INFRAMIX

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D.5.2

Users' appreciation in INFRAMIX developments

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Legal Disclaimer

Abbreviations and Acronyms

Acronym	Definition
DPO	Data Protection Officer
ITS	Intelligent Transport System
CCAD	Connected and Cooperative Automated Driving
VMS	Variable Message Sign
HMI	Human Machine Interface
CAM	Cooperative Awareness Message
DENM	Decentralized Environmental Notification Message
IVIM	In-Vehicle Information Message
RSU	Road Side Unit
TMC	Traffic Management Centre
IMC	INFRAMIX Management Centre
OBU	On Board Unit
AAE	Autopistas Abertis Espana
ODD	Operational Design Domain
OEM	Original Equipment Manufacturer
TPEG	Transport Protocol Experts Group
HD Map	High Definition Map
ADAS	Advanced Driver Assistance System
SP-WS	Spanish Workshop
SP-DM	Spanish Demonstration
AU-WS	Austrian Workshop
AU-DM	Austrian Demonstration

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Executive Summary

The first period of coexistence of conventional, connected and automated cars will be very important for the future of intelligent transport. A user-centric design should ensure that the gradual upgrade of the road infrastructure and its capabilities will meet the expectations of users from the start. INFRAMIX target is to prove the added value of INFRAMIX approaches to the daily lives of citizens.

Close reviews on user interest in the demonstration and workshop events took place to evaluate users' acceptance, its respective analyses and requirements, incorporation into demonstration sites and hybrid testing, and user interest in these activities.

A full assessment of the users' satisfaction, the effects on their behaviour, the percentage of active users, the accuracy of the information provided and the impact on traffic was carried out. The satisfaction factors of the users (willingness to use, perceived efficiency, and the behavioral improvements) measured with great acceptance over 70% in most cases, which is very significant for the intelligent transport society.

In Chapter 2, evaluation methodology is presented: approach followed and research questions developed

In Chapters 3, 4 , 5 and 6 Workshop and Demonstration events setup in Spain and Austria is described.

In Chapter 7 survey tools for capturing users' acceptance and statistic analysis tools are presented.

In Chapters 8 and 9 Human Machine Interface application and cellular application experiments analyses are provided.

Finally, in Chapter 10 all the users' appreciation statistic recults are presented for all the research questions covering all the scenarios in Austria and Spain.

1. Introduction

1.1 Purpose of Document

As described in the INFRAMIX DoA document, D5.2 implements the methodology and plan for evaluation as well as the process for engaging users described in [6]. The users' acceptance of INFRAMIX developments is considered of high importance.

The methodology has described the research questions, the setup of various tests, the analysis procedure to be followed, the sample sizes, the data to be collected, the performance indicators to be measured and the methods of study. Three scenarios were studied: i)dynamic lane assignment, ii) construction site / roadwork areas, iii) bottlenecks (on-ramps, lane drops, tunnels, bridges, sags).

The target of this task is the evaluation of the users' appreciation in INFRAMIX developments. The users' appreciation was assessed with regard to the overall information chain, pictograms, physical signs, electronic signals, traffic management strategies for mixed traffic scenarios etc. Some of the performance indicators, relevant to users' appreciation, which were evaluated in this task are understandability, learnability, willingness to use, perceived usefulness, expected impact especially on traffic efficiency and safety. Different ways for collecting users' feedback, such as dedicated digital and paper questionnaires, supported by videos simulating the developments and live demonstrations events at which selected users were passengers of connected vehicles were followed in this task.

2. Evaluation Methodology for Users' Appreciation

2.1 Methodological Approach

The generation, collection and analysis of the measurements provided by the target users were implemented in a structured and effective way with the aim to collect the users' opinions on INFRAMIX developments and the individual characteristics of the interviewees (demographics, education, profession etc.). Since the number of target users required by the D.o.A. does not allow performing reliable analysis per different group of interviewees, the main purpose for registering such characteristics was to assure that the sample would be as the most representative possible.

Participants were classified:

into 7 groups according to their age :

18-20	21-30	31-40	41-50	51-60	61-70	over 70

into 8 groups according to their profession :

Self – employed	Manager	Expert/office worker/scientist	Employee	Student	Unemployed	Retired	Other

into 7 groups according to their education:

No education completed	Elementary school	Middle school	High school or other secondary education	University Bachelor	University Master	PhD

into 5 groups according to driving licence possession data for other types of vehicles:

motorcycle	light truck/lorry	heavy truck/lorry	Bus	No

into 5 groups according to total annual driving Kilometers:

Less than 5000 Kilometers	5001-10000	10001 - 20000	20001-30000	More than 30000 Kilometers

The driving experience was determined to be very experienced, experienced, neither experienced nor inexperienced, inexperienced, or very inexperienced. Experience with relevant traffic management functionalities and familiarity with devices could be answered with considerable use experience (4), some use experience (3), I know what it is but never used it (2), not at all (1). Familiarity with devices data was used to classify the participants experience with all types of devices (navigation device, smartphone, tablet and in-vehicle integrated control/information screen). Below an indication of the background variables distribution for Spanish and Austrian Workshops

Table 1. Demographics/background distribution in Barcelona and Graz

Age, classified	SP-WS Barcelona %	AU-WS Graz %
18-20	0	0
21-30	12.5	14.5
31-40	25	23
41-50	32.5	30.5
51-60	20	22
61-70	10	10
Over 70	0	0
Profession, employment status		
Self –employed	5	3
Manager	40	42
Expert/office worker/scientist	47,5	44
Employee	5	6
Student	2,5	5
Unemployed	0	0
Retired	0	0
Education		
No education completed	0	0
Elementary school	0	0
Middle school	0	0
High school or other secondary education	0	0
University Bachelor	35	32
University Master	50	53
PhD	15	15
Car driving license possession in years,		

classified		
≤3	2,5%	3%
>3	97,5%	97%
Driving license possession for other types of vehicles		
motorcycle	30	32
light truck/lorry	10	8
heavy truck/lorry	0	0
Bus	0	0
No	60	60
Total annual driving kilometers		
Less than 5000	20	18
5001-10000	20	22
10001 -20000	30	32
20001-30000	15	13
More than 30000	15	15
Driving experience		
very experienced,	2,5	5,5
experienced	0	0
neither experienced nor inexperienced	10	12
inexperienced,	75	70
very inexperienced,	12,5	12,5
Experience with traffic management functionalities, real-time traffic information		
considerable use experience	2,5	2,5
some use experience	5	7
I know what it is but never used it	40	42
not at all	52,5	48,5
Experience with traffic management functionalities, real-time incident information		
considerable use experience	0	0
some use experience	15	14
I know what it is but never used it	47,5	49
not at all	37,5	37
Experience with traffic management functionalities, real time speed limit information		
considerable use experience	5	3
some use experience	5	4
I know what it is but never used it	45	50

not at all	45	43
Experience with traffic management functionalities, real time adaptive speed limit information		
considerable use experience	7,7	7,3
some use experience	25,6	26
I know what it is but never used it	38,5	40,5
not at all	28,2	26,2
Experience with traffic management functionalities, real time traffic/incident information		
considerable use experience	0	0
some use experience	12,5	13
I know what it is but never used it	40	39,5
not at all	47,5	47,5
Experience with traffic management functionalities, navigation with real-time speed limit information		
considerable use experience	0	0
some use experience	27,5	27
I know what it is but never used it	42,5	43
not at all	30	30
Experience with traffic management functionalities, navigation with real-time speed adaptation information		
considerable use experience	12,5	12
some use experience	35	35,5
I know what it is but never used it	37,5	34,5
not at all	15	18
Familiarity with handheld devices		
considerable use experience	12,5	11,5
some use experience	7,5	8,5
I know what it is but never used it	20,8	20,4
not at all	59,2	59,6

As it has already been mentioned, the sample size per Demonstration and Workshop event required by the D.o.A was not sufficient for performing analysis on background specific characteristics of the participants. However, even within this sample, no significant impact of involved subgroups of participants was found to have a change in user acceptance results and no differences in the relevant subgroup distributions were found. Analysis made on a scenario level, aggregating the relevant use cases as described in Section 3.1 of [6]

Before the statistical process, the questionnaires were checked as far as the quality of the received data. Questions were checked to make sure that answers to specific questions would not follow a very clear pattern so as to reflect thoughtful, accurate answers. Questionnaires with illegible, incomplete, inconsistent and ambiguous answers were fine-tuned and corrected through face to face interviews. Finally, a look at what people wrote about required open questions gave immediate insight into the out - of-sense answers that should be excluded from the analysis.

The number of target group members per event that answered the questionnaires was:

- Spanish Workshop (Barcelona): 40 people
- Spanish Demonstration (Girona): 28 people in Scenario 1, 20 in Scenario 2, 21 in Scenario 3
- Austrian Workshop (Graz): 40 people (39 Workshop participants plus one that answered only the questionnaire)
- Austrian Demonstration (Graz): 20 people

The target of 100 questionnaires was clearly overexceeded.

2.2 GDPR Compliance

The questionnaires were either anonymized or accompanied by written consent in the case that names were registered (Girona Demonstration). No personal sensitive data were requested and recorded. For this reason, no explicit question about gender was included in the background questionnaires distributed during the Workshop and Demonstration events. However, a discreet effort for a satisfactory representation of all genders was made. Indicative numbers for the genders representation percentages are mentioned in 2.3 section.

It was decided that it was not necessary to appoint a DPO not only due to the anonymity of data, the written consent for giving the answers and the lack of sensitive data but mainly due to the small -scale data processing and collecting during users' appreciation events. Written consent was given with the help of a completely unmistakable notice along the lines of "by submitting this form you agree that we will process your data in line with our privacy policy". This consent form was distributed before the participants answer the main body of questionnaires (users' appreciation and background). All the recorded data will be destroyed 6 months after the end of the project.

2.3 Research Questions / Hypotheses

The key problems in the user-related area are user reactions / behaviour, system reliability and acceptance by the user. These issues include both the efficiency with which drivers and systems react in normal and critical situations and how drivers perceive, understand, accept and trust the operating principles of the system. The main objectives of INFRAMIX users' appreciation evaluation are to research driver/passenger acceptance of innovations in INFRAMIX. The assessment focuses on evaluating the acceptance of users towards the new visual signs and the extensions of wireless messages required to implement the road infrastructure services. The demonstration tests were carried out in real traffic environment on test sites using mockup scenarios, controlling the traffic conditions and ensuring user safety.

In INFRAMIX user-related assessments, the reactions of users to the INFRAMIX functions were investigated by impartial participants in the scenarios of project traffic. Using unbiased subjects ensures that the test drivers will have similar experience and prior knowledge of the program as a later consumer. Both assessments were accompanied by questionnaires that included details on the transport operations in question regarding the opinions of the test drivers. Data for user assessment were collected at the test sites during demonstrations and at workshops, supported by interviews for the questionnaires fine tuning, where needed. Also system experience was evaluated via simulation visualization items, videos or depiction of new visual signs on cellular devices and on an board passenger screen.

Some INFRAMIX partners' companies employees (mainly ASFINAG and AUTOPISTAS) but not involved in INFRAMIX project participated in the appreciation tests, but also people from other critical stakeholder groups related to transport took part: industry, research, infrastructure, national authorities, information technology, consulting etc. An -as fair as possible, gender representation of the general public was achieved, taking into consideration the voluntary character of the participation events, and the gender distribution status quo in transport industry. The percentage of women in the Girona demonstration and the Graz Workshop were 31% and 26%, respectively.

High-level research questions were designed to categorize the evaluation of the main aspects affecting usability and user acceptance of the program. The High-Level Research Questions were thus identified as follows:

- Change of behaviour: Does the consumer behave according to the advice of the "hybrid" infrastructure?
- Willingness to use: How strong is the desire to use a motorway equipped with the INFRAMIX services?
- Usability perceived: Do users find usability / user experience good / high?

From the beginning of the project, project work has been divided into long-and short-term approach with respect to the time horizon. Consequently, the high-level research questions have been categorized as shown in the following table:

Table 2. Categorization of the research questions

	long	short	Comments
Does the user act according to the "hybrid" infrastructure recommendations?		X	

Is willingness to use a motorway equipped with "hybrid" infrastructure high?	X		the willingness is expected to increase with experience
Do the users consider usability/ user experience to be good/high?		X	

A visual overview of the relationship between users' appreciation variables, research questions and their related hypothesis is given in the following table. The study is based on three main factors of user satisfaction, each of which could be expressed into one or more research questions (RQs). The latter have to do with common hypothesis (Hs) that will be evaluated in different scenarios. In addition, colors show the priority of each RQ, with darker shades of higher priority. A list of both RQs and Hs is given below, whereas more insightful information is provided.

Table 3. Performance Indicators for Users' appreciation

Users' appreciation factor	Research question	Hypothesis	S1_UC_1	S1_UC_2	S1_UC_3	S2_UC_1	S2_UC_2	S3_UC_1	S3_UC_2	S3_UC_3
Behaviour change	RQ1.1 Behaviour change	H1.1	x	x	x	x	x	x	x	x
Willingness to use	RQ2.1 Willingness to use	H2.1	x	x	x	x	x	x	x	x
Perceived usability	RQ3.1 Traffic management	H3.1	x		x			x	x	x
	RQ3.2 Learnability	H3.2	x	x	x	x	x	x	x	x
	RQ3.3 Intuitiveness	H3.3	x	x	x	x	x	x	x	x
	RG3.4 Understandability	H3.4	x	x	x	x	x	x	x	x
	RQ3.5 Timing and number of signs	H3.5	x	x	x	x	x			
	RQ3.6 Correct information	H3.6	x	x	x	x	x	x	x	x
	RQ3.7 No distraction	H3.7	x	x	x	x	x	x	x	x
	RQ3.8 Immediate Reaction	H3.8	x	x	x	x	x	x	x	x

	RQ3.9 Potential benefit	H3.9	x	x	x	x	x	x	x	x

The detailed list of Research Questions is included here:

Table 4. Research Questions for Users' appreciation

RQ1.1 Do users state that they would consider following the sign suggestions?
RQ2.1 Do users state that they are willing to use the information provided by the signs?
RQ3.1 Do users perceive the traffic management functionalities/ app as useful and satisfying?
RQ3.2 Do users perceive the signs as easy to learn?
RQ3.3 Do users perceive the signs as intuitive?
RQ3.4 Do users perceive the signs as easy to understand?
RQ3.5 Do users appreciate the timing and number of signs (gantries) per kilometric distance?
RQ3.6 Do users believe that the signs provide correct information?
RQ3.7 Do users perceive that the signs are not distracting them from the driving task?
RQ3.8 Do users have a positive immediate reaction to the traffic management functionalities?
RQ3.9 Do users judge the potential benefit of having access to the traffic management functionalities as large?

The detailed list of Hypotheses is included here:

Table 5. Hypothesis for Users' appreciation

H1.1 Users state that they would consider following the sign suggestions
H2.1 Users state that they are willing to use the information provided by the signs
H3.1 Users perceive the traffic management functionalities /app as useful and satisfying
H3.2 Users perceive the signs as easy to learn
H3.3 Users perceive the signs as intuitive
H3.4 Users perceive the signs as easy to understand
H3.5 Users appreciate the timing of information from the infrastructure while driving in specific road segment)
H3.6 Users believe that the signs provide correct information
H3.7 Users perceive the signs are not distracting them from the driving task
H3.8 Users have a positive immediate reaction to the traffic management functionalities
H3.9 Users judge the potential benefit of having access to the traffic management functionalities as large

3. Workshop Setup in Spain

The INFRAMIX project organised its first interactive workshop "Preparing road infrastructure for the introduction of Automated Driving" on 14th May 2019 at Fira Barcelona, as part of the Barcelona International Motor Show held between the 11th and the 19th of May. The workshop took place at the end of the project's second year, before the start of the planned demonstrations at the test sites. It targeted a broader network of stakeholders that represent the relevant transport and mobility actors, road authorities, road operators, service providers, policy makers, standardisation bodies, public administrations, and others.

3.1 Barcelona International Motor Show

Established in 1919, the show celebrated a historic edition to mark its centenary year in 2019, with more than 800.000 visitors, and the participation of 44 high-end automobile trademarks, including Alfa Romeo, Aston Martin, Audi, BMW, Ferrari, Fiat, Ford, Honda, Hyundai, Infiniti, Jaguar, Jeep, Kia, Lamborghini, Land Rover, Lexus, Maserati, Mazda, Mercedes Benz, Mitsubishi, Nissan, Porsche, Renault, Seat, Skoda, Subaru, Suzuki, Tesla, Toyota, Volkswagen, Volvo, among others.

The internationally-renowned event offered visitors the opportunity to have a look at and experience the future of vehicles, and learn about the technologies that are changing it, namely autonomous cars that took the central stage at the event. Demonstrators were organized for different levels of autonomy so participants could experience them.

Figure 1. Barcelona International Motor Show 2019

This was a great opportunity for the first Inframix workshop, which took place atthis international event that brings together many stakeholders with relation to the introduction and proliferation of automated vehicles.

3.2 Workshop organization

The first Inframix workshop was intended to increase the visibility of the project, its solutions, and technologies, among the targeted stakeholders. In addition, it aimed to collect feedback from stakeholders regarding their perception and experience, as well as their appreciation and acceptance of the approaches and solutions adopted by Inframix. Furthermore, the workshop represented an opportunity for knowledge sharing among different experts and professionals active in fields related to automated mobility, as well as among consortiums of different European projects and working groups (namely ARCADE, CARTRE, ERTRAC, MAVEN and TransAid).

Time	Topic	Moderator
09:30	Registration and Coffee break	
10:00 10:10	**Welcome session**	Xavier Daura Autopistas
10:10 10:30	**The INFRAMIX project**	Martin Dirnwöber AustriaTech
10:30 11:40	**Panel of experts: Infrastructure classification scheme** We will discuss the purpose and characteristics of a classification scheme for road infrastructure in terms of digital capabilities to support Connected and Automated Driving, gathering the point of view of several initiatives and projects. - Stephane Dreher, ERTICO, representing ARCADE and CARTRE - Jacqueline Erhart, ASFINAG, representing ERTRAC - Jaap Vreeswijk, MAP traffic management, representing MAVEN and TransAid - Yannick Wimmer, ASFINAG, representing INFRAMIX	Stamatis Manganiaris ICCS
	10' minutes break	
11:50 13:00	**Interactive Session: Users appreciation** The attendees will have the chance to learn about the INFRAMIX scenarios via videos and mock-ups, to see the visual signs supporting Connected and Automated Driving and have their saying.	Katia Pagle ICCS
13:00 13.30	**Closing Session** The coordinator will summarize the discussions of the day and give the concluding remarks.	Martin Dirnwöber AustriaTech

Figure 2. Workshop agenda

The workshop covered several key topics related to the introduction of Automated Driving concepts in traffic, including infrastructure classification schemes, user perception, and new methods for managing traffic. The workshop's format was highly interactive and engaging, and encouraged participants to share their thoughts and ideas. Its agenda is shown in the figure above. It started with a welcome session, and continued to introduce the Inframix project, its aims and objectives, approaches, and technologies. Afterwards, a panel of experts was organized to address themes related to infrastructure classification schemes, followed by an interactive session to showcase the Inframix scenarios and acquire more user feedback. In addition, the workshop sessions aimed to foster a grounded cooperation and agreement among stakeholders in order to avoid market fragmentation where different stakeholder categories are promoting and lobbying for different solutions.

40 individual participants representing 16 different institutions participated in the workshop. 26% of them were from public administration, 19% from Infrastructure and construction firms, 16% from road operators & traffic management companies, 16% from C-ITS infrastructure and sensing technology firms, 10% from Research and innovation institutions, 5% from the automotive industry, and 8% from other domains.

3.3 Panel of experts

After a short welcome by Mr Xavier Daura from Abertis Autopistas and a brief introduction to Inframix by the coordinator Mr Martin Dirnwöber from AustriaTech, the panel of experts centered on discussing the purpose and characteristics of a classification scheme for road infrastructure in terms of digital capabilities to support Connected and Automated Driving. It looked into gathering the point of view of several initiatives and projects, through the contribution of the invited experts and audience.

The panel of experts included the following experts, in addition to representatives for the Inframix consortium:

Dr. Stephane Dreher, senior manager of innovation and development at ERTICO – ITS Europe, expert in the fields of Connected & Automated Driving and Blockchain, automated road transport, Cooperative systems, ITS, multi-modal Transport solutions, and mobile location-based services among others.

Jacqueline ERHART, program manager for Cooperative, Connected and Automated Driving in ASFINAG, expert in engineering physics and experimental research related to the automobile industry, and physical and digital infrastructure elements and services for CCAD on motorways.

Stamatis Manganiaris, Senior Researcher at the Intelligent Transport Systems department of the I-SENSE group, expert in high-end technology and business consulting, Telecoms Networks Deployment and Maintenance, IT security, IT & Technology Project Management, IT Service Design and Delivery, Business Continuity, Digital Transformation, Business Process Management & Re-engineering.

Katia Paglé, Senior Researcher at the Intelligent Transport Systems department of the I-SENSE group, expert in Intelligent Transport Systems, Cooperative ITS, Training and Education in the field of ITS, Evaluation, Assessment of Impact and User

Acceptance, Ergonomics, Field Tests, Automated and Cooperative Transport Systems and Electromobility.

Dr.ir. Jaap Vreeswijk, traffic architect for Connected and Automated Driving (CAD) at MAP, expert in ITS, smart mobility, centralised management for automated vehicles, Mobility-as-a-Service, and adapting and advancing infrastructure and traffic management through new innovations and technologies.

Dr. Yannick Wimmer, project manager for Cooperative, Connected and Automated Driving in ASFINAG, expert in electrical engineering, Microelectronics, semiconductor devices, Telematics Services, and Cooperative, Connected and Automated Driving (CCAD).

Figure 3. Pictures of the panel of experts session

3.4 Interactive session

Following the panel of experts, and in order to engage as many stakeholders as possible, and collect their direct feedback and efficiently disseminate project results, an interactive session was organized to showcase the implemented project's scenarios (bottlenecks, dynamic lane assignment and roadworks), using videos and mock-up examples in order to illustrate the approaches that Inframix takes to manage each of these scenarios. Participants were encouraged to share their thoughts, discuss their ideas, and give feedback on the scenarios.

Participants were also invited to formally register their reaction to the Inframix scenarios by filling assessment questionnaires designed for this purpose. A total of 40 questionnaires were completed, distributed covering the different scenarios.

4. Demonstration Setup on Spanish Test Site

The main objectives of the Inframix Spanish demonstrations centered on investigating the behaviour of vehicles in mixed situations, and validating the fidelity of the virtual test environment in reflecting the reality at the test site, and the effectiveness of the developed infrastructure measures in ensuring an appropriate vehicle/driver behaviour. Users' appreciation and safety performance are two key aspects considered throughout the whole process, and evaluated in the assessment activities.

On a technical level, the demonstrations aimed to showcase a bi-directional communication between infrastructure and vehicles, and to ensure a robust and complete information chain among all actors and components in the system, including between real-world elements and their counterparts in the virtual test environment. In addition, the demonstrations provided an opportunity to test and validate the sensing and communication technologies of the test site, as well as the systems deployed to interpret the data and to generate the relevant C-ITS messages.

The demonstrations were conducted on Autopista's specially equipped test site, in accordance with the project plan. They consisted of three days of organized tests and trials under real life conditions, and address the three traffic scenarios of Inframix (Dynamic Lane Assignment, Roadworks Zones, and Bottlenecks).

The organized demonstrations of mixed traffic scenarios paid particular attention to safety aspects and users' appreciation and acceptance in terms of visual signals, messages, and the relevant TMC control actions taken during the trials. In order to assess users' appreciation and acceptance, participants in the demonstrations were interviewed after each trial using instances of the generic questionnaire, translated by Autopistas to Spanish and Catalan, and tailored to fit the scenarios (three versions, each with specific adjustments introduced to accommodate the concerns related to the particular use case addressed).

4.1 Test Site Design and Infrastructure

The Spanish test site is located within the Mediterranean Corridor between Barcelona and the French border, to the west of the city of Girona. It is a 20 km four-lane highway segment with 3,5 m wide lanes, a 5 m median, an internal hard shoulder of 1m height, a 2,5 m external hard shoulder, and a speed limit of 120 km/h.

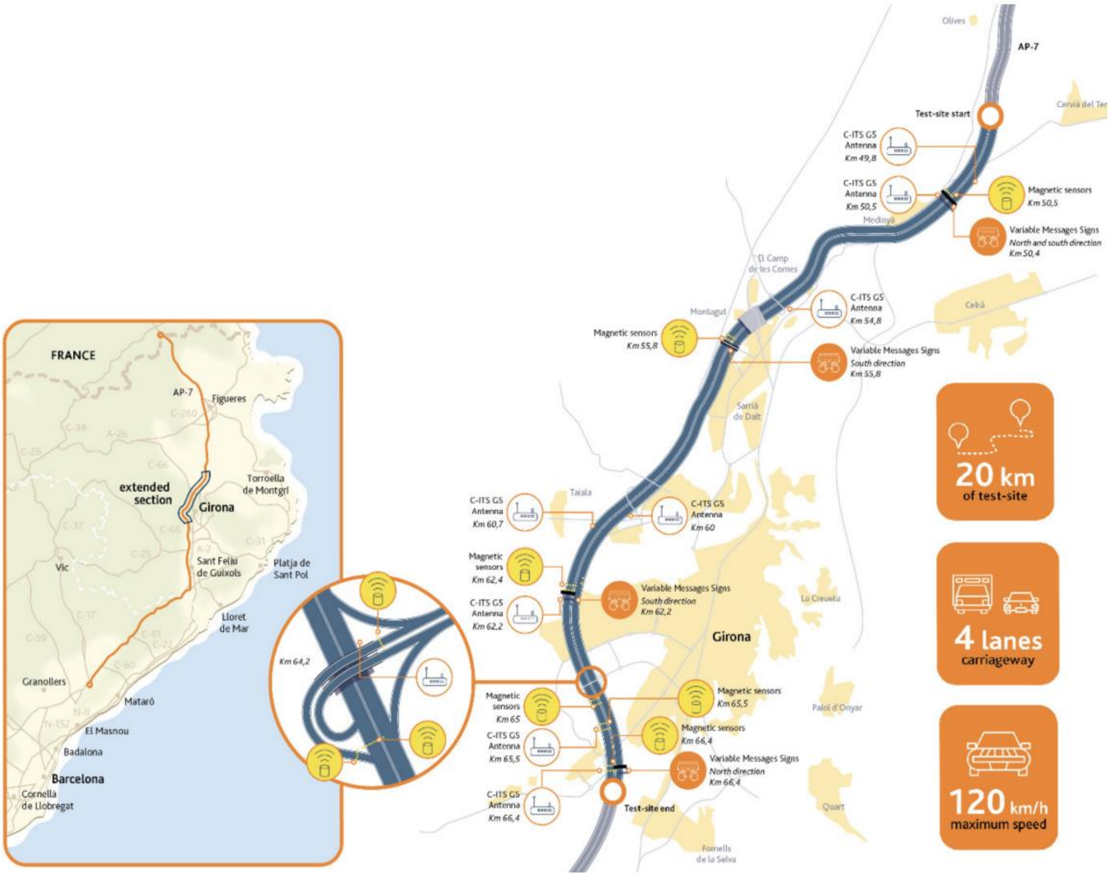


Figure 4. Schematic view of the Spanish test site

The location of the test site was selected to facilitate the conduction of realistic experiments without endangering ongoing traffic. The width of the selected highway segment, and the characteristics of its shoulders allow to isolate or repurpose specific lanes that pass by different situations, including intersections. To connect vehicles, the test site includes an ITS-G5 short range and cellular (4G/LTE) communication network, and transmits data in real time to the TMC via a proprietary Fiber Optic ring network with 10 Gbps Bandwidth capacity. This way, it supports I2V and V2I communications. In the context of Inframix, the ITS-G5 Road Side Units (RSUs) connect to the IMC, and send/receive messages to ITS-G5 On Board Unit (OBU) installed in test vehicles.

In addition, several adaptations and extensions to the test site have been made in order to accomodate the demonstrations of Inframix. These included the installation and deployment of VMS equipments and magnetometers capable of measuring traffic density.

Figure 5. Installed equipments

Approaching vehicles that are about to enter the test site, from the highway or from the on-ramp, are informed about ongoing tests on the site, and warned about roadworks and other events, through installed VMS panels. The passing of vehicles is tracked through 60 magnetometers capable of counting vehicles per lane and discerning the speed and type of each vehicle.

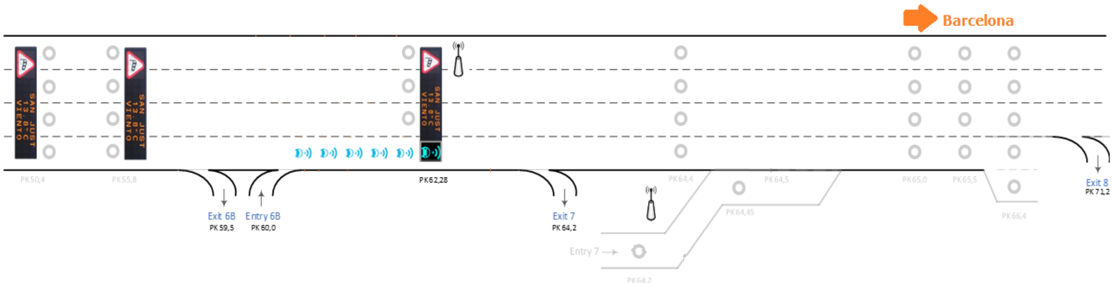


Figure 6. Detailed sketch of the test area

In order to conduct the tests, AAE provided three rented BMW vehicles having the exact specifications provided by BMW in order to support the communication in unicast mode (as opposed to broadcast mode). In addition, AAE provided two more vehicles from their fleet, one equipped with ATE's OBU, and the other with a tablet hosting TOM's application.

For the demonstrations, pictograms were painted every 100 meters on the rightmost lane to indicate a dedicated lane. In addition, four vertical signals were installed, three to warn about the proximity of the dedicated lane, and a fourth one to indicate its end. All the signalling is shown in the picture below.

Figure 7. Detailed sketch of the test area

4.2 Demonstration scenarios

The demonstrations aimed to implement, showcase, and assess the project's three scenarios and their specific use case, which were adapted for safety, quality of service, and road efficiency, and to demonstrate the project's technologies and approaches.

Scenario 1, Dynamic Lane Assignment (DLA), assigned dynamically an exclusive lane to automated traffic, in order to increase the traffic flow and reduce safety problems. Two segments were prepared accordingly: a detection zone where messages are received including the dedicated lane warning; and the relevance zone where vehicles should have adapted their trajectories, speed and time gap, with respect to the signals received. The vehicles entered the highway in entrance 6B to find the 1km dedicated lane starting in the PK 62,28, afterwards they took Exit 7 to returned back to the meeting point, in an estimated lap time of 35 min. Traffic data was gathered by the array of magnetometers, the full-colour VMS installed at the DLA start point was enabled, and existing VMS were used to inform vehicles about the ongoing test. In addition, the new painting had been applied beforehand to the lane in order to provide a more realistic scenario.

Scenario 2, Roadworks, the infrastructure safely guided the incoming mixed traffic through roadworks zones by providing accurate information to automated vehicles (electronic signals and up-to-date digital maps), and conventional vehicles (guidance to nomadic devices, visual signs, etc.). The traffic control strategies that the infrastructure could employ in the future take into consideration the penetration rate of automated vehicles. the prevailing traffic, and the weather conditions. Similarly to Scenario 1, two segments were prepared, one for sending messages, and one to observe how the traffic adjusted after receiving the messages. The vehicles participating in the demonstration entered the test site from entrance 6B, to find 1km of roadworks starting at PK62,5, and then exited at Exit 7 , in an estimated lap time of 15 min.

Scenario 3, Bottlenecks, investigated how real-time controllers and control measures, such as dynamic speed limits, dynamic lane assignment, and merge assistance can manage mixed traffic situations at bottlenecks and avoid traffic flow degradation. Four test site segments where prepared accordingly: Segment 1 was a safety area in which speed limits gradually decreased as vehicle approach the Mainstream Traffic Flow Control area or Segment 2, where control was applied using lower speed limits, then Segment 3 was used to accelerate traffic and reach Segment 4 (the actual bottleneck) with higher speeds than in Segment 2. The vehicles entered the highway in entrance 6B to find the merge ramp (entrance 7) in the PK 64,5. After the merge ramp, they took exit 8 (intermediate point) to return the toll gate, in as estimated lap time of 20 min.

4.3 Demonstration Organization

The demonstrations were organized from the 12th to the 14th of September 2019, and a total of 31 laps were performed under different settings according to the scenario and use cases . On the first day, 9 laps were conducted from 9am to 7pm for Scenario 2 (Roadworks). On the second day, 14 laps were conducted from 8:30am to 6pm for Scenario 1 (Dynamic Lane Assignment). Finally, on the third day, 6 laps were conducted from 11am to 5:30pm for Scenario 3 (Bottleneck).

The vehiclescirculated in the following order: First, an OBU-equipped AAE vehicle, followed by another AAE vehicle equipped with the TomTom App, and then the three BMW vehicles. The communication model between the vehicles and infrastructure is represented in the following figure. Each lap looped around the test site going southwards starting from the Girona Oest toll gate and driving towards a specific exit location from which the vehicles could change direction and drive back to the toll gate. Exit locations, and consequently the length of the lap, varied according to the scenario. The subject participants that used the vehicles and later filled the users' appreciation and acceptance surveys were invited from the staff and connections of AAE and other partners.

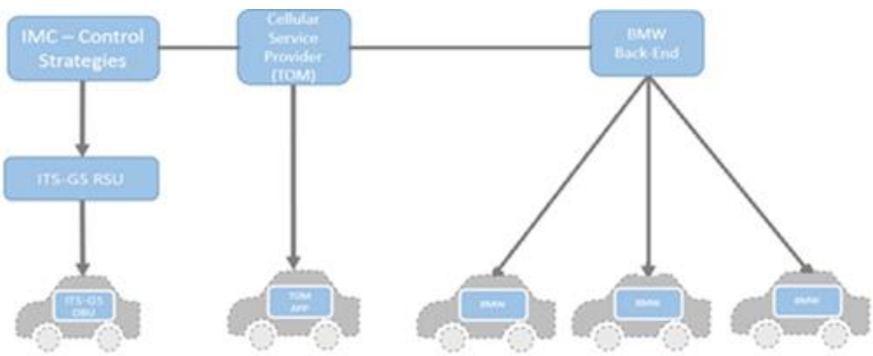


Figure 8. Detailed sketch of the test area

Overall, 31 laps were successfully performed, out of the 36 laps originally conceived in the demonstration plan. During the tests, some light but unforeseen technical issues and unexpected media attention generated by the test site activitiesslightly interfered with the testing schedule, causing the cancellation or rescheduling of specific laps. In addition, the partners decided to cancel a 4th half-day of tests in which up to 6 laps were scheduled, due to the fact that enough data had been gathered on all scenarios, and consequently these laps were deemed repetitive in terms of expected outcome.

4.4 Retrieved Results

Upon the completion of a lap, the subjects that were participating in the demonstrations were interviewed at the toll gate. They were also asked to fill in a survey questionnaire to document their experience. 10 distinct questionnaire models were prepared for each scenario and use case. A total of 69 surveys were completed, distributed among the different scenarios evaluated.

Technical incidents were detected and addressed or recovered during the demonstration period, with little or no effect on the conduction of experiments and the gathering of results.

5. Workshop Setup in Austria

INFRAMIX and TransAid organised a joint Workshop on infrastructure requirements and traffic control strategies for automated driving on 9th October 2019 in Graz. The Workshop took place in the facilities of the Virtual Vehicle research centre.

In addition to networking, the joint stakeholder workshop, due to the high diversity of attendees (see 5.2) was a perfect opportunity for fruitful discussions and for generating feedback on key topics of the two projects:

- Explore in more detail how increasingly automated vehicles are likely to behave in various traffic situations and how this may affect the traffic management task.
- Provide insight into the role that communication technology (digital infrastructure) can play in the shorter term of connected transport and the longer term of automated transport.
- Promote reflection among public, knowledge and technology stakeholders on proposed solutions, and on their role and responsibilities as automated driving evolves.

In addition, the exchange between the two projects (INFRAMIX and TransAID) was regarded as very profitable. The workshop consisted of plenary sessions in the morning and afternoon. These sessions were also used for digital questionnaires within the scope of the two projects.

5.1 Poster exhibition

In the foyer right outside of the meeting rooms, a permanent poster exhibition (10 posters) took place, so that during the coffee breaks, the participants could find further information and engage in discussions.

5.2 Workshop participants

39 participants joined the INFRAMIX and TransAID workshop in Graz, which comprised a very international audience as can be seen in the graphic below. Due to the location in Graz, Austria, the majority of attendees was Austrian, however, more than a half were international guests, a considerably high percentage.

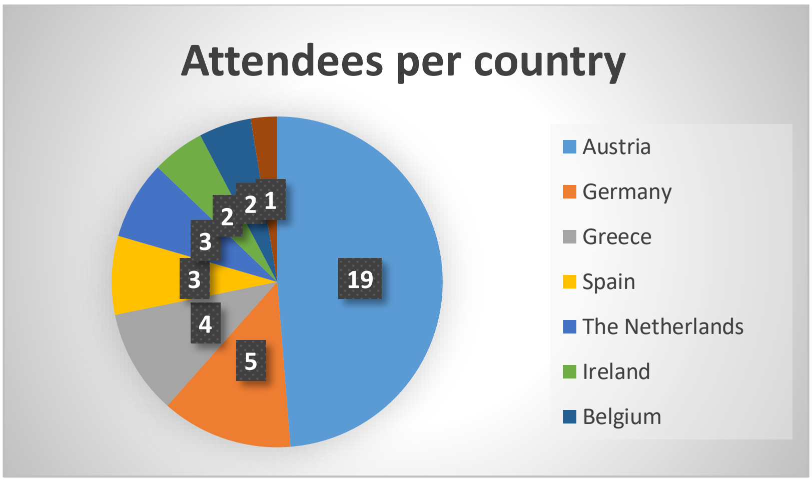


Figure 9. Graz Workshop attendees per country

Also concerning the attendees' affiliation, the workshop can be regarded as very diverse. The attendee list comprises a cross section of important stakeholders groups. This ensured valuable input and laid out a base for interesting discussion in the discussion sessions.

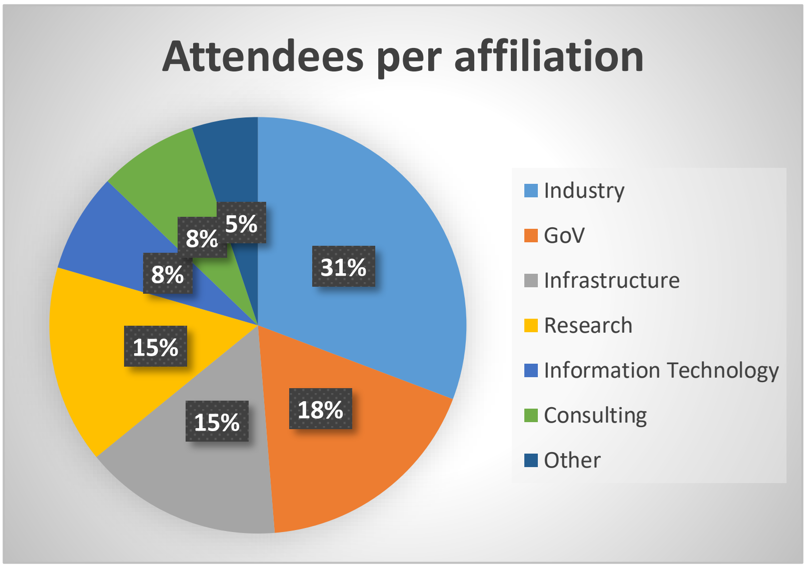


Figure 10. Graz Workshop attendees per affiliation

5.3 Report of plenary session

There were two plenary sessions, one in the morning and one in the afternoon.

Morning plenary session:

Time	Topic
09:00–09:30	Registration and coffee

09:30–10:30	Welcome & introduction – Eva Hackl (ASFINAG) and Aldo Ofenheimer (VIF) Research programmes and strategic research directions – the European Perspective – Rafal Stanecki (DG MOVE) INFRAMIX project – Wolfram Klar (ATE) TransAID project – Julian Schindler (DLR) Expectation towards automated driving – Sven Maerivoet (TML) (20 minutes)

The morning plenary session was devoted to an introduction to the two projects in order to outline the main goals and methods of the INFRAMIX and TransAID projects and to introduce these projects to those parts of the audience who might not have been familiar with the two projects.

The introduction to the day was given by Mr. Ofenheimer from Virtual Vehicle (as Virtual vehicle hosted the workshop at their facility) and by Mr. Stanecki of the European Commission. Mr. Stanecki's presentation gave an insight in the EC on the H2020 projects and on the general view of the EC on important traffic and transport topics of the future.

Afternoon plenary session:

Time	**Topic**
13:15–14:15	Discussion sessions – second round
14:15–14:45	Wrap up of discussion sessions by session moderators – Eva Hackl (ASFINAG)
14:45–15:00	Presentation of the three INFRAMIX use cases – Yannick Wimmer (ASFINAG)
15:00–15:30	Coffee break and poster exhibition
15:30–16:00	Interactive discussion – Sven Maerivoet (TML)
16:00–16:45	Meet the testing group – Yannick Wimmer (ASFINAG), Daniel Tötzl (SIEMENS), Stefaan Duym (BMW), Alexander Frötscher (ATE)
16:45–17:00	Closing remarks – Eva Hackl (ASFINAG)

The afternoon plenary session on the one hand was used to present a wrap up of the discussion groups, on the other hand for some more questionnaires. Since the INFRAMIX project was required to collect users' appreciation on their scenarios, therefore, Mr. Wimmer gave a short introduction to the scenarios (a follow up on the presentation of Mr. Klar in the morning). The audience was then asked to fill in a digital questionnaire. Furthermore, there was a follow up session on the morning-Mentimeter session more focussed on the Transaid project, which is described in D 8.1 of the Transaid project[1].

5.4 Report of break-out sessions

Late in the morning and in the beginning of the afternoon, there were two rounds of 4 breakout sessions. The sessions were the same two rounds with different participants. The summaries below cover both rounds.

Time	Topic
11:15–12:15	Breakout sessions – first round
13:15–14:15	Breakout sessions – second round

5.4.1 Session A - Limitations of automated driving – ODD, ToC

Alexander Frötscher (AustriaTech) of INFRAMIX and Julian Schindler (German Aerospace Center) of TransAID hosted the breakout session. The idea and meaning of the Operational Design Domain (ODD) had been explained in both sessions. Although INFRAMIX operates in well-defined ODDs, TransAID focuses, via infrastructure, on the respective ends of ODDs and potential extensions. For example, TransAID services are available to direct connected automated vehicles in areas where the capability of vehicle automation is restricted on its own, e.g. in road works or at complex intersections (see Transaid Deliverables 2.1 [2] and 2.2 [3] for more information). As digital and physical infrastructure comes into play both in INFRAMIX and TransAID, one of the key questions of the session was addressing the issue whether an ODD should be defined OEM internal, without sharing it with anyone, or if the ODD needs to be defined commonly, so that the infrastructure can guarantee e.g. automation readiness independent of the OEM. In addition to this, it was discussed which sections must be included in an Unusual description, and to which granularity.

Participants from academia, business, operators and cities visited all sides of the room. While a single OEM dominated the first half, cities dominated the second part. The discussions were therefore very different: The first part showed that the concept of an ODD is very complex and has many parameters, especially on the sensor side. Many parameters can be described here, including sensor capabilities but also environmental aspects such as direction of light, glare, material reflection, fog conditions, etc. Hence, a common concept which would be applicable for all vehicles independent of the sensor setup was deemed impossible. Many parameters can be defined here, including sensor capabilities but also environmental aspects such as direction of light, glare, material reflection, fog conditions, etc. Hence, a common concept which would be applicable for all vehicles independent of the sensor setup was deemed impossible. In contrast, the second break-out-session was having much more city focus, since no OEM was in the room. During this discussion, the necessity of having a common understanding of the ODD was stressed. Cities expressed high interest in getting insights into the ODD restrictions of the OEMs and to define criteria for ODDs. The aim of this is to be in the position of allowing vehicles of different automation capabilities to use specific roads and to be able to control the use or number of automated vehicles in certain areas. As – being a lesson learned from the first break-out-session – the number of parameters for the common definition of ODDs may be too large, it has been agreed that focusing on driving capabilities instead of sensor capabilities would be helpful. Here, it could be helpful to develop AV readiness classes of infrastructure.Developing infrastructure AV preparation classes here might be helpful. Instead of setting low-level parameters for each sensor, the classes would formulate more theoretical scenarios, such as "the automated vehicle should follow the road fitted with clearly visible daytime road markings and sunny weather conditions in low-building urban areas." These definitions leave a lot of space for interpretation at the moment, of course. But the abstraction in general leads to state that it is the duty of the OEMs at the end of the day to provide sensor setups in their vehicles that ensure driving within the classes ' specified contexts. Further discussions of course are necessary to get a more complete definition of all aspects of such classes and to get such classes developed. For TransAID, it is very important to foster such discussions, as the TransAID measures will take those parts of the road, where ODDs of several vehicles end. Therefore, it is a mandatory criterion to understand where those areas are. The TransAID services, however, are not bound to specific parameters of ODDs, but offer solutions for different ODD-related shortcomings, e.g. by saying that there are “no-AD-zones” on the road where vehicle support from the infrastructure is needed.

5.4.2 Session B - Modelling infra-assisted automated driving and simulation findings

Selim Solmaz (Virtual Vehicle Research Center) from INFRAMIX and Evangelos Mintsis (CERTH) from TransAID presented (sub)microscopic traffic modelling approaches with respect to connected and automated driving (CAD) during parallel Session B. TransAID focused on modelling the motion of connected and automated vehicles (CAVs) (i.e. car-following, lane changing, gap acceptance and downward control transitions) in the microscopic traffic simulator SUMO, while INFRAMIX introduced a co-simulation framework (VSimRTI & ICOS) that allows the simulation of real vehicle dynamics and Advanced Driver Assistance Systems (ADAS) functions (i.e. virtual vehicle or coupling actual vehicle(s) with simulation) in a microscopic traffic simulation environment. Thereafter, problems related to CAD modeling in microscopic traffic simulation software were discussed with the participants of the workshop. Initially, in the sense of cut-in situations caused by legacy vehicles, car-following activity of the CAVs was investigated. The majority of the participants deemed that CAVs (even of lower automation levels) could handle these situations in automated driving (AD) mode (CAVs could resume in AD mode even after emergency braking events), and should be modelled as such in simulation tools. It was agreed that lane change behaviour of CAVs can be expected more conservative (in terms of safe gaps) compared to manually driven vehicles. However, in order to avoid increased heterogeneity in mixed traffic conditions (legacy – automated – connected and automated vehicles) (C)AVs could be developed to adopt a human-like approach in terms of lane changing. Nonetheless, determining human-like lane change behaviour (which may vary according to several different factors) might be a rather challenging task[4] . With respect to modelling/simulating control transitions and minimum risk manoeuvres (MRMs), the participants argued that drivers should be allowed to take-over vehicle control during MRMs, but the vehicle should always be guided to a safety harbour (side-street location) to prevent safety-critical situations on the mainline lanes (e.g. rear-end collisions due to stop in lane after MRM). It was also discussed that the level of detail required in modelling CAD depends on the scope of each study. Therefore, modeling of real vehicle dynamics is required when evaluating individual vehicle-based ADAS functions, but due to resource constraints, the simulation of mixed traffic streams may be performed in less detail when it comes to vehicle / driver models. Moreover, it was pointed out that new traffic rules should be adopted with respect to CAD, to enable (C)AVs to cope with certain situations (disobeying existing rules might be even necessary in safety-critical situations). Finally, the session's participants agreed that traffic separation (based on automation capabilities) should be mainly warranted according to the penetration of (C)AVs in the fleet mix.

5.4.3 Session C - Traffic control strategies for mixed traffic

During both rounds the session was moderated by Anton Wijbenga (MAPtm) and Michele Rondinone (Hyundai), both from TransAID. A presentation was given to introduce several topics about which several questions were posed to the audience. During both rounds there were 9 different stakeholders present from several backgrounds (i.e. universities, companies such as Intel and Siemens, and road authorities such as POLIS and Rijkswaterstaat). The objective of the session was to get a common inter-stakeholder view on TransAID measures and an understanding on their advantages and possible associated risks. Below a summary of conclusions and/or additional questions is given.

- Limitations of- and restrictions to AD:
  - How an automated car can distinguish static situations (e.g. idle vehicle will not move) from dynamic ones? A solution could be AI (or rather machine learning) to recognise vehicle types/number plates and possibly the situation/ context to provide more insights. However it is expected that will not completely solve the problem because those machine learning models will learn by example and have limited reasoning capabilities which cannot solve every situation.
  - VRUs must be considered and taken into account when considering AD restrictions (i.e. no AD zones) imposed by the infrastructure (e.g. school zones).
  - What if infrastructure systems are down and enforcement is given by human operators (police, traffic regulator)? AVs might not be able to cope with such situations because it cannot recognise the instructions from the operator, hence a Transition Area emerges.
- The new role of Traffic Management in the era of AD: measures, risks/opportunities, vehicles support:
  - The TransAID approach and 5 services are positively received by road authorities (RWS and Rotterdam).
  - Most scenarios are very dynamic. There is a need of increasing infrastructure capabilities (sensing, computing and communications) to take the most advantage of TransAID measures in a dynamic way.
  - It would require big efforts to digitalise road infrastructure and to handle dynamic (traffic management) schemes. Due to the effort, there might not be a

positive return of investment in urban scenarios. Therefore, it makes sense to start on motorways and then consider applicability to urban roads.

- In the future, dedicated lanes for (C)AVs should be considered as an incentive for AD introduction to reach long term goals of safety/efficiency. However, due to possible reduced capacity (blocking a lane for remaining traffic), it is best to use dynamic assignment which considers the traffic composition.

- Trust, safety, liability, legal aspects:
  - For traffic management to be efficient, infrastructure must be authorised by road authorities to provide advices (that brake traffic rules) also in a fast dynamic way or be mandated for recurrent situations.
  - An intermediary service for implementing the TransAID measures as conceived by the project was positively received by the audience (see TransAID D4.1 [5]).
  - Road authorities or operators could assume liability for traffic management procedures. It is happening regularly already today and it could apply to the TransAID measures.
  - More dynamic situations are those that can create most problems from the liability point of view (roadworks vs. intersection & vehicle sensing).
  - From a liability point of view, it is better to provide information than instructions. The decision of finally adopting /implementing an advice lies at the vehicle side, and therefore the responsibility as well.
  - Finally, whoever has liability can be different case by case. There is the need of a governing framework for decision making.
- Legal frameworks and current implementations of traffic measures, sometimes limit the advantage of technical development. Need to adapt traffic rules for automation (Intel Mobileye RSS is trying to establish discussions on that[4]). For example, to differentiate speed/relevance areas for different categories of vehicles.

5.4.4 Session D- - ISAD – how can infrastructure support automated driving?

During both rounds of the breakout session, Stamatis Manganiaris (ICCS) presented the INFRAMIX ISAD approach to the audience. The topic raised great interest, and the session was well visited both times with approx. 15 participants in each of the sessions. Below are the highlights of both sessions:

- The necessity for infrastructure classification is strong since it will promote the cooperation between critical ITS stakeholders. It can be seen as an essential requirement for smooth and efficient ITS development.
- The ISAD classification is a dynamic work with many interactions and further discussions are needed. Especially, but not limited to, with respect to HD maps.
- A detailed specification is needed in terms of automated functionalities.
- Governance Models (Global or Local) and a Regulatory Framework are topics of great importance, since liability and (cross-countries) management issues are

complicated and undefined. These can be national or global depending on the level of automation.

- ISAD is related to ODD and can be used for closing ODD gaps.
- ISAD and vehicle automated driving system are cooperating and supporting one each other in improving intelligent transport
- ISAD classification should be extended to cover urban areas and not only highways
- OEM should be more involved in ISAD classification and improvement

6. Demonstration Setup in Austrian Site

In parallel to the workshop, the INFRAMIX project was testing on the test track around Graz. The workshop was concluded by a presentation on the current test days. It should also be mentioned that throughout the day, there was the possibility for workshop attendees to join a test run in the C-Roads Vehicle, a chance which nearly half of the attendees used. At the end of the workshop attendees could examine different test vehicles on the parking lot.

In the following an overview of the demonstrated scenarios is given. For further details about the tests the reader is referred to D 4.2. which contains a detailed summary.

6.1 Scenario 1: Dedicated Lane Assignment (East loop)

Scenario 1 was sent out on the East loop of the test track in order to have longer segments without on or off ramps. As for all scenarios, a different message set was designed for each driving direction.

SC1 UC2 was covered in Driving Direction 2 where there is the adverse weather condition warning within the relevance zone of the DDL.

Figure 11. Dedicated lane assignment (DLA)

Driving direction East (DD2)

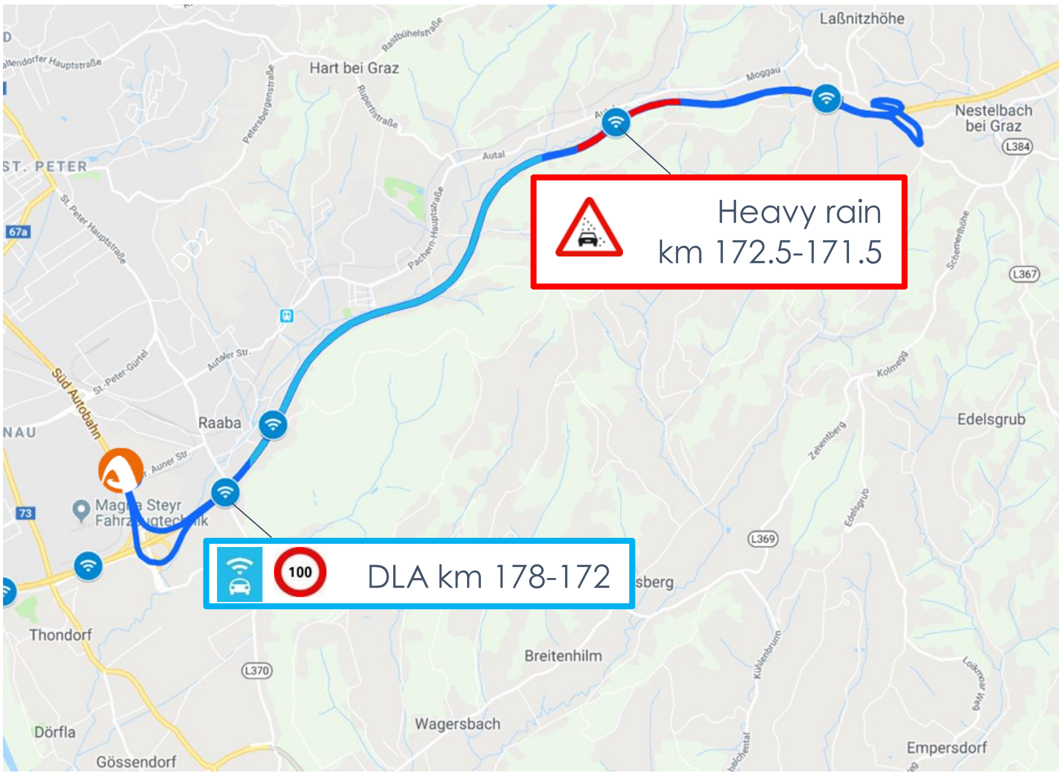


Figure 12. SC1 DD2 East loop

Driving direction West (DD1)

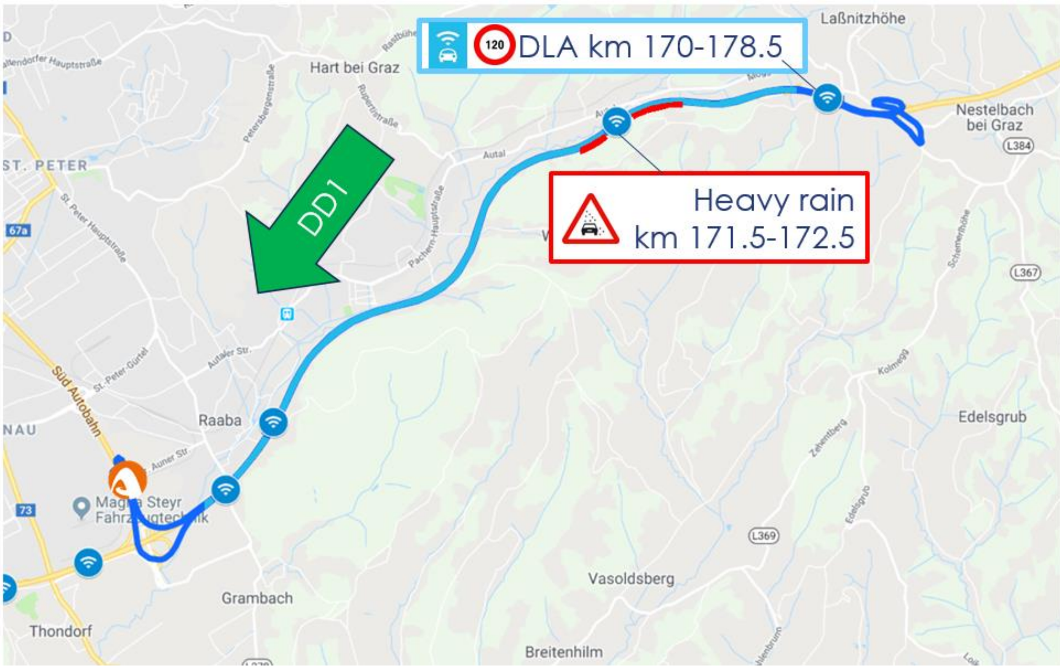


Figure 13. SC1 DD1 East loop

6.2 Scenario 3: Bottleneck (West loop)

We will first discuss the setup of Scenario 3 before laying out Scenario 2. The reason will become clear in the following. SC3 was sent out on the West loop, the corresponding bottlenecks are the on-ramps around km 183.5 "Flughafen Graz". Note that this is the same ramp that was used for the sub-microscopic simulations. The different possible control strategies were addressed by sending out a distance gap advice in one driving direction, but a lane change advice in the other one.

Figure 14. Bottleneck

Driving direction West (DD1)

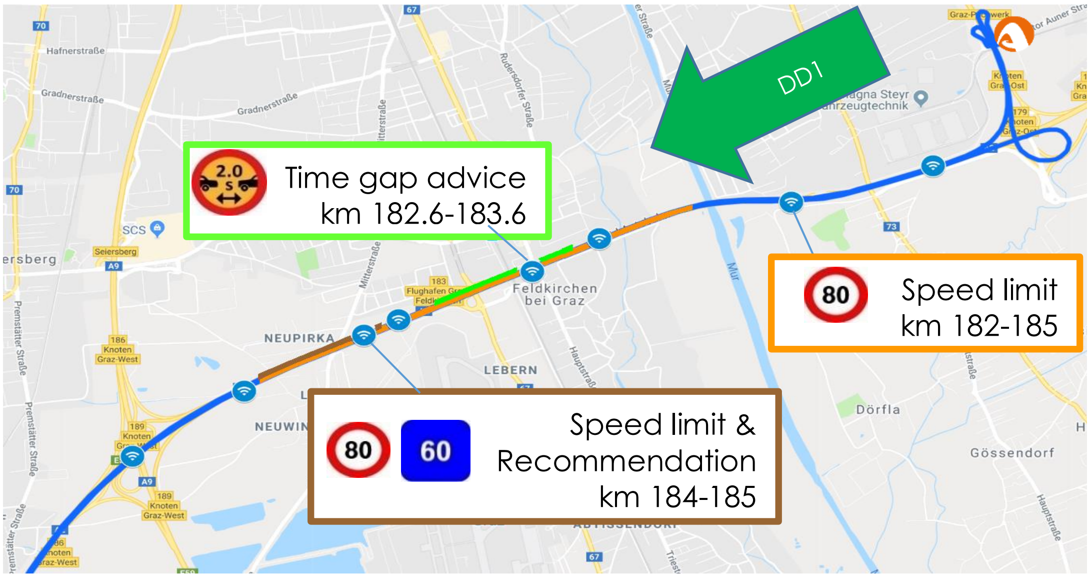


Figure 15. SC3 DD1 West loop

Driving direction East (DD2)

Figure 16. SC3 DD2 West loop

6.3 Scenario 2: Roadworks (West loop)

Since control strategies for the roadworks zone (especially with lane drop) were identified to be very similar as for the bottlenecks, the test setup for SC2 was chosen in a very similar way as for SC3. When comparing Figure 17 to Figure 18 or similar Figure 19 to Figure 20, one can see that they mainly differ in the additional roadworks warning which was added for each driving direction. For indicating the roadworks zone, an IMIS trailer was used.

Figure 17. Roadworks

Driving direction West (DD1)

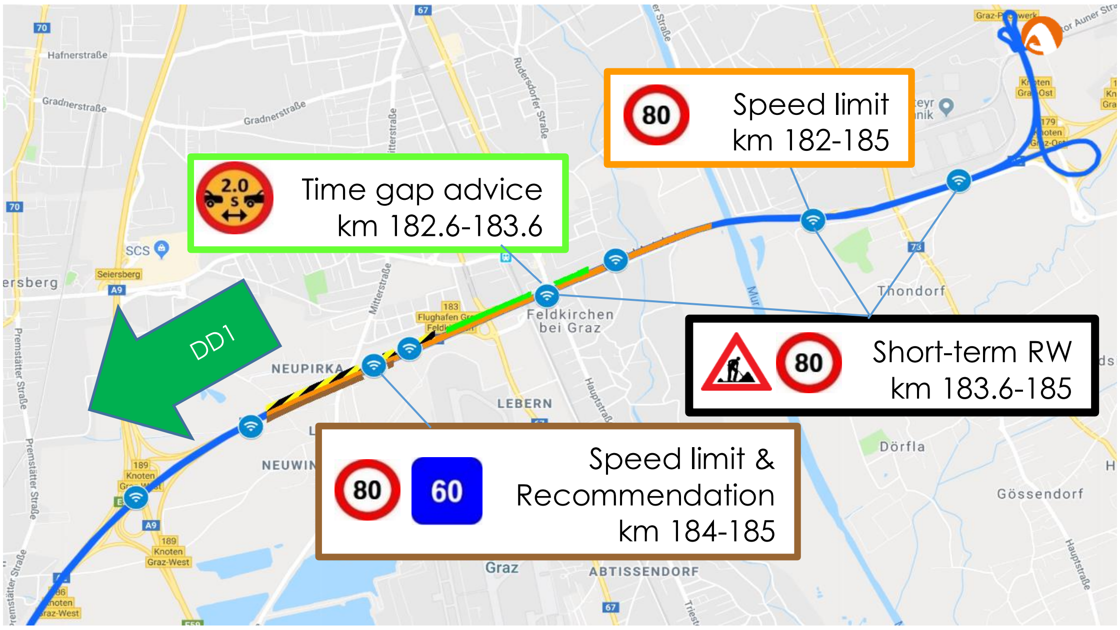


Figure 18. SC2 DD1 West loop

Driving direction East (DD2)

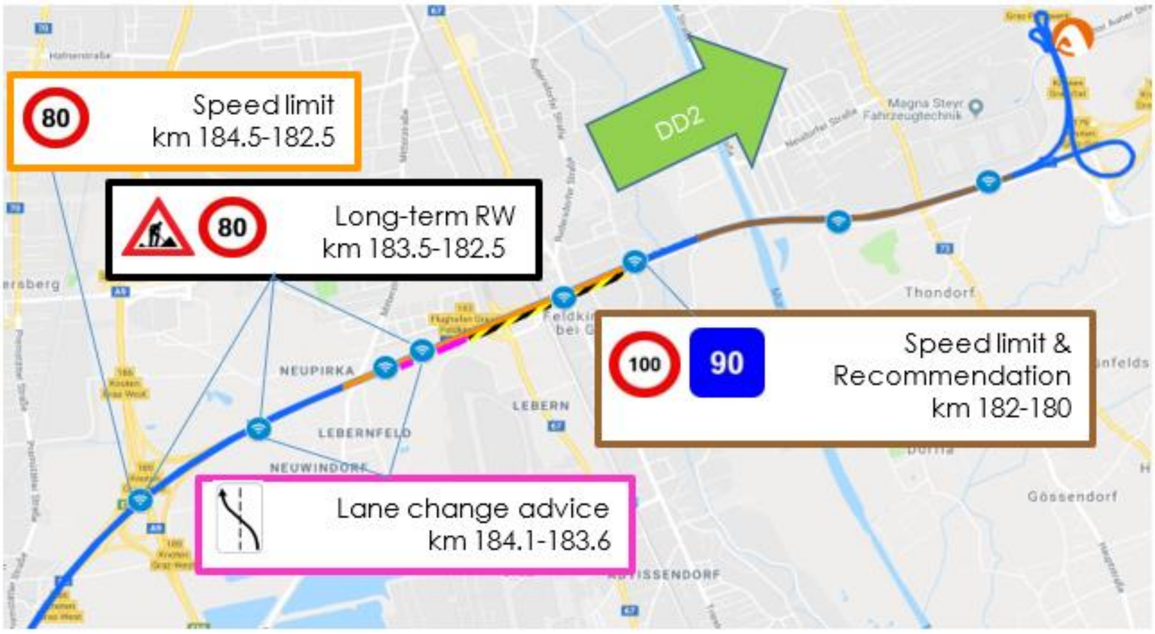


Figure 19. SC2 DD2 West loop

7. Tools for Survey and Analysis Tools

Depending on the goal of each survey and event (Workshop or Demonstration in Spain and Austria), various platforms and tools were used to engage users in the process. Demonstration sites: specific participants were engaged to provide their feedback in the areas after the demonstration activities answering targeted questionnaires.

Videos and digital surveys tools were used, like SociSurvey [7] in Graz Workshop and Kahoot [8] in the Barcelona Workshop. Use of videos was necessary to illustrate the three INFRAMIX scenarios (Dynamic Lane Assignments, Roadworks, Bottlenecks), since they describe new traffic conditions and capabilities that the participants do not experience in their real life. Furthermore, the use of digital surveys tools motivates participants' interest. Microsoft Excel was the main analysis tool used for the statistic process of the collected data. Mean value, standard deviation and coefficient of variation were the main statistical measures that were registered and analysed.

Since Interpreting rating scale data can be difficult in the absence of an external benchmark or historical norms, the top 2 box and bottom 2 box scores methodology was followed [9]. The top 2 box score is the sum of percentages for the top two highest points on a satisfaction, appreciation or awareness scale. The bottom 2 box score respectively, is the sum of percentages for the top two lowest points on a satisfaction, appreciation or awareness scale. The idea behind this practice is to focus only on those who have the strongest feelings, either positive or negative, toward a concept, product, development, application or service. It also should be noted that in all the measurements, the coefficient of variation was below 1.

8. HMI Application Evaluation

Spain

The INFRAMIX Interoperability event in Spain took place from 12 to 15 September on the motorway AP7 between entrance 6B direction Barcelona and exit 8. The purpose of the tests was the verification of the communication between ITS systems of different OEMs for ITS messages (CAM / DENM / IVIM) without Geo Net Security Header, decoding of the extended IVIM messages (incl. AVC Container) with the new ASN.1 Data Base. For this purpose, one mobile Siemens RSU and two Siemens Gantry RSUs had been installed on the AP 7 motorway (Autopista de la Mediterrania). Test tools used were Vector CANoe Car2x test environment with test configuration for receiving and ITS messages (IVIM/ DENM) and generation/sending CAM messages in RealBus mode via ITS-G5 without security header in Geo Net protocol.

Table 6. List of Test objects in Girona via SIEMENS RSU

RSU – Name	Description	Result: OK / failed / shifted / not executable
RSU_01_ITS_DENM_RWW_:	*Siemens Mobile RSU sends DENM RWW messages with Alacarte container with parameters: drivingLaneStatus, trafficFlowRule, speedLimit* *MessageIDs: 2111 – 2143 /s. below UC Table/*	**OK**: Messages decoded error-free with DENM RWW Protocol, visualized on the map (see Figure 20, 21a and 21b)
RSU_02_ITS_IVIM:	*Siemens Gantry RSU sends IVIM messages with GLC and new AVC (Automated Vehicle Container) with attributes: Speed Limit, Speed Recommendation, Gap Between Vehicles, Sae Automation Levels* *MessageIDs: 111-136 /s. below Table/*	**OK**: Message decoded error-free with IVIM Protocol, visualised on the map (see Figure 20, 22)
RSU_03_ITS_IVIM_:	*Siemens Gantry RSU sends IVIM messages with GLC with new AVC (Automated Vehicle Container) with attributs: Speed Limit, Speed Recommendation, Gap Between Vehicles, Sae Automation Levels*	**OK**: Messages decoded error-free with IVIM Protocol, visualized on the map (see Figure 20, 23)

RSU – Name	Description	Result: OK / failed / shifted / not executable
	MessageIDs: 3211-3254 /s. below Table/	

Figure 20. HMI window with IVIM and DENM Road Work Warning information

Figure 21a. DENM RWW with Alacarte container

Figure 22b. DENM RWW with Alacarte Container

Figure 23. IVIM message with AVC Container incl. SAE Automation Level und Speed Limit (100 kmh)

Figure 24IVIM message (ID3232) with AVC Container incl. SAE Automation Level und Distance between Vehicles (Gap in [m])

Austria

The INFRAMIX Interoperability event in Austria took place from 8th to 10th of October on the motorway A2 between Graz East to Laßnitzhöhe and Graz East and Graz West. The purpose of the tests was the verification of the communication for ITS messages (IVIM and DENM) without Geo Net Security Header, decoding of the extended IVIM messages (incl. AVC container) with ASN.1 Data Base. For this purpose, Siemens Gantry RSUs have been installed on the motorway A2. Test tools used were Vector CANoe Car2x test environment with test configuration for receiving and generation/sending ITS messages (IVIM/ DENM) in RealBus mode via ITS-G5 without security header in Geo Net protocol.

Table 7. List of Test scenarios in Graz

Test scenarios	Description	Result: OK / failed / shifted / not executable
INFRAMIX Austrian Test Scenario 1:	*INFRAMIX extended IVIM und DENM were transmitted by several RSUs between Graz East und Laßnitzhöhe.*	**OK:** Messages 1111 and an HLN Weather Condition were received without errors as expected and displayed on the HMI The HLN Weather Condition was received and displayed correctly on the HMI on both directions of the road. Problems: none.
INFRAMIX Austrian Test Scenario 2:	*INFRAMIX extended IVIM und DENM were transmitted by several RSUs between Graz East and Unterpremstätten.*	**OK:** all intended messages were received correctly. Problems: none.
INFRAMIX AC Styria Demonstration	*INFRAMIX extended IVIM and DENM were transmitted by RSUs between Graz East and Graz Airport*	**OK:** all messages were received and displayed correctly on the INFRAMIX HMI. Problems: none.

Figure 25. Scenario 1 – Dedicated lane assignment

Test results

All relevant messages has been decoded error-free with IVIM and DENM protocol and visualized on the map.

On the test track in Girona, some out of test scope messages were received from Gantry RSUs from other RSU providers, leading to unplanned IVIM and DENM messages being displayed on the map.

9. Cellular App Experiments

The HMI of the cellular experiments app provided by TomTom had two purposes. Primarily, it acted as a proxy for analyzing digital messages for use in an electronic vehicle horizon (D3.3) and, secondary goal was to analyze usability for human drivers.

9.1.1 Analysis of Digital Messages for Use in Electronic Vehicle Horizon

As described in D3.3, the electronic horizon for autonomous vehicles has to be extended with additional information that allows the vehicle to react to mixed traffic situations including INFRAMIX traffic control. Examples are detailed information on roadworks at lane-level or dedicated AV lane assignments. The digital signs and messages tested in INFRAMIX serve that purpose; however, a full vehicle horizon implementation is beyond the scope of the project such that usability of the digital signs was analyzed with the cellular experiments app.

Latency. Tests showed that digital signs and infrastructure information can be transferred to cars in a timely manner via the INFRAMIX system using cellular communication. The latency with which the messages are transferred turned out to be less critical, as path planning in an AV happens with a larger time horizon and required information has to be available already one, better more, kilometers before the actual location where the information applies. As AVs will require navigation systems for driving, such information along the planned route could be transferred to the car for multiple kilometers and could be updated if it changes.

Lower latencies in the range of seconds is required only for information that changes shortly before the car arrives at the affected location (e.g., a changing speed limit). A latency of less than a second is more than sufficient for such information but the actual mechanism used to fetch the data must allow for lower latencies. For example, a polling mechanism would have to run with a high frequency such that the needed information is retrieved in time and not withlarge delays. In our tests, we used a polling mechanism with a frequency of three seconds, but for a real system this might be too demanding in terms of server load and bandwidth consumption. To avoid that, a connection that is kept up is a better fit and would allow to transfer the information without any delay and network overhead added by a polling mechanism. Technically, this is easily possible with state of the art protocols, e.g., based on the http protocol.

Integration with existing protocols. In tests of the HMI, the focus was on developing and testing novel digital signs and less on the integration with digital information already received by connected cars nowadays, such as traffic data. The messages used in tests transfer information that overlaps with what is already received via other protocols. For example, traffic information is often transferred using standardized protocols such as TPEG. In contrast, roadworks traffic signs in INFRAMIX tests are sent on top of traffic data for simplification of the system setup. To avoid this duplication, an integration of the messages in existing protocols such as TPEG should be considered. First discussions on extensions for TPEG were started as part of the INFRAMIX project. Eventually, all information on certain traffic states could be sent via already existing protocols. The new digital signs would then not require any new protocols or new mechanisms for data transfer but use existing ones. The tests showed that such an integration should be readily possible.

Similarly, protocols for transferring HD maps also contain information such as speed limits. An example is TomTom's *AutoStream*, which streams HD map data to AVs.[10] Furthermore, such map streams contain detailed information on the street geometry, which is especially relevant in situations like road works, where the geometry changes dynamically. Consequently, all the messages are also candidates to be transferred with the HD map. For the case of roadworks this seems more natural in the long term as geometry information is mandatory for higher levels of automation to avoid hand-over to the driver. For lower levels of automation protocols such as TPEG are sufficient as long as a hand-over to the driver is possible.

Digital Signs. The digital signs listed below were used in our tests and could be transferred with lane-level granularity. Such lane-level information can be forwarded by a receiving component to the vehicle horizon, e.g., using ADASISv3 as described in D3.3. The HMI used in our tests showed the messages active at lane level for the current location of the car and cannot be used to draw conclusions on availability of the data for a vehicle horizon of the next kilometers.

- **Speed Limit:** Dynamic speed limits are being implemented in standards such as TPEG SPI. The main difference is lane-level granularity but this is currently being added to the standard, such that those messages could be transferred via TPEG. Forwarding that information to the car via ADASIS is straight forward.
- **Roadworks:** TPEG TEC contains detailed information on roadworks that covers the use cases of this project, except limited lane-level granularity, which is currently added to the standard. As mentioned, dynamic updates of road geometry in case of roadworks are mandatory for SAE levels 4 and 5. This is neither covered by INFRAMIX nor is it part of TPEG. Dynamic HD map streaming is likely the right channel to transfer such data.
- **Closed Lane:** Similar to roadworks, closed lane information may also require additional geometry updates but often the location of the closed lane is sufficient. Closed lane information is also part of TPEG.
- **Dedicated AV Lane, Lane Change Advice:** lane change advice must be sent early enough to be included in path planning of the car. Opposed to closed lanes, cars may not adhere to the advice, e.g., if safety is at risk. Exposing such information on the vehicle horizon would fit into standards such as ADASIS.
- **Speed recommendation, Time Gap:** This information is required for traffic control and similarly to lane change advice, cars may not adhere.

To summarize, all the digital signs used could be directly transferred to AVs via electronic vehicle horizons, e.g., based on ADASIS. In contrast to current use of such systems, information is transferred at lane-level, which is supported in version 3 of ADASIS. TPEG is a candidate for sending such information to the car, however, dynamically changing geometry, e.g., due to roadworks, has to be updated for higher levels of automation and is likely to be sent to AVs with the streamed digital map that is needed for path planning.

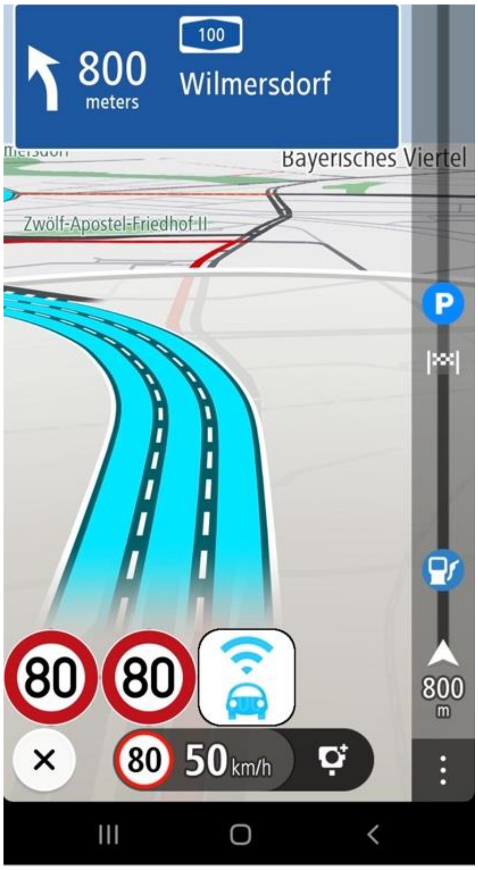
9.1.2 Analysis of the HMI for Human Drivers

In order to improve mixed traffic situations, also human drivers should be involved in controlling traffic. For that reason, we analyzed the HMI with respect to usability for human drivers.

The UI of the cellular experiments app was built with a focus on vehicle horizon testing and less for use by human drivers. Nevertheless, we could do a first analysis on how the signs are experienced by human drivers. As users' appreciation is analyzed in Section 10, we highlight below general limitations for human drivers w.r.t. a use in navigation systems.

Lane-level details. Independ of the concrete signs, the information shown to users is lane-specific. This requires guidance at lane-level which is nowadays not commonly available. In TomTom navigation products, lane-level guidance is already available for off-ramps on highways as shown in the right figure below. Both screenshots shows potential ways to visualize additional lane-level information with the example of speed limits and dedicated AV lanes.

Speed limits and dedicated AV lane without lane-level visualization.



Speed limits and dedicated AV lane if lane-level visualization is available.

Figure 26. Speed limits and dedicated AV lane

The picture on the left shows a view without lane-level visualization which is confusing for drivers as mapping the signs to lanes is not fully clear. However, this kind of visualization is preferred by some users of navigation systems and a proper integration of the new visual elements must be found. The figure also shows a mismatch between static speed limits coming from the map, shown at the bottom (which apply if there is no dynamic information received), and dynamic speed limits received over the air, shown above. Such confliction visualization must be resolved to avoid confusing situations as in the picture on the left. In this visualization it would be sufficient to remove the static speeds from the map.

In the figure on the right, assignments of signs to lanes are clear but given the dynamic behavior of lanes (e.g., shifting in the view, changing size due to zoom, etc.), this is also not optimal as the sign location would change dynamically and their size would be adjusted and may even result in too small pictograms. In general, we observed in drive tests that the information density is very high if there are multiple lanes with different information. For example, in the screenshots above, there are different signs shown on different lanes, potentially even with different speeds per lane. This would become even more complex if there are more lanes or if multiple signs per lane apply as it was the case for some scenarios in the INFRAMIX tests. Overall, this is clearly beyond what humans can easily process given the fact that they have to focus on driving the car and handling the traffic situation. To overcome this limitation, new ways for visualization have to be found.

One way is to extend lane-level guidance, which is beyond the scope of INFRAMIX and requires positioning at lane-level to be available. During the tests it became clear that proper lane-level guidance is necessary if lane-level control for conventional cars is needed. This does not mean to show all available signs per lane, but instead

- limit the information shown to the user to the actually required information, for example, showing only digital signs that apply to the lane the car currently driving in;
- guide drivers using proper visualization instead of showing signs directly to focus on the actually needed action; for example, showing an instruction to move to another lane by visualizing lane movement should be preferred over showing the digital sign for lane change.

Usability of digital signs. We also found that information can be confusing sometimes. For example, speed limits and speed recommendations are similar withrespectto the concept behind. Consequently those are harder to differentiate for drivers or may be mixed up if a driver is not really focused. Speed recommendations are usually also not commonly used nowadays and would be used in limited scenarios such that it is questionable if users would understand it. We conclude that some of the digital signs cannot be used by human drivers directly:

- **Speed Recommendations** require the user to understand the difference between speed recommendation and speed limit in a short amount of time as described above. Cars with ADAS could help and adjust the speed automatically. For cars without ADAS, proper visual instructions have to be developed to guide the driver.

- **Time Gap** requires to know an exact distance in time, which is beyond what humans can do. Here only ADAS can help to actually keep the proper distance. Nevertheless, informing the driver *what the car is doing*, i.e., why it is increasing the distance, is needed to understand the situation and increase trust in the technology used.

The limitations mentioned above do not limit the INFRAMIX concepts in general but constrain the way how the concepts must be implemented when used in cars driven by humans. To summarize, directly showing digital signs in navigation applications can be quite challenging for drivers; doing so for multiple lanes is beyond capabilities of an average driver. Proper visualization and guidance instructions have to be implemented to convert the information into a format that limits information shown and that can be easily and quickly understood by a driver that is focused on the street and not on the navigation system. These new ways of visualization are part of follow-up research within TomTom.

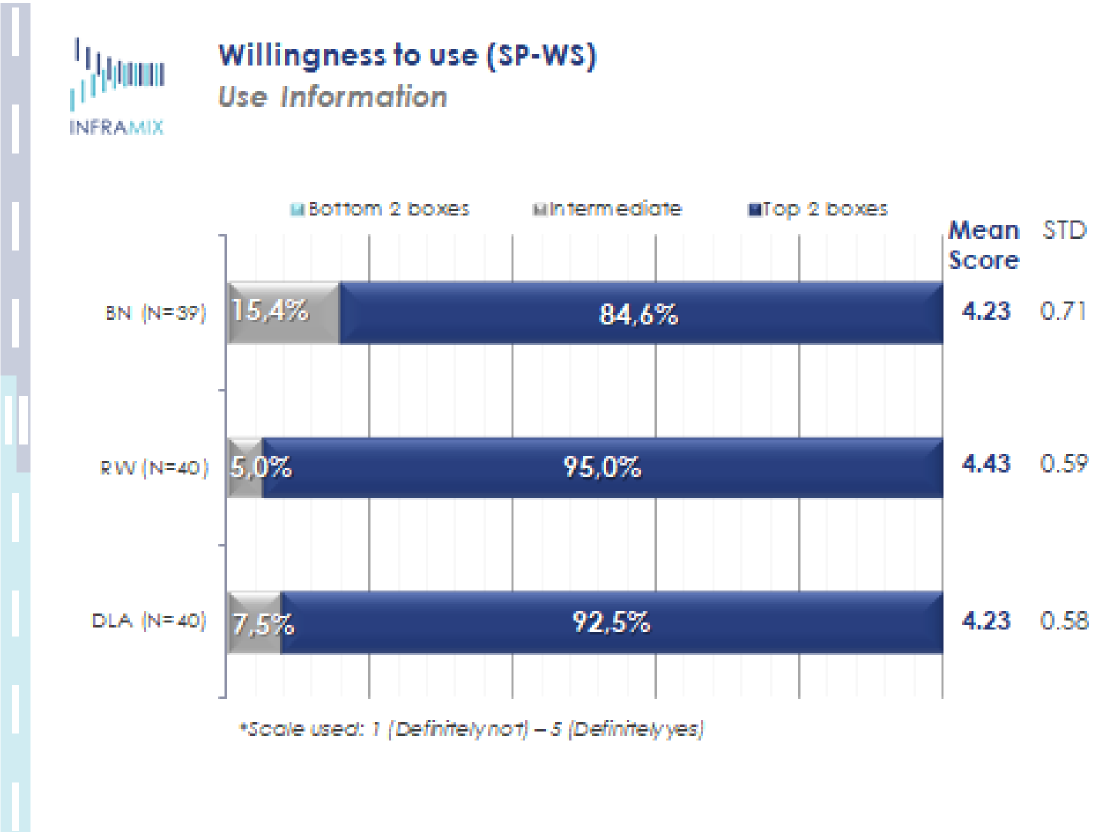
10. Users Appreciation Results

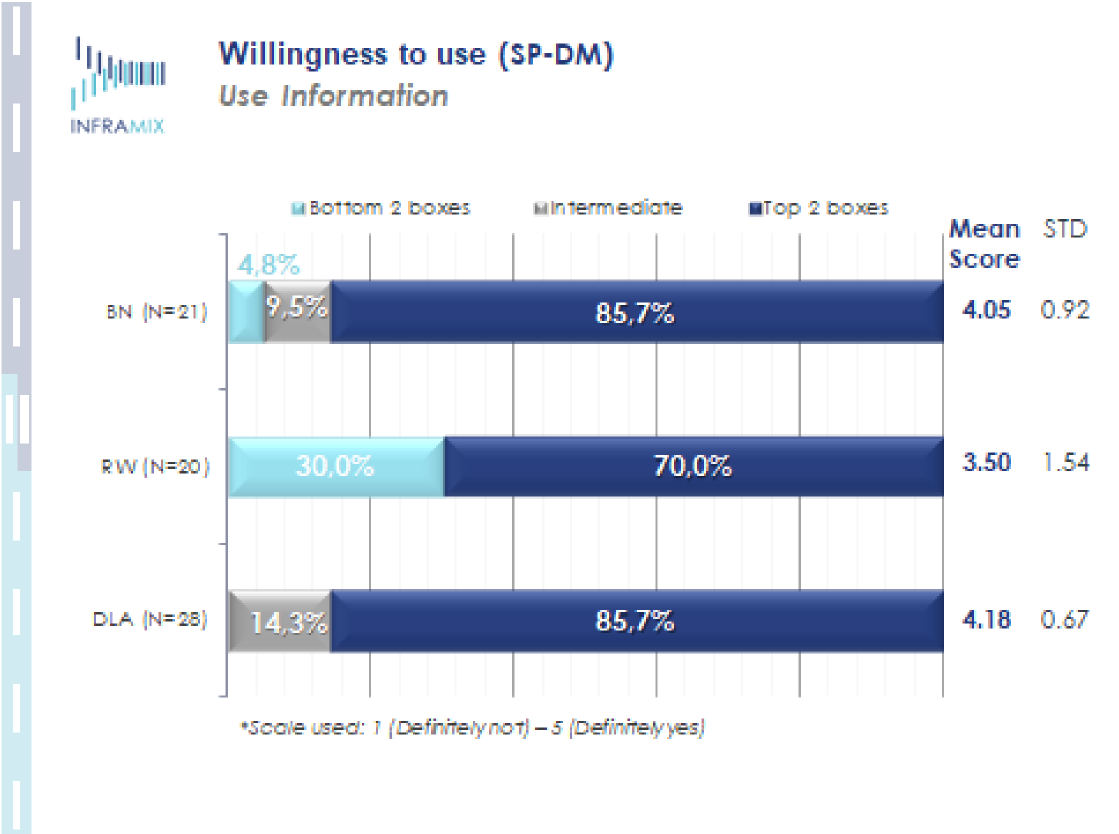
10.1 Willingness to use

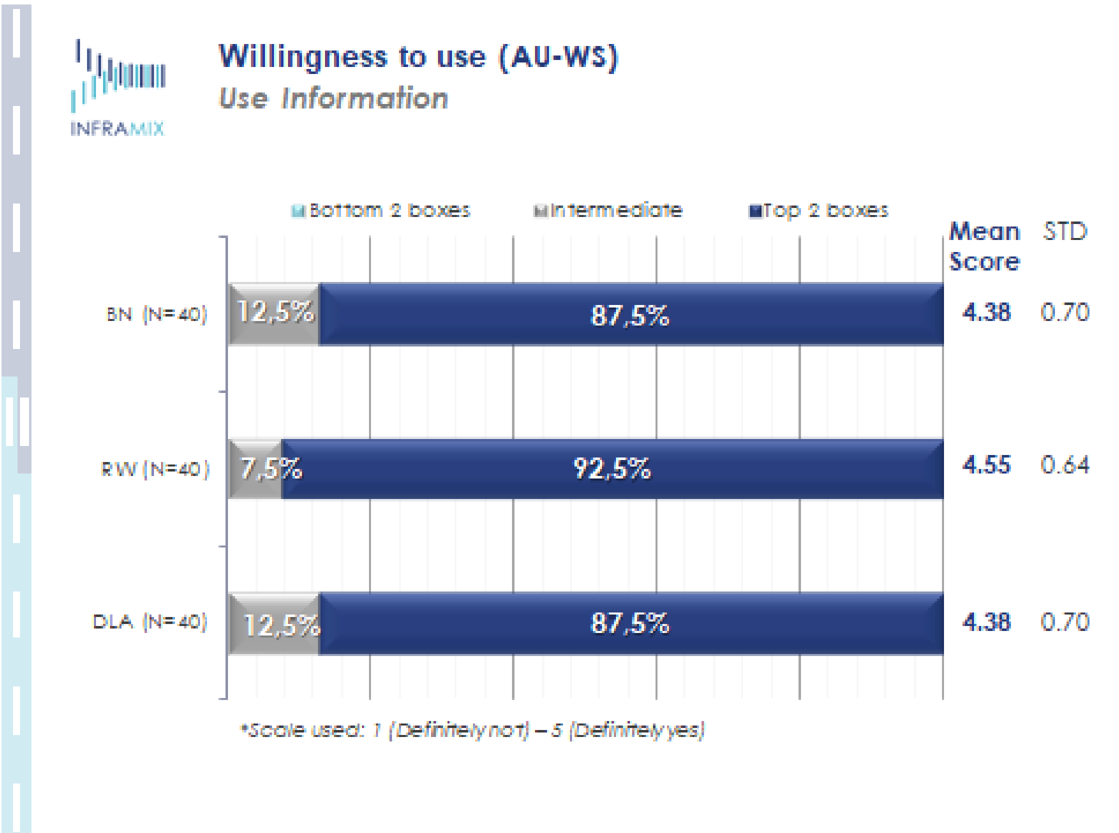
Study in "willingness to use" is a very important metric for a research area and subsequently for a research project. However, few researchers have studied the willingness of users/drivers to use the new, mostly future, but also current, intelligent traffic management features and applications.

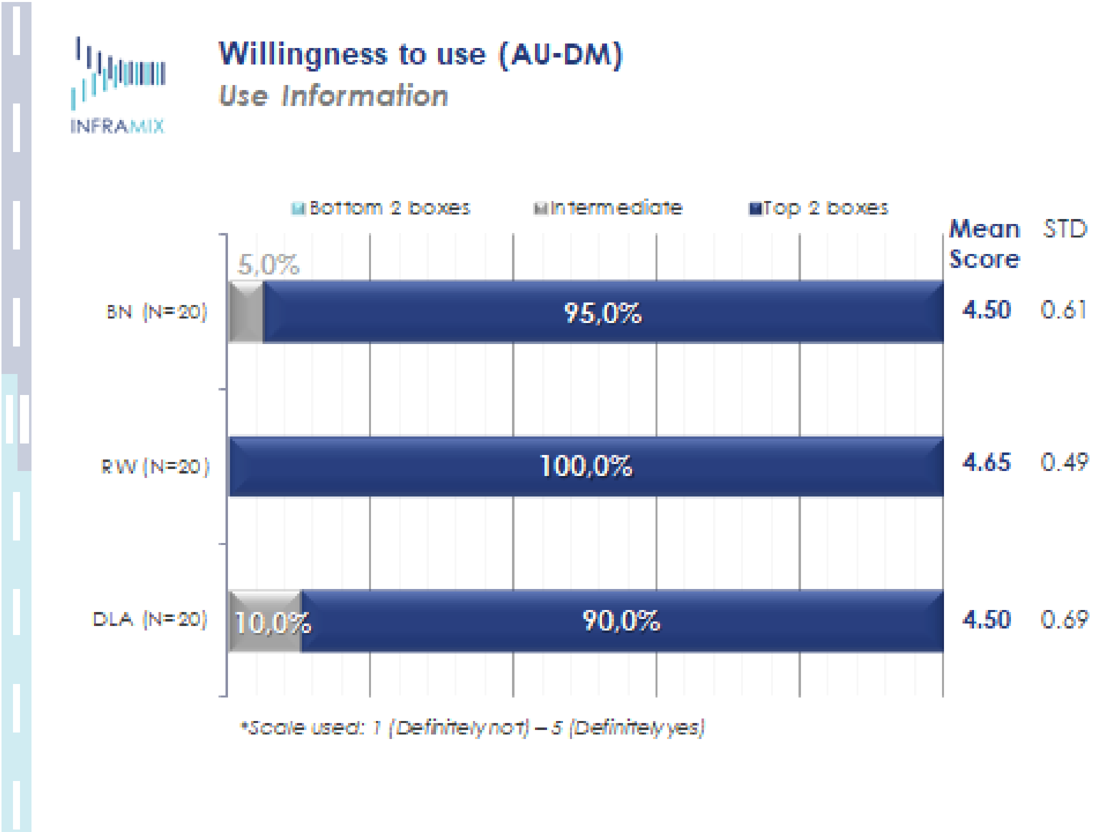
The users' willingness to pay is expected to increase with the experience related to the cost and travel benefits. This experience is unfeasible in the context of the project to be given to the users and therefore the specific research problem could not be tested.

The direct question was about the willingness to use the information provided by the traffic management (via road signs or in-vehicle pictograms), implying also intent to use a highway equipped with hybrid (conventional and intelligent) infrastructure.The results are following:




INFRAMIX
Willingness to use (SP-DM)
Use Information
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=21)
4,8%
9,5%
85,7%
4.05
0.92
RW (N=20)
30,0%
70,0%
3.50
1.54
DLA (N=28)
14,3%
85,7%
4.18
0.67
*Scale used: 1 (Definitely not) – 5 (Definitely yes)


INFRAMIX
Willingness to use (AU-WS)
Use Information
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=40)
12,5%
87,5%
4.38
0.70
RW (N=40)
7,5%
92,5%
4.55
0.64
DLA (N=40)
12,5%
87,5%
4.38
0.70
*Scale used: 1 (Definitely not) – 5 (Definitely yes)



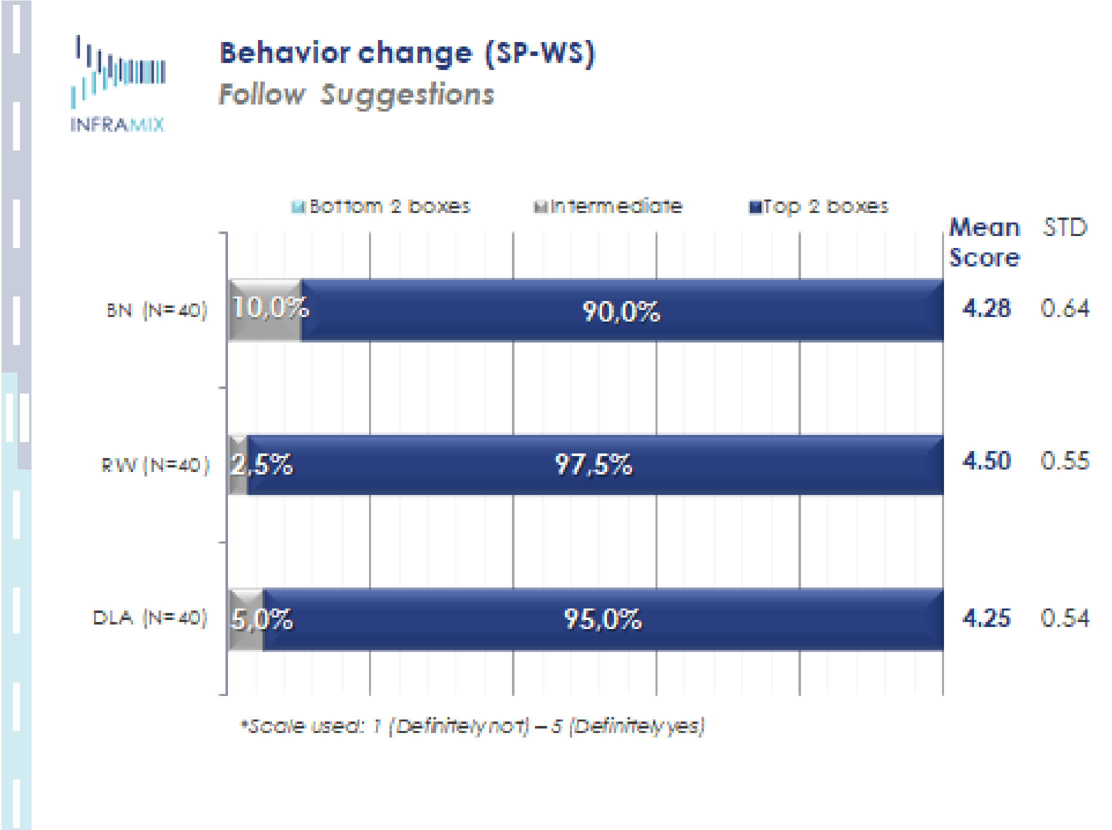
The impressive conclusion is that although - irrespective of the research area - in users' appreciation research, willingness is increased with the real in daily life experience(not existing nowadays), the results that were registered during the four demonstration and workshop events in Spain and Austria were remarkably high reaching up to **95% in top two boxes and 4,5 mean value for the Bottlenecks scenario, 100% top two boxes and 4,65 mean value for the Roadworks scenario and 90% top two boxes and 4,5 mean value for the DLA (Dynamic Lane Assignment) scenario. All of them in Austria Demonstration.**

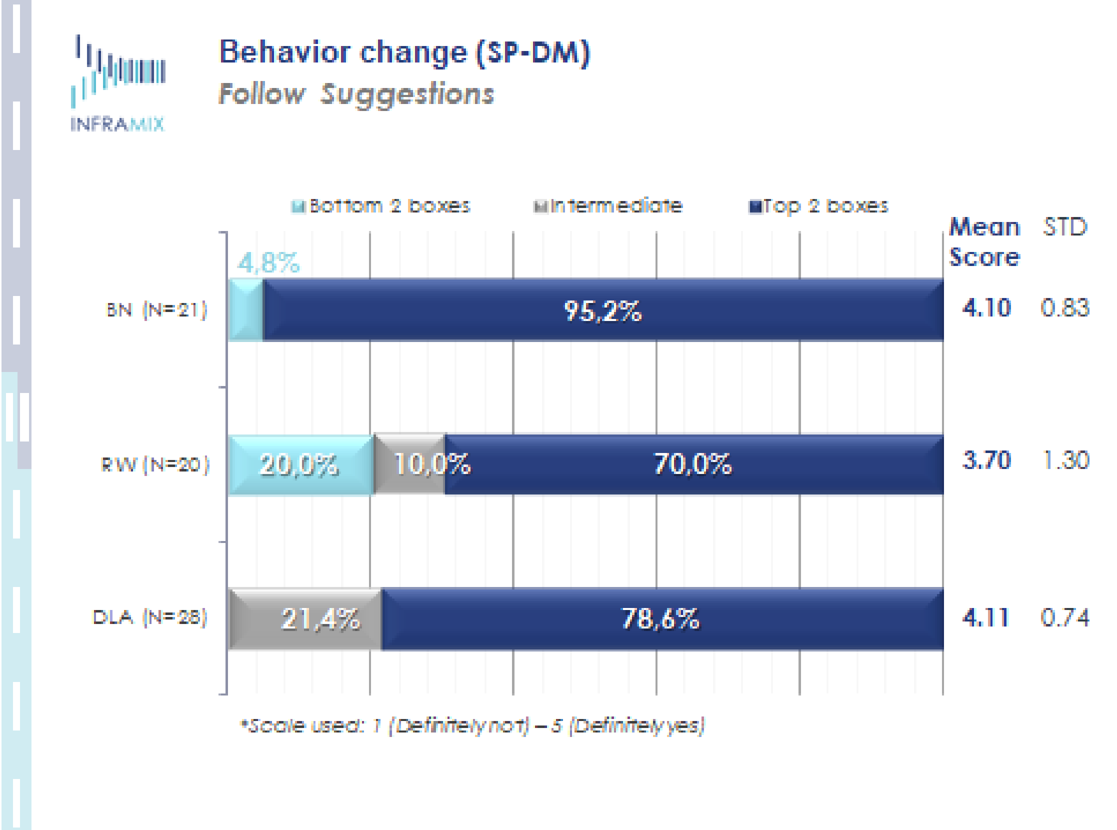
10.2 Behaviour Change

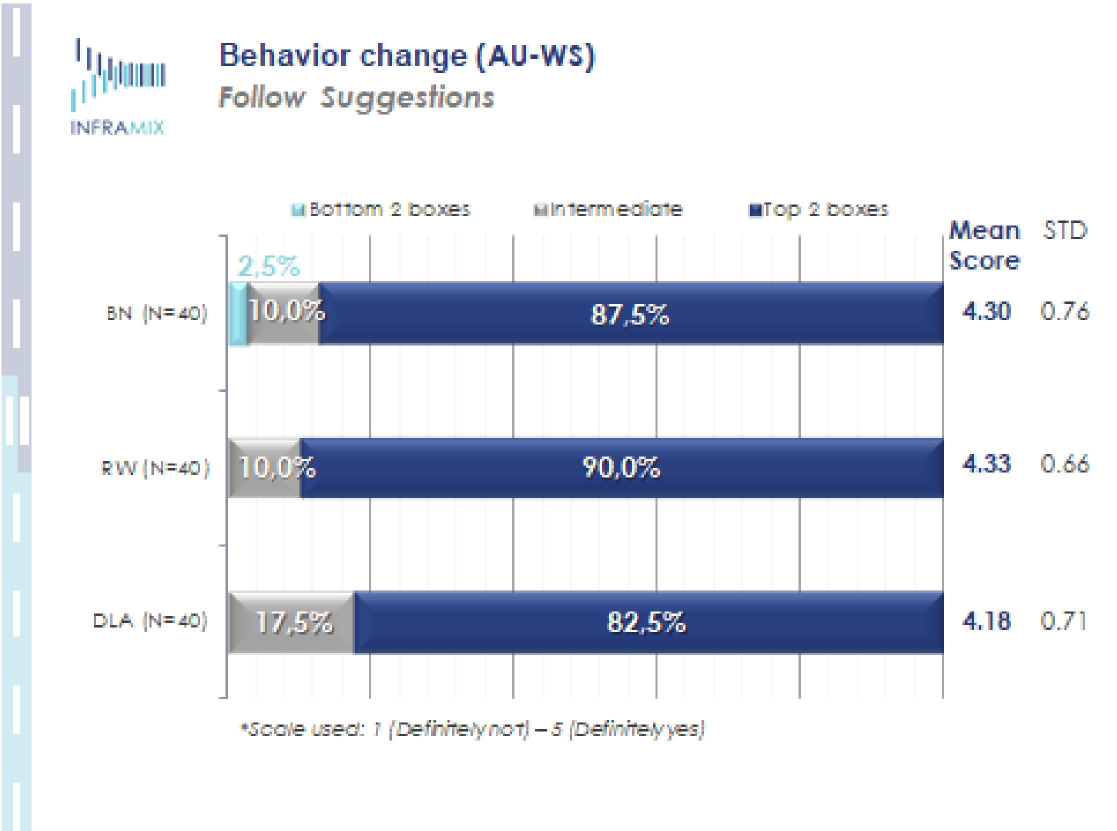
The TRA (Theory of Reasoned Action) [11] is one of a group of psychosocial theories of human social behaviour referred to collectively as expectancy-value theories. The name reflects a process thought to precede all behaviour: Decisions to act or not act are the result of an assessment of the likelihood of specific outcomes associated with the action along with the subjective value assigned to those outcomes. When the assessment produces a positive evaluation, (usually) a decision to act is made .

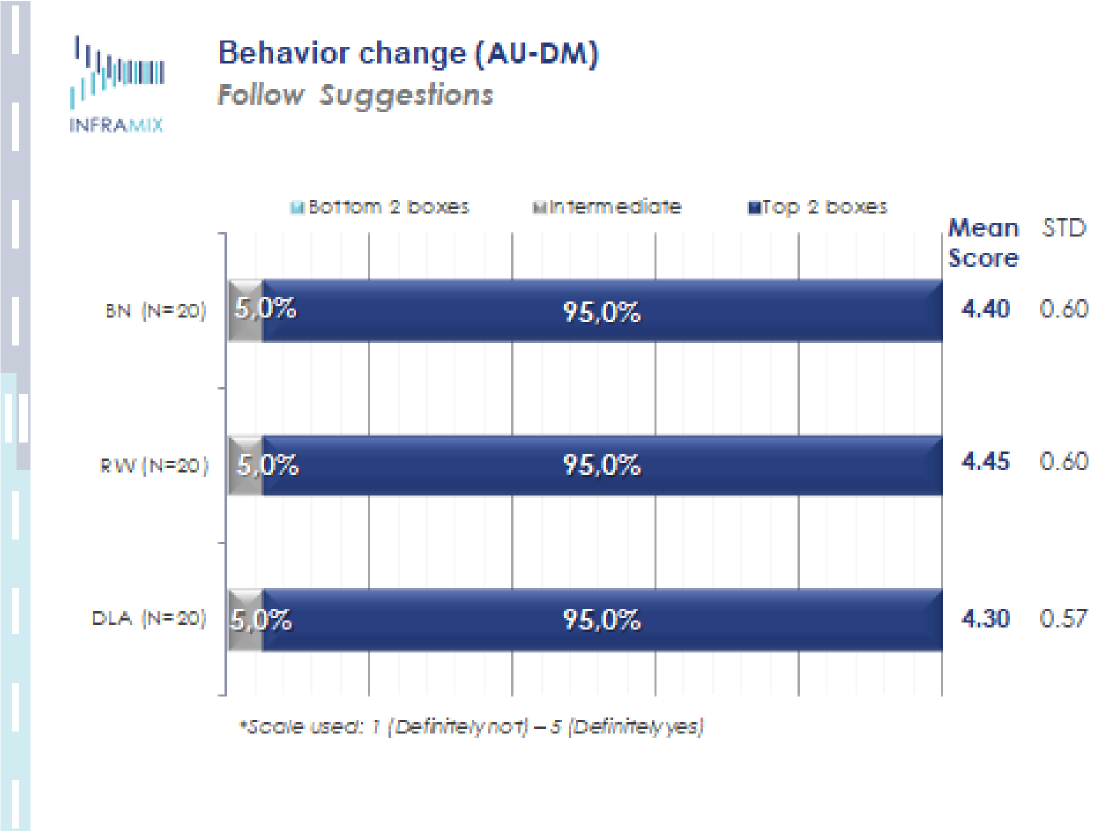
Behaviour change evaluation questions investigate whether the users consider following the traffic management suggestions (via road signs or in-vehicle applications) in the future. It is a step forward in comparison with the willingness to use because it is related to the possible change of driving process, actions, habits and style. Consequently, the more drivers will adopt the obligations stemming from the new "intelligent" traffic management suggestions, the higher the impact on traffic conditions.

Furthermore, if the users/drivers will not follow the hybrid infrastructure recommendations, there is a high risk that the benefits both in traffic efficiency and in safety will be less than expected. The results are following:




INFRAMIX
Behavior change (SP-DM)
Follow Suggestions
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=21)
4,8%
95,2%
4.10
0.83
RW (N=20)
20,0%
10,0%
70,0%
3.70
1.30
DLA (N=28)
21,4%
78,6%
4.11
0.74
*Scale used: 1 (Definitely not) – 5 (Definitely yes)


INFRAMIX
Behavior change (AU-WS)
Follow Suggestions
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=40)
2,5%
10,0%
87,5%
4.30
0.76
RW (N=40)
10,0%
90,0%
4.33
0.66
DLA (N=40)
17,5%
82,5%
4.18
0.71
*Scale used: 1 (Definitely not) – 5 (Definitely yes)

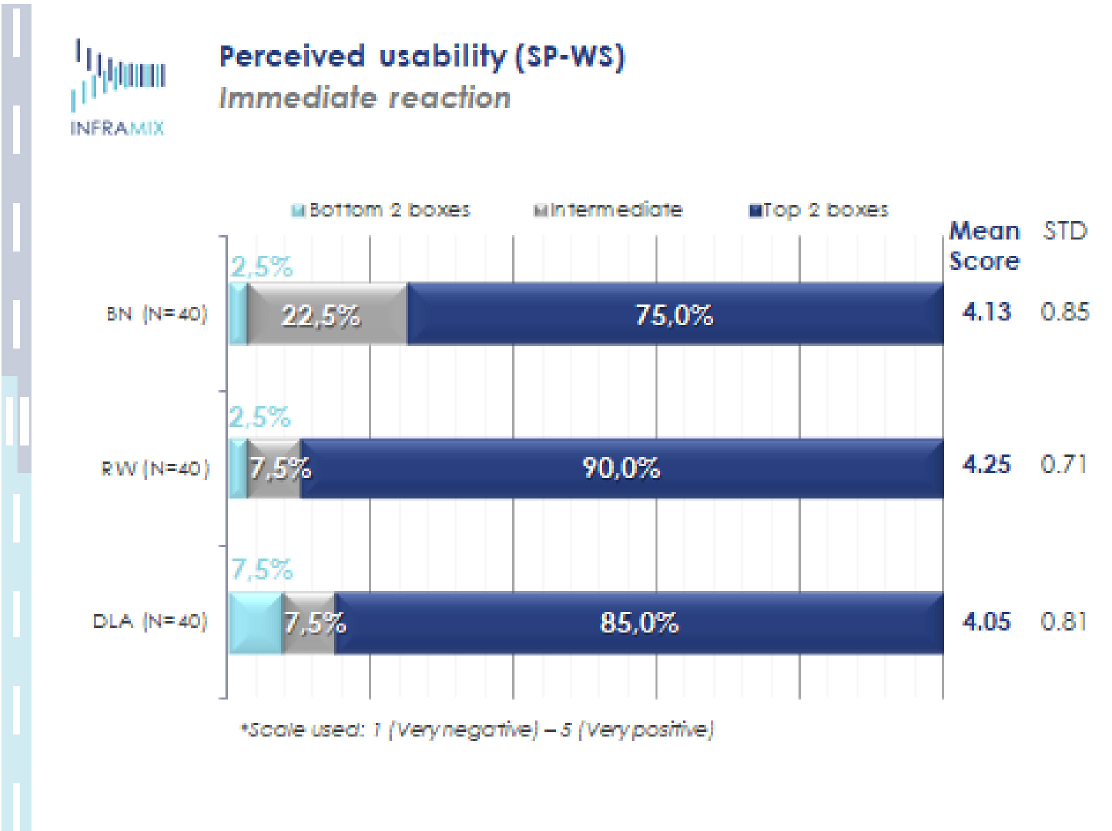


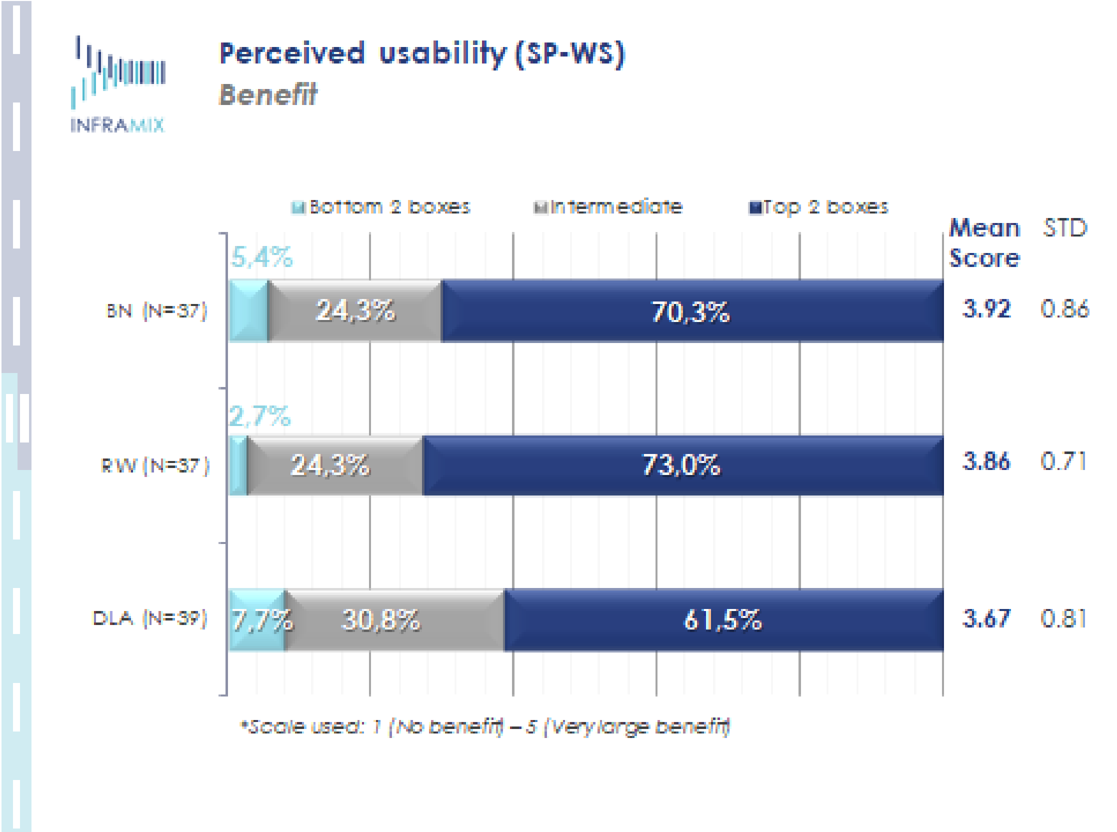
The results that were registered during the four demonstration and workshop events in Spain and Austria were remarkably high reaching up **to 95% in top two boxes and 4,4 mean value for the Bottlenecks scenario (Austrian Demonstration), 97,5% top two boxes and 4,50 mean value for the Roadworks scenario (Spain Workshop) and 95% top two boxes and 4,3 mean value for the DLA (Dynamic Lane Assignment) scenario (Austrian Demonstration).**

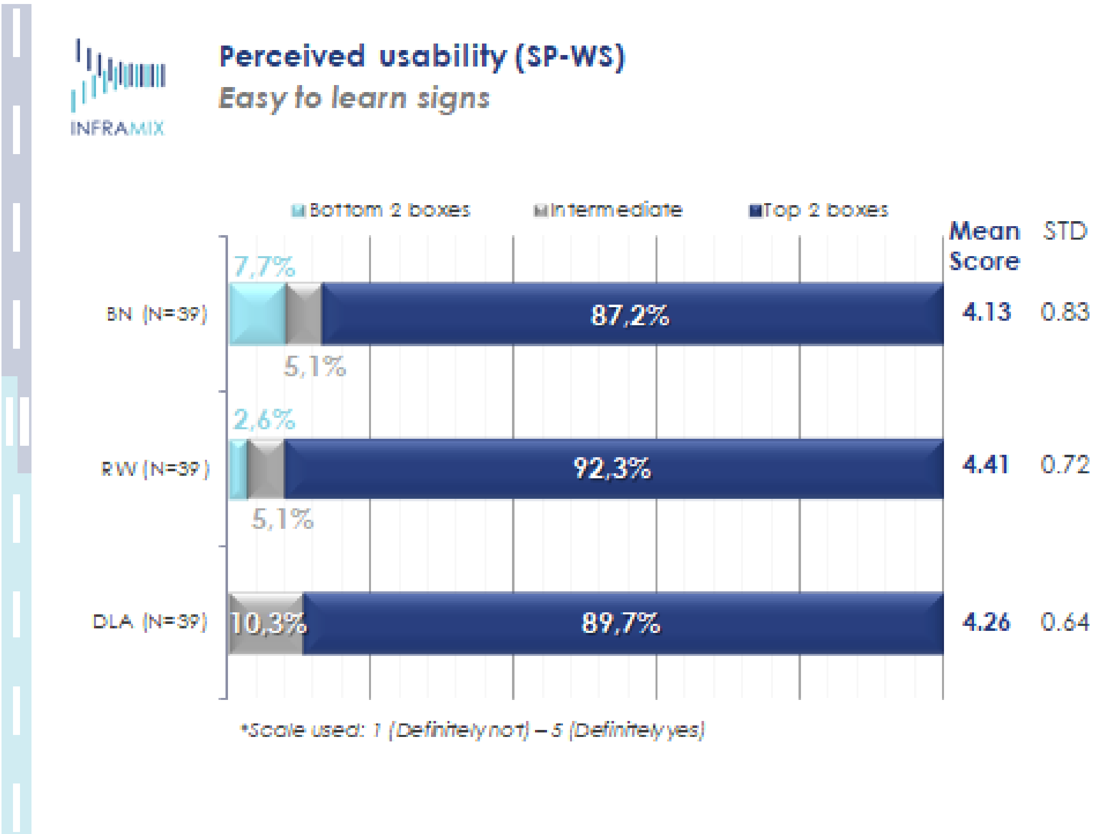
10.3 Perceived Usability

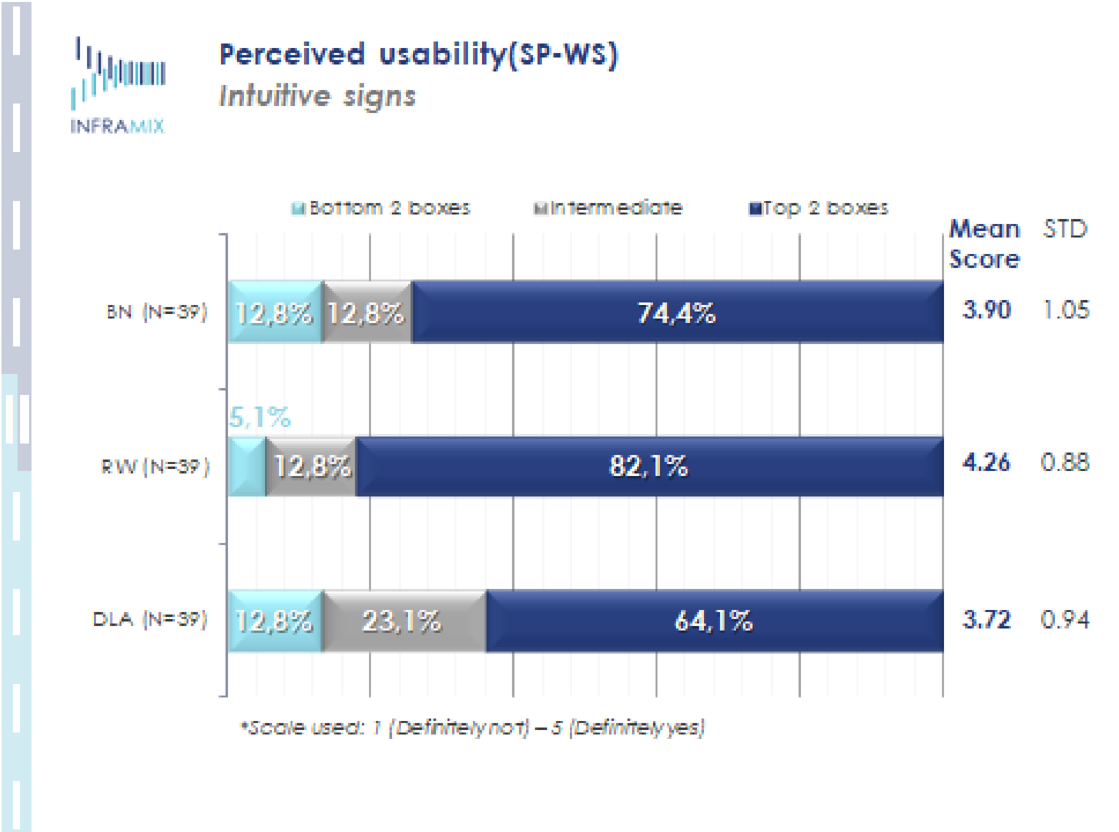
Perceived usefulness of innovative technologies is essential for their diffusion. Work on Intelligent Transport System seeks to understand and leverage the determinants of embracing user technology to affect the processes of designing and implementing technology and reduce user resistance. Usability is a pre-condition for approval. If a technology is considered highly accessible and useful, its intended customers will most likely accept the technology. Although many innovations were seen as highly useful, the intended users [12] never welcomed them. These systems were developed without a proper understanding of the needs of the individual consumer.

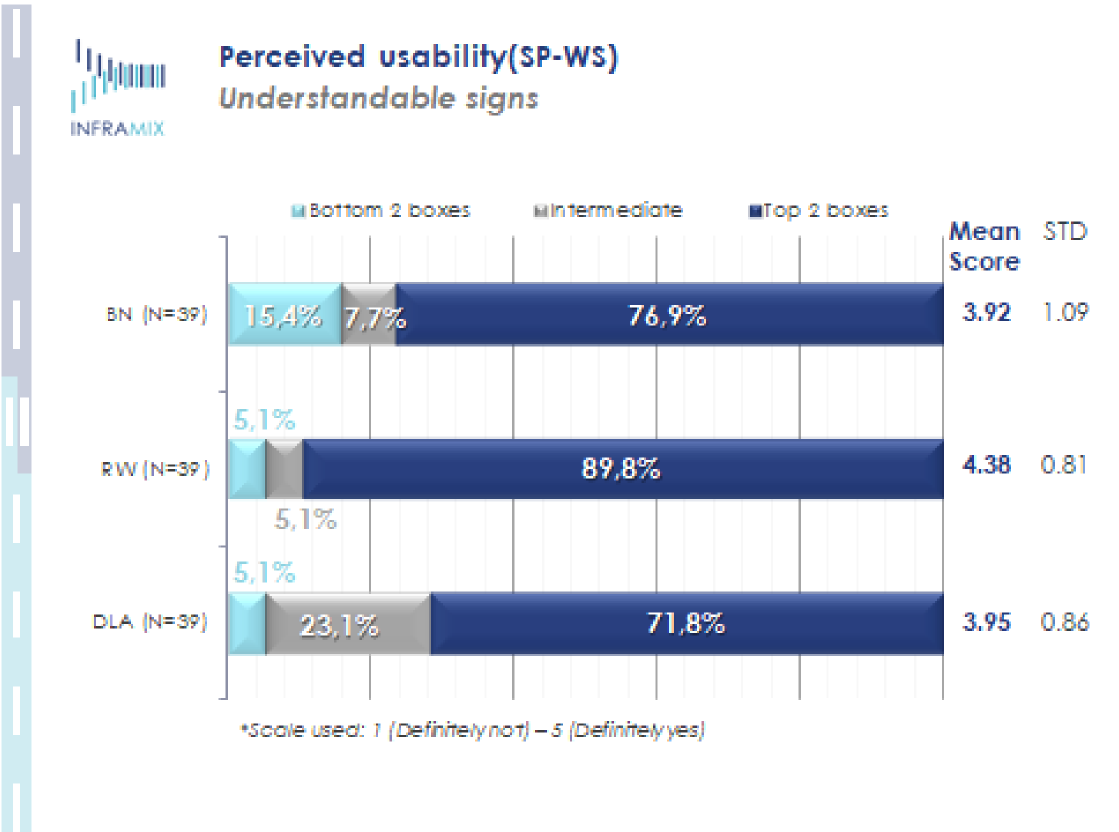
The perceived usability reflects the cognitive responses of participants in using the technology. Those cognitive reactions then affect the reaction (attitude) of the users towards using the technology. Finally, the reaction of the users determines their behavioural response (i.e., their behavioural intent to use) towards [13] technology. Nine research questions were identified and the corresponding hypotheses included in the questionnaires used in the user acceptance events. See Table 3 for more. The findings would be as follows:

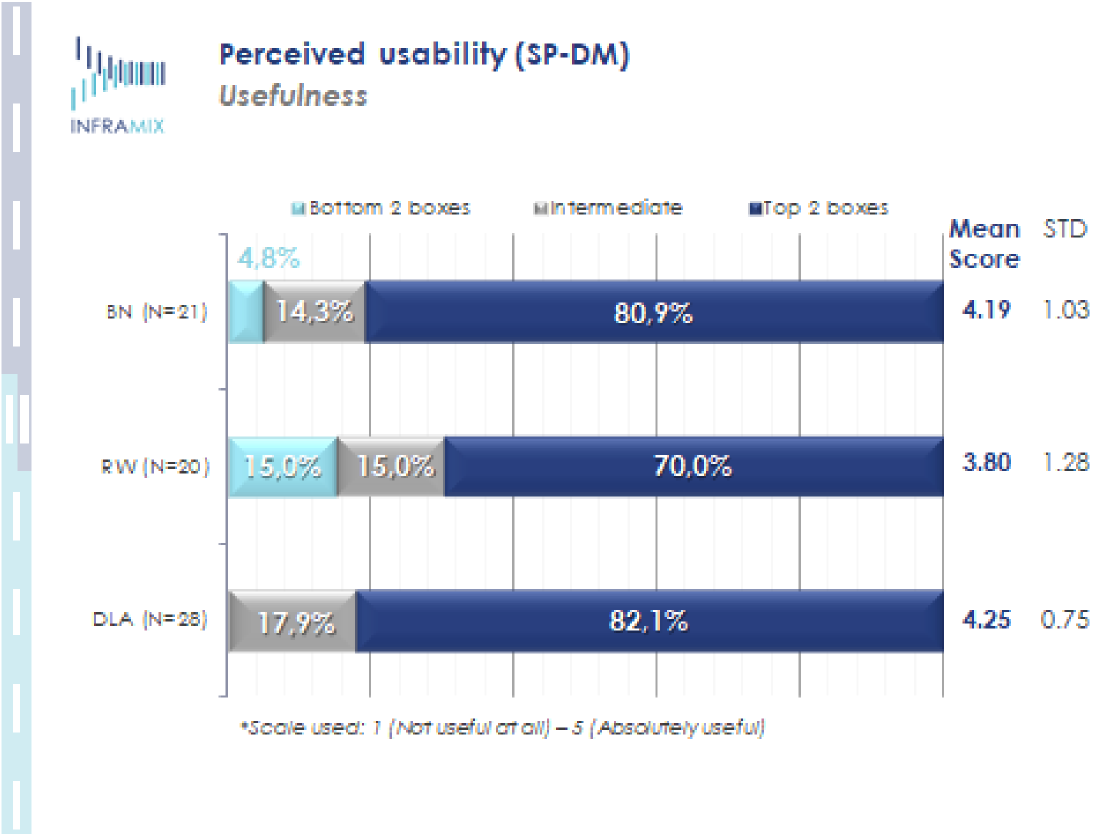


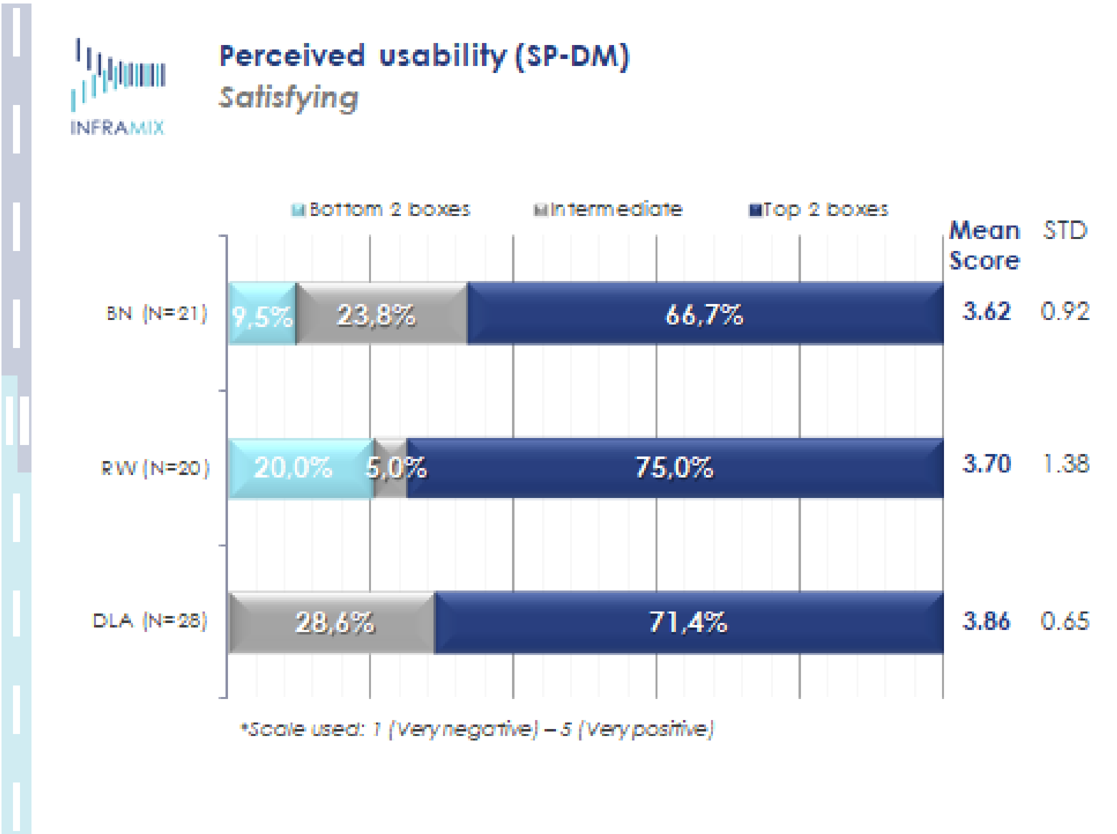

INFRAMIX
Perceived usability (SP-WS)
Benefit
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=37)
5,4%
24,3%
70,3%
3.92
0.86
RW (N=37)
2,7%
24,3%
73,0%
3.86
0.71
DLA (N=39)
7,7%
30,8%
61,5%
3.67
0.81
*Scale used: 1 (No benefit) – 5 (Very large benefit)

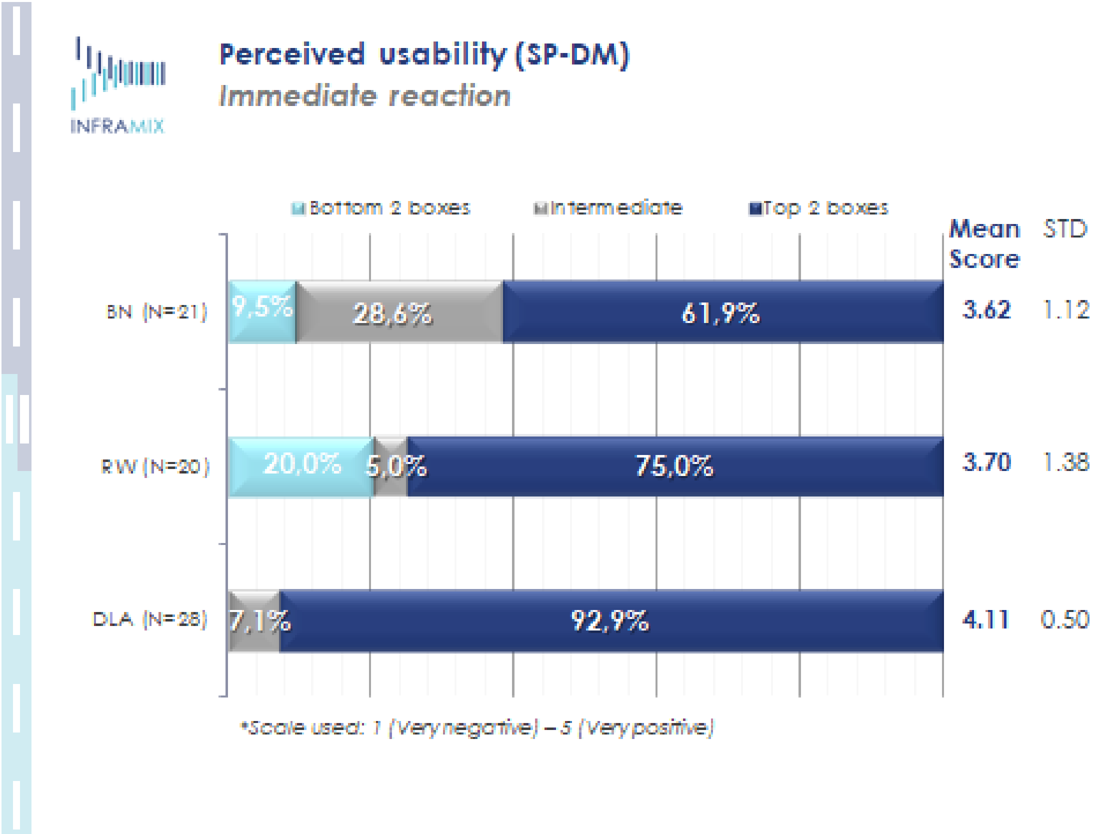

INFRAMIX
Perceived usability (SP-WS)
Easy to learn signs
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=39)
7,7%
5,1%
87,2%
4.13
0.83
RW (N=39)
2,6%
5,1%
92,3%
4.41
0.72
DLA (N=39)
10,3%
89,7%
4.26
0.64
*Scale used: 1 (Definitely not) – 5 (Definitely yes)

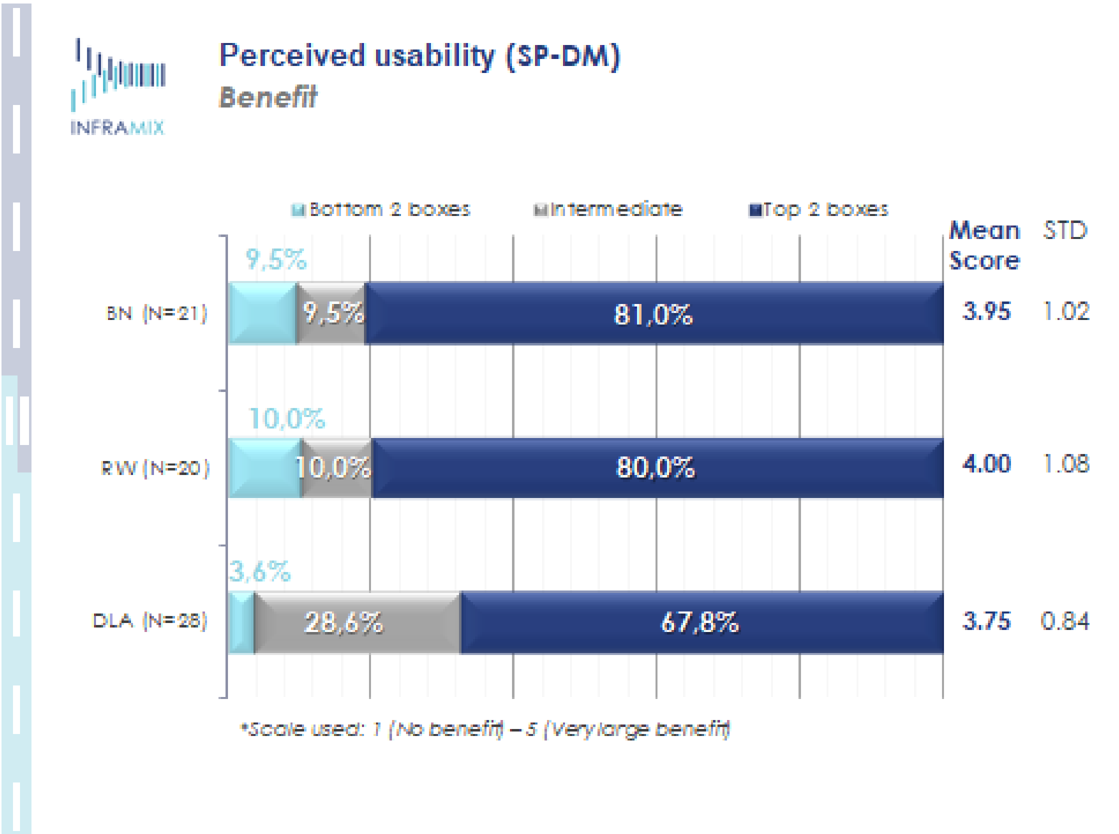

INFRAMIX
Perceived usability(SP-WS)
Intuitive signs
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=39)
12,8%
12,8%
74,4%
3.90
1.05
RW (N=39)
5,1%
12,8%
82,1%
4.26
0.88
DLA (N=39)
12,8%
23,1%
64,1%
3.72
0.94
*Scale used: 1 (Definitely not) – 5 (Definitely yes)

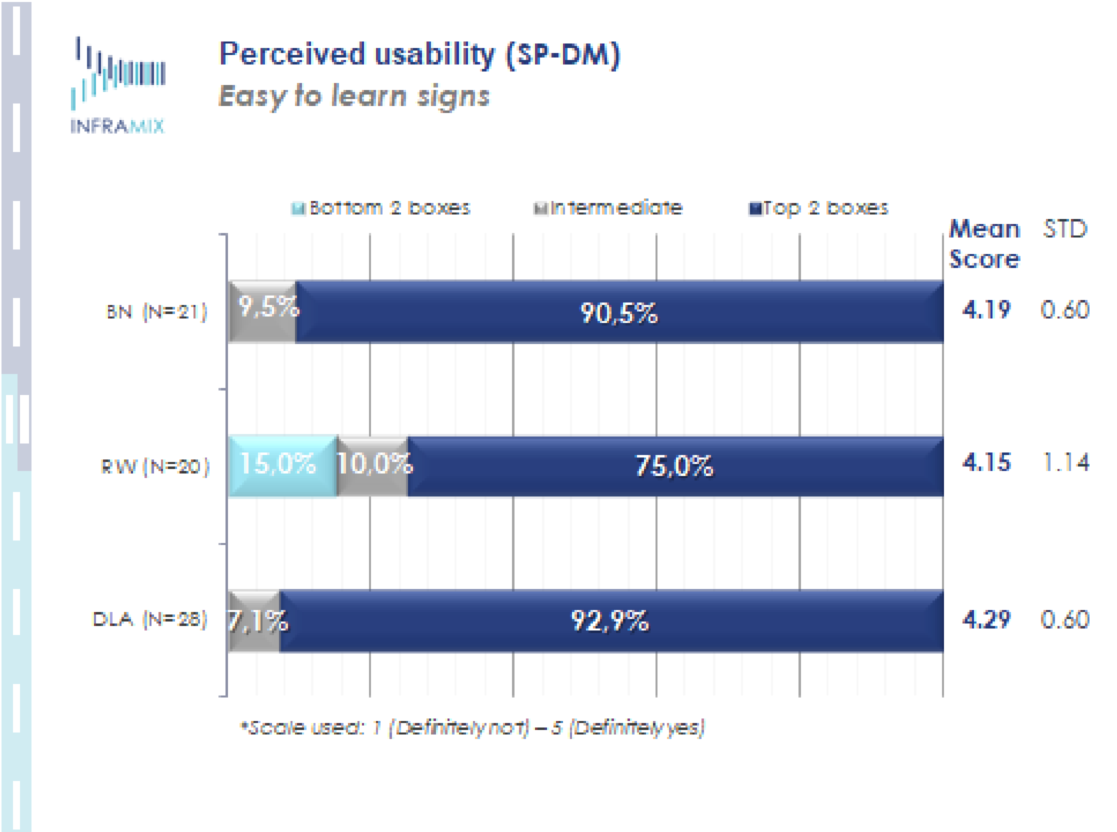

INFRAMIX
Perceived usability(SP-WS)
Understandable signs
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=39)
15,4%
7,7%
76,9%
3.92
1.09
RW (N=39)
5,1%
89,8%
5,1%
4.38
0.81
DLA (N=39)
5,1%
23,1%
71,8%
3.95
0.86
*Scale used: 1 (Definitely not) – 5 (Definitely yes)

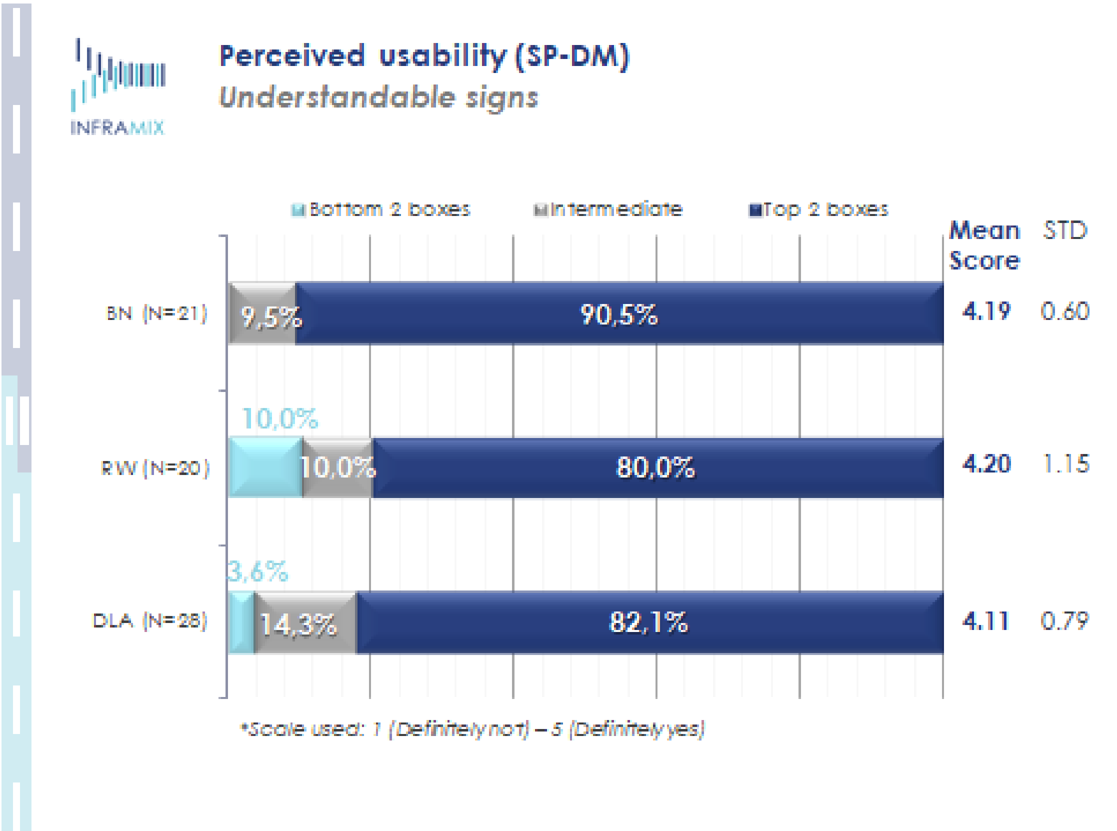

INFRAMIX
Perceived usability (SP-DM)
Usefulness
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=21)
4,8%
14,3%
80,9%
4.19
1.03
RW (N=20)
15,0%
15,0%
70,0%
3.80
1.28
DLA (N=28)
17,9%
82,1%
4.25
0.75
*Scale used: 1 (Not useful at all) – 5 (Absolutely useful)

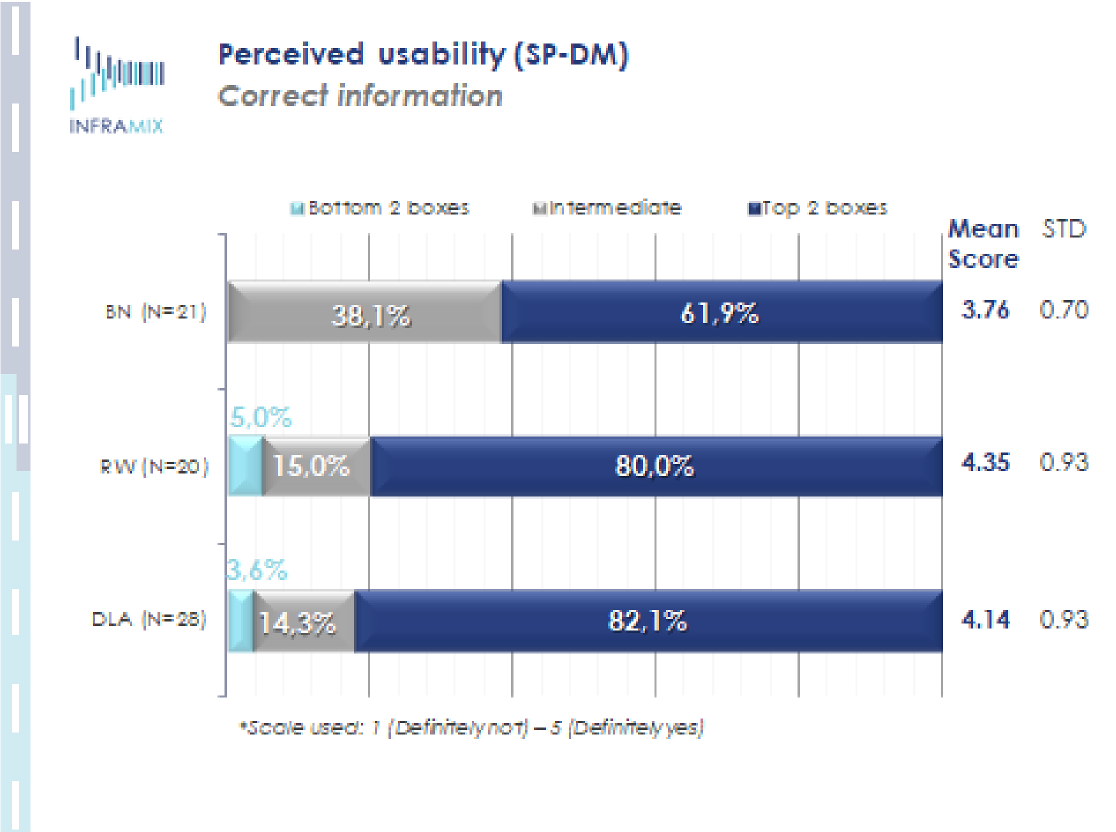

INFRAMIX
Perceived usability (SP-DM)
Satisfying
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=21)
9,5%
23,8%
66,7%
3.62
0.92
RW (N=20)
20,0%
5,0%
75,0%
3.70
1.38
DLA (N=28)
28,6%
71,4%
3.86
0.65
*Scale used: 1 (Very negative) – 5 (Very positive)

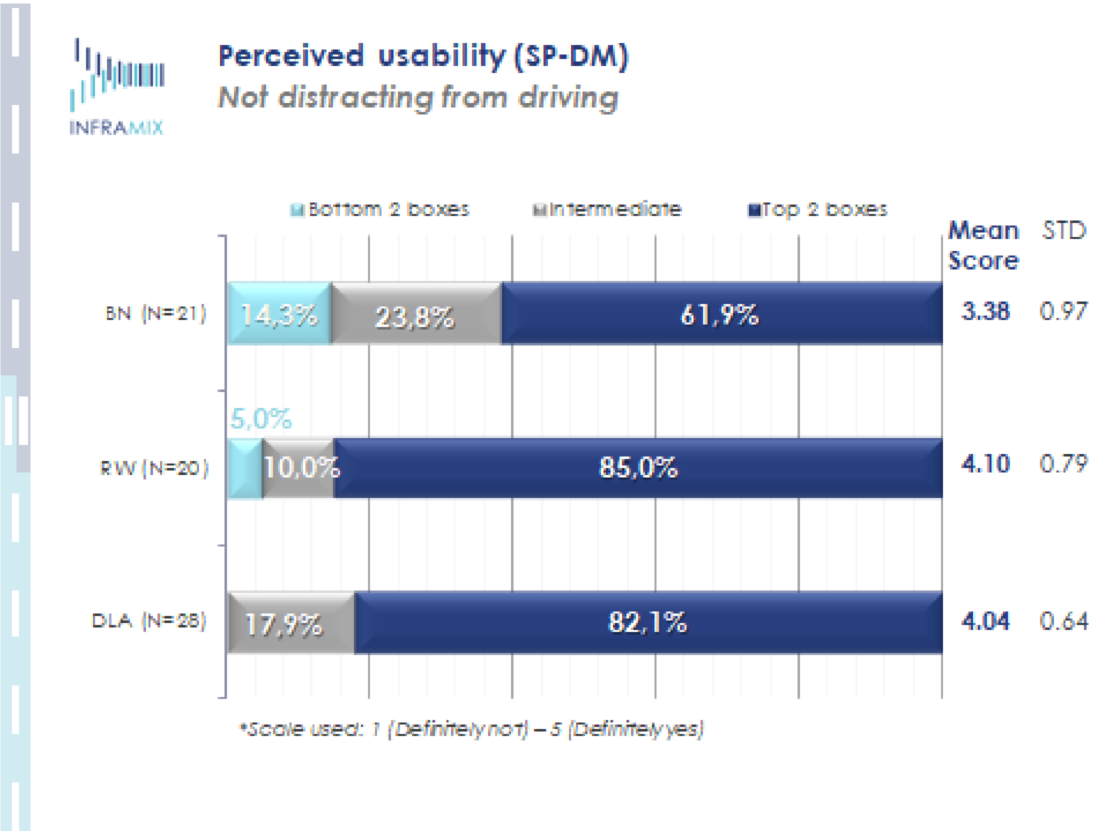

INFRAMIX
Perceived usability (SP-DM)
Immediate reaction
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=21)
9,5%
28,6%
61,9%
3.62
1.12
RW (N=20)
20,0%
5,0%
75,0%
3.70
1.38
DLA (N=28)
7,1%
92,9%
4.11
0.50
*Scale used: 1 (Very negative) – 5 (Very positive)

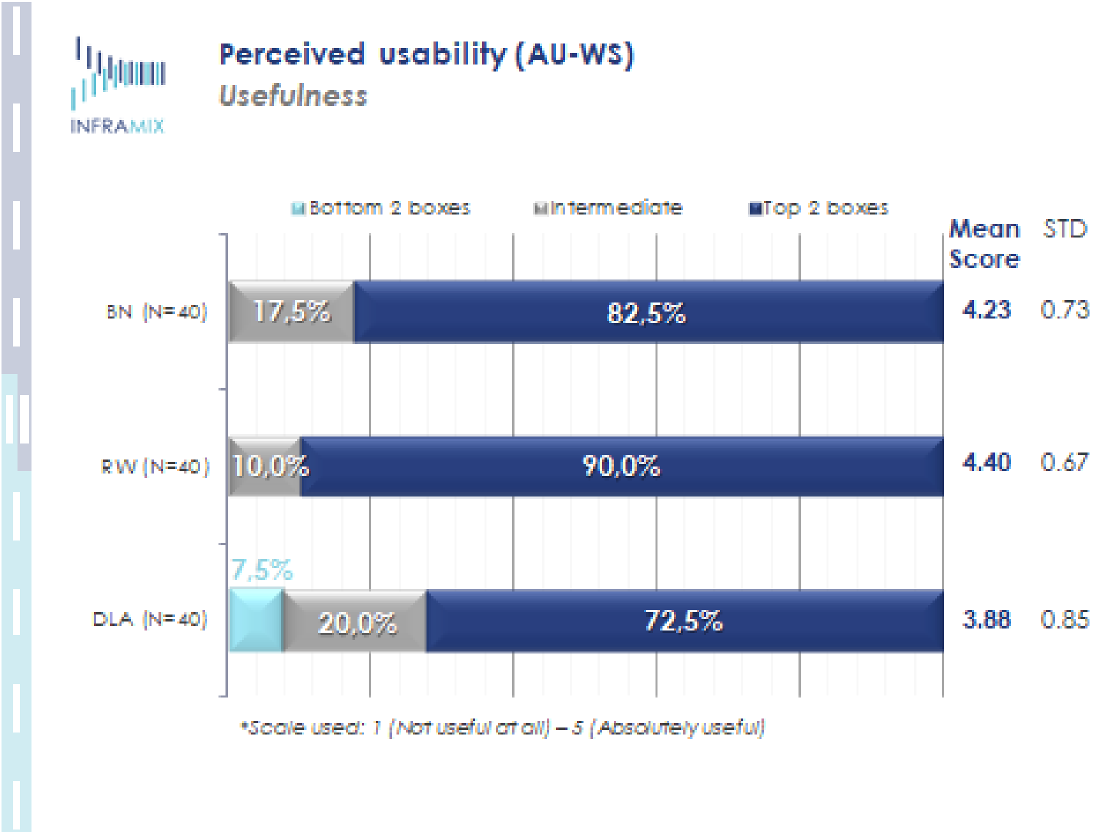

INFRAMIX
Perceived usability (SP-DM)
Benefit
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=21)
9,5%
9,5%
81,0%
3.95
1.02
RW (N=20)
10,0%
10,0%
80,0%
4.00
1.08
DLA (N=28)
3,6%
28,6%
67,8%
3.75
0.84
*Scale used: 1 (No benefit) – 5 (Very large benefit)

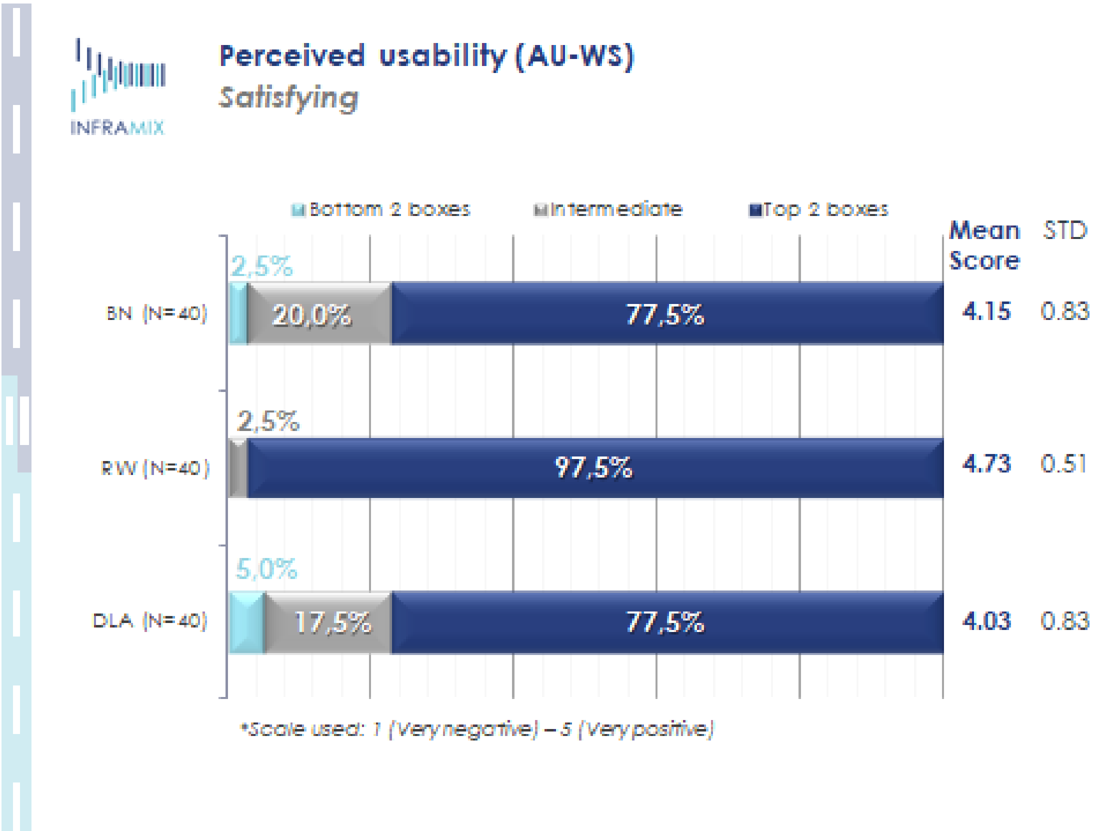

INFRAMIX
Perceived usability (SP-DM)
Easy to learn signs
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=21)
9,5%
90,5%
4.19
0.60
RW (N=20)
15,0%
10,0%
75,0%
4.15
1.14
DLA (N=28)
7,1%
92,9%
4.29
0.60
*Scale used: 1 (Definitely not) – 5 (Definitely yes)

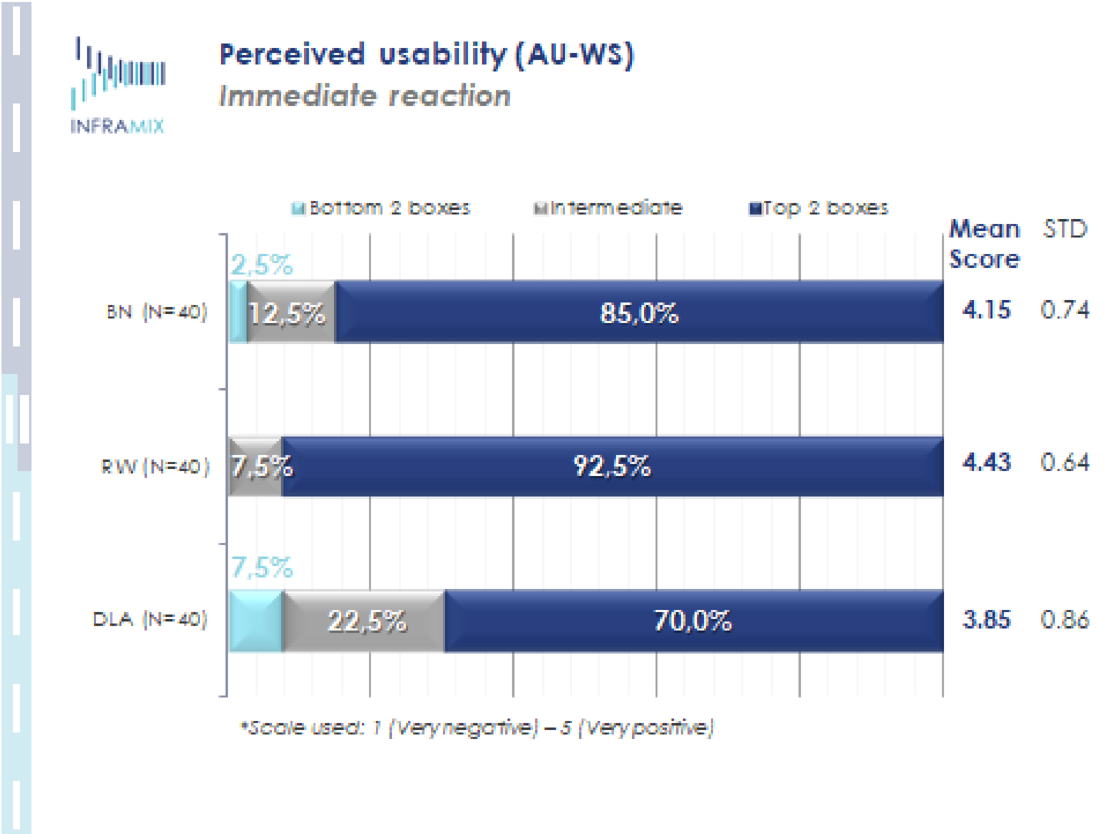

INFRAMIX
Perceived usability (SP-DM)
Understandable signs
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=21)
9,5%
90,5%
4.19
0.60
RW (N=20)
10,0%
10,0%
80,0%
4.20
1.15
DLA (N=28)
3,6%
14,3%
82,1%
4.11
0.79
*Scale used: 1 (Definitely not) – 5 (Definitely yes)

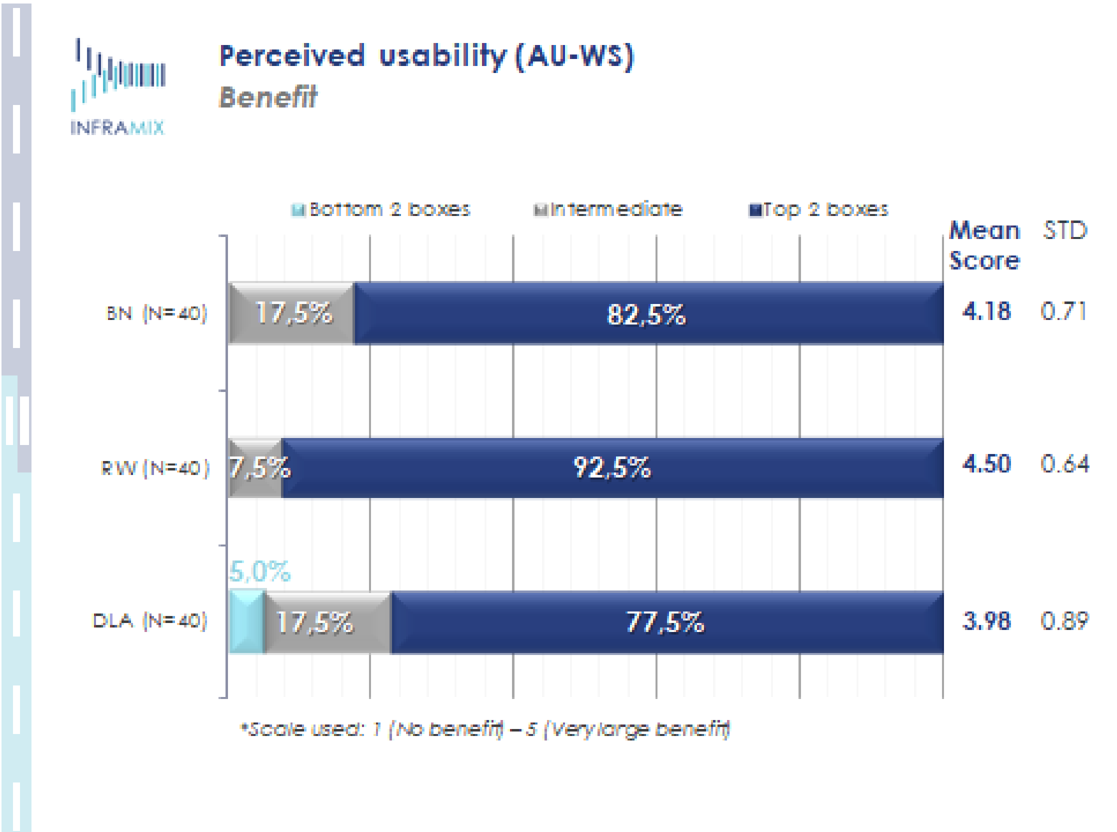

INFRAMIX
Perceived usability (SP-DM)
Correct information
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=21)
38,1%
61,9%
3.76
0.70
RW (N=20)
5,0%
15,0%
80,0%
4.35
0.93
DLA (N=28)
3,6%
14,3%
82,1%
4.14
0.93
*Scale used: 1 (Definitely not) – 5 (Definitely yes)

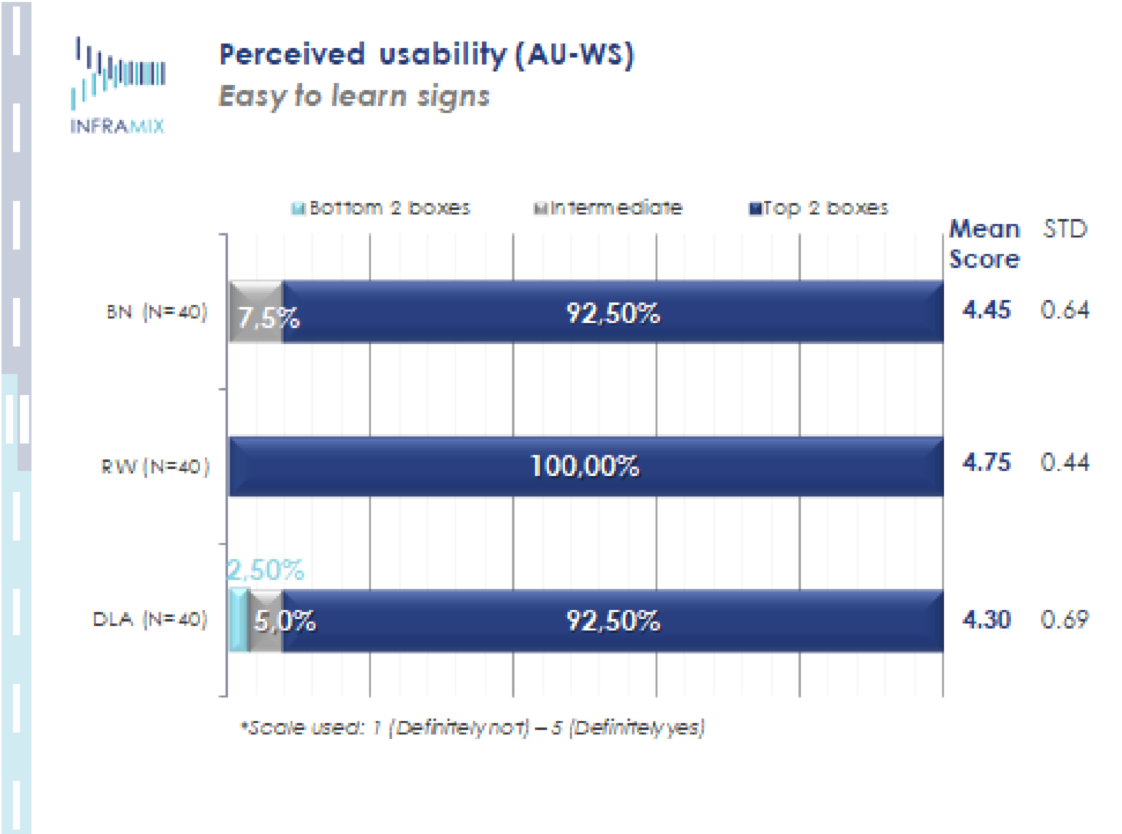

INFRAMIX
Perceived usability (SP-DM)
Not distracting from driving
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=21)
14,3%
23,8%
61,9%
3.38
0.97
RW (N=20)
5,0%
10,0%
85,0%
4.10
0.79
DLA (N=28)
17,9%
82,1%
4.04
0.64
*Scale used: 1 (Definitely not) – 5 (Definitely yes)

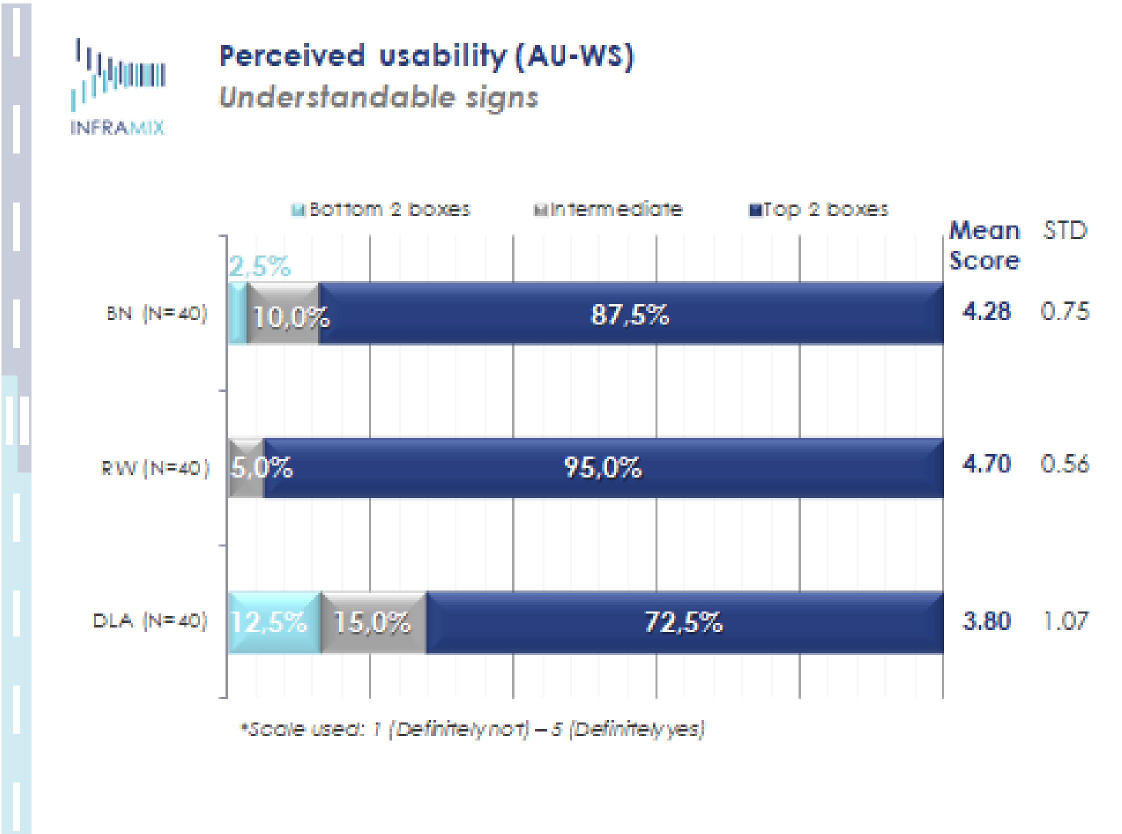

INFRAMIX
Perceived usability (AU-WS)
Usefulness
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=40)
17,5%
82,5%
4.23
0.73
RW (N=40)
10,0%
90,0%
4.40
0.67
DLA (N=40)
7,5%
20,0%
72,5%
3.88
0.85
*Scale used: 1 (Not useful at all) – 5 (Absolutely useful)

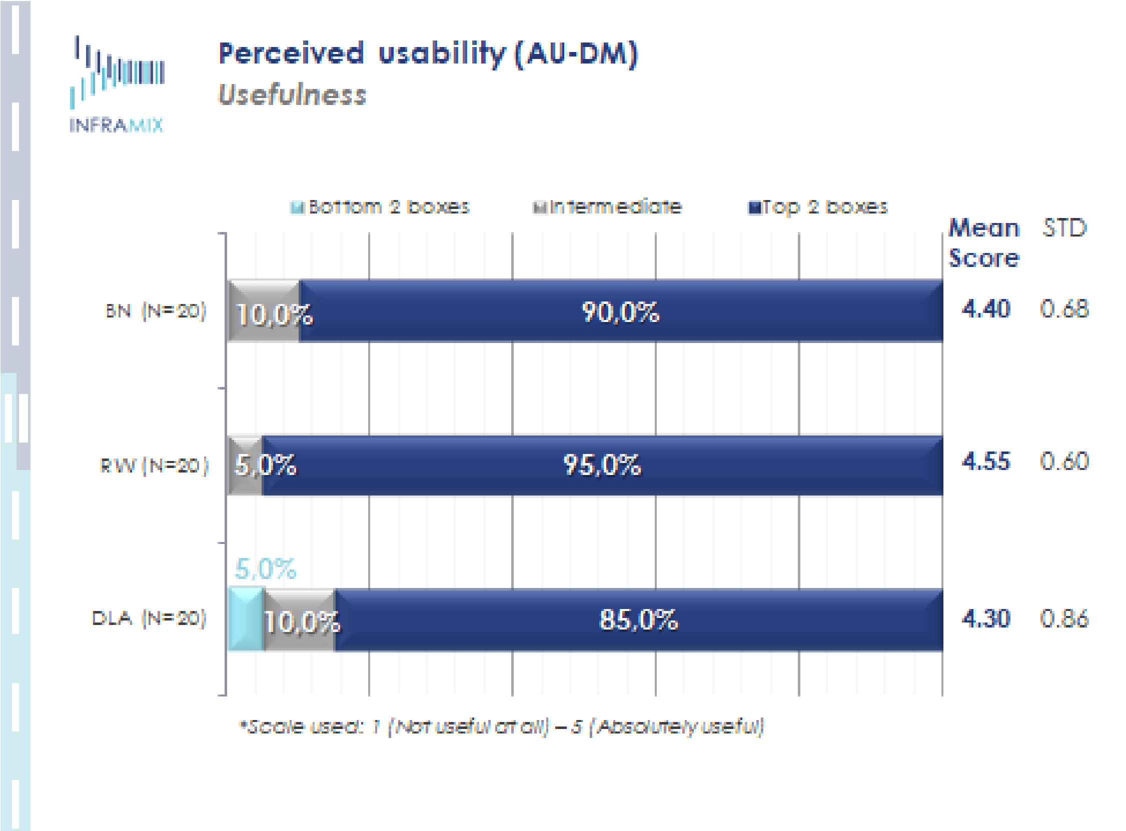

INFRAMIX
Perceived usability (AU-WS)
Satisfying
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=40)
2,5%
20,0%
77,5%
4.15
0.83
RW (N=40)
2,5%
97,5%
4.73
0.51
DLA (N=40)
5,0%
17,5%
77,5%
4.03
0.83
*Scale used: 1 (Very negative) – 5 (Very positive)

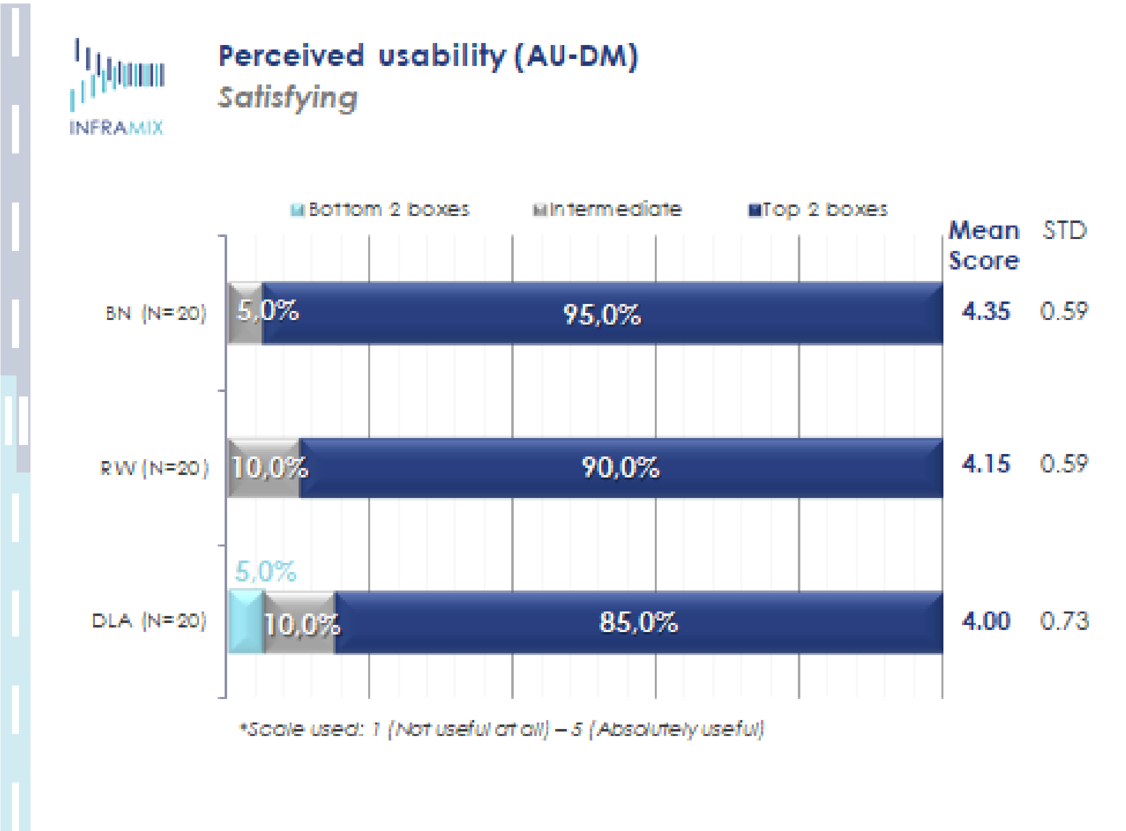

INFRAMIX
Perceived usability (AU-WS)
Immediate reaction
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=40)
2,5%
12,5%
85,0%
4.15
0.74
RW (N=40)
7,5%
92,5%
4.43
0.64
DLA (N=40)
7,5%
22,5%
70,0%
3.85
0.86
*Scale used: 1 (Very negative) – 5 (Very positive)

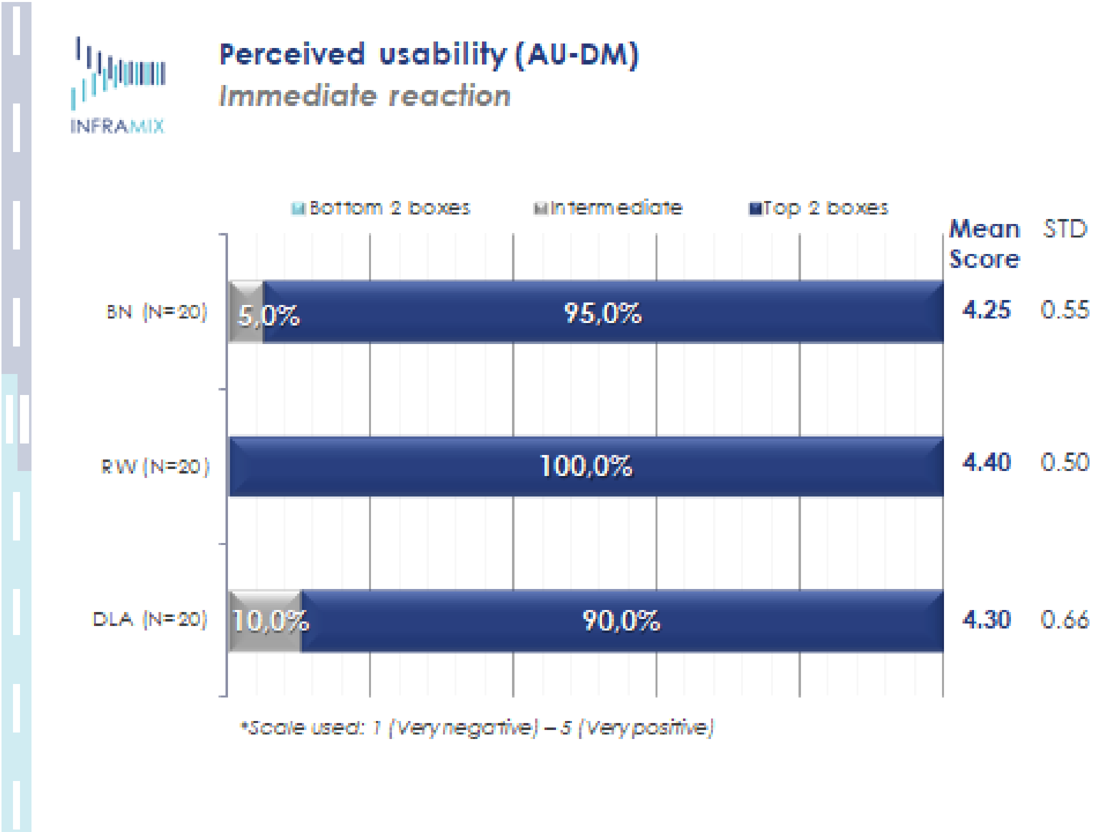

INFRAMIX
Perceived usability (AU-WS)
Benefit
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=40)
17,5%
82,5%
4.18
0.71
RW (N=40)
7,5%
92,5%
4.50
0.64
DLA (N=40)
5,0%
17,5%
77,5%
3.98
0.89
*Scale used: 1 (No benefit) – 5 (Very large benefit)

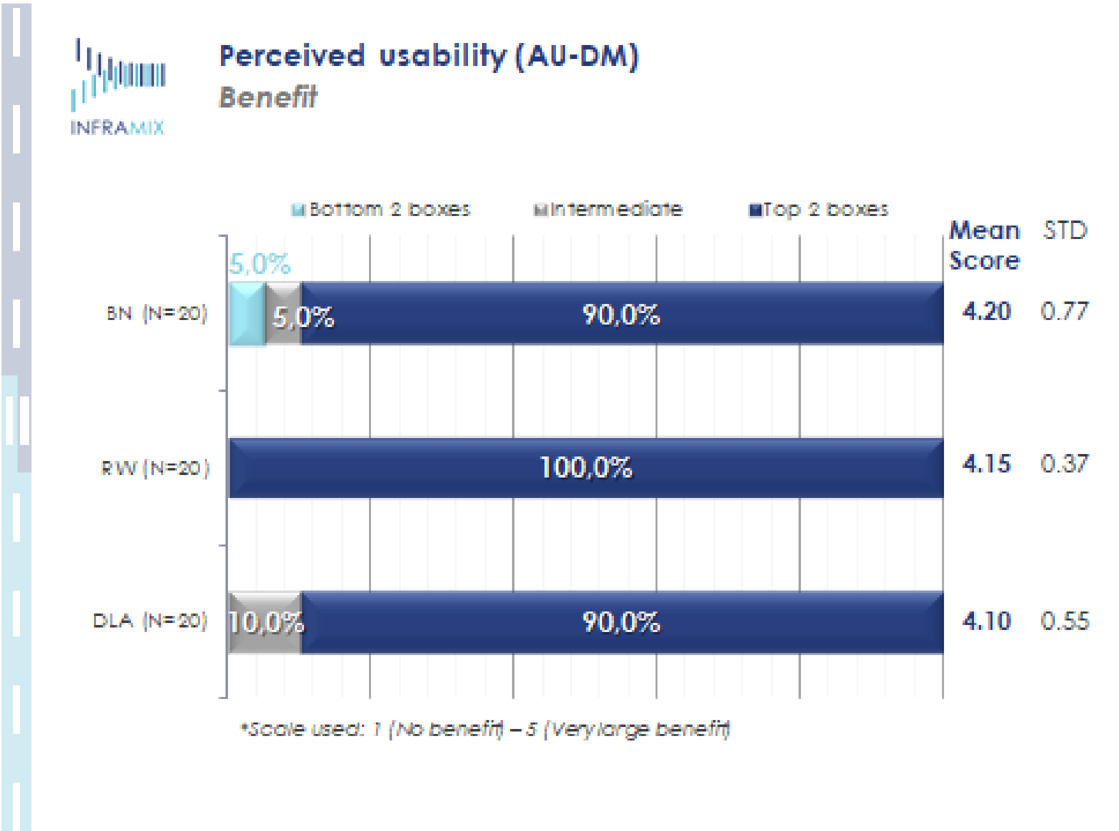

INFRAMIX
Perceived usability (AU-WS)
Easy to learn signs
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=40)
7,5%
92,50%
4.45
0.64
RW (N=40)
100,00%
4.75
0.44
DLA (N=40)
2,50%
5,0%
92,50%
4.30
0.69
*Scale used: 1 (Definitely not) – 5 (Definitely yes)


INFRAMIX
Perceived usability (AU-WS)
Understandable signs
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=40)
2,5%
10,0%
87,5%
4.28
0.75
RW (N=40)
5,0%
95,0%
4.70
0.56
DLA (N=40)
12,5%
15,0%
72,5%
3.80
1.07
*Scale used: 1 (Definitely not) – 5 (Definitely yes)


INFRAMIX
Perceived usability (AU-DM)
Usefulness
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=20)
10,0%
90,0%
4.40
0.68
RW (N=20)
5,0%
95,0%
4.55
0.60
DLA (N=20)
5,0%
10,0%
85,0%
4.30
0.86
*Scale used: 1 (Not useful at all) – 5 (Absolutely useful)

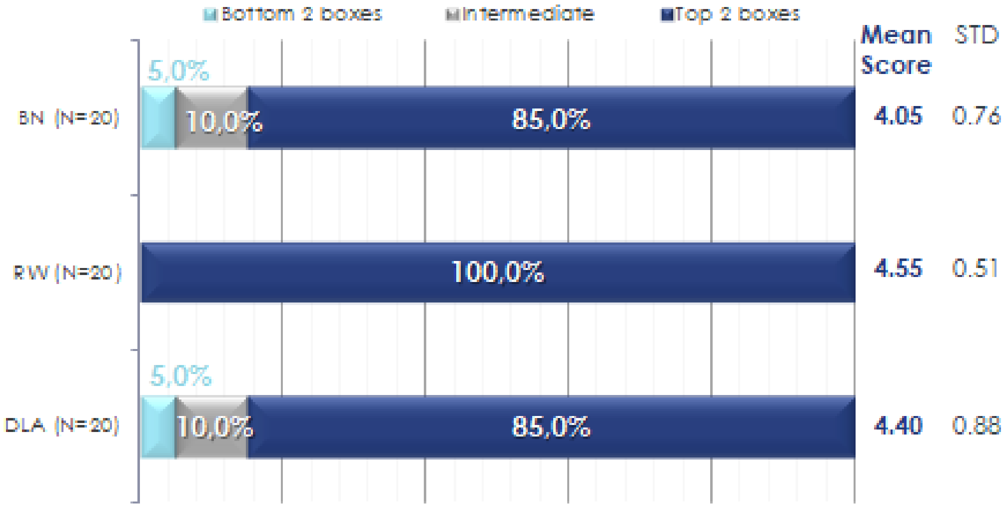

INFRAMIX
Perceived usability (AU-DM)
Satisfying
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=20)
5,0%
95,0%
4.35
0.59
RW (N=20)
10,0%
90,0%
4.15
0.59
DLA (N=20)
5,0%
10,0%
85,0%
4.00
0.73
*Scale used: 1 (Not useful at all) – 5 (Absolutely useful)


INFRAMIX
Perceived usability (AU-DM)
Immediate reaction
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=20)
5,0%
95,0%
4.25
0.55
RW (N=20)
100,0%
4.40
0.50
DLA (N=20)
10,0%
90,0%
4.30
0.66
*Scale used: 1 (Very negative) – 5 (Very positive)


INFRAMIX
Perceived usability (AU-DM)
Benefit
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=20)
5,0%
5,0%
90,0%
4.20
0.77
RW (N=20)
100,0%
4.15
0.37
DLA (N=20)
10,0%
90,0%
4.10
0.55
*Scale used: 1 (No benefit) – 5 (Very large benefit)

Perceived usability (AU-DM)

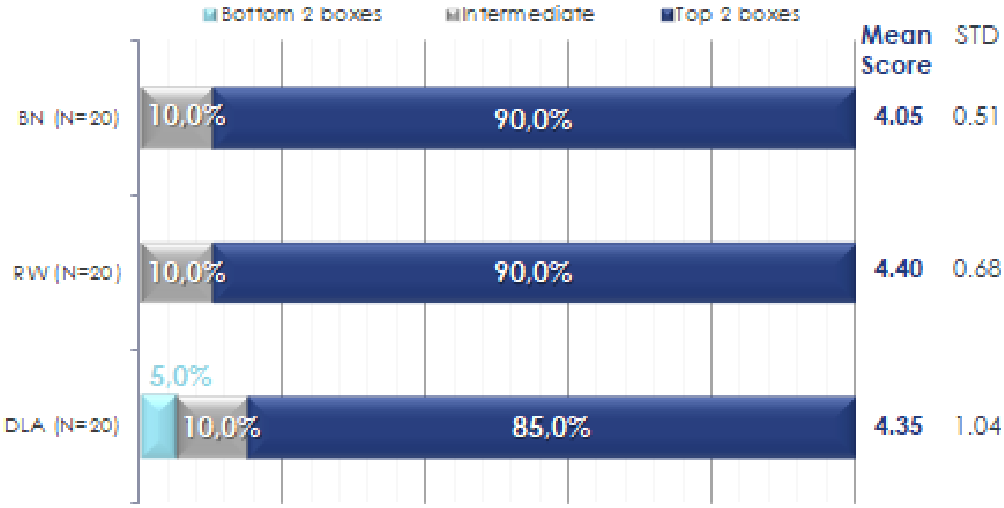
Easy to learn signs



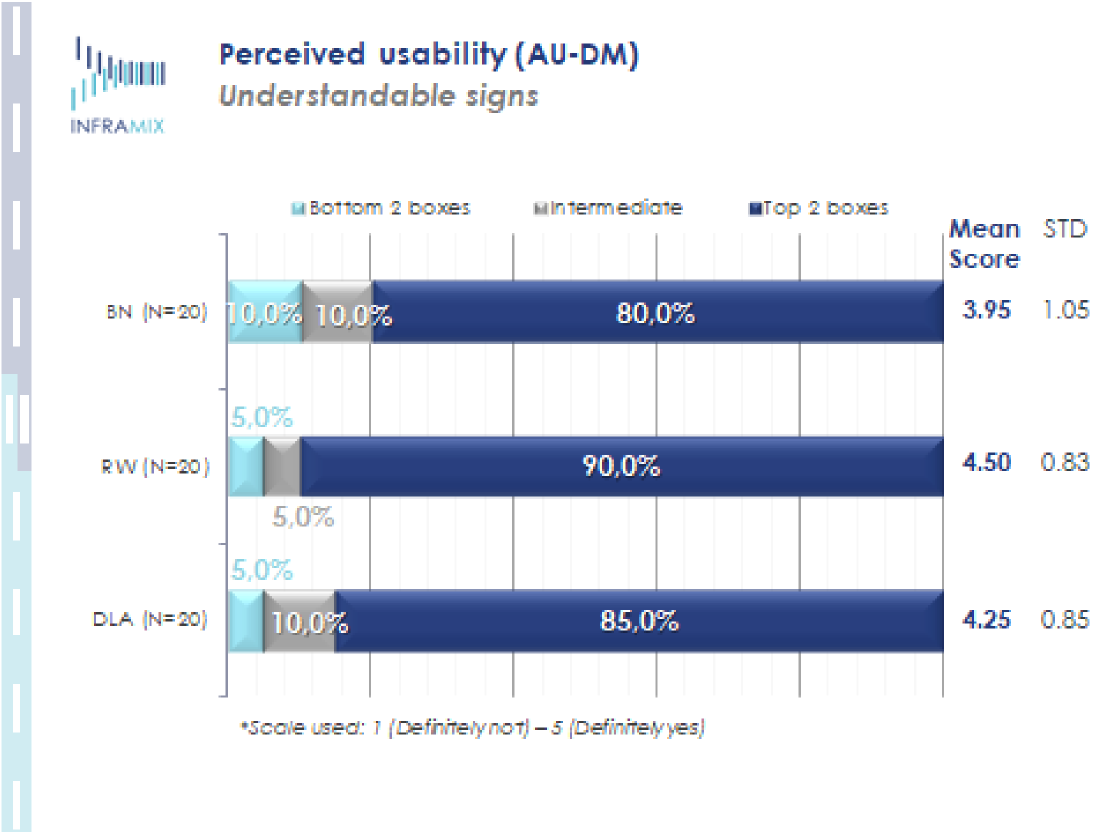
*Scale used: 1 (Definitely not) – 5 (Definitely yes)

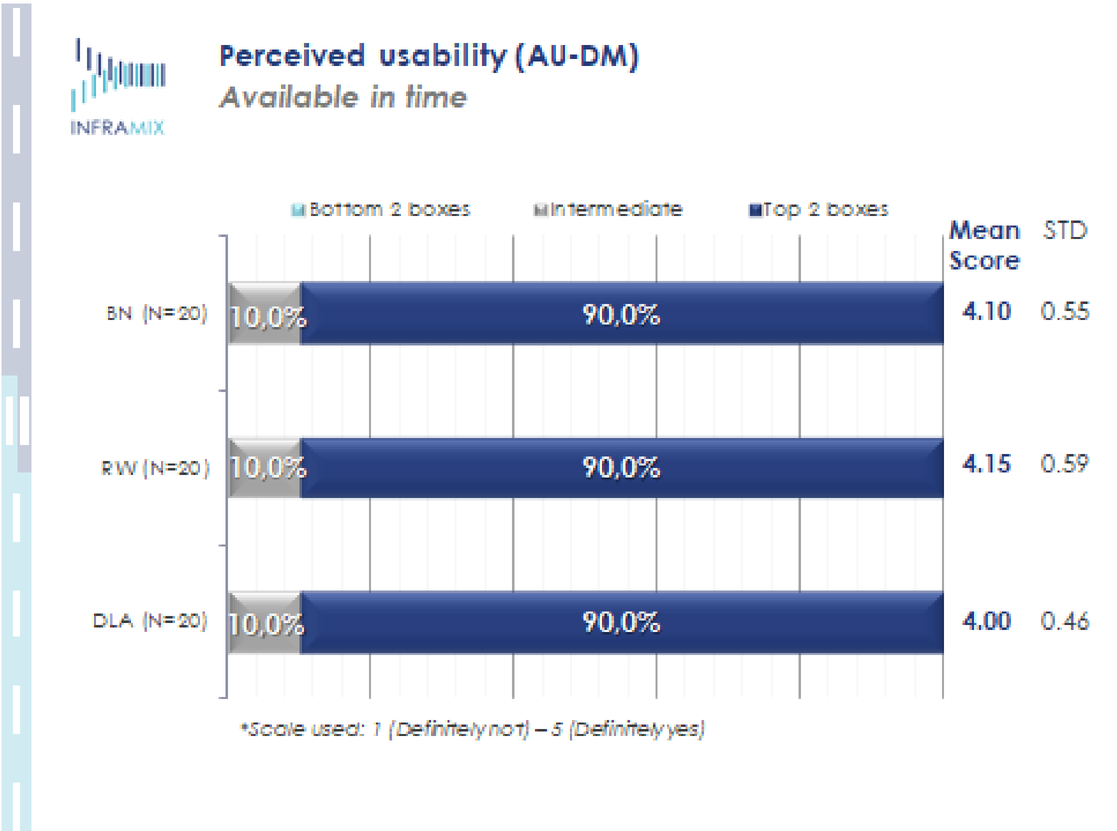
Perceived usability (AU-DM)

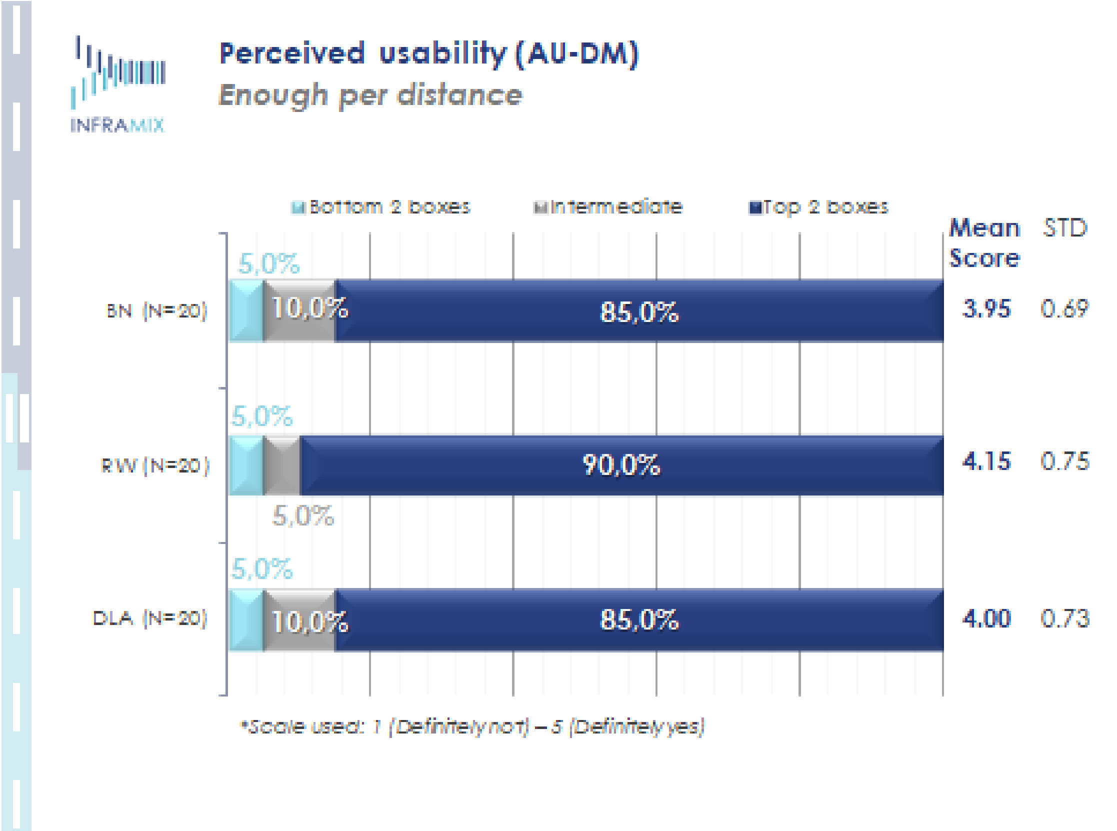
Intuitive signs

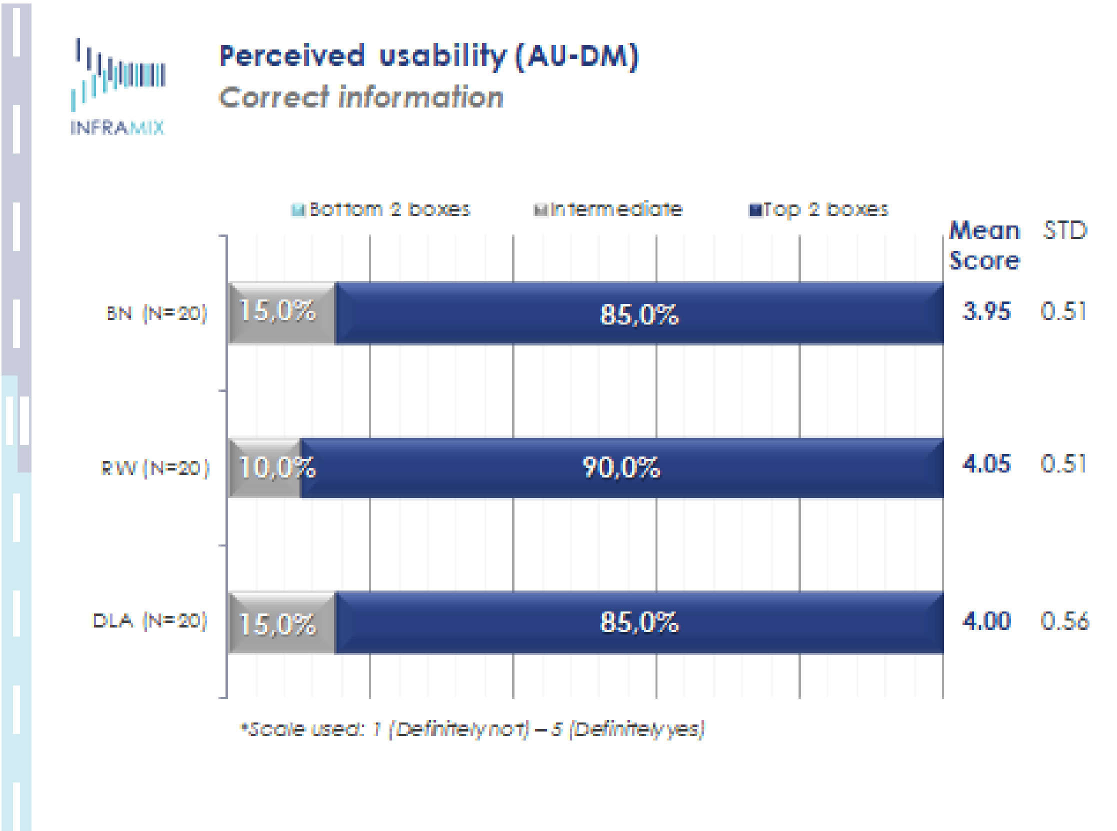


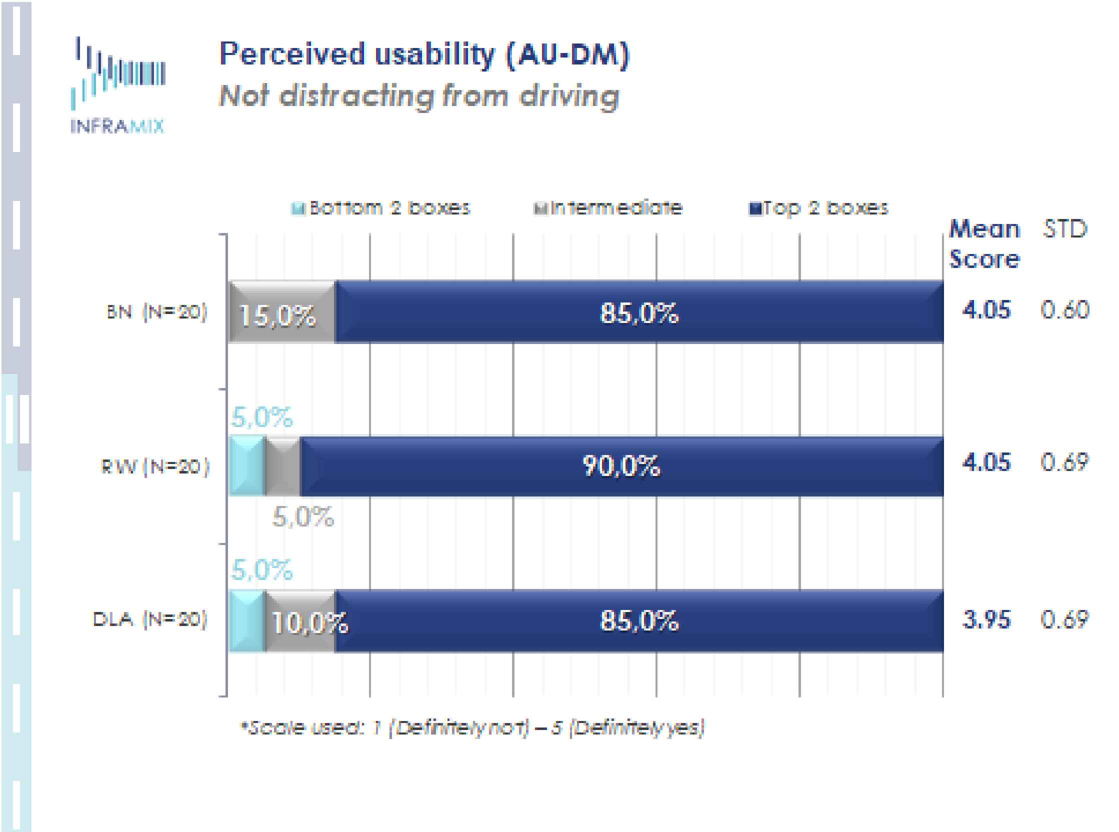
*Scale used: 1 (Definitely not) – 5 (Definitely yes)


INFRAMIX
Perceived usability (AU-DM)
Understandable signs
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=20)
10,0%
10,0%
80,0%
3.95
1.05
RW (N=20)
5,0%
90,0%
5,0%
4.50
0.83
DLA (N=20)
5,0%
10,0%
85,0%
4.25
0.85
*Scale used: 1 (Definitely not) – 5 (Definitely yes)


INFRAMIX
Perceived usability (AU-DM)
Available in time
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=20)
10,0%
90,0%
4.10
0.55
RW (N=20)
10,0%
90,0%
4.15
0.59
DLA (N=20)
10,0%
90,0%
4.00
0.46
*Scale used: 1 (Definitely not) – 5 (Definitely yes)


INFRAMIX
Perceived usability (AU-DM)
Enough per distance
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=20)
5,0%
10,0%
85,0%
3.95
0.69
RW (N=20)
5,0%
90,0%
5,0%
4.15
0.75
DLA (N=20)
5,0%
10,0%
85,0%
4.00
0.73
*Scale used: 1 (Definitely not) – 5 (Definitely yes)


INFRAMIX
Perceived usability (AU-DM)
Correct information
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=20)
15,0%
85,0%
3.95
0.51
RW (N=20)
10,0%
90,0%
4.05
0.51
DLA (N=20)
15,0%
85,0%
4.00
0.56
*Scale used: 1 (Definitely not) – 5 (Definitely yes)



The results were quite to very satisfactory reaching up to **92,5% in top two boxes and 4,45 mean value for the Bottlenecks scenario (in Austrian workshop "easy to learn" research question), 100% top two boxes and 4,75 mean value for the Roadworks scenario (in Austrian workshop "easy to learn" research question), and 85% top two boxes and 4,4 mean value for the DLA (Dynamic Lane Assignment) scenario ((in Austrian demonstration "easy to learn" research question).** It is obvious that in most of research questions and scenarios the target of 70% of users' appreciation was exceeded**.**

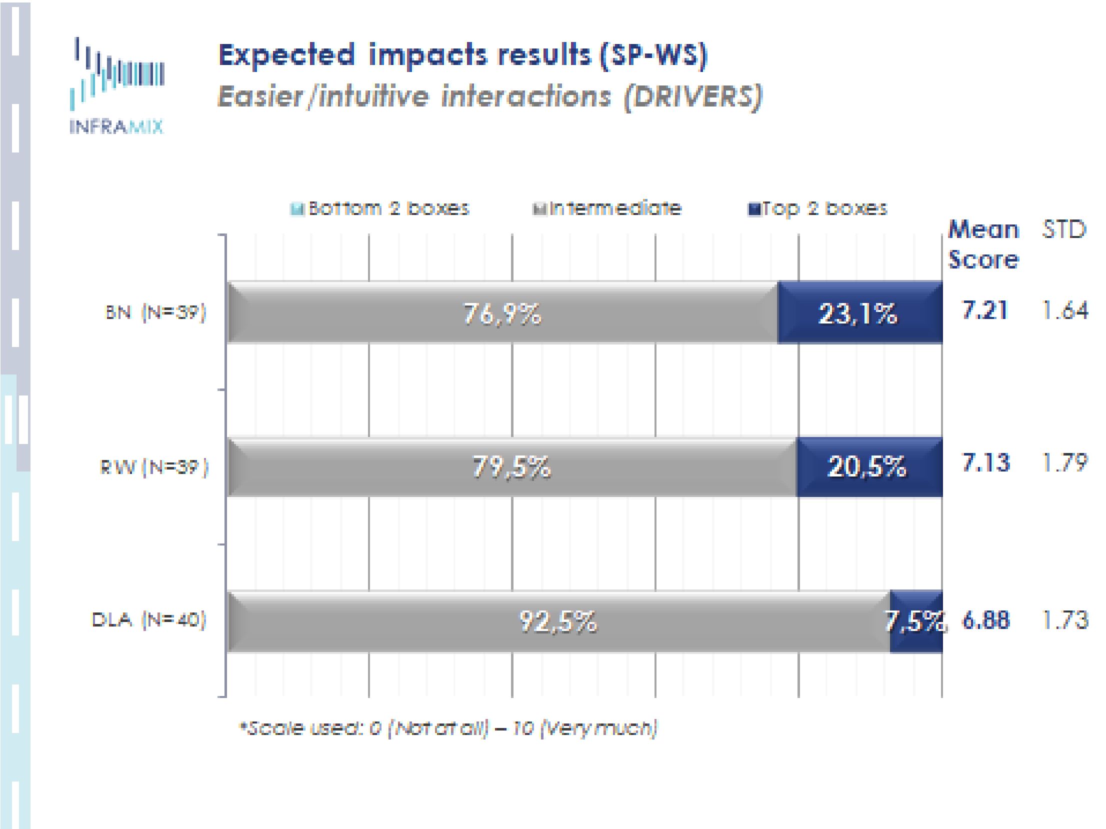
Concerning some small deviations from the above overall very positive picture, these were in very few cases: in Spanish Demonstration Bottlenecks scenario concerning "immediate reaction" research question with 61,9% top two boxes, and in Spanish Workshop in DLA scenario concerning "potential benefit" and "intuitiveness" research questions(61,5% and 64,1%) respectively. Bottlenecks always cause a little bigger fear and concerns to the drivers something that may make them less enthusiastic about future strategies for this challenge, especially if they have not real experience how the intelligent traffic management capabilities will affect and improve the upstream and downstream traffic in bottlenecks areas. About having a Dedicated Lane Assignment for connected and automated vehicles, the lower appreciation (although still over 60%) percentages in few cases are attributed probably to the scepticism of drivers and passengers from their moderate experience by dedicated lanes use for other purposes (e.g. public transport), but also due to their feeling that a dedicated lane that probably they will not use on their own if they drive conventional cars may cause congestion to other lanes. However, these few exclusions do not change at all the very positive overall results.

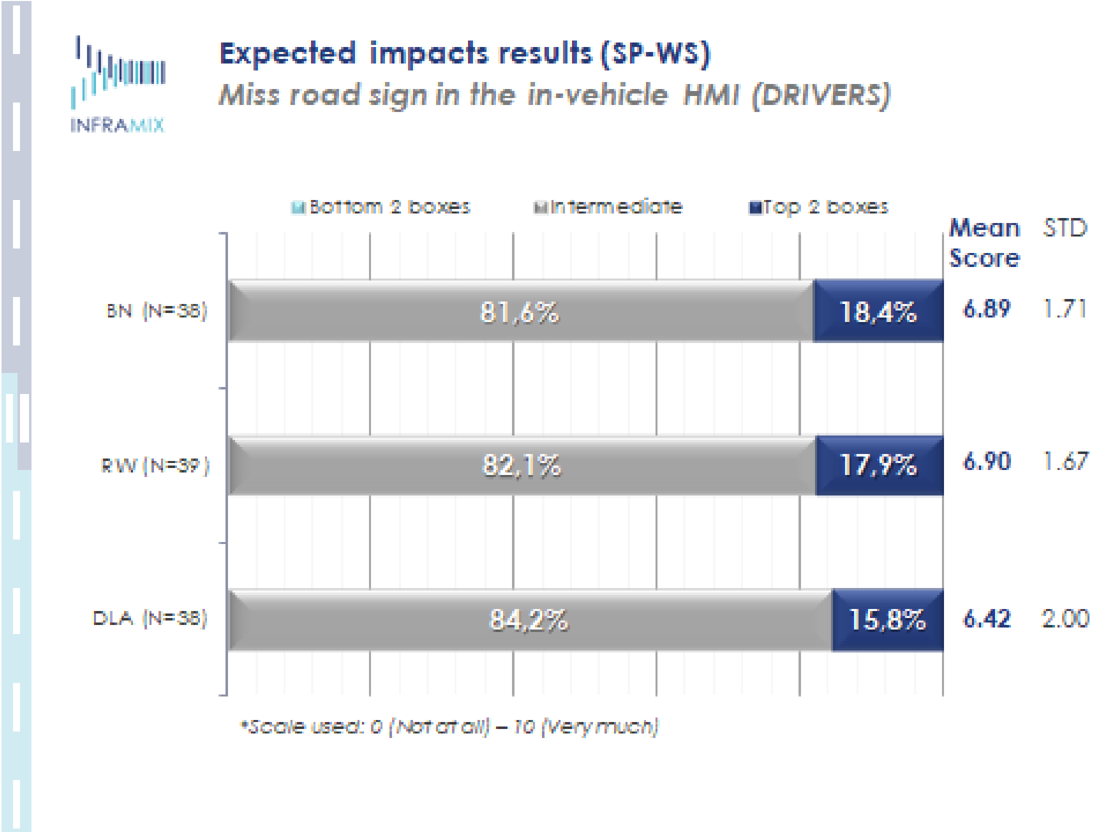
10.4 Expected Impacts

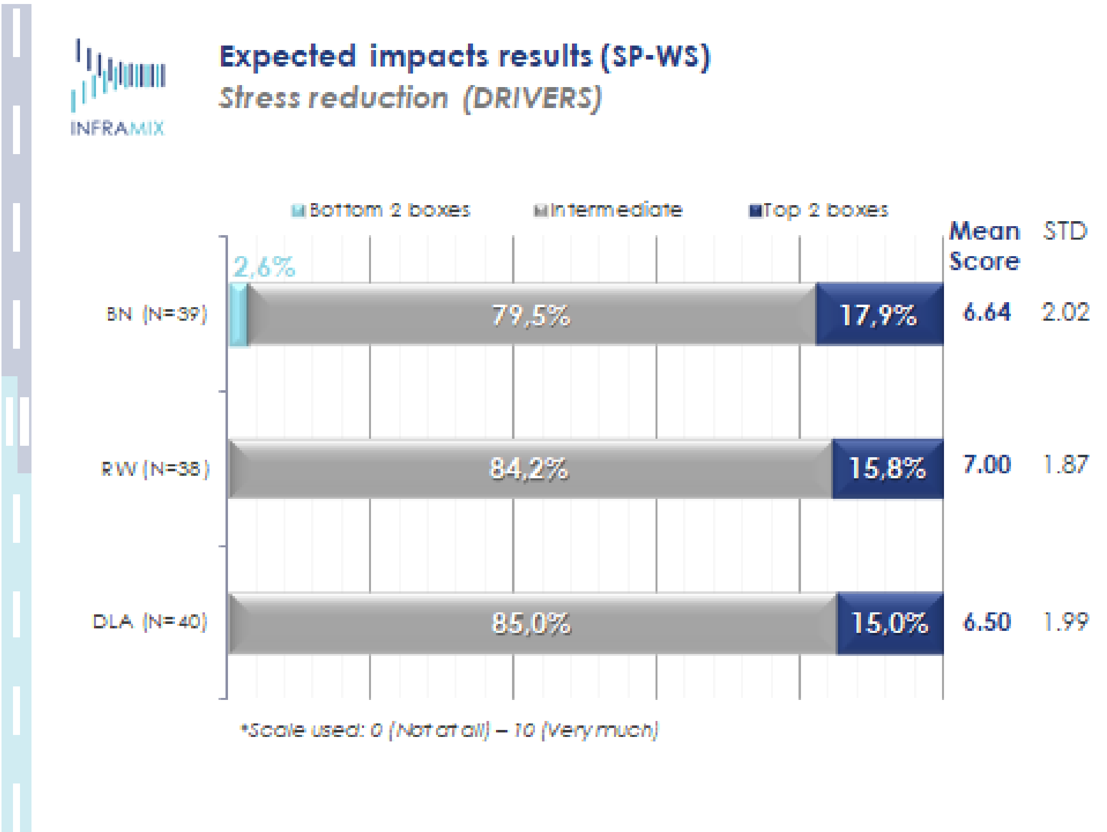
Although “expected impacts” was not initially included in users’ appreciation factors of [6], it was decided to formulate a specific category in the questionnaires about potential users’ expectations about the impact of new automated capabilities on drivers, passengers, transport operators and traffic conditions. The expected impacts on traffic efficiency and safety will be considered separately in the following section.

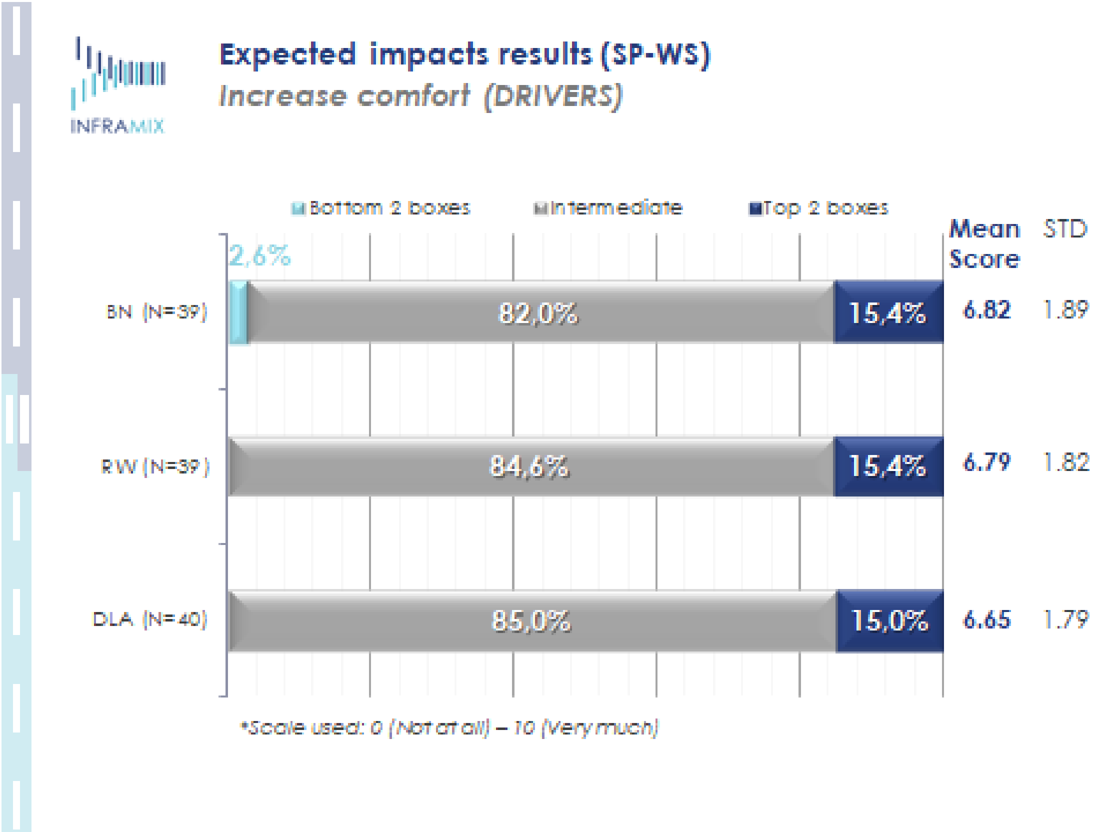
It could seem rather contradictory that critical appreciation factors (willingness to use, perceived usability, behaviour change) show high acceptance rates , while the expected impacts research category received moderate, neutral responses. However, it is justified: drivers are willing to use new traffic management capabilities and change their driving behaviour. They also understand or are optimistic that these new applications and capabilities will be useful. At the same time, they can not be positive about the specific impacts on theirs and operators’ lives of something it still seems rather far into the future.

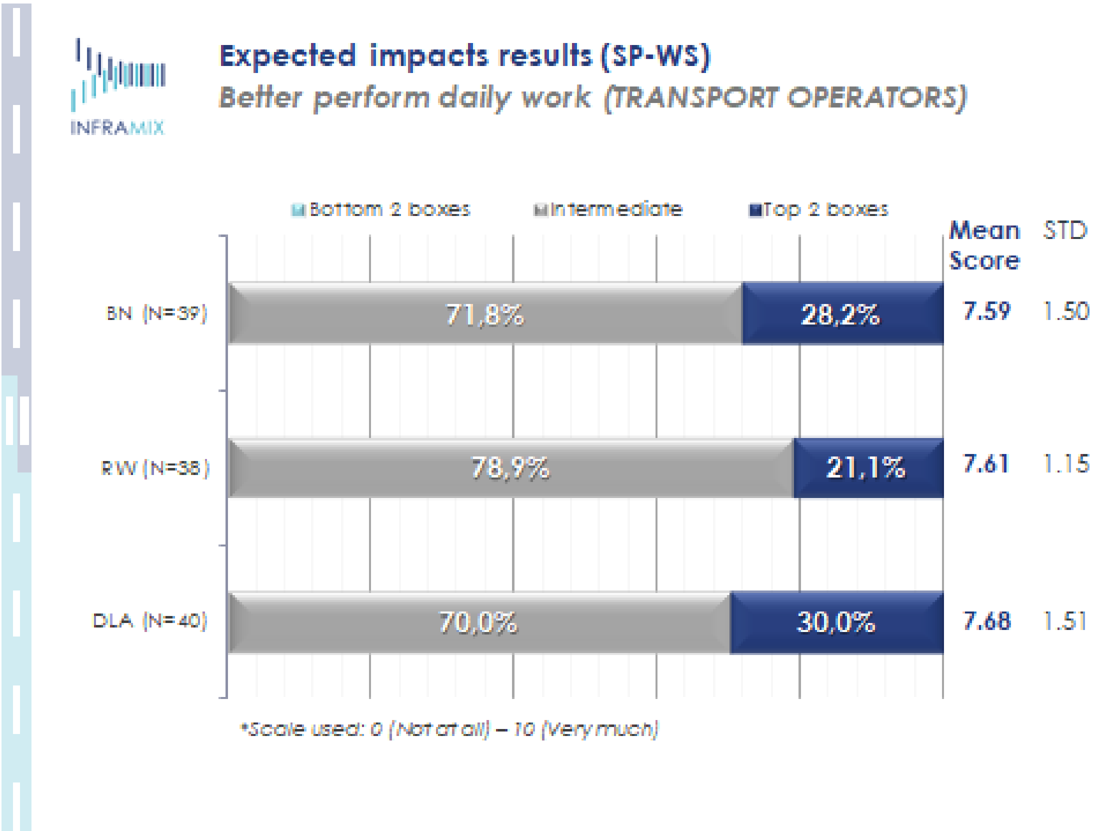
In the following section we will see that when the discussion concerns the broader expected impacts on traffic efficiency and safety, the appreciation is again as high as it was in the first three appreciation factors. In other words, users are optimistic about the improvement in traffic conditions the automated management capabilities will bring, but they can not be still positive about how this improvement will be reflected in specific results.

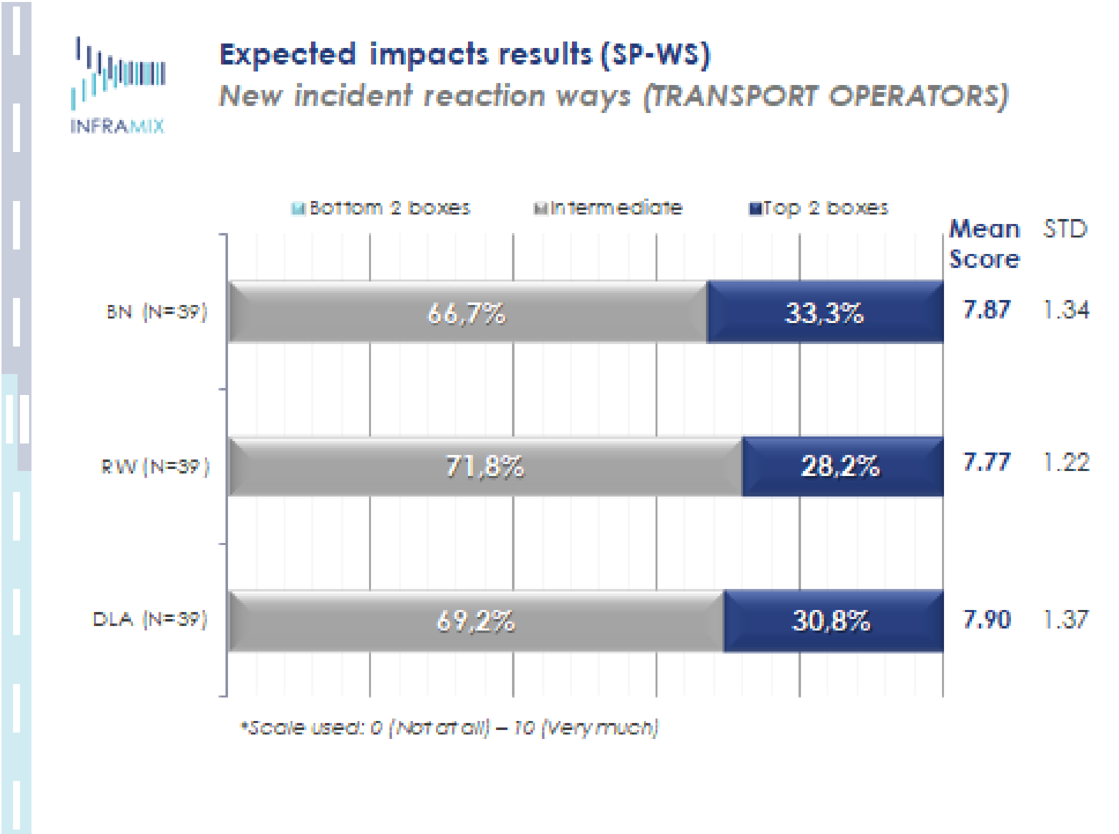


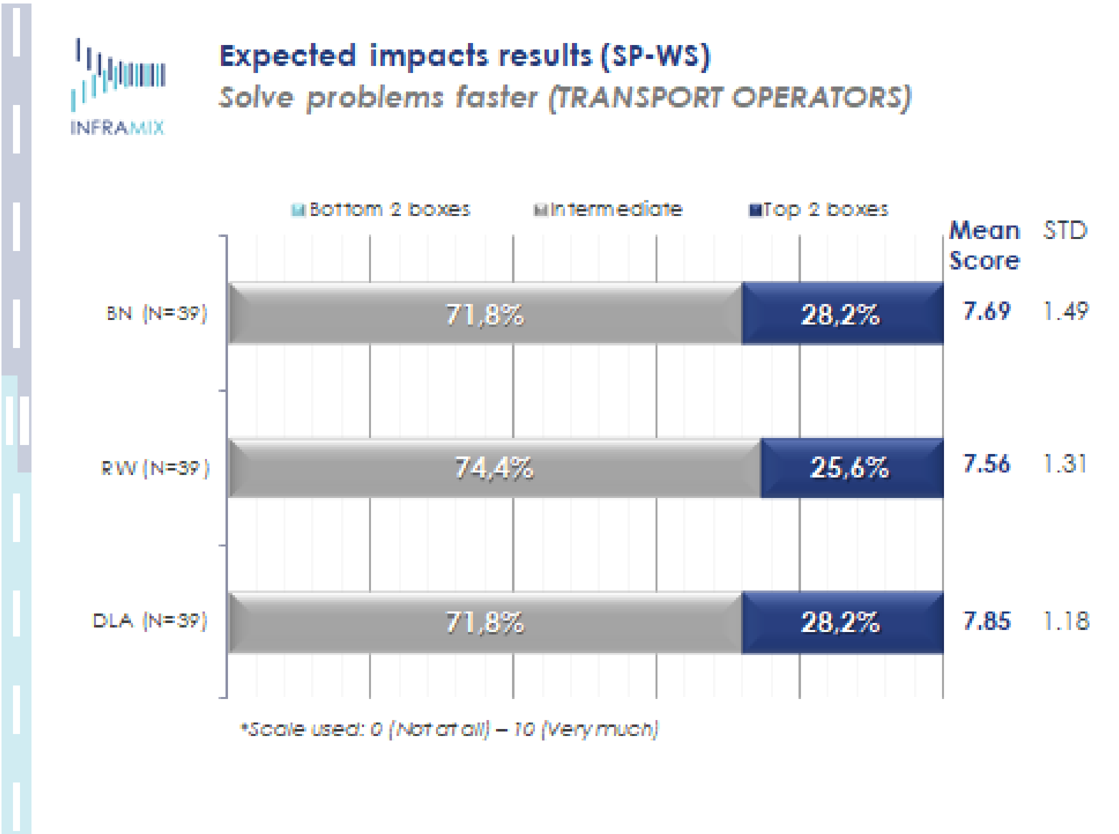

INFRAMIX
Expected impacts results (SP-WS)
Miss road sign in the in-vehicle HMI (DRIVERS)
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=38)
81,6%
18,4%
6.89
1.71
RW (N=39)
82,1%
17,9%
6.90
1.67
DLA (N=38)
84,2%
15,8%
6.42
2.00
*Scale used: 0 (Not at all) – 10 (Very much)

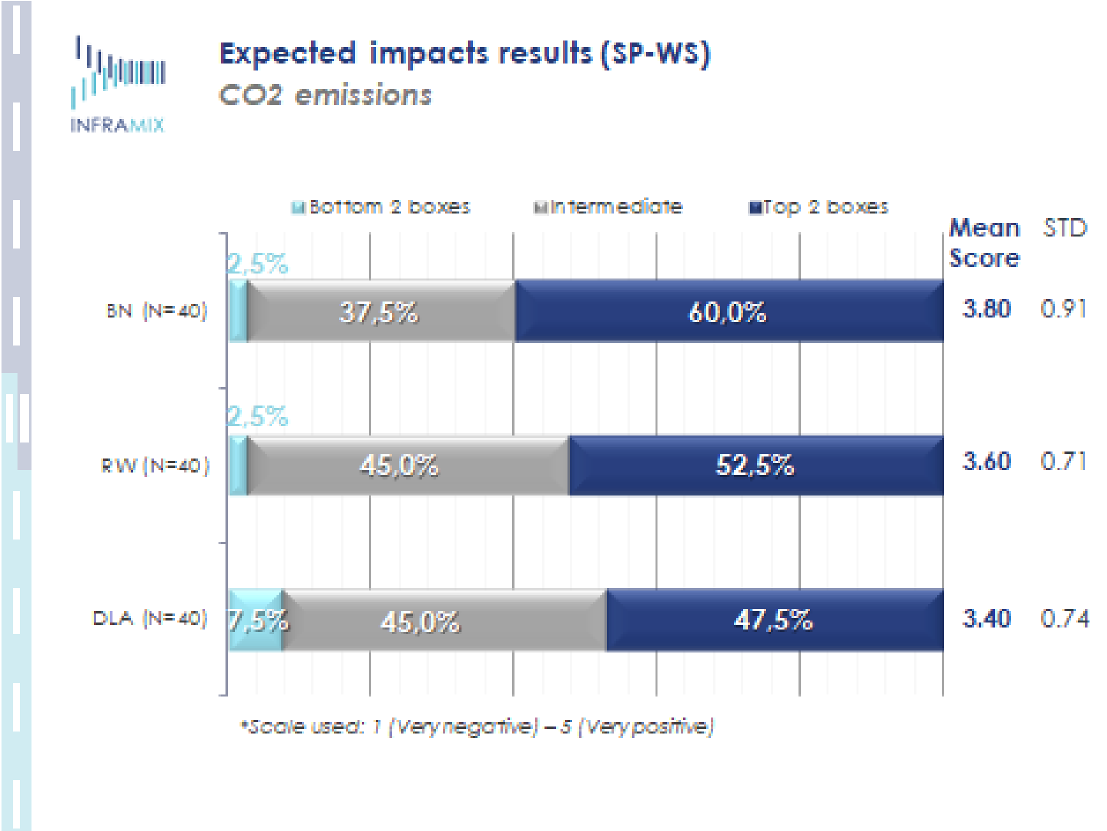

INFRAMIX
Expected impacts results (SP-WS)
Stress reduction (DRIVERS)
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=39)
2,6%
79,5%
17,9%
6.64
2.02
RW (N=38)
84,2%
15,8%
7.00
1.87
DLA (N=40)
85,0%
15,0%
6.50
1.99
*Scale used: 0 (Not at all) – 10 (Very much)

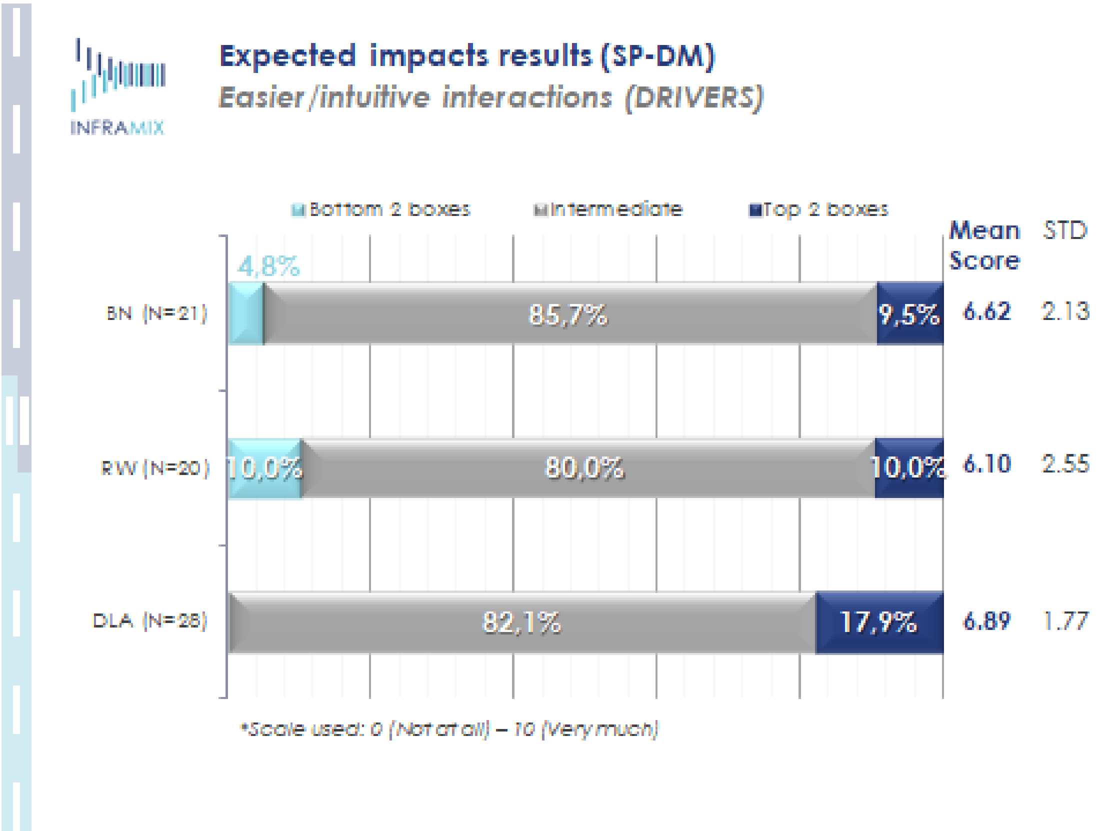

INFRAMIX
Expected impacts results (SP-WS)
Increase comfort (DRIVERS)
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=39)
2,6%
82,0%
15,4%
6.82
1.89
RW (N=39)
84,6%
15,4%
6.79
1.82
DLA (N=40)
85,0%
15,0%
6.65
1.79
*Scale used: 0 (Not at all) – 10 (Very much)

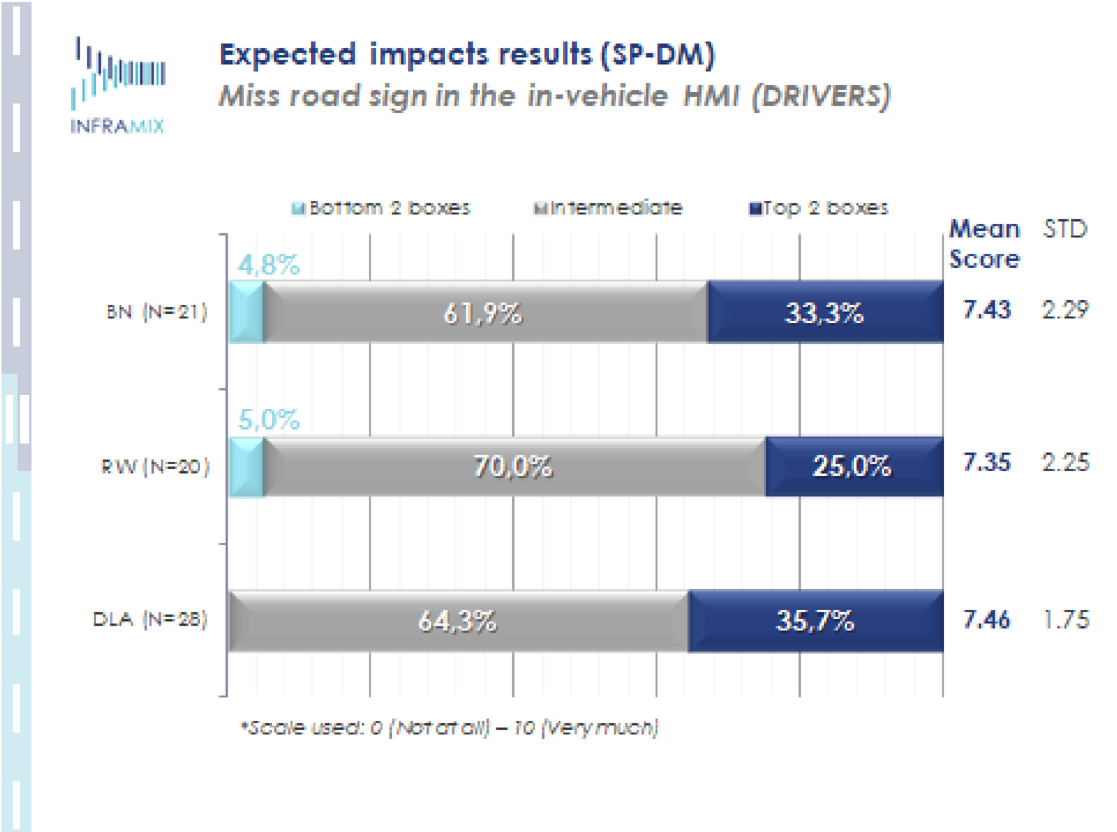

INFRAMIX
Expected impacts results (SP-WS)
Better perform daily work (TRANSPORT OPERATORS)
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=39)
71,8%
28,2%
7.59
1.50
RW (N=38)
78,9%
21,1%
7.61
1.15
DLA (N=40)
70,0%
30,0%
7.68
1.51
*Scale used: 0 (Not at all) – 10 (Very much)

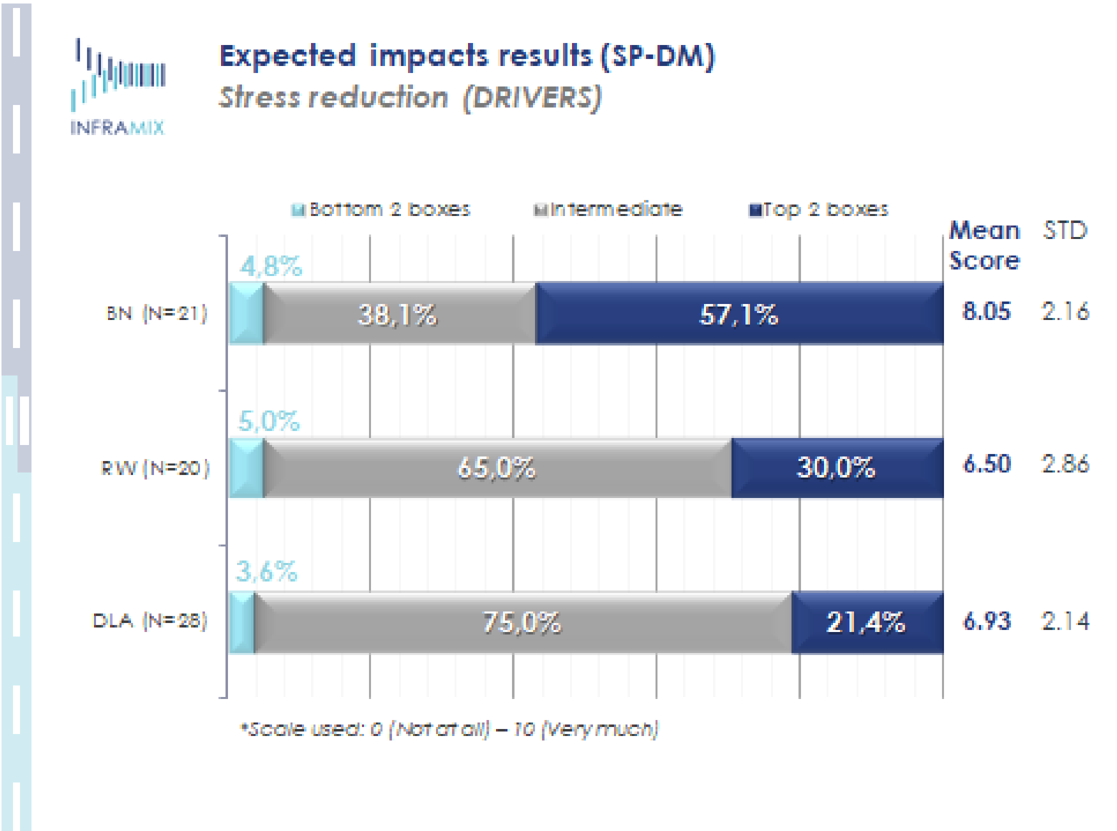

INFRAMIX
Expected impacts results (SP-WS)
New incident reaction ways (TRANSPORT OPERATORS)
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=39)
66,7%
33,3%
7.87
1.34
RW (N=39)
71,8%
28,2%
7.77
1.22
DLA (N=39)
69,2%
30,8%
7.90
1.37
*Scale used: 0 (Not at all) – 10 (Very much)

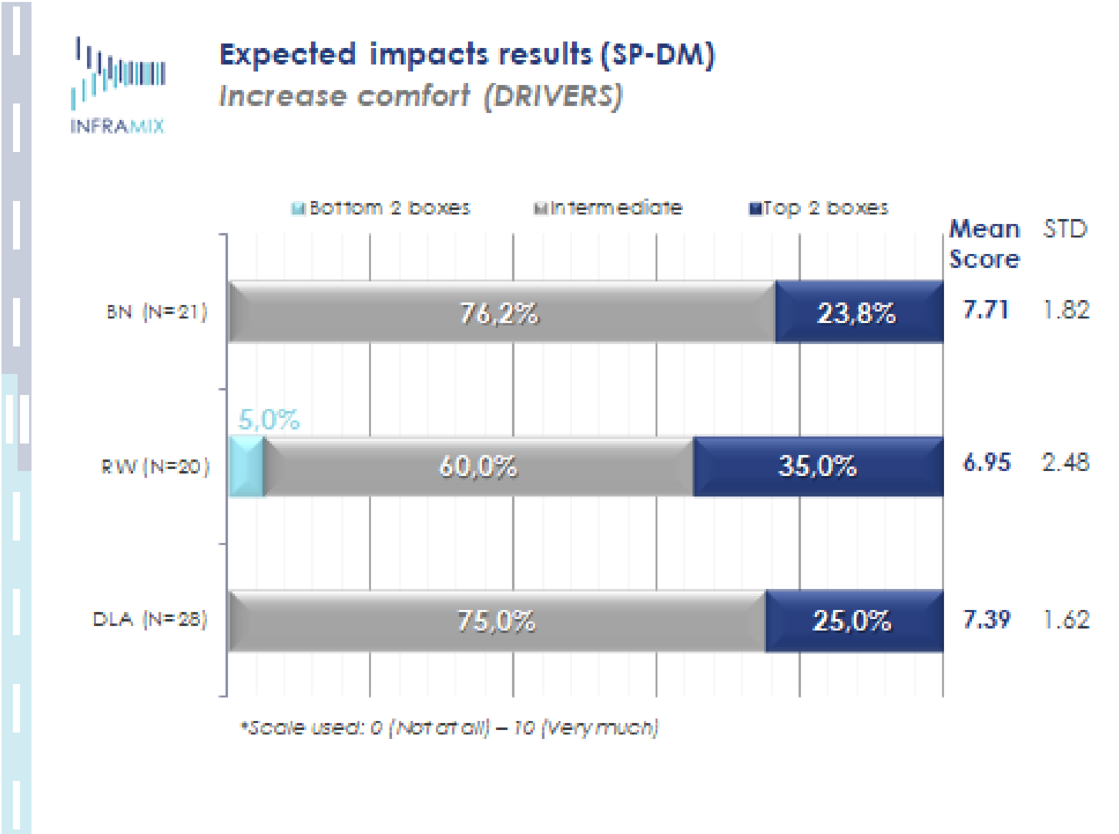

INFRAMIX
Expected impacts results (SP-WS)
Solve problems faster (TRANSPORT OPERATORS)
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=39)
71,8%
28,2%
7.69
1.49
RW (N=39)
74,4%
25,6%
7.56
1.31
DLA (N=39)
71,8%
28,2%
7.85
1.18
*Scale used: 0 (Not at all) – 10 (Very much)

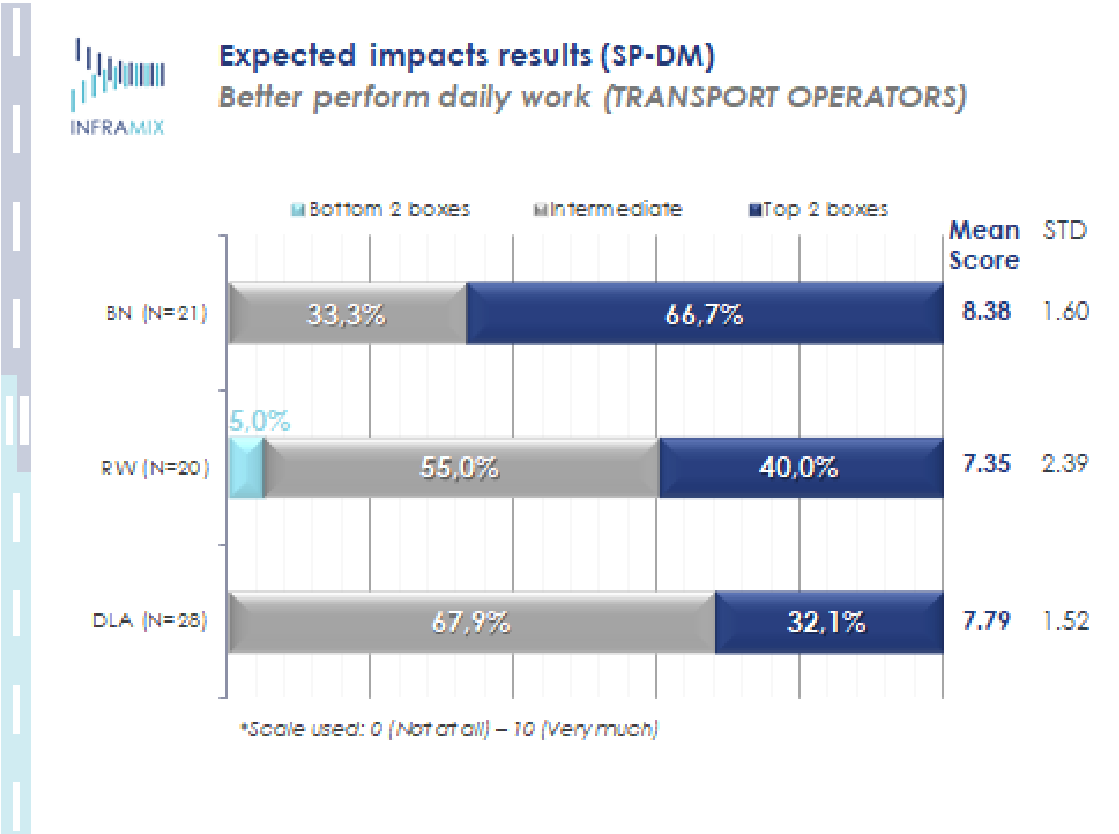

INFRAMIX
Expected impacts results (SP-WS)
CO2 emissions
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=40)
2,5%
37,5%
60,0%
3.80
0.91
RW (N=40)
2,5%
45,0%
52,5%
3.60
0.71
DLA (N=40)
7,5%
45,0%
47,5%
3.40
0.74
*Scale used: 1 (Very negative) – 5 (Very positive)

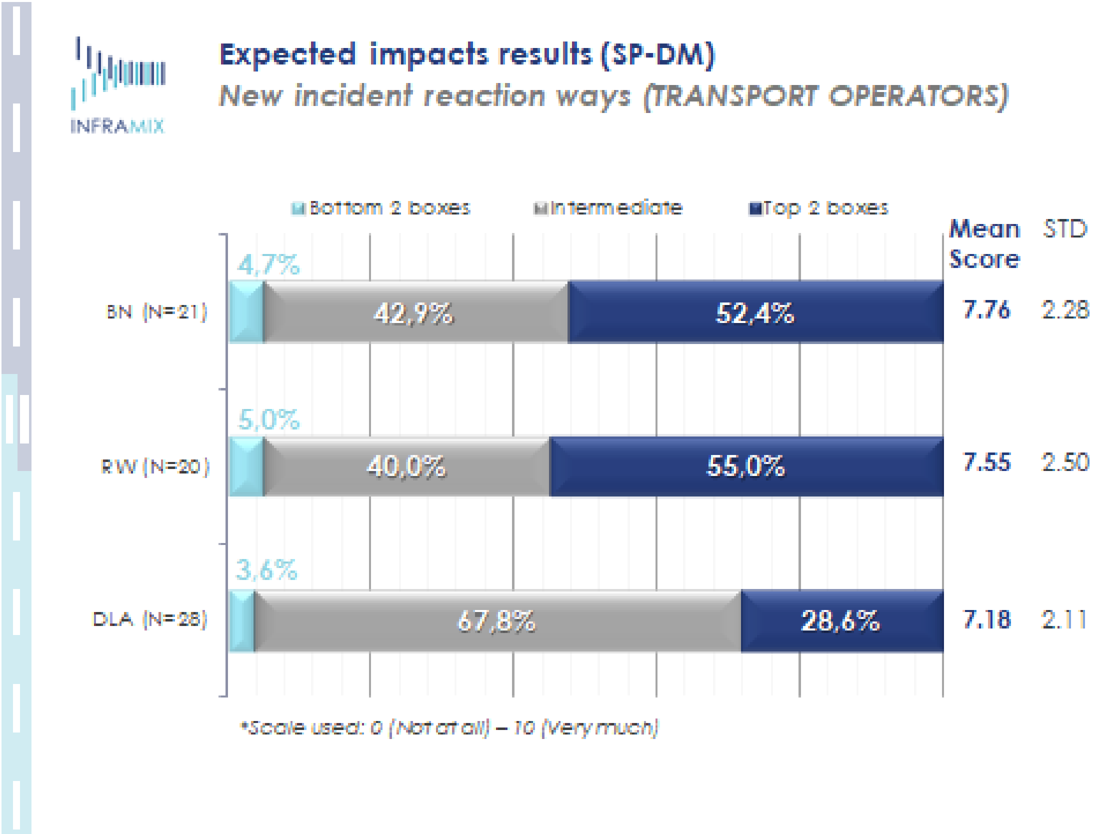

INFRAMIX
Expected impacts results (SP-DM)
Easier/intuitive interactions (DRIVERS)
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=21)
4,8%
85,7%
9,5%
6.62
2.13
RW (N=20)
10,0%
80,0%
10,0%
6.10
2.55
DLA (N=28)
82,1%
17,9%
6.89
1.77
*Scale used: 0 (Not at all) – 10 (Very much)

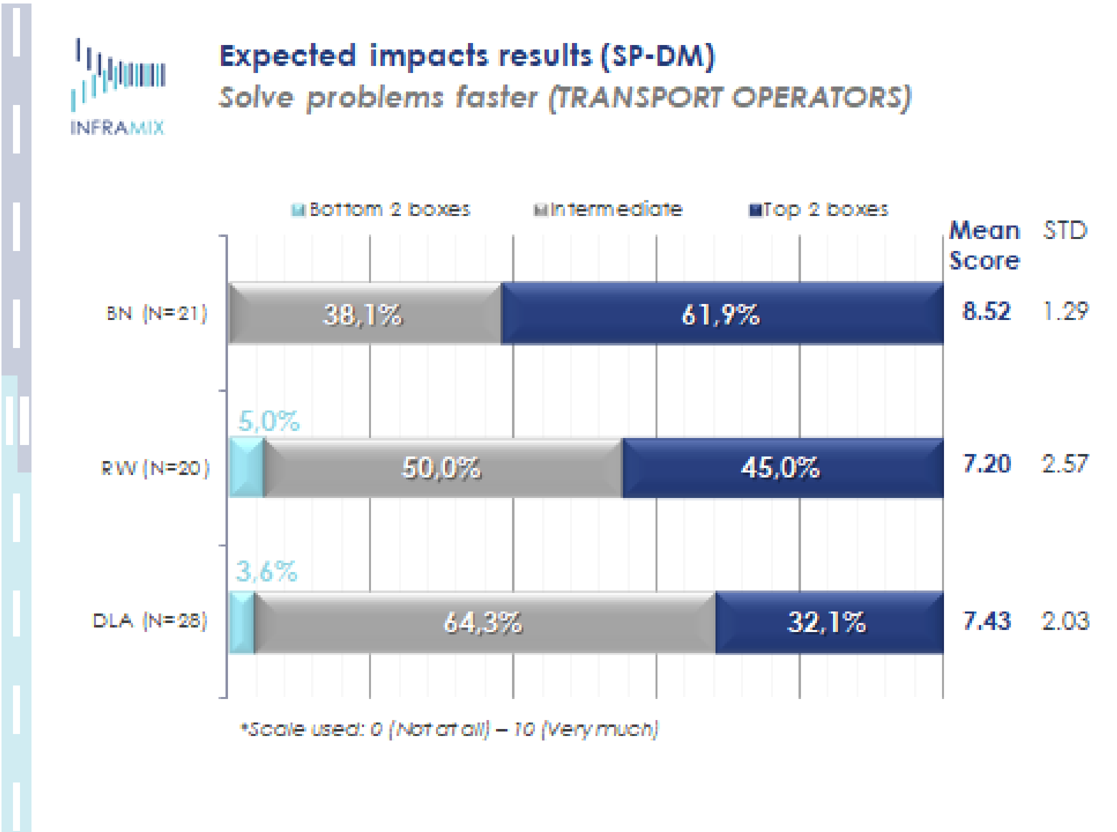

INFRAMIX
Expected impacts results (SP-DM)
Miss road sign in the in-vehicle HMI (DRIVERS)
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=21)
4,8%
61,9%
33,3%
7.43
2.29
RW (N=20)
5,0%
70,0%
25,0%
7.35
2.25
DLA (N=28)
64,3%
35,7%
7.46
1.75
*Scale used: 0 (Not at all) – 10 (Very much)


INFRAMIX
Expected impacts results (SP-DM)
Stress reduction (DRIVERS)
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=21)
4,8%
38,1%
57,1%
8.05
2.16
RW (N=20)
5,0%
65,0%
30,0%
6.50
2.86
DLA (N=28)
3,6%
75,0%
21,4%
6.93
2.14
*Scale used: 0 (Not at all) – 10 (Very much)


INFRAMIX
Expected impacts results (SP-DM)
Increase comfort (DRIVERS)
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=21)
76,2%
23,8%
7.71
1.82
RW (N=20)
5,0%
60,0%
35,0%
6.95
2.48
DLA (N=28)
75,0%
25,0%
7.39
1.62
*Scale used: 0 (Not at all) – 10 (Very much)

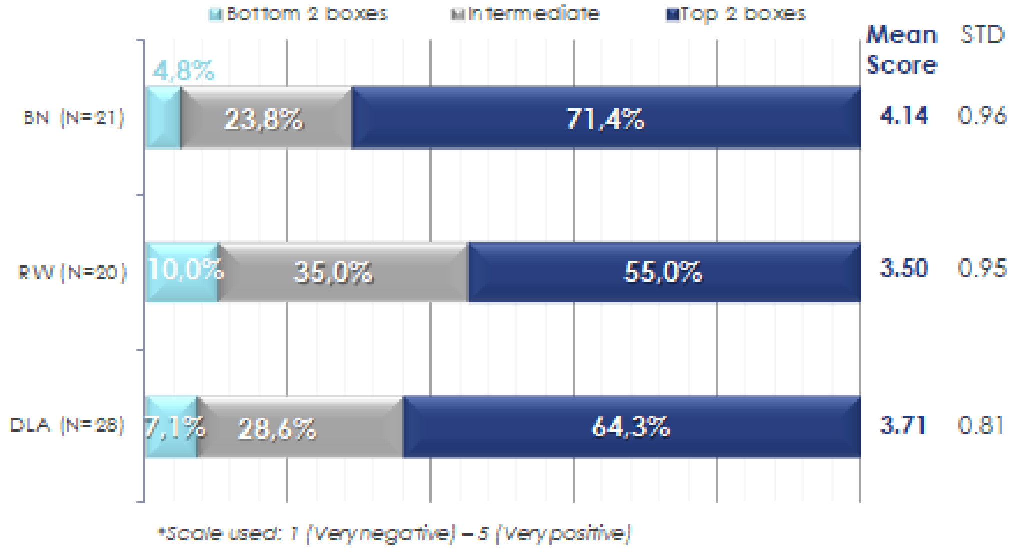

INFRAMIX
Expected impacts results (SP-DM)
Better perform daily work (TRANSPORT OPERATORS)
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=21)
33,3%
66,7%
8.38
1.60
RW (N=20)
5,0%
55,0%
40,0%
7.35
2.39
DLA (N=28)
67,9%
32,1%
7.79
1.52
*Scale used: 0 (Not at all) – 10 (Very much)


INFRAMIX
Expected impacts results (SP-DM)
New incident reaction ways (TRANSPORT OPERATORS)
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=21)
4,7%
42,9%
52,4%
7.76
2.28
RW (N=20)
5,0%
40,0%
55,0%
7.55
2.50
DLA (N=28)
3,6%
67,8%
28,6%
7.18
2.11
*Scale used: 0 (Not at all) – 10 (Very much)


INFRAMIX
Expected impacts results (SP-DM)
Solve problems faster (TRANSPORT OPERATORS)
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=21)
38,1%
61,9%
8.52
1.29
RW (N=20)
5,0%
50,0%
45,0%
7.20
2.57
DLA (N=28)
3,6%
64,3%
32,1%
7.43
2.03
*Scale used: 0 (Not at all) – 10 (Very much)

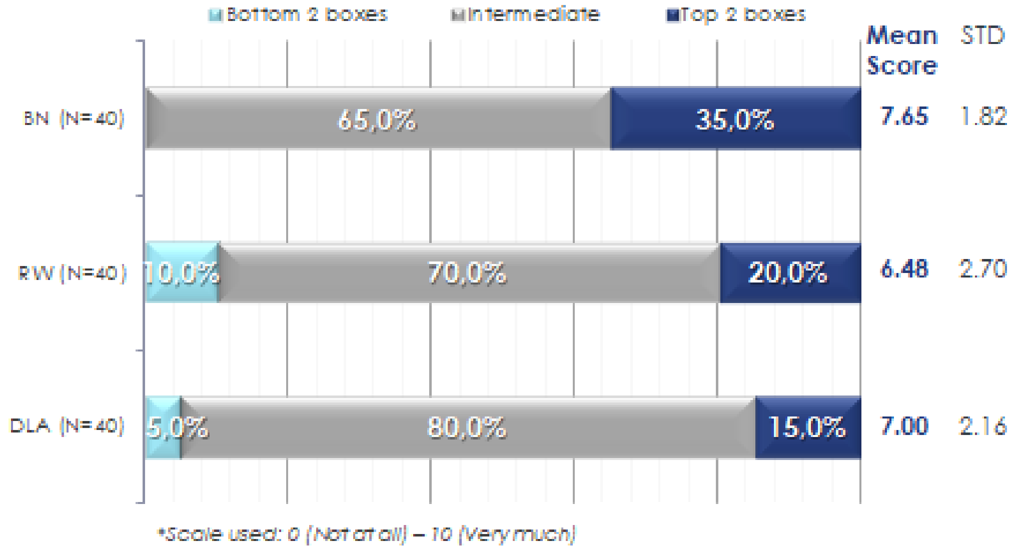
Expected impacts results (SP-DM)

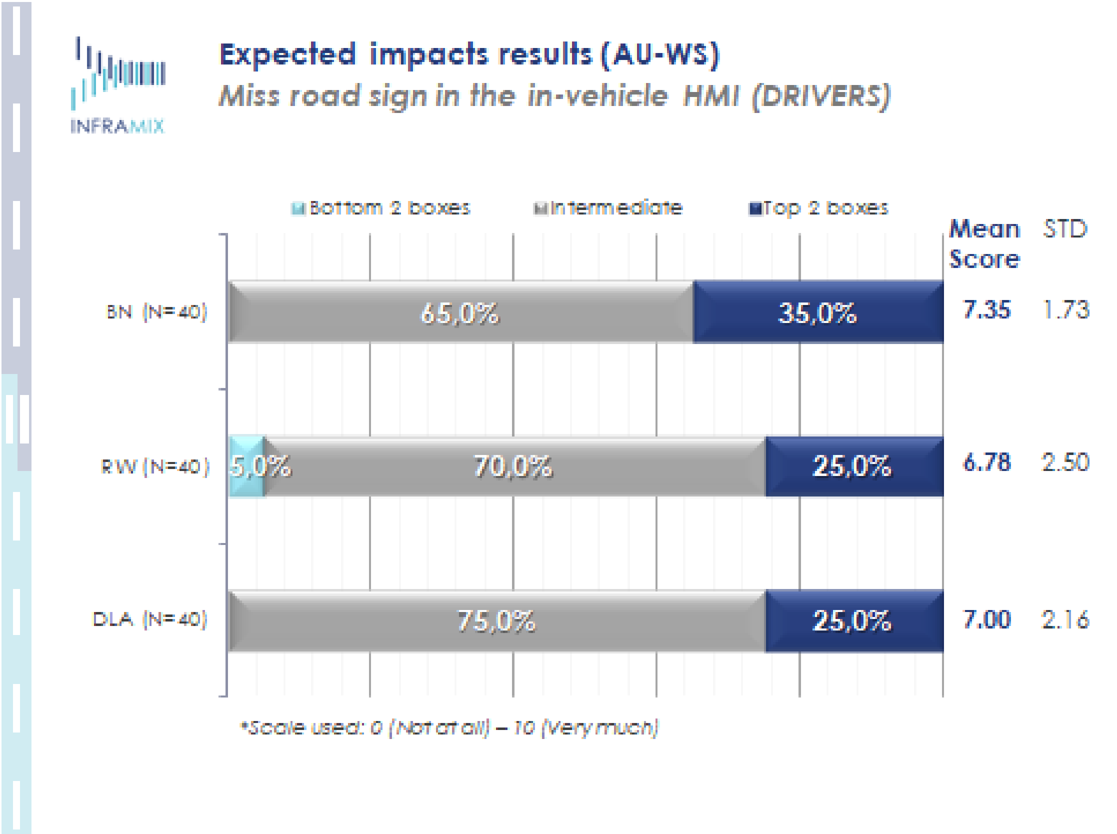
CO2 emissions



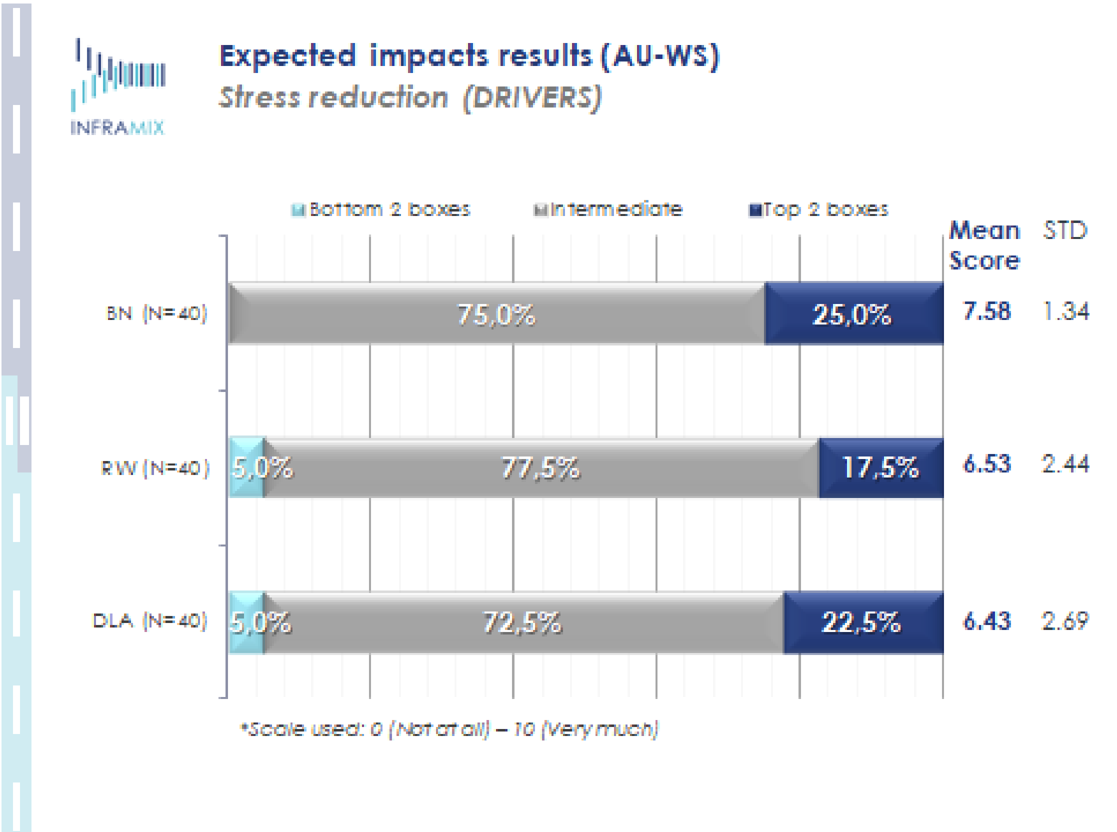
Expected impacts results (AU-WS)

Easier/intuitive interactions (DRIVERS)

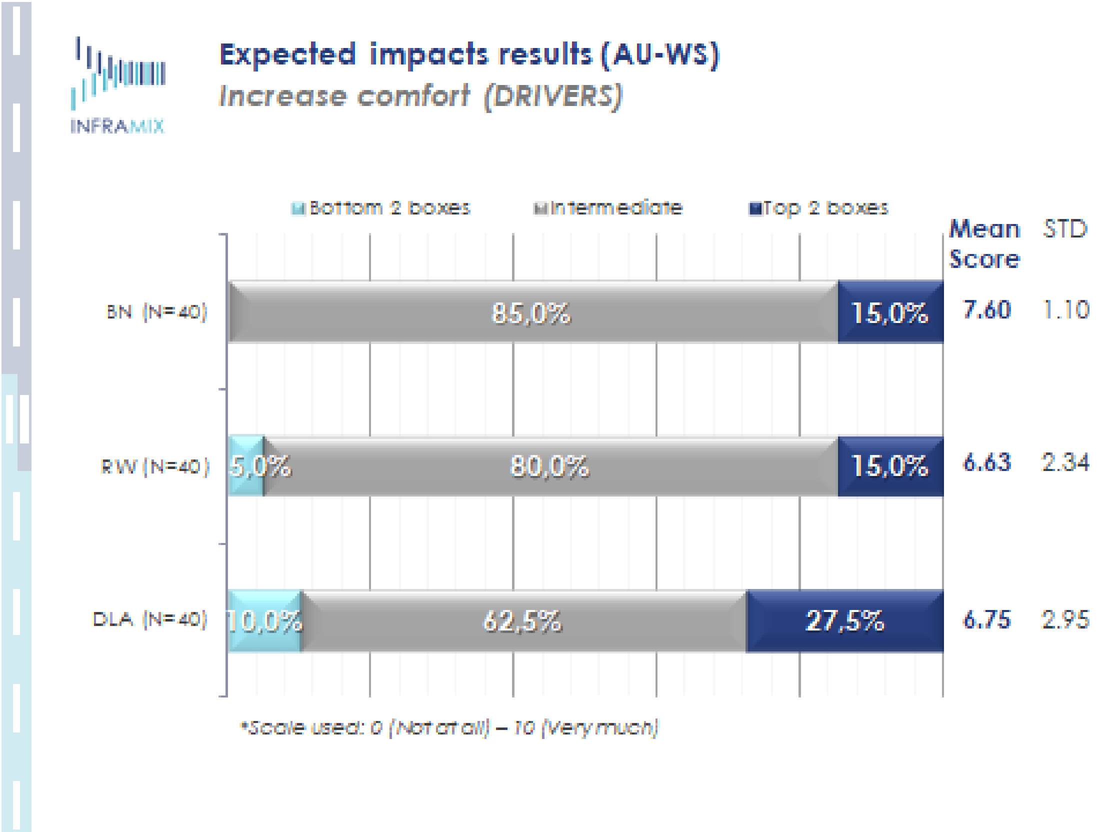


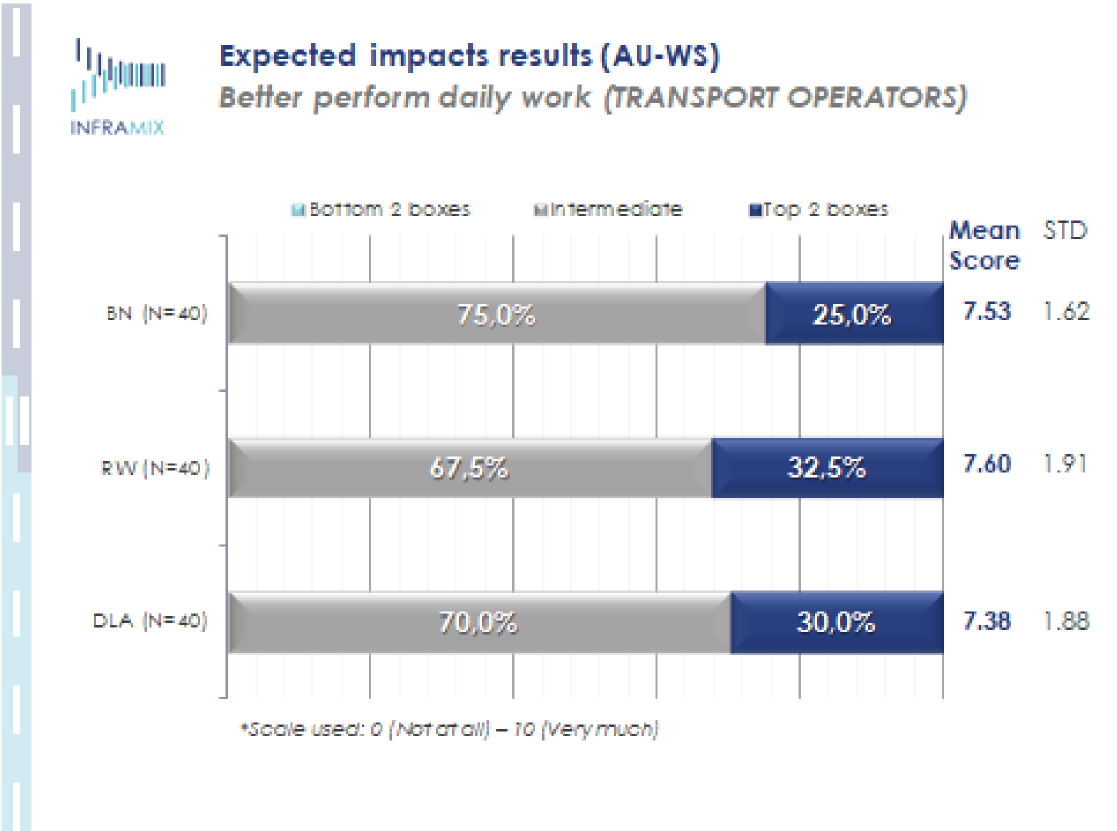


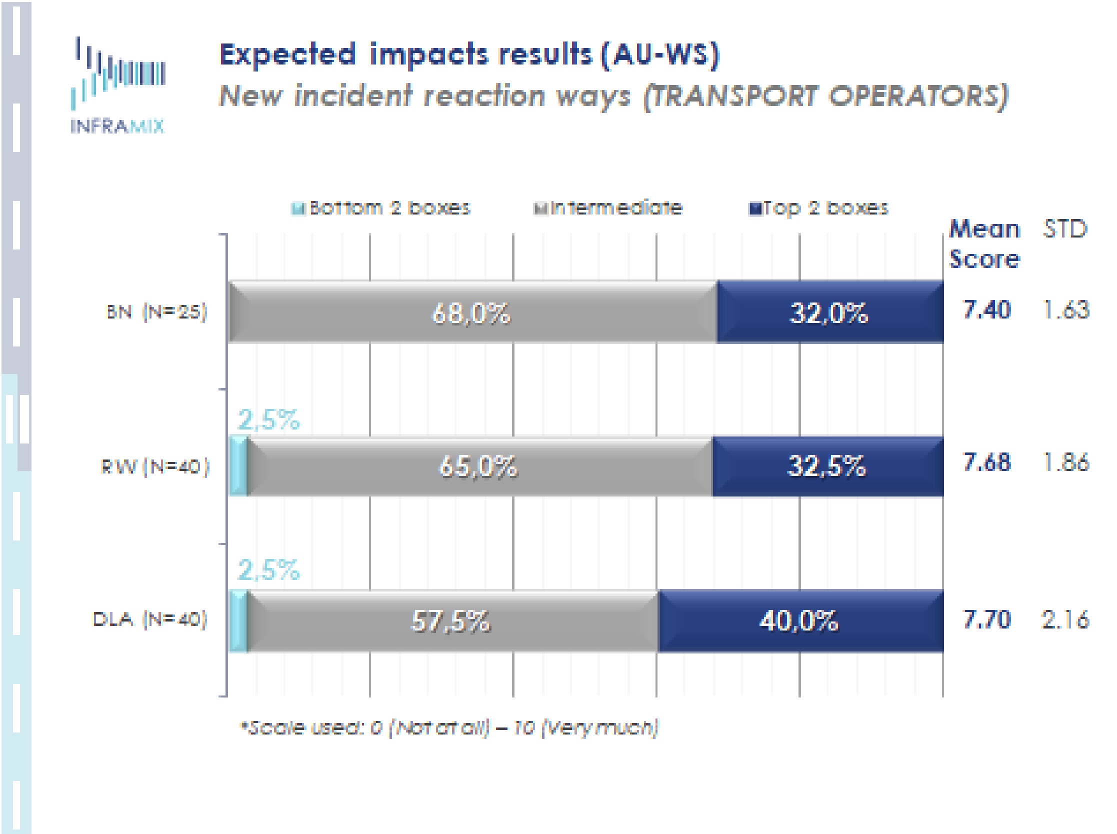
INFRAMIX
Expected impacts results (AU-WS)
Miss road sign in the in-vehicle HMI (DRIVERS)
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=40)
65,0%
35,0%
7.35
1.73
RW (N=40)
5,0%
70,0%
25,0%
6.78
2.50
DLA (N=40)
75,0%
25,0%
7.00
2.16
*Scale used: 0 (Not at all) – 10 (Very much)

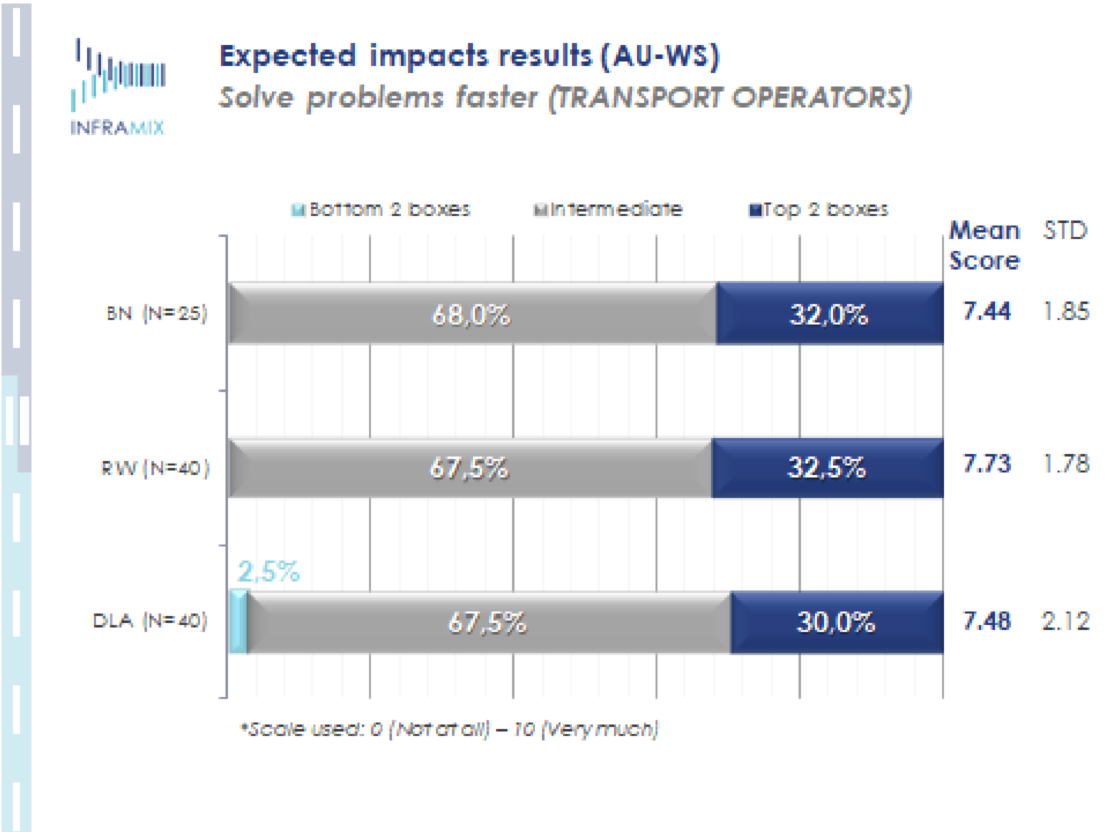


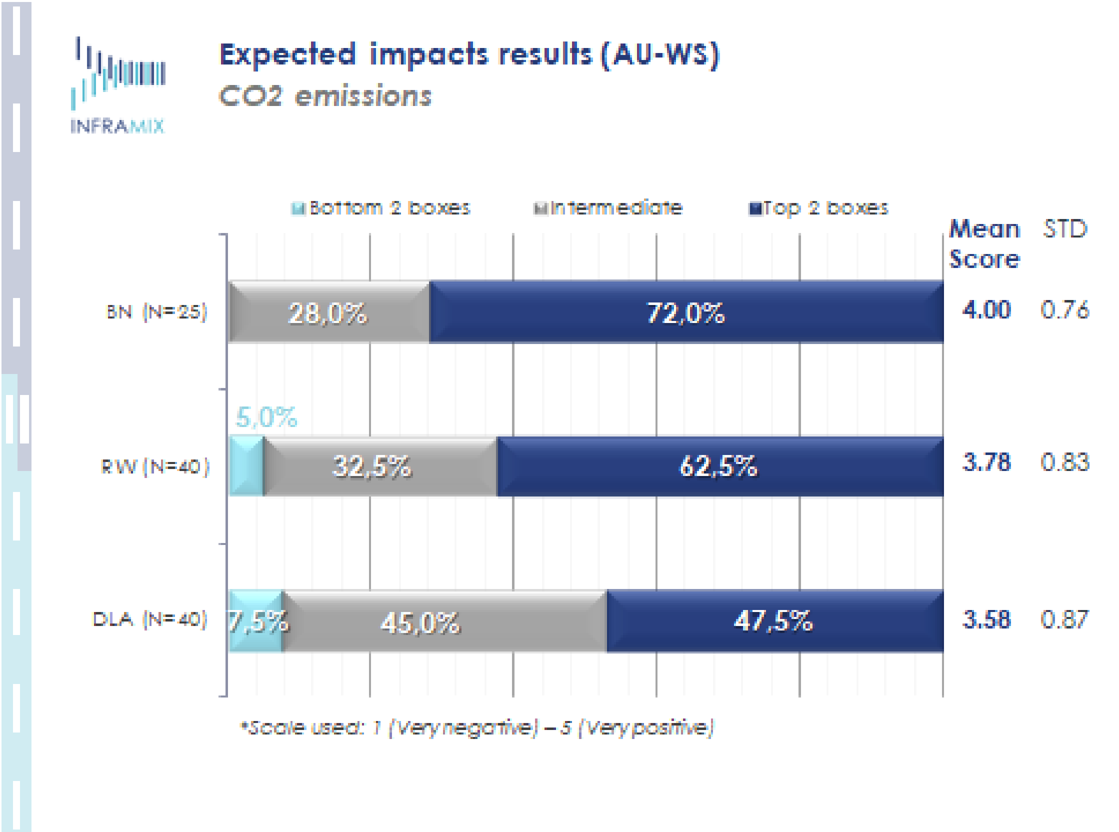
INFRAMIX
Expected impacts results (AU-WS)
Stress reduction (DRIVERS)
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=40)
75,0%
25,0%
7.58
1.34
RW (N=40)
5,0%
77,5%
17,5%
6.53
2.44
DLA (N=40)
5,0%
72,5%
22,5%
6.43
2.69
*Scale used: 0 (Not at all) – 10 (Very much)

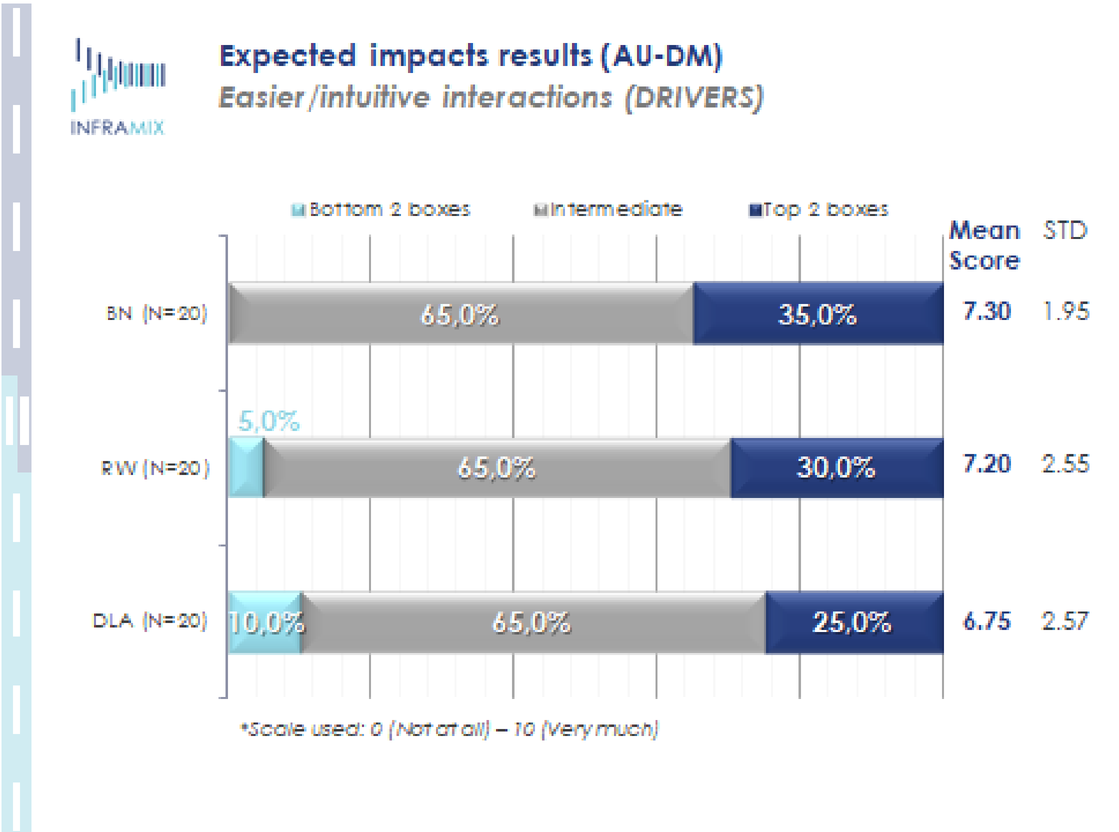

INFRAMIX
Expected impacts results (AU-WS)
Increase comfort (DRIVERS)
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=40)
85,0%
15,0%
7.60
1.10
RW (N=40)
5,0%
80,0%
15,0%
6.63
2.34
DLA (N=40)
10,0%
62,5%
27,5%
6.75
2.95
*Scale used: 0 (Not at all) – 10 (Very much)


INFRAMIX
Expected impacts results (AU-WS)
Better perform daily work (TRANSPORT OPERATORS)
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=40)
75,0%
25,0%
7.53
1.62
RW (N=40)
67,5%
32,5%
7.60
1.91
DLA (N=40)
70,0%
30,0%
7.38
1.88
*Scale used: 0 (Not at all) – 10 (Very much)


INFRAMIX
Expected impacts results (AU-WS)
New incident reaction ways (TRANSPORT OPERATORS)
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=25)
68,0%
32,0%
7.40
1.63
RW (N=40)
2,5%
65,0%
32,5%
7.68
1.86
DLA (N=40)
2,5%
57,5%
40,0%
7.70
2.16
*Scale used: 0 (Not at all) – 10 (Very much)

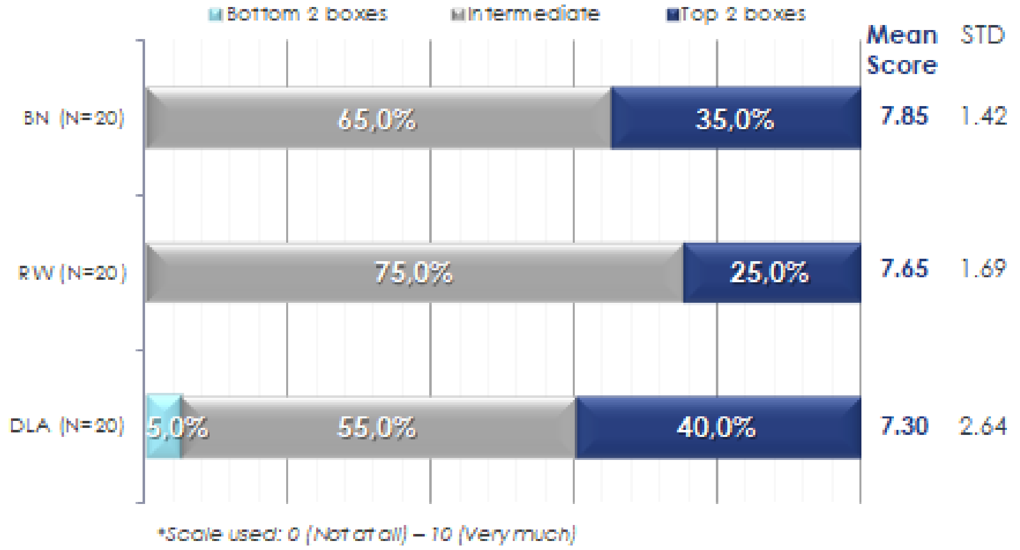

INFRAMIX
Expected impacts results (AU-WS)
Solve problems faster (TRANSPORT OPERATORS)
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=25)
68,0%
32,0%
7.44
1.85
RW (N=40)
67,5%
32,5%
7.73
1.78
DLA (N=40)
2,5%
67,5%
30,0%
7.48
2.12
*Scale used: 0 (Not at all) – 10 (Very much)


INFRAMIX
Expected impacts results (AU-WS)
CO2 emissions
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=25)
28,0%
72,0%
4.00
0.76
RW (N=40)
5,0%
32,5%
62,5%
3.78
0.83
DLA (N=40)
7,5%
45,0%
47,5%
3.58
0.87
*Scale used: 1 (Very negative) – 5 (Very positive)


INFRAMIX
Expected impacts results (AU-DM)
Easier/intuitive interactions (DRIVERS)
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=20)
65,0%
35,0%
7.30
1.95
RW (N=20)
5,0%
65,0%
30,0%
7.20
2.55
DLA (N=20)
10,0%
65,0%
25,0%
6.75
2.57
*Scale used: 0 (Not at all) – 10 (Very much)

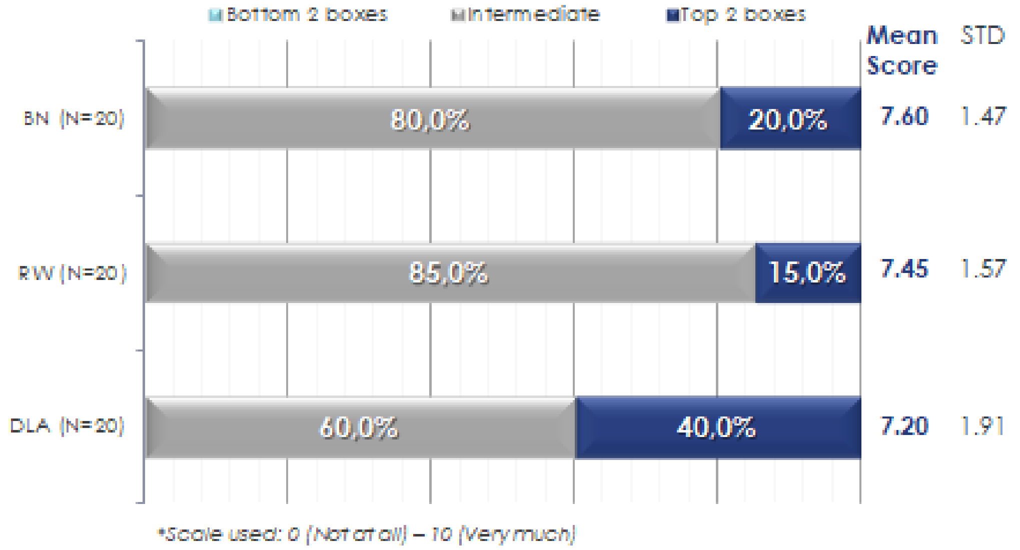
Expected impacts results (AU-DM)

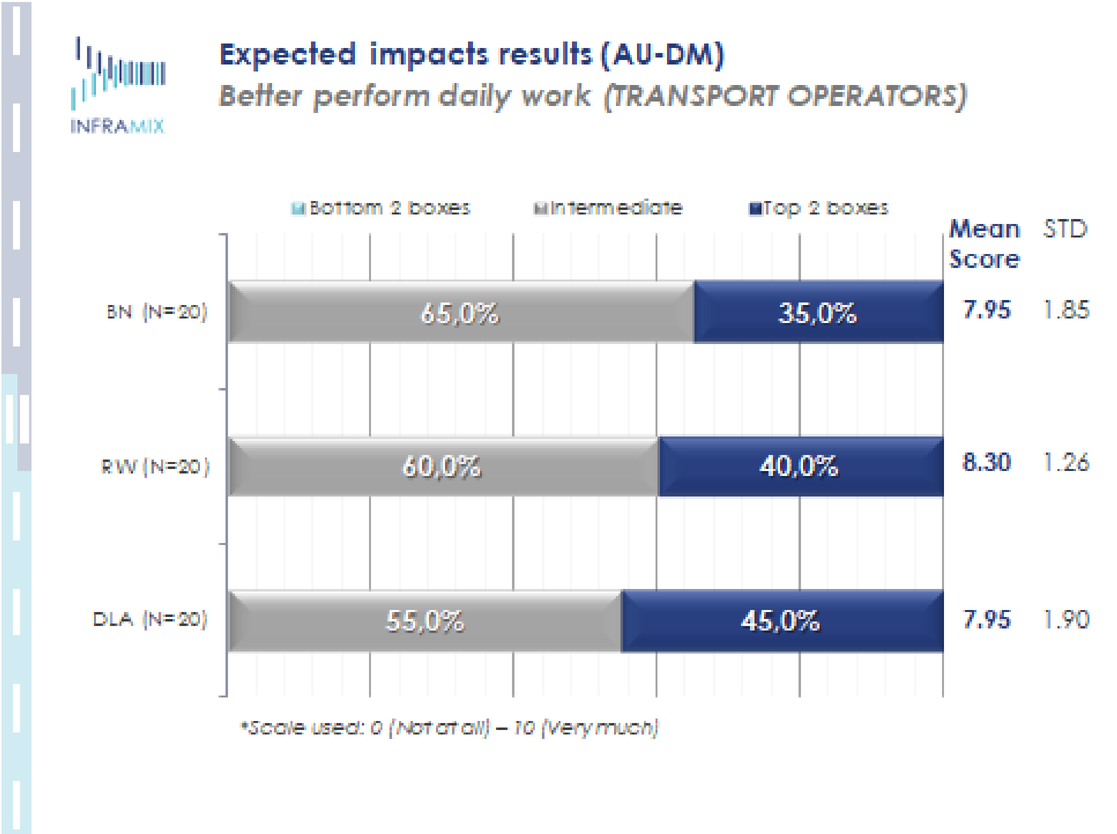
Stress reduction (DRIVERS)

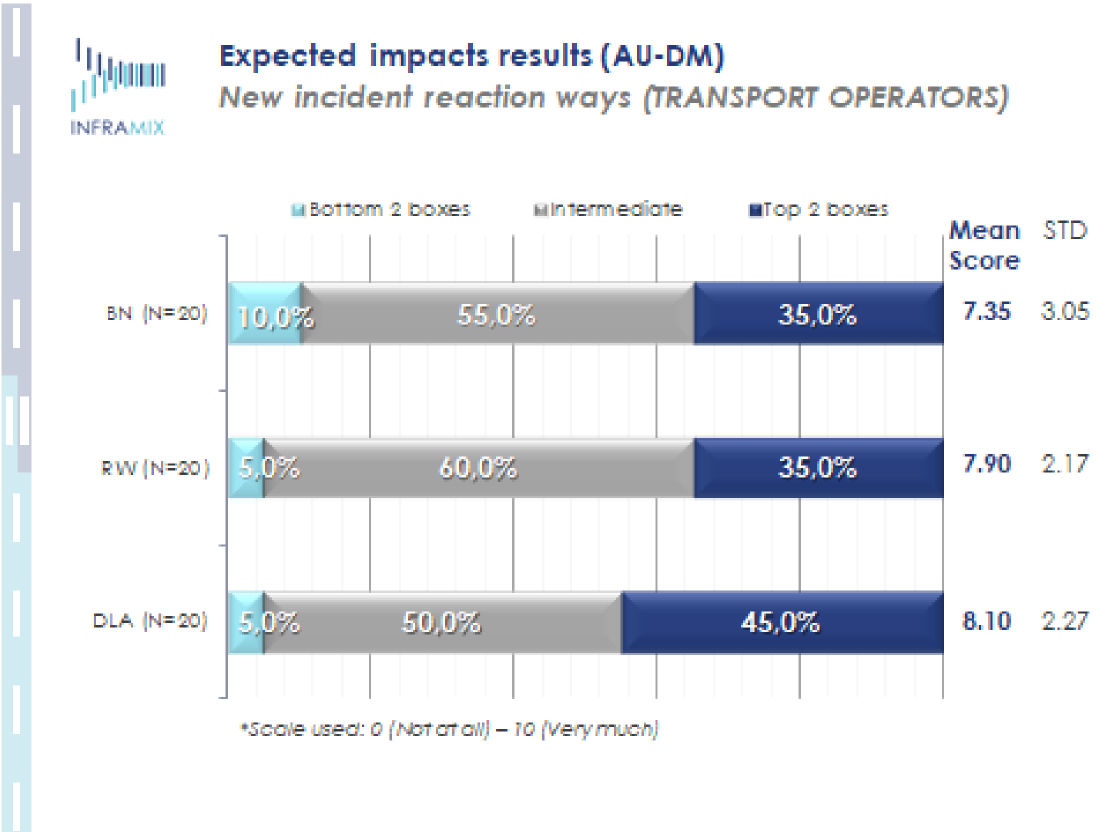


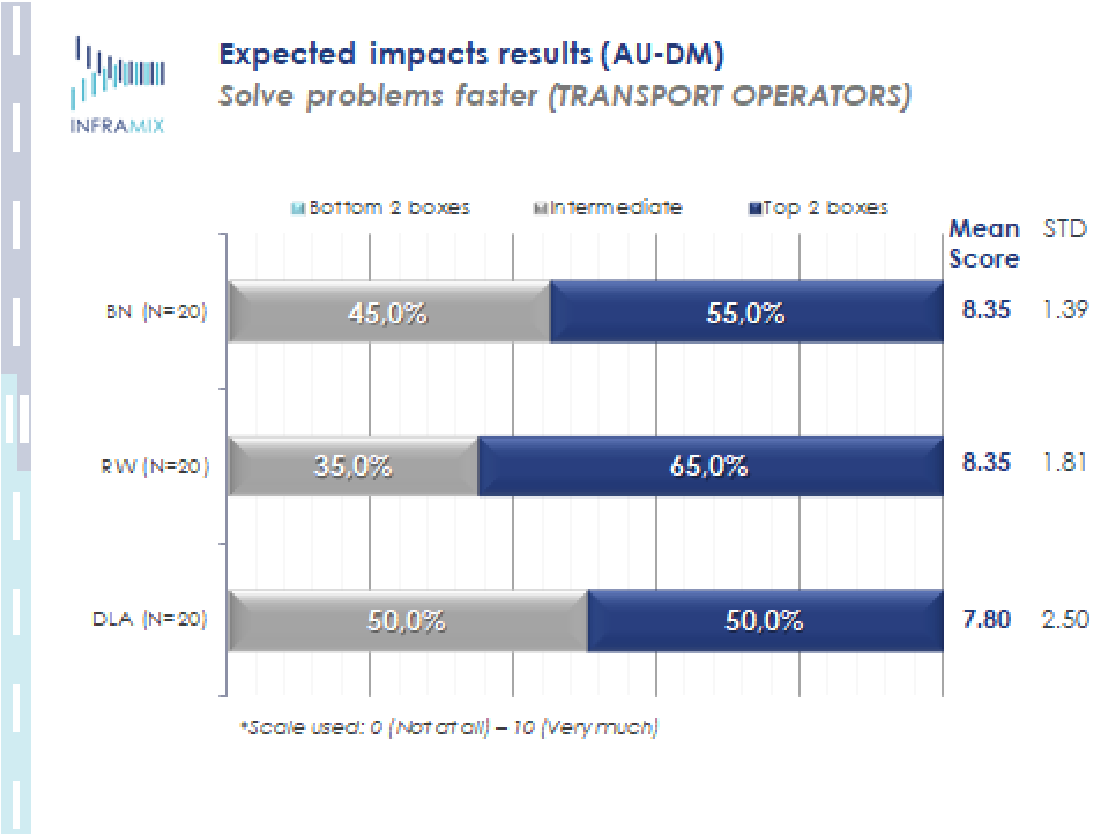
Expected impacts results (AU-DM)

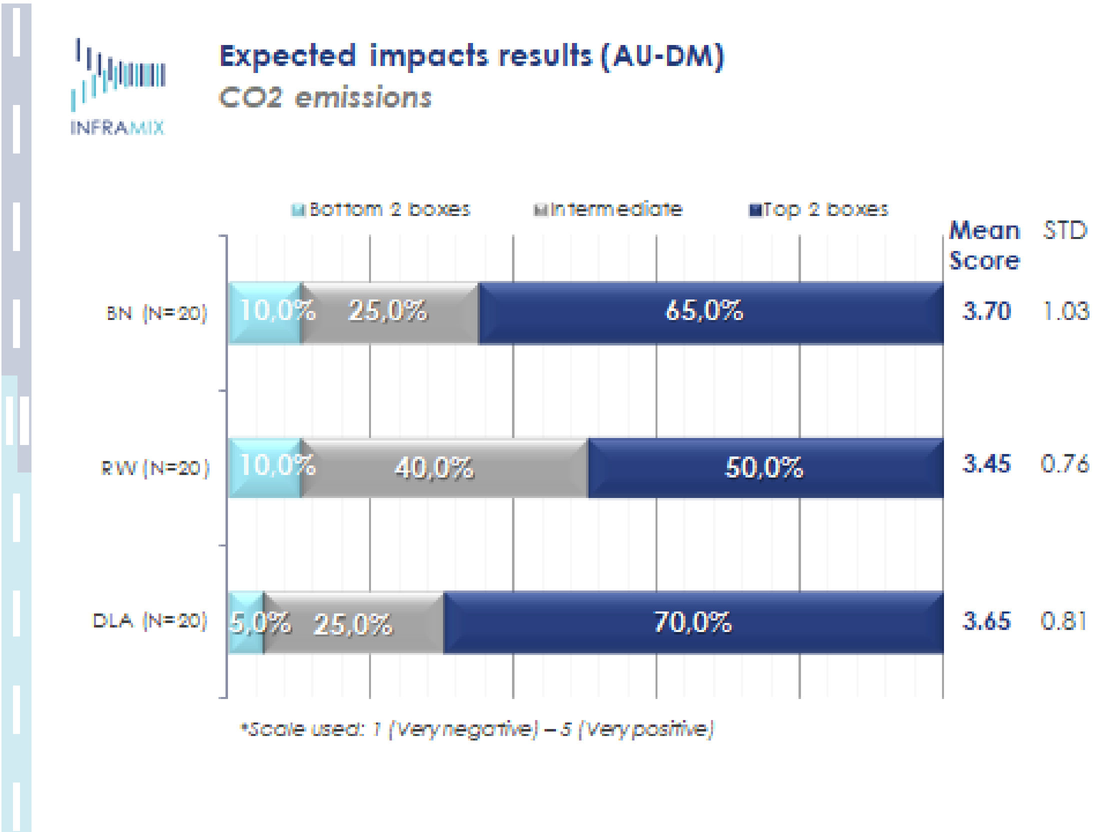
Increase comfort (DRIVERS)




INFRAMIX
Expected impacts results (AU-DM)
Better perform daily work (TRANSPORT OPERATORS)
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=20)
65,0%
35,0%
7.95
1.85
RW (N=20)
60,0%
40,0%
8.30
1.26
DLA (N=20)
55,0%
45,0%
7.95
1.90
*Scale used: 0 (Not at all) – 10 (Very much)


INFRAMIX
Expected impacts results (AU-DM)
New incident reaction ways (TRANSPORT OPERATORS)
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=20)
10,0%
55,0%
35,0%
7.35
3.05
RW (N=20)
5,0%
60,0%
35,0%
7.90
2.17
DLA (N=20)
5,0%
50,0%
45,0%
8.10
2.27
*Scale used: 0 (Not at all) – 10 (Very much)

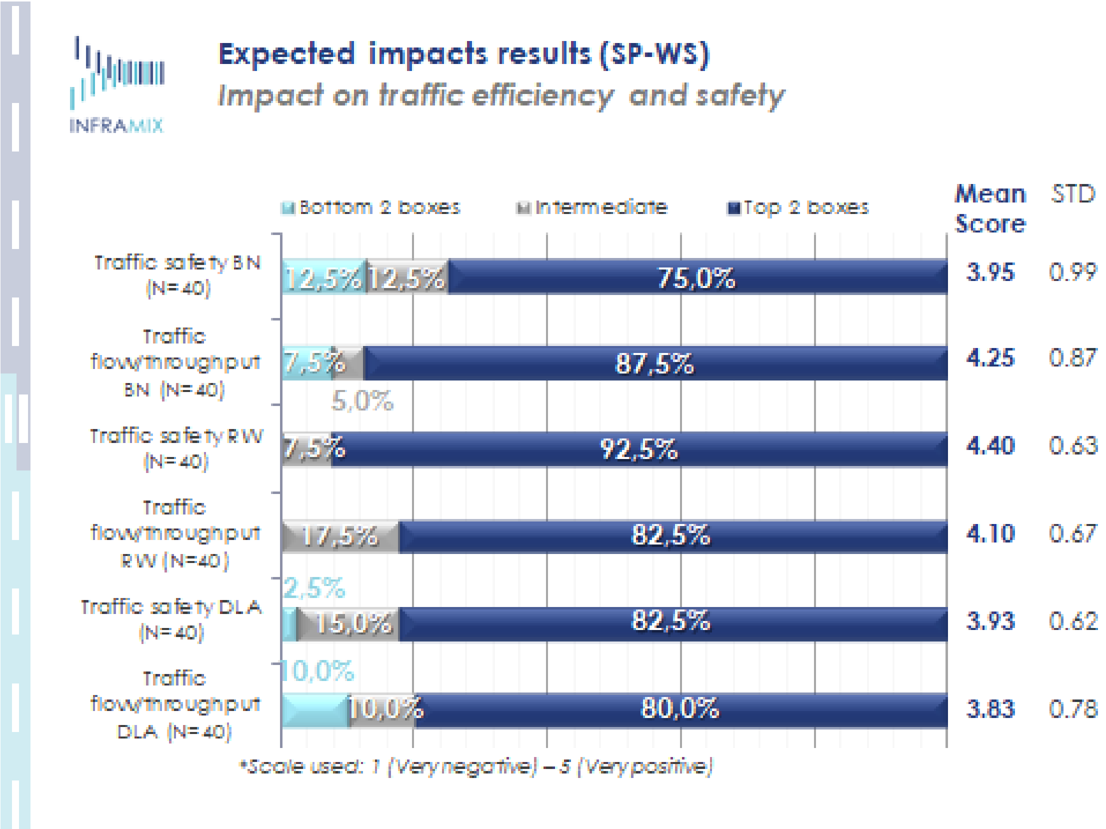

INFRAMIX
Expected impacts results (AU-DM)
Solve problems faster (TRANSPORT OPERATORS)
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=20)
45,0%
55,0%
8.35
1.39
RW (N=20)
35,0%
65,0%
8.35
1.81
DLA (N=20)
50,0%
50,0%
7.80
2.50
*Scale used: 0 (Not at all) – 10 (Very much)


INFRAMIX
Expected impacts results (AU-DM)
CO2 emissions
Bottom 2 boxes
Intermediate
Top 2 boxes
Mean Score
STD
BN (N=20)
10,0%
25,0%
65,0%
3.70
1.03
RW (N=20)
10,0%
40,0%
50,0%
3.45
0.76
DLA (N=20)
5,0%
25,0%
70,0%
3.65
0.81
*Scale used: 1 (Very negative) – 5 (Very positive)

It is also very encouraging that bottom 2 boxes percentages are still too low: another proof that users/drivers are in general optimistic about the Intelligent Transport future.

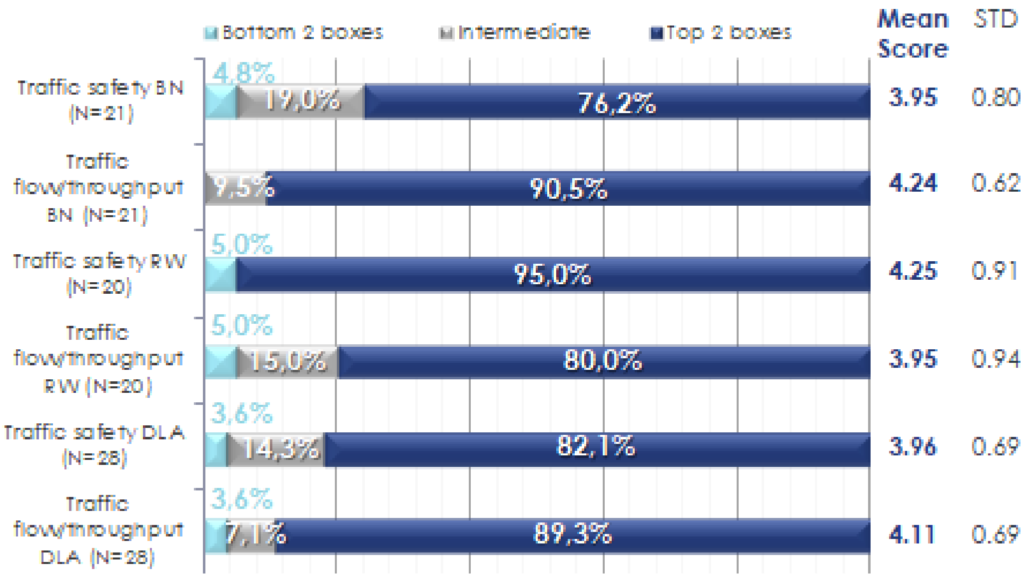
10.4.1 Expected Impacts on Traffic Efficiency and Safety

In this section the users' appreciation concerning the main targets of INFRAMIX project, improvement in traffic efficiency and safety, will be considered. As stated in the previous section, users are optimistic that the automated management capabilities would improve traffic conditions.



Expected impacts results (SP-DM)

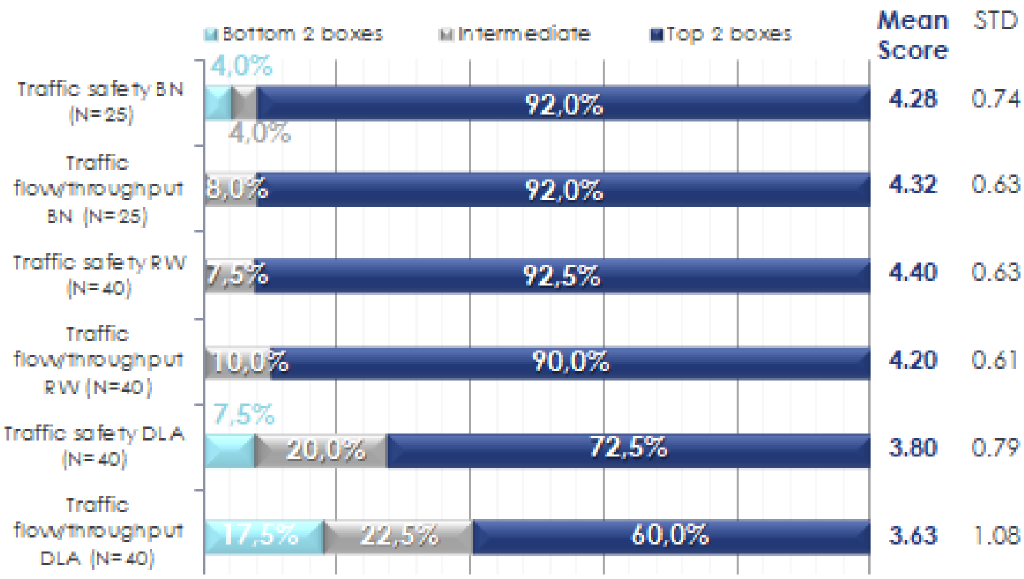
Impact on traffic efficiency and safety



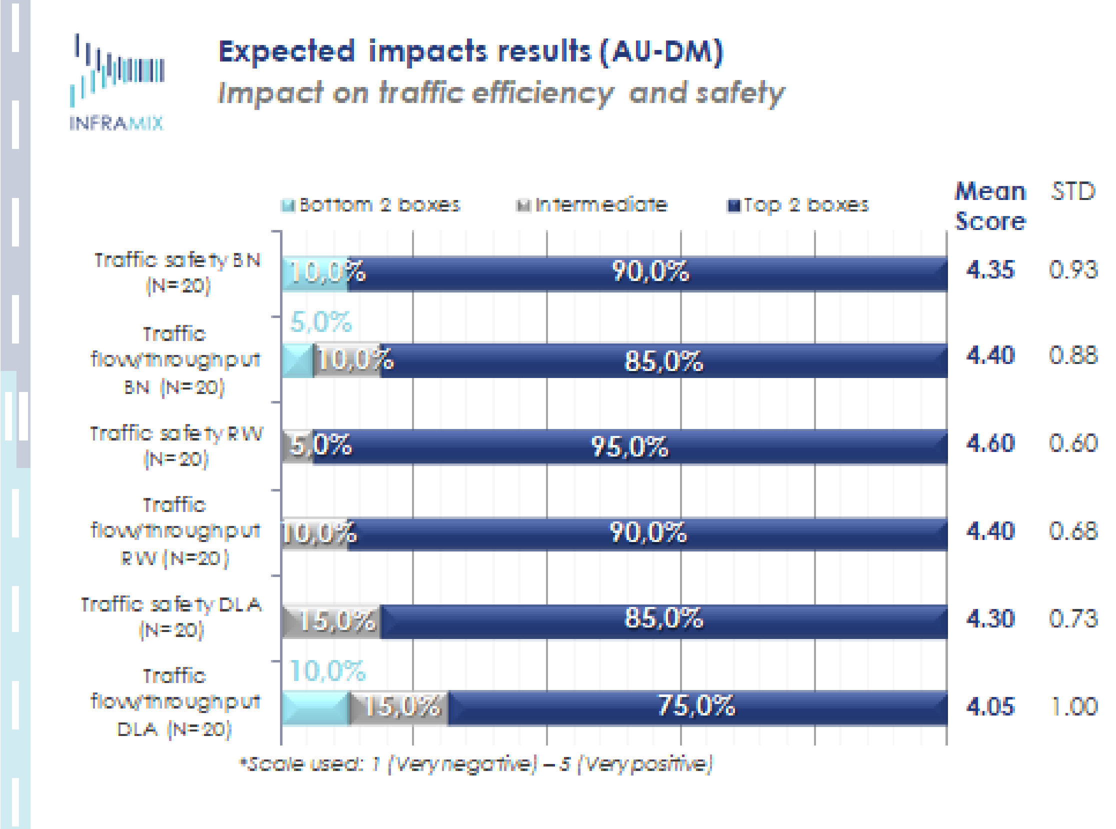
*Scale used: 1 (Very negative) – 5 (Very positive)

Expected impacts results (AU-WS)

Impact on traffic efficiency and safety



*Scale used: 1 (Very negative) – 5 (Very positive)



The **traffic efficiency** appreciation results that were registered during the four demonstration and workshop events in Spain and Austria were remarkably high reaching up **to 85% in top two boxes and 4,4 mean value for the Bottlenecks scenario(Austrian Demonstration), 90% top two boxes and 4,40 mean value for the Roadworks scenario(Austrian Demonstration), and 89,3% top two boxes and 4,11 mean value for the DLA (Dynamic Lane Assignment) scenario (Spanish Demonstration).**

The **safety appreciation** results that were registered during the four demonstration and workshop events in Spain and Austria were also high reaching up **to 90% in top two boxes and 4,35 mean value for the Bottlenecks scenario, 95% top two boxes and 4,60 mean value for the Roadworks scenario and 85% top two boxes and 4,3 mean value for the DLA (Dynamic Lane Assignment) . All in Austrian Demonstration.**

Anyway, this kind of discrepancy between the great expectation impacts overall on traffic efficiency and safety and the moderate expectation impacts on specific aspects of traffic environment and activities should be taken into consideration. It illustrates and confirms an initial INFRAMIX statement about the great importance of the first period of the coexistence of conventional and connected vehicles. The transition towards automation should be smooth and carefully designed so as the initial or current users reservations will turn into optimism and the specific expected impacts will get high appreciation, as the overall traffic efficiency and safety expected impacts get.

10.5 Overall Results in four Demonstration and Workshop events

10.5.1 Spain Workshop

Overall Results (SP-WS)

	BN		RW		DLA	
	Mean	STD	Mean	STD	Mean	STD
Willingness to use (scale used 1-5)						
Use information	4.23	0.71	4.43	0.59	4.23	0.58
Behavior change (scale used 1-5)						
Follow suggestions	4.28	0.64	4.50	0.55	4.25	0.54
Perceived usability (scale used 1-5)						
Easy to learn signs	4.13	0.83	4.41	0.72	4.26	0.64
Usefulness	4.10	0.74	4.28	0.60	3.93	0.94
Immediate reaction	4.13	0.85	4.25	0.71	4.05	0.81
Benefit	3.92	0.86	3.86	0.71	3.67	0.81
Intuitive signs	3.90	1.05	4.26	0.88	3.72	0.94
Understandable signs	3.92	1.09	4.38	0.81	3.95	0.86
Expected Impacts Results (scale used 0-10)						
Easier/intuitive interactions (DRIVERS)	7.21	1.64	7.13	1.79	6.88	1.73
Miss road sign in the in-vehicle HMI (DRIVERS)	6.89	1.71	6.90	1.67	6.42	2.00
Stress reduction (DRIVERS)	6.64	2.02	7.00	1.87	6.50	1.99
Increase comfort (DRIVERS)	6.82	1.89	6.79	1.82	6.65	1.79
Better perform daily work (TRANSPORT OPERATORS)	7.59	1.50	7.61	1.15	7.68	1.51
New incident reaction ways (TRANSPORT OPERATORS)	7.87	1.34	7.77	1.22	7.90	1.37
Solve problems faster (TRANSPORT OPERATORS)	7.69	1.49	7.56	1.31	7.85	1.18
Expected Impacts Results (scale used 1-5)						
Traffic safety	3.95	0.99	4.40	0.63	3.93	0.62
Traffic flow/throughput	4.25	0.87	4.10	0.67	3.83	0.78
CO2 emissions	3.80	0.91	3.60	0.71	3.40	0.74

10.5.2 Spain Demonstration

Overall Results (SP-DM)

	BN		RW		DLA	
	Mean	STD	Mean	STD	Mean	STD
Willingness to use (scale used 1-5)						
Use information	4.05	0.92	3.50	1.54	4.18	0.67
Behavior change (scale used 1-5)						
Follow suggestions	4.10	0.83	3.70	1.30	4.11	0.74
Perceived usability (scale used 1-5)						
Usefulness	4.19	1.03	3.80	1.28	4.25	0.75
Satisfying	3.62	0.92	3.70	1.38	3.86	0.65
Immediate reaction	3.62	1.12	3.70	1.38	4.11	0.50
Benefit	3.95	1.02	4.00	1.08	3.75	0.84
Easy to learn signs	4.19	0.60	4.15	1.14	4.29	0.60
Understandable signs	4.19	0.60	4.20	1.15	4.11	0.79
Correct information	3.76	0.70	4.35	0.93	4.14	0.93
Not distracting from driving	3.38	0.97	4.10	0.79	4.04	0.64
Easier/intuitive interactions (DRIVERS)	6.62	2.13	6.10	2.55	6.89	1.77
Miss road sign in the in-vehicle HMI (DRIVERS)	7.43	2.29	7.35	2.25	7.46	1.75
Stress reduction (DRIVERS)	8.05	2.16	6.50	2.86	6.93	2.14
Increase comfort (DRIVERS)	7.71	1.82	6.95	2.48	7.39	1.62
Better perform daily work (TRANSPORT OPERATORS)	8.38	1.60	7.35	2.39	7.79	1.52
New incident reaction ways (TRANSPORT OPERATORS)	7.76	2.28	7.55	2.50	7.18	2.11
Solve problems faster (TRANSPORT OPERATORS)	8.52	1.29	7.20	2.57	7.43	2.03
Traffic safety	3.95	0.80	4.25	0.91	3.96	0.69
Traffic flow/throughput	4.24	0.62	3.95	0.94	4.11	0.69
CO2 emmissions	4.14	0.96	3.50	0.95	3.71	0.81

10.5.3 Austria Workshop

Overall Results (AU-WS)

	BN		RW		DLA	
	Mean	STD	Mean	STD	Mean	STD
Willingness to use (scale used 1-5)						
Use information	4.38	0.70	4.55	0.64	4.38	0.70
Behavior change (scale used 1-5)						
Follow suggestions	4.30	0.76	4.33	0.66	4.18	0.71
Perceived usability (scale used 1-5)						
Easy to learn signs	4.45	0.64	4.75	0.44	4.30	0.69
Usefulness	4.23	0.73	4.40	0.67	3.88	0.85
Satisfying	4.15	0.83	4.73	0.51	4.03	0.83
Immediate reaction	4.15	0.74	4.43	0.64	3.85	0.86
Benefit	4.18	0.71	4.50	0.64	3.98	0.89
Understandable signs	4.28	0.75	4.70	0.56	3.80	1.07
Expecied Impacts Results (scale used 0-10)						
Easier/intuitive interactions (DRIVERS)	7.65	1.82	6.48	2.70	7.00	2.16
Miss road sign in the in-vehicle HMI (DRIVERS)	7.35	1.73	6.78	2.50	7.00	2.16
Stress reduction (DRIVERS)	7.58	1.34	6.53	2.44	6.43	2.69
Increase comfort (DRIVERS)	7.60	1.10	6.63	2.34	6.75	2.95
Better perform daily work (TRANSPORT OPERATORS)	7.53	1.62	7.60	1.91	7.38	1.88
Solve problems faster (TRANSPORT OPERATORS)	7.44	1.85	7.73	1.78	7.48	2.12
Expecied Impacts Results (scale used 1-5)						
Traffic safety	4.28	0.74	4.40	0.63	3.80	0.79
Traffic flow/throughput	4.32	0.63	4.20	0.61	3.63	1.08
CO2 emissions	4.00	0.76	3.78	0.83	3.58	0.87

10.5.4 Austria Demonstration

Overall Results (AU-DM)

	BN		RW		DLA	
	Mean	STD	Mean	STD	Mean	STD
Willingness to use (scale used 1-5)						
Use information	4.50	0.61	4.65	0.49	4.50	0.69
Behavior change (scale used 1-5)						
Follow suggestions	4.40	0.60	4.45	0.60	4.30	0.57
Perceived usability (scale used 1-5)						
Easy to learn signs	4.05	0.76	4.55	0.51	4.40	0.88
Usefulness	4.40	0.68	4.55	0.60	4.30	0.86
Satisfying	4.35	0.59	4.15	0.59	4.00	0.73
Immediate reaction	4.25	0.55	4.40	0.50	4.30	0.66
Benefit	4.20	0.77	4.15	0.37	4.10	0.55
Intuitive signs	4.05	0.51	4.40	0.68	4.35	1.04
Understandable signs	3.95	1.05	4.50	0.83	4.25	0.85
Available in time	4.10	0.55	4.15	0.59	4.00	0.46
Enough per distance	3.95	0.69	4.15	0.75	4.00	0.73
Correct information	3.95	0.51	4.05	0.51	4.00	0.56
Not distracting from driving	4.05	0.60	4.05	0.69	3.95	0.69
Expected Impacts Results (scale used 0-10)						
Easier/intuitive interactions (DRIVERS)	7.30	1.95	7.20	2.55	6.75	2.57
Stress reduction (DRIVERS)	7.85	1.42	7.65	1.69	7.30	2.64
Increase comfort (DRIVERS)	7.60	1.47	7.45	1.57	7.20	1.91
Better perform daily work (TRANSPORT OPERATORS)	7.95	1.85	8.30	1.26	7.95	1.90
Solve problems faster (TRANSPORT OPERATORS)	8.35	1.39	8.35	1.81	7.80	2.50
Expected Impacts Results (scale used 1-5)						
Traffic safety	4.35	0.93	4.60	0.60	4.30	0.73
Traffic flow/throughput	4.40	0.88	4.40	0.68	4.05	1.00
CO2 emissions	3.70	1.03	3.45	0.76	3.65	0.81

11. Conclusions

The users' appreciation factors "willingness to use", "perceived usability" and"behaviour change" received great acceptance in our evaluations exceeding in most of the cases the 70%.This is very important for the intelligent transport society.

According to our results, drivers are willing to take advantage of the new traffic management capabilities and change their driving behaviour, they also understand or are more optimistic that these new applications and capabilities will be useful, but results suggest that they can not yet grasp specific impacts on their and operators' lives of something that still looks pretty far ahead.

The survey data further shows, that drivers, passengers and road operators believe that the advanced traffic management systems would bring positive changes in traffic conditions, but they seem unsure about how this change will be reflected in specific results. A certain sceptiscism can also be observed when failures occur or the limits of the technology are reached (for example camera technology in foggy weather).

The first period of coexistence of conventional, connected and automated cars will be very important for the future of intelligent transport. The impressive high user acceptance as it was reflected in the evaluation results of the demonstration and workshop events is a positive sign for the future.

The general results are very encouraging and should fill all the ITS society with optimism.

12. References

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