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D9.1

Report on vehicle survey operator needs

Safe tolerance zone calculation and interventions for driver-vehicle-environment interactions under challenging conditions

iDREAMS

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Glossary and abbreviations

Word / Abbreviation	Description
i-DREAMS	smart Driver, Vehicle & Environment Assessment and Monitoring System
OEM	Original Equipment Manufacturers
SPAD	Signal Passed At Danger

1 Introduction to *i*-DREAMS

In the era of digitization, technology developments have been making massive and detailed operator performance data easily available, thus upscaling transport technology into a new level of challenging conditions and drastically transforming the framework of operator-vehicle-environment interactions. Consequently, the need for increased understanding of the human factors – distraction, fatigue and drowsiness, health concerns, extreme emotions and socio-cultural factors – affecting the behaviour of operators, and the harmonization of them with the current state of transport and data technology, create an opportunity to detect and design customised interventions to mitigate road risks, increase awareness and dynamically upgrade road operators' performance.

The project entitled **'Safety tolerance zone calculation and interventions for driver-vehicle-environment interactions under challenging conditions' — '*i*-DREAMS'** aims to setup a framework for the definition, development, testing and validation of a context-aware 'Safety Tolerance Zone' for driving, within a smart Driver, Vehicle & Environment Assessment and Monitoring System (*i*-DREAMS). This framework should translate into new road safety interventions, improved driver well-being and transfer of control between human and vehicle, as well as a more eco-efficient driving style since safer driving implies an eco-friendlier behaviour.

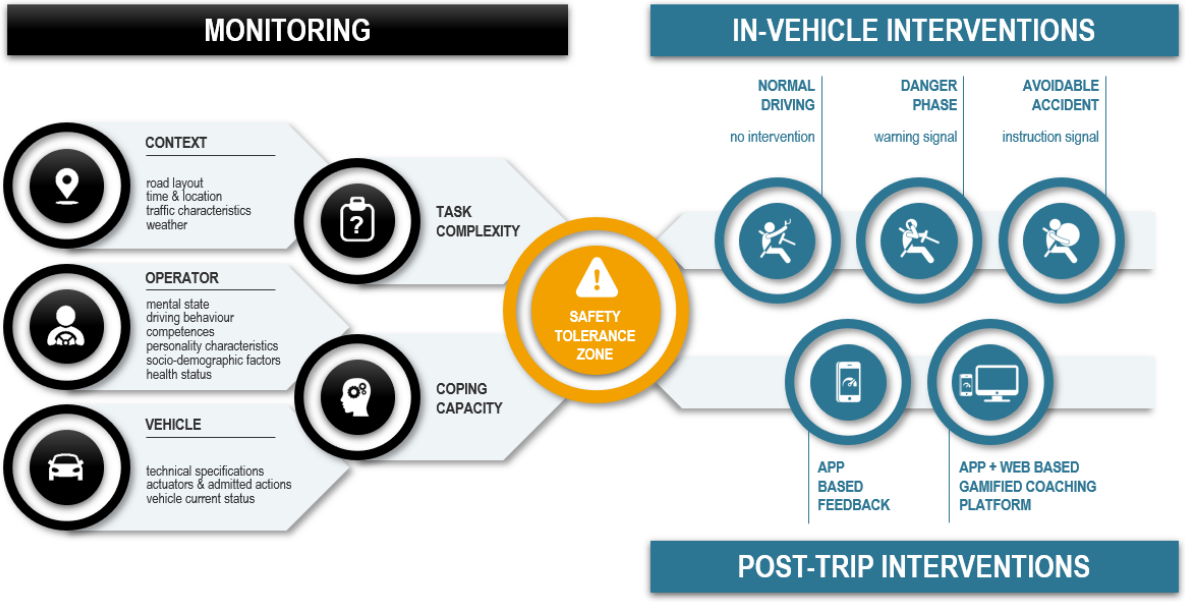

*Figure 1: **Conceptual Framework**: the i-DREAMS platform with the monitoring module (pillar I: Determination of safety tolerance zone via monitoring of task complexity and coping capacity) & interventions module (pillar II: Implementation of in-vehicle and post-trip interventions)*

Taking into account, on the one hand, driver-related background factors (age, driving experience, safety attitudes and perceptions, etc.) and real-time risk-related physiological indicators (e.g. fatigue, distraction, stress, etc.), and on the other hand, driving task-related complexity indicators (e.g. time of day, speed, traffic intensity, presence of vulnerable road users, adverse weather, etc.) a continuous real-time assessment will be made to monitor and determine if a driver is within acceptable boundaries of safe operation (i.e. safety tolerance zone).

Initial testing will take place in a driving simulator environment after which promising interventions will be tested and validated under real-world conditions in a testbed consisting of 600 drivers in total across 5 EU countries. Market roadmaps will be developed to support smooth transition of the investigated technologies to the market and experience from use cases in different European countries will be used to disseminate best practices.

1.1 Deliverable Overview

Essential to the definition, development, testing and validation of the project itself, *i*-DREAMS, and in particular its work package **WP9. Stakeholder consultation and dissemination** will ensure wide consultation of all relevant stakeholders.

Such consultation will take form of:

- The Expert Advisory Board, formed by five members active in various fields relevant for *i*-DREAMS who will contribute to the project's activities, comment on relevant deliverables and draft recommendation to support the exploitation of the concepts and technologies created by the project and the development of new road safety interventions;
- The User Advisory Board, formed by a total of 25 members categorised as original equipment manufacturers and suppliers, local/regional/national authorities, insurance companies and driver associations representatives, road, fleet and public transport operators, as well as researchers and driver educators, who will help the project gather sufficient data, knowledge and experience on the development, testing and validation of a 'safety tolerance zone' for driving.

The consultation activities will be complemented by feedback from the User Advisory Board, as well as from the Expert Advisory Board.

1.2 Report Structure

This report outlines and analyses the results of the *i*-DREAMS Stakeholder Survey, as well as its context, aims and methods of submission. On one hand, particular attention is given to respondents/stakeholders and their overall user profile. On the other hand, the survey analysis focuses on three modes of transport (Passenger car, Bus/coach, Truck) and their respective experts – giving voice to their needs and beliefs in relation to technology applied to road safety. Trains and Trams are briefly taken into account and separately mentioned. The main findings and related recommendations to engage with users are made on the basis of the results collected and analysed. This report is a necessary step to the introduction, creation and work-in-progress of the User Advisory Board, which will help the project gather sufficient data, knowledge and experience on the development, testing and validation of a 'safety tolerance zone' for driving.

2 *i*-DREAMS Stakeholder Survey

2.1 Context and Aims

In order to understand how the *i*-DREAMS system could best address the problems leading to accidents, a survey was required to capture experts' opinions of the main issues leading to accidents and the barriers which experts think require overcoming to successfully integrate the system into everyday lives of drivers.

The *i*-DREAMS Stakeholder Survey aimed to capture what industry experts for various transport modes thought were the main accident types, the reasons behind these accidents, how technology might be able to help reduce such accidents and their personal experience of technologies, both current and concept designs.

The results of the survey fulfil the requirements of Deliverable 3.1 Framework for the operational design of experimental work in *i*-DREAMS (M9) and Deliverable 9.1 Report on survey on vehicle operator needs (M6).

2.2 Method

The questionnaire at the centre of the *i*-DREAMS Stakeholder Survey was developed by a team of researchers at Loughborough University, UK, with experience in human factors/ergonomics in the transport domain and driver state issues. The questions (17 in total) were written to meet the above-mentioned aims (see 2.1 Context and Aims) in a logical and succinct way. This required the use of open, closed and ranking questions as deemed most appropriate to the issue being addressed. It was important that the same questions would be relevant for all transport modes (cars, trains, trams, trucks and buses/coaches), which added to the complexity of the design.

The survey questionnaire was disseminated to project partners for feedback multiple times until its completion. It was then approved by Loughborough University Ethics for distribution. The final version was entered into Online Surveys (https://www.onlinesurveys.ac.uk/) to allow for easy electronic distribution and survey completion across countries. The survey was forwarded to relevant contacts by partners within the *i*-DREAMS project, including Polis networks' 3948 contacts (3660 successful deliveries - 92.71%) from four *ad-hoc* members mailing lists (Local and regional authorities, New Alerts - Road safety & security, Info Polis Newsletter, EU Project Updates). The survey was made available and directly accessible on the *i*-DREAMS website, too: this allowed for easy sharing on social media thanks to an in-built Twitter handle. The survey remained open from the 4th September to 2nd October 2019.

The survey took approximately 15 minutes to complete and respondents could withdraw at any time by closing their browser.

In accordance with the GDPR and Data Protection Act regulations, respondents could eventually, and above-all voluntarily, enter their email addresses upon completion if they wished to become part of the *i*-DREAMS User Expert Group. 55 respondents out of 103 thus gave their email addresses. Due to the sensitivity of this information, a way to handle and store this data was devised, whereas all other questions were collected with anonymised data that will be stored by the research team for 5 years.

Personal data will be kept exclusively and separately for the duration of the project.

2.3 Respondents

The survey was completed by 103 responders, all of whom gave informed consent to use their anonymised data in the *i*-DREAMS project deliverables and relevant publications.

Most responses (96) came from within the EU, with the most responders being from Portugal (28), the United Kingdom (14), Belgium (11) and Greece (10). Other remarkable EU-results were scored by Austria (7), Germany (4), Italy and Vatican City (4), the Netherlands (4) and Spain (3). The remaining extra-European responses (6) came from the USA (3), Iran (1), New Zealand (1) and Qatar (1).

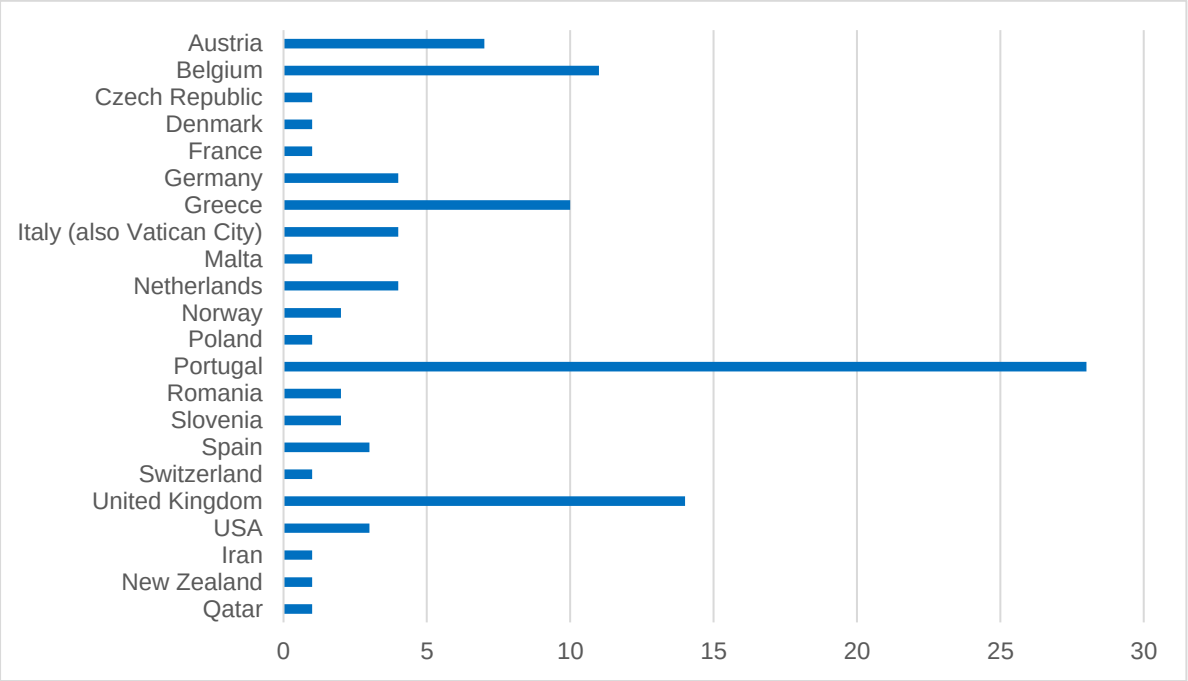

Figure 2: ***Respondents' country of work (Q2)***

Academic and commercial researchers – which corresponded to two different selectable categories within question 3 *"Which of these best defines your field of work (please select one only)"* – were the highest responders (37), followed by Operators (20) and Policy makers (8). 14 responders marked themselves as 'Other' indicating they did not fall under any of the pre-selected groups. Responses in the comments box indicate these included:

- Consultants (5)
- a Lawyer
- a University Lecturer
- a Data Analyst
- a Project Manager in public transport
- a Government Agent
- a Distributor
- a Purchaser
- a Regulator
- a Mobility and Road Safety Expert
- an Agent in an NGO for Transport Sustainability

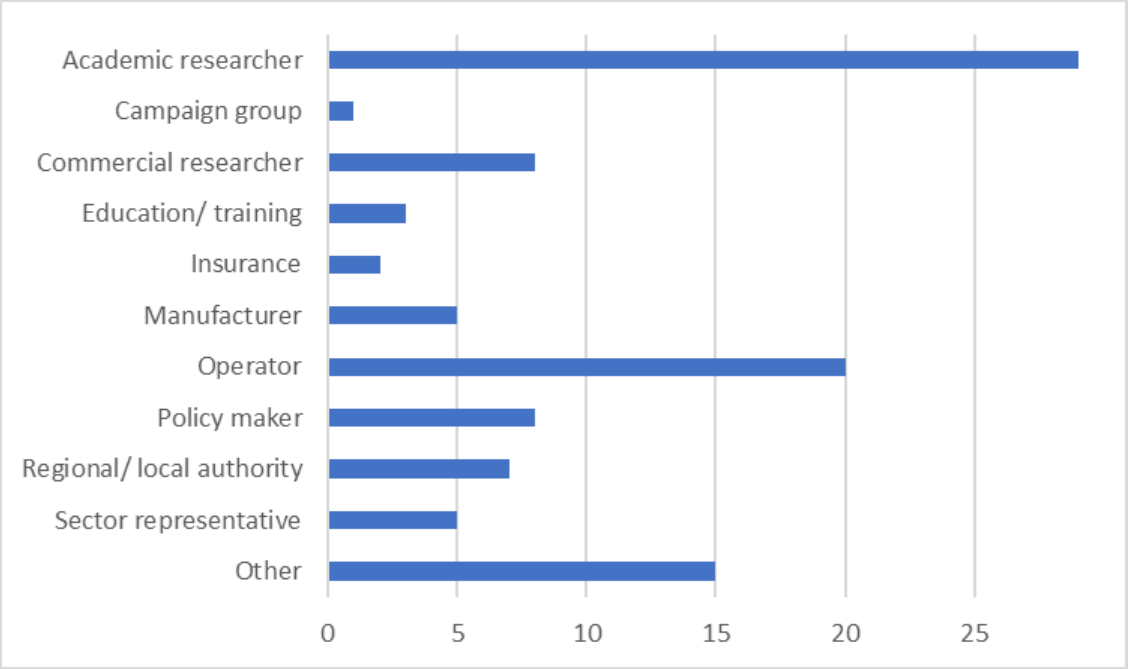

Figure 3: ***Respondents' field of work (Q3)***

Most responders (66) were very experienced, falling into the '11+ years' category in their field, followed by 22 responders in the '0-5 years' bracket and 14 in the '6-10 years' one. One result is missing (see Figure 4).

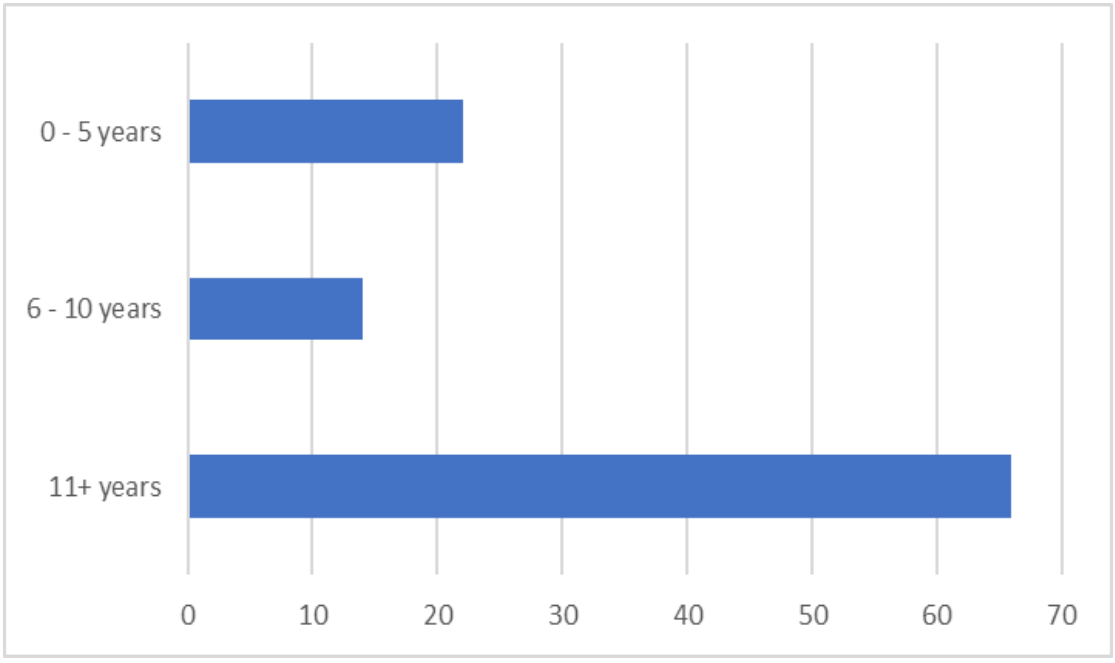

Figure 4: ***Respondents' years of experience (Q4)***

In addition to this data, survey responders were asked to complete the survey representing their views for only one transport mode (with an option to complete the survey again to represent a different mode if they desired to do so). The majority of responses (63) were for Passenger Car, followed by Bus/Coach (24), Truck (10), Train (4) and Tram (1).

For this reason, the present Deliverable 9.1 mainly analyses data regarding the resulting top three modes:

- Passenger car
- Bus/Coach
- Truck

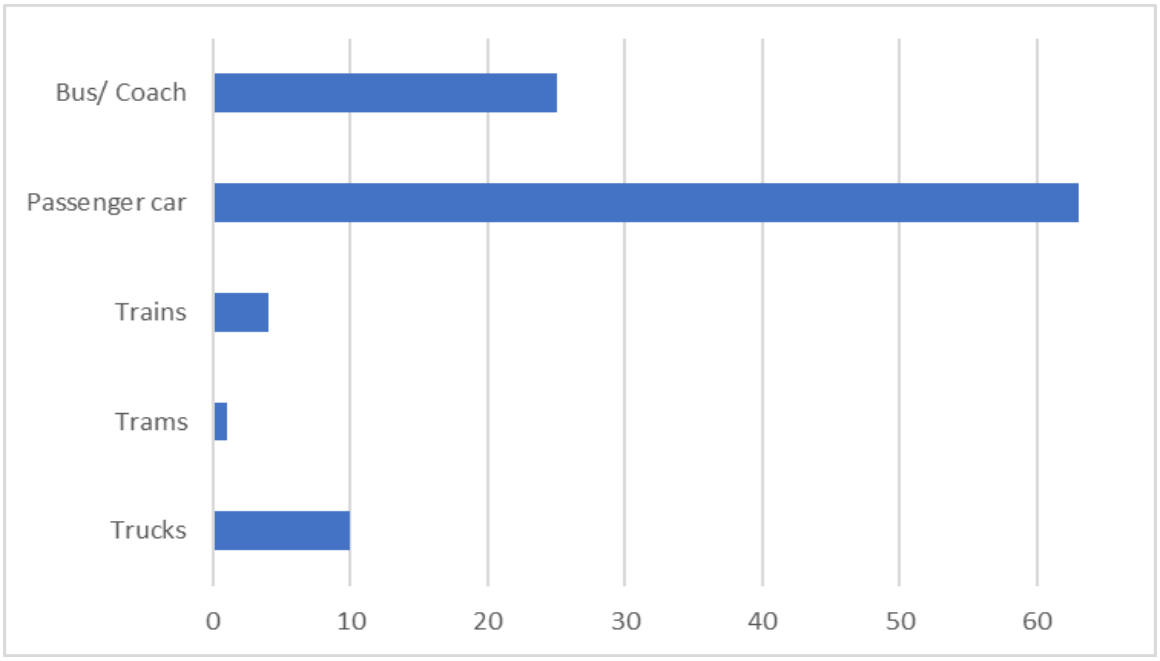

Figure 5: ***Respondents' transport mode of experience (Q5)****: The graph shows the different transport modes the i-DREAMS Stakeholder Survey' responders may have experience on. All respondents were encouraged to select the mode they would consider themselves more experienced with.*

3 Survey Analysis

The analysis of the *i*-DREAMS Stakeholder Survey initially delves in the data concerning the top three modes together: Passenger Car, Bus/Coach, and Truck.

After comprehensive analysis of all modes, the main responses to the following questions are discussed in this deliverable:

- Question 6 (Q6) What type of collisions are most important (e.g. in most need of addressing) for your transportation mode? (select all that apply)
- Question 12 (Q12) What are the largest barriers and constraints you see for driver assistance in real time?
- Question 15 (Q15) What do you think would incentivise people to engage with post-trip interventions in your mode?

The analysis of the *i*-DREAMS Stakeholder Survey then delves in the data concerning the three modes detected. Finally, the deliverable takes briefly into account Trams and Trains' results.

3.1 All modes (Passenger Car, Bus/Coach, Truck)

The following 'All modes analysis' is heavily influenced by the Passenger Car results (**see 3.1.1 – Passenger Car**), which constitute the vast majority of responses.

Considering all modes as one group, collision with vulnerable road users (pedestrian/cyclist/motorcyclist) was seen as the most important type of collision within the survey, followed by head on collision and rear end collision.

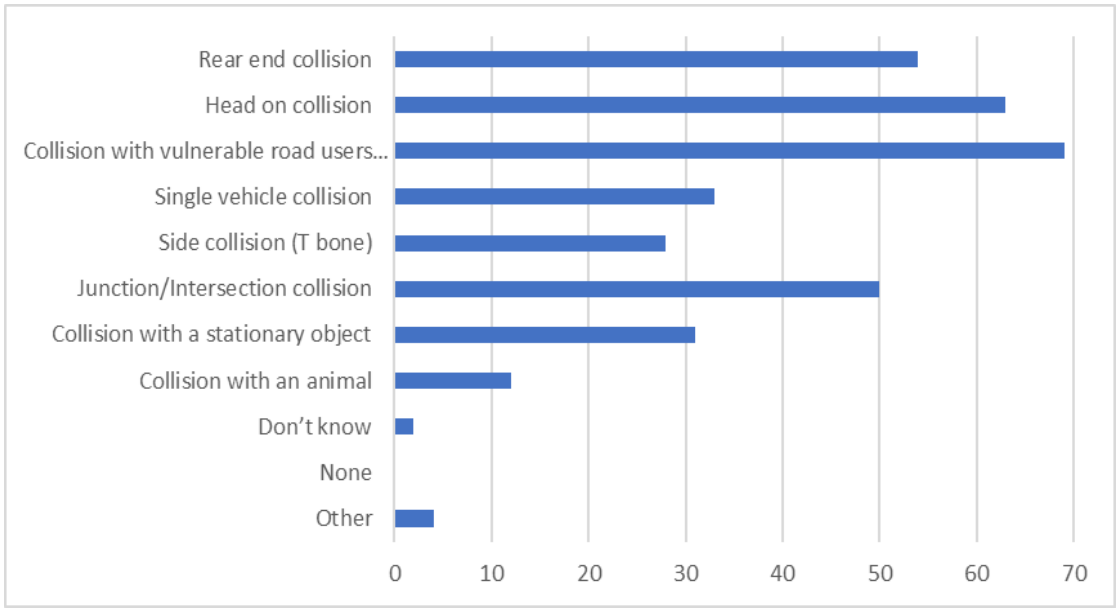

Figure 6: ***Most important collision in Passenger Car, Bus/Coach and Truck (Q6)****: Answers to 'What type of collisions are most important (e.g. in most need of addressing) for your transportation mode?'*

The largest barriers that all modes experts collectively saw for real time interventions were getting drivers to trust the system and to feel engaged to it, as well as overcoming their personal refusal towards such technologies. It is interesting to note that expense, reliability of the infrastructure and driver distraction concerns were also mentioned as barriers by more than half of the respondents.

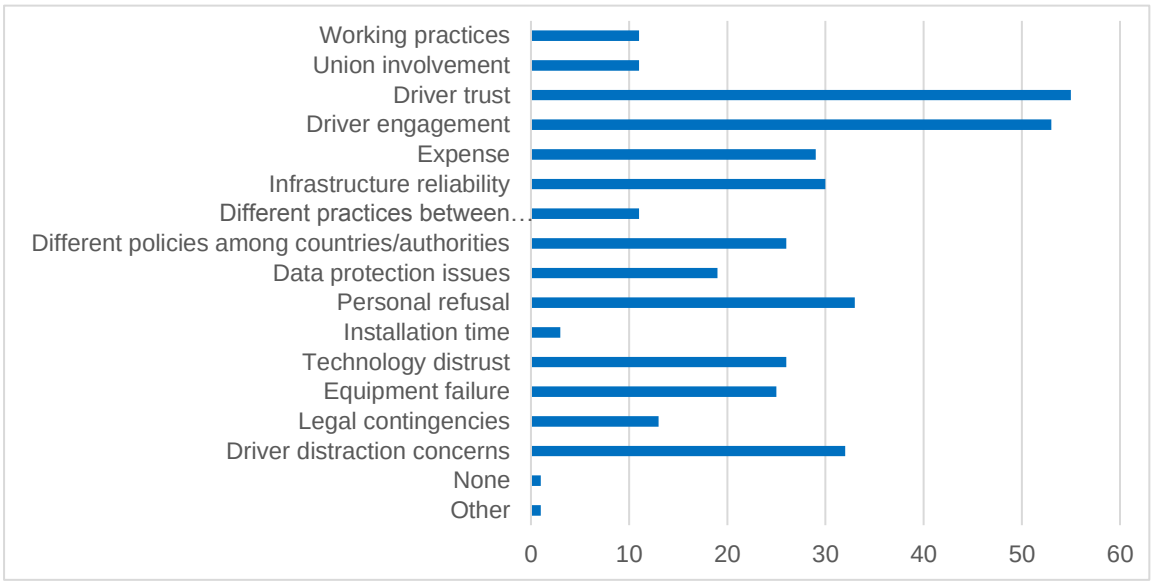

Figure 7: ***Largest barriers and constraints in real-time driver assistance in Passenger Car, Bus/Coach and Truck (Q12)****: Answers to 'What are the largest barriers and constraints you see for driver assistance in real time?'*

Finally, all experts were required to answer a question regarding post-trip interventions, which would inform the driver of their performance and ways they could modify their behaviour after the journey has taken place.

According to the respondents, the best way to incentivise all three sectors to engage with post-trip interventions is through rewards, positive reinforcement and evidence-based suggestions and feedback. Personaliseable apps and gamification also scored quite high.

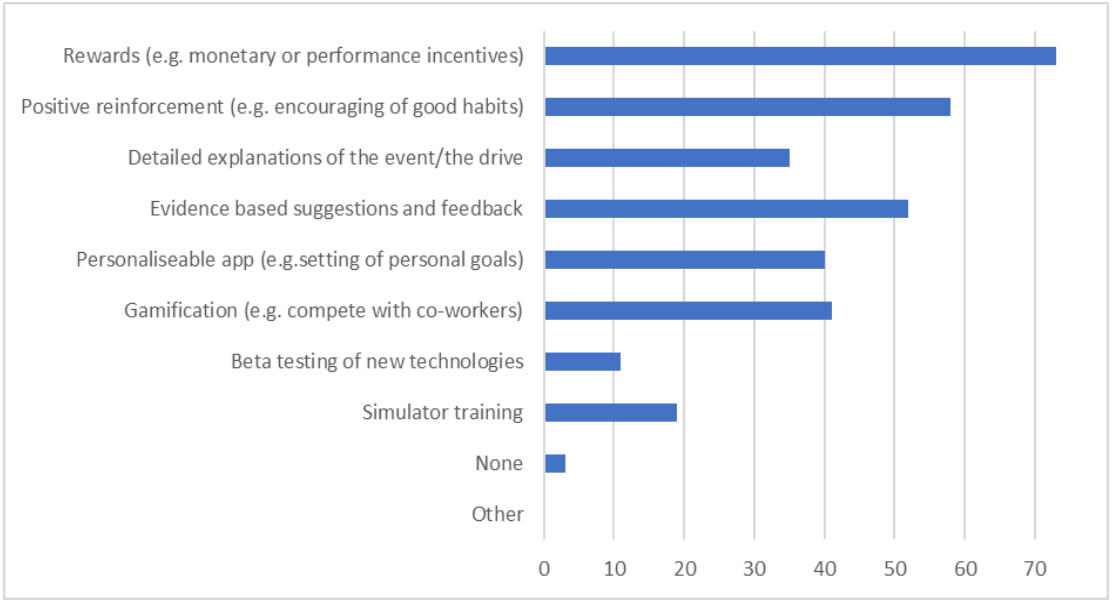

Figure 8: ***Incentives for people to engage with post-trip interventions in Passenger Car, Bus/Coach and Truck (Q15)****: Answers to 'What do you think would incentivise people to engage with post-trip interventions in your mode?'*

3.1.1 Passenger Car

The total responses for Passenger Car were 63. Most respondents were from Greece (10), United Kingdom (9), Portugal (7) and Belgium (6).

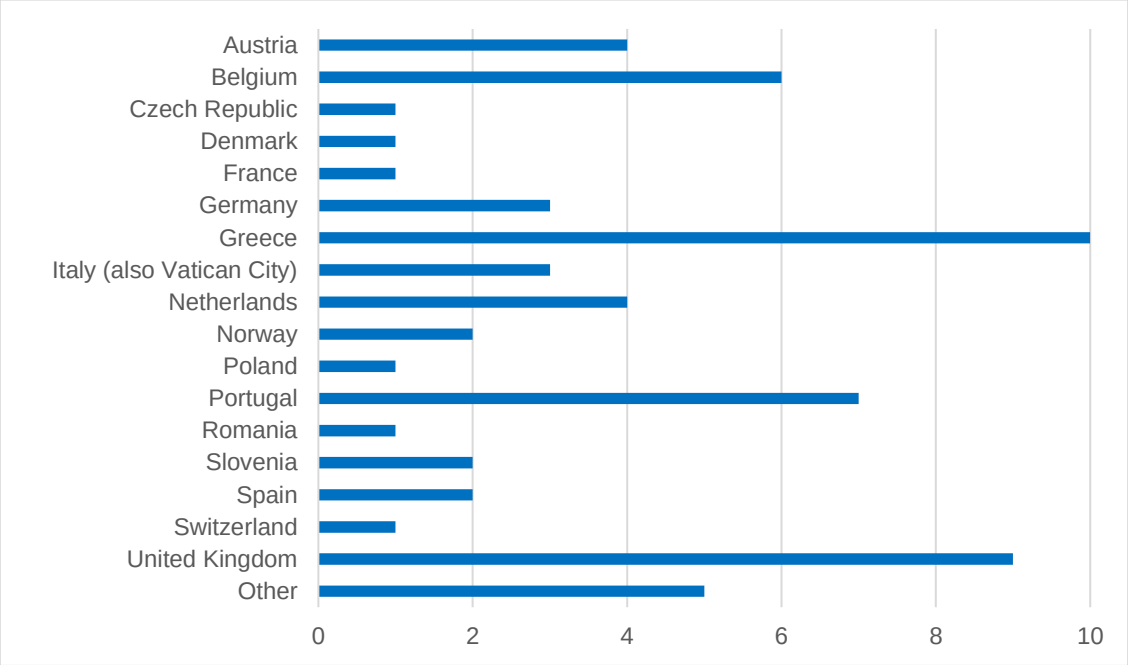

Figure 9: ***Passenger Car Respondents' country of work****:*

Academic researchers were the main stakeholder group completing the survey for Passenger Car, leading results with 27 respondents. Following, there were Commercial researchers (7) and Policy Makers (7). Respondents who selected 'Other' indicated to be Consultants (4), Lawyers (1), University Lecturers (1), Data Analyst (1), Government Agents (1) and Mobility and Road Safety Experts (1).

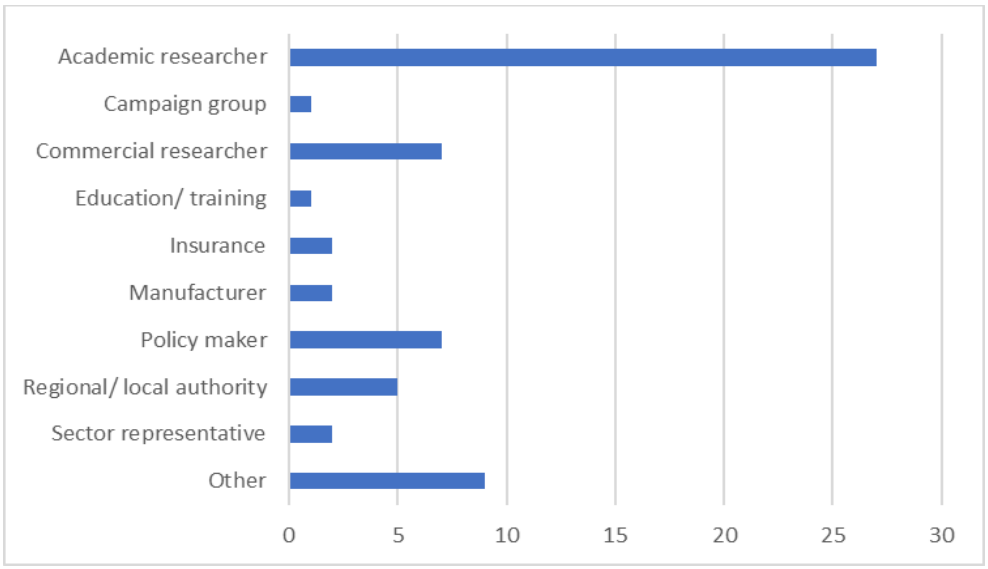

Figure 10: ***Passenger Car Respondents' field of work****:*

As of Passenger Car respondents, answers mainly came from an experienced cohort, with the vast majority (38) having more than 11 years' experience in the field.

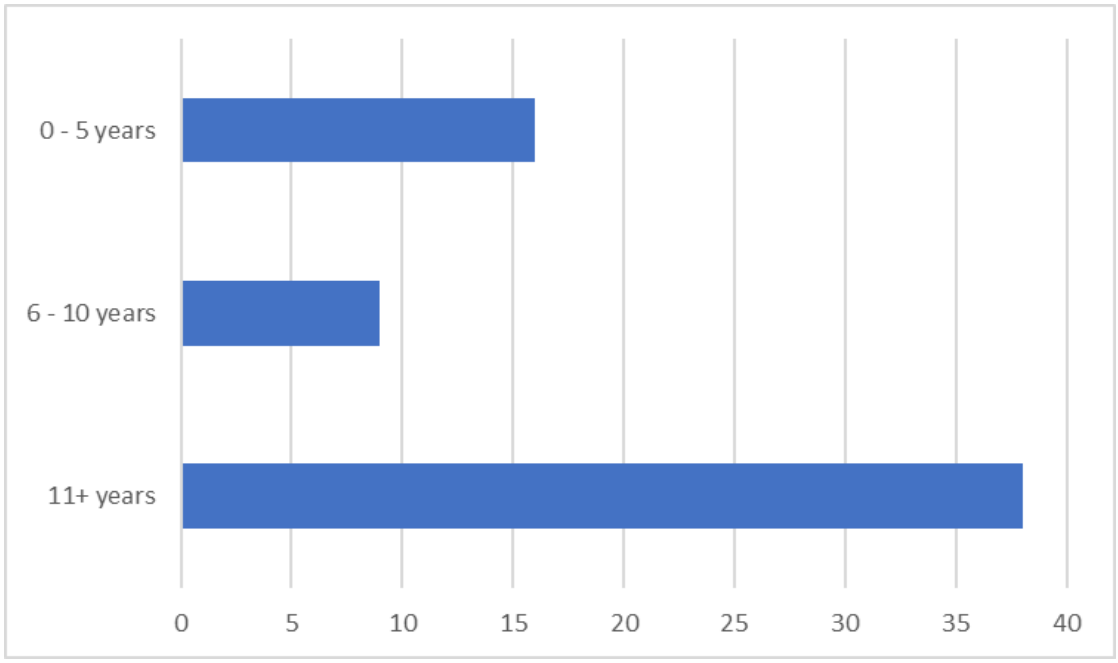

*Figure 11**: Passenger Car Respondents' degree of experience**: The graph shows the years of experience of the i-DREAMS Stakeholder Survey' responders for Passenger Car. – Q4*

Collision with vulnerable road users (pedestrian/cyclist/motorcyclist) was seen as the most important type of collision for Passenger Car respondents (54), followed by head on collision (41), junction/Intersection collision (38) and rear end collision (31) (see Figure 12).

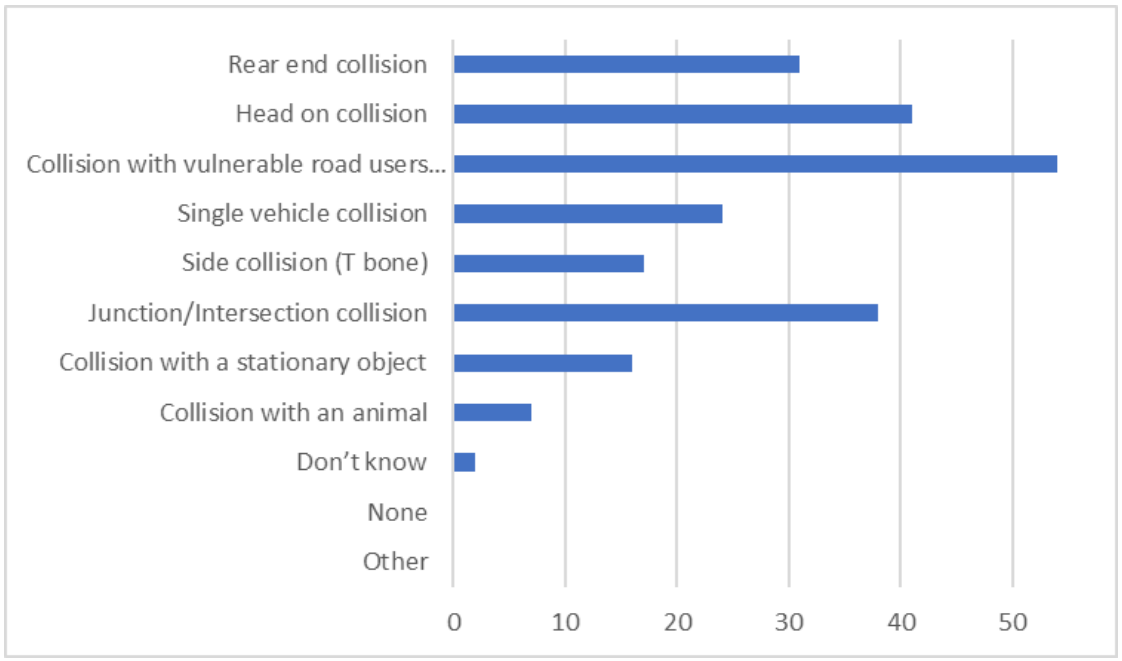

*Figure 12: **Most important collision in Passenger Car**: Answers to 'What type of collisions are most important (e.g. in most need of addressing) for your transportation mode?' – Q6*

The most important safety breach/incident reported by the survey respondents for Passenger Car was loss of control, followed by close following another vehicle and failure to give way (see Figure 13).

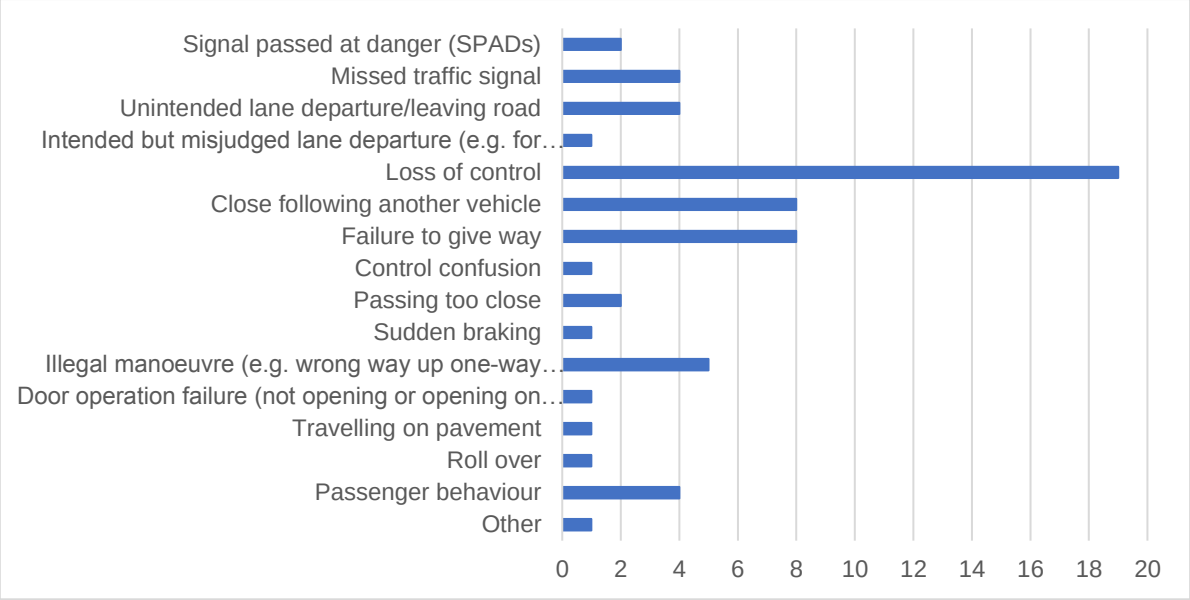

Figure 13: ***Most important safety breach/incident in Passenger Car****: Answers to '[…] please, select what you think are the three most important safety breaches/incidents for your transportation mode' – Q7*

The survey was then structured to have two follow-up questions related to the top selected safety breach/incident – in this case loss of control. According to these questions, Passenger Car experts had to share their opinion on what causes loss of control (Q8) and what *i*-DREAMS can do to help stop loss of control (Q11). Specifically, when asked which issues contribute to loss of control, Passenger Car experts answered that, according to their opinion, it is mostly caused by excessive speed (18), inattention/distraction (12) and fatigue/sleepiness (10).

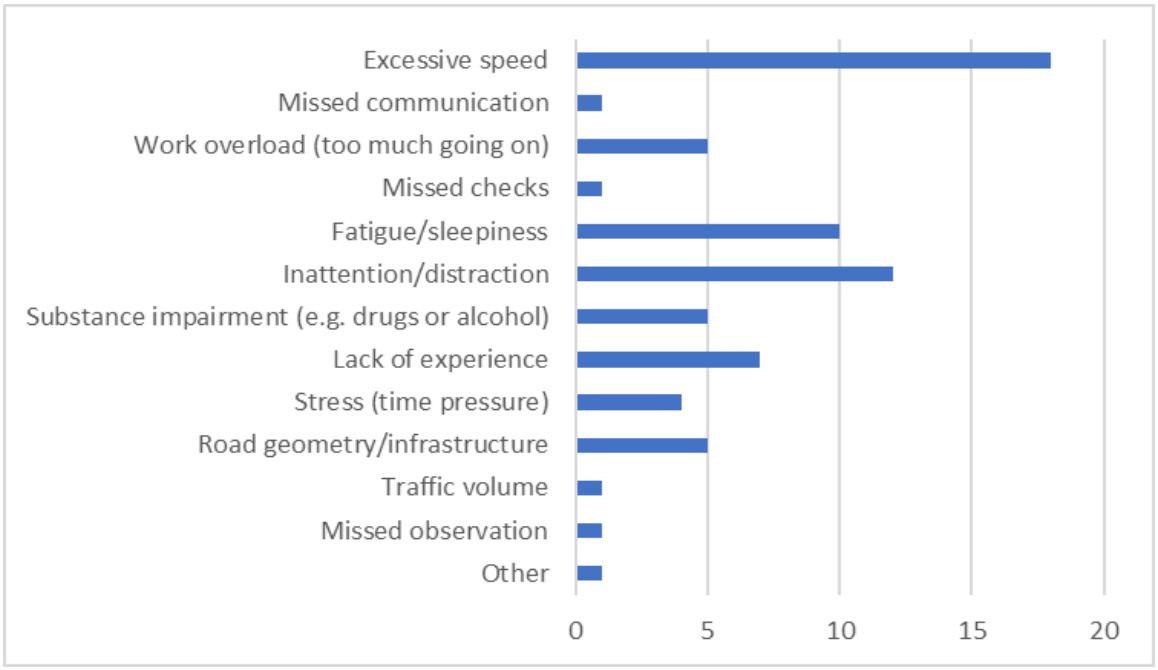

Figure 14: ***What causes 'Loss of Control' in Passenger Car****: Answers to 'Which issues contribute to the most important safety breach/incident identified in Q7?' – Q8*

In addition, when asked what *i*-DREAMS could do to help stop loss of control, Passenger Car experts answered that, according to their opinion, providing timely warnings (8) and manipulating vehicle motion according to level of automation (6) could be the best solutions.

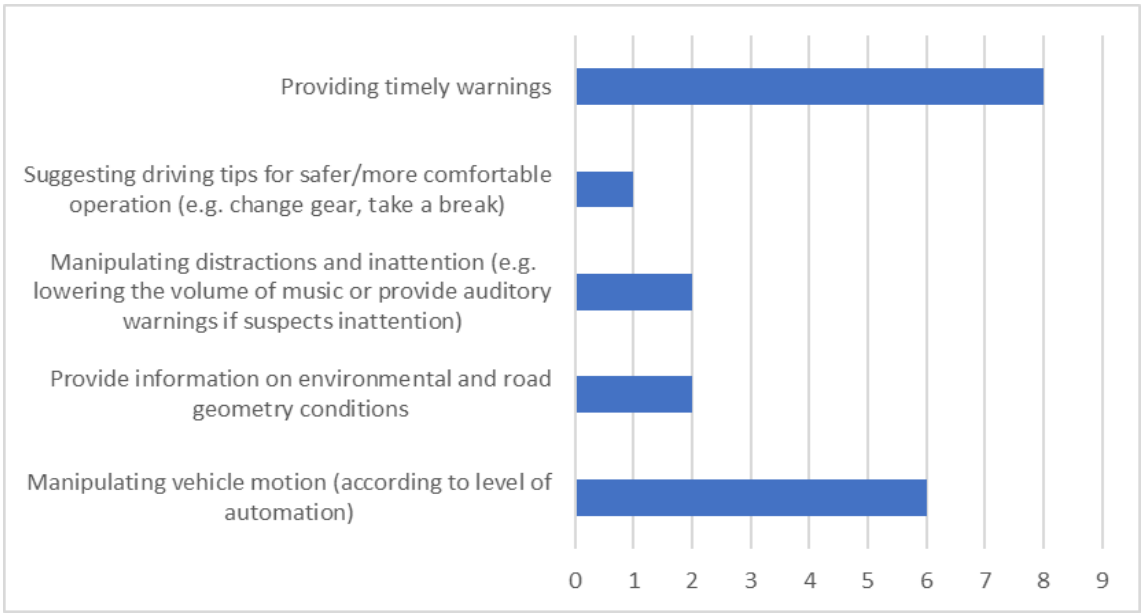

Figure 15: ***What i-DREAMS can do to help stop 'Loss of control' Passenger Car****: Answers to 'How do you think the i-DREAMS system could aid in preventing the safety breaches/incidents prioritised previously (Q7)?' – Q11*

The largest barriers that Passenger Car experts saw for real time interventions were getting drivers to trust the system and to feel engaged to it, as well as overcoming their personal refusal towards such technologies. To a lesser extent, infrastructure reliability, technology distrust and driver distraction were also mentioned as potential barriers.

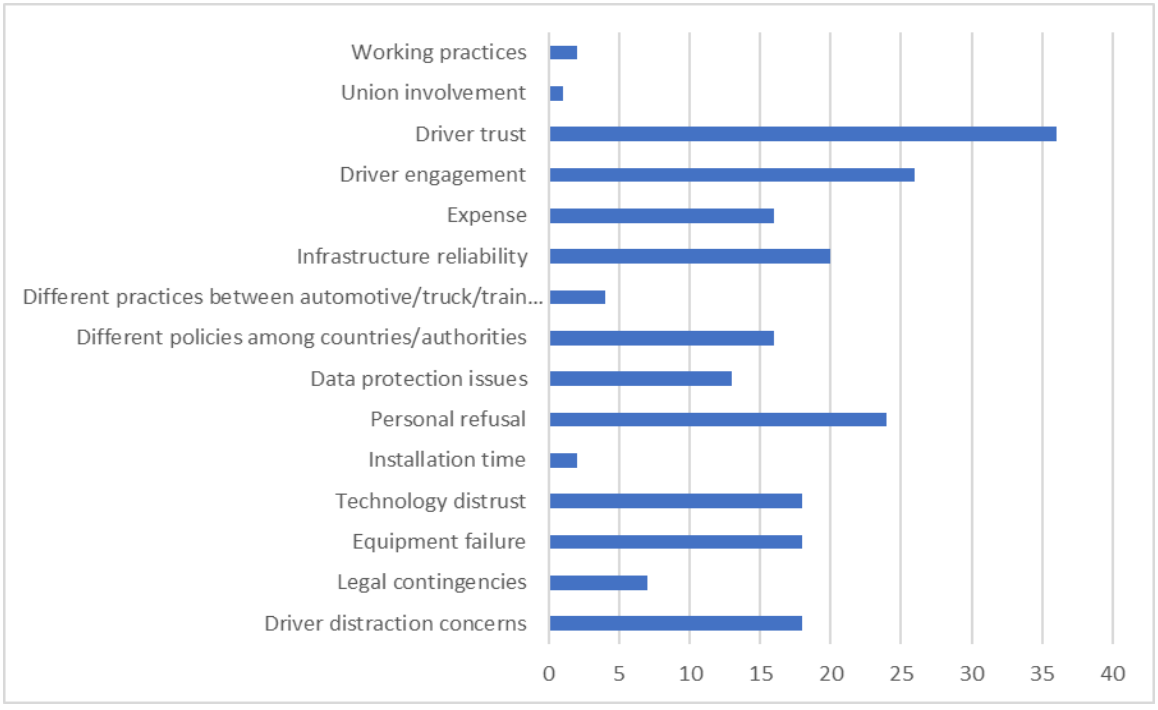

Figure 16: ***Largest barriers and constraints for driver assistance in real time - Passenger Car****: Answers to 'What are the largest barriers and constraints you see for driver assistance in real time?' – Q12*

Further, considering what technologies are currently available and in use to assist drivers in passengers cars and their relevance in terms of safety, crash avoidance and mitigation, Passenger Car experts have mostly (and positively) picked reversing cameras/detectors, automatic emergency braking, lane deviation monitoring, insufficient headway monitoring and speed violation warning. Technologies that Passenger Car experts would like to use but that are not currently in use are, most notably, attention/distraction monitoring and fatigue monitoring. It is then interesting to note that a specific technology that is not currently in use and that Passenger Car experts would not use is the most privacy- and driver-invasive one, which is the physiological monitoring.

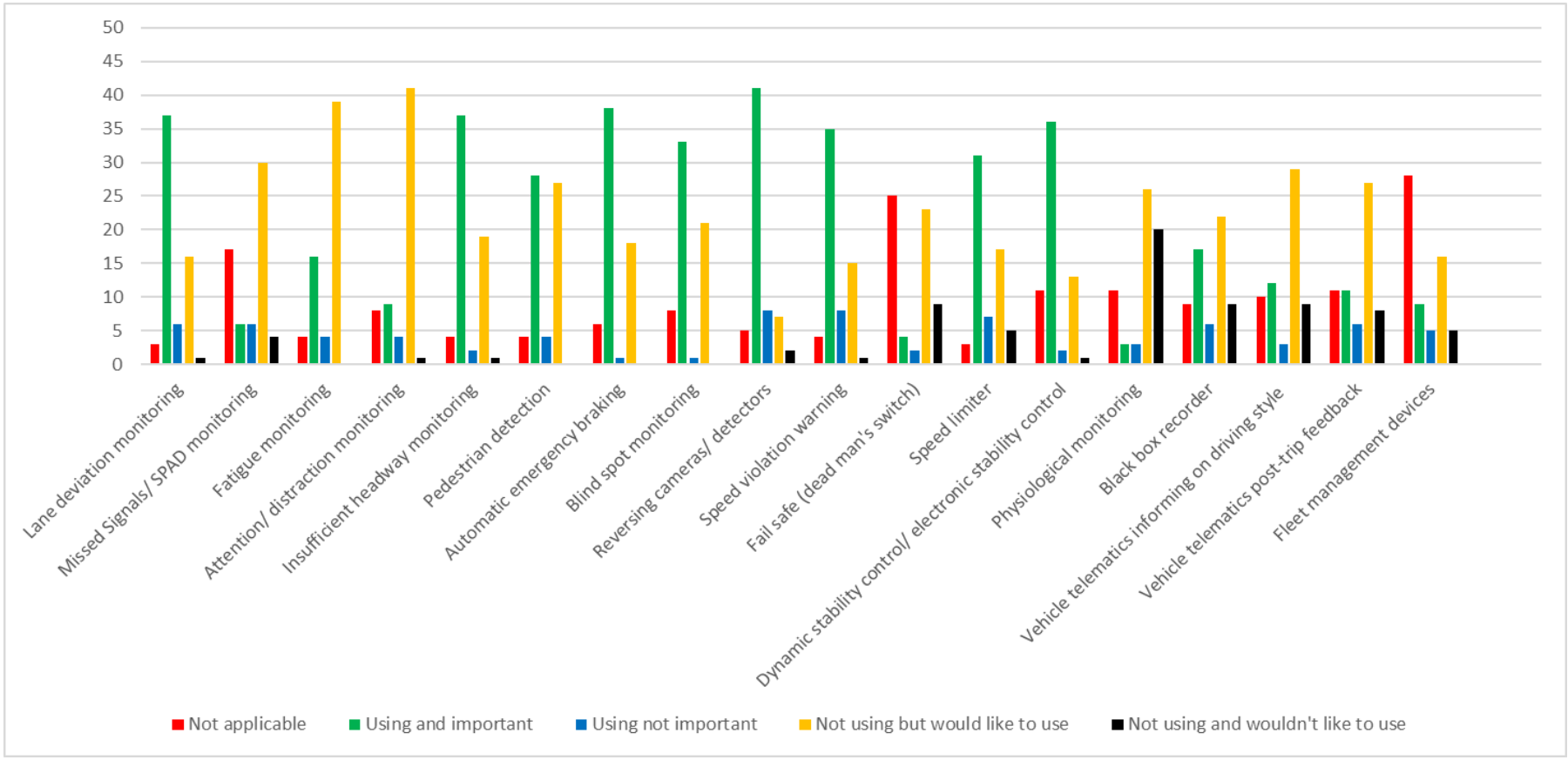

Figure 17: ***What technologies are currently being used to assist drivers in your transportation mode?*** *- Answers by Passenger Car experts to Q13*

Finally, Passenger Car experts where required to answer two more questions (Q15 and Q16) regarding post-trip interventions, which would inform the drivers of their performance and ways they could modify their behaviour after the journey has taken place.

Hereby focusing on Q15, according to Passenger Car respondents, the best way to incentivise those in the car sector to engage with post-trip interventions is through rewards, positive reinforcement and evidence-based suggestions and feedback.

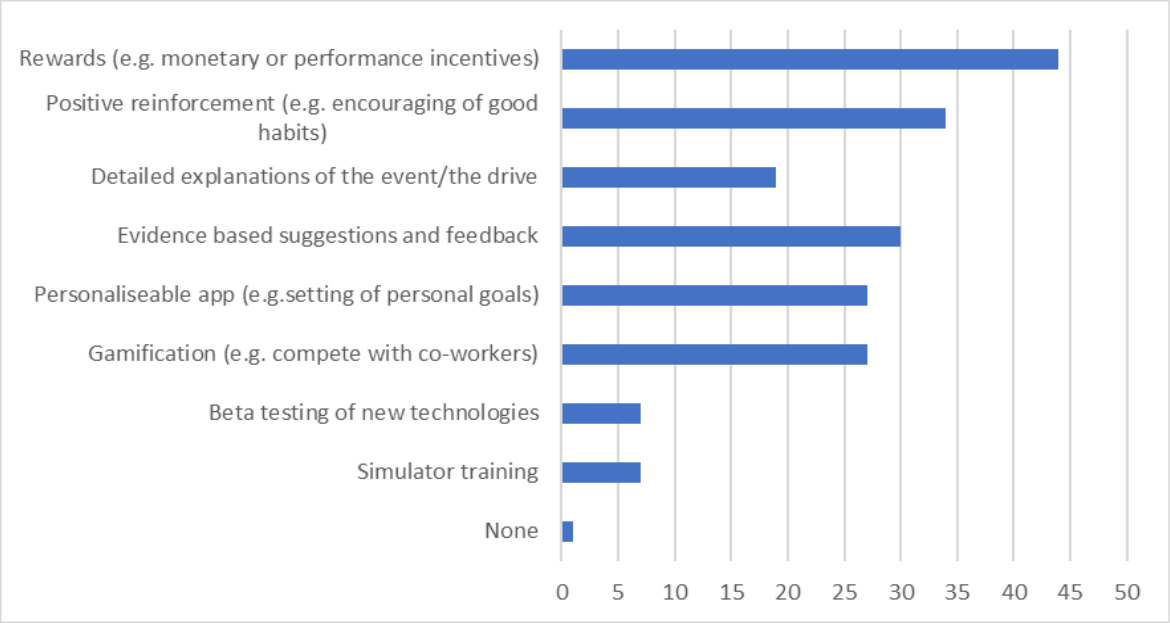

Figure 18: ***What do you think would incentivise people to engage with post-trip interventions in your mode?*** *- Answers by Passenger Car experts to Q15*

3.1.2 Bus/Coach

The total responses for Bus/Coach were 25. The majority of respondents were from Portugal (16).

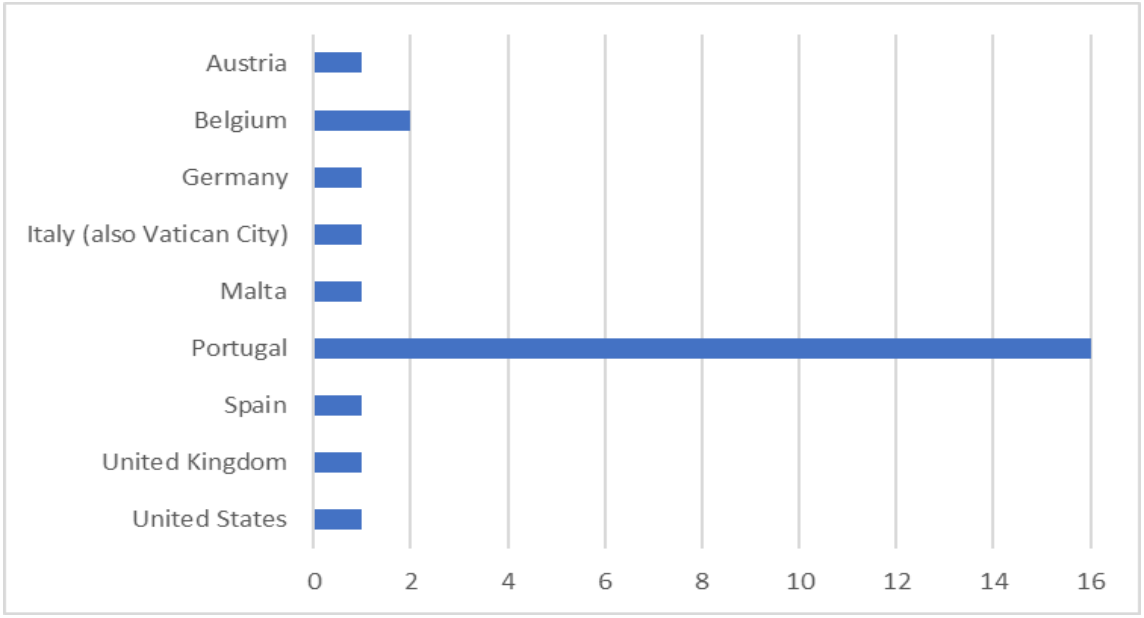

Figure 19: ***Bus/Coach Respondents' country of work****: The graph shows the countries of origin of the i-DREAMS Stakeholder Survey's Respondents for Bus/Coach – Q2*

Operators were the main stakeholder group completing the survey for Bus/Coach, leading results with 14 respondents. Respondents who selected 'Other' indicated to be Consultants (1), Project Managers in public transport (1) and NGO agents for Transport Sustainability (1).

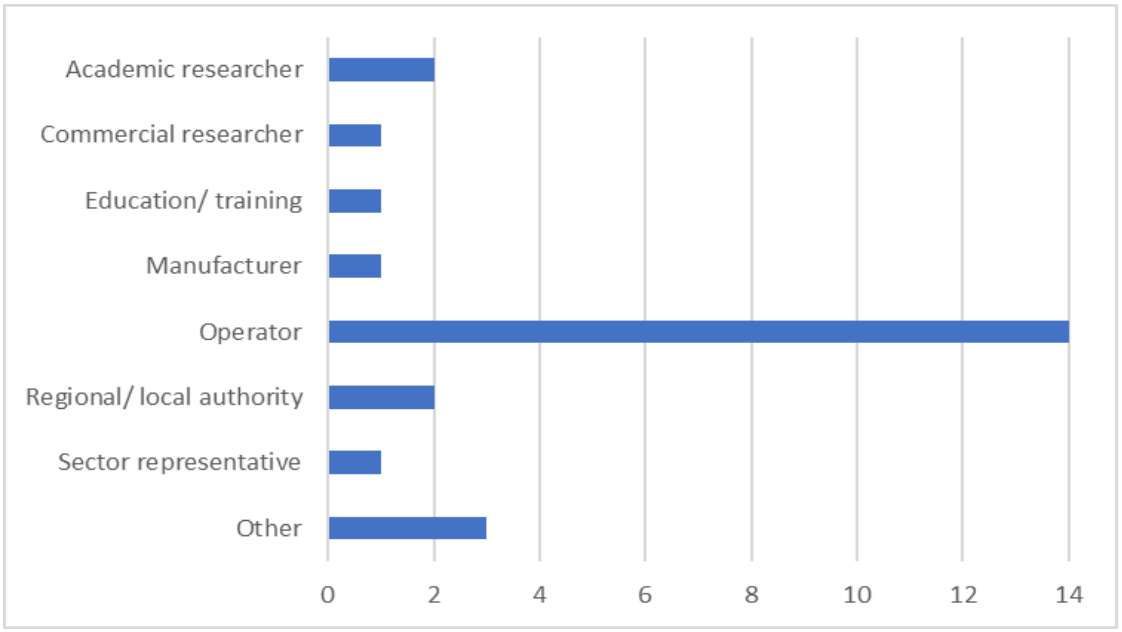

Figure 20: ***Bus/Coach Respondents' field of work****: The graph shows the fields of work of the i-DREAMS Stakeholder Survey' responders for Bus/Coach. Multiple selection was not allowed, but comments were required when selecting the 'Other' option. – Q3*

As of Bus/Coach respondents, answers mainly came from an experienced cohort, with the vast majority (17) having more than 11 years' experience in the field.

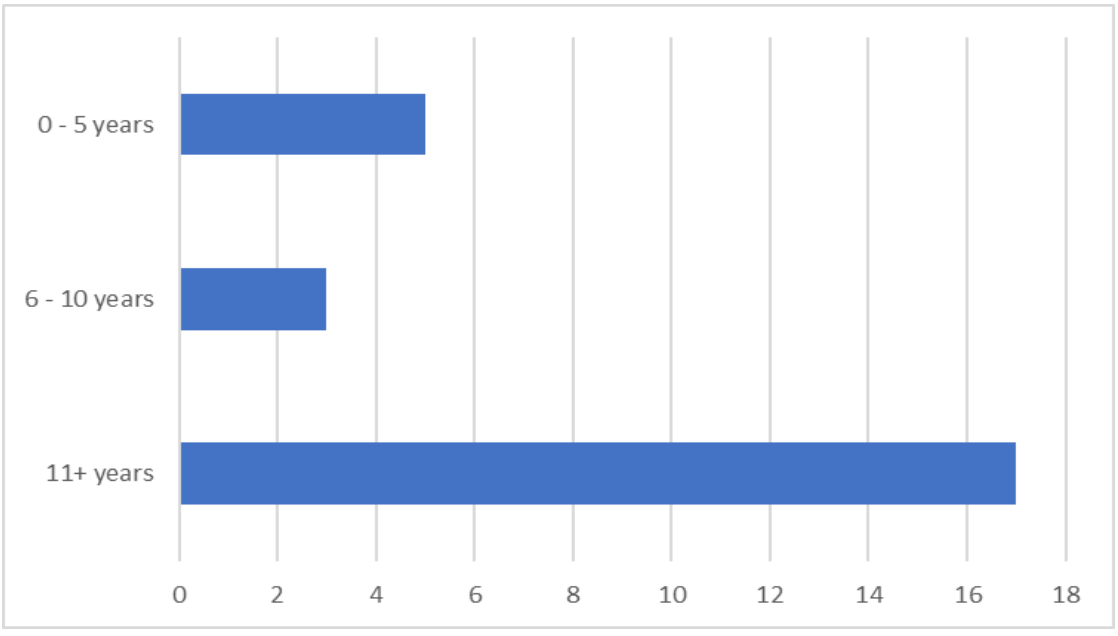

*Figure 21****: Bus/Coach Respondents' degree of experience****: The graph shows the years of experience of the i-DREAMS Stakeholder Survey' responders for Bus/Coach. – Q4*

Head on collision (14), followed by collision with vulnerable road users (13) and rear end collision (12) were seen as the most important types of collision for Bus/Coach respondents: these results are very similar, thus have to be all considered equals.

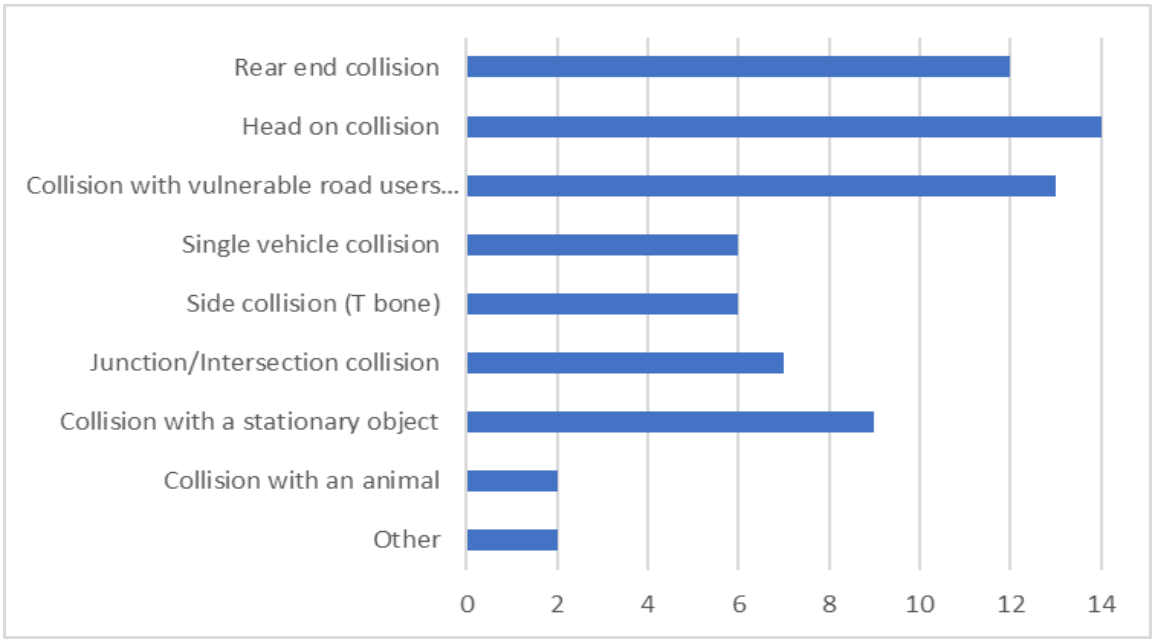

Figure 22: ***Most important collisions in Bus/Coach****: Answers to 'What type of collisions are most important (e.g. in most need of addressing) for your transportation mode?' – Q6*

The most important safety breaches/incidents reported by the survey respondents for Bus/Coach were loss of control and sudden braking, closely followed by signal passed at danger (SPADs) (Figure 23). It is interesting to note that passenger behaviour was considered a secondary, but nonetheless important, breach/incident in Bus/Coach (Figure 24).

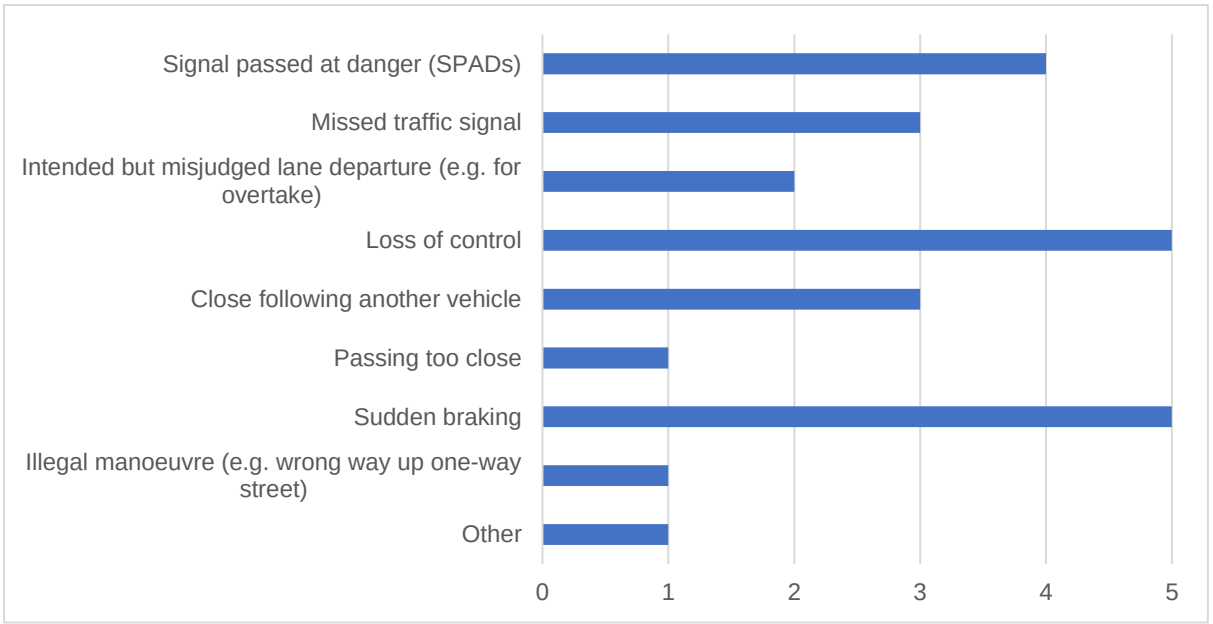

Figure 23: ***Most important safety breach/incident in Bus/Coach****: Answers to '[…] please, select what you think are the three most important safety breaches/incidents for your transportation mode' – Q7*

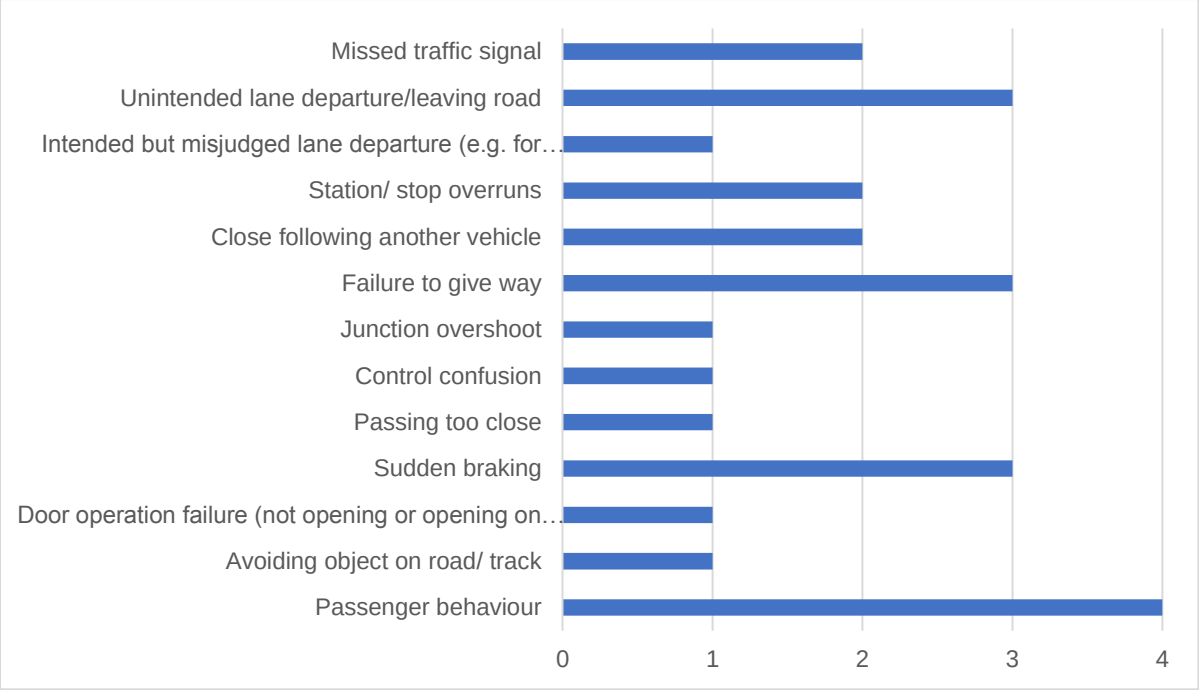

Figure 24: ***Other important safety breach/incident in Bus/Coach****: Answers to '[…] please, select what you think are the three most important safety breaches/incidents for your transportation mode' – Q7*

The survey was then structured to have two follow-up questions related to the top selected safety breach/incident – in this case loss of control and sudden braking. According to these questions, Bus/Coach experts had to share their opinion on what causes loss of control and sudden braking (Q8) and what *i*-DREAMS can do to help stop loss of control and sudden braking (Q11). Specifically, when asked which issues contribute to loss of control and sudden braking, Bus/Coach experts answered that it is mostly caused by inattention/distraction (7), excessive speed (5), fatigue/sleepiness (5) and lack of experience (5).

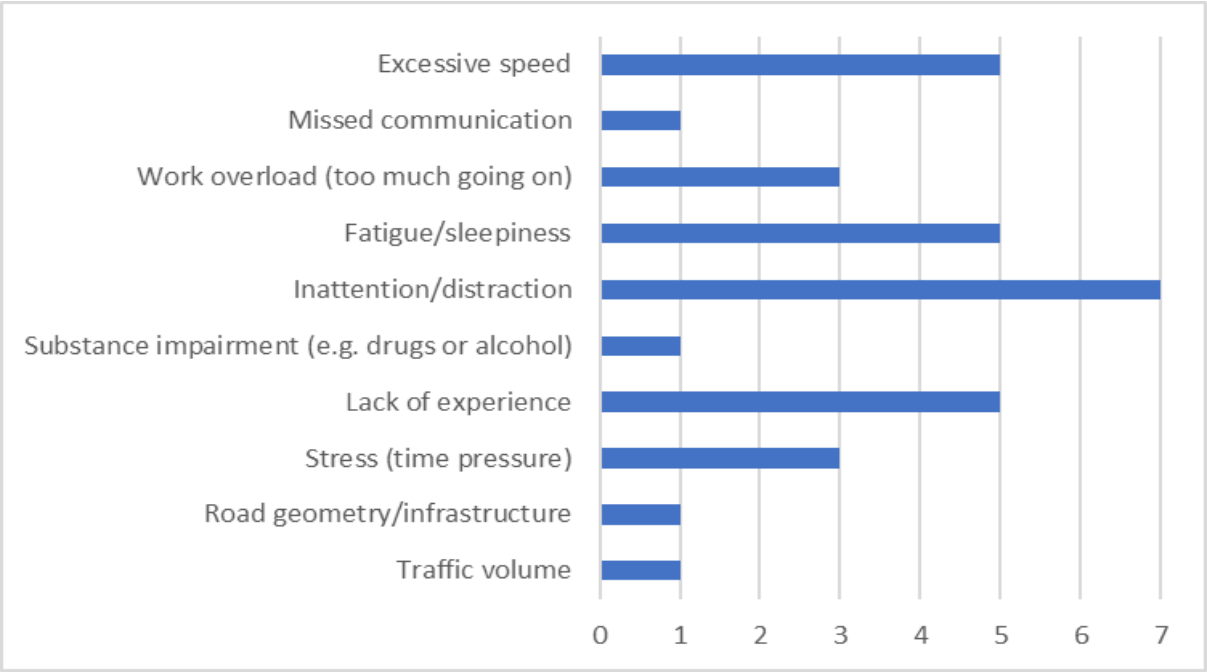

Figure 25: ***What causes 'Loss of Control' and 'Sudden Braking' in Bus/Coach****: Answers to 'Which issues contribute to the most important safety breach/incident identified in Q7?' – Q8*

In addition, when asked what *i*-DREAMS could do to help stop loss of control and sudden braking, Bus/Coach experts answered that, according to their opinion, providing timely warnings (5) could be the best solution.

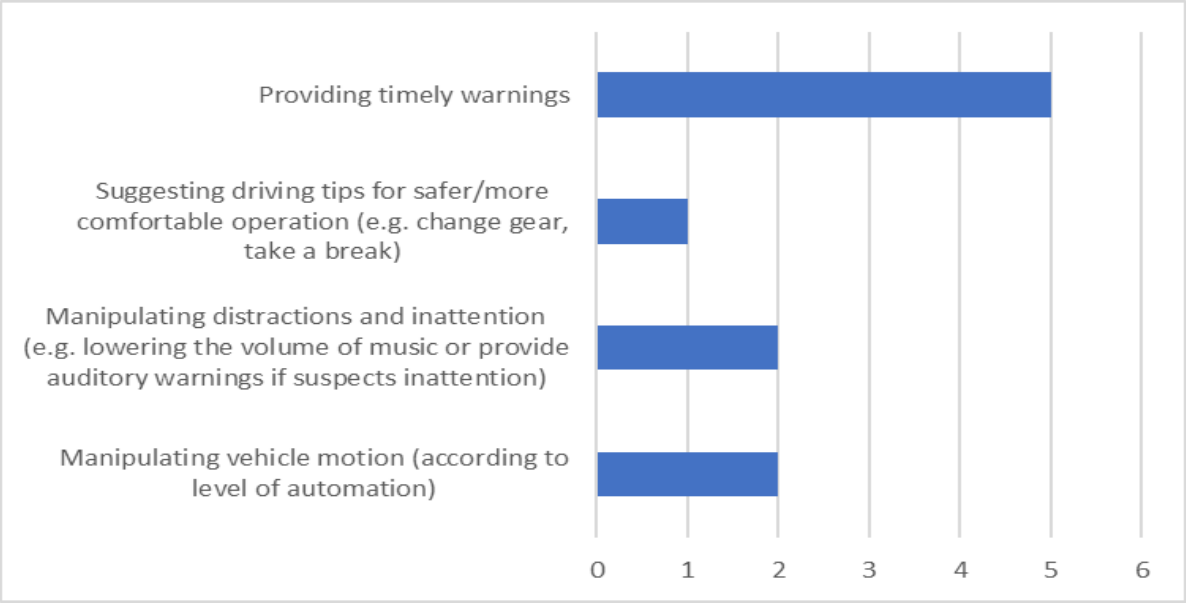

Figure 26: ***What i-DREAMS can do to help stop 'Loss of control' and 'Sudden braking' in Bus/Coach****: Answers to 'How do you think the i-DREAMS system could aid in preventing the safety breaches/incidents prioritised previously (Q7)?' – Q11*

The largest barriers Bus/Coach experts saw for real time interventions were getting drivers to engage with the system as well as the drivers trusting the system. Driver distraction concerns were also expressed by more than half of the Bus/Coach experts.

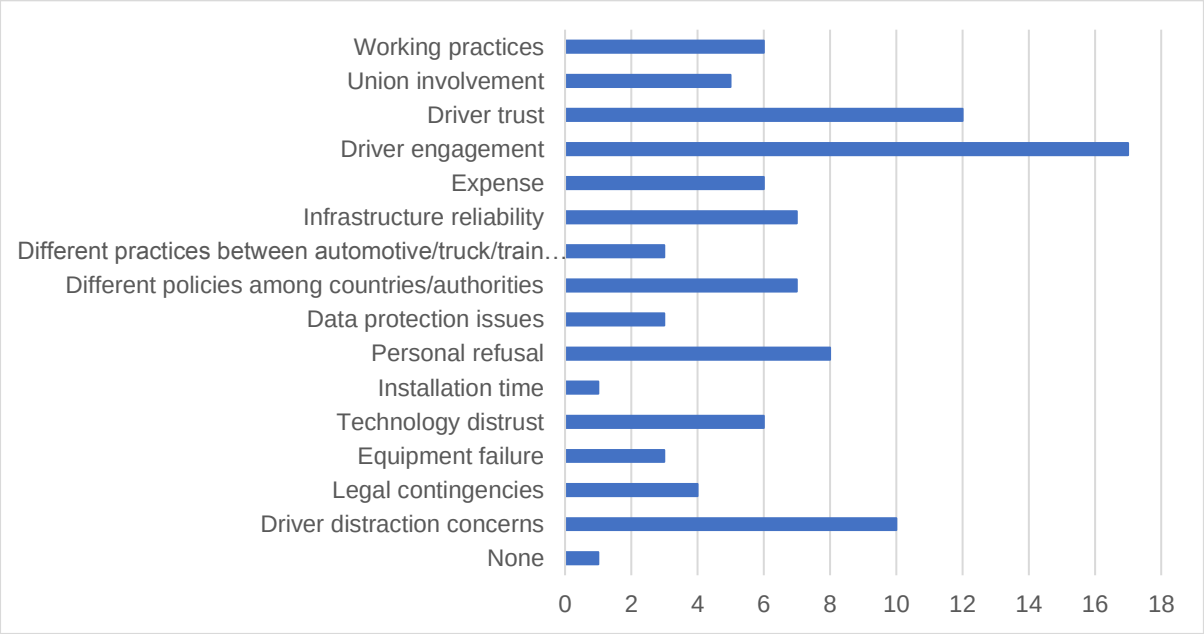

Figure 27: ***Largest barriers and constraints for driver assistance in real time – Bus/Coach****: Answers to 'What are the largest barriers and constraints you see for driver assistance in real time?' – Q12*

Futher, considering what technologies are currently available and in use to assist drivers in buses and coaches and their relevancy in terms of safety, crash avoidance and mitigation, Bus/Coach experts have mostly (and positively) picked dynamic stability control/eletronic stability control, reversing cameras/detectors, speed violation warning and speed limiter. Technologies that Bus/Coach experts would like to use but that are not currently in use are, most notably, attention/distraction monitoring and fatigue monitoring. It is then interesting to note that a specific technology that is not currently in use and that Bus/Coach experts would not use is the fail safe (dead man's switch).

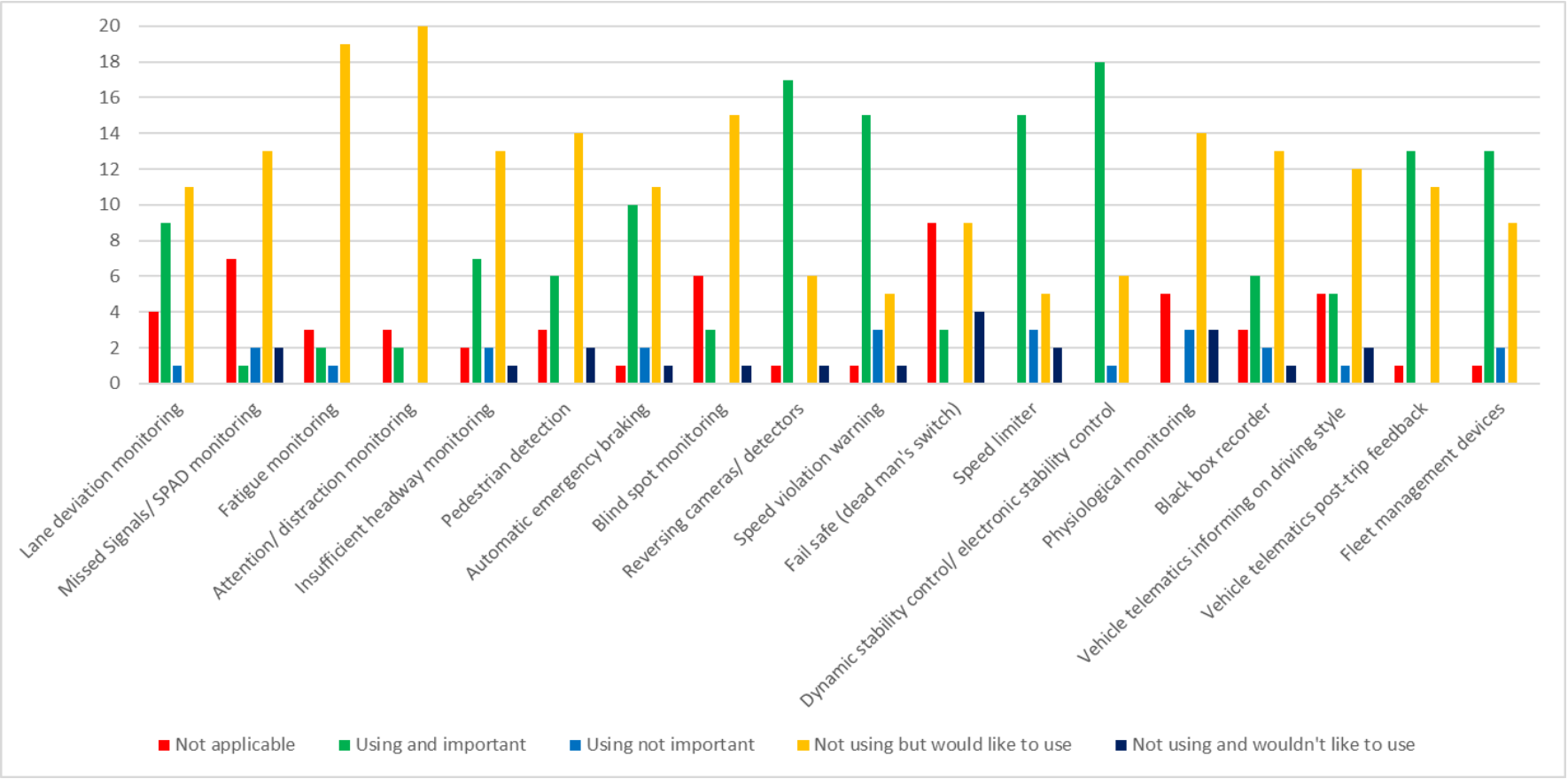

Figure 28: ***What technologies are currently being used to assist drivers in your transportation mode?*** *- Answers by Bus/Coach experts to Q13*

Finally, Bus/Coach experts were required to answer two more questions (Q15 and Q16) regarding post-trip interventions, which would inform the driver of their performance and ways they could modify their behaviour after the journey has taken place.

Focusing on Q15, according to Bus/Coach respondents, the best way to incentivise those in the bus/coach sector to engage with post-trip interventions is through rewards, evidence-based suggestions and feedback and positive reinforcement.

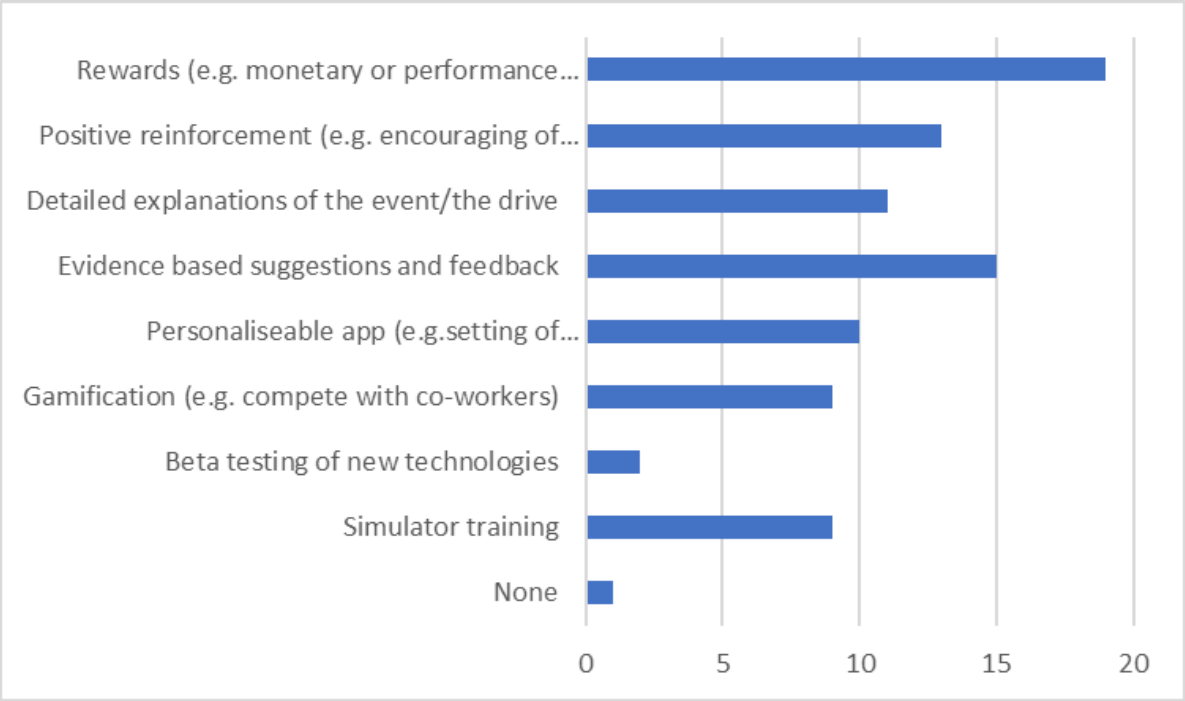

Figure 29: ***What do you think would incentivise people to engage with post-trip interventions in your mode?*** *- Answers by Bus/Coach experts to Q15*

3.1.3 Truck

The total responses for Truck were 10. Most respondents were from Portugal (5) and Belgium (3).

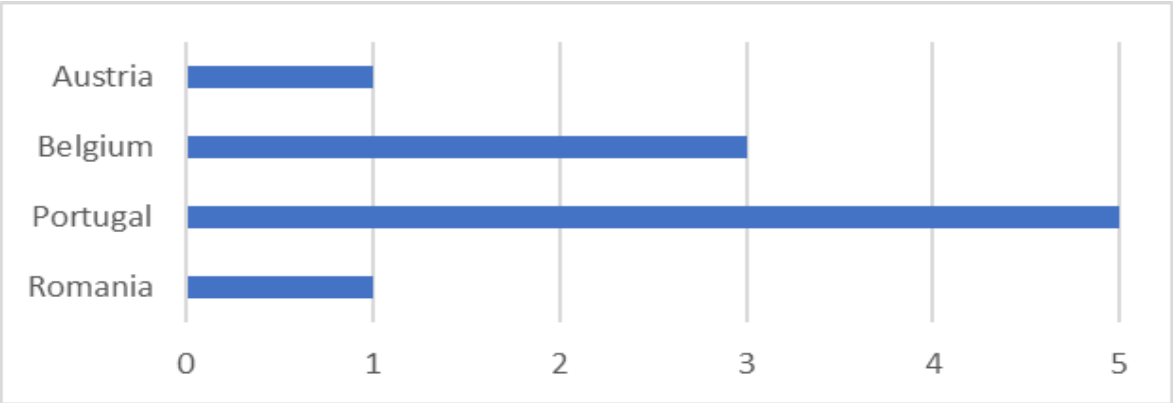

Figure 30: ***Truck Respondents' country of work****: The graph shows the countries of origin of the i-DREAMS Stakeholder Survey's Respondents for Truck – Q2*

Operators were the main stakeholder group completing the survey for Trucks, along with Manufacturers and Sector representatives. Respondents who selected 'Other' indicated to be Distributors (1) and Purchasers (1).

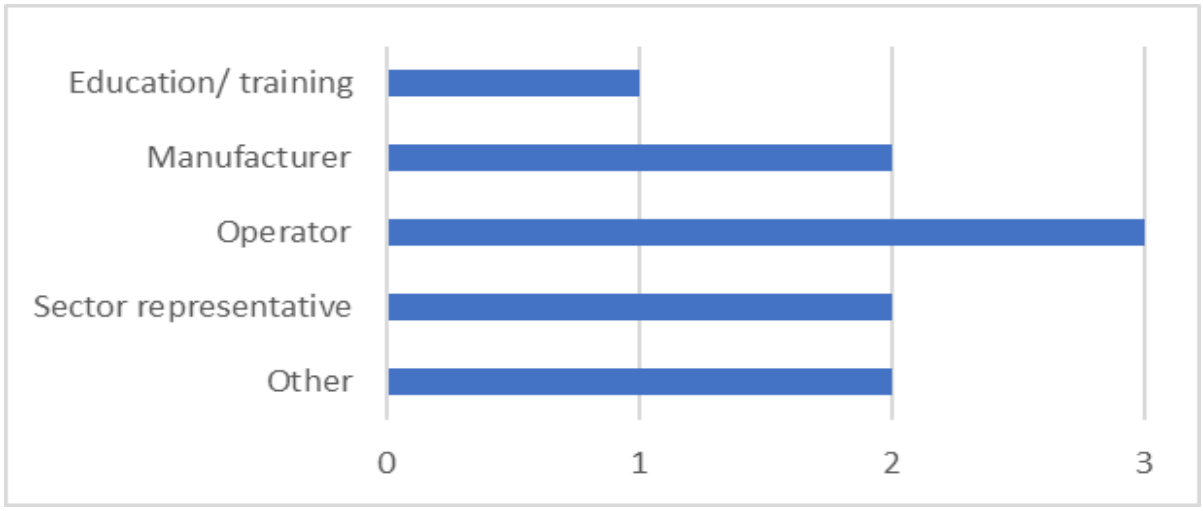

*Figure 31: **Truck Respondents' field of work**: The graph shows the fields of work of the i-DREAMS Stakeholder Survey' responders for Truck. Multiple selection was not allowed, but comments were required when selecting the 'Other' option. – Q3*

As of Truck respondents, answers mainly came from an experienced cohort, with the vast majority (9) having more than 11 years' experience in the field.

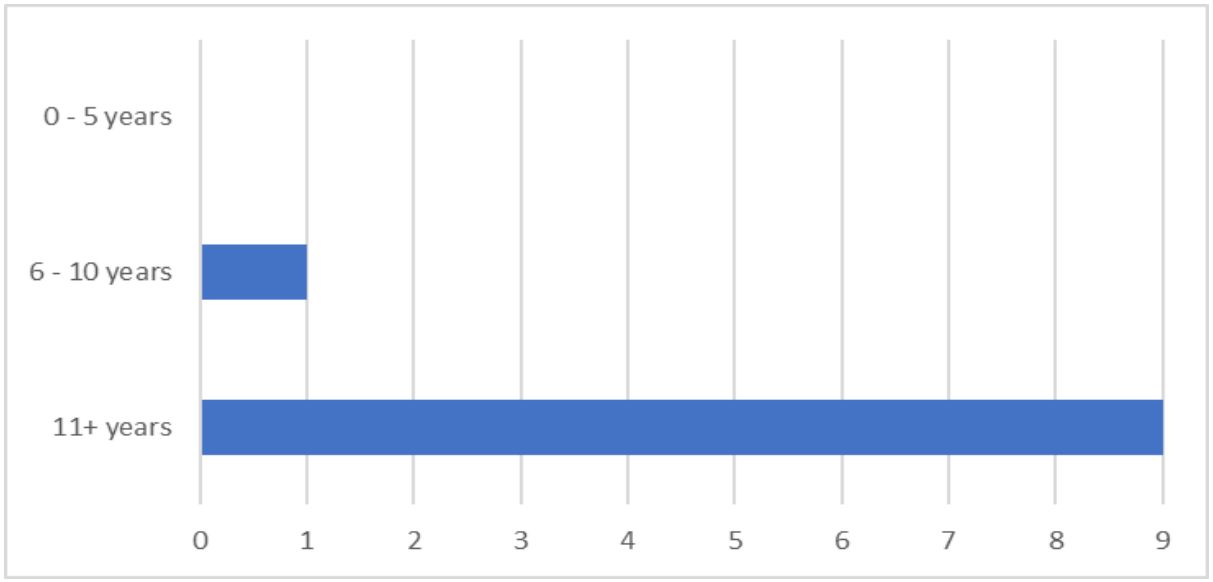

*Figure 32**: Truck Respondents' degree of experience**: The graph shows the years of experience of the i-DREAMS Stakeholder Survey' responders for Truck. – Q4*

Rear end collision (7), followed by head on collision (5) and collision with a stationary vehicle (5) were seen as the most important types of collision for Truck respondents.

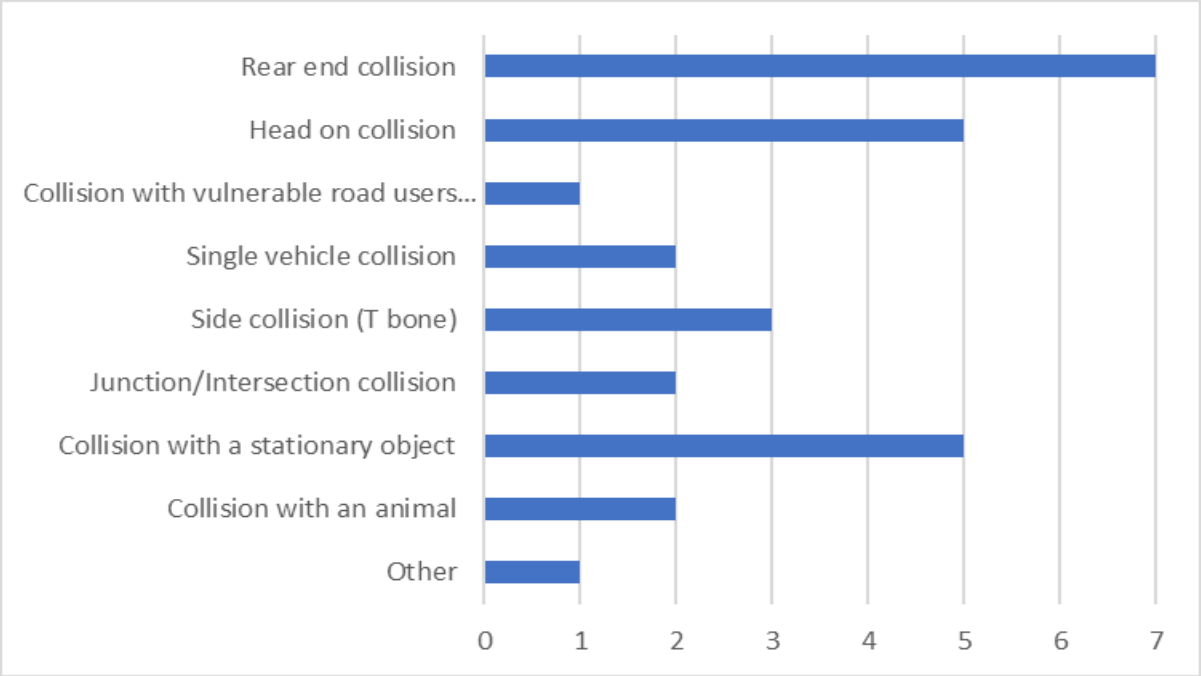

*Figure 33: **Most important collisions in Truck**: Answers to 'What type of collisions are most important (e.g. in most need of addressing) for your transportation mode?' – Q6*

The most important safety breach/incident reported by the survey respondents for Truck is close following of another vehicle.

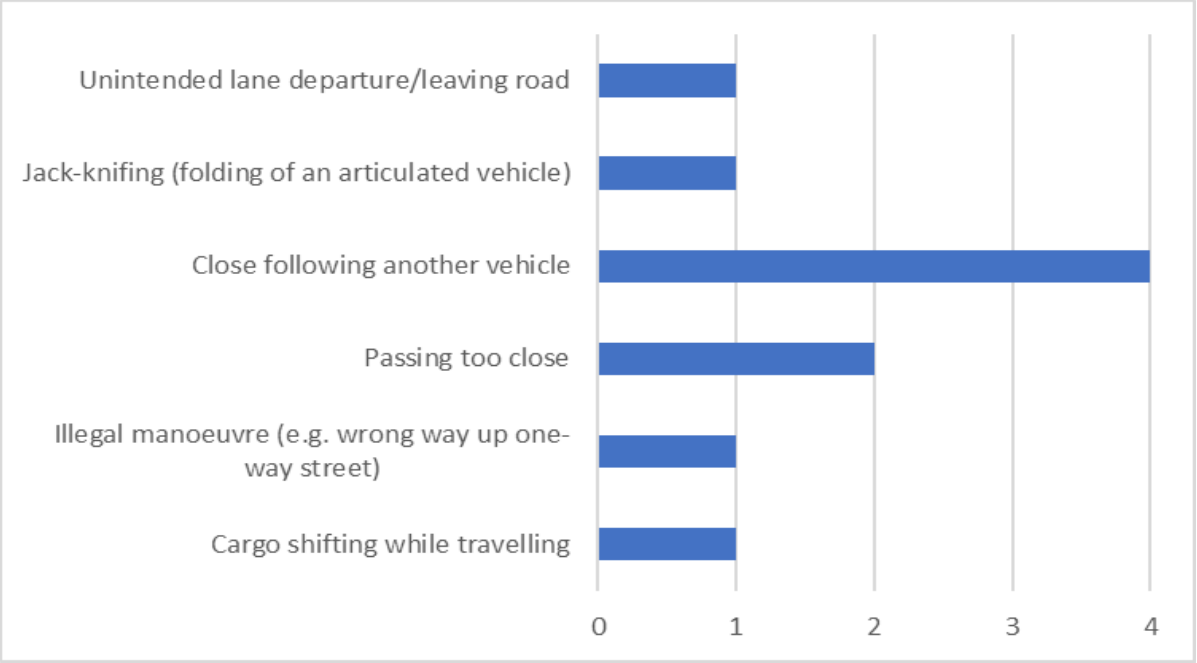

*Figure 34: **Most important safety breach/incident in Truck**: Answers to '[…] please, select what you think are the three most important safety breaches/incidents for your transportation mode' – Q7*

The survey was then structured to have two follow-up questions related to the top selected safety breach/incident – in this case close following of another vehicle. According to these questions, Truck experts had to share their opinion on what causes close following of another vehicle (Q8) and what i-DREAMS can do to help stop close following of another vehicle (Q11). Specifically, when asked which issues contribute to close following of another vehicle, Truck experts answered that it is mostly caused by inattention/distraction (6) and stress (time

pressure) (5). Fatigue/sleepiness (4) and excessive speed (4) were also believed to lead to close following of another vehicle.

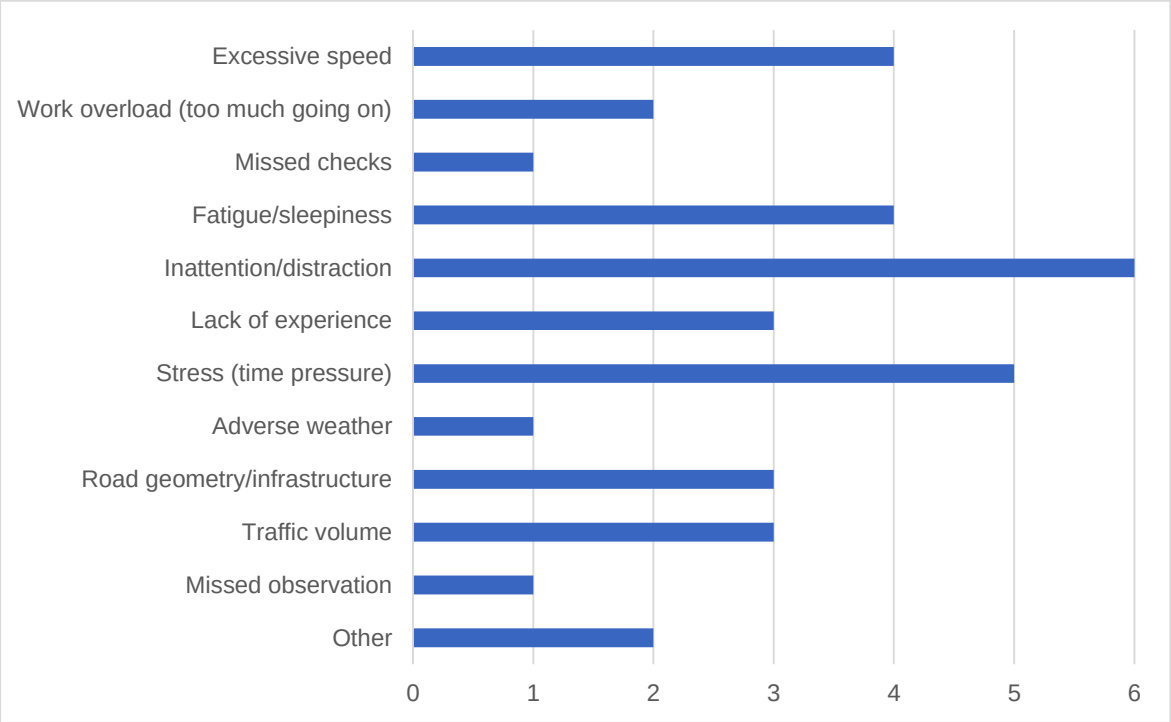

Figure 35: ***What causes 'Close following of another vehicle' in Truck****: Answers to 'Which issues contribute to the most important safety breach/incident identified in Q7?' – Q8*

In addition, when asked what *i*-DREAMS could do to help stop close following of another vehicle, Truck experts answered that providing timely warnings (4) could be the best solution.

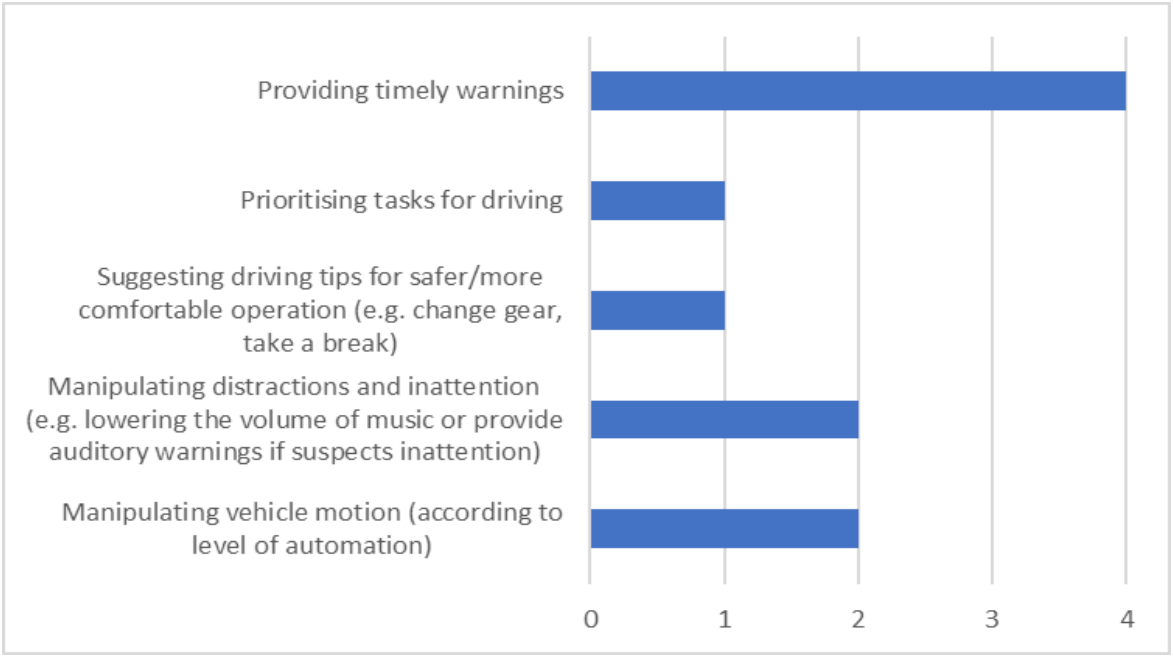

Figure 36: ***What i-DREAMS can do to help stop 'Close following of another vehicle' in Truck****: Answers to 'How do you think the i-DREAMS system could aid in preventing the safety breaches/incidents prioritised previously (Q7)?' – Q11*

The largest barriers Truck experts saw for real time interventions were getting drivers to engage with the system, the drivers trusting the system, the expense of implementing such technology and the equipment itself failing.

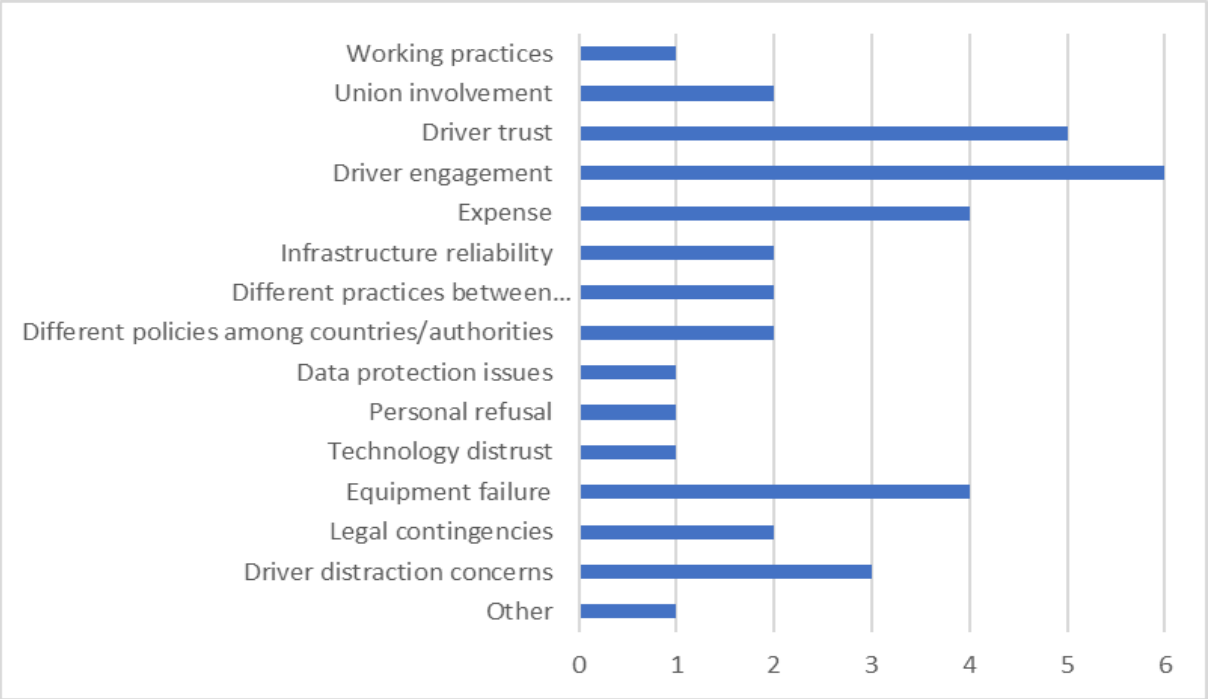

Figure 37: ***Largest barriers and constraints for driver assistance in real time – Truck****: Answers to 'What are the largest barriers and constraints you see for driver assistance in real time?' – Q12*

Futher, considering what technologies are currently available and in use to assist drivers in buses and coaches and their relevancy in terms of safety, crash avoidance and mitigation, Truck experts have mostly (and positively) picked dynamic stability control/electronic stability control, automatic emergency braking, lane deviation monitoring and speed limiter. Technologies that Truck experts would like to use but that are not currently in use are, most notably, blind spot monitoring, missed signal/SPAD monitoring, fatigue monitoring and attention/distraction monitoring. It is then interesting to note that a specific technology that is not currently in use and that Truck experts would not use is the fail safe (dead man's switch) and physiological monitoring.

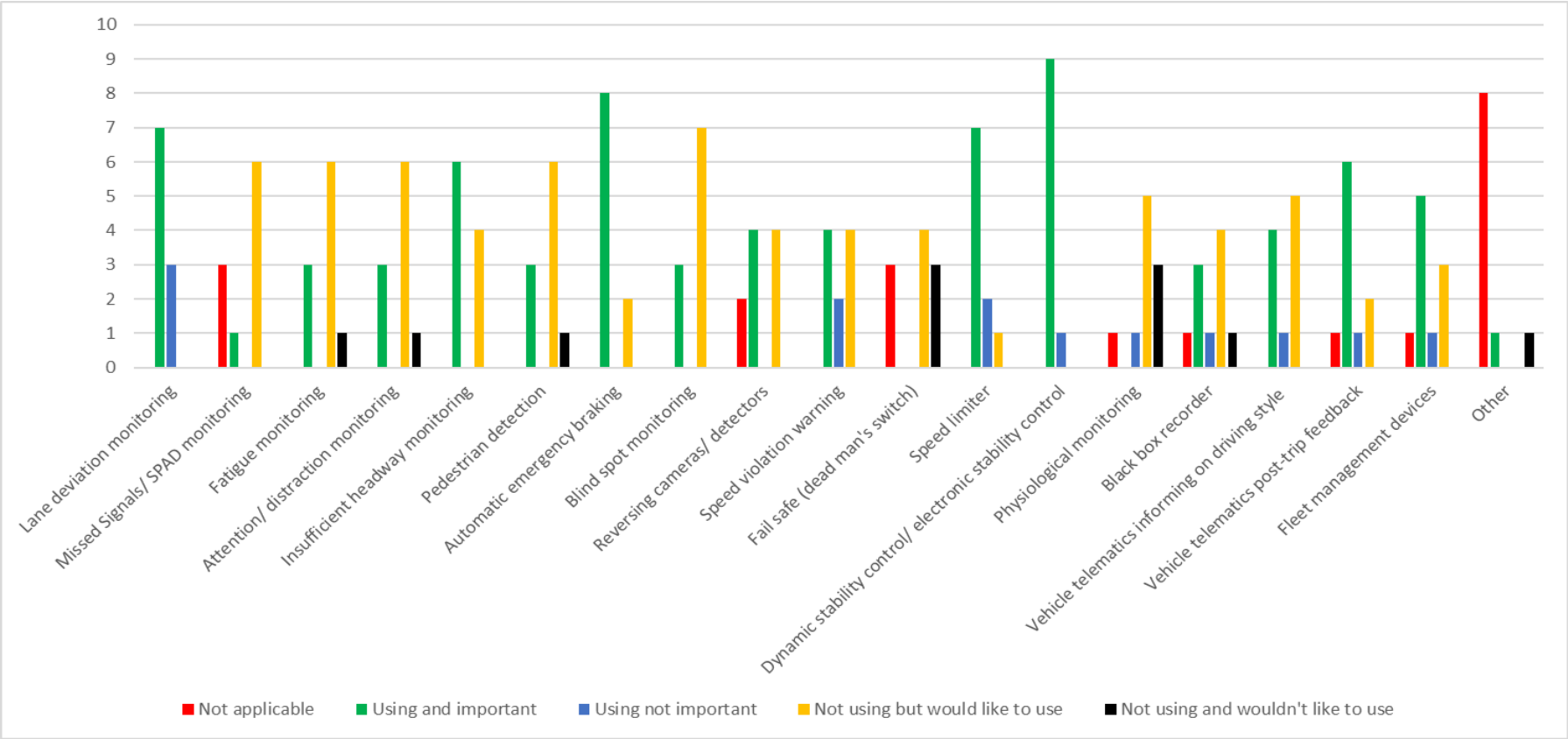

Figure 38: ***What technologies are currently being used to assist drivers in your transportation mode?*** *- Answers by Truck h experts to Q13*

Finally, Truck experts were required to answer two more questions (Q15 and Q16) regarding post-trip interventions, which would inform the driver of their performance and ways they could modify their behaviour after the journey has taken place.

Focusing on Q15, according to Truck respondents, the best way to incentivise those in the truck sector to engage with post-trip interventions is through rewards, positive reinforcement and evidence-based suggestions and feedback.

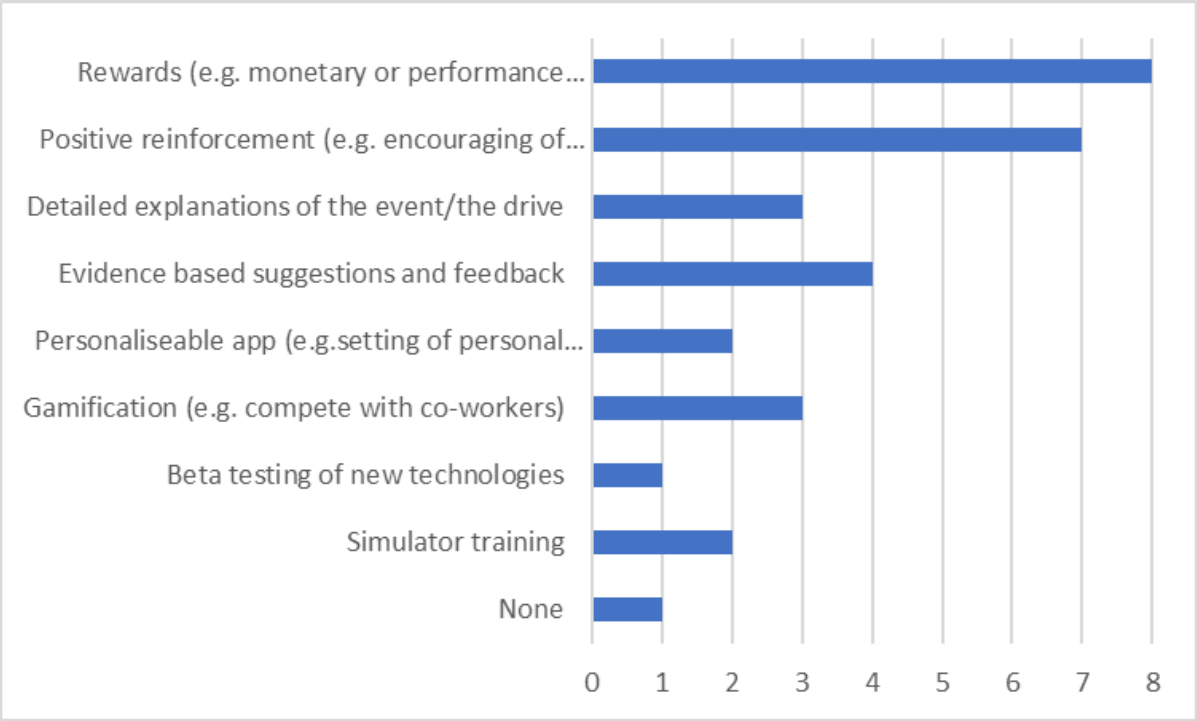

Figure 39: ***What do you think would incentivise people to engage with post-trip interventions in your mode?*** *- Answers by Truck experts to Q15*

3.2 Other modes (Train, Tram)

Train and Tram received 4 and 1 responses respectively. Therefore, the results for these modes have been combined and descriptively summarised.

Respondents for Train and Tram were from the United Kingdom (4) and Austria (1). Operators were the main stakeholders' group completing the survey for Train and Tram, leading results with 3 respondents. Following, there were Policy makers (1) and Regulators (1). 3 Stakeholders fell into the '11+ years' of experience category in their field, followed by 1 in the '6-10 years' and another in the '0-5 years'.

Considering Train and Tram as one group, rear end collision was selected as the most important collision type (4). This was explained in the comments, stating that whilst head on collision would be the greatest risk in terms of potential injury, trains and trams run one behind each other on the railway: therefore, rear end collisions represent a greater risk when the trains' and trams' safety systems fail. Head on collisions, however, together with junction/intersection collisions, were the second most important collision type.

Apart from collisions, the most important safety breach for Train and Tram was signal passed at danger (SPADs) (2). Track departure (1), door operation failure (1) and passenger behaviour (1) were also selected. When asked which issues contributed the most to the occurrence of SPADs, stakeholders suggested inattention/distraction (2). Missed

communication, work overload and underload, missed checks, fatigue/sleepiness and missed observations were also selected as contributing factors.

Comments also revealed that there may be some *expectation bias* with drivers assuming that certain signals will be green based on previous experience. Finally, stakeholders were asked how they thought the *i*-DREAMS could aid in the prevention of SPADs. Providing timely warnings, manipulating vehicle motion and suggesting driving tips for safer/more comfortable operation were suggested.

In relation to what technologies are currently being used to assist Train and Tram drivers, stakeholders indicated that fail safe (dead man's switch; 5), missed signals/SPAD monitoring (4), automatic emergency braking (4), speed violation warning (4) and black box recorder (4) are all used and important to the transportation modes. In terms of technology that is not currently used but stakeholders would like to use, fatigue monitoring (3), attention/distraction monitoring (3) and vehicle telematics informing of driving style (3) were selected as the most important.

Finally, the largest barriers and constraints for driver assistance in real time were identified as driver engagement (4), union involvement (3), and expense (3). Working practices (2), driver trust (2), different practices between automotive/truck/train operation (2) and data protection issues (2) were also identified as barriers.

In order to incentivise people to engage with post trip interventions, stakeholders for Train and Tram suggested positive reinforcement (4). Evidence based suggestions and feedback (3), rewards (2) and gamification (2) were also selected as important incentives.

4 Conclusions

4.1 Main Findings

The responses to the *i*-DREAMS survey confirm that experienced stakeholders (11+ years - academy researchers and operators above all) believe road-safety is indeed an important issue and is high on their agenda.

In particular, it shows that the global landscape for road safety is changing and that stakeholders are indeed convinced that it needs to be comprehensively tackled with other contingent factors and considerations – e.g. technological developments in automation.

Within the survey, collision with vulnerable road users (pedestrian/cyclist/motorcyclist) was seen as the most important type of collision for Passenger Car experts, whereas head on collision and rear end collision were respectively considered more important for Bus/Coach and Truck experts.

The most important safety breach/incident that would lead to such collisions would in general be loss of control for all modes, with further interesting outcomes:

- Passenger Car experts reported as most important safety breach/incident loss of control, followed by close following another vehicle and failure to give way.
- Bus/Coach experts reported as most important safety breaches/incidents loss of control and sudden braking, closely followed by signal passed at danger (SPADs). It is interesting to note that passenger behaviour was considered a secondary, but nonetheless important, breach/incident in Bus/Coach.
- The most important safety breach/incident reported by the survey respondents for Truck is close following of another vehicle.

A dangerous condition all vehicles find themselves in – and especially Passenger cars - involves speed. Speeding not only increases the distance needed to come to a complete stop, but it also greatly increases the risk of losing control of the vehicle, causing lane deviations and roll-overs. The likelihood of other road users, and in particular vulnerable ones (cyclists and pedestrians ahead), being involved in these types of crashes is also higher, considering the odds of the vehicle crossing lanes occupied by other users.

With bigger vehicles such as buses and trucks, it is no surprise that braking and close following another vehicle were considered significant factors in road crashes for these two modes. With such conditions, head on or rear end collisions may result from sudden stops that do not allow enough space and time to come to complete stop. In addition, the larger or longer the vehicle, the less visibility the driver has of the surrounding areas, thus increasing the risk of crashing into objects or running other vehicles off the road.

A very important issue resulting in the above-mentioned reasons for losing vehicle control and not abiding by the rules of the road comes also from a behavioural stand. Distracted drivers are four times more likely to be involved in road crashes than alert drivers[1]. Also, driver fatigue has shown to have an impact on driver behaviour. Without the appropriate amount of sleep and rest, drivers' performance on all modes is significantly declined in many areas, such as reaction time, vision quality, and overall judgment. A driver who is sleep-deprived will either

[1] *Klauer, S.G., Dingus, T.A., Neale, V.L., Sudweeks, J.D. and Ramsey, D.J. (2006). The Impact of Driver Inattention on Near-Crash/Crash Risk: An Analysis Using the 100-Car Naturalistic Driving Study Data. National Highway Traffic Safety Administration, Washington DC.*

become a danger to other drivers or will not have the ability and awareness needed to successfully avoid dangers from other drivers.

Considering what technologies are currently available and in use to assist drivers and their relevancy in terms of safety, crash avoidance and mitigation, the survey outlined that the majority of respondents for all modes picked devices with the abilities of controlling the vehicle in some way (automatic emergency braking, dynamic stability control/eletronic stability control, speed limiters) and, above all, monitoring issues and warning the driver (reversing cameras/detectors, lane deviation monitoring, insufficient headway monitoring, speed violation warning).

It is interesting to note that technologies not currently in use but seen as desirable by all responders were focused around ways to monitor the driver state (attention/ distraction monitoring and fatigue monitoring) along with a wider array of systems giving warnings and detecting issues (blind spot monitoring, missed signal/SPAD monitoring). Technologies that are not currently in use and that all experts would not use are the most privacy- and driver-invasive ones, such as physiological monitoring.

4.2 Recommendations

Partners in the *i*-DREAMS project should focus their efforts and adapt the system tools mostly to the needs of users. As shown in the *i*-DREAMS survey, further steps can be taken to ensure road safety and avoid collisions - and investigating how safety technologies are applied to transport modes could be essential to the development of the *i*-DREAMS system. During this phase, learning about the types of technologies available and understanding driver attitudes and behaviours will be crucial, as road safety technologies are only as successful as the attitudes and behaviours of the road users implementing them.

Stakeholders must foster an environment that encourages and enforces proper adherence to safety technologies. In the *i*-DREAMS survey, all modes experts detected barriers such as drivers trusting the road safety system and feeling engaged to it while overcoming their personal refusal towards such technologies in real time interventions, and believed that the best way to incentivise driver's engagement with the post-trip interventions should be through rewards, positive reinforcement and evidence-based suggestions and feedback. This shows that influencing drivers' attitudes and behaviours towards road safety technologies should always begin with allowing time and resources to make users comfortable and engaged with the transition and integration of the technology systems. The distraction-inducing effect of this technologies has been noted by many experts, and this is another issue needing attention within the i-Dreams technology framework.

Survey respondents have shown a strong focus on monitoring and warning technological devices as vital instruments for road safety, but also wished for future tech implementations that will take into account human factors that influence driver behaviour. Therefore, *i*-DREAMS should support a more holistic approach in its technology development by monitoring, preserving and evaluating technology standards to determine the necessary upgrades and transitions required for the system while harmonising them to user needs and features and creating a trusting environment for trials and applications. The *i*-DREAMS system should then collect best practices to address vehicle safety and the application of advanced driver assistance systems, show how national, regional and local authorities can work together effectively with the private sector to implement road-safety technology and transfer knowledge

and promote broad public education to instil the importance of advanced technology for safety in a clear and transparent way.

Annex 1: *i*-DREAMS Stakeholder Survey Questionnaire

Page 1: Participant Information

You are invited to complete this survey exploring the needs of various transport modes with regards to driver monitoring and interventions. This is part of the i-Dreams Horizon 2020 project (www.idreamsproject.eu) which investigates advanced technology's ability to maintain a safety tolerance zone (safe driving performance) in multiple modes of transport. Your knowledge and expertise are vital for the development of this research to ensure technology being developed will address the most important problems.

We are asking a range of stakeholders to complete this survey which will inform the project's future plans.

This survey will take you approximately 15 minutes to complete. You can withdraw at any time by closing your browser.

If you have any issues or further questions please contact Dr. Graham Hancox g.hancox@lboro.ac.uk or Rachel Talbot r.k.talbot@lboro.ac.uk.

Data Protection Privacy Notice

The data collected in this survey will be held anonymously and securely by according to Loughborough University's data retention and handling policies. Personal data will be kept for the duration of the project only. The anonymised results will be kept by the research team for 5 years. The results will contribute to project deliverables and publishable research outputs. Once the data have been anonymised it may not be possible to withdraw your individual contributions from the research.

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 814761.

Page 2: Consent Form

Please take the time to read through this consent form. Contact Dr. Graham Hancox g.hancox@lboro.ac.uk or Rachel Talbot r.k.talbot@lboro.ac.uk if you have any questions.

If you do not agree with any of the given statements and do not wish to proceed, please close your browser and your details will be withdrawn from the study.

Please read the following statements carefully:

- I am over the age of 18.
- The purpose and details of this study have been explained to me. I understand that this study is designed to further scientific knowledge and that all procedures have been approved by the Loughborough University Ethics Approvals (Human Participants) Sub-Committee.
- I have read and understood the information sheet and this consent form.
- I have been provided with contact information where I can ask questions about my participation.

Use of Information

- I understand that all the information I provide will be processed in accordance with data protection legislation on the public task basis and will be treated in strict confidence.
- I understand that information I provide will be used for research outputs such as reports and publications. I agree that information I provide can be quoted anonymously in research outputs.

1. Based on the above information, I give my informed consent to participate in this study. * *Required*

◉ Yes

Page 3: Demographic Information and Experience

2. In which country are you working? Please select one from the drop down box below. * *Required*

Please select

3. Which of these best defines your field of work (please select only one): * *Required*

- Academic researcher
- Campaign group
- Commercial researcher
- Education/ training
- Emergency service representative
- Insurance
- Manufacturer
- Operator
- Policy maker
- Regional/ local authority
- Sector representative
- Other

4. Approximately how long have you been working in this field?

- 0 - 5 years
- 6 - 10 years
- 11+ years

5. Which of these transport modes do you consider yourself to be predominantly experienced in working in (please choose only one): * *Required*

- Bus/ Coach
- Passenger car
- Trains
- Trams
- Trucks

Note: Please answer all the following questions **only in relation to your chosen transport mode.**

If you feel you can answer for another transport mode please re-start the survey once you have finished this one and select the second transport mode.

Page 4: i-Dreams Concept and Most Prevalent Collisions

The i-DREAMS project is developing a system that can monitor driver state (e.g. attention/alertness), the driving context (e.g. speed limits, weather) and driver behaviour (e.g. lane positioning, headway) in order to assist drivers. Real time warnings and alerts will be given when safety falls below a critical threshold with the aim of keeping drivers within a 'safety tolerance zone'. The safety tolerance zone is a continuum that includes normal or safe driving, a 'danger phase' where this risk of a collision is increased and an 'avoidable accident phase' where action needs to be taken to avoid a collision. If the i-DREAMS system detects that the driver has entered the danger phase a warning will be given and if it detects the transition into the 'avoidable accident phase' an instruction to take action will be given. The driver will also be provided with information following their trip (post trip intervention) to advise about when they were safe and unsafe.

The answers to the following questions for your chosen transport mode will help us in developing this system further.

Reminder: Please answer all the following questions **only in relation to your chosen transport mode.**

6. What type of collisions are most important (e.g. in most need of addressing) for your transportation mode? (select all that apply) * *Required*

- ☐ Rear end collision
- ☐ Head on collision
- ☐ Collision with vulnerable road users (pedestrian/cyclist/motorcyclist)
- ☐ Single vehicle collision
- ☐ Side collision (T bone)
- ☐ Junction/Intersection collision
- ☐ Collision with a stationary object
- ☐ Collision with an animal
- ☐ Don't know
- ☐ None
- ☐ Other

b. If you have any further comments, please use the textbox below.

Page 5: Safety Breaches/ Incidents

This part of the survey uses a table of questions, view as separate questions instead?

7. Apart from collisions, please select what you think are the three most important safety breaches/incidents for your transportation mode.

	Please select one safety breach/incident per option
Most important	Please select ▼
Second most important	Please select ▼
Third most important	Please select ▼

a. If you have any further comments, please use the textbox below.

The following 3 questions relate to the contributing factors for the safety breaches/incidents that you selected.

8. Which issues contribute to the **most important** safety breach/ incident identified in question 7? *
Required

Please select between 1 and 5 answers.

- [ ] Excessive speed
- [ ] Insufficient speed
- [ ] Missed communication
- [ ] Work overload (too much going on)
- [ ] Work underload (not enough going on)
- [ ] Missed checks
- [ ] Fatigue/sleepiness
- [ ] Inattention/distraction
- [ ] Substance impairment (e.g. drugs or alcohol)
- [ ] Lack of experience
- [ ] Stress (time pressure)
- [ ] Adverse weather
- [ ] Road geometry/infrastructure
- [ ] Impairment from a disability
- [ ] Traffic volume
- [ ] Missed observation
- [ ] Unfamiliar vehicle/controls
- [ ] Other
- [ ] Not applicable

b. If you have any further comments, please use the textbox below.

9. Which issues contribute to the **second most important** safety breach/ incident identified in question 7? *
Required

Please select between 1 and 5 answers.

- [ ] Excessive speed
- [ ] Insufficient speed
- [ ] Missed communication
- [ ] Work overload (too much going on)
- [ ] Work underload (not enough going on)
- [ ] Missed checks
- [ ] Fatigue/sleepiness
- [ ] Inattention/distraction
- [ ] Substance impairment (e.g. drugs or alcohol)
- [ ] Lack of experience
- [ ] Stress (time pressure)
- [ ] Adverse weather
- [ ] Road geometry/infrastructure
- [ ] Impairment from a disability
- [ ] Traffic volume
- [ ] Other
- [ ] Not applicable

b. If you have any further comments, please use the textbox below.

10. Which issues contribute to the **third most important** safety breach/ incident identified in question 7? *
Required

Please select between 1 and 5 answers.

- [ ] Excessive speed
- [ ] Insufficient speed
- [ ] Missed communication
- [ ] Work overload (too much going on)
- [ ] Work underload (not enough going on)
- [ ] Missed checks
- [ ] Fatigue/sleepiness
- [ ] Inattention/distraction
- [ ] Substance impairment (e.g. drugs or alcohol)
- [ ] Lack of experience
- [ ] Stress (time pressure)
- [ ] Adverse weather
- [ ] Road geometry/infrastructure
- [ ] Impairment from a disability
- [ ] Traffic volume
- [ ] Other
- [ ] Not applicable

b. If you have any further comments, please use the textbox below.

Page 6: i-Dreams Concept Development/ Considerations

Reminder: The i-DREAMS project is developing a system that can monitor driver state (e.g. attention/alertness), the driving context (e.g. speed limits, weather) and driver behaviour (e.g. lane positioning, headway) in order to assist drivers. Real time warnings and alerts will be given when safety falls below a critical threshold with the aim of keeping drivers within a 'safety tolerance zone'. The safety tolerance zone is a continuum that includes normal or safe driving, a 'danger phase' where this risk of a collision is increased and an 'avoidable accident phase' where action needs to be taken to avoid a collision. If the i-DREAMS system detects that the driver has entered the danger phase a warning will be given and if it detects the transition into the 'avoidable accident phase' an instruction to take action will be given. The driver will also be provided with information following their trip (post trip intervention) to advise about when they were safe and unsafe.

This part of the survey uses a table of questions, view as separate questions instead?

11. How do you think the i-Dreams system could aid in preventing the safety breaches/incidents prioritised previously? Please select the top three options.

One	Please select ▼
Two	Please select ▼
Three	Please select ▼

a. If you have any further comments, please use the textbox below.

12. What are the largest barriers and constraints you see for driver assistance in real time? *
Required

Please select between 1 and 5 answers.

- [ ] Working practices
- [ ] Union involvement
- [ ] Driver trust
- [ ] Driver engagement
- [ ] Expense
- [ ] Infrastructure reliability
- [ ] Different practices between automotive/truck/train operators
- [ ] Different policies among countries/authorities
- [ ] Data protection issues
- [ ] Personal refusal
- [ ] Installation time
- [ ] Technology distrust
- [ ] Equipment failure
- [ ] Legal contingencies
- [ ] Driver distraction concerns
- [ ] None
- [ ] Other

b. If you have any further comments, please use the textbox below.

Page 7: Technologies Currently Available and in Use

This part of the survey uses a table of questions, view as separate questions instead?

13. What technologies are currently being used to assist drivers in your transportation mode? (Note: consider "important" in terms of safety, crash avoidance or mitigation).

	* Required					
	Not applicable	Using and important	Using not important	Not using but would like to use	Not using and would not like to use	Name or examples of technology being used if applicable
Lane deviation monitoring	○	○	○	○	○	
Missed signals/SPADs monitoring	○	○	○	○	○	
Fatigue monitoring	○	○	○	○	○	
Attention/distraction monitoring	○	○	○	○	○	
Insufficient headway warning (too close to vehicle in front)	○	○	○	○	○	
Pedestrian detection	○	○	○	○	○	
Automatic emergency braking	○	○	○	○	○	
Blind spot monitoring	○	○	○	○	○	
Reversing cameras/detectors	○	○	○	○	○	
Speed violation warning	○	○	○	○	○	
Fail safe (dead man's switch)	○	○	○	○	○	
Speed limiter	○	○	○	○	○	
Dynamic stability control/electronic stability control	○	○	○	○	○	
Physiological monitor (e.g. heart rate)	○	○	○	○	○	
Black box recorder	○	○	○	○	○	
Vehicle telematics informing on driving style (in real time)	○	○	○	○	○	
Vehicle telematics (post-trip feedback)	○	○	○	○	○	
Fleet management devices	○	○	○	○	○	
Other	○	○	○	○	○	

a. If you have any further comments, please use the textbox below.

14. What additional technologies and future technology capabilities do you think could contribute to safety within your transportation mode?

Page 8: Post-Trip Intervention

Post-trip interventions inform the driver of their performance and ways they could modify their behaviour after the journey has taken place.

15. What do you think would incentivise people to engage with post-trip interventions in your mode? *
Required

Please select between 1 and 5 answers.

- ☐ Rewards (e.g. monetary or performance incentives)
- ☐ Positive reinforcement (e.g. encouraging of good habits)
- ☐ Detailed explanations of the event/the drive
- ☐ Evidence based suggestions and feedback
- ☐ Personaliseable app (e.g.setting of personal goals)
- ☐ Gamification (e.g. compete with co-workers)
- ☐ Beta testing of new technologies
- ☐ Simulator training
- ☐ None
- ☐ Other

b. If you have any further comments, please use the textbox below.

16. Do you have any personal experience of platforms monitoring driver behaviour and providing gamified feedback (either while driving or as a post trip intervention)? If so, please provide information relating to the system and any strengths and weaknesses you may have encountered.