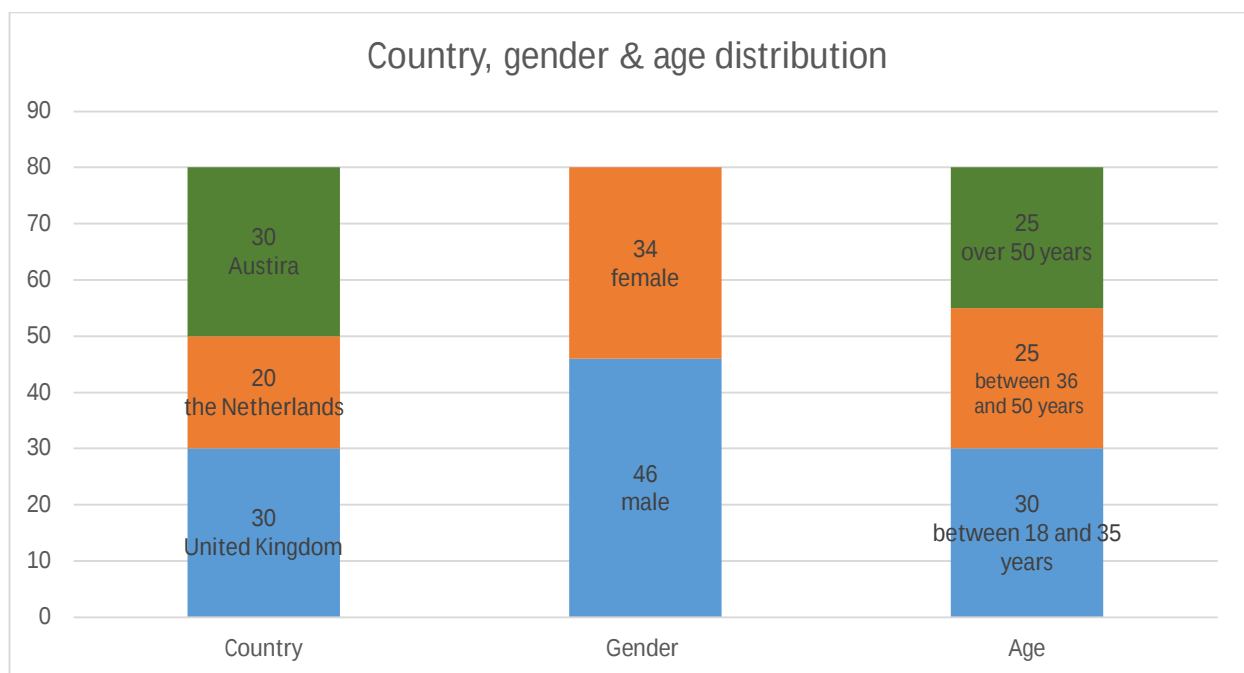


Figure 7: Country Gender and age distribution (n=80)

The distribution of driving experience on motorways was like the distribution of the first simulation test and consisted of test persons who drive only a few times a year on a motorway and low mileage and test persons who drive daily on a motorway with high mileage.

² See Annex Error! Reference source not found. S 43Error! Reference source not found.

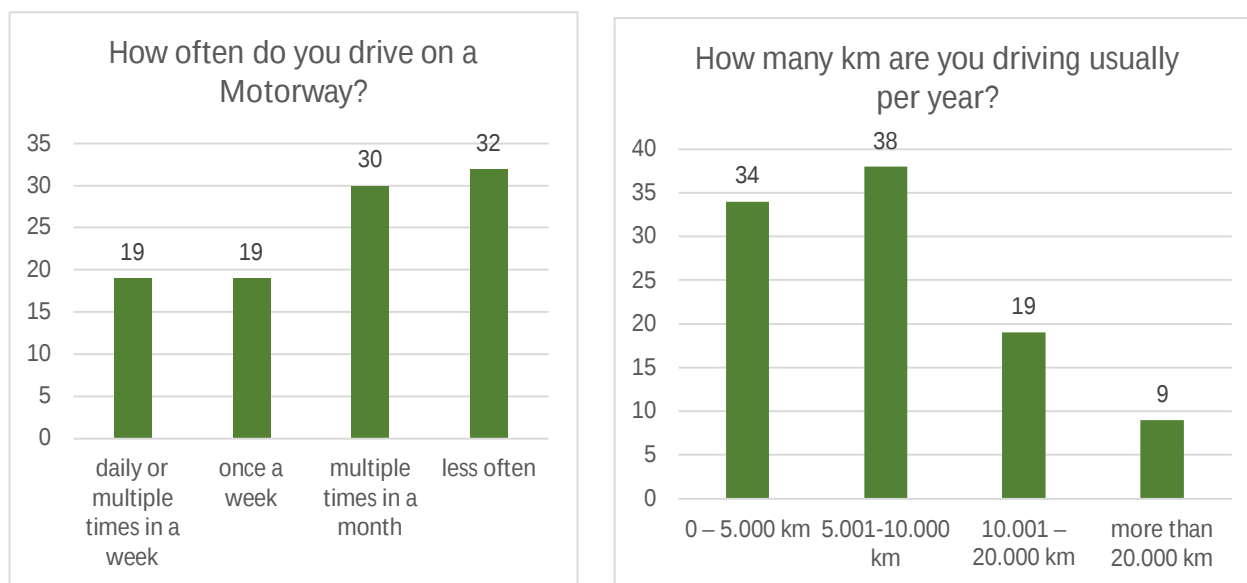


Figure 8: Driving Experience and motorway experience in % (n=80)

4.2.3 Results

4.2.3.1 The simulation rides

The participants were asked to make four simulation rides. In each ride they were confronted with a stopped vehicle and were informed in advance through different channels about this event: impact protection vehicle, gantry, traffic news, dashboard.

Similar behaviour was reported in the three different countries and under the different weather and traffic conditions. Therefore, it is difficult to make any country-specific statements or assumptions about the influence of different weather and traffic conditions.

In the following pros and cons of the different information sources that were mentioned after the ride by the test persons are presented.

Scenario 1 Impact Protection Vehicle (IPV)

The first scenario used an impact protection vehicle of the sort used in mobile lane closures, which could be for roadworks. The impact protection vehicle guards further stationary objects – in this case another stopped vehicle. The test persons drove on a two-lane motorway with a hard shoulder in good weather conditions with light traffic volume. There was no information beforehand. The test persons were suddenly confronted with the impact protection vehicle.



The test persons were suddenly confronted with the impact protection vehicle.

Standardised results

Almost all test persons mentioned that seeing the IPV would cause them to change their lane. Half of the test persons mentioned that based on seeing the IPV there has to be some kind of incident ahead while one third stated that there is a lane closure.

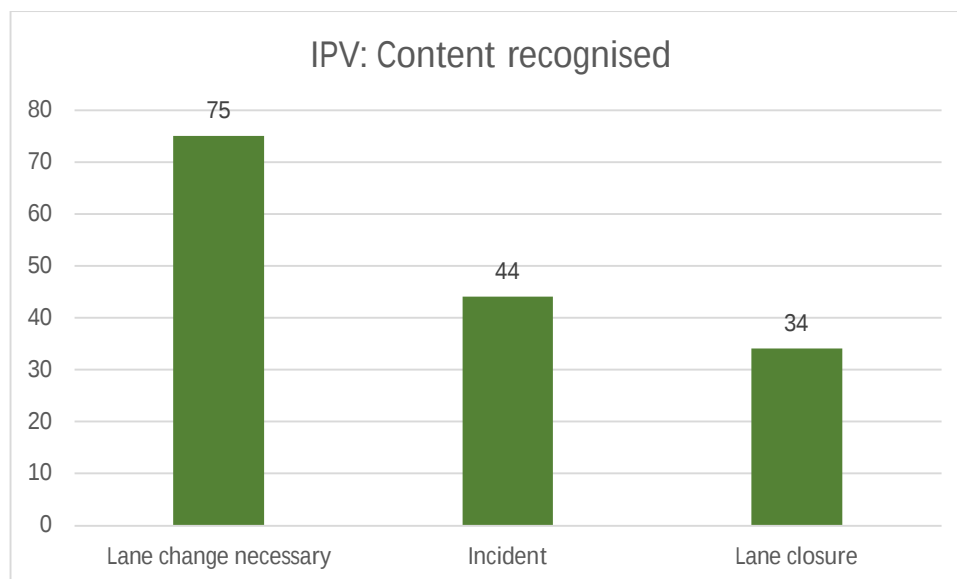


Figure 9: IPV: Content recognised (n=80)

Most of the test persons stated in a first reaction that they would perform a lane change as recommended by the sign on the vehicle or would behave the same way as the simulation car. About a half mentioned that they would also reduce their speed in this situation. Only a few mentioned that they consider driving more carefully, increase safety distance or turn on their radio after they saw the IPV.

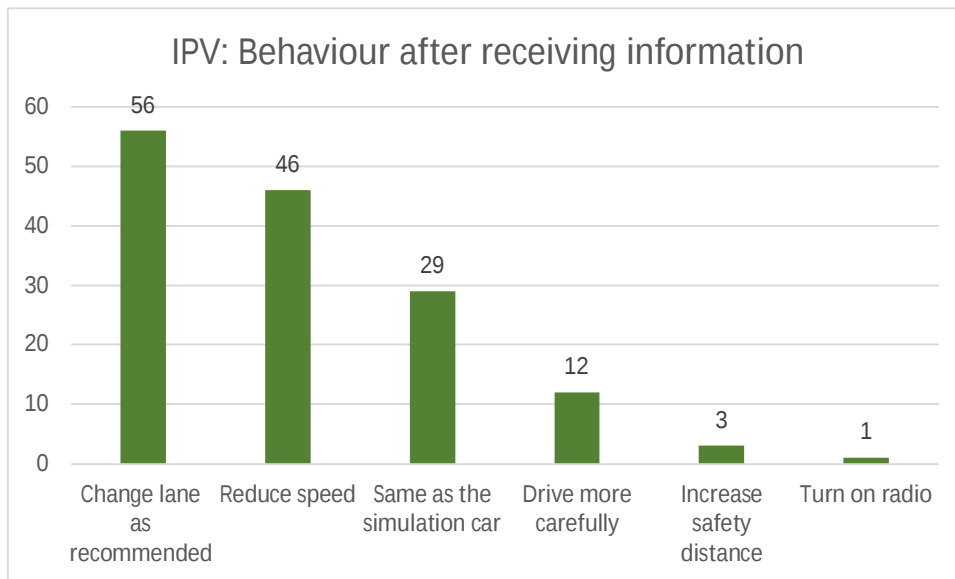


Figure 10: IPV: Behaviour after receiving information (n=80)

40% of the test persons stated that the information given via the IPV was not sufficient and not given early enough (see Test person comments).

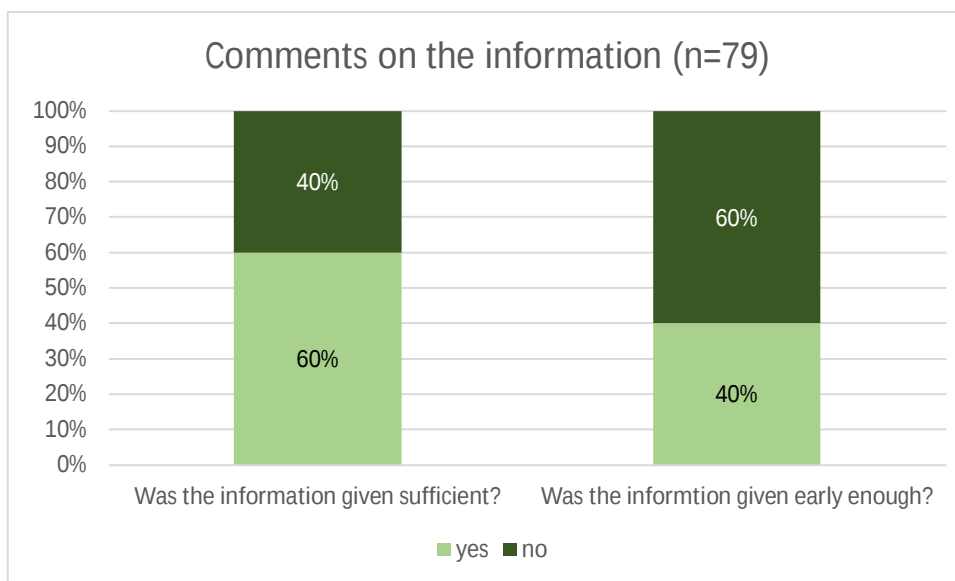


Figure 11: IPV: Comment on the information (n=79)

Test person's comments

Most of the test persons considered the car ride as relaxed and would have driven a little faster.

With respect to the impact protection vehicle the following points were positively mentioned:

- Low speed of the car made it possible to react in time
- IPV is in the field of vision and not distracting eyes off the road
- IPV is visible from afar
- Flashing arrows indicate incident, danger
- Arrows indicate change of lane is necessary

- The area of incident was well secured

The following aspects were considered undesirable:

- No prior warning of hazard: most of the test persons would have appreciated a prior warning 500m to one km earlier
- IPV connected to road works, usually a speed reduction is displayed beforehand
- IPV was too close to what it protected
- In case of high traffic volume reaction in time, might have not been possible
- Trucks could obstruct the view of the vehicle and make a timely reaction impossible
- The items downstream of the IPV (which in this case were another stopped vehicle) were not appropriately secured - no lateral barrier
- From afar it was not quite clear which lane was closed
- The reason for the lane closure was not given.

Scenario 2 Gantry

The test persons drove on a three-lane motorway with a hard shoulder in Austria and the Netherlands and on a four-lane motorway in the UK without hard shoulder, with medium traffic volume. There was light rain. This scenario slightly differed in the UK. While in the Netherlands and Austria there was no text on gantry, only symbols, in the UK scenario there was also text on the gantry. The test subjects were directed to the incident by the gantries. The position and detail of the information varied nationally, following existing patterns in each of UK and the Netherlands:



- For UK scenario, the first information on the gantry appeared around 5km before the incident, with speed limit reduced to 60mph for all lanes. The speed limit continues until the gantry downstream of the incident.
- For Austria and Netherlands scenario, the first information on the gantry appeared around 1.8km before the incident, with speed limit reduced to 90kph for all lanes. Then at regular intervals of 600 metres, a lane change and closure were displayed, and further speed limit reduction applied.

Standardised results

Almost all test persons recognised the new speed limit displayed on the gantry and that a lane change is necessary. Half of the test persons stated that there is a lane closure ahead while one third stated that they assumed there is an incident.

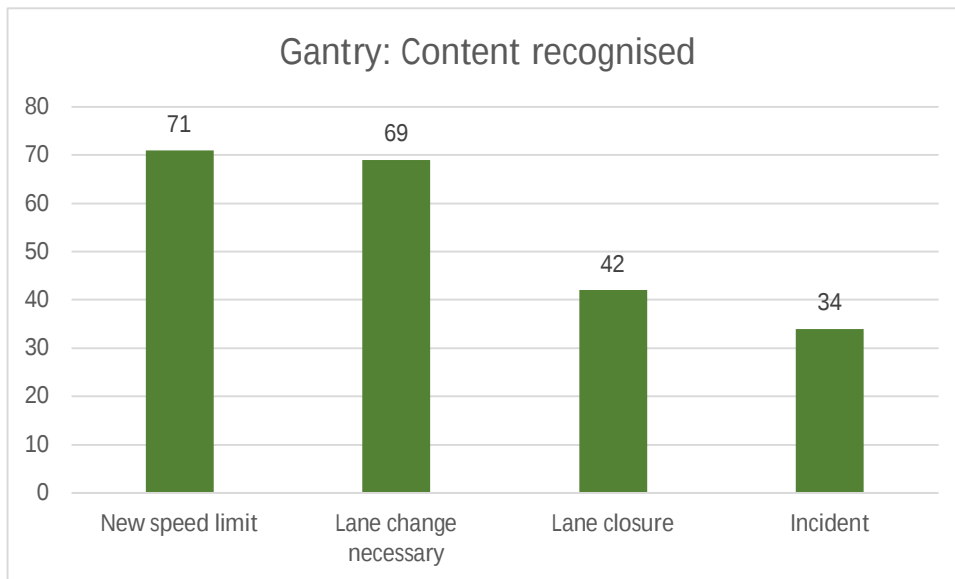


Figure 12: Gantry: Content recognised (n=80)

As a first reaction most of the test persons would reduce their speed according to the information and would change lanes as guided or would behave the same way as the simulation car. Some of the test persons (17) would drive more carefully after receiving the information or would increase their safety distance. Only a few would not change lanes any more or search for an alternative route.

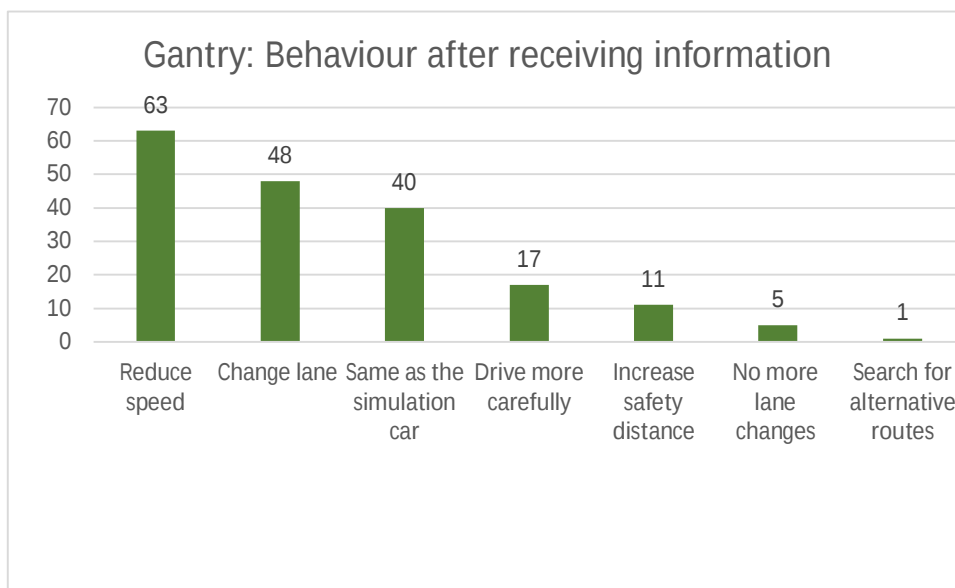


Figure 13: Gantry: Behaviour after receiving information (n=80)

While almost all test persons stated that the information on the gantry was given early enough only about a half thought that the information was sufficient (see Test person comments).

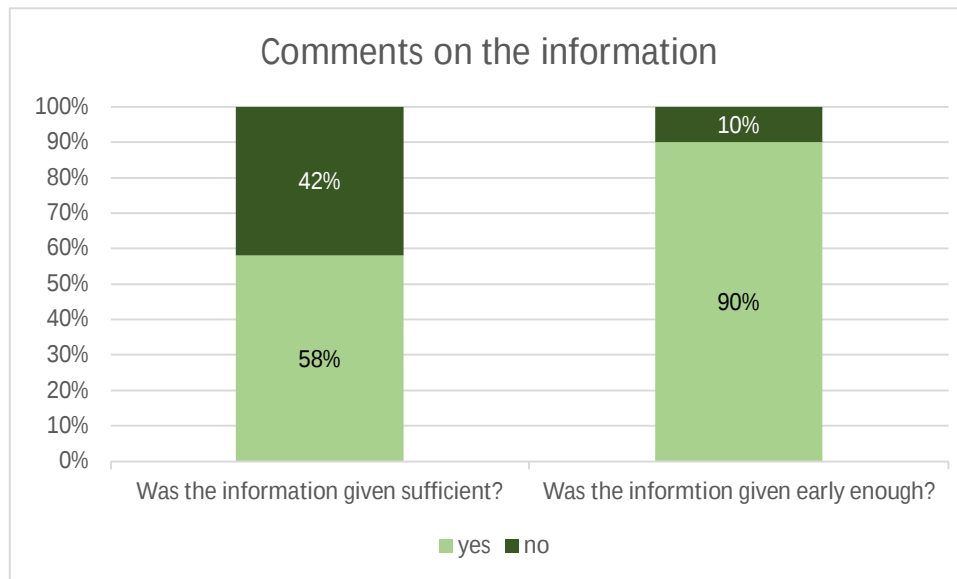


Figure 14: Gantry: Comment on the information (n=80)

Test person comments

The car journey was evaluated differently by the test persons. Some would have driven faster, others slower because of the weather conditions, some were already stressed, others very relaxed. In general, however, the test persons would have behaved according to the information on the gantry as the VR-car had done.

With respect to the gantries the following aspects were mentioned positively:

- Clear and simple instructions
- Lane closure indicated (Austria and the Netherlands)
- Slowly leading to the incident site
- Repetition of information
- All car drivers get the same information
- Used to such kind of information

Drawbacks mentioned about the gantries are the following:

- The first arrows were not recognized by all as lane change indicators
- Stopped vehicle was not secured
- Lane closure could have been indicated more often (Austria and the Netherlands)
- Reason for lane closure was not indicated (sign of a car crash)
- No information beforehand if exit is closed
- No information where exit J6 was (UK)
- Lane closure was not removed after the incident, so it was not clear if you can use the exit or if it is closed (Austria and the Netherlands)
- Lane was not blocked off; accidents might happen if people do not stick to the information on the gantries
- Number of the lane blocked was missing

- More information is wanted e.g. person on the road
- Warning was too soon, should be closer to the incident
- Too much warning
- The text on the gantry was hard to read (UK)

Scenario 3 Traffic News

In the third scenario the radio was turned on during the ride and the participants listened to the traffic news. The test persons drove on a two-lane motorway with hard shoulder. There was light rain and light traffic volume.

The test subjects received the traffic message once, upstream of the stopped vehicle (5.8km upstream for UK, 5.3km upstream for Austria/Netherlands).



"Here are the traffic messages for Austria. Attention! On the A1 motorway in the direction of Salzburg. Shortly before the Sale exit, a car has come to a standstill in the left lane. Please drive carefully, keep to the right and do not overtake. Repeat. On the A1 motorway in the direction of Salzburg. Just before the Sale exit, a car has come to a standstill in the left lane. Please drive carefully, keep to the right and do not overtake."

The message varied slightly in the different countries and was adapted to the British and Dutch style of traffic news.

Standardised results

After listening to the traffic news almost all test persons stated that there is an incident and two thirds said that it is required to drive on the right lane. About a third of the test drivers remembered that the traffic news also mentioned to drive more carefully. Less than a quarter stated that a lane is closed that a lane change is necessary and that a slower speed is required.

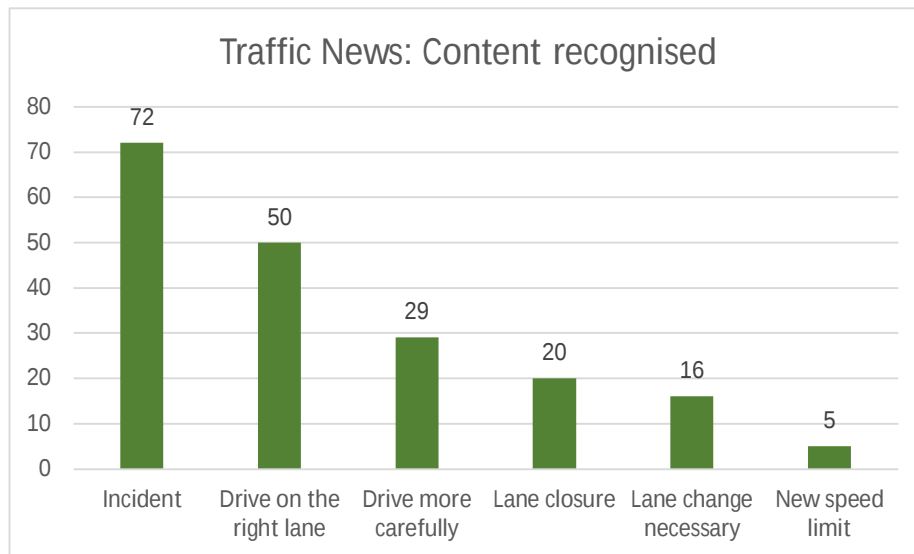


Figure 15: Traffic News: Content recognised (n=80)

Most of the test persons stated as a first reaction that they would not change lanes anymore after receiving the traffic news. Three quarters would further reduce their speeds. About a third would drive more carefully, while a quarter would change lanes as recommended. A few also mentioned that they would increase their safety distance or search for an alternative route.

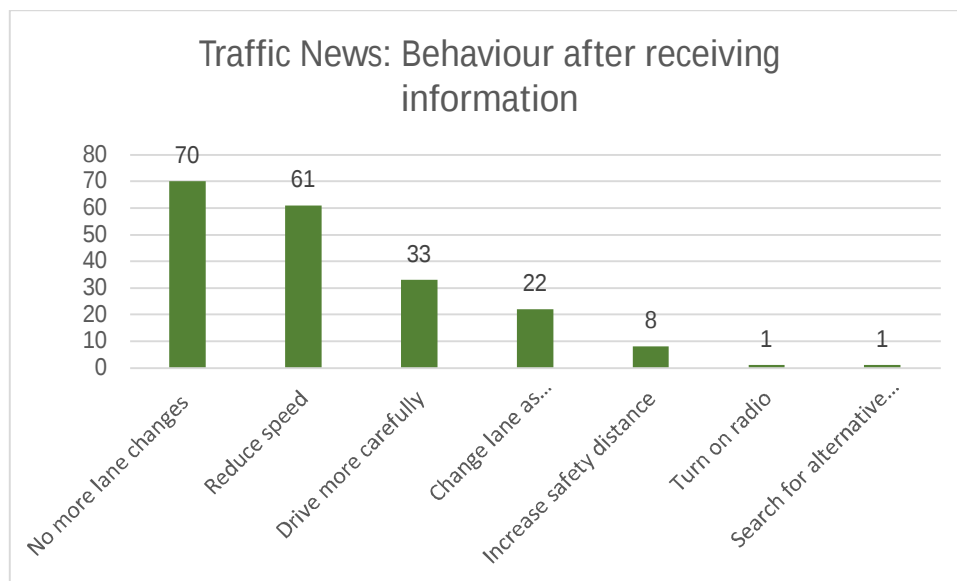


Figure 16: Traffic News: Behaviour after receiving information (n=80)

Three quarters of the test persons stated that the information given via the traffic news was sufficient, and a similar proportion considered it was given early enough.

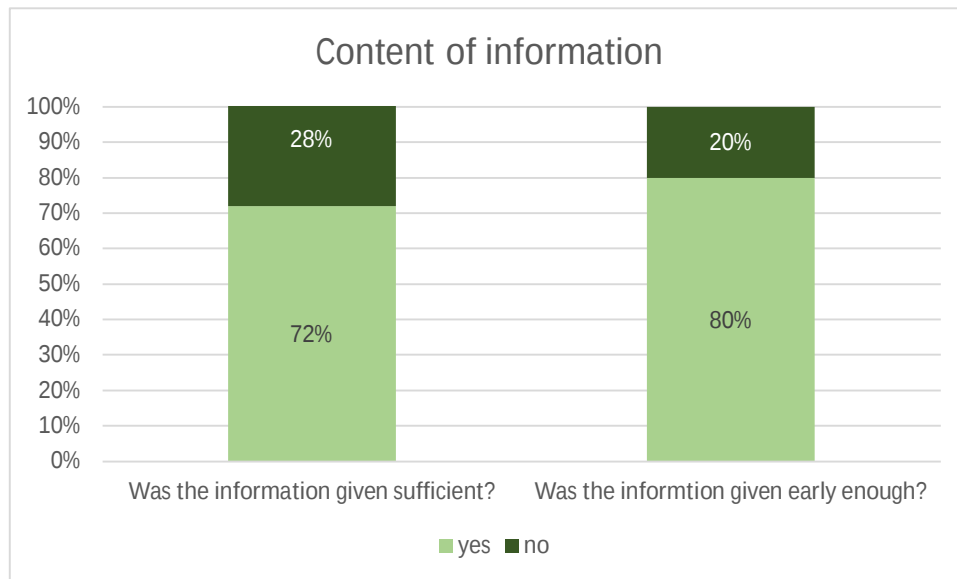


Figure 17: Traffic News: Comment on the information (n=80)

Test person comments

As in scenario 2 the test persons described the car trip in different ways. Some were irritated that the cars were driving without lights despite the rain. Others were made nervous by the following driver who repeatedly initiated an overtaking manoeuvre and then did not carry it out after all. Still others described this ride as relaxing as well. Most would drive more slowly. The participants agreed that they would have stopped overtaking after the radio message and would have stayed in the right lane.

The following points were mentioned positively with respect to the traffic news

- Clear instructions
- Detailed information: what happened where and what to do
- Information can be anticipated
- Repetition of information
- Used to listen to the traffic news
- Audio information not distracted from the road
- Information in time

The following aspects were considered drawbacks:

- Traffic news were too early
- No signs how far exit Sale is
- The precise location is missing
- Not all people listen to the radio
- Most traffic news items do not concern oneself, tendency to ignore them
- Warning could be missed if distracted by other passengers e.g. children in the car
- Person talked too fast
- Information was only in one language
- Most important information was at the end (stay right)

Scenario 4 Dashboard

In the fourth scenario the test persons were informed via dashboard. The participants drove on a two-lane motorway with a hard shoulder in good weather conditions with light traffic volume. Before the stopped vehicle (700m upstream for UK, 250m upstream for Austria/Netherlands) they received the following message on the dashboard:



"Attention stopped vehicle! Left lane closed."

The text again varied slightly between the different countries. The information on the dashboard was announced with an acoustic signal.

Standardised results

Almost all test persons recognised the information on the dashboard stating that there is an incident ahead. After reading the message about a half also stated that there will be a lane closures while only a quarter mentioned that the information also said to drive on the right lane.

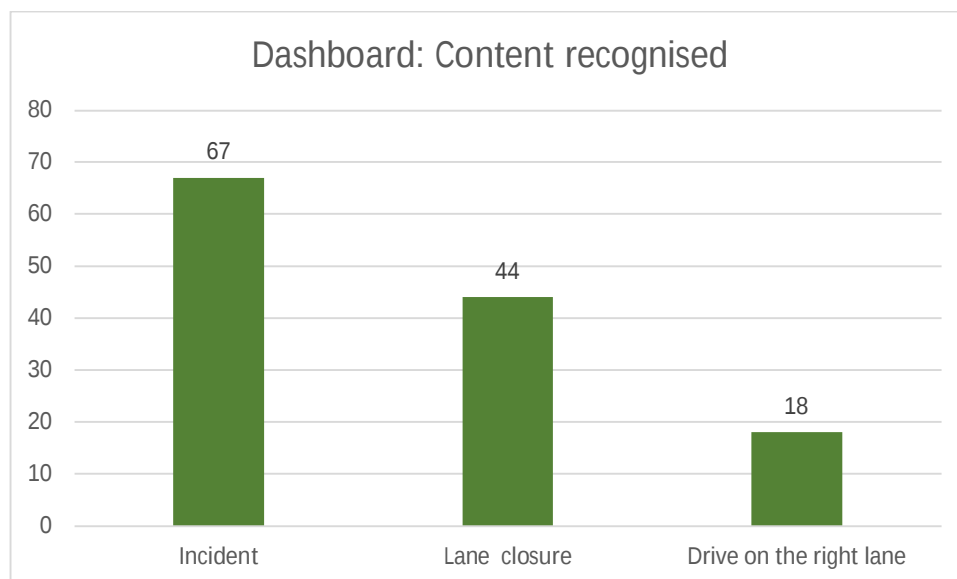


Figure 18: Dashboard: Content recognised (n=80)

Most of the test persons stated that they would reduce their speed and change lanes as recommended after reading the information on the dashboard. A quarter of the test persons or less mentioned that they would drive more carefully, would not change lanes anymore, would increase their safety distance, or would turn on the radio.

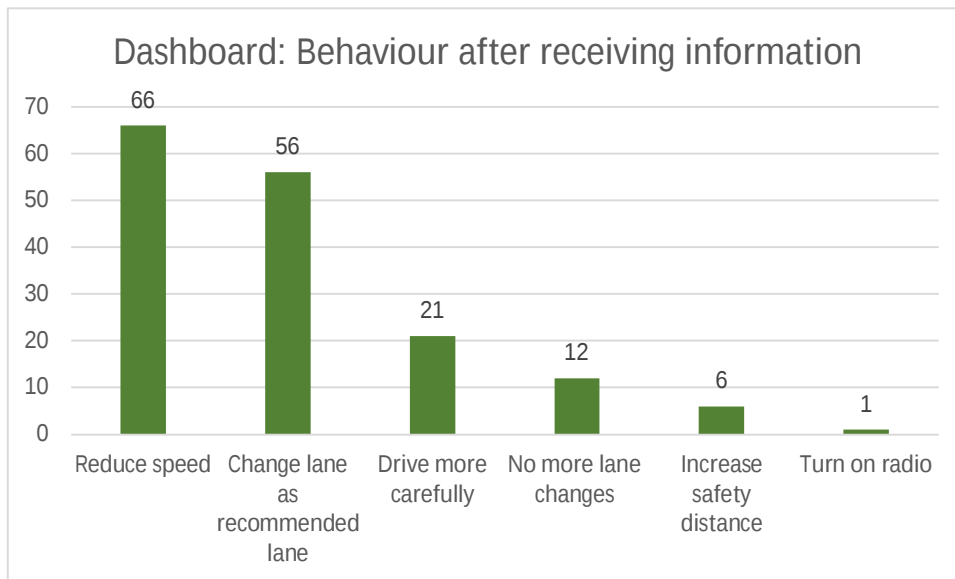


Figure 19: Dashboard: Behaviour after receiving information (n=80)

More than a half of the test persons stated that the information given via the dashboard was sufficient, but more than two thirds were of the opinion that it was not given early enough.

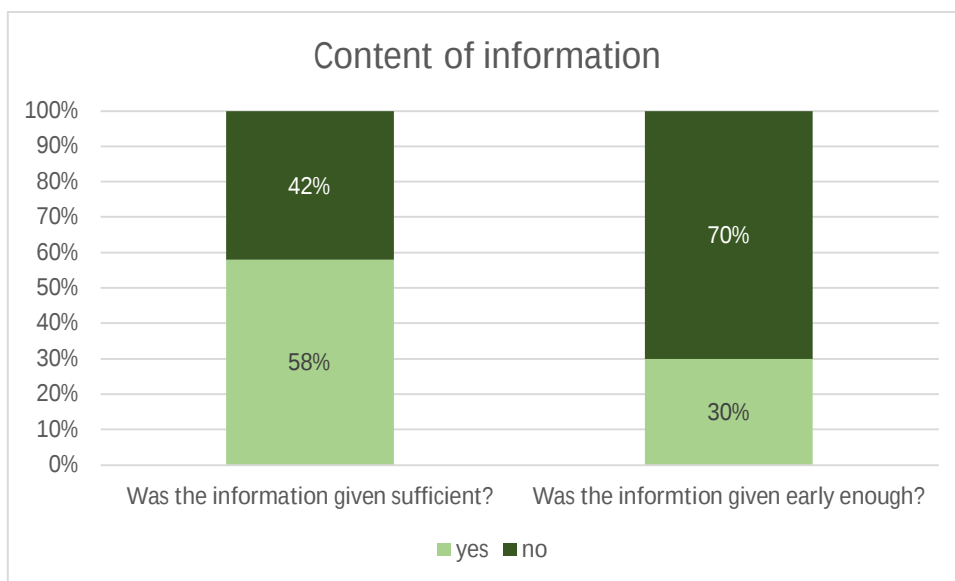


Figure 20: Dashboard: Comment on the information

Test person comments

Despite the stopped car the ride was considered as relaxed by the test persons.

With respect to the dashboard the following aspects were mentioned positively:

- Short and concise information
- Reason of incident is mentioned
- Audio jingle and red triangle indicate “be alerted”

Drawbacks connected to the dashboard are the following:

- Information is out of the field of vision

- Distracted by reading
- Audio Information was missing
- Incident was indicated too late to react in time
- Important information left lane blocked was at the end
- Too much text
- Distance to the obstacle was missing
- Not used to such information delivery

4.2.3.2 Summary

In total the information via the gantry was seen as the best information source, followed by the radio news. These are the most common ways how to inform drivers about incidents. Although most of the test persons thought that the information was given early enough, there were also many test persons who thought that the information was not sufficient and especially with the radio that the information should have been repeated in case some information was missed. The information via the dashboard was a rather unfamiliar information source and the test persons thought it was not given early enough. The information given by seeing the IPV used in the scenario without other prior information was seen as too late.

There were some differences between the countries regarding which was the best information source. While gantries were the favourite in the Netherlands and Austria, it was the radio in the UK closely followed by the dashboard information and the gantry. On the other hand, radio was not chosen by any test person in the Netherlands.

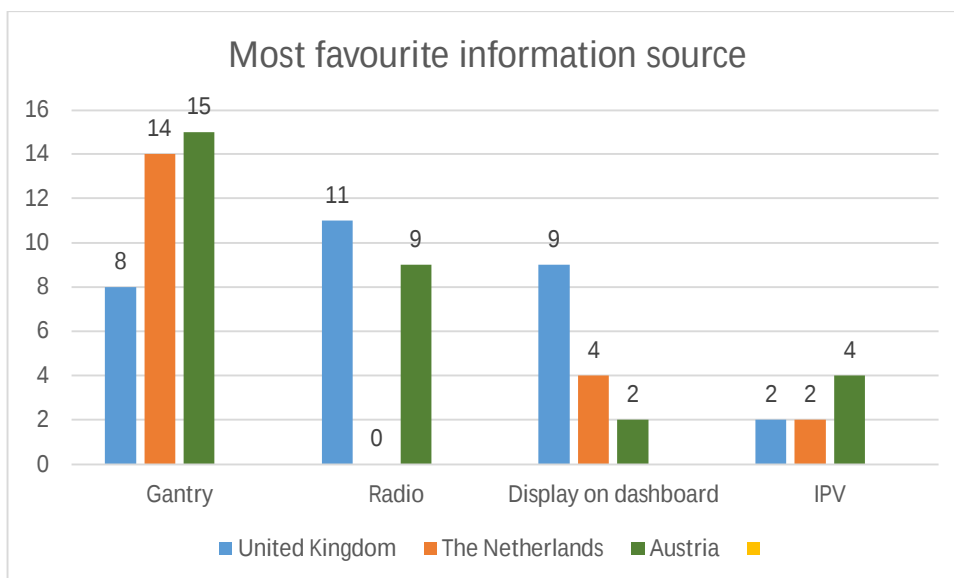


Figure 21: Favourite information source (n=80)

Basically, the main information about the incident ahead and how the test persons should alter their driving behaviour could be received successfully with all four different information sources. Depending on how the information was presented to the test person, different content of the information was dominantly recognised. With the traffic news and the dashboard information the test person recognised that there is some kind of incident and

that they should drive on the right (left) lane. With the IPV and the gantry, the main information received was that a lane change was necessary. At the gantry the test persons also mentioned the new speed limit as main information they recognised.

As a first reaction almost all test persons would follow the information given via the different sources, which includes lane changes when they saw the information on the IPV and lane changes and reducing speed after passing by a gantry, no more lane changes and reducing speed after hearing the traffic news, and reducing speed and lane changes as recommend after receiving the information on the dashboard.

Almost all test persons would either drive on or exit the motorway after passing by the stopped vehicle. The number of test persons who would stop and see if they could help was reduced tremendously in comparison to the first simulation test. Only when the test persons received the information via the dashboard six test persons considered stopping. This was the only information source where it was not clear where the information is coming from (V2V, V2X) and therefore also not clear if the incident was already reported. For the other information sources, it was clearer that the incident has already been reported as someone (road worker, road authorities, etc.) has sent out the information so no help from the test person is needed anymore.

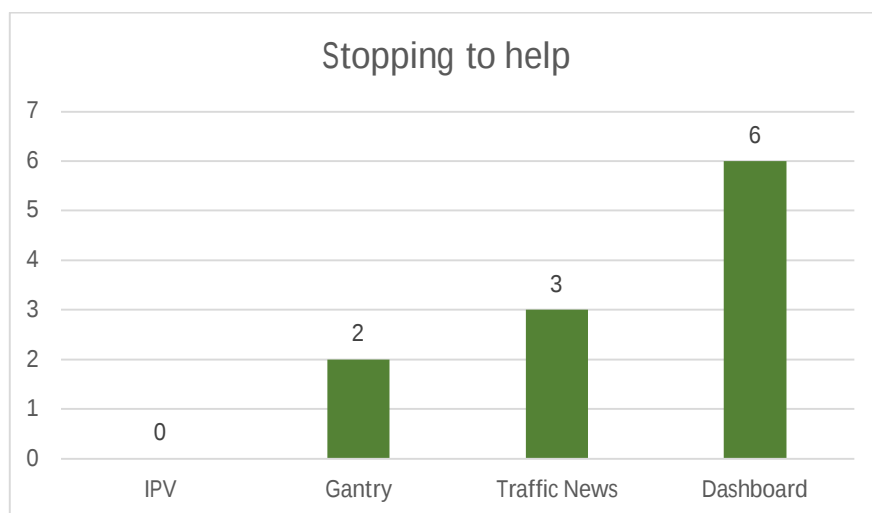


Figure 22: Considering stopping to help after passing by the stopped vehicle

Each information source had advantages and disadvantages. The following table summarizes the main results of the four scenarios: aspects considered positive for the different information sources, and suggestions made for improvement.

Table 4: Pros of the four information sources and suggestions for improvements

Information source	Positive Aspects	Suggestions for improvements
Impact Protection Vehicle	- Information is in the field of vision - Flashing light/ arrows associated with "attention" - Instruction to change lane	- Prior warning of hazard: at least one km earlier - Ordering a speed reduction 500m to 1 km before the incident - Better securing of the incident car - Indicate reason for lane closure 500m to 1 km before
Gantry	- Information is clear and simple - Clear instructions - Repetition of information - Same information for all car drivers	- Adapt arrows (lane change) to common signs in the different countries - Stopped vehicle should be secured - Indicate symbol for reason of lane closure - Lift the lane closure after incident - Indicate, if exit can be used - Indicate the lane that is blocked
Traffic News	- Detailed information: what happened where and what to do - Immediate repetition of information - Audio does not distract the driver	- Indicate the precise location - Repetition of Traffic news after a while - Slower speaking of the message - Multilingual traffic news - Change order of the information: what to do first and then why, e.g. Stay right and then stopped vehicle on A 1)
Dashboard	- Short and concise information - Reason of incident is mentioned - Audio jingle and red triangle indicate "be alerted"	- Information in the field of vision - Audio and visual Information - Important information at the beginning (left lane blocked!) - Indicate distance to the obstacle

4.2.3.3 VR-Experience

After both simulation studies the test persons were asked about their experience with the VR- simulation in a standardised way (1 = Strongly agree to 4 = Strongly disagree).

The average scores in both simulation rides were mostly between 2 and 3, which means that the test persons in general agreed to the statements asked.

The highest scores (disagreement) were given to the question on whether the test persons found the usage of the VR-glasses exhausting, with an average score of 2.5 for the first and 2.7 for the second simulation. Also 2.5 on average was given for both simulation rides to the question on whether the test drivers found the trip realistic.

During each of the simulation tests the test persons were able to assess distances a bit better than their own driven speed or the speeds of the other car drivers.

Finally, the situation with the stopped vehicle with additional information beforehand during the second test ride was seen more realistic (average score of 1.8) than the situation with the stopped vehicle during the first simulation (average score of 2.3).

Table 5: Average scores for the assessment of the usage of the VR-glasses and scenarios

Items	1 st simulation	2 nd simulation
I found driving with VR glasses to be exhausting.	2.5	2.7
I experienced the trip as realistic.	2.5	2.5
<i>I was able to assess ...</i>		
...the distances well during the VR-ride.	2.0	2.2
...the speeds well during the VR-ride.	2.3	2.3
...the speeds of the other car drivers well during the VR-ride.	2.3	2.3
The situations with the stopped vehicle were realistic.	2.3	1.8

There were some country-specific differences regarding the assessment of the VR-glasses. The test persons of the Austria sample found the use of the VR-glasses much more exhausting in both simulation tests than the test persons in the UK and the Netherlands.

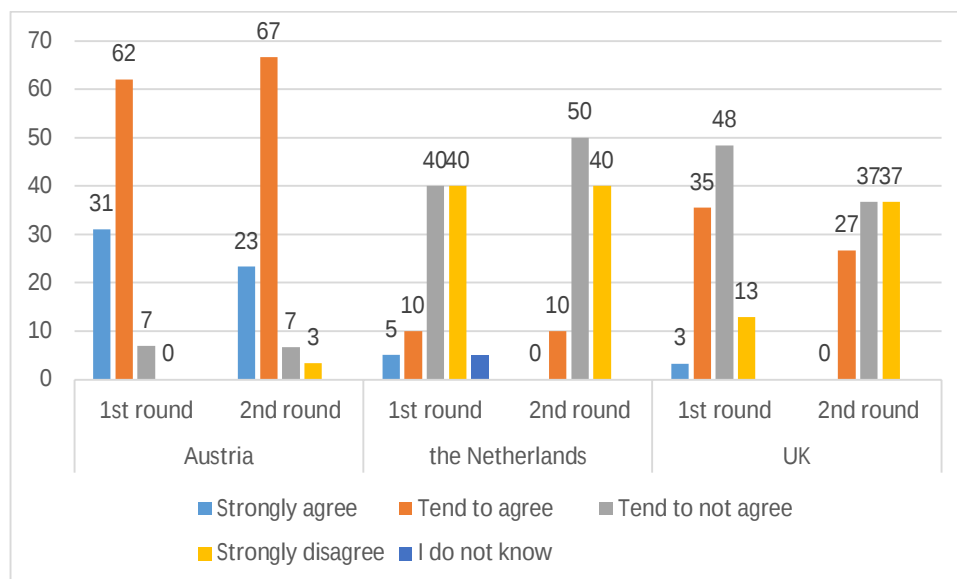


Figure 23: I found driving with VR glasses to be exhausting in % (n= 103)

With regard to whether the test persons found the trip realistic, the Austrian test persons did not agree in the same way as the test persons in the UK and the Netherlands.

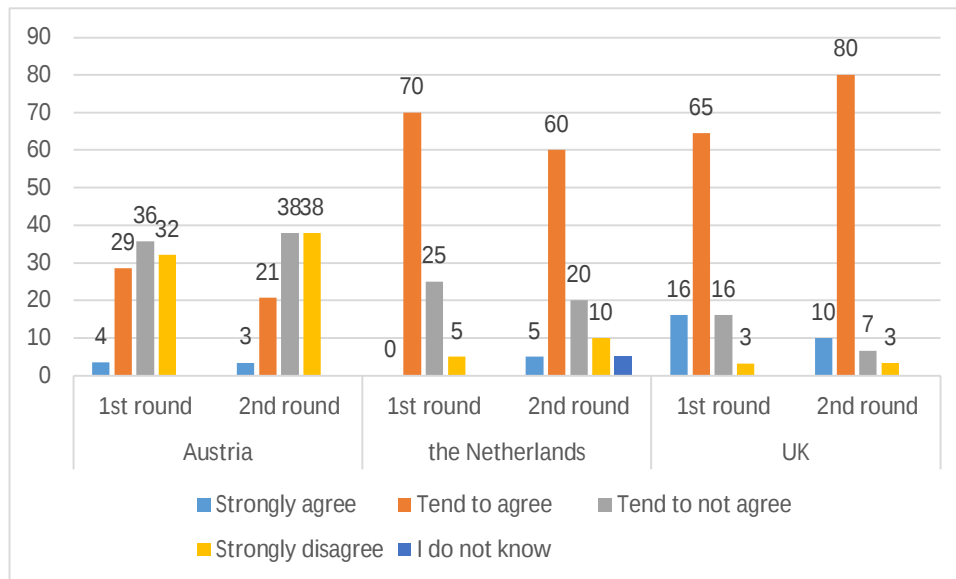


Figure 24: I experienced the trip as realistic in % (n= 103)

With regard to the assessment of distances, the own driven speed and the speed of the other car drivers, a similar picture can be seen in all three countries and for both simulation rides as most test persons tended to agree or even strongly agreed.

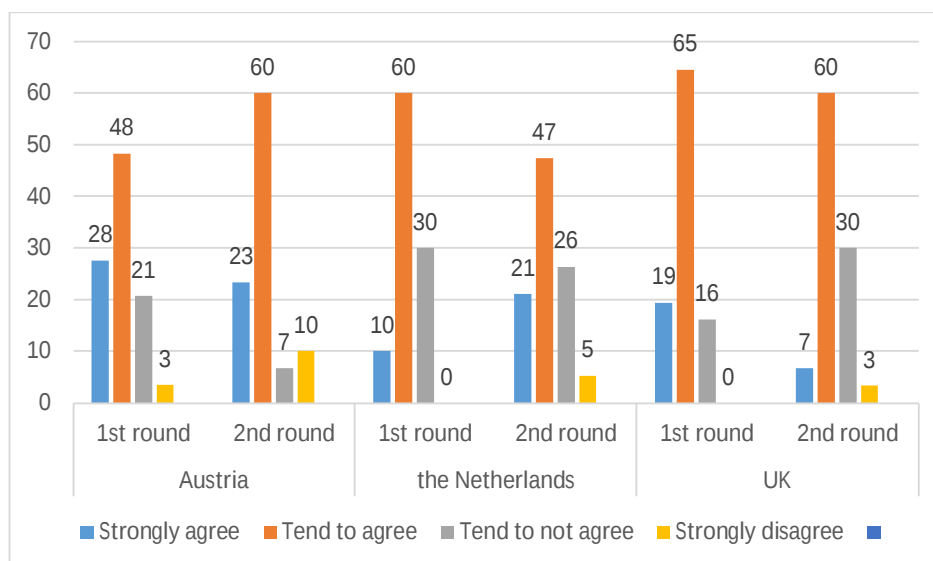


Figure 25: I was able to assess the distances well during the VR-ride in % (n= 103)

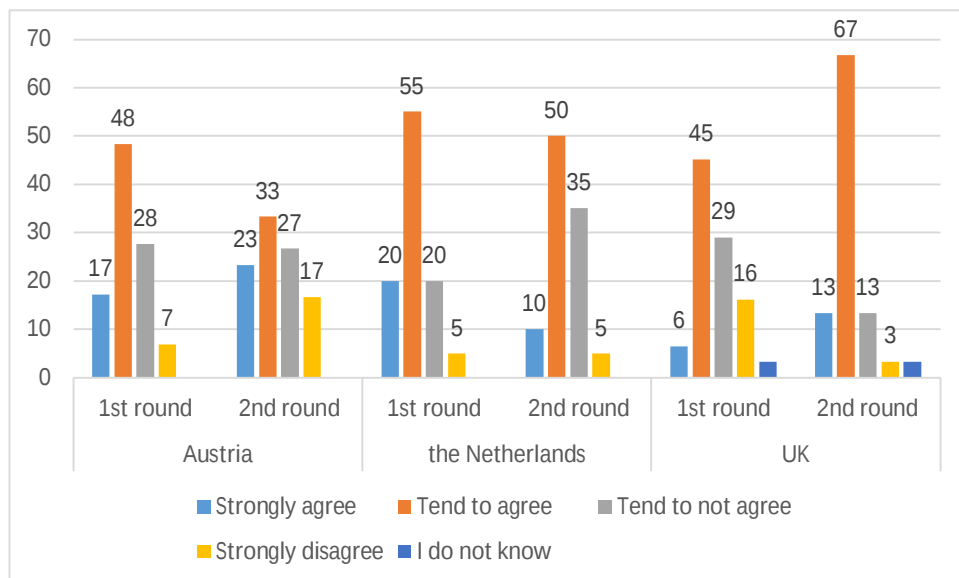


Figure 26: I was able to assess the speeds well during the VR-ride in %

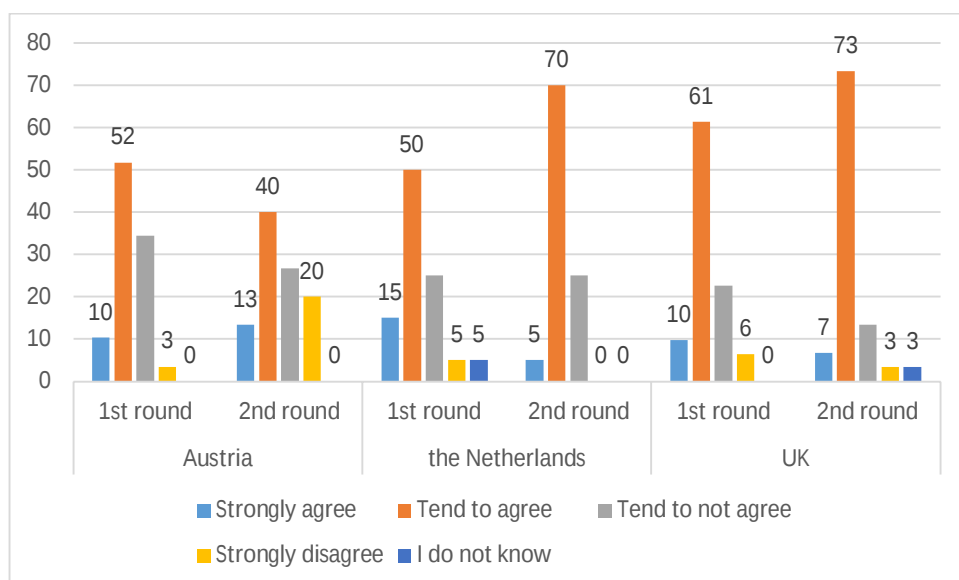


Figure 27: I was able to assess the speeds of the other car drivers well during the VR-ride in % (n=103)

In all three countries the situation with the stopped vehicle during the second simulation test was seen as more realistic than during the first simulation test in which no information was given to the test persons.

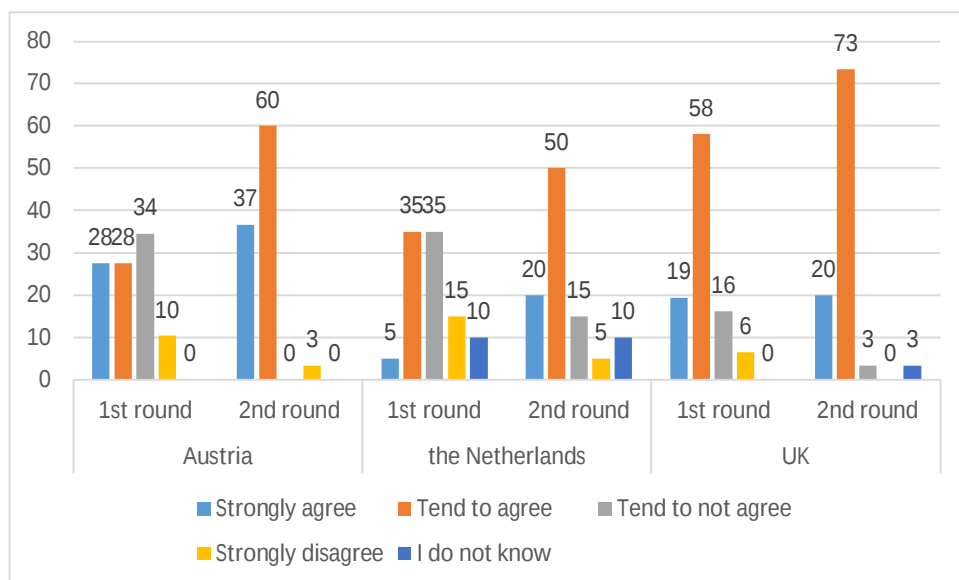


Figure 28: The situations with the stopped vehicle were realistic in % (n= 103)

5 Conclusions

The first simulation study has shown that with regard to a stopped vehicle in a live lane on a motorway, there is a lot of uncertainty among road users as to how to behave correctly. Different kind of behaviour when encountering a stopped vehicle was reported including dangerous behaviour such as trying to get in contact with the driver of the stopped vehicle or stopping next to the stopped car. The behaviour between the three countries (AT, NL, UK) was similar, also with regard to different weather and traffic conditions.

Questions arise on whether it is desirable to warn following vehicles by turning on hazard lights, or to contact someone in such a case, and if so, who should you inform. Here it was seen that the potential among those drivers who are coming first to the incident is not used, because many do not report the stopped vehicle, and many do not know who to contact. Information about the correct behaviour and whom to report the stopped vehicle could be one aspect to improve the speed of detection.

As the second simulation study has shown, information beforehand about the stopped vehicle helps to cope better with the situation. The test persons would have followed the instructions (reduce speed, change lane, stay on recommended lane) given by the various channels. Furthermore, as soon as the test persons received this information also dangerous behaviour such as stopping next to the stopped vehicle decreased to almost zero. Within all four scenarios with the different information channels between 28 and 42 percent of the test persons considered the information given as not sufficient. This shows that for some people it is enough to know how to behave, others would like to know the reason to consider it as a reliable information, while others need the location as exact as possible to feel fully informed. This underlines the importance of using different channels as for example traffic news could be more specific while gantries repeat basic information over a certain distance. Another argument for using various channels was that the test persons had different preferences regarding how the information is given. Visual information not in sight (information on the dashboard) or too much information on the gantries was seen as a problem, while with the traffic news it was stated that they could easily be missed due to other distractions.

From the opinions of the participants the following can be summarised:

- **Short and precise information**

Where (approximate location, what lane is affected); what do I have to do → clear instructions e.g., stay right, do not overtake, continue driving; What is the reason e.g. stopped vehicle. Too much text on the gantry or dashboard irritates and might distract the driver.

- **Repetition of information**

Repeated information makes it possible that it is perceived by many road users, that the content is understood, and that the information is considered important.

- **Multilingual information**

Not only traffic news, but written information on gantry should be not only in the national language of the country, but in other languages too. Symbols used (e.g. lane change arrows) should have international validity.

- **Multisensory information**

Visual information can be complemented by auditory information and vice versa to appeal to as many senses as possible. In this way, for example, road users who are distracted from driving by visual information on the dashboard are also adequately informed.

- **Multichannel information**

Even though gantries were rated as the best source of information by many test persons, it is recommended to use different information channels to get the attention of a wide range of road users. Gantries are not always placed everywhere; car drivers are not always listening to radio; SatNav and navigation apps are not used by everyone, especially on everyday trips; IPV without any prior warnings was considered dangerous as they suddenly appear. If several channels are used in parallel the chance for the car drivers to receive the warning and react adequately is increased.

To decrease the general lack of knowledge how to react in a situation when encountering a vehicle which has stopped in a live lane the following aspects can be considered:

- **Make it a topic in the driver's education**

How to react to a stopped vehicle is obviously not part of driver's education in contrary to what to do when one's own car is stopping on the motorway. This topic could be included in the driving school and learner drivers. One suggestion would be to have a "three-step plan" (e.g. reduce speed – pass by stopped vehicle carefully - stop at a safe place and report) which could be taught on what is best to do in such a case.

- **Make a traffic safety campaign**

Most test subjects were surprised and shocked at the stopped vehicle, as it was perceived to be a rare event. Yet when it does it can be fatal. A road safety campaign on stopped vehicles brings such a situation to people's attention.

- **Install/advertise a hotline**

The test persons did not know who to contact in such a case. An easy-to-remember number, propagated in the media, creates a point of contact for situations related to traffic events.

6 Literature

- Froschauer U., Lueger M. (2003). Das qualitative Interview: Zur Praxis interpretativer Analyse sozialer Systeme, 1st ed.
- Iryo-Asano, Miho & Hasegawa, Yu & Dias, Charitha (2018). Applicability of Virtual Reality Systems for Evaluating Pedestrians' Perception and Behavior. International Symposium of Transport Simulation (ISTS'18) and the International Workshop on Traffic Data Collection and its Standardization (IWTDCS'18). Transportation Research Procedia 00 (2018) 000–000
- Someren M.W., Barnard Y.F., Sandberg J.A.C. (1994). The think aloud method. A practical guide to modelling cognitive processes, London
http://echo.iat.sfu.ca/library/vanSomeren_94_think_aloud_method.pdf
- Sportillo, Daniele & Paljic, Alexis & Ojeda, Luciano. (2018). Get ready for automated driving using Virtual Reality. Accident Analysis & Prevention. 118. 102-113. 10.1016/j.aap.2018.06.003.

Appendix A - Guideline single interviews

SHADAR WP4: Road user behaviour

Interview guide single interviews

The project “**SHADAR**” (Stopped vehicle Hazards – Avoidance, Detection, And Response) addresses the objective of “Preventing collisions with stopped vehicles in a live traffic lane”. Stopped vehicles on the highway network present a significant hazard with impact, especially on safety.

The aim of the interview is to gather more knowledge of how car drivers are behaving in situations in which a stopped vehicle is blocking a lane on a highway. We also want to know where drivers get their information about incidents on the highway and whether there are any suggestions for improvement in this respect.

General questions

- How often do you drive on highways?
- How and when (before the journey, during the journey) do you inform yourself about traffic situations on highways? Which information, channels do you use?

Questions about incidents

- How often have you been confronted with unexpected incidents while driving on the highway? What kind of incidents?
- How do you normally react to information that on the way ahead are problems?
 - Reducing speed, driving with more attention, changing the route?
 - What are signs that there might be problems ahead?
 - Imagine the following situation. You are driving on the highway and a car suddenly stops in front of you. How do you behave?
 - Would you behave differently if you do not see anybody next to the car?
- Would you inform somebody about the stopped vehicle? If yes, whom and how would you inform them?
- Would you consider stopping and have a look yourself?
- How would you behave under different circumstances e.g., when it is raining or in the night?

Suggestions for improvement

- Do you know any technology that warns you about a stopped vehicle on a lane ahead?
- How would you like to be informed about a stopped vehicle on a lane ahead?
 - Navigation system, radio, mobile phone message, in-vehicle technology?
- What information would you need in advance to react appropriate to stopped vehicles?
 - How would you improve the existing system of “stopped vehicle management”?

Appendix B – Informed Consent

SHADAR
Stopped vehicle Hazards – Avoidance, Detection , And Response

Consent to the collection and use of data

This study is carried out by Factum within the project SHADAR - Stopped vehicle Hazards – Avoidance, Detection, And Response. The project is co-ordinate by the British company Mott MacDonald. The responsible project manager at Mott MacDonald is Ian Cornwell. The responsible study directors on site are _____ and _____. The aim of this study is to investigate car drivers' behaviour because of a stopped vehicle within the highway.

You hereby agree that the material (text, audio, video, photos, etc.) created and collected during the study may subsequently be used for the evaluation or development of scientific research results. The material will be evaluated anonymously and the raw data to be evaluated will not be disclosed to third parties outside the project consortium. Collected audio and video material will be deleted after the end of the project. Your personal data (name, telephone number, etc.) will not be disclosed to any third parties also not within the project consortium.

By signing this document, you give your irrevocable consent that the data and materials collected in connection with this study may be used for the above-mentioned purpose and that you may not derive any claims against the project and study management. You further undertake to treat all information concerning this study as confidential and not to pass it on to third parties.

You confirm that you participate in this study voluntarily and at your own risk. You acknowledge that neither the persons conducting the study, nor the project or study management or individual project partners assume liability for any damage to persons and/or property and that no legal claims can be asserted against them. In addition, you confirm that you have been sufficiently informed about the project and the study, that you have the right to withdraw at any point during the study and that your questions have been answered.

Name in capital letters _____

Date

Signature

Appendix C – Pre Questionnaire

SHADAR – Stopped Vehicle Hazards – Avoidance, Detection And Response

Datum: _____ VP-Nr.: _____

Pre-questionnaire

Please fill in the following questionnaire completely and conscientiously. You are making a valuable contribution to scientific research. Thank you for your contribution to this study!

1 Please choose among one of the following: You are

- ☐ male
☐ female
☐ divers

2 Please indicate your age: You are _____ years old.

3 What best describes the area you live in

- ☐ Rural (village)
☐ Suburb or small town
☐ Urban (big city, capital)

4 Which modes of transport do you usually use and how often?

	Every day	min. 1x per week	Multiple times in a month	Less often	never
Car	☐	☐	☐	☐	☐
Public transport	☐	☐	☐	☐	☐
Bicycle	☐	☐	☐	☐	☐
On foot	☐	☐	☐	☐	☐
Other _____	☐	☐	☐	☐	☐

5 How often do you drive on a motorway

- ☐ daily or multiple times in a week
☐ once a week
☐ multiple times in a month
☐ less often

6 How many km are you driving usually per year?

- ☐ 0 – 5.000 km
☐ 5.001-10.000 km
☐ 10.001 – 20.000 km
☐ more than 20.000 km

SHADAR – Stopped Vehicle Hazards – Avoidance, Detection And Response

Datum: _____ VP-Nr.: _____

7 Is your car equipped with an eCall system?

Since March 2018, car manufacturers in the EU have been obliged to equip their new vehicle models to be approved with the so-called automatic emergency call system eCall. In serious car accidents in which, for example, airbags are deployed, eCall systems automatically send an emergency call.

- ☐ yes
☐ no
☐ I do not know

8 How do you usually inform yourself about the traffic situation before or during a motorway trip?
Please tick all that apply

	Before the motorway trip	During the motorway trip
At home on the computer (e.g. google maps)	☐	☐
Radio – traffic messages	☐	☐
Smartphone – Apps such as	☐	☐
In-car navigation system	☐	☐
Gantry 	☐	☐
Others	☐	☐
I do not need any information	☐	☐

9 How do you usually react when you receive the information that there are problems 5 km ahead of you on the motorway? Please tick all that apply

If possible, leave the motorway	☐
Drive more carefully	☐
Reducing speed	☐
Increase distance to other cars	☐
I do not change my driving behaviour	☐
Others _____	☐

Appendix D – Final Questionnaire

SHADAR – Stopped Vehicle Hazards – Avoidance, Detection And Response

Datum: _____ VP-Nr.: _____

Final questionnaire

1 Please indicate to what extent you agree or disagree with the following statements about driving with VR glasses.

	Strongly agree	Tend to agree	Tend to not agree	Strongly disagree	I do not know
I found driving with VR glasses to be exhausting.	☐	☐	☐	☐	☐
I experienced the trip as realistic.	☐	☐	☐	☐	☐
I was able to assess ...					
...the distances well during the VR-ride.	☐	☐	☐	☐	☐
...the speeds well during the VR-ride.	☐	☐	☐	☐	☐
...the speeds of the other car drivers well during the VR-ride.	☐	☐	☐	☐	☐
The situations with the stopped vehicle were realistic.	☐	☐	☐	☐	☐

The goal of this study is to find ways to improve the present situation with stopped vehicles. Information for car drives play an important role in this context.

2 How would you like to be informed about a vehicle which is blocking a lane before or during a motorway trip? Please tick all that apply

	Before the motorway trip	During the motorway trip
At home on the computer (e.g. google maps)		
Radio – traffic messages	☐	☐
Smartphone – Apps such as	☐	☐
In-car navigation system		☐
Gantry 		☐
Others	☐	☐
I do not need any information	☐	☐

SHADAR – Stopped Vehicle Hazards – Avoidance, Detection And Response

Datum: _____ VP-Nr.: _____

3 What are the three most important pieces of information you would like to know when a vehicle has stopped on a motorway lane? *Maximum three mentions*

- ☐ Expected duration until the lane is clear again
- ☐ Name and number of the motorway
- ☐ Approximate location where the stopped vehicle is standing
- ☐ Information which lane is blocked
- ☐ How should one behave, e.g. recommended driving speed, choice of lane
- ☐ Possible alternative routes
- ☐ other: _____

4 How would you improve the current procedure for accidents and incidents on motorways?

THANK YOU FOR YOUR CONTRIBUTION!

Appendix E – General VR-study guideline first run

SHADAR – Stopped Vehicle Hazards – Avoidance, Detection And Response

Scenario 2: vehicle stopped at Lane 2 – the Test Person's vehicle will be on Lane 2 when approaching the stopped vehicle. It will then switch lane to drive past the stopped vehicle and continue on the motorway.

The stopped vehicle will be presented in a variety of the following conditions: hazard lights on / off; and driver standing adjacent to the stopped vehicle / staying within the stopped vehicle.

1.4 Variation of order of scenarios

In order to avoid study artefacts due to the order of the scenarios, the scenarios will be altered for each test person as presented in the following table.

Gender	Age	Nr.	Code Nr.	Order			
women (1)	18-35 (1)	1	111	2b	1b	2a	1a
		2	112	1a	1b	2a	2b
		3	113	2b	1a	1b	2a
		4	114	2a	2b	1a	1b
		5	115	1b	2a	2b	1a
	36-50 (2)	6	126	1b	2a	2b	1a
		7	127	2a	2b	1a	1b
		8	128	1a	1b	2a	2b
		9	129	2b	1a	1b	2a
		10	1210	2a	1a	1b	2b
	over 50 (3)	11	1311	2b	1a	1b	2a
		12	1312	1a	1b	2a	2b
		13	1313	2a	1b	1a	2b
		14	1314	2a	2b	1a	1b
		15	1315	1b	2a	2b	1a
men (2)	18-35 (1)	16	2116	2b	1a	1b	2a
		17	2117	2a	2b	1a	1b
		18	2118	2b	2a	1b	1a
		19	2119	1b	2a	2b	1a
		20	2120	1a	1b	2a	2b
	36-50 (2)	21	2221	1a	1b	2a	2b
		22	2222	2a	2b	1b	1a
		23	2223	2b	1a	1b	2a
		24	2224	1b	2a	2b	1a
		25	2225	2a	2b	1a	1b
	over 50 (3)	26	2326	1b	2b	2a	1a
		27	2327	1a	1b	2a	2b
		28	2328	2b	1a	1b	2a
		29	2329	2a	2b	1a	1b
		30	2330	1b	2a	2b	1a

SHADAR – Stopped Vehicle Hazards – Avoidance, Detection And Response

GENERAL STUDY GUIDE SHADAR - VR simulation study

1 Introduction

This document describes the development requirements and procedure of the VR driver simulation as part of the Work Package 4 of SHADAR.

1.1 Research objectives and structure of the study

- Investigate the behaviour of car drivers because of a stopped vehicle within the highway network
- Elaborating solutions, how drivers want to be informed about stopped vehicles on highways, and how to report an incident
- Evaluation of the effect of measures with respect to stopped vehicles on the driving behaviour

1.2 Basic set-up of the study

The VR study takes place in three countries: Austria, the United Kingdom and the Netherlands. We are aiming for 30 test persons (age and gender balanced) per country.

age	Women			Men		
	18-35	36-50	over 50 years	18-35	36-50	over 50 years
Number of participants	5	5	5	5	5	5

The study is divided into three parts:

- Introduction and pre-questionnaire**, in which primarily socio-demographic data are asked for, as well as questions about driving on motorways (mileage, preparation etc.)
- Survey during the virtual motorway trip**, to gather information about the test person's behaviour in relation to the research goal
- Final questionnaire** that focuses on wishes and suggestions for improvement, as well as questions about the use of VR glasses and the general study design.

The pre- and final questionnaires are structured or partially structured questionnaires with closed and open questions. The during-survey is purely qualitative with open questions.

General information

- Venue:
 - Austria: Factum aptec ventures GmbH, 1230 Wien
 - UK:
 - Netherlands:
- The test persons come individually to the event location in compliance with the Covid-19 regulations
- Duration of the VR simulation study per test person approx. 1 hour

1

SHADAR – Stopped Vehicle Hazards – Avoidance, Detection And Response

- Each test persons will be supervised by the study facilitator
- The test persons must sign a declaration of consent for the use of the data collected including a disclaimer of liability
- The pre- and final questionnaire are completed by the test persons themselves, the survey during the VR-test is conducted by the study facilitator and recorded with a dictaphone
- The test subjects receive € 25 in the form of vouchers for participation, for which a confirmation of receipt must be signed

1.3 VR - simulations

In total, eight independent simulations are available: Four simulations for right hand drive for Austria and the Netherlands and four simulations for left Hand Drive for the tests in United Kingdom. It is the responsibilities of the Facilitator to select the simulation for the Test Person. The following table gives an overview of the eight different simulations.

	Weather condition	Traffic volume	Stopped vehicle hazard lights on	Driver standing next to stopped vehicle	Simulation Reference
Left Hand Drive: Rural dual carriageway with 4 running lanes in each direction	Good	Light	Yes	Yes	L1A
	Light rain	Medium	Yes	No	L1B
	Light rain	Light	Yes	Yes	L2A
	Good	Medium	No	No	L2B
Right Hand Drive: Rural dual carriageway with 3 running lanes + hard shoulder in each direction	Good	Light	Yes	Yes	R1A
	Light rain	Medium	Yes	No	R1B
	Light rain	Light	Yes	Yes	R2A
	Good	Medium	No	No	R2B

The stopped vehicle will always be located towards the end of the simulation.

Scenario 1: vehicle stopped at Lane 1 near an exit – the Test Person's vehicle switch from Lane 2 to Lane 1 prior approaching the stopped vehicle with the intention to exit the motorway. The Test Person's vehicle will then switch lane and drive past the stopped vehicle and exit the motorway.

2

SHADAR – Stopped Vehicle Hazards – Avoidance, Detection And Response

2 Study procedure

2.1 Rough Overview study procedure

In the following a rough overview is given of the study procedure

- Welcome:** The test person is welcomed, shortly informed about
 - the project Shadar and the aim of the VR-simulation study
 - the Covid-19 regulations
 - completion and signing of the declaration of consent
 - Explanation of the procedure
 - Completion of the pre-questionnaire
- VR Simulation Rides (detailed information see VR-simulation study guide)**
 - Accommodation ride
 - 4 VR test rides with two different scenarios with two variation each plus questioning during the rides
 - Filling in the final questionnaire
- Farewell:** Handing out voucher and have the confirmation of receipt signed, informing of the 2nd VR study in January

2.2 Tasks of the facilitator

- Technical preparations**
 - setting up the hardware for the simulation including computer equipment (computer and VR headset); and a seating area where the Test Person can undertake the simulation undisturbed.
 - Dependent on VR headset being used, an initial set up procedure may be required before the first session; consider power supply and/or charging facilities for the computer equipment.
- Follow Up**
 - undertaking a cleaning regime to suit the site set up in accordance with COVID 19 regulations. The VR headset should always be cleaned between uses.
 - Safe the data: filling the questionnaires, checking the recordings, transferring the recordings to the computer and delete file from the dictaphone
 - Setting up the hardware for the next test person

4

Appendix F – Interview Guide VR-study first run

SHADAR – Stopped Vehicle Hazards – Avoidance, Detection And Response

Shadar interview guide – VR SIMULATION

1. Welcome and Introduction (10 min)

Welcome

Hello! My name is _____. I'm a researcher of the institute _____ and I will facilitate you through the study. The whole simulation study will take about one hour.

Project Shadar – Objective of the study

The project "SHADAR" (Stopped vehicle Hazards – Avoidance, Detection, And Response) addresses the objective of "Preventing collisions with stopped vehicles in a live traffic lane". Stopped vehicles on the highway network present a significant hazard with impact, especially on safety.

The aim of the VR-simulation study is to

- Investigate the behaviour of car drivers because of a stopped vehicle within the highway network
- Elaborate solutions, how drivers want to be informed about stopped vehicles on highways
- Evaluate the effect of measures with respect to stopped vehicles on the driving behaviour

General information

Explanation of the specific COVID-19 regulations, information where the toilet is, information that study can be canceled by the test person at any time. If you did not understand the instruction at any time, please do not hesitate to ask immediately for repeating the instruction.

Informed Consent – Pre - questionnaire

During the study, various data will be collected via interviews and recorded. The VR-rides will be recorded via video. Besides I will take photos as documentation for the client. Therefore, I ask you to read the following data usage permission and, if you agree to participate in the study, to sign it. As a rule, all data collected will be analysed and used anonymously.

The informed consent is handed out for signing

Before we will start with the VR-rides I ask you to fill in the first questionnaire.

Pre-questionnaire is handed out

SHADAR – Stopped Vehicle Hazards – Avoidance, Detection And Response

Instructions for the Facilitator

If the test person hardly or do not comment about the driving situation (speed, lane choice, overall situation) the facilitator will stop the simulation after approx. 2 minute and ask the test person the following questions.

- Driving speed
 - what speed to you think you are driving
 - would you rather drive faster or slower or is the driven speed be okay?
 - any situations in which you would drive faster or slower
- Lane choice
 - would you also choose this lane, or another, which one
 - when would you change lane
 - would you change lanes more often
- Overall situation on the motorway
 - How do you experience the situation on the motorway e.g. stressful, relaxed, easy to understand, complex
 - What is pleasant or uncomfortable for you while driving
 - How do you experience the interaction with other road users

After the questions the simulation will go on until the stopped vehicle will appear

Stop before the situation = in front of the stopped vehicle

The facilitator asks the test person the following questions:

- Please describe the situation in front of you. Have you ever been in such a situation? If so, how did you behave at the time
- How would you act in this situation?
- What would make you most uncomfortable about this situation?
- Would you get help? If so, how and whom would you notify?
- What do you expect from other road users?
- Could you imagine stopping or under what circumstances would you stop?
- Would you act differently at night?

After the questions the simulation will go on until the end of the simulation

Stop after the situation

- How do you think the situation has been resolved? What was good, what was not so good?
- Could you imagine stopping now or under what circumstances would you stop?
- Would you get help now? If so, how and whom would you notify?
- Would you consider passing by the stopped vehicle on the right (left) side?
- When, how and what information would you need in order to be able to deal with the situation adequately? What kind of help do you expect?
- Did other cars influence your own behaviour?

SHADAR – Stopped Vehicle Hazards – Avoidance, Detection And Response

2. VR-Simulation – rides (45 min)

General introduction for the test person

Before we will start with the actual Study-VR rides, you will have time to get used to the VR-glasses by a short accommodation ride.

After the accommodation ride with the VR glasses, you will experience four VR simulations. In each simulation you will drive on a motorway and

You will experience the simulation by wearing a VR headset. The head position of the VR simulation will be on the driver seat of a car. You will have the freedom to look anywhere. However, you will not be able to control the movement of the vehicle, nor the speed.

Please comment during the trips:

We will stop the simulation several times in order to ask you some questions.

If you have any questions or you are feeling uncomfortable, please tell us and we can stop the simulation at any time.

The test person tests the VR-glasses and starts then with VR-Simulations

SHADAR – Stopped Vehicle Hazards – Avoidance, Detection And Response

There will be a short break after the first ride. The facilitator explains that for the second, third and fourth ride the test person will follow the same procedure and starts the second and in the following the third and fourth ride.

After the fourth ride:

You are nearly done, there is just one more questionnaire to fill in.

The facilitator hands out the final questionnaire

3. Farewell (5 min)

Thanks a lot for participating in our study. I hope you will take part in our second part of the study in January 2022 (?) You have made an important contribution to our scientific work. You receive an XY voucher worth € 25. I ask you to confirm the receipt of the voucher.

Facilitator takes care of the follow up:

- undertaking a cleaning regime to suit the site set up in accordance with COVID 19 regulations. The VR headset should always be cleaned between uses.
- Safe the data: filling the questionnaires, checking the recordings, transferring the recordings to the computer and delete file from the dictaphone
- Setting up the hardware for the next test person

Appendix G –VR-study guide second run

SHADAR – Stopped Vehicle Hazards – Avoidance, Detection And Response

STUDY GUIDE SHADAR - VR simulation study

1 Introduction

This document describes the development requirements and procedure of the 2nd VR driver simulation as part of the Work Package 4 of SHADAR.

1.1 Research objectives and structure of the study

The aim of the second VR-simulation study is to investigate if the test persons show reactions in a wished-for way if they are informed beforehand of a stopped vehicle in a live lane

Questions:

- Do test persons perceive the additional information about the incident?
- Do the test persons behave according to the recommendations (change speed, change lane, drive more carefully etc.)?
- Is the information given sufficient and comprehensible?

1.2 Basic set-up of the study

The VR study takes place in three countries: Austria, the United Kingdom and the Netherlands. We are aiming for 30 test persons (age and gender balanced) per country. A part of the test persons (15-20) should already have taken part in the first simulation test.

age	Women			Men		
	18-35	36-50	over 50 years	18-35	36-50	over 50 years
Number of participants	5	5	5	5	5	5

The study is divided into three parts:

- Introduction and pre-questionnaire** (only for those who participate the first time), in which primarily socio-demographic data are asked for, as well as questions about driving on motorways (mileage, preparation etc.)
- Survey during the virtual motorway trip**, to gather information about the test person's behaviour and opinions in relation to the research goal
- Final questionnaire** that focuses on wishes and suggestions for improvement, as well as questions about the use of VR glasses and the general study design.

All questionnaires are standardised with some open questions.

General information

SHADAR – Stopped Vehicle Hazards – Avoidance, Detection And Response

Scenario 1 + 2: Vehicle stopped at Lane 1 near exit	2 + hard shoulder	good	light	yes	no	Mobile lane closure	S1
	3 + hard shoulder	light rain	medium	yes	yes	Electronic messages on gantries	S2
Scenario 3 + 4: Vehicle stopped at Lane 2	2 + hard shoulder	light rain	light	yes	yes	Traffic radio	S3
	2 + hard shoulder	good	light	yes	no	In-vehicle information	S4

The stopped vehicle will always be located towards the end of the simulation.

1.4 Variation of order of scenarios

In order to avoid study artefacts due to the order of the scenarios, the scenarios will be altered as presented in the following table.

If the test person participated already during the first test run please use the same code number. If the test person participating the first time please add an "n" to the code number.

Gender	Age	Nr.	Code Nr.	Order			
women (1)	18-35 (1)	1	111	S4	S2	S3	S1
		2	112	S1	S2	S3	S4
		3	113	S4	S1	S2	S3
		4	114	S3	S4	S1	S2
		5	115	S2	S3	S4	S1
	36-50 (2)	6	126	S2	S3	S4	S1
		7	127	S3	S4	S1	S2
		8	128	S1	S2	S3	S4
		9	129	S4	S1	S2	S3
		10	1210	S3	S1	S2	S4
	over 50 (3)	11	1311	S4	S1	S2	S3
		12	1312	S1	S2	S3	S4
		13	1313	S3	S2	S1	S4
		14	1314	S3	S4	S1	S2
		15	1315	S2	S3	S4	S1
men (2)	18-35 (1)	16	2116	S4	S1	S2	S3
		17	2117	S3	S4	S1	S2
		18	2118	S4	S3	S2	S1
		19	2119	S2	S3	S4	S1
		20	2120	S1	S2	S3	S4

3

SHADAR – Stopped Vehicle Hazards – Avoidance, Detection And Response

- UK:
- Netherlands:

- The test persons come individually to the event location in compliance with the Covid-19 regulations
- Duration of the VR simulation study per test person approx. 30 minutes
- Each test persons will be supervised by the study facilitator
- The test persons must sign a declaration of consent for the use of the data collected including a disclaimer of liability
- The pre- and final questionnaire are completed by the test persons themselves, the survey during the VR-test is conducted by the study facilitator and recorded with a dictaphone
- The test subjects receive € 25 in the form of vouchers for participation, for which a confirmation of receipt must be signed

1.3 VR - simulations

In total, eight independent simulations are available: Four simulations for right hand drive for Austria and the Netherlands and four simulations for left Hand Drive for the tests in United Kingdom. It is the responsibilities of the Facilitator to select the simulation for the Test Person. The following table gives an overview of the eight different simulations.

United Kingdom

Stopped Vehicle Scenario	Number of lanes	Weather conditions	Traffic volume	Stopped vehicle hazard lights on	Driver standing next to stopped vehicle	Additional information	Scenario nr.
Scenario 1 + 2: Vehicle stopped at Lane 1 near exit	2 + hard shoulder	good	light	yes	no	Mobile lane closure	S1
	4	light rain	medium	yes	yes	Electronic messages on gantries	S2
Scenario 3 + 4: Vehicle stopped at Lane 2	2 + hard shoulder	light rain	light	yes	no	Traffic radio	S3
	2+HS	good	light	Yes	no	In-vehicle information	S4

Austria and the Netherlands

Stopped Vehicle Scenario	Number of lanes	Weather conditions	Traffic volume	Stopped vehicle hazard lights on	Driver standing next to stopped vehicle	Additional information	Scenario nr.
--------------------------	-----------------	--------------------	----------------	----------------------------------	---	------------------------	--------------

2

SHADAR – Stopped Vehicle Hazards – Avoidance, Detection And Response

36-50 (2)	21	2221	S1	S2	S3	S4
	22	2222	S3	S4	S2	S1
	23	2223	S4	S1	S2	S3
	24	2224	S2	S3	S4	S1
	25	2225	S3	S4	S1	S2
over 50 (3)	26	2326	S2	S4	S3	S1
	27	3327	S1	S2	S3	S4
	28	2328	S4	S1	S2	S3
	29	2329	S3	S4	S1	S2
	30	2330	S2	S3	S4	S1

2 Study procedure

2.1 Overview study procedure

In the following an overview is given of the study procedure

- Welcome:** The test person is welcomed, shortly informed about
 - the project Shadar and the aim of the VR-simulation study
 - the Covid-19 regulations
 - completion and signing of the declaration of consent
 - Explanation of the procedure
 - Completion of the pre-questionnaire (if necessary)
- VR Simulation Rides** (detailed information see VR-interview guide)
 - Accommodation ride
 - 4 VR test rides with four variation each plus questioning during the rides
 - Filling in the final questionnaire
- Farewell:** Handing out voucher and have the confirmation of receipt signed, informing of the 2nd VR study in January

2.2 Tasks of the facilitator

- Technical preparations**
 - setting up the hardware for the simulation including computer equipment (computer and VR headset); and a seating area where the Test Person can undertake the simulation undistracted.
 - Dependent on VR headset being used, an initial set up procedure may be required before the first session; consider power supply and/or charging facilities for the computer equipment.

4

SHADAR – Stopped Vehicle Hazards – Avoidance, Detection And Response

- Follow Up
 - undertaking a cleaning regime to suit the site set up in accordance with COVID 19 regulations. The VR headset should always be cleaned between uses.
 - Safe the data: filing the questionnaires, checking the recordings, transferring the recordings to the computer and delete file from the dictaphone
 - Setting up the hardware for the next test person

2.3 Check-list for the facilitator

The following equipment/documents are needed for the study:

	Check
Equipment	
Simulation hardware, VR-head-set	
Disinfectant	
25 € Vouchers as incentive	
Dictaphone	
Paper/pencil for taking notes during the simulation	
Water for the test person	
Documents	
General Study guide	
Study guide VR-simulation	
Order of scenarios	
Consent to the collection and use of data	
Pre-questionnaire	
Final questionnaire	
Confirmation of receipt the voucher	

Appendix H – Interview guide VR-study second run

SHADAR – Stopped Vehicle Hazards – Avoidance, Detection And Response

Shadar interview guide – VR SIMULATION

1. Welcome and Introduction (10 min)

Welcome

Hello! My name is _____, I'm a researcher of the institute _____ and I will facilitate you through the study. The whole simulation study will take about one hour.

Project Shadar – Objective of the study

The European project "SHADAR" (Stopped vehicle Hazards – Avoidance, Detection, And Response) addresses the objective of preventing collisions on motorways.

General information

Explanation of the specific COVID-19 regulations, information where the toilet is, information that study can be canceled by the test person at any time. If you did not understand the instruction at any time, please do not hesitate to ask immediately for repeating the instruction.

Informed Consent – Pre - questionnaire

During the study, various data will be collected via interviews and recorded. The VR-rides will be recorded via audio. Besides I will take photos as documentation for the client. Therefore, I ask you to read the following data usage permission and, if you agree to participate in the study, to sign it. As a rule, all data collected will be analysed and used anonymously.

The informed consent is handed out for signing

Before we will start with the VR-rides I ask you to fill in the first questionnaire (only if test person is coming for the first time).

Pre-questionnaire is handed out

3. VR-Simulation – rides (20 min)

1. Adjusting the VR-glasses to the test person's head

2. Short accommodation ride with the VR-glasses

Asking the test person, if there are any open questions and if the test rides can be started now?

Reminder that the test person should comment on speed, lane choice and overall situation.

3. Start first VR-Simulations

Start recording

Taking notes about special comments or behaviour

4. When information is given through different sources (gantry, SatNav, radio)

- Fill in the questionnaire according to the comments of the test person with regard to
 - Information recognised
 - Content of information
 - How test person would behave (differently)
- Taking notes about special comments or behaviour

5. Stop of simulation after passing by the stopped vehicle

If test person has not commented on the information given during the test ride he/she should be asked if information was recognised, about the content and how he/she would have behaved.

Additional questions with regard to:

Considering passing by the stopped vehicle on the right (left) side?

Information given sufficient/early enough/what was missing

Anticipation of the situation

6. Short break

There will be a short break after the first ride. The facilitator explains that for the second, third and fourth ride the test person will follow the same procedure

SHADAR – Stopped Vehicle Hazards – Avoidance, Detection And Response

2. Introduction to the VR-Simulation (5 min)

General introduction for the test person

Before we will start with the actual Study-VR rides, you will have time to get used to the VR-glasses by a short accommodation ride.

After the accommodation ride with the VR glasses, you will experience four VR simulations. In each simulation you will drive on a motorway and leave the motorway at the exit "Sale".

You will experience the simulation by wearing a VR headset. The head position of the VR simulation will be on the driver seat of a car. You will have the freedom to look anywhere. However, you will not be able to control the movement of the vehicle, nor the speed.

Please comment during the trips:

- Driving speed
 - what speed do you think you are driving
 - would you rather drive faster or slower or is the driven speed okay
 - any situations in which you would drive faster or slower
- Lane choice
 - would you also choose this lane, or another, which lane
 - when would you change lane
 - would you change lanes more often
- Overall situation on the motorway
 - How do you experience the situation on the motorway e.g. stressful, relaxed, easy to understand, complex
 - What is pleasant or uncomfortable for you while driving
 - How do you experience the interaction with other road users

If you are feeling uncomfortable, please tell us and we can stop the simulation at any time!

Do you have any questions? Do you need to go to toilet before we start the simulation?

SHADAR – Stopped Vehicle Hazards – Avoidance, Detection And Response

7. Start next simulation and repeat procedure from point 3 on

8. After the fourth ride:

Ask final questions and hand out the final questionnaire

4. Farewell (5 min)

Thanks a lot for participating in our study. You have made an important contribution to our scientific work. You receive an XY voucher worth € 25. I ask you to confirm the receipt of the voucher.

Facilitator takes care of the follow up:

- undertaking a cleaning regime to suit the site set up in accordance with COVID 19 regulations. The VR headset should always be cleaned between uses.
- Safe the data: filing the questionnaires, checking the recordings, transferring the recordings to the computer and delete file from the dictaphone
- Setting up the hardware for the next test person

Appendix I – Interview questions VR-study second run

Datum: _____ VP-Nr.: _____

Questionnaire for the simulation ride S1 – impact protection vehicle

If the test person mentions or comments during the simulation, please tick the box.

	Mentioned during the simulation
Comments on the information which was given by the impact protection vehicle	☐
Content of the information	
Lane change necessary	☐
Lane closure	☐
Incidents	☐

	Mentioned during the simulation, how he/she would react
Change lane as recommended	☐
No more lane changes	☐
Reduce speed	☐
Increase safety distance	☐
Turn on radio	☐
Drive more carefully	☐
Search for alternative routes	☐
Same as the simulation car	☐
Other reactions:	

Additional important comments during the simulation rides:

Seitenumbruch

Datum: _____ VP-Nr.: _____

Additional question after passing by the stopped vehicle S1 – impact protection vehicle

If the test person has not commented on the information given:

Have you recognized that additional information that was given before the incident? → ☐ Yes ☐ No

What was the content of the information? (Open question: Only tick those boxes, that are mentioned by the interviewee. Do not ask for the categories).

Lane change necessary	☐
Lane closure	☐
Incidents	☐
Others	

If the test person has not comment on how he/she would behave:

How would you behave? (Open question: Only tick those boxes, that are mentioned by the interviewee. Do not ask for the categories)

Change lane as recommended	☐
No more lane changes	☐
Reduce speed	☐
Increase safety distance	☐
Turn on radio	☐
Drive more carefully	☐
Search for alternative routes	☐
Same as the simulation car	☐
Other reactions:	

Would you consider passing by the stopped vehicle on the right (left) side? → ☐ Yes ☐ No

Was the information given sufficient to be able to react adequately to the situation? → ☐ Yes ☐ No

If ticked no, what was missing: _____

Was the information given early enough? → ☐ Yes ☐ No

→ If ticked no, when should the information be given? _____

What would you do next, when you passed the stopped vehicle?	mentioned
Drive on	☐
Stopping to help	☐
Exit motorway	☐
Other:	

Datum: _____ VP-Nr.: _____

Questionnaire for the simulation ride S2 – gantry

If the test person mentions or comments during the simulation, please tick the box.

	Mentioned during the simulation
Recognised the information which was given by the impact protection vehicle	☐
Content of the information	
Lane change necessary	☐
Lane closure	☐
Incidents	☐
New speed limits	☐

	Mentioned during the simulation, how he/she would react
Change lane as recommended lane	☐
No more lane changes	☐
Reduce speed	☐
Increase safety distance	☐
Turn on radio	☐
Drive more carefully	☐
Search for alternative routes	☐
Same as the simulation car	☐
Other reactions:	

Additional important comments during the simulation rides:

Seitenumbruch

Datum: _____ VP-Nr.: _____

Additional question after passing by the stopped vehicle S2 – gantry

If the test person has not comment on the information given:

Have you recognized that additional information was given before the incident? → ☐ Yes ☐ No

What was the content of the information?

Lane change necessary	☐
Lane closure	☐
Incidents	☐
New speed limits	☐
Others	

If the test person has not comment on how he/she would behave:

How would you behave?

Change lane as recommended lane	☐
No more lane changes	☐
Reduce speed	☐
Increase safety distance	☐
Turn on radio	☐
Drive more carefully	☐
Search for alternative routes	☐
Same as the simulation car	☐
Other reactions:	

Would you consider passing by the stopped vehicle on the right (left) side? → ☐ Yes ☐ No

Was the information given sufficient to be able to react adequately to the situation? → ☐ Yes ☐ No

If ticked no, what was missing: _____

Was the information given early enough? → ☐ Yes ☐ No

→ If ticked no, when should the information be given? _____

What would you do next, when you passed the stopped vehicle?	mentioned
Drive on	☐
Stopping to help	☐
Exit motorway	☐
Other:	

Questionnaire for the simulation ride S3—Radio

If the test person mentions or comments during the simulation, please tick the box.

	Mentioned during the simulation
Recognised the information which was given by the impact protection vehicle	☐
Content of the information	
Lane change necessary	☐
Lane closure	☐
Incidents	☐
New speed limits	☐
Drive on the right lane	☐
Drive more carefully	☐

	Mentioned during the simulation, how he/she would react
Change lane as recommended	☐
No more lane changes	☐
Reduce speed	☐
Increase safety distance	☐
Turn on radio	☐
Drive more carefully	☐
Search for alternative route	☐
Same as the simulation car	☐
Other reactions:	

Additional important comments during the simulation rides:

Seitenumbruch

Additional question after passing by the stopped vehicle S3—Radio

If the test person has not comment on the information given:

Have you recognized that additional information was given before the incident? → ☐ Yes ☐ No

What was the content of the information?

Lane change necessary	☐
Lane closure	☐
Incidents	☐
New speed limits	☐
Drive on the right lane	☐
Drive more carefully	☐

If the test person has not comment on how he/she would behave:

How would you behave?

Change lane as recommended	☐
No more lane changes	☐
Reduce speed	☐
Increase safety distance	☐
Turn on radio	☐
Drive more carefully	☐
Search for alternative route	☐
Same as the simulation car	☐
Other reactions:	

Would you consider passing by the stopped vehicle on the right (left) side? → ☐ Yes ☐ No

Was the information given sufficient to be able to react adequately to the situation? → ☐ Yes ☐ No

If ticked no, what was missing:

Was the information given early enough? → ☐ Yes ☐ No

→ If ticked no, when should the information be given?

What would you do next, when you passed the stopped vehicle?	mentioned
Drive on	☐
Stopping to help	☐
Exit motorway	☐
Other:	☐

SHADAR—Stopped Vehicle Hazards—Avoidance, Detection And Response

Datum: —VP-Nr.:

Questionnaire for the simulation ride S4—IVT

If the test person mentions or comments during the simulation, please tick the box.

	Mentioned during the simulation
Recognised the information which was given by the impact protection vehicle	☐
Content of the information	
Lane closure	☐
Incidents	☐
Drive on the right lane	☐

	Mentioned during the simulation, how he/she would react
Change lane as recommended	☐
No more lane changes	☐
Reduce speed	☐
Increase safety distance	☐
Turn on radio	☐
Drive more carefully	☐
Search for alternative route	☐
Same as the simulation car	☐
Other reactions:	

Additional important comments during the simulation rides:

Seitenumbruch

SHADAR—Stopped Vehicle Hazards—Avoidance, Detection And Response

Datum: —VP-Nr.:

Additional question after passing by the stopped vehicle S4—IVT

If the test person has not comment on the information given:

Have you recognized that additional information was given before the incident? → ☐ Yes ☐ No

What was the content of the information?

Lane closure	☐
Incidents	☐
Drive on the right lane	☐

If the test person has not comment on how he/she would behave:

How would you behave?

Change lane as recommended	☐
No more lane changes	☐
Reduce speed	☐
Increase safety distance	☐
Turn on radio	☐
Drive more carefully	☐
Search for alternative route	☐
Same as the simulation car	☐
Other reactions:	

Would you consider passing by the stopped vehicle on the right (left) side? → ☐ Yes ☐ No

Was the information given sufficient to be able to react adequately to the situation? → ☐ Yes ☐ No

If ticked no, what was missing:

Was the information given early enough? → ☐ Yes ☐ No

→ If ticked no, when should the information be given?

What would you do next, when you passed the stopped vehicle?	mentioned
Drive on	☐
Stopping to help	☐
Exit motorway	☐
Other:	☐

Seitenumbruch

SHADAR—Stopped-Vehicle-Hazards—Avoidance, Detection-And-Response¶

¶

Datum: _____ ---VP-Nr.: _____¶

¶

¶

Final-questions-after-the-four-simulation-rides¶

Which-of-the-different-information-sources-was-the-best-so-that-you-could-anticipate-the-incident-and-react-according-to-it?-(only-one-answer-possible)¶

☐ Gantry ☐ Display-on-dashboard ☐ Traffic-News-via-radio ☐ Impact-protection-vehicle¶

¶

Why-was-this-the-best-source? _____¶

¶

What-was-missing-at-the-other-sources? _____¶

¶

Any-other-comments? _____¶