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Report on stakeholder responsibilities in the areas of data exchange, digital platform, and actions needed for making identified use cases reality

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Executive summary

The major goal of DIRIZON is to support the European National Road Authorities (NRAs) in their digital transition and in their interaction with other stakeholders regarding Connected Automated Driving (CAD). The analysis of potential implications and consequences on data needs and requirements for data-exchange are especially based on the selected use cases (core topics) as follows:

1. Provision of High-Definition (HD) maps for automated mobility
2. Distribution of digital traffic regulations
3. Infrastructure support services for Cooperative Automated Driving

In the respect to the original objective, the scope of WP4 was broadened to validate the developed process flow of the mentioned use cases and the included actors, roles and available data not only from the view of "other" stakeholders, but furthermore also from the view of the NRAs. This extension was necessary as the needed input from NRAs was not available right from the start of the project and subsequently the interviews with the NRAs in WP2 (*NRAs and Digitalisation and Automation*) focused on a more general level.

The results of WP3 (*Digitalisation and Automation: Implications for use cases, Relationships with Stakeholders and Data needs and requirements*) and this work package WP4 (*Other Stakeholders' views on Digitalisation and Automation on the selected use cases*) together provide the very basis for the data exchange concept in WP5 (*Towards a digital platform*), the business models in WP6 (*Exploration of Business models)*, and the formulated recommendations towards the next steps in WP7 (*Step by step transition towards a full Digitalisation of the road network*). They also form input to CEDR to lay the groundwork for new ways of cooperation with other actors in the future.

In order to get an overall picture on the detailed level of the use cases, WP4 started with a literature review. The research showed that the actors' responsibilities within the use case scenarios have not yet been focused on in detail, however, the stakeholder groups already see their roles for the transition towards Connected Automated Driving. It became apparent that the need for collaboration is seen as essential by all different stakeholders. There are still lots of problems regarding privacy, security and data management that call for a constant dialogue between all the actors involved in order to solve them. Especially the cooperation between Road Operators and OEMs has to be enforced while National and European Road Authorities are in the position to enable collaboration and set rules for an open and flexible process.

Based on the results of previous WPs and the literature review within WP4 a semi-structured web-based questionnaire was devised to validate the proposed process flow of each use case, to highlight the roles and responsibilities of the different actors and get insights into the required data. In order to reach the stakeholders, the WP4 leader together with the consortium used their networks, existing synergies, events and platforms to distribute the questionnaire as widely as possible in the period from 01 October 2019 to 31 January 2020.

In total, 53 participants from 10 different countries responded to the questionnaire whereby a different level of participation was achieved for the individual use cases. Of all respondents, OEMs, Research Institutions and Public Road Operators together make up about 50%. It can be highlighted that all the major target groups which are essential for the three core topics could be reached.

Summarising all the individual results we can conclude that the process and storyline presented are widely agreed by the experts, which is a valid basis for further development of

data exchange options and related business models. Nevertheless, there is the need for slight changes in some parts.

Based on the results received one can conclude that activities in the context of Content/Data Creation are relevant for all three core topics. Compared to this, the statistics show that there is a high insecurity in regards to a functional concept of a Trusted Electronic Regulation Access Point (TERAP) and/or the National Access Point (NAP) for Content Aggregation in the sense of data collection and distribution (especially from (C-)ITS service providers, regional transport authorities).

Based on the responses received some experts do not see a real end-user service in practice as the end-user is the automated vehicle itself. In the view of the potential risk of service abuse by citizens, NRAs highlight to cover only CCAV and not personal information devices.

Furthermore, this report shows that the success of implementing connected automated mobility depends on cooperation between the various stakeholder groups. This can be emphasized by the fact that numerous data types, which can be provided by different actors, are relevant to implement the core topics.

The first core topic shows that the number of potential actors is partly more extensive than expected for providing HD Maps for automated mobility. The participants see not only Road Operators in charge of providing traffic regulations and static road-related parameters (e.g. road classification, lane models, georeferencing data) but also this should involve (public) transport authorities and/or HD map providers. This data represents the basis for HD Map production by HD map providers as well as ITS service providers. This trend of cooperation between several players is also continuing in the context of service integration and presentation.

On balance, interoperability might also be seen as the key if cross-border services should become more and more standard. In this context, it is important to emphasize that the general willingness to transfer knowledge and to cooperate between different stakeholder groups as well as countries is necessary in any case. The interconnection of heterogeneous national system concepts in terms of transnational data exchange is the objective for WPs 5 and 6.

Looking at the responses regarding the availability of the data in machine-readable format as well as access conditions for data and information, huge differences between the different countries exist as well. In principle, it can be stated that making the relevant data available in machine-readable form must be one of the next steps towards full Digitalisation of the road network.

In the context of data sharing among non-EU countries potential legal restrictions should be considered. In addition other challenges related to privacy legal issues might appear, therefore GDPR expectations must be fulfilled. This is very much connected with other big challenges like cybersecurity and certification (see HD Maps). Next to this aspect, within Core topic 2 Distribution of Digital Traffic Regulations, one of the most important tasks that was fully approved by all stakeholder groups is the provision of a standardised framework and the compliance with standards. This emphasized the need for even more efforts in the related standardisation groups (as CEN/TC 278 WG17). Independently from each other many respondents added latency issues as a major challenge for all three core topics, e.g. "*To make best use of this data, sharing needs to be mandated and low-latency infrastructure used for maximum benefit".*

If these challenges can be tackled in a good way, numerous benefits and opportunities may be expected from the implementation of all three core topics. The experts in the questionnaire assume better traffic management and improved road capacity, which will lead to an

enhancement of quality of service to road users. Various stakeholders as well as the society as a whole can benefit from the expected improvements in safety and efficiency.

After the conclusions of the major results, the last chapter 7 deals in particular with the inputs regarding the proposed process flows. As already mentioned, the experts are mostly in line with the suggested activities and their actors, but inputs and comments that suggest changes were analysed in more detail and the flow charts were adapted. The overall evaluation of the process in addition to the comments is a very helpful input for the final fine-tuning of the use cases as a basis for the upcoming work packages. The revised diagrams accompanied by chapter 7 are the main input to WP5/6. In the context of WP5 the results are valuable for the different use case requirements and the related data streams to be focussed in order to derive appropriate data exchange options.

In WP6, the DIRIZON consortium will develop scenarios that demonstrate how the service flows developed in the use cases are implemented on a European scale. There will be three different variants of the scenario: "NRA-driven", "market-driven" and "Hybrid". These scenarios will to a certain extent reflect the differences in opinions on roles and scope, as presented above. They will then be evaluated on defined criteria, in order to identify which approach provides which benefits, as an input for WP7 on step-by-step transition to full digitalisation of the road network.

In summary, the results of WP4 are not only an important basis for the following WPs in DIRIZON, but the results of the survey may also be highly relevant for further research projects in the field of digitalisation and automation.

Project information

Project title	advanced options for authorities in light of automation and **DI**gitalisation ho**RIZON** 2040.		
Acronym - Logo			
CEDR Topics addressed	CEDR Call 2017: Automation: ☐ A. How will automation change the core business of NRA's? ☒ B. What new options do NRAs have from digitalisation and automation? ☐ C. Practical learnings for NRAs from test sites.		
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	Albrecht Consult		DE
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	HERE (Associated Partner)		DE
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Abbreviations

Abbreviation	Full Title
AD	Automated Driving
CAD	Connected and Automated Driving
CAM	Cooperative Awareness Message
CCAV	Connected and Cooperative Automated Vehicle
CCAM	Connected and Cooperative Automated Mobility
(C-)ITS	(Cooperative) Intelligent Transport Systems
CEN/TC	European Committee for Standardization/ Technical Committee
C-Roads	Cooperative Roads
DoS	Denial of Service
HD	High-Definition
GDPR	General Data Protection Regulation
INFRAMIX	Preparing road infrastructure for mixed vehicle traffic flows
ISAD	Infrastructure Support for Automated Driving
ITS	Intelligent Transportation System
MaaS	Mobility as a Service
METR	Management for Electronic Traffic Regulations
MNO	Mobile Network Operator
NRA	National Road Authority
ODD	Operational Design Domain
OEMs	Original Equipment Manufacturers
PKI	Public Key Infrastructures
RO	Road Operator
RSU	Road Side Unit
SAE	Society of Automotive Engineers
SRTI	Safety-Related Traffic Information
TERAP	Trusted Electronic Regulation Access Point
TMC	Traffic Message Channel
VMS	Variable Message Signs
V2I	Vehicle to Infrastructure
WG	Working Group
WP	Work Package

Definitions

Term	Definition
ACTIVE SAFETY SYSTEM	Vehicle systems that sense and monitor conditions inside and outside the vehicle for the purpose of identifying perceived present and potential dangers to the vehicle, occupants, and/or other road users, and automatically intervene to help avoid or mitigate potential collisions via various methods, including alerts to the driver, vehicle system adjustments, and/or active control of the vehicle subsystems (brakes, throttle, suspension, etc.) (SAE J3016 June 2018)
ACTOR	An entity (human or otherwise) that interacts with the system for the purpose of completing an event.
ACTOR (PRIMARY)	An actor that is necessary for the deployment of a use case. It has a goal with respect to the system - one that can be satisfied by its operation. It not only has a primary interest in the use case but can may also be the initiator of the Use Case.
ACTOR (SECONDARY)	A third-party actor from which the system needs assistance to achieve the primary actor's goal.
AUTOMATED DRIVING	A traffic system in which vehicles are capable of sensing its environment and operating and manoeuvring in traffic to achieve a goal, with little or no human input. It is supported by connectivity consisting of Vehicle-to-Infrastructure (V2I) communication, Vehicle-to-vehicle (V2V) communication, Vehicle to Everything (V2X) communication, Infrastructure to everything communication (I2X).
AUTOMATED DRIVING SYSTEM	The hardware and software that are collectively capable of performing the entire dynamic driving task on a sustained basis, regardless of whether it is limited to a specific operational design domain (ODD); this term is used specifically to describe a level 3, 4, or 5 driving automation system (SAE J3016 June 2018)
DEVICES	The components of an Information Technology (IT) network that permit the communications needed required for data applications and services (such as servers, routers, detection systems etc.).
DIGITAL INFRASTRUCTURE	A digital infrastructure includes and facilitates V2I, V2X and V2V communication
DIGITALISATION	The implementation of digital technologies, which when combined with Information and Communication Technology (ICT) tools, assist in making transport modes more interoperable and smarter
DIGITISATION	The process of converting physical information into a digital format.
DRIVING AUTOMATION SYSTEM	The hardware and software that are collectively capable of performing part or all of the dynamic driving task on a sustained basis; this term is used generically to describe any system capable of level 1-5 driving automation (SAE J3016 June 2018)

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Term	Definition
OPERATIONAL DESIGN DOMAIN (ODD)	A description of the specific operating conditions in which the Automated Driving system is designed to properly operate. It includes but is not limited to roadway types, speed range, environmental conditions (weather, day/ night time, etc.), prevailing traffic law and regulations, and other domain constraints (SAE J3016 June 2018).
PHYSICAL INFRASTRUCTURE	All infrastructure on the road including, but not limited to, grass verges, roadway widths, cross sections, safety barriers, signage, lines, power requirements ducting and C-ITS based devices.
PUBLIC KEY INFRASTRUCTURE (PKI)	A set of dedicated policies, procedures and technology that are needed to deal with digital certificates in a public key cryptography scheme. This includes Certificate Authorities (CA) communication for initial enrolment of ITS stations, certificate requests and re-keying and certificate renewal (ENISA, 2019 & C-Roads, 2018c)
SYSTEM	It comprises a set of sequences of actions and variants that are performed within it and lead to value of an actor. It can be a complex combination of various components that interact each other to satisfy individual objectives.
SYSTEM SECURITY	It consists of all functions required for a secured message generation, i.e. signature generation, key and certificate handling, as well as authentication (verification) of received messages (C-Roads, 2018c).
USE CASE / CORE TOPIC	A function of the system, the desired behaviour (of the system and actors), specification of system boundaries and definition of one or more usage scenarios. It combines all possible scenarios that can occur when an actor tries to achieve a certain technical objective (business goal) with the help of the system under consideration.

1 Introduction

1.1 WP4 - Other Stakeholder's views in the DIRIZON overall project context

The major goal of DIRIZON is to support the European National Road Authorities (NRA's) in their digital transition and in their interaction with other stakeholders regarding Cooperative Automated Driving. To this end, DIRIZON is assisting the aforementioned road authorities/Road Operators in identifying how these developments will affect their operations and their interaction with others. In this respect, DIRIZON can determine the implications of Digitalisation and Automated Driving on specific core topics and their consequences on data needs and requirements for data-exchange.

This deliverable is part of WP4 (Other Stakeholders' views on Digitalisation and Automation on the selected use cases). The objectives, according to the proposal, of this WP are to

- Collect views of "other" stakeholders and NRAs (see below) on data needs, data exchange (incl. prerequisites), roles and responsibilities, security, data protection, privacy and governance issues.

- Challenge the views of NRAs with the results of other stakeholder groups

- Summarize input, develop conclusions and provide input into further WPs

As described in Deliverables D2.1. (Tucker et al., 2019) and D3.1. (Malone et al., 2020) the actual input data collection, especially regarding input from National Road Authorities (NRAs) to the selected use cases was not available right from the start of the project. As the interviews done in WP2 were relevant for selecting the DIRIZON use cases (or core topics, as they were called in the WP4 questionnaires), the focus of the interviews in phase 1 was on more general interviews with the NRAs and Road Operators regarding the current status of Digitalisation/Automated Driving, their policies, benefits and barriers they expect.

Therefore, the scope of WP4 was broadened to validate the developed process flow and the included actors, roles and available data not only from the view of "other" stakeholders, but furthermore also from the view of the NRAs.

After selecting and finalizing the details of the use cases in the WP2 and WP3, WP4 takes a step further and focuses on the activities of all required stakeholders and identifies the congruent and conflicting views in the present and future with other stakeholders with respect to data exchange. The original objective of the WP4 has changed in the respect that finally the different roles of various stakeholder groups, also including NRAs, are compared to get an overall picture on the detailed level of the use cases. Hereby a specific focus was given on eliciting stakeholder views on data availability, data exchange, roles, security, privacy and governance. This was done by desk studies (especially by analysing position papers) and collecting data via a web-based questionnaire.

Hence, WP4 provides the very basis for the further developments regarding a data exchange platform and the related business models in the upcoming WPs. The outcome of WP4, as described in this report, will give a better understanding for each of the use cases, highlighting the roles and responsibilities of the different actors and emphasizing on conflicting views and open aspects in relation to the full implementation of the use cases.

1.2 Structure of this report

This report summarizes the work done within WP4, starting with the literature review, development of web-based questionnaires and the analysis of the collected data. It provides a good overview of the input collected and will draw first conclusions as basis for the further work to be done in DIRIZON in the upcoming months.

This report is structured as following:

- **Chapter 2: Methodology and the DIRIZON use cases**, describes the overall methodological approach and the steps taken to collect in-depth information on the DIRIZON use cases. Furthermore, this chapter outlines briefly the DIRIZON use cases that are the basis for the effort done in this WP.

- **Chapter 3: Results of the Literature Review (Position papers)**, summarizes current available sources as the basis for the further developments of the use cases.

- **Chapter 4: Collection of stakeholder views**, provides an overview starting point for the collection of the stakeholder views, summarizes the main stakeholder groups that are relevant for the DIRIZON use cases and gives an insight on the content and structure of the web-based questionnaire that was designed and how it was actually distributed to gather the relevant data.

- **Chapter 5: Analysis of collected data**, includes the analysis of the data coming from the web-based questionnaire on an overall basis and on the level of the different use cases.

- **Chapter 6: Conclusions of the major results**, identifies the major key findings from the analysis in respect to the three use cases.

- **Chapter 7: Recommendations and next steps**, draws very first conclusions from the analysis of the collected data and includes the recommendations of experts in regards to the proposed process flows. This can be seen as the basis for the next steps in DIRIZON.

2 Methodology and the DIRIZON use cases

2.1 Sources and Methods used

WP4 is based on the following sources:

- Outcomes of WP2 (literature review, interview findings and definition of the use cases) which are in principle summarized in Deliverable D2.1. (Tucker et al., 2019).
- Outcomes of WP3 (list of data and data categories for the selected use cases), which can be found in Deliverable D3.1. (Malone et al., 2020), as well as the updated WP3 use cases.
- Findings of the WP4 literature review process with focus on position papers (concentrating on relevance for the DIRIZON use cases)
- Data collected from the web-based questionnaire, which was elaborated within WP4.

The findings of the literature review are done only on the basis of a qualitative analysis.

For the web-based questionnaire different quantitative analysis methods were applied. The results were analysed using suitable statistical methods (e.g. cross-tabulations/contingency tables, frequencies, etc.). Case frequencies allowed making some statements on trends and priorities/views of respondents, even in those cases where the sample size was too small for applying appropriate statistical methods.

Note: It has to be mentioned that the previous learnings of DIRIZON showed that the number of experts that are able to make profound statements on the very specific DIRIZON use cases is very small. For the analysis this means that the consortium received a valuable number of feedback from experts to the web-based questionnaire. Based on the responses, it is possible to validate the process depicted, the different actors and roles and relevant data and evaluate whether changes are necessary. Due to a low statistical population this analysis is less about statistical significance than about deriving overall trends based on expert knowledge. It allows identifying congruent and contradicting aspects in the process flow of the different use cases, as well as different possibilities for the actors taking an active role, as well as national differences. Taking into account the current available detailed data on the DIRIZON use cases these results mean a major step forward in identifying the basics for the data exchange platform, as it will be developed in WP5.

2.2 Overview of DIRIZON use cases

The project approached the broad topic of digitalization by identifying three use cases (which are referred as core topics in the following), which were based on the previous work done in DIRIZON and finally selected together with the CEDR/CAD working group in Oslo on November 6-7, 2018:

- **Provision of High-Definition (HD) Maps for Automated Mobility:**
  This core topic deals with High-Definition maps meaning the provision of detailed mapping in a machine-readable format to support a cooperative, connected automated vehicle's (CCAV) ability to understand its precise positioning, plan beyond sensor vision, possess contextual awareness of the environment and local knowledge of the road rules.

- **Distribution of Digital Traffic Regulations:**
  Distribution of digital traffic regulation becomes more and more relevant for CAM (Connected and Automated Mobility) (as well as for other areas e.g. smart cities). The core topic breaks down the process for the distribution of digital traffic regulations from the triggering event to the provision to the connected automated vehicle.

- **Infrastructure Support for Cooperative Automated Driving (CAD):**
  Infrastructure support for Connected and Cooperative Automated Driving (ISAD) is digitized information, on top of the HD map and the digitized traffic regulations, to support CAD (connected and Automated Driving) functioning.

These core topics will be analysed in detail in the upcoming chapters of this report based on the results of the literature review and especially the web-based questionnaire.

The three use cases are conceptually linked, as illustrated in Figure 1 below.
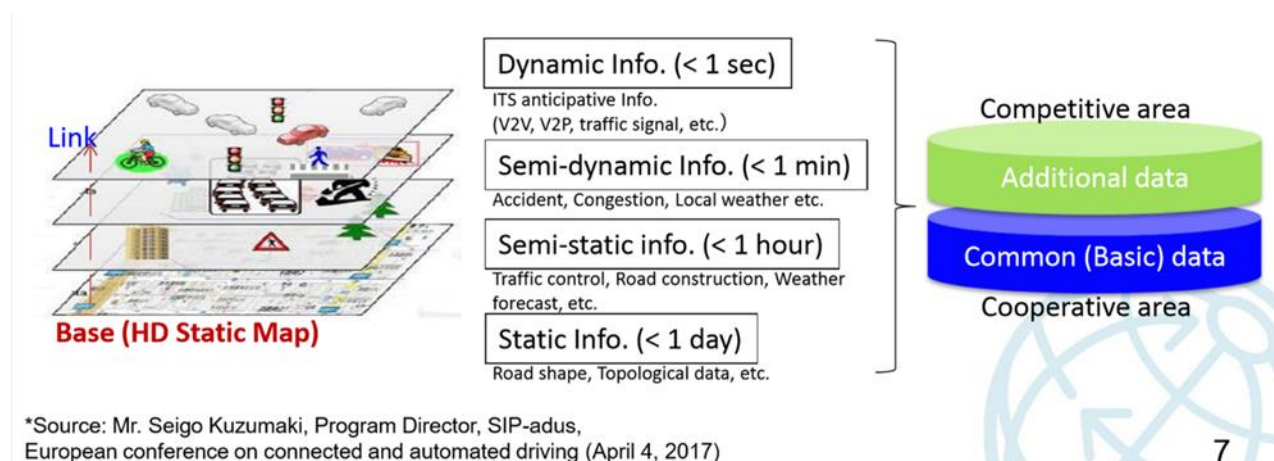
Figure 1: Visualisation of the layers and data types for a High-Definition (HD) map. Source: presentation of Jun Shibata at the SIS 37, 12th ITS European Congress Strasbourg, June 21, 2017 [Shibata, 2017]

The DIRIZON project sees the core topics as building on top of each other. The base layer is the static data in the HD map. The Distribution of Electronic Traffic Regulations adds regulations to the static data in digital form. Infrastructure support for Connected and Cooperative Automated Driving (ISAD) is digitized information, on top of the HD map and the digitized traffic regulations, to support CAD functioning. Thus, this use case covers vehicles in a mixed environment, supporting Cooperative, Connected and Automated Vehicles (CCAVs) by extending their Operational Design Domain (ODD) and improving safety, traffic flow and environmental impacts. Figure 1 illustrates the layers and data types for a High-Definition (HD) map. Figure 1 shows layers that differ according to how static or dynamic the data is. Conceptually, the HD map integrates layers of different types of data, which can come from different use cases. Furthermore, the core topics will evolve over time, for example, information provision will be to human drivers in the short term, evolving to providing information to more and more vehicles with higher levels of automation. The focus of DIRIZON is on digitized information for the Cooperative and Connected Automated Vehicles (CCAVs), not on presenting to the human driver. Of course on-going research on human-machine interaction in the automated vehicle is of critical importance but tackled specifically within DIRIZON.

For each of the described core topics the DIRIZON consortium prepared a process flow diagram and a storyline that are the basis for the validation within the web-based questionnaire, the upcoming analysis and the further work to be done.

For a more detailed summary for each core topic (including process flow diagram and storyline) please have a look at the chapters 5.2, 5.3 and 5.4 where the core topics are discussed and the responses from the questionnaire are evaluated.

3 Results of the Literature review

3.1 Availability of information and the value of position papers

In preparation for the development of the questionnaire, thematically appropriate position papers were researched. In a first step, the literature review from WP 2 was evaluated and general papers on Automated Driving were analysed. Subsequently, position papers by stakeholders were screened. However, it has to be clarified that the core topics are very specific and therefore only little research work has been done on a very detailed level which made our goal of finding position papers rather difficult.

The focus within WP4 was the analysis of the roles and responsibilities of stakeholders in the considered core topics as well as the proposed flow diagram/process of the services. The Knowledge Base on Connected and Automated Driving (CAD) proved to be particularly helpful in this context.

This chapter features papers produced within EU-wide projects as well as scientific papers and position papers written by certain stakeholder groups concerning their role in Automated Driving:

- Especially the Horizon 2020 project **CARTRE** (Coordination of Automated Road Transport Deployment for Europe) has delivered very helpful position papers that gave insight in the challenges and next steps for Automated Driving (CARTRE, 2018).
- Findings from the project **C-MobILE** (Accelerating C-ITS Mobility Innovation and depLoyment in Europe) have also been included (Lu et al., 2018).
- We also took a proposal for a project (**CCAM**) into account since it aims to connect all the different stakeholders through an EU wide platform (CCAM, 2020).
- As part of the project **INFRAMIX**, a conference paper for the ITS World Congress Copenhagen "Road Infrastructure Support Levels for Automated Driving" has been screened and highlights the challenges for Road Operators (Carreras et al., 2018).
- The **EU ITS Platform** (Courbon et al., 2016) has also been particularly helpful defining requirements for stakeholders for making Automated Driving possible (especially in the Sub-activity 4.2 "Facilitating Automated Driving").
- A master thesis on **"Infrastructure requirements for Automated Driving"** (Lu, 2018) gives insights into who the critical actors for the process are and what their roles could be.
- An article from 2016 on "**Autonomous Driving in the iCity** - HD Maps as a Key Challenge of the Automotive Industry" focuses on the main challenges in regards to data and Automated Driving (Seif & Hu, 2016).
- An **Action Points Paper by the UITP** which is a non-profit advocacy organization for public transport authorities and operators, policy decision-makers, scientific institutes and the public transport supply and service industry, has also highlighted the roles of different stakeholders and their interest in data (UITP, 2018).
- An Automated Driving Roadmap by **ACEA** (European Automobile Manufacturers' Association) shows the future goals for OEMs in the field of CAD (ACEA, 2019).
- A report by the World Road Association **PIARC** on "Connected Vehicles - Challenges and Opportunities for Road Operators" has also been screened (PIARC, 2019).
- The "**European Roadmap Smart Systems for Automated Driving**" published by EPoSS (European Technology Platform on Smart Systems Integration) is based on surveys and consultations among major European automotive manufacturers and suppliers and examines the challenges and activity fields (Meyer et al., 2015).

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3.2 Summary of key findings

As the findings from the literature review in D2.1. already stated (Tucker et al., 2019), most literature does not give any explicit details about the roles of the different stakeholders involved and their responsibilities. However, the focus of this literature review was then to find position papers that examine the stakeholders' perspectives in more detail and detect how they see their role in the process towards Automated Driving and what challenges are in their way.

Overall, there is a broad consensus about the challenges and necessary steps in order to make Automated Driving possible. Actors from different organizations like public transport authorities, European automobile manufacturers, and Road Operators and research institutions see similar issues that have to be addressed in order to get to the scenarios of the use cases.

Firstly, this chapter highlights the overall findings and what most papers agreed on. Subsequently, there are sections on three stakeholder groups where position papers were found that focused on their specific roles in the process:

- Road Operators
- National Authorities and EU
- OEMs

Overall findings

The overarching theme that is mentioned in almost every paper evaluated is the **need for collaboration of the various stakeholders**. It can be seen as a requirement for all processes and, therefore, this might be the biggest challenge. Collaboration will be important in order to achieve the vision of fully Automated Driving in the EU, but will also be essential in the future when the use cases are already established e.g. for data sharing, feedback loops etc. It is seen as one of the most important requirements when it comes to the deployment of Automated Driving and **all actors have a responsibility to foster cooperation**.

Especially the proposal for the CCAM platform emphasizes the complex cross-sectoral value chain as a big problem as one of the main reasons for the proposal is the complex multi-stakeholder environment. The proposal claims that "**effective, profitable and transparent cooperation among local and regional authorities and the private sector** is mandatory to provide end-users with inclusive, equitable and accessible services for all, and to develop interoperable systems and operating conditions". Moreover, it states that collaboration and coordination of research and innovation activities on infrastructure, services and vehicles is very important from early stages onwards to enable seamless deployment (CCAM, 2020).

The European Roadmap Smart Systems Automated Driving also mentions that "the industry, utilities, infrastructure providers, academia and public authorities should join their efforts in **specific Public-Private Partnership and joint programs horizontally covering all aspects of Automated Driving including research and innovation**" (Meyer et al., 2015).

The results from the project C-Mobile state "**To create viable and functioning partnerships is a must** for establishing large-scale deployment of sustainable services in complex urban areas". In the paper, they raise the questions which policies (at European, national, regional and local levels) are needed for stimulating C-ITS deployment as well as how to best join efforts in this context. We can therefore conclude that in addition to collaboration within the field of research, there is also a **need to collaborate on the different levels of policy-making** (Lu et al., 2018).

The PIARC report emphasizes the fact that "**the key point is not technical**, it is to involve all stakeholders: **Cooperative ITS are indeed, above all, a matter of cooperation".** It states that **interoperability** is a main challenge that can only be overcome through extensive cooperation between the significant numbers of stakeholders involved (PIARC, 2019)**.**

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Moreover, cooperation will be an important aspect when it comes to facing problems of responsibilities. The position paper by CARTRE on physical and digital infrastructure (CARTRE, 2018) mentions the challenge to make sure to "**determine at all times who is responsible for the data, and also of the maintenance of the physical and digital infrastructure, among others"**. Another CARTRE paper on Artificial Intelligence and Big Data (CARTRE 2018) mentions that "**data is collected from many different sources and by different parties**". They also see this as one of the major technical challenges since "the storage and accessibility of this data will become a real challenge at some point".

Road Operators

All stakeholders agree that collaboration is one of the most important factors. For Road Operators, especially the **cooperation with OEMs** seems crucial for the next steps towards Automated Driving. A recommendation by PIARC to road and traffic operators is a "**coordinated approach with vehicle manufacturers to ensure a clear plan for the introduction of in-vehicle as well as infrastructure technologies**" (PIARC, 2019).

The EU ITS Platform also highlights the importance of **collaboration between Road Operators and car manufacturers**. If they work together, Road Operators could use the data produced by automated vehicles as an "opportunity for **gaining better knowledge on the network state and implementation of more sophisticated network management strategies**". Moreover, in order to achieve a network optimum, cooperation between traffic operators and car (or navigator) manufacturers is needed on **development of routing strategies** (Courbon et al., 2016).

The PIARC report states that Road Operators need to intensify "**global cooperation with** the key stakeholders such as **vehicle, telecommunication/IT industries as well as service providers** within various fields of mobility services as a consequence of the ongoing rapid development. The primary aim of this cooperation is to **address the common challenges of legal issues, data/cyber security, and harmonization**". For Road Operators, one of the main focuses is the **functional interoperability of C-ITS services**. "They have also an important role in ensuring that planned services are able to be delivered via roadside broadcasting and cellular technologies in such a way that they are fit for purpose and compatible with the corresponding technologies implemented by the automotive industry". **Significant coordination with OEMs is therefore required since there are multiple options available to ROs with car manufacturers equipping cars with different technologies**. PIARC also emphasizes that ROs need to be aware that the state of available services and technologies are likely to change, so they need to remain flexible to changes and aware of emerging trends (PIARC, 2019).

Moreover, the EU ITS Platform emphasizes **the importance for Road Operators to ensure "consistency and continuity within the network** but also between networks, without many local particularities that would require special treatment, for things like road markings, signs, road surface quality, traffic management strategies and maintenance processes". This will be crucial for car manufacturers (Courbon et al., 2016).

The INFRAMIX Conference Paper claims that a **key issue for Road Operators is the digitalization of the road infrastructure** as "automated vehicles are supposed to be independent of road infrastructure elements and to rely solely on its built-in sensors". This means that the quality of infrastructure elements is crucial. Road infrastructure can play a key role in enabling and supporting automated driving. **A classification scheme for infrastructure support for automated driving (ISAD) has recently been introduced, which groups the availability of static and dynamic infrastructure information together with communication capabilities into classes.** The ISAD classification will support automated vehicles to operate under a more predictable environment. While ODDs may get

downgraded by a sudden change in the road topology layout, by heavy traffic conditions or under adverse weather conditions the infrastructure can support the vehicle's perception and close certain information gaps (Erhart et al., 2020, Carreras et al., 2018).

Research shows that the implication of physical infrastructure is as important as digital infrastructure and **requirements on physical infrastructure** are even more than that on digital infrastructure in the beginning. The thesis on Infrastructure requirements for Automated Driving suggests conducting a Cost-Benefit Analysis for each infrastructure requirement solution to make it clear to stakeholders whether infrastructure upgrading is necessary (Lu, 2018).

Backing this up, CARTRE came to the result that "The needs to adapt the existing physical infrastructure and to deploy new digital infrastructure for Automated Driving and transport are likely to increase with higher (SAE) vehicle automation levels". Moving towards levels 4 and 5, the **adaption of physical infrastructure and its link with the digital infrastructure is becoming a key factor for the deployment of AD** (CARTRE, 2018).

National Road Authorities and European Level

One of the major results from the Master Thesis on Infrastructure is that **Road Authorities can set concrete collaboration forms and rules with manufacturers in order to gain more trust**. They are active players who can enable cooperation and may involve more stakeholders who could have different interests in the process. "**Road authorities shall design an open and flexible process to make the decision and hold the international perspective**" (Lu, 2018).

The CARTRE position paper on AI and Big Data defines Policy challenges that are faced by policy makers and legal organisations on the national and EU levels. In order to overcome **privacy and security barriers** for sharing big traffic data, **appropriate solutions and security approaches are required**. Policies need to be established that take this into account as well as the **ownership of data**. The writers of the paper state that the EU should find ways to **enforce and/or stimulate data sharing** like open data pilots (CARTRE, 2018).

The EU ITS Platform has defined steps for states and the EU to take in order to establish a legal and normative framework for AD. This should include **protecting consumer and network operator rights and interests**, allow independent researchers to analyse and audit AD systems without facing legal consequences while also allowing industry stakeholders to preserve their commercial interests. This would help strengthen security and safety. Preferably at the largest possible level, at European level, a clarification of the **repartition between stakeholders** should **ensure that industry members have incentives to design AD systems with road safety as a key and overruling requirement**. Furthermore, **type homologation for automated vehicles should be done at European level**. Since the procedures are complex and expensive to design, this would avoid replicating costly work both for OEMs and public stakeholders. Lastly, "Data privacy agencies (ombudsmen) already exist in European countries. Specific regulation may be necessary for Automated Driving systems" (Courbon et al., 2016).

OEMs

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The ACEA roadmap for AD shows that vehicle manufacturers have the goal to further develop Automated Driving technology and its practical applications and provide the necessary technical expertise to support the regulatory process. Their 4 key focus areas for research and development in the near future are "Security, User adaption, Artificial Intelligence and Testing". The European automotive sector is one of the biggest investors in R&D and has a great interest in boosting European competitiveness in the global market. The proposed strategy for vehicle manufacturers includes especially to **"further develop Automated Driving technology and its practical applications"** and to **"provide the necessary technical expertise to support the regulatory process"** (ACEA, 2019).

In the European Roadmap Smart Systems for Automated Driving it is stated that "Offering good quality at reasonable prize is the key solution for staying on international market's lead positions and one of the major objectives of the European OEMs". Since **car manufacturers rely on consistency within and between networks, their role is also to cooperate with Road Operators to find an optimal strategy**. OEMs are set in the global market, therefore, it is in their interest to have as few as possible local or national peculiarities to deal with (Meyer et al., 2015).

3.3 *Conclusions on the literature review*

Based on these findings in our research, we can conclude that the responsibilities within the use case scenarios might not have been focused on in detail yet, since important advancements need to happen before we reach this phase. However, the position papers bring to light what the different stakeholder groups see as necessary steps in order to facilitate Automated Driving.

What can be seen throughout all the papers we screened is the need for collaboration between the different actors. Cooperation will be essential for the deployment of Automated Driving since lots of issues regarding privacy, security and responsibilities have to be solved. It becomes clear that no stakeholder group alone can tackle these problems, but that there needs to be a constant dialogue. For Road Operators, the main collaboration must happen with OEMs regarding the adaptions of physical infrastructure and its Digitalisation. The networks need to be consistent and the technologies have to be in line with car manufacturers. On a broader scale, Road Operators should work together with other Road Operators in order to avert national differences and ensure interoperability. OEMs also play their part in this collaboration and work together with Operators. Moreover, they see it as their responsibility to provide necessary expertise to support the regulatory process. National Road Authorities are in the crucial position to make collaboration possible. They can set collaboration forms and rules to ensure that a partnership between public and private stakeholders is possible and that there is an open and flexible process. Moreover, policies concerning privacy of data and cyber-security are big issues that have to be addressed. Our literature research also made it very clear that standardisation of data and type-homologation for automated vehicles need to happen on a European level.

Our research shows that there is literature on how certain stakeholder groups can contribute to making AD possible and therefore heading in the direction of the use case scenarios. However, it is not clear what role they will play in the end since circumstances are constantly changing and the future is quite unpredictable.

This leads to more general results from our desk research, but shows that the data collection and analysis within WP4 is very important to get an idea what the different actors envision for their future responsibilities at the moment.

4 Collection of stakeholder views

4.1 Need for direct collection of input from the stakeholders

As shown in the previous chapter as well as in DIRIZON Deliverable D.2.1. (Tucker et al. 2019), there are numerous open issues related to the upcoming necessities in the area of Digitalisation, connectivity and Automated Driving. On the other hand, the experiences and available sources of information regarding the real deployment and operation of Automated Driving in a mixed traffic environment are still rare and limited. As one overall objective of DIRIZON is to provide a concept for a technical data-exchange platform, with corresponding business models for its exploitation, in light of the step-by-step Digitalisation of NRA road assets and current and future relationships with stakeholders, the level of detail available from desk-research is not sufficient to answer these questions.

Therefore, DIRIZON's overall approach is to enrich the information available from desk-research with information directly collected from experts working actively in the area tackled. As described before this was done in two different steps:

Step 1 targeted general aspects related to the Digitalisation and Automated Driving (see D.2.1.). The consortium decided to go for personal interviews with key stakeholders from the group of the National Road Authorities/Operators addressing their current status of Digitalisation/automation, their policies, benefits and barriers they expect. This information was used for selecting the use cases and pre-defining the major core topics.

Step 2 is now covered by WP4 and needs detailed - use case related - information to validate the developed process flows and the included actors, roles and responsibilities and available data. Next to that, the concrete data needs, data exchange prerequisites, security and governance issues, as well as cross-border interoperability aspects need to be tackled. The information needed is relatively specific. This means, the number of experts able to answer at this level of detail is limited. In order to challenge the views of NRAs with the results of other stakeholder groups a differentiation to the different groups is also relevant. This means more responses are needed from different organisations in a very structured and comparable way.

To this end, a semi-structured web-based questionnaire was devised. This approach enabled the same information to be provided to each respondent and made the responses comparable, using quantitative and qualitative statistical analysis. While the analysis might not be of statistical significance, the comparison of responses using more simple statistical tools will allow to validate the use cases described, highlight the different roles and responsibilities and provide an overview of the different data availability and data exchange aspects, barriers and challenges related to security, interoperability etc. Furthermore, it will show clear trends and enables challenging the different views of different stakeholder groups.

The results of WP2 and WP3 were used as a basis for the implementation of the questionnaire. The developed process flow diagram for each use case convey what the activities are to deliver the use case, which types of data are exchanged, and which roles are involved to deliver the service. It is the task of WP4 to gather the views of different stakeholders on which roles and responsibilities of the stakeholders can be expected for the successful implementation of the services.

In this respect, the main aim of this questionnaire was to cover the different views on the different roles of the involved actors and their interaction. The results will be the very basis for the further data exchange concept provided by DIRIZON and the formulated recommendations towards the next steps.

4.2 Identification of relevant stakeholders, associations and platforms

An important task is to address all stakeholder groups relevant for the use cases identified.

In order to ensure the comparability of results and enable the challenging of different views of different stakeholder groups the aim of WP4 was, besides the identification of relevant stakeholders and the finding of associations and platforms, to address the stakeholders properly and as neutrally as possible.

Based on the findings of WP2 and WP3, the following stakeholder groups were identified that might be of relevance for the 3 DIRIZON use cases:

- Automotive suppliers
- (C-)ITS service providers
- Communication network providers
- Data providers / data holders
- (Digital) Map providers
- European Commission
- Frequency authorities
- Infrastructure suppliers
- Local transport authorities / administrations
- Logistics service providers
- National transport authorities / administrations
- OEMs
- Private Road Operators
- Public Road Operators
- Regional transport authorities / administrations
- Research / scientific institutions
- Road maintenance service providers
- Software suppliers
- Standard Development Organisations
- Transport service providers

The different stakeholder groups are expected to have different functions in the use cases. Some of them are actively involved, some are only passively involved (e.g. through the relevant Directive or regulations).

From this long list of relevant stakeholder groups, the DIRIZON consortium narrowed it down to a set of stakeholders that would be the target focus of the questionnaire. They were identified as main target groups based on previous findings and the expectations of their active role in the use cases. WP4 wanted to make sure that respondents from these specific groups could be reached since they are deemed to play a crucial and active part in the process of the deployment of Automated Driving and can therefore evaluate and extend the use cases provided in DIRIZON.

The following stakeholder groups were identified as main target groups:

- **Road Operators (public/private)**
- **Transport authorities (national/regional)**
- **Communication network providers**

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- **(Digital) Map Providers**
- **OEMs**
- **Platforms and Associations related to the abovementioned**

Next to the before listed main active stakeholder groups, **Research Institutions** were also targeted since they will be an important link to the current status of discussion regarding the innovative aspects.

To tackle the stakeholders, the DIRIZON consortium also identified relevant stakeholder associations/platforms and projects as multipliers to reach as many groups and potential respondents as possible (see Chapter 4.4 for a detailed description). In the following chapters, you will see that DIRIZON tried especially to collect input from these main stakeholder groups to collect the expected input.

4.3 Content and structure of the web-based questionnaire

As described before in the methodology, a desk study was conducted by analysing position papers and online questionnaires were prepared to achieve the required results in WP4. In the following, the overall structure and the main content areas of the questionnaire will be presented.

For the implementation of the web-questionnaire the consortium decided to go for the online survey tool "LamaPoll"[1]. This tool met the appropriate requirements of the General Data Protection Regulation and had the basic requirements regarding the necessary setup of the questions. As AustriaTech had some previous experiences with the tool the decision was taken quickly.

Based on the given requirements AustriaTech analysed the available information from WP2 and WP3 outcomes and prepared a first draft of the questionnaire. Following the draft was updated with input from all consortium members, especially considering additional parts for WP5 (platform concept) and WP6 (business models). The set of questions was cross-checked by the CEDR Project Manager in advance.

After that, the implementation of the online questionnaire took place, which was done with several feedback loops. Finally, the questionnaire was published on the 1st of October 2019.

After a short general introduction to the project the questionnaire was divided into seven main sections:

- **General Organisational Information on the respondent**
- **Description of the core topic incl. overview, process flow diagram, storyline**
- **Evaluation of activities and actors for each phases in the process flow**
- **Evaluation and feedback on data and data provision**
- **Risks and challenges & Opportunities and benefits for the core topic**
- **Overall evaluation of the process flow and storylines as basis for the reflected process**
- **Contact data / request for further information on the project**

In *Annex 1: Exemplary implementation of the questionnaire (see 9.1),* some screenshots of questions of the mentioned main sections enable a better overview on the realisation of the web-questionnaire in the survey tool "LamaPoll".

The questionnaire was first distributed after some pre-tests in October 2019, however, the response rate was quite low in the beginning. Subsequently, another version was issued on the 20th of November which divided the questionnaire into three parts (one poll for each core topic instead of all in one) and had a shorter introduction. This should ensure that potential respondents would not be discouraged by the length of the whole questionnaire and could simply select their preferred core topic. One of the reasons for splitting up the questionnaire was to achieve more focused input and responses for each use case. Furthermore, AustriaTech added a download option for the overview of the core topic (including the storyline and flow chart) on each page in order for respondents to have more time to look at the details while answering the questions. The consortium decided to also keep the full version of the questionnaire open in addition to spreading the shortened versions.

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[1] https://www.lamapoll.de/

4.4 Distribution of the questionnaire and Collection of Data

The consortium defined who the potential experts and stakeholders are to answer the questionnaire appropriately, based on their knowledge related to the use cases.

To reach the stakeholders, the WP4 leader together with the consortium used their networks, existing synergies, events and platforms to spread the questionnaire as widely as possible.

As mentioned before, the potential respondents' group was not that high, as it required deep knowledge in the respective use cases.

In order to reach these specific potential respondents, the whole consortium started a distribution initiative and different strategies were chosen:

- via the project website
- via LinkedIn by different members of the consortium
- via partners social media channels

As a core strategy, the questionnaire was promoted (e.g. via emailing, presentation) in the thematically relevant groups, platforms and associations, including:

- Thematic related platforms, associations and working groups:
  5GAA, ACEA Smart Mobility Team and ACEA network, Amsterdam Group, C-Roads platform, CLEPA, CENT TC278/WG 17 Urban ITS/METR Working Group, CEDR CAD group, CEDR PEB Group, EuroRAP, PIARC TC B2, EUCAR, C2CC, Women in ITS, Working Group CCAM
- Thematic relevant project consortia*:*
  INFRAMIX, ICT4CART, CEDR R&D projects, Crocodile, DATEX II (key stakeholders)
- Numerous key stakeholders directly from the network of the DIRIZON consortium:
  e.g. *TomTom, HERE, Siemens, Centro Ricerche Fiat, ASFINAG, KOZUT, BMW, Virtual Vehicle, Autopistas, DARS, Autovie Venete, Autostrade di Brennero, ICCS, Bosch, Nokia, Links Foundation, CEDA, Volkswagen, etc.*

Last but not least, the project and the questionnaire link were directly promoted at important events:

- *ITS Austria Conference 2019 (01/10/2019, Vienna/Austria)*
- *Austrian Forum for Automated Driving (02/10/2019, Vienna/Austria)*
- *PIARC World Road Congress 2019 (6-10/10/2019, Abu Dhabi/United Arab Emirates)*
- *ITS World Congress 2019 (21-25/10/2019, Singapore)*
- *2019 Annual ITS Conference, Ireland (13 – 14/11/2019, Enfield, Co. Meath/ Ireland)*
- *CEDR CAD Group Meeting (Plenary Meeting, 25/11/2019, Brussels/Belgium)*

As promotional material for the events the consortium designed a specific insert sheet, Figure 2, which was directly distributed and included in all DIRIZON folders which were distributed at the events.

Figure 2: Insert sheet for folders

Moreover, the questionnaire was promoted as part of project presentations at different events, e.g. ITS Ireland conference in the executive session and within the Plenary Meeting of the CEDR CAD Group in November.

The questionnaire was opened at 01 October, 2019 and was completed at the end of January 2020. The questionnaire was open for a total of 4 months. During this time the consortium promoted the questionnaire additional times, especially after the "split questionnaire" links were launched in November 2019 (see also chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**). The details on the actual respondent rate are included in the upcoming chapters on the analysis.

5 Analysis of collected data

As already mentioned in subchapter 2.1, the number of experts able to make profound statements on the very specific DIRIZON use cases is relatively small, as expertise is limited in this area. The consortium received valuable feedback and responses to the web-based questionnaire for analysis, which allows validating the process depicted, as well as the different actors and roles and relevant data. Even though there might not be statistical significance due to the relatively low statistical population, it allows identifying congruent and contradicting aspects in the process flow of the different use cases, as well as different possibilities for the actors taking an active role, as well as national differences. Taking into account the current available detailed data on the DIRIZON use cases these results represent a major step forward in identifying the basic requirements for the data exchange platform, as it will be developed in WP5.

As we were referring in the questionnaires to the "core topics", this term is also used for the upcoming analysis.

5.1 General statistics

In total, 53 participations responded to all three of the individual questionnaires not counting the responses that filled out less than 5% of the questions. In total, 10 countries are represented, however, it is not an even geographical distribution (see Figure 3). Most participants come from the United Kingdom with 12 respondents, closely followed by Germany with 11 and Austria with 9. Therefore, these three countries together make up 60% of all the answering organisations.

Geographical Distribution for all 3 Core Topics
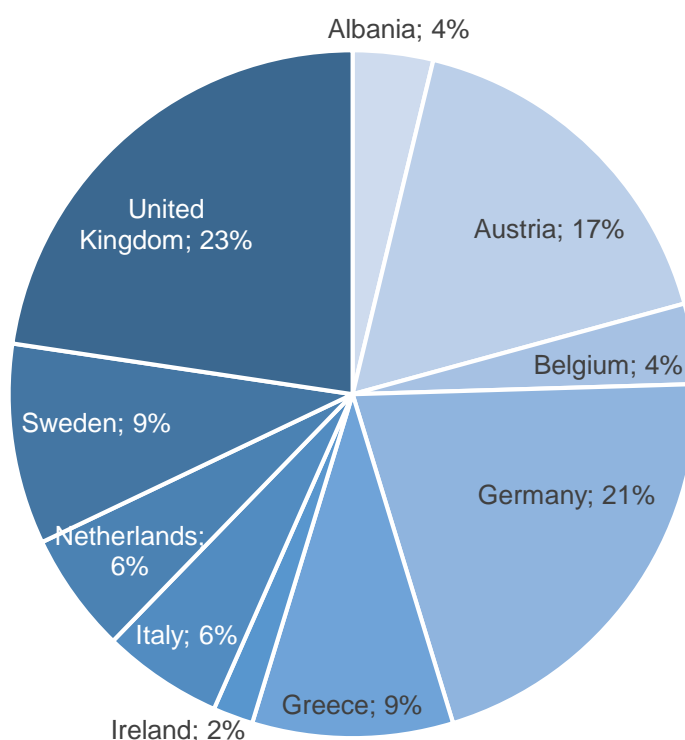
Figure 3: Geographical Distribution for all 3 Core Topics

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List of countries participating in the survey (alphabetically):

- Albania
- Austria
- Belgium
- Germany
- Greece

- Ireland
- Italy
- Netherlands
- Sweden
- United Kingdom
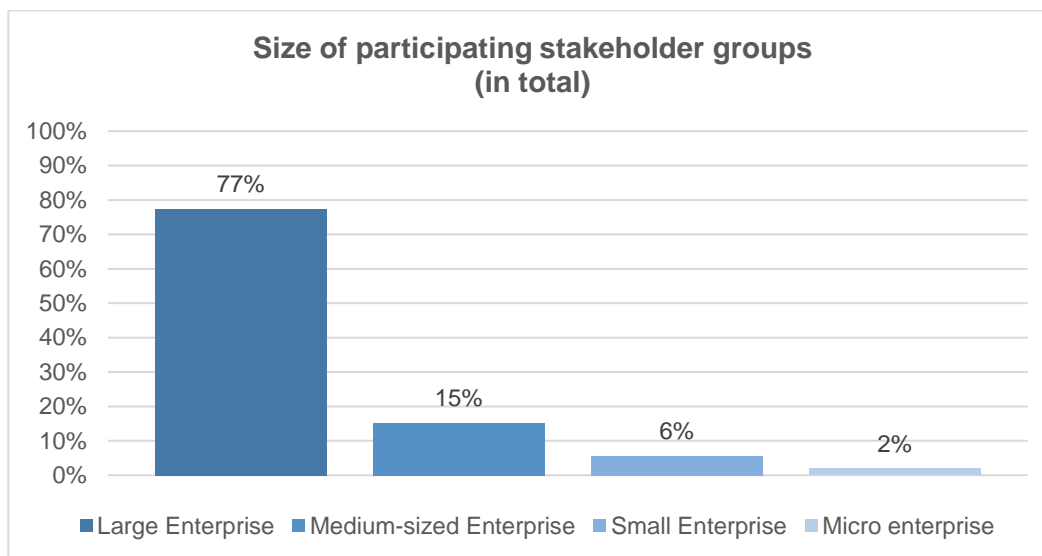
Figure 4: Size of participating stakeholder groups (in total)

Figure 4 shows that over 75% of the participating stakeholders come from large enterprises with more than 250 employees. The others mostly come from medium-sized organisations, only less than 10% from small or micro enterprises. One possible explanation for this distribution is that the field of experts for these specific topics is quite limited in the first place and in addition to that, small enterprises are harder to reach through the network. Of all respondents (listed in Figure 5), OEMs, Research Institutions and Public Road Operators together make up about 50%.
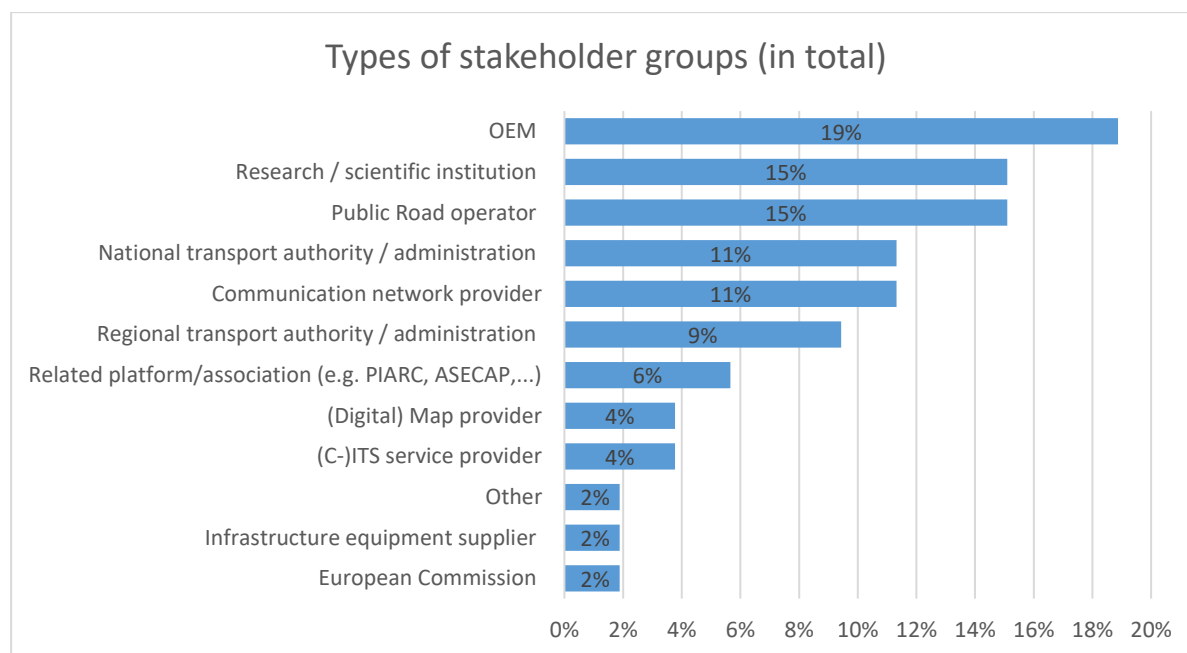
Figure 5: Types of stakeholder groups (in total)

5.2 Analysis of core topic 1 - Provision of High-Definition Maps for Automated Mobility

5.2.1 Overview of core topic 1 content

In this section, a summary of the storyline and the process flow diagram (see Figure 6), as it was provided to the respondents within the questionnaire, is presented.
Please consider that the process flow diagrams are future, generic implementations. Thus, not country-specific:

Storyline:
Core topic 1, deals with High-Definition maps meaning the provision of detailed mapping in a machine-readable format to support a cooperative, connected automated vehicle's (CCAV) ability to understand its precise positioning, plan beyond sensor vision, possess contextual awareness of the environment and local knowledge of the road rules:

Road Operators or authorized parties provide data needed for HD maps via a National Access Point (option 1) and / or to the Map Providers (option 2). These data include road model data (road geometry, width, gradients, and junctions), lane model data (number of lanes, widths, and attributes), localization model data (beacons, signs, and landmarks) or other relevant road related information (e.g. public parking information, etc). Road Operators provide certified / signed Electronic Traffic Regulation (ETR) data relevant to the HD map either to the trusted electronic regulation access point (option 3), or directly to HD Map Providers via a trusted party / secure connection (option 2). The process flow diagram shows the National Access Point and the Trusted Electronic Regulation Access Point are functionally different, with the Trusted Electronic Regulation Access Point requiring an extra level of certification and security. However, they do not need to be completely separate entities. For example, the Trusted Electronic Regulation Access Point could be a secure section within a National Access Point. The exact configuration is up to the responsible authority. WP5 of DIRIZON will investigate the blueprint for the data sharing platform, and will consider the repercussions of requirements on the Trusted Electronic Regulation Access Point for the blueprint of the platform.

If they have not received it directly, the HD Map Providers can pick up ETR from the trusted electronic regulation access point, and digitized road and lane models and localization data from the National Access Point. These information are integrated into its HD map, along with the certificate for the regulations.

The HD Map Provider provides its map to the service provider. The service provider uses the HD map in its service such as navigation, providing it to CCAVs and to smartphone devices to be used by human drivers. The information provided to the CCAVs and to the smartphones is then "visualised" for use.

The CCAVs and smartphones also provide feedback to service providers when inconsistencies are found between the information provided in the services and the environment sensed by the vehicle sensors or the smartphone mounted on the windshield or perceived by the human driver (map updates).

HD Map providers provide automated feedback to road authorities via the National Access Point and Trusted Electronic Regulation Access Point. The feedback concerns how and whether the data provided are used and feedback on the quality of the data provided. This allows the Road Operators to better optimize their process.

The topic of enforcement is not covered in this core topic.

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For some parts of the chain secure communication and provision of trusted information is necessary!
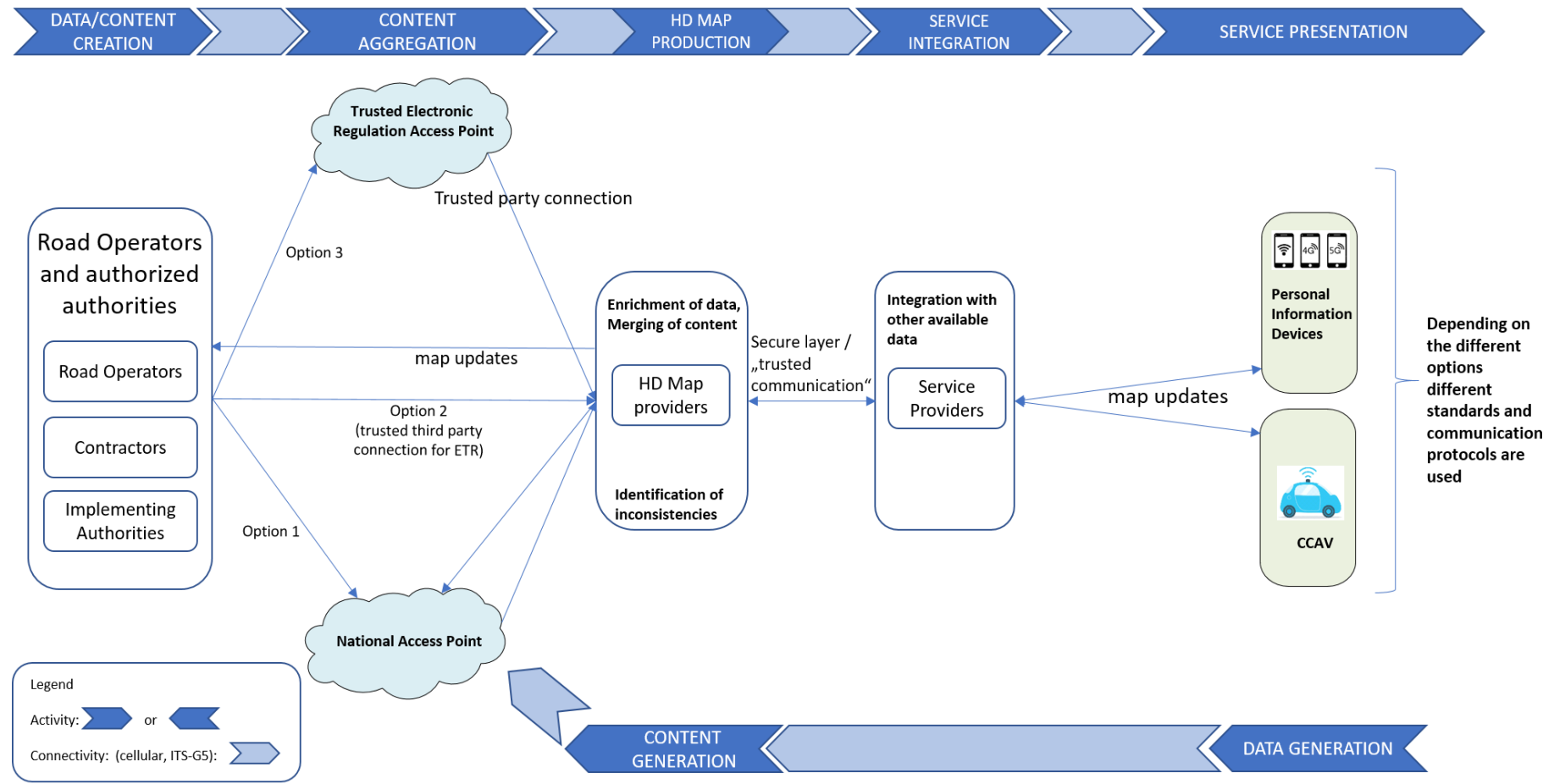
Figure 6: Process Flow Diagram for core topic 1

5.2.2 Core topic 1: Participation statistics

To set the results presented in the following subchapters into context, this chapter provides an overview of the participating stakeholder groups, the size of their organisations and the distribution of the organisations among different countries.

In total, 23 experts have participated in the questionnaire on the core topic on HD Maps. This number includes all those who have answered at least one question set of the questionnaire on HD Maps. In contrast, participants who only provided information on their organisation and country, but did not answer a single question regarding the topic, were not considered in further evaluations (19 participants).

In the survey, many different types of organisations and stakeholders were reached. Figure 7 shows an overview of all participating stakeholder groups and organisations. It is important to highlight here that **ALL the major target groups** - as described in chapter 4.2 (Identification of relevant stakeholders, associations and platform) – **could be reached** and answered the questionnaire. **The core target group of DIRIZON (incl. Road Operators and transport associations) represented one third of the respondents** (7 out of 23, corresponding to 30,4% of the participants). With the goal of comparing the view of these groups with "others" in WP4 the share is in line with the project goals and will foster the comparison between the different views. Contrary to expectations, only two (Digital) Map providers filled in the questionnaire on HD maps. With 8,7% of respondents the share could be higher, as it was expected to be one of the high priority topics of Digital Map Providers in the future. However, the low number of participation of Digital Map Providers in the questionnaire may also lead to the assumption that they currently do not see that they have an active role in the process. On the other hand, it has to be mentioned that this is the only core topic where Digital Map providers actively participated.

With 17,4% (4 out of 23) OEMs showed active interest in the topic, as well as Research and scientific institutions with the same ratio.

It has to be mentioned positively that among "Other" and "Related platform/association" there are participants from the 5G Automotive Association (5GAA) and the Dutch National Data Warehouse (NDW) which are important multipliers.

Participating organisations/stakeholder groups
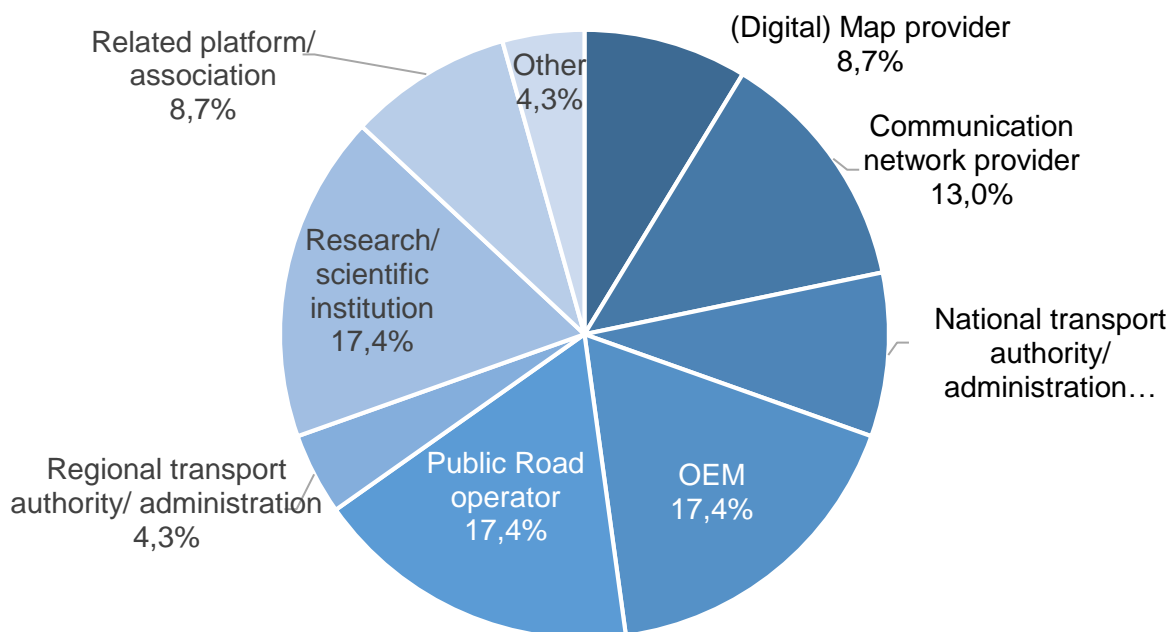
Figure 7: Overview of all participating stakeholder groups

According to Figure 8, mainly experts from large companies, which includes enterprises with more than 250 employees) have participated.
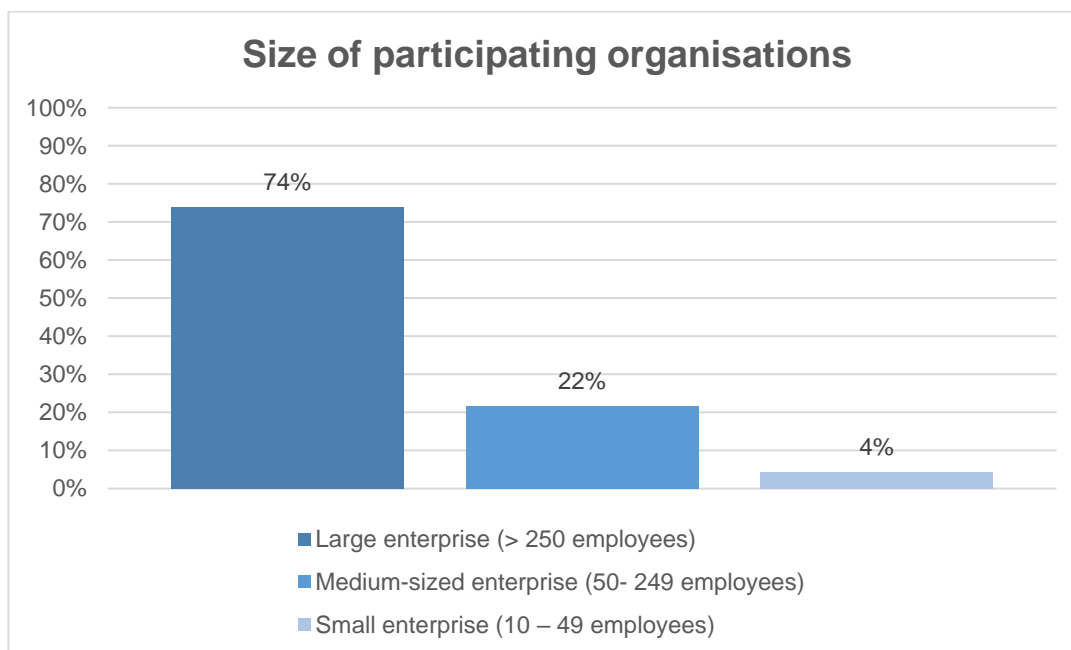
Figure 8: Size of the participating organisations in core topic 1

Having a look at the geographical coverage of responding organisations in Figure 9, we can see that more than half of them come from Germany, the United Kingdom and Austria (in total 56,5%). The remaining participants come in equal numbers from Italy, the Netherlands, Sweden and Greece (2 each) and one participant each from Belgium and Ireland. Based on the responses, this means that we do not have a majority of one country and we cannot derive trends from North to South Europe.

Participants per country
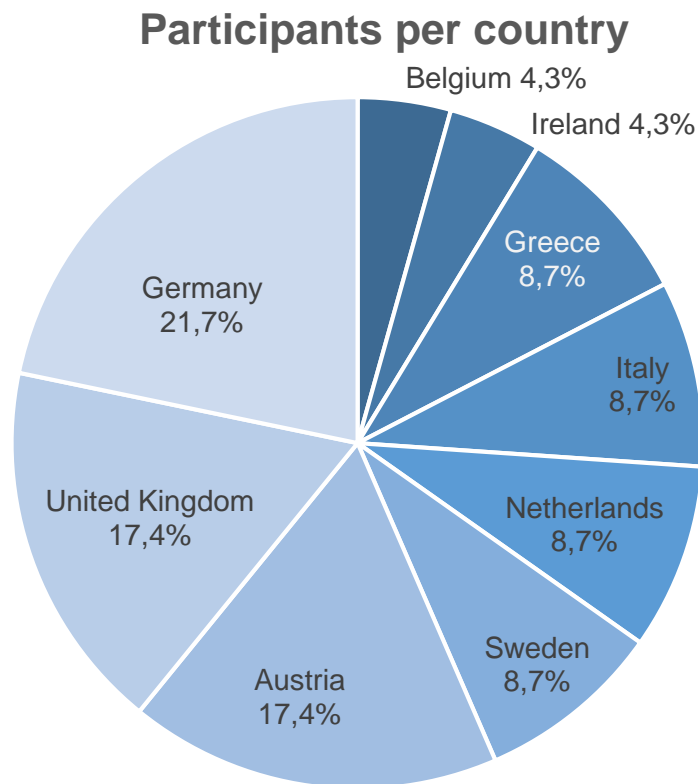
Figure 9: Participants per country in core topic 1

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5.2.3 Core topic 1: Validation of process flow diagram – Activities and Actors

In the previous work packages within DIRIZON, some main activities and actors for the provision of HD maps for automated mobility were already identified. In this context, an activity describes a small sub-part of each phase of the process (see Figure 6) and an actor is a certain type of organisation that fulfils activities.

To validate what has been described within DIRIZON and collect additional information on the role of the actors the participants were asked to evaluate the proposals on activities and actors involved by analysing their relevance for the core topic. Furthermore, they should indicate if their organisation could fulfil the proposed activities. Figure 10 is about the different activities and the question whether they are seen as a part of the process for implementing HD Maps or not.

To ease the step by step validation, the activities were structured to different phases, as they were used in the process flow diagram. For core topic one the following phases were relevant:

- *PHASE 1: Content Creation*
- *PHASE 2: Content Aggregation*
- *PHASE 3: HD Map Production*
- *PHASE 4: Service Integration*
- *PHASE 5: Service Presentation*
- *PHASE 6: Feedback loops*
- *PHASE 7: Enabling and regulation (this phase is not included in the flow chart for visualisation reasons)*

In the following analysis of results, we refer to these phases.

The first part of the analysis is focused on the overall consent or dissent to the depicted process for core topic 1. The second part distinguished between the different stakeholder groups, as they reveal some clarifications for the responses.
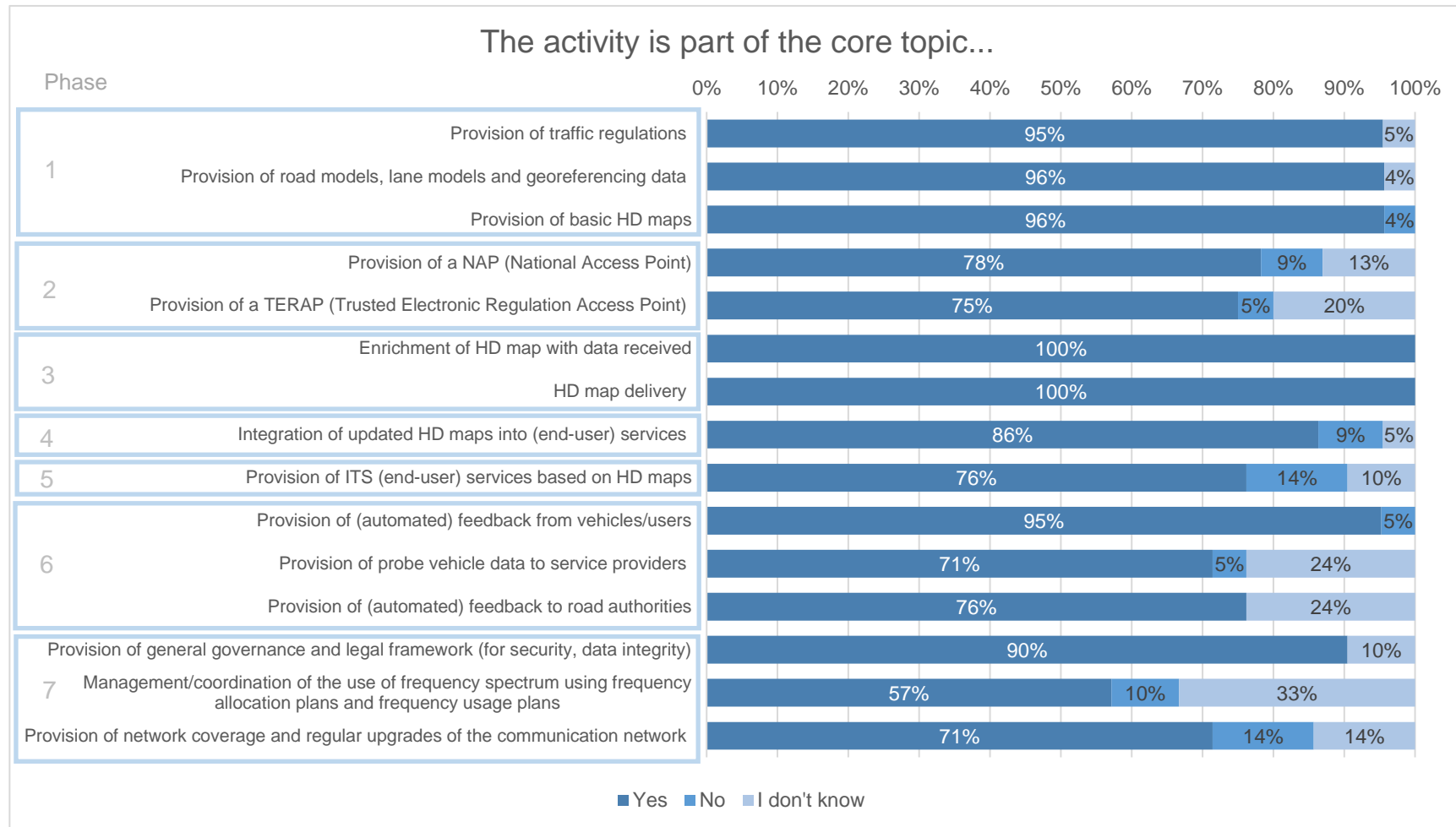
Figure 10: Overview of the acceptance rate regarding the process/flowchart in general (core topic 1)

Activities \ Stakeholder groups	(Digital) Map provider	Communication network provider	National transport authority / administration	Regional transport authority / administration	OEM	Public Road operator	Research/ scientific institution
Provision of traffic regulations	100%	100%	100%	100%	100%	100%	75%
Provision of road models, lane models and georeferencing data	100%	100%	100%	100%	100%	75%	100%
Provision of basic HD maps	100%	100%	50%	100%	100%	100%	100%
Provision of a NAP (National Access Point)	100%	100%	100%	0%	50%	100%	75%
Provision of a TERAP (Trusted Electronic Regulation Access Point)	100%	100%	50%	0%	100%	67%	100%
Enrichment of HD map with data received	100%	100%	100%	100%	100%	100%	100%
HD map delivery	100%	100%	100%	100%	100%	100%	100%
Integration of updated HD maps into (end-user) services	100%	100%	50%	100%	75%	75%	100%
Provision of ITS (end-user) services based on HD maps	100%	100%	50%	100%	75%	75%	100%
Provision of (automated) feedback from vehicles/users	100%	100%	100%	100%	100%	75%	100%
Provision of probe vehicle data to service providers	100%	67%	50%	100%	67%	25%	100%
Provision of (automated) feedback to road authorities	50%	67%	100%	100%	100%	25%	100%
Provision of general governance and legal framework (for security, data integrity)	50%	100%	100%	100%	100%	100%	100%
Management/coordination of the use of frequency spectrum using frequency allocation plans and frequency usage plans	0%	67%	100%	0%	100%	75%	33%
Provision of network coverage and regular upgrades of the communication network	100%	100%	100%	100%	100%	50%	33%

Table 1: Overview of the acceptance rate ("Yes, the activity is part of the core topic") regarding the process/flowchart by stakeholder groups

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Starting with the overview (see Figure 10) it can be stated that on a general level the validation shows that the process, as defined in the process flow diagram (accompanied by the storyline) by the DIRIZON consortium, is in line with the view of the DIRIZON stakeholders and therefore a valid basis for the definition of the further steps.

The statistics show that there is a broad agreement with the process in general for all participants. Nevertheless, there are phases and activities where the degree of approval varies. We could identify some activities that are clearly part of the process and other activities that should be investigated more thoroughly. In addition to the general acceptance rate of the activities (see Figure 10), Table 1 below gives an overview of the degree of approval by the different stakeholder groups.

Looking at the statistics, one can see that there is an outstanding acceptance regarding the activities within *Phase 1: Content Creation*. All three activities within this phase received a consent of 95% from the respondents (Figure 10).

When looking at *Phase 2: Content Aggregation* the participants do not agree with such a high degree it is notable that at least 20% (4 out of 20 participants) are not sure if the Provision of a TERAP (Trusted Electronic Regulation Access Point) is a necessary part for implementing HD Maps.

This might be accompanied by a lack of understanding regarding TERAP. But to understand the response rate one could have a deeper look at the different stakeholder groups and their responses (Table 1).

What we can see from the differentiation between the stakeholder groups is that especially the regional transport authorities don't agree or are not sure about the provision of the NAP as part of the use case, whereas the other public institutions absolutely agree with the provision of a NAP. As the NAP is a role that is handled on the national level, regional authorities might not perceive the NAP as that relevant compared to national bodies. On the other hand national transport authorities do not fully support the idea of a TERAP. This can be caused by the fact that the TERAP means building up another institution next to the NAP that is not discussed or harmonised on national level. Therefore, potential organisational models or ideas for financing are not available yet. Furthermore, a definition of TERAP is missing currently in international papers on the topic. So this might be another reason for the uncertainty.

In *Phase 3: HD Map Production,* there is 100% (22/22) approval that the proposed activities are part of this core topic. From the figures, it is apparent that *Phase 3* is essential within the process flow of the provision of high-definition maps.

For *Phase 4: Service Integration* we can see a principal approval (86%, which means 19 out of 22 respondents agree with this phase as described). But there are some comments that gave a more in-depth look, with one NRA stating "No" adding that "the HD map should have a declared quality, but the integration is not necessarily part of the core topic".

But *Phase 4* has significantly more approval than the 76% in *Phase 5: Service Presentation* (16 out of 22).

It is interesting that 14% of the participants see no need for a provision of ITS (end-user) services based on HD maps. Looking at the additional comments respondents that stated "No" added that: the provision of an end-user service "*is something that is handled outside the core topic*" (NRA),"*will be specific certain products, customers and touchpoin*t" (OEM), as well as

"*Provision of ITS (end-user) services are added value services rather than core services*" (Public RO).

For the further phases this can be considered in the business models or as different variants of the organisation of the data exchange platform.

For *Phase 4*, as well as for *Phase 5*, mainly national road authorities, OEMs and Public Road Operators had the feeling that these activities are not part of the core topic or were uncertain of the real need. This could mean that NRAs (and Public Road Operators) see this task as something that is not part of the core activities, when discussing HD maps for Automated Driving. **This is a clear difference that has to be discussed when looking at the contradicting views of the different stakeholder groups** that might come from different role definitions in these two groups (see Table 1).

The results demonstrate that the approval to the individual activities varies within the Phase 6 *Feedback Loops*. On a general level we can say that the provision of feedback from different sources is one of the most contradicting issues so far and requires further investigation but is out of the scope of this project, especially as we can see that some groups clearly agree with the fact of using e.g. NAP data, while they don't see the need in providing feedback to raise the data quality.

The majority (95%) sees the activity *Provision of (automated) feedback from vehicles/users* as part of core topic while the other two activities show a high degree of uncertainty (24%), see Figure 10.

While it is clear for most of the stakeholder groups that the automated feedback from vehicles and users must be considered in the provision of the service, this is not that clear for other types of feedback. Looking at the point of view of public institutions like NRAs and Public Road Operators they are not sure if probe vehicle data will be included in the provision of the service in the future. In future projects on this subject one should take a deeper look at the reasons for this (costs for data provision, availability, quality of data…).

The last activity of this phase deals with the automated feedback provided to road authorities via the National Access Point and Trusted Electronic Regulation Access Point. The feedback concerns how and whether the data provided is used and feedback on the quality of the data provided. This allows the Road Operators to better optimize their process.

Regarding the provision of feedback to road authorities, especially (Digital) Map Providers have inconsistent views. The discussions and premises on the level of the Map Providers are different, which means for the next steps that this has to be on the discussion agenda in the future. With regards to data quality, the feedback from the (Digital) Map Providers to the NAP or road authorities might be of high relevance. This is one important contradicting issue that will be in the focus of further activities.

The same is true for Public Road Operators for reasons that are not quite obvious and might be based on the current expectation of Public Road Operators regarding the role of the NAPs.

It is especially interesting as 100% of the Public Road Operator agreed that the provision of data via the NAP in an earlier phase is clear, while they don't see the feedback to the NAP as part of the process.

In the final *Phase 7: Enabling and regulation,* the acceptance rate for the activities varies widely (see Figure 10).

Only the first activity *Provision of general governance and legal framework (for security, data integrity)* is generally considered as a necessary part of the core topic by an agreement of 90%.

Especially the activity *Management/coordination of the use of frequency spectrum using frequency allocation plans and frequency usage plans* shows a very low approval (57%), additionally one third (33%) are not sure whether the activity is part of the core topic or not. Especially for the (Digital) Map providers and the regional transport authorities this activity is not included in the core process. It seems that there is no discussion regarding this aspect including these two stakeholder groups. The view of the Research Institutions on the topic is varying.
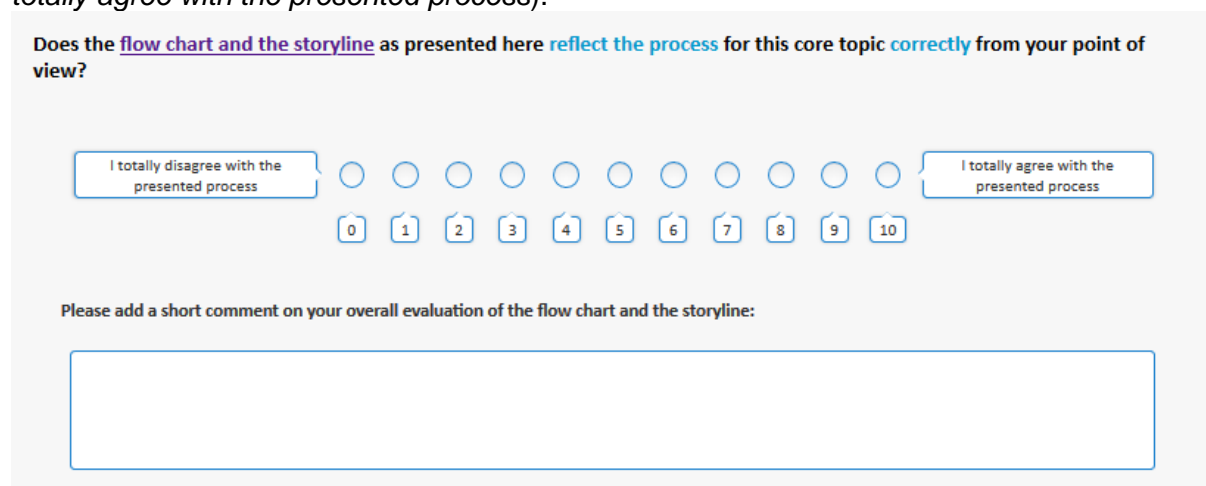
As an additional comment, one respondent added: "*It is an important topic but should not be addressed in the scope of HD map creation*", while another respondent added together with a "*No*": "*because the core is on the HD map management and not on the distribution to the users/vehicles*". Due to these results the DIRIZON consortium will again focus on this activity and have a deeper look if this should be really handled as part of this topic or only be described as relevant framework conditions, but outside the sphere of the core topic (see chapter 7.1).

The last activity *Provision of network coverage and regular upgrades of the communication network* indicates an approval of 71% (15/21), on the contrary, the answers "no" and "I don't know" show a rate of 14% each. These findings reinforce the fact that there are great uncertainties within the last phase, which could derive from not being visible on the flowchart and therefore not being seen as a single part of the process but more as an overarching phase. Another interpretation for the 14% "No" might be the fact that respondents see this as a meta topic, that has to be defined outside the restricted frame of the core topic. This is also supported by the comments "*It is an important topic but should not be addressed in the scope of HD map creation*", "*because the core is on the HD map management and not on the distribution to the users/vehicles*".

5.2.4   Core topic 1: Overall evaluation of process flow diagram and storyline

In the last part of the questionnaire respondents were asked "*Does the flow chart and the storyline as presented here reflect the process for this core topic correctly from your point of view?*"
The idea is to focus on the general feedback on the process as a whole. Respondents could rate the general flow on a scale (*0 – I totally disagree with the presented process* up to *10 – I totally agree with the presented process*).

Figure 11: Screenshot on overall evaluation of flow chart and storyline

On an overall level the process flow chart and the included storyline received an average rating of 7,6. This means that the respondents agree in wide parts with the presented storyline and the presented process for core topic 1.

Stakeholdergroup	Rating
(Digital) Map provider	6,5
Communication network provider	9
National transport authority / administration	6
OEM	6
Public Road operator	7
Regional transport authority / administration	8
Research / scientific institution	9
Total rating all stakeholder groups	**7,6**

Table 2: Results overall rating process core topic 1

On the level of the different stakeholder groups we see that at the moment not all relevant aspects for our core target group, especially NRAs are considered, because of a rating of "6". The basis is there, but from the point of view of NRAs there are some adaption needs, while other groups like scientific institutions and Communication network providers could align very well with the process.

Some respondents used the option to add additional comments. In the section below we summarize especially those that recommended some specific aspects and changes as basis for the further discussion within the project.

Looking at the (Digital) Map provider, that have rating of 6,5 in average commented that:
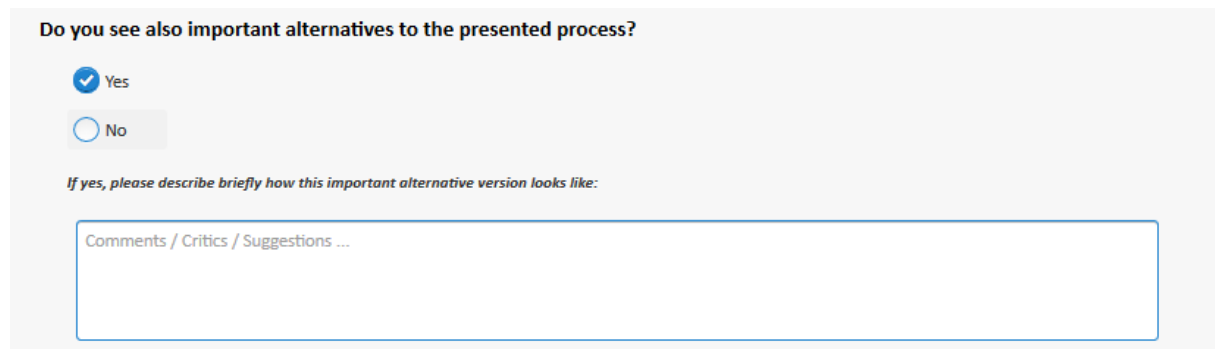
- *"Sometimes roles are overlapping in reality (service provider are at the same time Map Provider)"*
- *"The Map update arrow between the Road Operators/authorities and HD Map providers is going in the wrong direction. Any public related changes that concern the map should be communicated to this."*
- *"The arrow implies that road authorities/operators can also be a user of a HD map. For what purpose/use case could this happen?"*
- *"The diagram gives the impression that the HD map is used for "visualisation", but the HD map should be thought of as the "brain" of the autonomous vehicle. It's not seen by the driver."*
- A *"content delivery phase is also needed in the process flow chart, alongside or within the data/content creation".*

The communication network providers, which, in principle, were confident about the presented process (average rate 9), added in addition to the fact that the process is visualised quite well that "*concrete Autonomous driving function/service and AD vehicle service (like AD taxi) are not considered*" and "*the description of a low-latency information layer for immediate traffic warnings is missing*".

The Public Road Operators (with an average rating of 7) added that

- *"Some map layers might not require to be integrated in a HD map in the cloud but are directly exchanged between service provider and Road Operator".*
- *"There should be a direct communication for Delta changes of the HD map between data to CCAV"*

In addition, respondents had the possibility to **describe important alternatives** to the described process.

Do you see also important alternatives to the presented process?

- ● Yes
- ○ No

If yes, please describe briefly how this important alternative version looks like:

Comments / Critics / Suggestions ...

Figure 12: Screenshot of questionnaire with option to describe alternatives to the presented process

The following alternatives were collected:

- *"All data flow to the car is to be managed by the OEM - similar to how Apple manage all apps on the apple products. This minimises risk to drivers safety and security."* (OEM)

- *"Some map layers might not require to be integrated in a HD map in the cloud but are directly exchanged between service provider and Road Operator"* (public RO).

The overall evaluation in addition to the comments is a very helpful input for the final fine-tuning of the use cases as a basis for the upcoming work packages.

5.2.5 Core topic 1: Validation of roles and responsibilities

Another aim of this work package was to examine which responsibilities the stakeholder groups see themselves taking and which responsibilities they expect others to take.

In a first step in context of the questionnaire, the participants were asked to evaluate which actors can fulfil the proposed activities. Therefore, certain types of organisations were previously identified for each activity within the different phases of the process. The participants also had the opportunity to name additional actors who could fulfil the proposed activities according to their experience.

In the case where the activity was seen as part of the core topic, the acceptance towards proposed actors was analysed. The following figures give an overview of actors and their roles in the process of provision of HD Maps for Automated Driving.

As this was done together with the validation of the activities, the following analysis is also based on the phases:
- *PHASE 1: Content Creation*
- *PHASE 2: Content Aggregation*
- *PHASE 3: HD Map Production*
- *PHASE 4: Service Integration*
- *PHASE 5: Service Presentation*
- *PHASE 6: Feedback loops*
- *PHASE 7: Enabling and regulation (not visible in the flowchart)*

For the analysis of the roles and responsibilities only those respondents were considered that marked the relevant activities as "part of the core topic". Multiple actors for each activity were possible.

Core Topic 1: Overview of most important actors

Content Creation	Content Aggregation	HD Map Production	Service Integration	Service Presentation	Feedback Loops	Enabling & Regulation
•HD Map Providers •Road Operators •Public Transport Authorities	•Other	•HD Map Providers •(ITS) Service Providers	•HD Map Providers •(ITS) Service Providers	•(ITS) Service Providers •HD Map Providers	•Automated feedback from users or automated driving cars •Automated Driving Cars •ITS Service Providers	•European Commission •Frequency Authorities •Communication Network Providers

Figure 13: Overview of most important actors of Core Topic 1

This flow diagram, shown in Figure 13, lists the three most important actors in each of the seven phases in the process of providing HD Maps for Automated Driving. The reason why some phases have just two actors listed is that we only included actors if more than 50% of the respondents see that they can fulfil activities within the phase.

It is possible to draw first conclusions from this diagram, for example that HD Map providers are among the most important actors in the first phases of this core topic which is not surprising. ITS Service providers also play a big part in the provision of HD Maps. Road Operators as well as public transport authorities are mostly concerned with the creation of content while the procured data from Automated Driving cars is especially important for feedback loops. Moreover, it is not surprising that the last phase that is not visible in the flowchart (for visualisation reasons) calls for completely different actors than the first six phases (e.g. European Commission).

Figure 13 serves as a first overview to get the full picture of all important actors. The following figures show the results in much more detail as the phases are split into activities and all actors and percentages of approval are stated.

Those who see the first two activities of *Phase 1: Content Creation* as part of the core topic assume that **Road Operators will play an important role in providing traffic regulations (76%,16/21) and road models**, lane models and georeferencing data (86%; 19/22), while the provision of HD maps is clearly a task for the HD Map Providers (91%; 20 out of 22 respondents). Yet, also Road Operators are seen as potential providers of HD maps (41%, 9 out of 22), see Figure 14. What we can see from the analysis that the provision of road/lane models and georeferencing data can be as well a task for the Road Operators, but also for the public transport authorities. This might depend on the national differences and general responsibilities regarding the lane and road models. Also, other potential actors were named for the provision of road and lane models like Research Institutions, Map Providers or map operators and certain private companies.
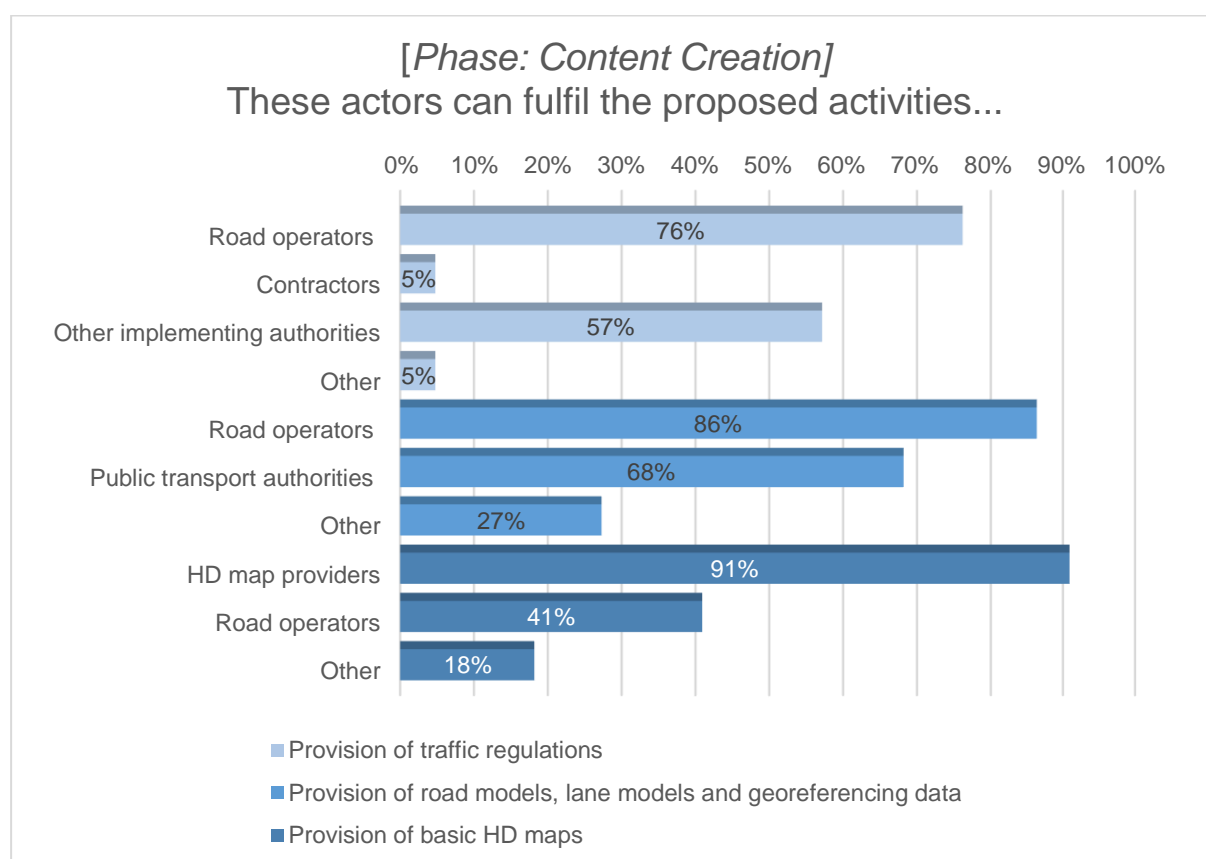
Figure 14: Proposed actors Phase Content Creation

This could be confirmed by considering whether the participants organisation can fulfil the activity. **75% the respondents from the Public Road Operators marked that they could fulfil this activity**. Besides that, other **implementing authorities like public transport authorities** are also worth considering while thinking about suitable actors for the first activities of the process.

For the HD Map Providers it is quite clear, as all answering (Digital) Map Providers responded that they can fulfil this activity.

Phase 2: Content Aggregation (which is referring to the provision of a NAP and a TERAP) is more complicated regarding the potential responsible actors compared to other activities of the process flow.

The results show clearly that the NAP is a task of a national organisation/authority, like ministries or similar public organisations. Equally, this is a task for those institutions that have already been providing the NAP like the National Data Warehouse for Traffic Information in the Netherlands. Moreover, the option of international organisations or communication system providers were added as options.

For *Phase 3: HD Map Production* the results are clearer (Figure 15). As predicted, most of the respondents (86-100% depending on the activity) assume that HD Map Providers could fulfil the proposed activities, directly followed by ITS service providers (65%-68%). **For the enrichment of the HD map, Road Operators might play a role**. This finding is consistent with the analysis of stakeholder groups' answer where digital Map Providers see themselves taking over these tasks. In addition, ITS service providers can probably fulfil the mentioned activities within *Phase 3* (see Figure 15). 45% of those who see the activity as part of the core topic assume that also Road Operators could be entrusted with the enrichment of HD map with data received. All of this points to the fact that cooperation between different actors may be the solution for a successful HD Map Production.
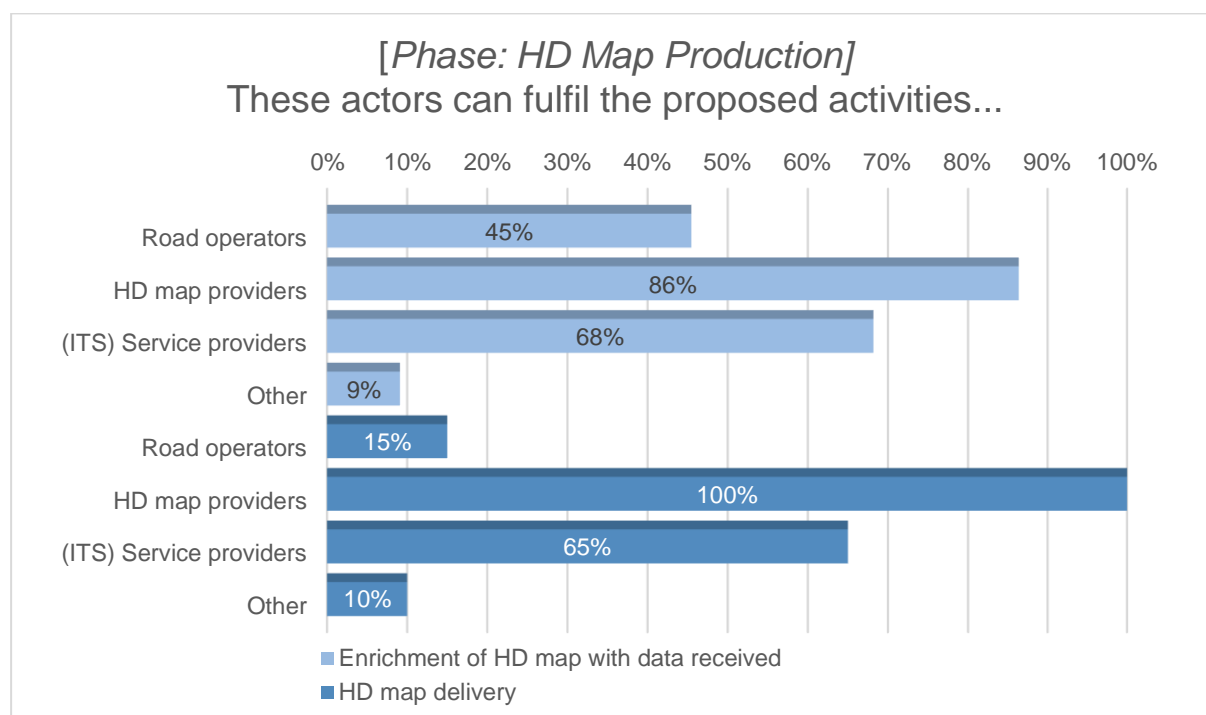
Figure 15: Proposed actors Phase HD map production

In Figure 16, the Phases *Service Integration* and *Service Presentation* were combined for further analysis of potential actors.
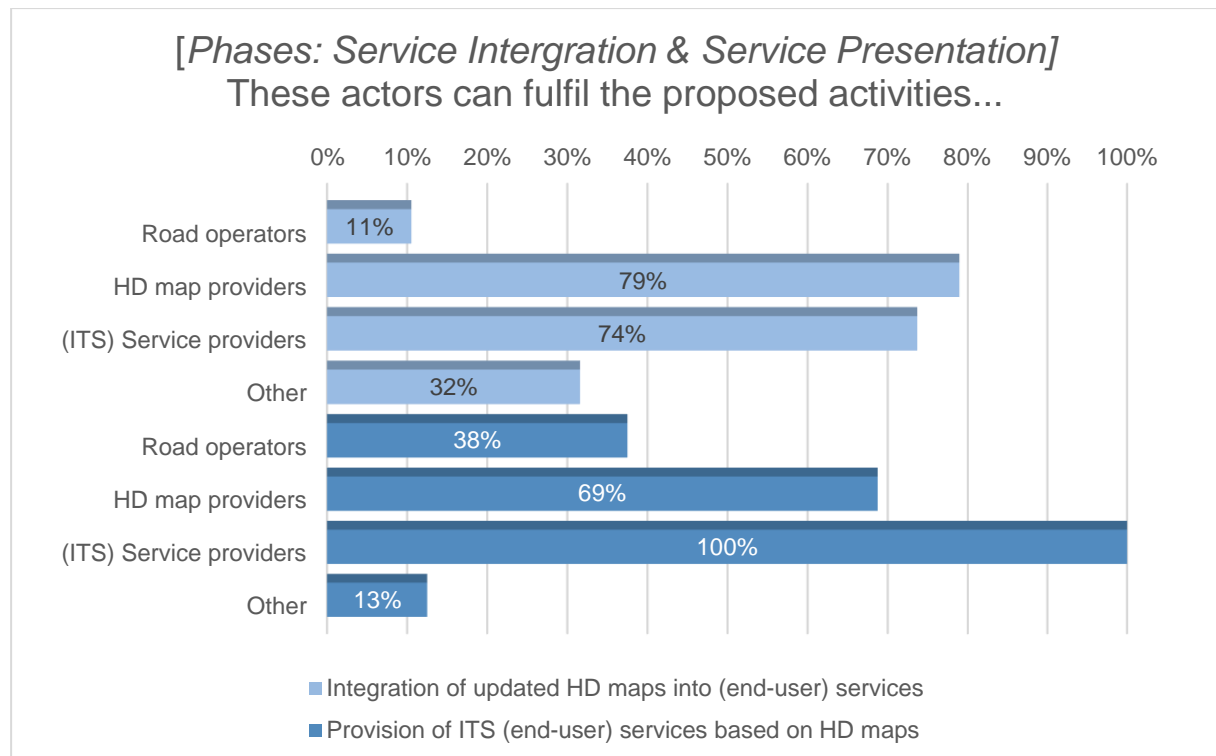
Figure 16: Proposed actors Phases Service Integration & Service Presentation

Taking into account the statistical data, HD Map Providers (79 %) as well as ITS service providers (74%) could be responsible for the integration of updated HD maps into (end-user) services. This leads to the conclusion that **more than one actor can fulfil this activity** and that **cooperation between multiple stakeholder groups is key**. Especially ITS service providers (100%) play a significant role in the provision of ITS (end-user) services based on HD maps. However, at least half of the participating Public Road Operators see themselves taking the responsibilities. Also other stakeholder groups assume that besides ITS service providers, Road Operators (38%) as well as HD Map Providers (69%) can fulfil the proposed task (see Figure 16).

Regarding the Phase *Feedback Loops* the participants assume, as expected, that the provision of (automated) feedback from vehicles/users results from a cooperation from Automated Driving cars (95%) and users (75%). In this context, some other actors were mentioned like "ITS equipment/mobile phones" or "various applications" which could provide feedback.
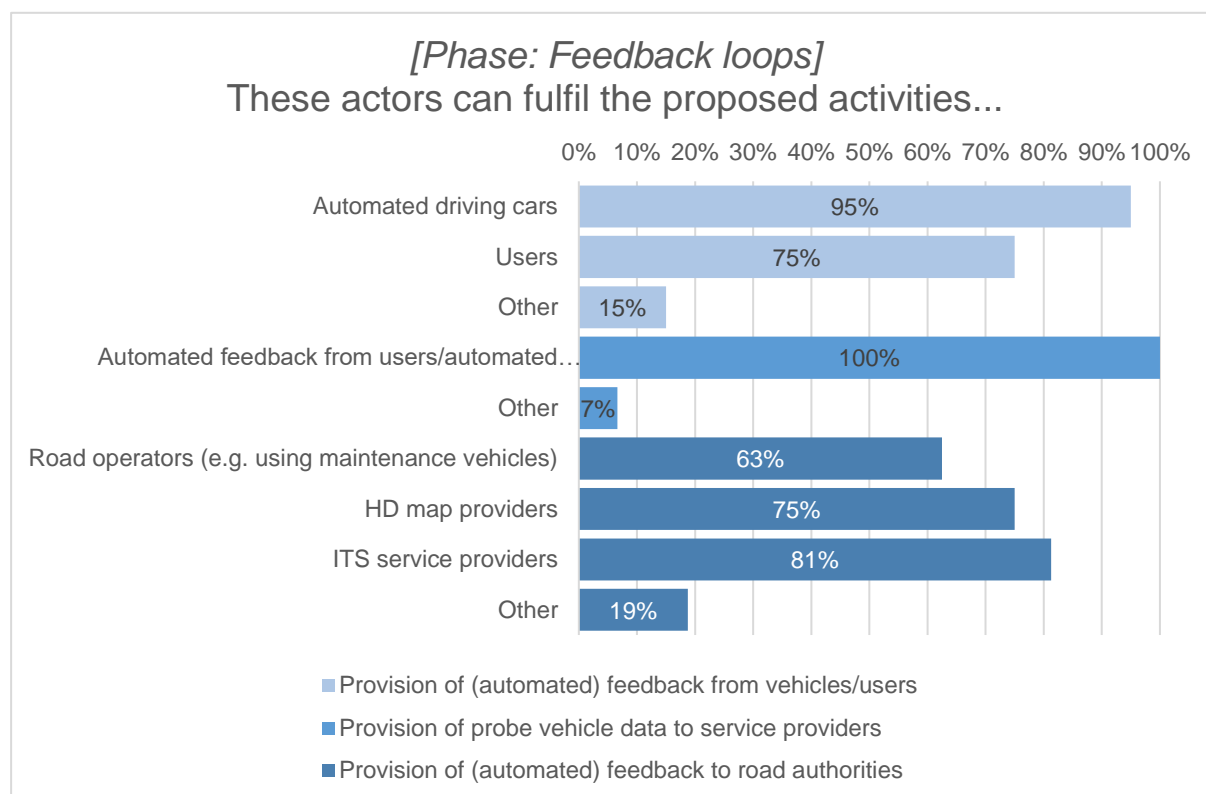
Figure 17: Proposed actors Phase Feedback loops

The fact that the number of those who are uncertain whether the last two activities are necessary (24%), is confirmed by a small number of stakeholder groups who see themselves as actors that could fulfil this activity. This includes (Digital) Map providers and Research/Scientific Institutions. All of those 71% of respondents who see the Provision of probe vehicle data to service providers as part of the core topic assume that users as well as Automated Driving cars will provide automated feedback. In comparison, it should be highlighted that the participants suppose that different actors are responsible for providing /automated) feedback to road authorities. According to the answers ITS service providers, HD Map Providers as well as Road Operators could fulfil the proposed activity.

Last but not least, the results of the questionnaire show that within the last Phase *Enabling and Regulation,* the fewest of the participating stakeholder groups can fulfil the proposed activities. Consequently, a direct correlation with the minor share of those who see the activities of the last Phase *Enabling and Regulation* as part of the core topic is obvious (Figure 18).

In contrast, those who consider the proposed activities as necessary have a clear opinion on the distribution of roles within the activities. All of them see the European Commission in the role of responsibility when it comes to the provision of general governance and legal framework. In this sense, the European Commission and the relevant governmental bodies play an important role for the general development of the core topic. Furthermore, communication network providers can fulfil the last activity Provision of network coverage and regular upgrades of the communication network.
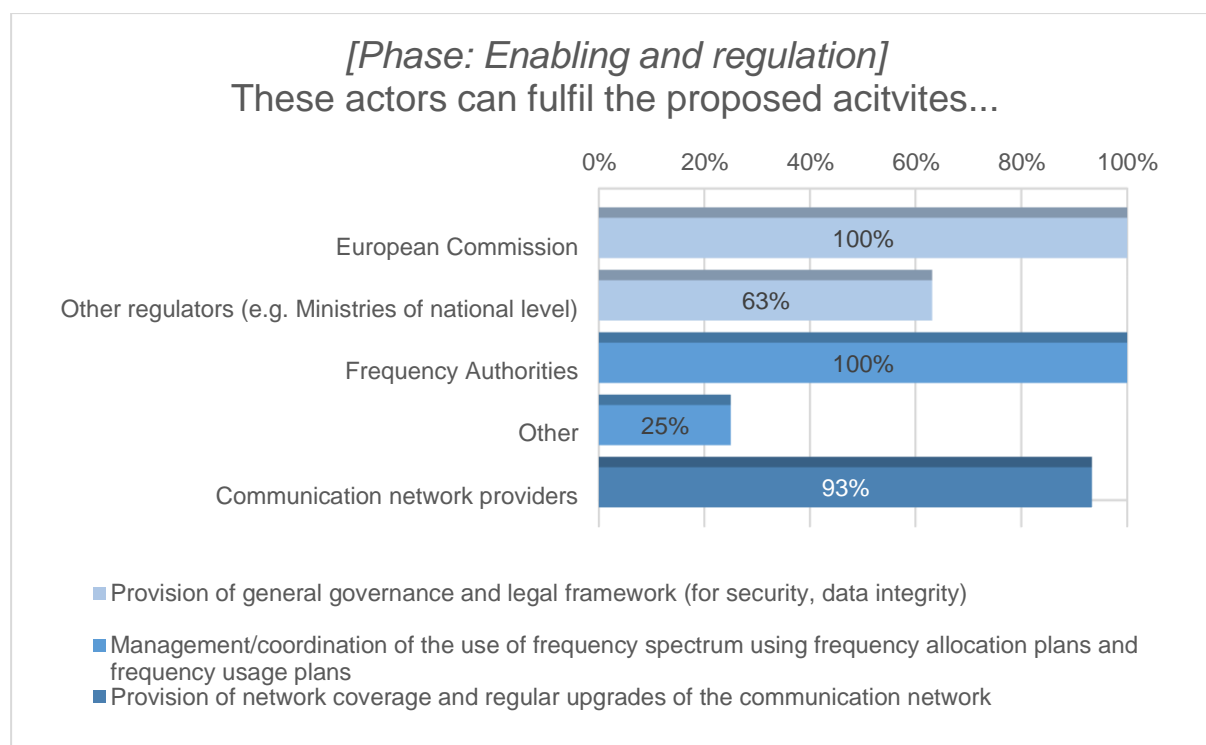
Figure 18: Proposed actors Phase Enabling and regulation

Cross-border aspects related to the responsible actors

The questionnaire also addressed necessary changes regarding cross-border interoperability. Respondents were asked *"How will it affect your answers if the end-user/vehicle uses the same service in another country? Will there be any changes e.g. regarding the activities or the related actors?"*

Analysis showed that the majority (**60%;** 12/20) of the participants **do not expect any changes.** At least **25%** (5/20) of the experts estimate that **minor changes** may be expected (coming from the groups of Communication network providers, Public Road Operators as well as Research/Scientific Institutions and an engineering consultancy).

It is assumed that depending on cross-border differences some adaptions would be necessary. This includes **"*language adaptions for different traffic signs*"** as well as the need for an "*extra layer of checking/conversion*". All of this points to the fact that more alignment between Road Operators becomes relevant. Another participant assumes moderate changes because of the completely different rules in China compared to the United States or the European Union. Especially OEMs and communication network providers expect moderate or even significant changes.

On balance, "*interoperability is the key issue*" if cross-border services should become more and more standard. In this context, it is important to emphasize that the **general willingness to transfer knowledge and to cooperate between different stakeholder groups as well as countries is necessary** in any case.

5.2.6   Core topic 1: Validation of necessary data and data availability

In the course of the project, the consortium identified main data/data types that are needed to make the core topic "Provision of HD maps for automated mobility" a reality. The participants of the questionnaire were asked to evaluate the proposed data needed as well as their availability. The different data types were divided into three general parts:

1. *Legal boundaries*
2. *Static road parameters and*
3. *Semi-static information*

As a first step, the participants were requested to verify whether the proposed data is relevant within the core topic or not. In addition, they should evaluate if the data type is available in machine-readable format. In a further step, they were asked to assess the proposed data providers.

5.2.6.1   Data types relevant for core topic 1

Figure 19 gives an overview of the evaluation of the participants regarding the proposed data types. **Taking into account the statistical data, it can be summarized that the participants have quite clear ideas which data is relevant for provision of high-definition maps for Automated Driving. The results show a general broad acceptance of the suggested data.** 95% of those who answered the question (19 out of 20 respondents) see traffic regulations as a necessary part of the core topic. The different data types, which are part of the category *static road parameters*, are mainly seen as relevant for the core topic. Especially road related data like road geometry and width, gradients, junctions as well as road classification definitely play an important role in providing HD maps for Automated Driving. The results reveal that information on location of tolling stations are essential according to the participating experts. As might be expected, data on the HD lane model, which includes the **number of lanes and link attributes (100%) and HD localisation model (beacons, landmarks) (90%),** is relevant for the provision of HD maps. **The acceptance rate towards data on location of parking spaces and service areas and information on their availability which is seen as semi-static data is very high (90%).** Around 86% of all participating experts (18 out of 21) estimate that information on location of charging points and location of public transport stops are relevant for the core topic. **Compared to this high consent the results show that just 62% suppose that data on location of delivery areas are important. The remaining 38% are not sure whether this information is relevant for the provision of HD maps or not..** According to the results, semi-static information is a relevant aspect when it comes to HD maps in automated vehicles. Besides the location of charging points for electric vehicles, knowledge about availability of these points should be considered when implementing the core topic (89% approval). **The diagram below (Figure 19) depicts that information on costs of parking or road use is less relevant for the core topic (60%);** one third of the respondents (35%) are unsure whether this information is necessary or not.

This data is relevant for the core topic...

Data type	Yes	No	I don't know
Traffic regulation	95%	5%	
Road model incl. road geometry/width, gradients, junctions	100%		
Road classification	100%		
Location of tolling stations	90%	10%	
HD lane model incl. number of lanes and link attributes	100%		
HD localisation model – beacons, landmarks	90%	10%	
Location of parking spaces and service areas	90%	10%	
Location of charging points	86%	14%	
Location of public transport stops	86%	14%	
Location of delivery areas	62%		38%
Availability of parking spaces	90%	10%	
Cost of parking or road use	60%	5%	35%
Availability of charging points for electric vehicles	89%	5%	5%

■ Yes ■ No ■ I don't know

Figure 19: Acceptance rate of suggested data types (HD maps)

In addition, it is important to have a look at the question "Are any data (types) (as before e.g. "permanent access restrictions") missing? Please add them and describe them briefly." to identify any gaps in the list.

According to communication network providers, *"**data on different mobility services, which includes information on shuttle bus stations at night, car-sharing stations as well as dynamic taxi information**"*, should be considered in the frame of this core topic. Furthermore, the results show the need for *"**immediate traffic warnings" e.g. from other cars.*** In this regard, car manufacturers or mobile network operators could be potential sources of this information, as added by the respondents. Public Road Operators highlighted the relevance of general road related information. Particularly data from service providers on location of road works and roadblocks were mentioned. From the national transport authorities' point of view the data requirements referred to in the Delegated Act Priority Action b should also be covered by the core topic. When it comes to the listed data categories in the Annex of the Delegated Regulation (EU) 2015/962 from the 18th of December 2014[2], a number of data, especially from the static road data section is already covered. But for the further work within DIRIZON this means that WP5 needs to cross-check the existing list of data with the Annex of the aforementioned Delegated Regulation.

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[2] https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32015R0962

5.2.6.2 Availability of data for core topic 1 in machine-readable format

When it comes to the automation of the process and Automated Driving the availability of data in a machine-readable format is the very basis to make this reality.

Figure 20 shows that there is partly no consistent opinion regarding the availability of the proposed data types in machine-readable format. This applies particularly to semi-static information and to some extent to static road parameters. Based on the responses, most of the data listed by DIRIZON seems to be available in machine-readable format.
Regarding the groups of "I don't know" it can be assumed that this topic has not been appropriately specified yet.
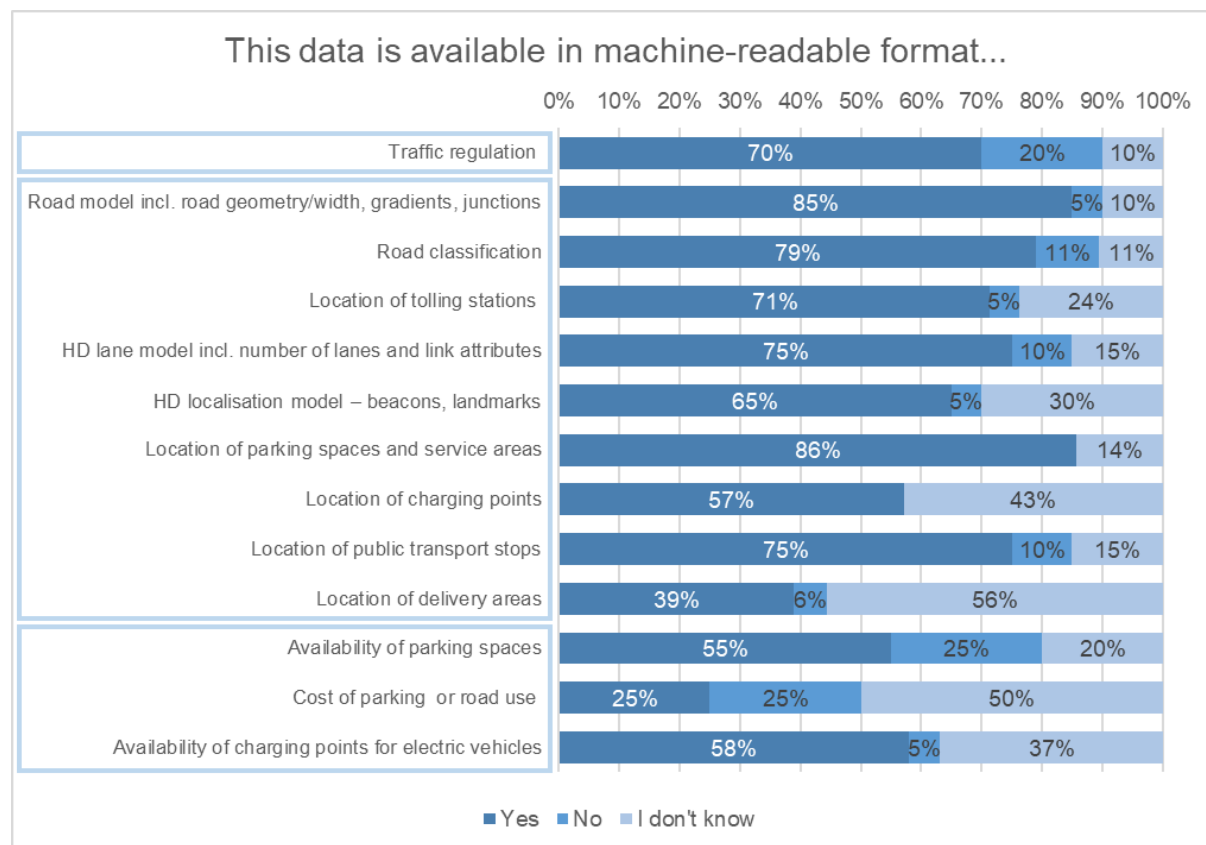
Figure 20: Assessment of respondents regarding the availability of data in machine-readable format

The availability of location and availability of charging points for electric vehicles in machine-readable format is clear an open issue, as only 57% and 58% marked them as available, while between 37%-43% of respondents don't know if this is available. For the next step the need of this data together with the availability has to be on the discussion list. One reason might be the fact that the topic of electric mobility is relatively new and not all actors are aware of the latest developments. Furthermore, there is also a broad uncertainty regarding information on location of delivery areas. More than half of the participants (56%) are uncertain whether this data will be available in machine-readable format. Compared to these findings the likelihood that the location of parking spaces and service areas (86%) or public transport stops (75%) are available in machine-readable format is much higher. On the other hand, at least 24% are not sure whether data on location of tolling stations will be available in machine-readable format or not.

Moreover, the participating experts assume that the availability of the proposed semi-static information in machine-readable format is still uncertain. This includes data on availability of

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parking spaces and charging points for electric vehicles plus cost of parking or road use. Only 25 to 58 % are convinced that the proposed dynamic data types can be provided in machine-readable format.

However, we don't see a clear picture, as there are always mixed "yes" and "no" for one data type.

In order to consider where these differences come from, DIRIZON **had a look a national differences** (Figure 21). If all respondents from a certain country answered "yes" we can assume that this data type is available in that country, while a "no" of all respondents from a country leads to the assumption that this is not available in this specific country.

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	Traffic regulation	Road model incl. road geometry/width, gradients, junctions	Road classification	Location of tolling stations	HD lane model incl. number of lanes and link attributes	HD localisation model – beacons, landmarks	Location of parking spaces and service areas	Location of charging points	Location of public transport stops	Location of delivery areas	Availability of parking spaces	Cost of parking or road use	Availability of charging points for electric vehicles
Austria	Unclear (Yes+No)	Yes	Yes	Yes	Yes	Yes	Yes	Don't know	Unclear (Yes+No)	Don't know	Yes	Unclear (Yes+No)	No
Belgium	No	Yes	Yes	Don't know	Yes	Yes	Don't know	Don't know	Don't know	Don't know	Yes	Don't know	Yes
Germany	No	Yes	Unclear (Yes+No)	Unclear (Yes+No)	Yes	Yes	Yes	Yes	Unclear (Yes+No)	Yes	Yes	No	Yes
Greece	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Ireland	Yes	Yes	Yes	Yes	Yes	Don't know	Yes	Yes	Yes	Don't know	Don't know	Don't know	Yes
Italy	Unclear (Yes+No)	Unclear (Yes+No)	Yes	Yes	Unclear (Yes+No)	No	Yes	Yes	Yes	Yes	Unclear (Yes+No)	Unclear (Yes+No)	Yes
Netherlands	Yes	Yes	Don't know	Yes	Yes	Don't know	Yes	Yes	Yes	Don't know	Unclear (Yes+No)	No	Yes
Sweden	Yes	Yes	Yes	Yes	Unclear (Yes+No)	Don't know	Yes	Yes	Yes	Don't know	Don't know	Don't know	Don't know
United Kingdom	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Figure 21: Overview of machine-readable data availability in the different countries (Core topic 1)[3]

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[3] If all respondents from a certain country answered "yes" or "I don't know" it's "yes", if all respondents answered with "no" or "I don't know" it's "No", if there are both answers it's "Unclear (Yes+No)", if all respondents answered "I don't know" it's "Don't know".

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So for example, for traffic regulation it might be considered for the further project that this data is not available in machine-readable format in Belgium and Germany, according to the responses, while it would be available in the other respondent's countries (e.g. Greece, Ireland, Netherlands, Sweden and United Kingdom). For Italy and Austria there might be differences on the availability on the different levels. Also the HD localisation models might not be available in Italy.

For other data types one has to take a deeper look on the actual availability, so e.g. for road classification, location of tolling stations and location of public transport stops in Germany or traffic regulations, road model, HD lane model, availability of parking spaces and costs on parking in Italy. Due to fragmented administration structure the availability might vary on regional/national level.

In general, based on this analysis one could assume that static and semi-static information is (besides some aspects like charging point and delivery areas) in principle available in machine-readable format.

5.2.6.3   Data providers for core topic 1

The acceptance towards proposed actors was further analysed among those, who see the data/data types as relevant for the core topic.

This analysis is helpful as it reveals the assessment of the respondents who might be a potential provider of the related data category.
Summarizing, we can state that Road Operators are expected to provide different types of static road parameters like road classification, location of tolling stations, HD lane model incl. number of lanes and link attributes (like access conditions, speed limits,…), and location of parking spaces and service areas, as well as the traffic regulations, which were categorised as legal boundaries.

For certain categories HD Map Providers are the clearest option (in the case of road models incl. road geometry or HD localisation models – beacons, landmarks) or the second option besides the Road Operators (e.g. for HD lane model, location of charging points).

The following four figures (Figure 22 – Figure 25) show graphically which actors can be considered as main suppliers in the context of static road parameters.
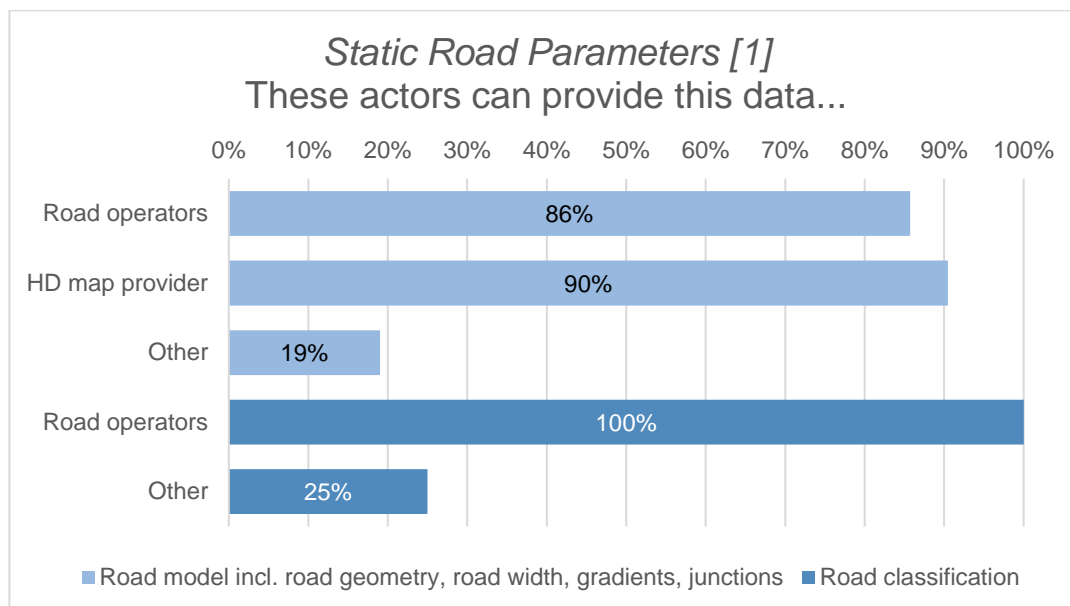
Figure 22: Assessment of providers of static road parameters (1/4)
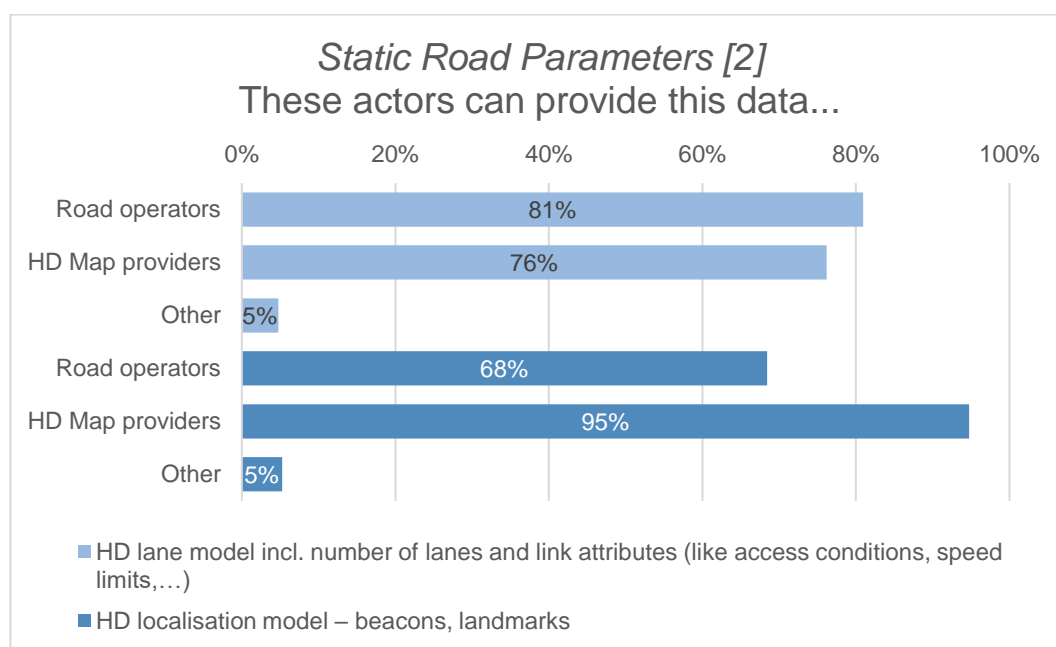
Figure 23: Assessment of providers of static road parameters (2/4)

Static Road Parameters [3]
These actors can provide this data...
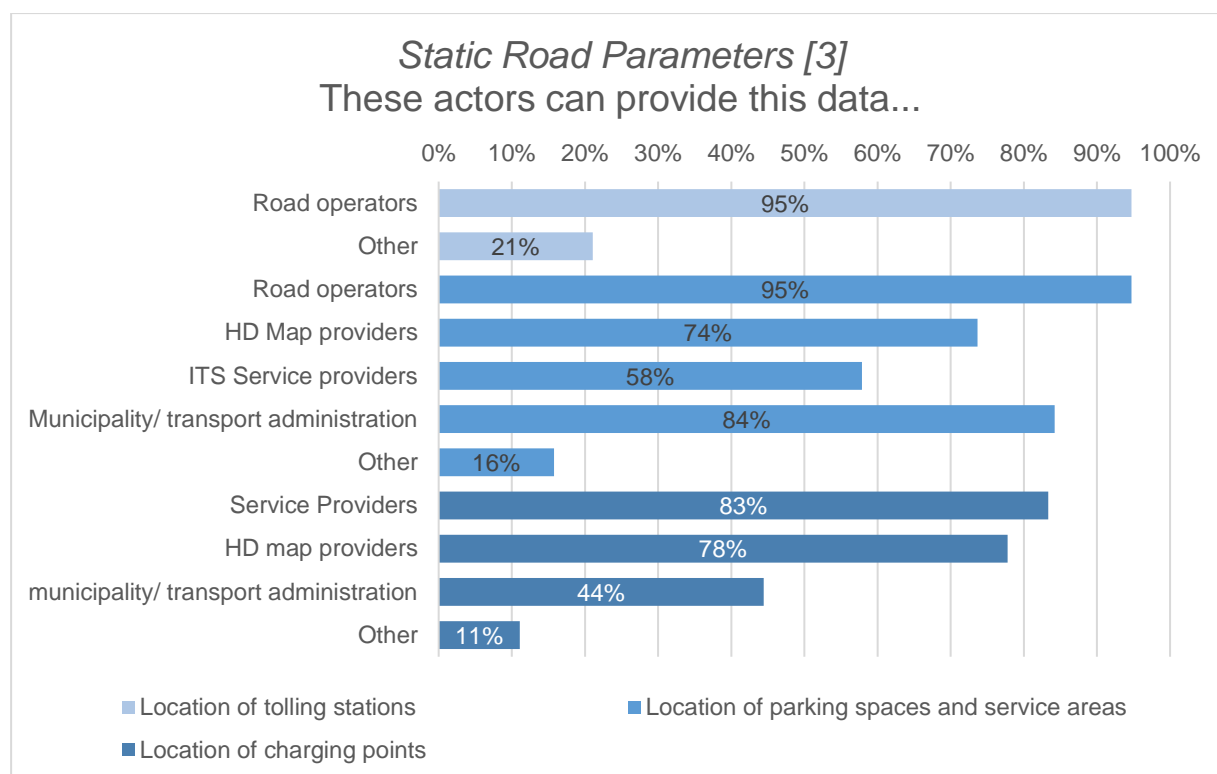
Figure 24: Assessment of providers of static road parameters (3/4)

For certain topics, like the location of parking spaces and service areas, a variety of potential data providers exist. This was expected that way as this could refer on the one hand e.g. to the urban road network, but also to motorways. So depending on the relevant area, Road Operators, as well as municipalities or certain ITS service providers could provide the necessary data. For the use cases this has to be looked at in more detail, especially regarding the operation area concerned.

Some collaborations between actors are also in the context of providing other static information of high priority (see Figure 25). Data on location of public transport stops could mainly be provided by public transport operators. As expected, 94% of the participants suppose that this stakeholder group will be an important supplier. The statistics show a broad acceptance of the other proposed actors as well. At least 67% of the participating experts propose that also HD Map providers, Transport authorities or municipalities/transport administrations could support the provision of data on public transport stops for implementing HD maps. Logistics service providers (92% approval) play an important role in the distribution of data on locations of delivery areas.

Static Road Parameters [4]
These actors can provide this data...

Public transport operators — 94%
HD Map providers — 67%
Transport authorities — 67%
Municipality/ transport administration — 67%
Logistics service providers — 92%
HD Map providers — 77%
Municipality/ transport administrations — 54%
Other — 8%

■ Location of public transport stops   ■ Location of delivery areas
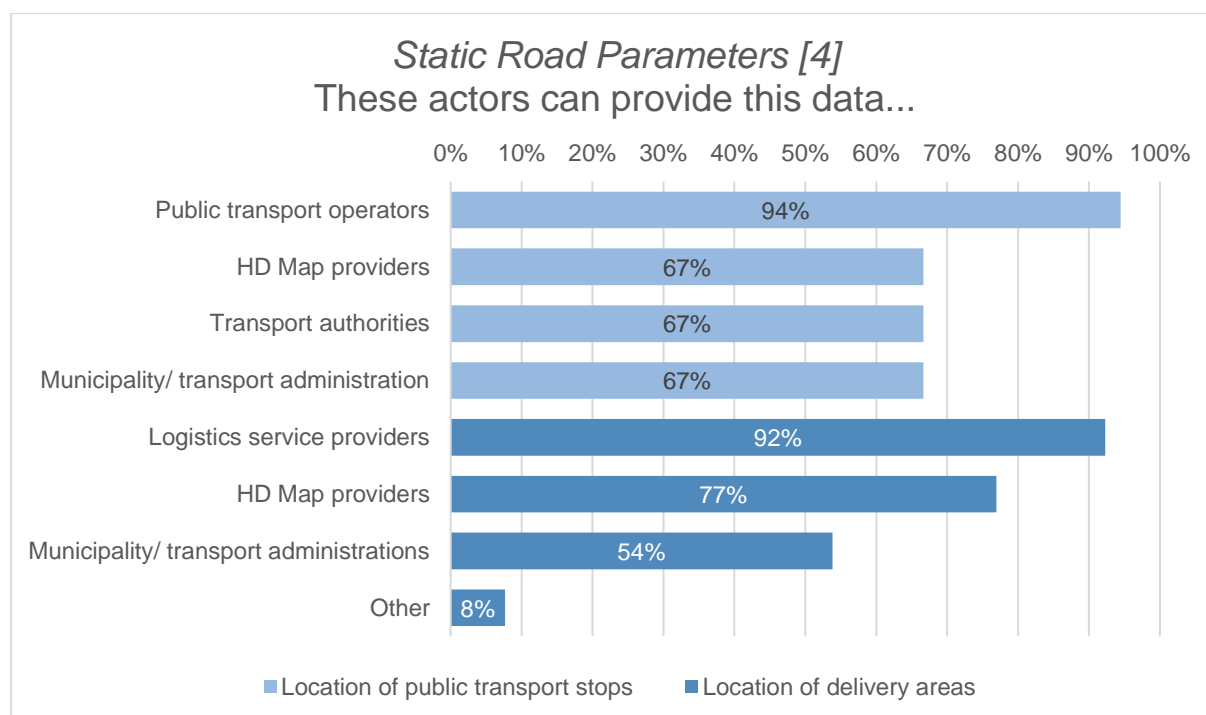
Figure 25: Assessment of providers of static road parameters (4/4)

According to the responses, Road Operators and service providers could provide information about the availability of parking spaces. ITS Service providers play a more important role in the provision of data on availability of charging points for electric vehicles and of information about cost of parking or road use. Not only service providers, but also municipalities/transport administrations could be relevant when it comes to the availability of data on parking or toll charges (see Figure 26).

Semi-static information
These actors can provide this data...

Road operators — 83%
Service provider — 94%
ITS Service provider — 92%
municipality/ transport administration — 75%
Other — 8%
ITS Service provider — 82%
Other — 18%

■ Availability of parking spaces
■ Cost of parking or road use
■ Availability of charging points for electric vehicles
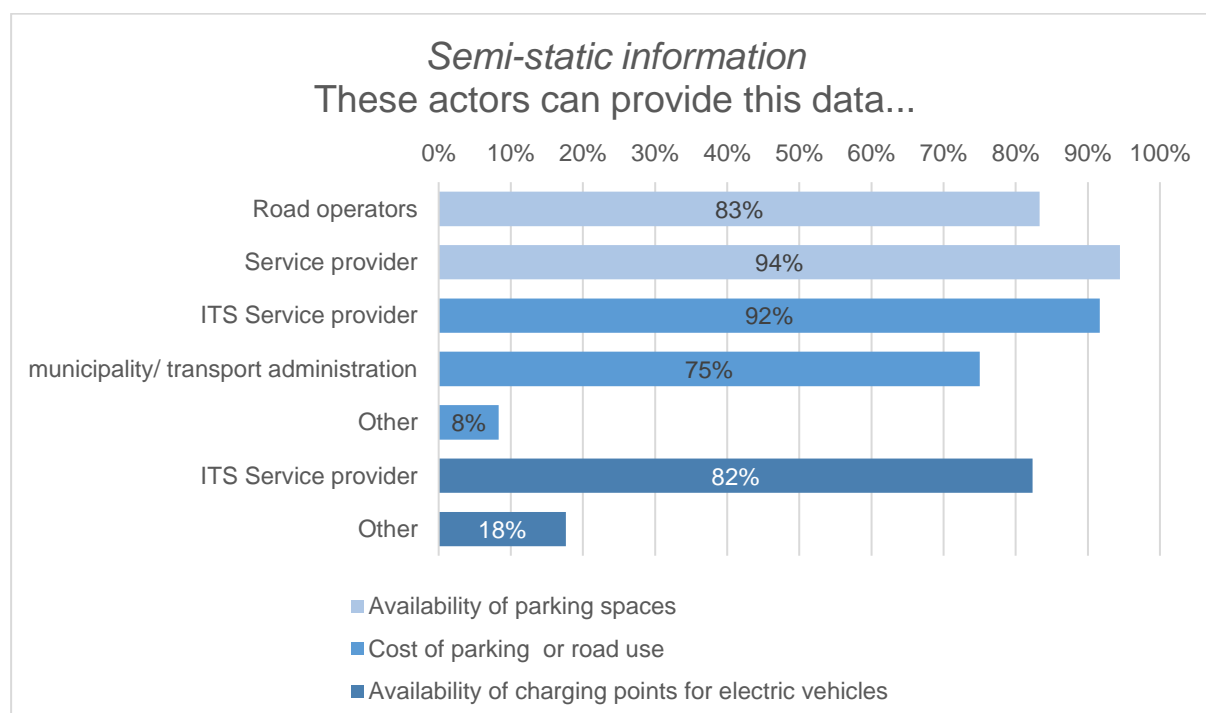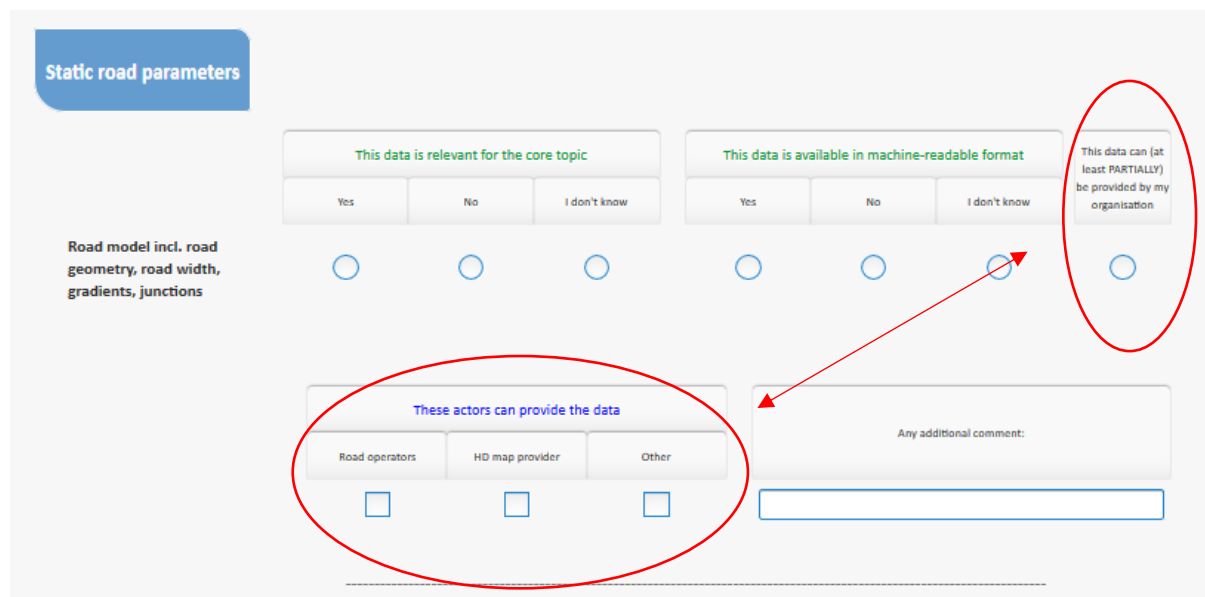
Figure 26: Assessment of providers of semi-static information

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5.2.6.4 Cross-analysis "Expected data providers" and "I could provide this data"

In addition, we cross-checked the section "*These actors can provide the data*" with the section "*This data can (at least partially) be provided by my organisation*".

Figure 27: Screenshot of questionnaire for cross-check of the sections "This data can (at least PARTIALLY) be provided by my organisation" and "These actors can provide the data"

Having a look at the previous tables and the aggregated table of responses based on "This data can be provided by my organisation" one can see that this matches (in wide parts) on an aggregated level. Even when we consider the fact that some national difference might exist (which cannot be displayed here due to DGPR reasons) we can conclude on an overall level that the **expectation of who the data providers are and their basic willingness to provide the specific data under certain conditions match** (see Table 3). This is a positive sign for the further development in this core topic.

Stakeholder group	Legal boundaries	Static road parameters									Semi-static information		
	Traffic regulations	Road model incl. road geometry, road width, gradients, junctions	Road classification	Location of tolling stations	HD lane model incl. number of lanes and link attributes (like access conditions, speed limits,…)	HD localisation model – beacons, landmarks	Location of parking spaces and service areas	Location of charging points	Location of public transport stops	Location of delivery areas	Availability of parking spaces	Cost of parking or road use	Availability of charging points for electric vehicles
(Digital) Map provider	x	x			x	x	x	x	x		x	x	x
National transport authority / administration	x	x	x	x									
Public Road operator	x	x	x	x	x	x	x	x	x	x	x	x	
Related platform/association (e.g. PIARC, ASECAP,…)		x											
Research / scientific institution	x	x											

Table 3: Aggregated responses "My organisation can – at least partially – provide this data" (aggregated on all responses from the stakeholder groups – some respondents of one stakeholder group might not provide all marked data types)

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5.2.6.5 Access conditions for the data provision

For each data type that respondents marked as "*This data can be (at least partially) provided by my organisation*" the respondents had the chance to answer if "*this data can be shared – yes/no/conditionally*". "Please describe the potential use and access conditions and used data format".

In general, we could see that traffic regulations could be shared. The description on the potential use and access conditions and used data format revealed the following:

- *"Geo-fencing applications"*
- *"Use Datex II feed after registration"*
- *"Traffic regulations are generally available as open data free of charge. Can be provided through the National Access Point. Format should be in any common type (e.g. csv or xml)"*

Just a few participants (2/17) have any sample contracts regarding use and access conditions. In addition, both see no chance to share them with DIRIZON.

5.2.6.6 Cross-border aspects related to the data availability and the service availability

Two different aspects of changes and challenges related to cross-border aspects were analysed: the data availability and the service availability.

The respondents were asked *"How will it affect your answers if the end-user/vehicle uses the same service in another country? Will there be any changes e.g. regarding the available data availability and the data quality?"* and *"Do you see any challenges or issues regarding access conditions and use of data for CROSS-BORDER service availability (meaning your organisation's data made available abroad OR that type of information (from other organisations) made available abroad)?"*

Even if the **majority** (14 out 19 respondents) suggests that **no challenges** are expected when it comes to the availability of service abroad, **others** see **minor or moderate changes that could have an important impact on the availability of the data and therefore the service across borders.**

Therefore, varying access conditions have to be considered in this respect. Related to this, the **importance of international standards** and alignments were highlighted.

Furthermore, it was mentioned that **language adaptions e.g. traffic signs have to be realized when the same service is used in different countries.**

In the light of the fact that different shades of data are available, cooperation and knowledge exchange between countries for example as part of projects is essential.

One respondent added that "V2X sharing would be a great help "across the borders in the „interest of road safety".

The use of personalised data is another aspect that has to be considered here according to the comments. Especially according to Public Road Operators, **challenges can arise due to GDPR restrictions**, e.g. vehicle and/or driver must remain anonymised. Other challenges lie in the **sharing of data among other countries, non-EU members**. Map providers suppose challenges and uncertainty in the **meaning of open data and fees for data in different countries.**

5.2.7   Risks and Challenges for core topic 1

The experts were asked to mention issues, risks or challenges they expect in regard to the security aspects, privacy aspects, data protection, cross-border service availability, as well as additional aspects not covered before.

What we can see from the list below is that especially in the area of HD maps, **cybersecurity** and certification are major topics that will challenge the actors in the future. This is very much connected with other big challenges like **privacy and data protection.** Next to this aspect, the **need for standards** and the **compliance with standards** has been emphasized. Also the respondents added the challenges regarding **latency**!

Security related risks and challenges (e.g. in terms of Trusted Information Provision)

- *"HD Map providers must ensure the security of content and delivery channel in line with relevant standards. No major risks identified."*
- *"Central certificate trust body needed. Legally binding. Minimise connectivity and data - More connections equals higher risk of hacking and spoofing. Not all vehicle/infrastructure architecture follow the same function safety ASIL specs - which will compromise ASIL level systems. Vehicle safety will be compromised."*
- *"Cyber-security of the data exchanged via the network shall be dealt with"*
- *"Being slow by fragmented security/system landscape cross-borders"*
- *"Trusted information from the public sector needs a certification"*

Risks and challenge related to privacy aspects

- *"HD Map providers must ensure privacy of user in line with relevant standards. No major risks identified."*
- *"Position information is only used for short range communication (broadcast), No backend system should get the positioning information of the user."*
- *"Privacy shall be granted as a 'must'."*
- *"Only share what is necessary. Not everything. GDPR issues and concerns if user data is shared."*
- *"GDPR expectations must be fulfilled"*

Risks and challenges related to data protection

- *"HD Map providers must ensure data protection of user in line with relevant standards. No major risks identified."*
- *"Missing clarity in regulation."*
- *"Data protection shall be granted as a 'must'."*
- *"Data must be anonymous. Customer must have the choice of not opting in.*
- *"OEM/Tier 1 IP must be protected."*
- *"GDPR expectations must be fulfilled."*

Risks and challenges regarding cross-border service availability

- *"Cross-border services will be build by data aggregator and Map Provider, connectivity needs to be solved."*
- *"Same standard."*
- *"Defining responsibility when roads cross borders"*
- *"Interoperability shall be granted as a 'must'."*

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- *"V2X technology will help bridge gaps. Only transmitted data can be monitored. Internet connections can help bridge gaps with HD Maps - via OEM's system."*
- *"Sharing among non-EU countries may raise legal restrictions."*
- *"Reachability of data coming from different Road Operators."*

In addition to all risks and challenges, which were already mentioned above, the respondents had the possibility to give a comment on other potential risks and challenges they expect. Independently from each other many respondents added latency issues as a major challenge. So this aspect should be definitely tackled when taking the first step in core topic 1.

Other risks and challenges expected in core topic 1

- *"Ensuring commonality/shared standard of the feedback from autonomous vehicles and smartphone applications. Working with MNOs to ensure appropriate coverage and low-**latency** delivery of information."*
- *"Too much data will lead to internal car **latency issues**. A car may want to issue an AEB command. But is too busy sending out data to others to do the task."*
- *"**Latency issues** - some safety critical features may suffer if too much data is being sent."*
- *"Older technology will not be able to cope with large HD map data."*
- *"Any data shared should be for improving map knowledge."*

Numerous tasks and open issues can be derived from these risks and benefits that should be considered by actors, when defining the next steps. In this regard this will be of major importance for the DIRIZON WP7 recommendations.

5.2.8   Opportunities and Benefits for core topic 1

In contrast to the risks the respondents were also asked about their expectations of the opportunities coming from the implementation of core topic 1: *"What are opportunities from implementing the core topic? Who will benefit?"*

So aggregating the responses we could see that **respondents expect numerous benefits like**:

- *"Safer and more comfortable driving for user, which will increase the uptake of automated vehicles and lead to safer and more efficient mobility."*
- *"All trustable nodes will benefit."*
- *"A data flow for map updates will be available."*
- *"In complex environments HD map help to locate and identify signs, lights, poles and other objects to help self-driving vehicles make sense of their surroundings."*
- *"Vehicle automation can be deployed in complex-traffic areas e.g. cities."*
- *"Less hand-over manoeuvres are needed."*
- *"Commercial opportunities e.g. added value services on HD maps are a benefit of the implementation of the core topic."*
- *"Map providers and Service providers may offer enhanced maps with specialised content (e.g. entertainment, tourist info etc.)."*

And who will benefit from the implementation from their point of view?

- *Drivers, passengers and road users* (where named 6 times)
- *(HD) map service providers* (named 3 times)
- *Taxpayers and consumers* (named 2 times)
- *Road Operators*

So the implementation of the core topic 1 is clearly in the interest of the individual user.

5.2.9 Summary of the results of core topic 1

The core target group, thus the stakeholder groups that will take active roles in the provision of HD maps for Automated Driving, could be reached by the DIRIZON questionnaire. In total, **23 experts have <u>participated on the first core topic</u>.**

The provision of HD maps was the only topic within the questionnaire that was answered by Digital Map Providers which suggests that they only see an active role within this core topic. The analysis of the size of the organisations that were participating in this topic showed that this core topic seems to be **driven by the industry and large organisations only.** It can be assumed that **SMEs don't have an active role in this context** or SMEs are not part of the thematic relevant project and platforms.

Having a look at the geographical coverage of responding organisations we could see that more than half of them come from Germany, the United Kingdom and Austria (in total 56,5%).

On an overall level the <u>process flow chart and the included storyline</u> received a total rating of 7,6. This means that the respondents agree in wide parts with the presented storyline and the presented process for core topic 1.

When considering these results on the level of different stakeholder groups, especially NRAs see some adaption needs, while other groups like scientific institutions and Communication network providers could align very well with the process.

(Digital) Map providers would like to see some changes especially regarding the overlapping of roles (e.g. in cases of service and Map Providers). The feedback loops e.g. for Map updates should be re-evaluated.   A "content delivery phase is also needed in the process flow chart, alongside or within the data/content creation". OEMs see an alternative process flow, where all data flow is to be managed by the OEMs. This concept could be considered for the further data platform concept and the related business models.

What we can see from the differentiation between the stakeholder groups is that especially the regional transport authorities don't agree or are not sure about the provision of the NAP as part of the use case, whereas the other public institutions absolutely agree with the provision of a NAP. As the NAP is a role that is handled on the national level regional authorities might not percept the NAP as that relevant compared to national bodies. On the other hand, national transport authorities do not fully support the idea of a TERAP. This can be caused by the fact that the TERAP means building up another institution next to the NAP that is not discussed or harmonised on a national level. Therefore, potential organisational models or ideas for financing are not available yet. Furthermore, a definition of TERAP is missing currently in international papers on the topic.

The **<u>validation of the activities needed for core topic 1 </u>show a broad agreement.**

Looking at the statistics, one can see that there is an outstanding acceptance regarding the activities within *Phase 1: Content Creation*. All three activities within this phase received a consent of 95% from the respondents.

When looking at *Phase 2: Content Aggregation* the participants do not agree with such a high degree it is notable that at least 20% (4 out of 20 participants) are not sure if the Provision of a TERAP is a necessary part for implementing HD Maps (e.g. national transport authorities). What we can see from the differentiation between the stakeholder groups is that especially the

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regional transport authorities don't agree or are not sure about the provision of the NAP as part of the use case, whereas the other public institutions absolutely agree with the provision of a NAP.

In *Phase 3*: *HD Map Production,* there is 100% approval that the proposed activities are part of this core topic.

For *Phase 4: Service Integration* we can see a principal approval, some NRAs see the need of HD map in high quality, but their integration not directly as part of core topic.

It is interesting that 14% of the participants see no need for a provision of ITS (end-user) services based on HD maps (*Phase 5: Service Presentation)*, see chapter 7.1. for some details. For *Phase 4*, as well as for *Phase 5*, mainly national road authorities, OEMs and Public Road Operators had the feeling that these activities are not part of the core topic or were uncertain of the real need.

We can say that the provision of feedback from different sources (*Phase 6: Feedback Loops*) is one of the most contradicting issues and need an in-depth inquiry, especially as we can see that some groups agree with the fact of using NAP data (e.g. Public RO), while they don't see the need in providing feedback to raise the data quality. In the final *Phase 7: Enabling and regulation,* the acceptance rate for the activities varies widely, as we can see a very low approval (57%) for *Management/coordination of the use of frequency spectrum using frequency allocation plans and frequency usage plans.*

The **validation of roles and responsibilities** showed some interesting aspects that will need to be considered:

The analysis supported the assumption that **Road Operators will play an important role** in providing traffic regulations, road models, lane models and geo-referencing data (*Phase 1),* while the provision of HD maps is **clearly a task for the HD Map Providers** *(Phase 3).* But also Road Operators and ITS Service Providers are seen as potential providers of HD maps. What we can see from the analysis is that the provision of road/lane models and geo-referencing data can be as well a task for the Road Operators, but also for the public transport authorities. This might **depend on the national differences and general responsibilities** regarding the lane and road models.

Those institutions that have already been providing the NAP should carry out the tasks of *Phase 2: Content Aggregation*, this often concerns national authorities.

Taking into account the statistical data, HD Map Providers as well as ITS service providers could be responsible for the integration of updated HD maps into (end-user) services *(Phase 4/5).* This leads to the conclusion that **more than one actor can fulfil this activity** and that **cooperation between multiple stakeholder groups is key**.

Driving Cars and Users are most important when it comes to the provision of feedback (*Phase 6).*

Those who consider the proposed activities of *Phase 7: Enabling and Regulation* as necessary, see the European Commission and the relevant governmental bodies in the role of responsibility. Furthermore, communication network providers can fulfil the last activity *Provision of network coverage and regular upgrades of the communication network.*

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When it comes to the **changes in regards to the core actors related to the cross-border availability of the service** we could summarize that **60% of respondents do not expect any changes** related to the cross-border aspects. **Minor changes** may be expected (coming from Communication network providers, Public Road Operators as well as Research/Scientific Institutions and an engineering consultancy), this includes *language adaptions for different traffic signs"* as well as the need for an "*extra layer of checking/conversion*". On balance, "*interoperability is the key issue"* if cross-border services should become more and more standard.

Taking into account the statistical data, it can be summarized that the participants have quite clear ideas which **data is relevant for provision of high-definition maps for Automated Driving**.

The different data types, which are part of the category *static road parameters*, are mainly seen as relevant for the core topic. As might be expected, data on the HD lane model, which includes the **number of lanes and link attributes (100%) and HD localisation model (beacons, landmarks) (90%),** is relevant for the provision of HD maps. **Compared to this high consent the results show that just 62% suppose that data on location of delivery areas are important.** According to the results, semi-**static information is mainly a relevant aspect** when it comes to HD maps in automated vehicles, but costs of parking or road use is important for just 60% of the respondents.

In addition to the supposed data types, *"data on different mobility services, which includes information on shuttle bus stations in night, car-sharing stations as well as dynamic taxi information"*, should be considered in the frame of this core topic.

There is partly no consistent opinion regarding the **availability of the data in machine-readable format**, as the rate of "I don't know" is high to some extent. In general, based on the analysis one could assume that static and semi-static information is (besides some aspects like charging point and delivery areas) in principle available in machine-readable format. **For the further platform concept developed in DIRIZON national differences have to be somehow considered (see chapter 5.2.6.2).**

The analysis of the **expected data providers** revealed that – based on the given responses –**Road Operators are expected to provide different types of static road parameters** and location of parking spaces and service areas, as well as the **traffic regulations**, which were categorised as legal boundaries. **For certain categories HD Map Providers are the clearest option** (in case road models incl. road geometry or HD localisation models – beacons, landmarks) or the second option besides the Road Operators (e.g. for HD lane model, location of charging points).   To put the results in a nutshell, we can conclude that some collaborations between actors are also in the context of providing static information of high priority. According to the statistics, it can be highlighted that ITS Service Providers might be relevant when it comes to the availability of semi-static information.

Looking at the responses of the **access conditions for data and information,** one could conclude that **in principle, traffic regulations could be shared.**

The results show that in the context of HD Maps some **risks and challenges** were mentioned from the **participants. Cybersecurity and certification are major topics what will challenge the actors in the future.** This is very much connected with other big challenges like **privacy and data protection.** Next to this aspect, the **need for standards** and the **compliance with standards** has been emphasized. Also the respondents added the challenges regarding **latency**.

The **potential benefits related to the implementation of core topic 1** include increased safety and comfort for the users. HD Maps may also help to locate and identify signs and help automated vehicles to understand their surroundings. We can expect that **mainly drivers and road users will benefit** from the implementation of this use case. But also (HD) map service providers are assumed to gain benefits.

5.3 Analysis of core topic 2 - Distribution of Digital Traffic Regulations

5.3.1 Overview of core topic 2 content

The following sections provide a summary of the storyline and the process flow diagram (see Figure 28), as it was provided to the respondents within the questionnaire. As for Core Topic 1, the process flow diagrams are future, generic implementations and, as such, not country-specific:

Storyline:
The flow diagram shows the process flow for the distribution of digital traffic regulations. Traffic regulations comprise static and temporary (dynamic) regulations. Temporary regulations have temporary triggers, such as rain, snowfall, etc. (which are not determined and unforeseen by their nature). Other triggers can be e.g. regulations deriving from European legislation or new national and regional framework conditions. A traffic regulation can be a traffic ban, traffic restriction or a traffic facilitation (either route/section-related, vehicles category-related or time-related or a combination of these). The traffic regulation authorities define the regulation within their area of competence, whether it be long-term static regulations or temporary traffic regulations. The enacted regulations are implemented by the authorized authorities (Road Operators, administrative bodies, police, etc.). The authorized authorities notify the traffic regulation authorities of the implementation.

There are three options for communication of the traffic regulations to road users as depicted in the flow diagram:
- Option 3 shows what already takes place: the regulations are displayed via physical infrastructure, via signs or on Variable Message Signs (VMSs).
- Option 2 is for the authorized authority to provide the regulations to a Trusted Electronic Regulation Access Point via a secure channel. These regulations can be picked up by Service providers via a secure channel, for use in their (C-)ITS services, integrating the binding information with the certificate and communicating it to vehicles and smartphones. The certificate should lead the driver or automated vehicle to trust the information and observe the traffic regulation.
- Option 1 is for the authorized authority to provide the regulations digitally via a bidirectional, secure channel to service providers. The information is a certificate from the authorized implementing authority.

This core topic requires that the total chain makes use of secure communication channels and that the digital traffic regulations are provided in a certified manner so that the information is trusted. CEN/TC 278 WG17 states that "this service needs strong security support. Regulations need legal proof from the generating entity all the way to the end user, so that all main security features like confidentiality (privacy), integrity (trust) and availability (Denial of Service/DoS) is present. This includes security services new to the ITS domain like non-repudiation. Luckily the public key infrastructure (PKI) developed for C-ITS will work directly out of the box, so this work is mainly related to apply C-ITS security in the context of METR" [Knut Evensen (2018)].

For the depiction the following has to be considered:
- It is expected that the traffic regulation and relevant infrastructure elements (e.g. traffic signs and related additional information) will be gradually digitised in a computer-readable format. In this context "relevant" is the minimum infrastructure data required to facilitate implementation of Management for Electronic Traffic Regulations (METR) at each stage of maturity.

- There are mixed traffic conditions on the infrastructure (i.e. both automated vehicles and not). However, most of the vehicles are expected to be connected and automated in the long term.

For the total chain secure communication and provision of trusted information is necessary!
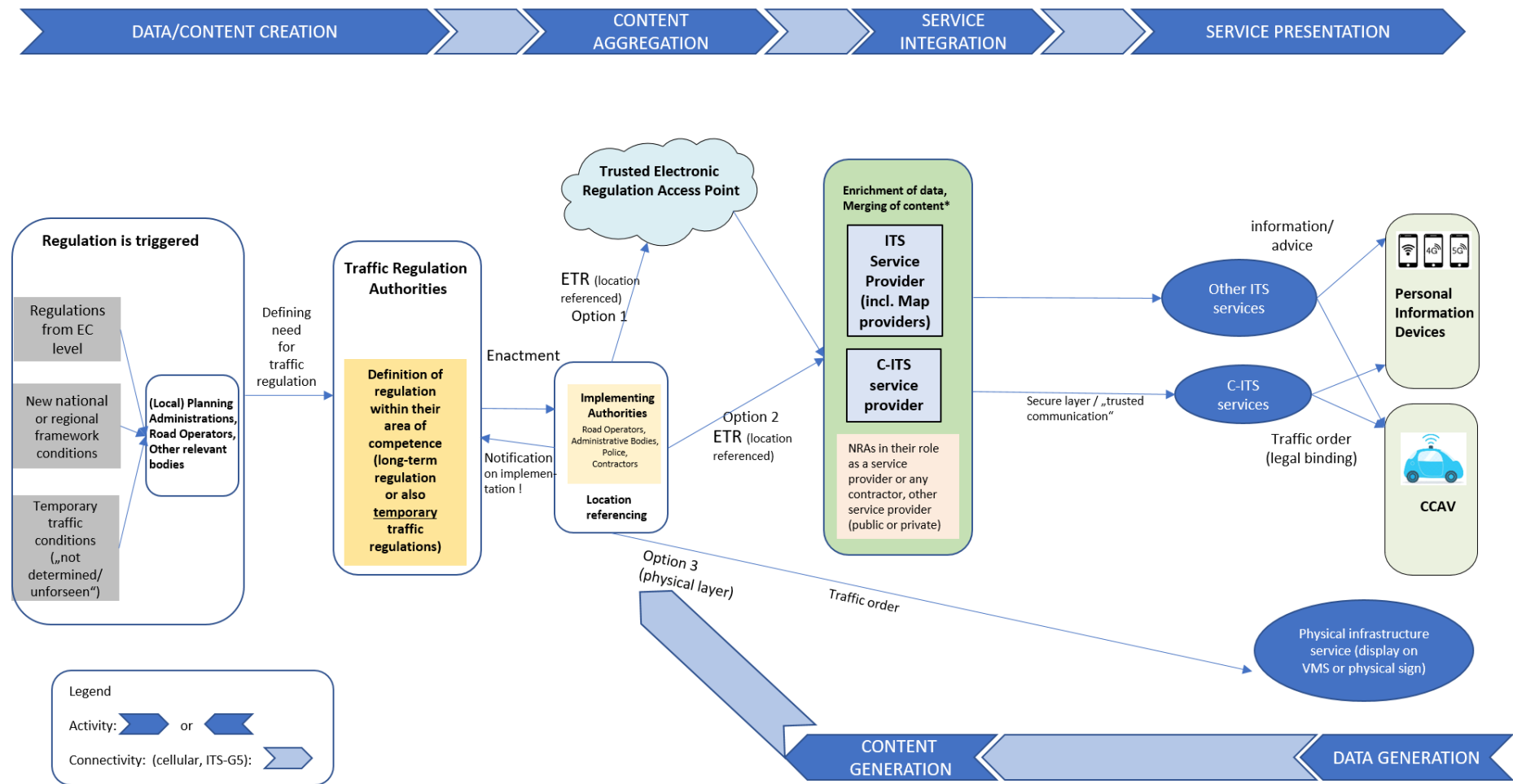

Figure 28: Process Flow Diagram for core topic 2

5.3.2 Core topic 2: Participation statistics

In order to set the results presented in the following subchapters into context, this chapter provides an overview on the participating stakeholder groups, size of their organisations and the distribution of the organisations among different countries.

In total, 14 experts have participated on the core topic *Distribution of Digital Traffic Regulations*. This number includes all those who have answered at least one question set of the questionnaire on Distribution of Digital Traffic Regulations. In contrast, participants who only provided information on the organisation and country, but did not answer any question regarding the topic, were not considered in further evaluations (7 participants).

Many different types of organisations and stakeholders were reached throughout the survey. The following figure shows an overview of all participating stakeholder groups and organisations. **ALL the major target groups, as described in chapter 4.2 (Identification of relevant stakeholders, associations and platform), were reached** which was an important goal, and answered the questionnaire.

Looking at the process flow, the active or **primary actors related to METR are all types of authorised authorities like traffic regulation authorities or implementing authorities (Road Operators, administrative bodies, police, etc), as well as (C-)ITS service providers (and Map Providers) or (public/private) contractors of NRAs** that have an active role in the provision of the service.

Examining the participants' statistics, primary actors are around 50% (7 out of 14). Other emergency services (like the police) are currently not represented in the analysis, which might give a bias. Nevertheless, it is possible to derive some trends, especially in the light of the DIRIZON context.

Having a deeper look at the respondents especially OEMs as well as National Transport Authorities showed active interest in answering the questionnaire regarding core topic 2. Together they made up more than 40% of the respondents (6 out of 14).
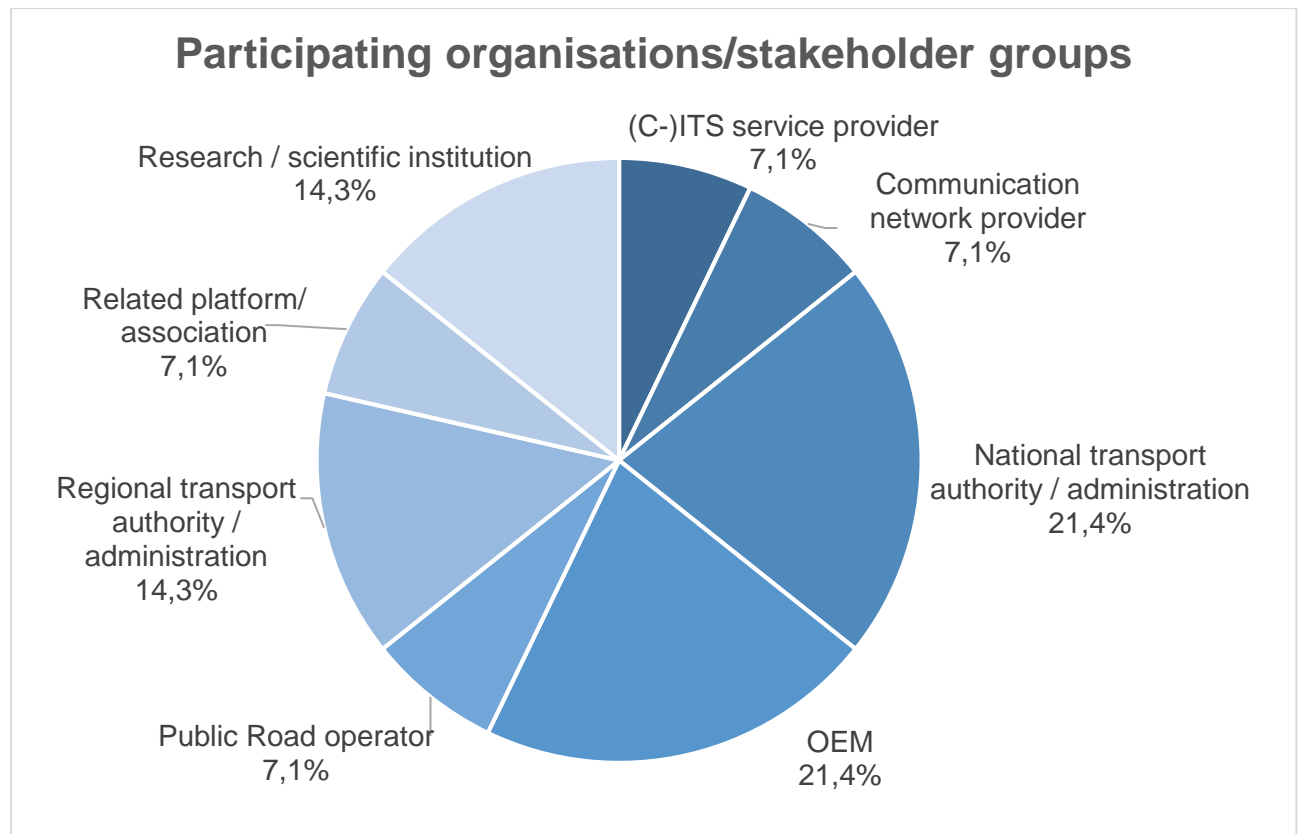
Participating organisations/stakeholder groups

Figure 29: Overview of all participating stakeholder groups

Analysing the size of the participating organisations it is clear that **almost all respondents represent large enterprises (12 out of 14).** There is only one participant each from a medium-sized and a small enterprise. Similar to the analysis of HD maps (see core topic 1) this could lead to the assumption that this core topic is driven especially by larger size organisations (or those larger ones are the ones that are active in the networks that were reached with the questionnaire distribution). As all types of public authorities, Road Operators as well as OEMs and communication network providers are by nature larger sized organisations, this could make sense. However, **(C)-ITS service providers also medium- and small sized enterprises are active in Europe. These smaller service providers could not be reached appropriately with the questionnaire, which might bias the results in this specific aspect. This fact should be considered, when deriving the conclusions from the results.**
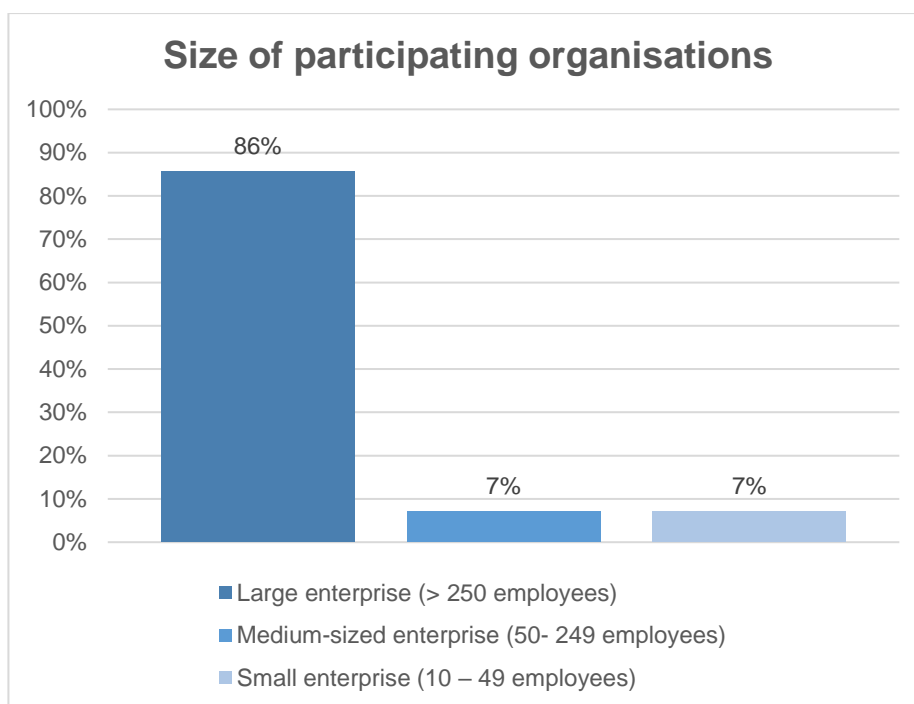
Size of participating organisations

Figure 30: Size of the participating organisations in core topic 2

Having a look at the geographical coverage of the responding organisations, we can see that **over a third of the respondents come from the United Kingdom** (5 out of 14). The remaining participants come in **equal numbers from Austria, Sweden and Germany** (2 each) and one participant each from **Greece, Belgium and the Netherlands**. **North and Central Europe are therefore better represented than the South of Europe.**
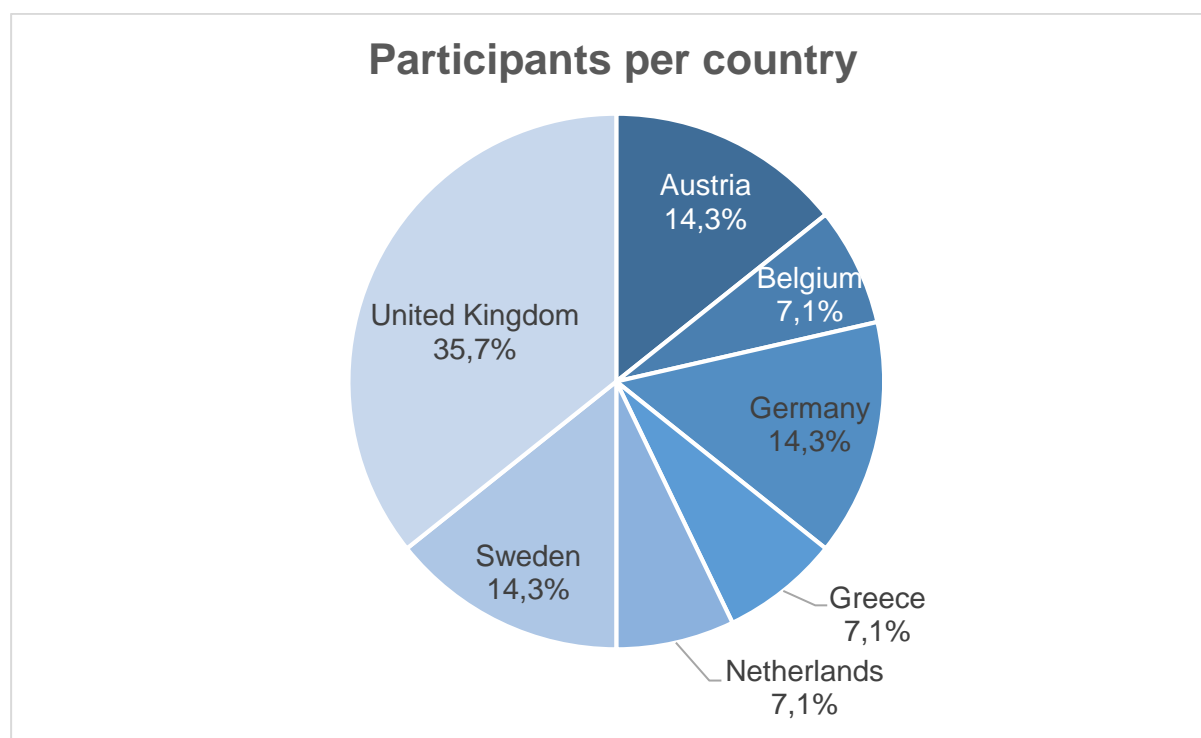
Participants per country

Figure 31: Participants per country for core topic 2

5.3.3 Core topic 2 Validation of process flow diagram – Activities and Actors

In the previous work packages within DIRIZON, some main activities and actors for the Distribution of Digital Traffic Regulations were already identified. In this context, an activity describes a small sub-part of each phase of the process (see Figure 28) and an actor is a certain type of organisation that fulfils activities.

To validate what has been described within DIRIZON and collect additional information on the role of the actors, the participants were asked to evaluate the proposals on activities and actors involved by analysing their relevance for the core topic. Furthermore, they should indicate if their organisation could fulfil the proposed activities. Figure 32 summarises the different activities and whether they are seen as a part of the process of distributing digital traffic regulations.

To ease the step by step validation, the activities were structured into different phases, as they were used in the process flow diagram. For this core topic, the following phases were relevant:

- *PHASE 1: Data/Content Creation*
- *PHASE 2: Content Aggregation*
- *PHASE 3: Service Integration*
- *PHASE 4: Service Presentation*
- *PHASE 5: Feedback loops*
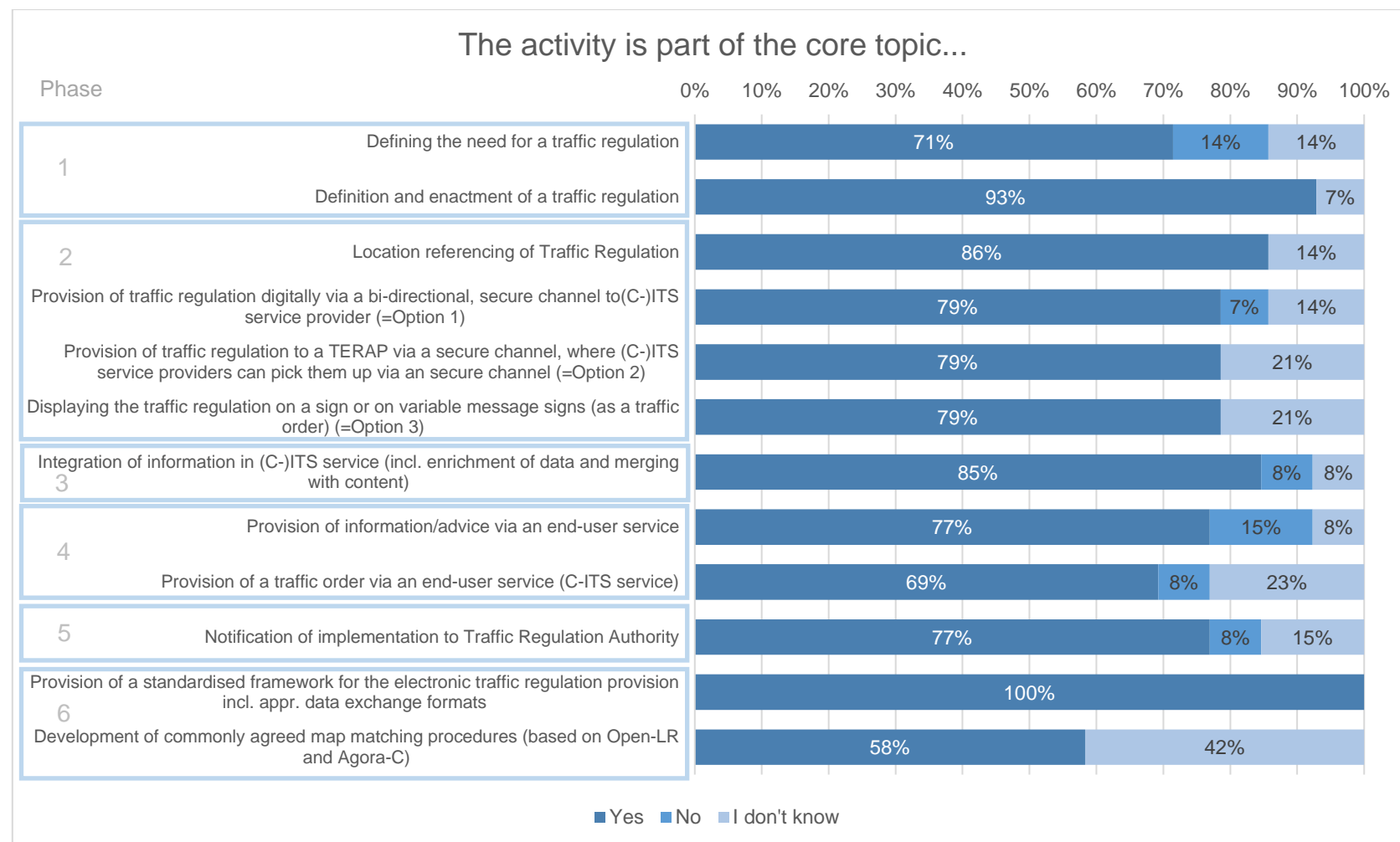- *PHASE 6: Enabling and regulation (not visible in the flowchart)*

Figure 32: Overview of the acceptance rate regarding the process/flowchart in general (core topic 2)

Activities \ Stakeholder groups	(C-)ITS service provider	Communication network provider	National transport authority / administration	Regional transport authority / administration	OEM	Public Road operator	Related platform/association (e.g. PIARC, ASECAP,...)	Research/ scientific institution
Defining the need for a traffic regulation	100%	100%	67%	100%	67%	0%	0%	100%
Definition and enactment of a traffic regulation	100%	100%	100%	100%	67%	100%	100%	100%
Location referencing of Traffic Regulation	100%	0%	100%	100%	67%	100%	100%	100%
Provision of traffic regulation digitally via a bi-directional, secure channel to(C-)ITS service provider(=Option 1 in diagram)	100%	100%	67%	50%	67%	100%	100%	100%
Provision of traffic regulation to a Trusted Electronic Regulation Access Point via a secure channel, where (C-)ITS service providers can pick them up via an secure channel(=Option 2 in diagram)	100%	100%	100%	50%	33%	100%	100%	100%
Displaying the traffic regulation on a sign or on variable message signs(as a traffic order)(=Option 3 in diagram)	0%	100%	67%	100%	67%	100%	100%	100%
Integration of information in (C-)ITS service (incl. enrichment of data and merging with content)	100%	100%	33%	100%	100%	100%	100%	100%
Provision of information/advice via an end-user service	100%	100%	33%	100%	50%	100%	100%	100%
Provision of a traffic order via an end-user service (C-ITS service)	100%	100%	67%	100%	0%	100%	0%	100%
Notification of implementation to Traffic Regulation Authority	100%	0%	33%	100%	100%	100%	100%	100%
Provision of a standardised framework for the electronic traffic regulation provision including appropriate data exchange formats	100%	100%	100%	100%	100%	100%	100%	100%
Development of commonly agreed map matching procedures (based on Open-LR and Agora-C)	100%	0%	50%	100%	50%	0%	100%	50%

Table 4: Overview of the acceptance rate by stakeholder group ("Yes, the activity is part of the core topic") regarding the process/flowchart by stakeholder groups

On an overall level, the acceptance of the suggested process flow for core topic 2 is quite high.

While for some activities there are uncertainties in form of a considerable rate of "I don't know", some activities (in *Phase 1,2, 4 and 5*) have to be investigated deeper, as there is a number of clear responses indicating "No, this activity is not part of the core topic".

For *Phase 1: Content Creation* the activity Defining the need of the traffic regulation is not seen as a part of the core topic by 14% of the respondents, including a Public Road Operator and a related platform. One comment added that this activity is not relevant for the core topic, as the respondent would assume that the process of the core topic itself starts, when the decision on the traffic regulation has been taken (Figure 32).

For *Phase 2: Content Aggregation* Option bi-directional secure channel to the (C)-ITS service provider is questioned by OEMs and Regional Transport Authorities (14%). National Transport Authorities see no need for this activity at all (7%).

In principle, the approval for this phase is harmonised for all activities, as for each phase around 11 respondents agreed with the need of this activity for the core topic, while 2-3 respondents were not completely sure about it.

Phase 3: Service Integration shows that 85% of respondents agree, while one National Transport Authority disagrees with this adding the comment that this activity is not relevant for the core topic "Distribution of digital traffic regulation". As a majority agrees with this phase, DIRIZON will keep the phase for the further work. Nevertheless the comment will be again considered in the next steps.

Phase 4: Service Presentation needs to be looked at in more detail. The provision of information via an end-user service is not seen as part of the core activity by 15% (2 out of 13) of the respondents, including an OEM and a National Traffic Authority. The comments show that those respondents don't see a real end-user service in practice ("End-user service for whom? For an automated vehicle?") and the "Risk of service abuse by citizens, which will undermine the objective." These are important considerations that will be taken into consideration in the next phase to further define the service. Furthermore this aspect will be added to the risks related to the core topic. Due to the general approval of this activity, it will be kept for the further work.

In addition, another comment summarizes some important aspects related to the topic of service presentation: "As a citizen centred service, it is highly conceivable to image that traffic regulation data is published in the open data domain. Those actors who are part of a regulated service chain (creating authority, ITS service provider, Map Provider, (C)-ITS service provider) will have to provide secure authenticated communications. Other data service providers of unregulated services may not have the same obligation."

The provision of a traffic order via end-user service is clearly part of the relevant activities for 69% of the respondents (9 out of 13), 23% are uncertain about it (3 out of 13), and only one respondent disagrees completely (Figure 32). The "No" is related to the same cause that was given in the previous activity: "Risk of service abuse by citizens, which will undermine the objective." There are no additional comments that would explain why the 3 respondents are not sure on the activity. Based on the given answers, it is concluded that it will be included as part of the process flow, but maybe in more detail.

The reason that especially OEMs and National Transport Authorities are only partly approving of this activity is an interesting aspect that should be further investigated. The reasons for that are not clear from the responses so far.

Analysing the distribution of consent, dissent and uncertainty in the *Phase 5: Feedback Loops*, which mainly covers the notification of the traffic regulation authority that the traffic regulation has been implemented (see Figure 32).

Based on the comment, one could learn that the term "implementation of traffic regulation" was not fully clear for all respondents. Looking at the "No" responses we can see from the comments made by a National Transport Authority that the volume of data to be verified could be a problem for some organisations: "It will probably be impossible to manage the volume of data for verification. Should preferably be regulated within a contract between regulating authority and service provider. However, it would be interesting to receive feedback on data quality from service providers."

On the other hand, comments were added from respondents that stated "Yes, this is part of the core topic" or "This is essential for the quality of a future robust electronic service - it is an area of weakness of current processes." Furthermore the "assessment of compliance bodies" was mentioned.

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So in principle, we can assume from the responses given in the questionnaire that respondents coming from the group of (C-)ITS providers, regional transport authorities, OEMs, Public Road Operators and Research and Scientific Institutions agree with the need for the notification on implementation, while communication network providers and national transport authorities are not fully convinced. Considering the comments this might be related to the need for verifying the feedback. This should be considered in the further work to detail how the process for the notification is done at the moment and can be done when considering electronic traffic regulations. It has to be investigated further if such notification processes (e.g. for traffic sign installations) already exist on the level of the national transport authorities or handled elsewhere. For the communication network providers, it might be one reason that they are not primary actors in this action and therefore do not consider this as part of the core topic (see Table 4).

Finally for *Phase 6: Enabling and regulation*, which is again not visible in the flowchart due to visualisation reasons, we can see that the action Provision of a standardised framework is clearly one important task within this core topic, that has been fully approved by all stakeholder groups . This emphasizes the need for even more efforts in the related standardisation groups (as CEN/TC 278 WG17).

For the second activity Development of commonly agreed map matching procedures, a high uncertainty exists within all stakeholder groups. Especially the core target group of Public Road Operators, as well as communication network providers answered that they "don't know, if this is part of the core topic". For national transport authorities, only 50% of each group (1 out of 2 respondents) agreed with the fact that this activity is something that is part of the core topic.

One respondent mentioned that "*the model of TN-ITS implementation*" should be used for this action. No further comments were added. Maybe this topic is very specific, which leads to a high degree of uncertainty.

Missing activities

The following activities have been added by the respondents to the core topic:

- Providing the infrastructure for latency-critical information layer (added by (C)-ITS service provider)
- Feedback loop regarding data quality (added by National Transport Authority)
- Standardization/harmonization of access restriction schemas (added by related platform/association)

The activities added vary very much in their nature. While the first one is infrastructure-related, the second one includes an additional loop and procedure in the process, looking more in detail at the quality of data, while the third one is related to the area of standardisation and harmonisation in respect to the electronic traffic regulations.

The DIRIZON consortium will evaluate the possibilities to add these activities in the next steps.

5.3.4   Core topic 2: Overall evaluation of process flow diagram and storyline

The first impression is that major parts of the process flow diagram were approved by the respondents with some comments and adaptions that will be considered in the further steps of DIRIZON, especially in WP5 and WP6. Risks were mentioned for some of the activities, as well as questions on the actual procedure and the workload coming from the new adapted procedures were raised.

This picture is also visible in the results of the overall evaluation of the flow chart. In the last part of the questionnaire, respondents were asked "*Does the flow chart and the storyline as presented here reflect the process for this core topic correctly from your point of view*?"

The idea is to focus on the general feedback of the process as a whole, independently from some details respondents might not agree with. Respondents could rate the general flow on a scale (*0 – I totally disagree with the presented process* up to *10 – I totally agree with the presented process*).

On an overall level the process flow chart and the included storyline received an average rating of 7,5. This result shows that the respondents agree in wide parts with the presented storyline and the presented process for core topic 2. This result is very similar to the overall evaluation of core topic 1 with an average score of 7,6.

What we can see from the scoring per stakeholder group is that the **process as described seems to match very well the view of the communication network providers, the Public Road Operators and the Research and Scientific Institutions,** as we can also see from some comments, e.g. "*A quite good effort for defining responsibilities*".

The picture of OEMs on the process seems to be different. Unfortunately, no additional comments were added to get a clearer picture on that.

The scoring of the National transport authorities was very well underlined with additional comments, which mainly give some important hints, where **NRAs are missing some details and activities in the flowchart that need to be better fine-tuned.** Also the distribution via open channels was mentioned.

- *"Responsibilities are missing. Difficult to understand what activities are included in each part of the chart. The questions need to be fine-tuned. **It would be better to only cover CCAV and not personal information devices.** Digital traffic regulation for automation is an essential issue.*
- *The flowchart is missing the distribution of traffic regulation information in advance of implementation and **distribution via open channels**. **The role of distribution by authorities is not limited to just 'NRA'.***
- ***There are some national minor deviations** from the flow chart but in principal it's usable for these kind of discussion.*

In addition it was mentioned by one respondent (from the group of OEMs) that it is not clear "**who should operate the access point**" mentioned in the core topic. Furthermore, it was added, that ***"all options can be implemented in parallel"***. As this is something that is also considered from the side of DIRIZON, this needs to be emphasized more clearly in the use cases in the next steps.

The related platforms, with an overall score of 6 especially mentioned that the complexity of a **multi-actor-environment is not fully represented** in the kind of presentation of the flowchart, but an essential part for the implementation of the core topic. DIRIZON will consider for the further steps how this aspect can be better integrated:

- *"I don't see content creators as part of the flow chart. The flow chart is presented as 1 layer. But most elements are represented by a set of organisations (at least one in each country). This means a multitude of connections. I also miss the role of the NAP's in the scheme."*

Furthermore, it was mentioned in the comments that **attempts already exist to create a database with (digital) information on all traffic regulations, which have faced huge challenges so far**.

Stakeholder group	Rating
(C-)ITS service provider	8
Communication network provider	10
National transport authority / administration	5,7
OEM	5
Public Road Operator	10
Regional transport authority / administration	7,5
Related platform/association (e.g. PIARC, ASECAP,...)	6
Research / scientific institution	9,5
Total rating all stakeholder groups	**7,5**

Table 5: Overall rating of process for core topic 2

These results give the impression that the views of some stakeholder groups are already well represented. **We see that differences exist between the various stakeholder groups and have some first impressions where these contradicting views are.** In principle, this means that this is valid basis for the further discussion and is **drawing variants based on the view of the different stakeholder groups.**

In addition, respondents had the possibility to **describe important alternatives** to the described process.

Two respondents answered with "Yes" but didn't leave additional comments what the important alternatives might be, besides the missing activities that were already mentioned before. All other respondents answered "No, I don't see important alternatives to the presented process". Based on this result, considering the comments on the missing activities and some fine-tuning, the described process can be considered as valuable for the further discussion within DIRIZON.

5.3.5 Core topic 2: Validation of roles and responsibilities

Another aim of this work package was to examine which responsibilities the stakeholder groups see themselves taking and which responsibilities they expect others to take.

In a first step in the context of the questionnaire, the participants were asked to evaluate which actors can fulfil the proposed activities. Therefore, certain types of organisations were previously identified for each activity within the different phases of the process. The participants also had the opportunity to name additional actors who could fulfil the proposed activities according to their experience.

In case the activity was seen as part of the core topic, the acceptance towards proposed actors was analysed. The following figures give an overview of actors and their roles in the process of provision of HD Maps for Automated Driving.

As this was done together with the validation of the activities, the following analysis is also based on the phases:

- *PHASE 1: Data/Content Creation*
- *PHASE 2: Content Aggregation*
- *PHASE 3: Service Integration*
- *PHASE 4: Service Presentation*
- *PHASE 5: Feedback loops*
- *PHASE 6: Enabling and regulation(not visible in the flowchart)*

For the analysis of the roles and responsibilities, only those respondents were considered that marked the relevant activities as "part of the core topic". Multiple actors for each activity were possible.

Furthermore we considered in the following analysis the responses, where organisations indicated that they could be an actor to fulfil a certain activity (as described in chapter 9.1.3) for each activity (see Figure 33).

Figure 33: Screenshot of the questionnaire "My organisation can fulfil this activity"

Core Topic 2: Overview of most important actors

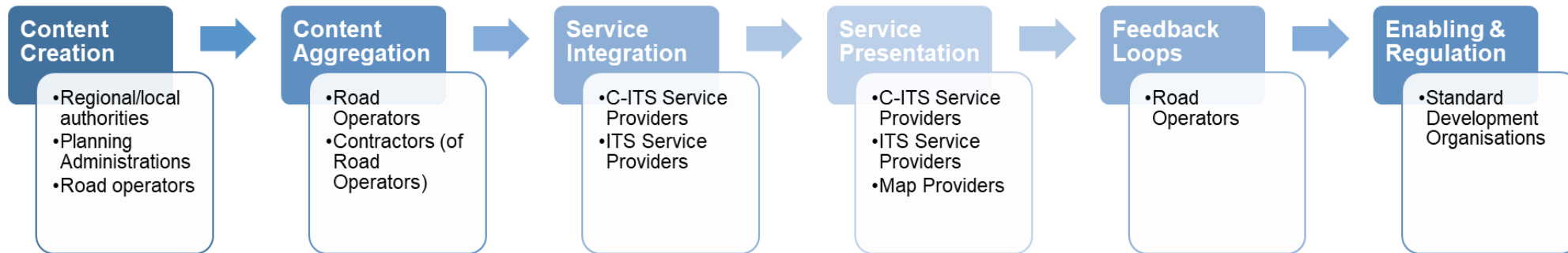| Content Creation	Content Aggregation	Service Integration	Service Presentation	Feedback Loops	Enabling & Regulation
•Regional/local authorities •Planning Administrations •Road operators	•Road Operators •Contractors (of Road Operators)	•C-ITS Service Providers •ITS Service Providers	•C-ITS Service Providers •ITS Service Providers •Map Providers	•Road Operators	•Standard Development Organisations

Figure 34: Overview of most important actors of Core Topic 2

This flow diagram in Figure 34 lists the most important actors in each of the six phases in the process of distributing digital traffic regulations. However, since this just serves as an overview only the three most important actors are included and only if more than 50% of the respondents see that they can fulfil activities within the phase. The following figures in this chapter show the results for each activity in more detail.

It is clear that Road Operators seem to play an important role in the first two phases and especially as providers of feedback since Road Operators are the first ones to witness whether users comply with traffic regulations or not. It is also not surprising that the participants see C-ITS and ITS service providers as important when it comes to service integration and presentation.

Those who see the first two activities of *Phase 1: Content Creation* as part of the core topic assume that **Road Operators and (Local) Planning Administrations will be mainly those organisations that will *define the need for a traffic regulation*** (based on some triggers). They were named 8 times each by 10 respondents in total (80%). **This is contradicting to the responses given according to the indication "*my organisation can fulfil this activity*".** For this first activity, one National Transport Authority and two Regional Transport Authorities indicated themselves as actors. The responding Road Operators did not see themselves in charge of this activity. As no local planning administrations took part in the questionnaire this is only of little significance.

For the next activity, **regional/local authorities will play a crucial role in the *Definition and enactment of a traffic regulation* (with 100%, 13 out of 13 respondents)** based on the expectations of the respondents. Also, Road Operators and ministries were seen as potential actors that can fulfil this activity (by 7 respondents). Only 2 respondents see the police as an actor for the definition of the traffic regulation. The responses were not related to the type of stakeholder (as coming from two different types), as well as from two different nationalities. Nevertheless, some national differences and complexities have to be considered for the long-term implementation. So e.g. in Sweden 3 levels of authorities exist, that are involved in this activity - local, regional and federal, as was added by one participant. This is also relevant related to the answer if one organisation can fulfil the activity, because this means e.g. the National Transport Administration in Sweden can only fulfil this activity partially. Aligned to this National Transport Authorities, Regional/Local Authorities and Public Road Operators stated that they could fulfil this activity.
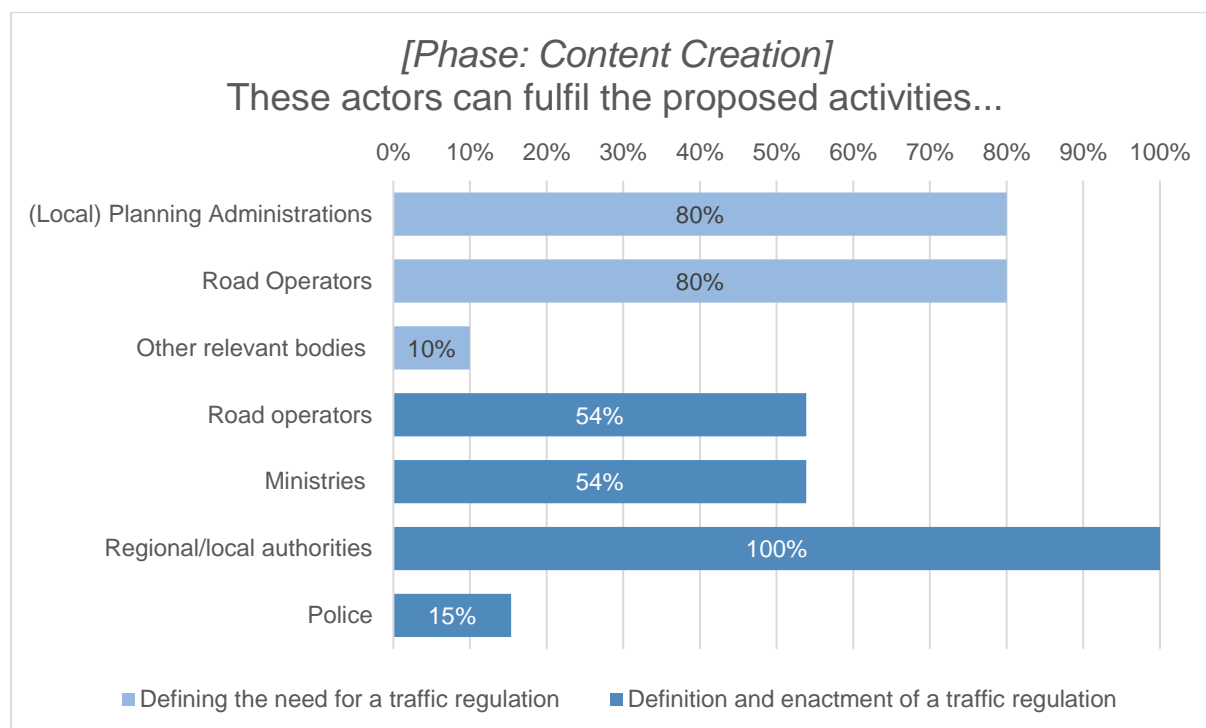

Figure 35: Proposed actors Phase Content Creation

For the *Location referencing of the traffic regulation respondents,* the participants see mainly Road Operators in charge, but also administrative bodies, contractors or the police might play a role. One respondent added that also "other" bodies like an enactment body, the National Transport Administration, local highway authorities, map operators or local planning administrations might take a role in this activity. This is in line with the statements of the respondents. National Transport Authorities, Regional/Local Transport Authorities, as well as Public Road Operators and a related platform stated that they could fulfil this activity.

For the *Provision of traffic regulation digitally via a bi-directional, secure channels to an (C-)ITS service,* the picture is very much the same, besides the fact that only one respondent sees the police in charge of this activity, while 2 respondents added in addition also the following actors: Traffic regulation authorities, National Transport Administration, Communication Service Provider, Local highway authority. Communication network providers, Road Operators, a related Platform, as well as a Regional/local transport authority indicated themselves as fulfilling actor. For the last group national differences were visible in the responses.
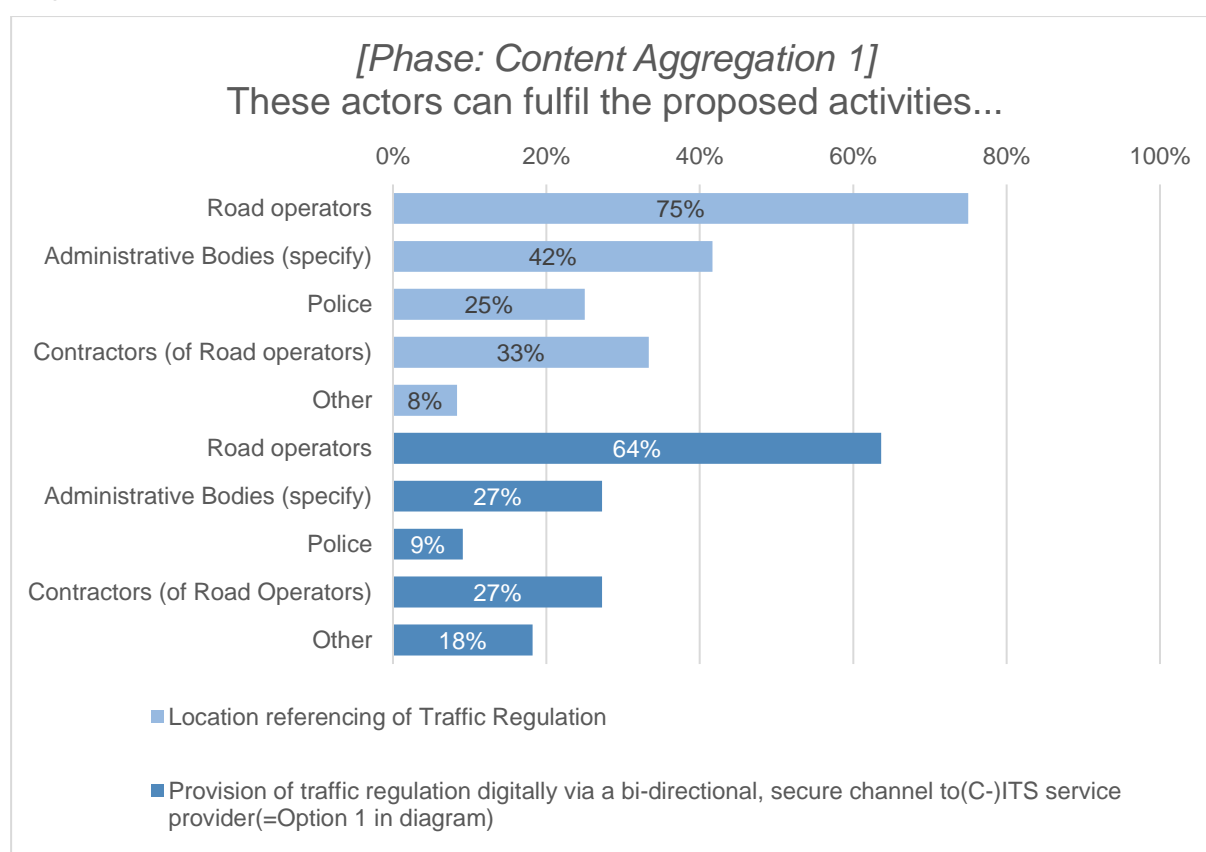

Figure 36: Proposed actors Phase Content Aggregation (1/2)

For the other option *Provision of a traffic regulation to a Trusted Electronic Regulation Access Point via a secure channel,* Road Operators and their contractors definitely play an important role in the view of the respondents. Followed by Administrative bodies (e.g. the National Transport Administration), which were selected 3 times. Again, traffic regulation authorities, Communication Service Providers and local highway authorities were named under "other" actors that can fulfil this activity.

Communication network providers, National Transport Authorities, Public Road Operators and Regional Transport Authorities marked themselves as active actors for this activity.

This is in line with the picture given of the actors that are expected to fulfil this activity. Many actors see a potential role for themselves in this activity.

The picture is more or less identical when it comes to the third option, '*Displaying the traffic regulation on a sign or variable message sign'*. Similarly, Road Operators and their contractors are the major choice. Looking at the indication of actors that stated they can fulfil this activity we see National Transport Authorities, Regional Transport Authorities and Public Road Operators, which more or less complements the picture with the indication given also in the previous activities.

No major national differences (besides the "other" actors and between the regional transport authorities) could have been identified based on the responses given.
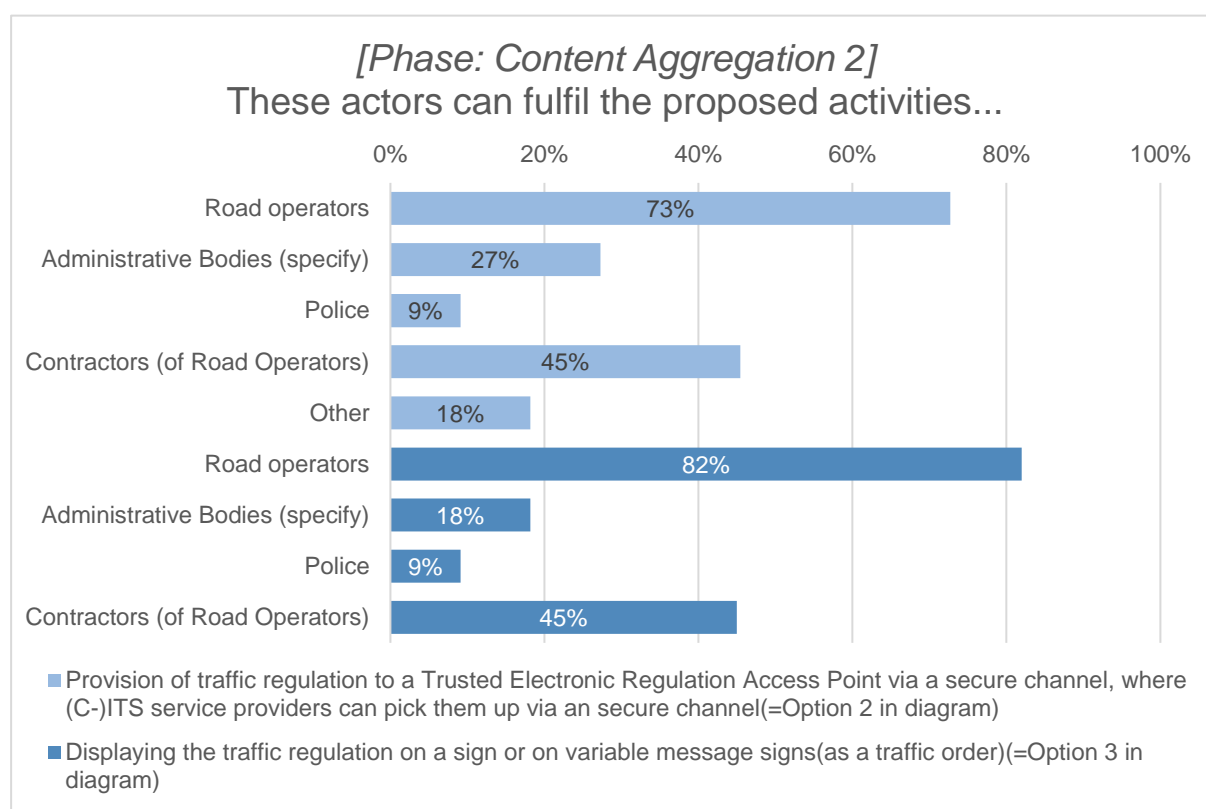
Figure 37: Proposed actors Phase Content Aggregation (2/2)

For the ***Phases 3 and 4 Service integration & Service presentation*** *the responses* are quite clear for all the different activities:

The responses regarding the actors that will be in charge for the activity **Integration of information in (C-)ITS services are the C-ITS and ITS service providers**, as named by 91% and 100% of the respondents (which means they have been ticked 10 and 11 times). In addition it was added by one respondents that the following "*other*" actors can fulfil this activity, like "*mobile network operators*" and "*any other content processor*". As an interesting fact, **only Road Operators indicated that they could fulfil this activity. The (C-)ITS service providers did not mark themselves as active actors. This has to be investigated more in detail but could be based on the fact that the Road Operators fulfil also the role of a (C-)ITS service provider in some countries.**

Regarding the ***provision of information/advice via an end-user service*** **ITS service providers and Map Providers** are seen as actors by a majority of respondents (ticked 8 and 9 times). Again, one respondent added "*mobile network operators*" and "*any other content processor*" as additional actors.

For the last activity ***Provision of a traffic order via an end-user service,*** **the (C)-ITS service providers were seen as potential actors by all respondents** of this question (9 times). In addition two respondents named "*mobile network operators*" as "*other*" organisations that can fulfil this activity.

For both activities related to the Phase Service Presentation, only Public Road Operators and Regional/local Transport Authorities indicated that they could fulfil this activity, not the participating C-ITS service provider. **Again, this could be related to the fact that the Road Operators, as well as some Transport Authorities are also fulfilling the role of (C-)ITS service providers in their country, which leads to an blurring of the roles.** It has to be investigated in detail, but the fact that those that indicated themselves as active actor also ticked that (C)-ITS service providers are potential actors fulfilling this activity would support that hypothesis.
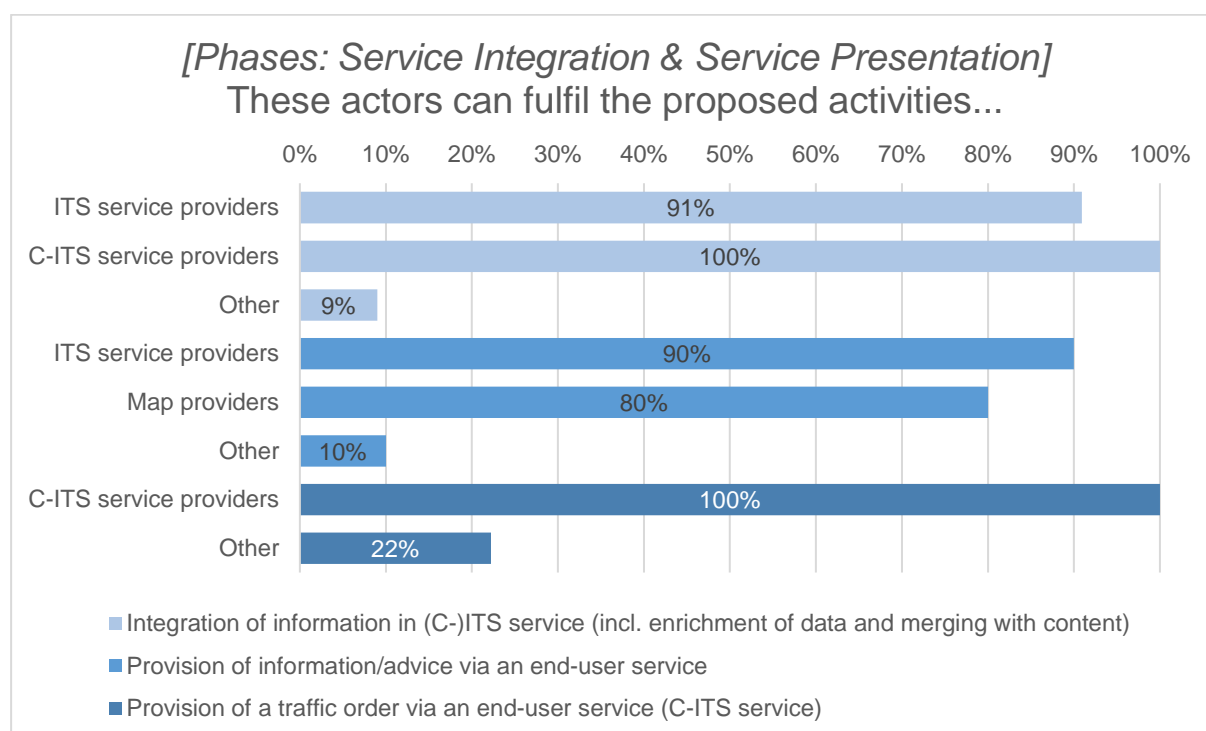

Figure 38: Proposed actors Phases Service Integration & Service Presentation

The last two phases *Feedback Loops & Enabling and Regulation* are combined in the following Figure 39.

For the *phase **5 Feedback Loops (including the Notification on the implementation),*** there is quite a **clattered picture**. While Road Operators were named 7 times (from a total of 10 respondents that see this activity as part of the core topic), their contractors were as well named 4 times, as it is also true for the Administrative bodies. Also, the police were named twice here, as well as "*other*" ("*other road contractors, utility companies, map operators and mobile network operators*"). **For the feedback loops, C-ITS service providers indicated**

themselves as actors that can fulfil this activity, although they were not named as actors that could potentially fulfil this activity. This is interesting, as this is exactly the contrary to what happened in the two activities previously described. In addition, **Road Operators and a Regional/Local Transport Authority indicated themselves as active actors** as well, which is in line with the given responses of the actors that are expected to fulfil this activity.

For *phase 6 Enabling and Regulation* the picture based on the responses given is clearer. For both activities (*Provision of a standardised framework* and *Development of commonly agreed map matching procedures*), **Standard Development Organisations are clearly the actors that are seen in charge for the activities** by the respondents of the questionnaire. In addition, 3 respondents for the first activity and one for the latter activity could imagine "*other*" actors like "*Communication Service Provider*", "*law commission*" and *"RAs"* in case of the previous activities and *"map developers"* in case of the last activity.

For the *Provision of a standardised framework* Communication Service Providers, a Regional/Local Transport Authority and a Public Road Operator marked that they could fulfil this activity. For the Development of commonly agreed map matching procedures, a National Transport Authority stated that they could fulfil this activity. **As it seemed to be clear from the previous question that Standard Development Organisations should be the active actors in this activity this could lead to the assumption that those groups are already actively involved or plan to be actively involved in the Standardisation Activities that take place on European level related to the core topic.**
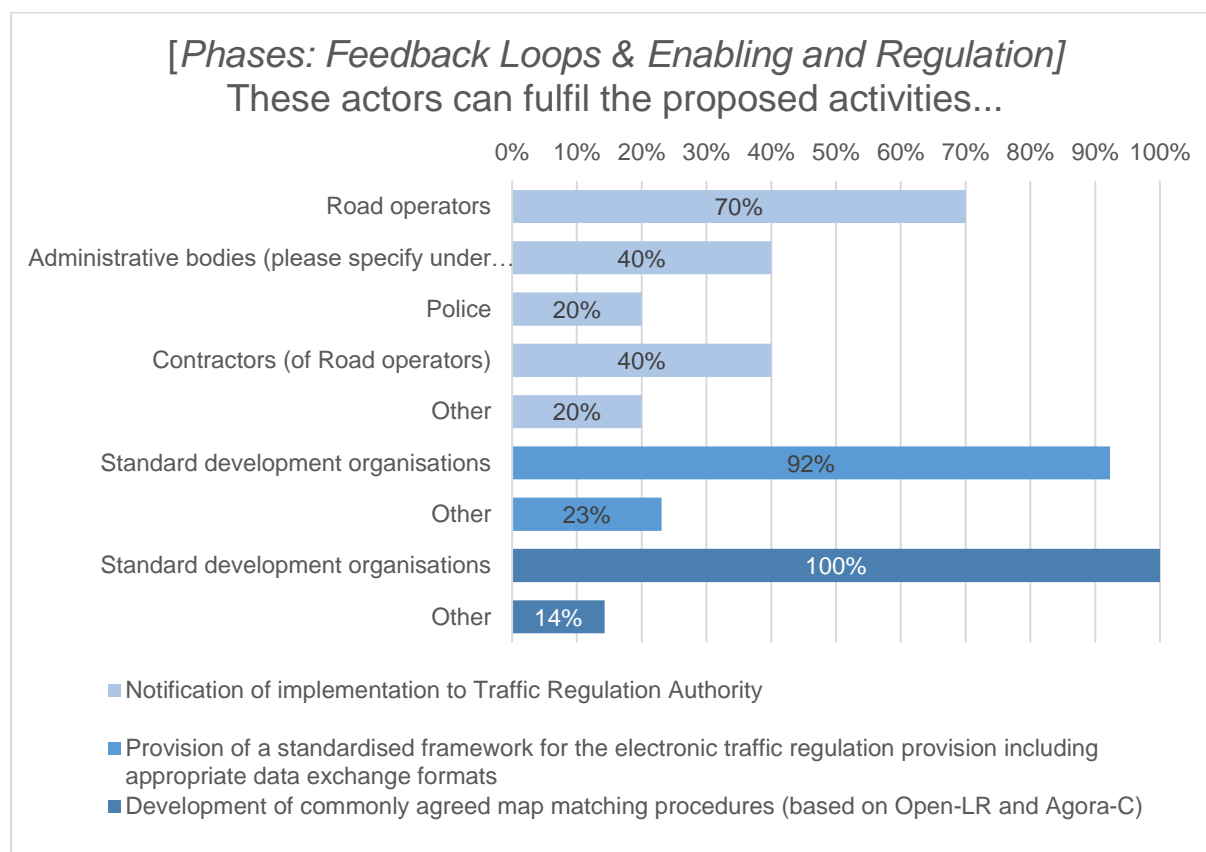

Figure 39: Proposed actors Phases Feedback Loops & Enabling and Regulation

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Missing actors

Similar to the activities section, respondents had the possibility to add actors that are missing the process flow so far.

The following actors were added:

- Law making bodies, defining the framework and steering the direction
- POLIS (the European network for cities and regions), for an inventory/harmonization of access restriction schemes
- Mobile Network Operators
- Service Providers
- Map Makers
- Road Authorities

Cross-border aspects related to the responsible actors

The questionnaire also addressed the fact of necessary changes regarding cross-border interoperability. Respondents were asked *"How will it affect your answers if the end-user/vehicle uses the same service in another country? Will there be any changes e.g. regarding the activities or the related actors?"*

The analysis of responses showed that **77% of respondents** (10 out of 13) **do not expect any changes** related to the cross-border aspects. **15% of respondents** (2 out of 13), including National Transport Authorities and OEMs, **expect moderate changes** and 1 respondent (OEM) **(7%)** expects **significant changes**, which is related to the national differences that exist related to traffic in general and the **need for adapted national/local solutions, instead of one overall approach**: *"Traffic varies across the planet. Traffic in London is somewhat different to Paris, Moscow, New York. Culture and driver standards are also different – e.g. India vs US etc. You can't enforce the same solution."*

Regarding the moderate changes, the main aspects are again the **need for interoperability and harmonisation processes** on the one hand and the aspect of **existing national legal differences** on the other hand. These have to be considered for a European, or even worldwide implementation concept for METR, which has already been mentioned in the paragraph before:

- *"The METR data delivery concept is currently a concept that has no standing in legislation and operational practice. A strong degree of harmonisation of processes and quality measures are required - this does not imply that the actors in the national legislative systems must be identical."* (added by National Transport Authority)
- *"The core topic depends significantly on driving behaviours, landscape and law enforcement in general which can vary across countries."* (added by OEM*)*

The need for different solutions (or at least adaptions) needed for the different countries seems to be very tangible in the view of the OEMs and has to be considered in further projects in this context*.*

5.3.6   Core topic 2: Validation of necessary data and data availability

In the course of the project, the consortium identified main data/data types that are needed to make the core topic "Distribution of Digital Traffic Regulations" reality. The participants of the questionnaire were asked to evaluate the proposed data needed as well as their availability. The different data types were divided into two general parts:

1. *Static data*
2. *Semi-dynamic/dynamic data*

As a first step, the participants were requested to verify whether the proposed data is relevant within the core topic or not. In addition, they should evaluate if the data type is available in machine-readable format. In a further step, they were asked – similar to the activities and actors part - to analyse the proposed data providers.

5.3.6.1   Data types relevant for core topic 2

Figure 40 gives an overview of the evaluation of the participants regarding the proposed data types. **Taking into account the static data, it can be summarized that the participants have quite clear ideas which data is relevant for the distribution of digital traffic regulations.** Half of the data types that were asked about in the questionnaire were seen as relevant for the core topic by 100% of the respondents. **Therefore, the results show a broad acceptance of the suggested data**.
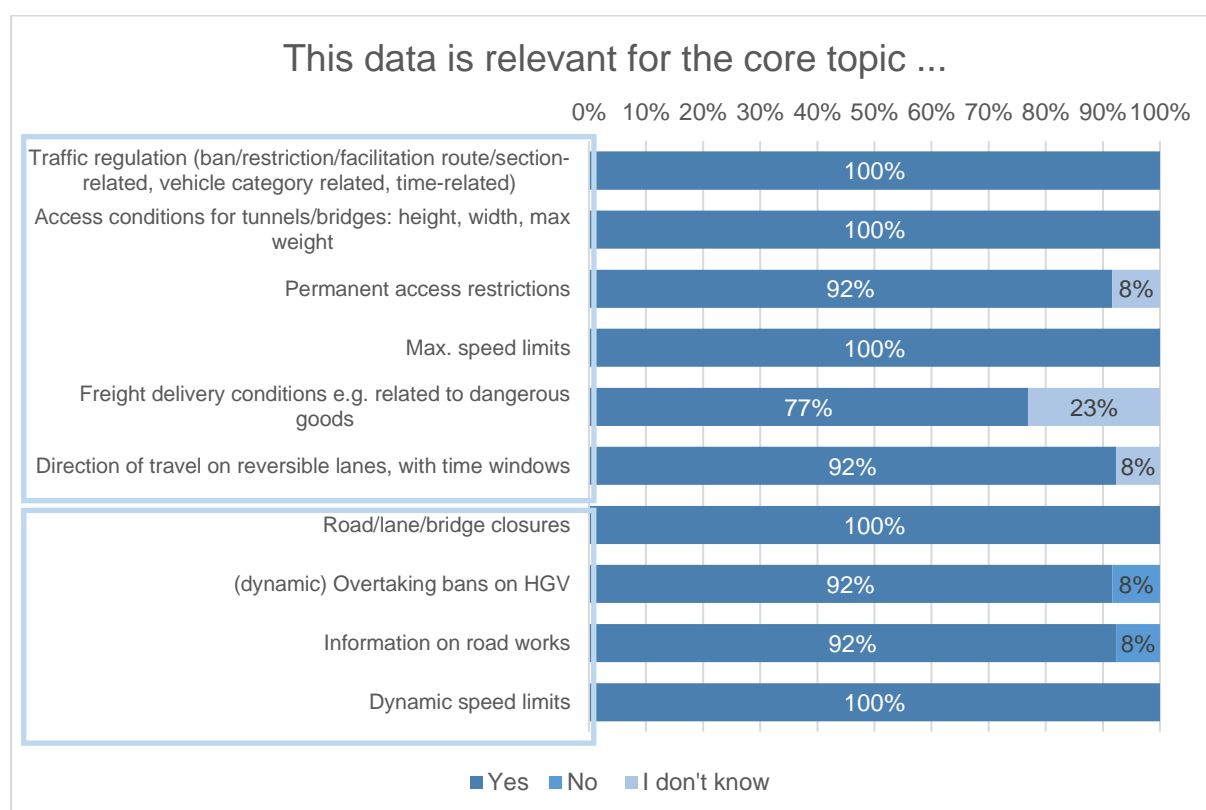

Figure 40:   Acceptance rate of suggested data types (Digital Traffic Regulations)

Looking at the static data for core topic 2, **all respondents (13 out of 13 respondents)** agree on the **importance of the data *regarding traffic regulations, access conditions for tunnels and bridges* as well as *maximum speed limits*** in order to make the distribution of digital traffic regulations possible. For the latter, one a respondent added that "*Temporary*

speed limits are not always captured", which might be relevant when setting up the concept for the data platform as this could have an impact on the quality of data and information available.

One respondent added as a comment that one has to consider that the *data on traffic regulations, access conditions*, etc. is "*is very fragmented available, and sometimes only on paper".* This aspect is also considered in the following section on machine-readable data.
The results also show that information on *permanent access restrictions* and *direction of travel on reversible lanes* are essential according to the participating experts with only one respondent each being uncertain about it.

The only kind of data that **23% of the experts are not certain about** is information on **freight delivery conditions**, but still over 70% deem this data as relevant. Similar to core topic 1, we see that the data and information related to freight delivery are an open issue in this respect and that there is a high degree of uncertainty within the group of respondents. This could only be verified by investigating the freight related aspects with freight associations, which were not reached with the questionnaire. This clarification with the freight sector could be considered for future measures.

For **semi-dynamic and dynamic data**, the **acceptance rate is generally very high**. 100% of the experts see data on closures of roads, lanes and bridges as well as dynamic speed limits as relevant for the core topic. One respondents commented the following, which has to be considered for further work: "*Make the distinction between the legal order permitting a road closure and the implementation enacting it".*

Information on *dynamic overtaking bans on Heavy Goods Vehicles* and *information on road works* also seem important for 92% of the participating experts in this core topic, while 8% of respondents (National Transport Authority) states "*No, this data is not relevant*". While for the *dynamic overtaking bans on HGVs* no additional comments were added, the "*No*" related to the *information on road works* is combined with the following comment: "*Depends on the nature of the roadworks - not all roads require TROs, in general it is those that close roads, apply temporary speed limits, etc.".* One OEM also added that the information on roadworks "*only give the overall area over the alotted time. Not the exact location of RW per day."*

In general, for the data types relevant for core topic 2, it has to be considered that the work is currently in progress, but in many cases the traffic regulations are not available yet, as this comment infers: *"The METR-related TRO activities in the UK are moving towards the provision of secure digital Traffic Regulation Order data - this is not currently available. (National Transport Authority)"*

Missing data types

In addition to the aforementioned data types that were mainly agreed by the respondents, additional data missing from the proposed flow diagram was collected:

- *One-way streets*
- *Access restrictions - by type, by dimensions, by use*
- *Dynamic environmental zones and other dynamic access restrictions*

5.3.6.2 Availability of data for core topic 2 in machine-readable format

When it comes to the automation of process and Automated Driving, the availability of data in a machine-readable format is the very basis to make this reality.

As explained in chapter 5.3.6, respondents were also asked about the availability of certain data types in machine-readable format.

The analysis of the responses showed **that for a majority of the data categories, one can't count on the availability in a format** that would be easy to process in an automated way and therefore, the availability for Automated Driving cars or related ITS services is uncertain (see Figure 41: Assessment of respondents regarding the availability of data in machine-readable formatFigure 41). **However, we don't see a clear picture**, as there are mixed "yes" and "no" for one data type. To consider where these differences come from, DIRIZON **also had a look at national differences**. If all respondents from a certain country answered "yes", we can assume that this data type is available in that country, while a "no" of all respondents of a country leads to the assumption that this is not available in this specific country (see Table 6).

For the static data, the respondents were most certain about the availability of *max. speed limits* in machine-readable format. Only 8% (1 out of 13) stated that this is not available, but with the comment "yet". 23% of respondents were not sure about this (3 out of 13), coming from the categories OEM, communication service provider and (C-)ITS service provider. Again, there is a high insecurity related to the availability of *freight delivery conditions*. This is connected with the insecurity on the availability of the data at all, which was also mentioned in the previous chapter.
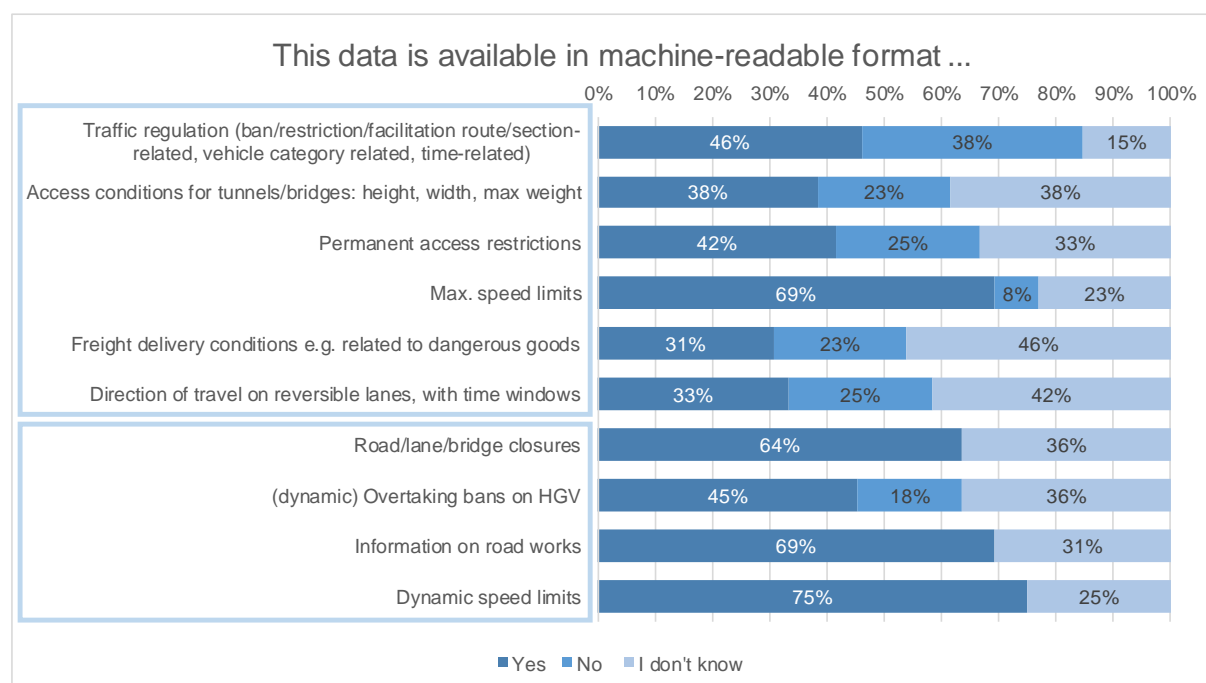

Figure 41: Assessment of respondents regarding the availability of data in machine-readable format

It is worth mentioning that 46% state that traffic regulations are available in machine-readable format versus 38% that say it is not available. **The data showed no clear differences between the different stakeholder types. However, we see that there are national differences that have to be considered.**

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	Traffic regulation (ban/restriction/facilitation route/section-related, vehicle category related, time-related)	Access conditions for tunnels/bridges: height, width, max weight	Permanent access restrictions	Max. speed limits	Freight delivery conditions e.g. related to dangerous goods	Direction of travel on reversible lanes, with time windows	Road/lane/ bridge closures	(dynamic) Overtaking bans on HGV	Information on road works	Dynamic speed limits
Austria	Unclear (Yes+No)	Don't know	No	Yes	Don't know	No	Yes	Yes	Yes	Yes
Germany	No	No	No	Yes	No	No	Yes	Yes	Yes	Yes
Greece	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Netherlands	No	No	/	Yes	No	Don't know	Yes	Don't know	Yes	Yes
Sweden	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
United Kingdom	Unclear (Yes+No)	Unclear (Yes+No)	Unclear (Yes+No)	Unclear (Yes+No)	Unclear (Yes+No)	Unclear (Yes+No)	Yes	Unclear (Yes+No)	Yes	Yes

Table 6: Overview of machine-readable data availability in the different countries (core topic 2)[4]

Having Figure 41 and Table 6 in mind, one could summarize that the dynamic and semi-dynamic data categories seem to be available in machine-readable data format (which makes sense due to the constantly changing nature of these data), as well as max. speed limits, while for all other data types from the static data category national differences have to be taken into account, so that in some cases certain data types are not available at the moment for the further automated process.

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[4] If all respondents from a certain country answered "yes" or "I don't know" it's "yes", if all respondents answered with "no" or "I don't know" it's "No", if there are both answers it's "Unclear (Yes+No)", if all respondents answered "I don't know" it's "Don't know".

5.3.6.3 Data providers for core topic 2

The acceptance towards proposed actors was further analysed among those, who see the data/data types as relevant for the core topic.

This analysis is helpful as it reveals the assessment of the respondents, who are seen as potential providers of the related data category (multiple responses were possible in the questionnaire).

For the *traffic regulations,* the expected data providers are the **regional/local authorities** (92% meaning they were named 12 times by the respondents), followed by **Road Operators** (named 9 times). But also Ministries, as well as the Police have a decent share.

For **all other data types of the static data category, Road Operators** are expected as main data providers, **followed by HD Map Providers**.

This is interesting especially considering that HD Map Providers were only explicitly mentioned as active actors in the provision of an end-user service in the validation of the actors in the previous chapters.

For the static data, "*other*" actors were also named with a share of 15%-23% as data providers. In concrete, "*highway authorities*" and "*regional/local authorities*" were included for all static data types, as well as the "*National Access Point (NAP)*" and "*Research organisations*" for the *max. speed limits.*
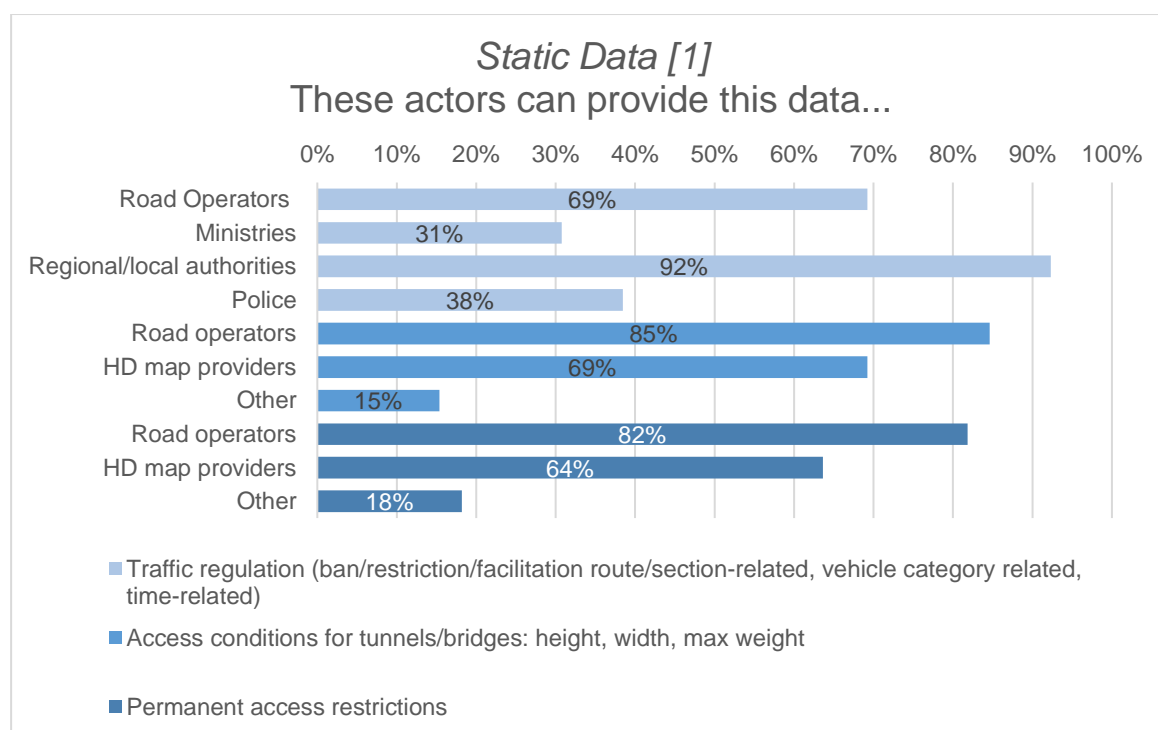
Figure 42: Assessment of providers of static data (1/2)

Static Data [2]
These actors can provide this data...
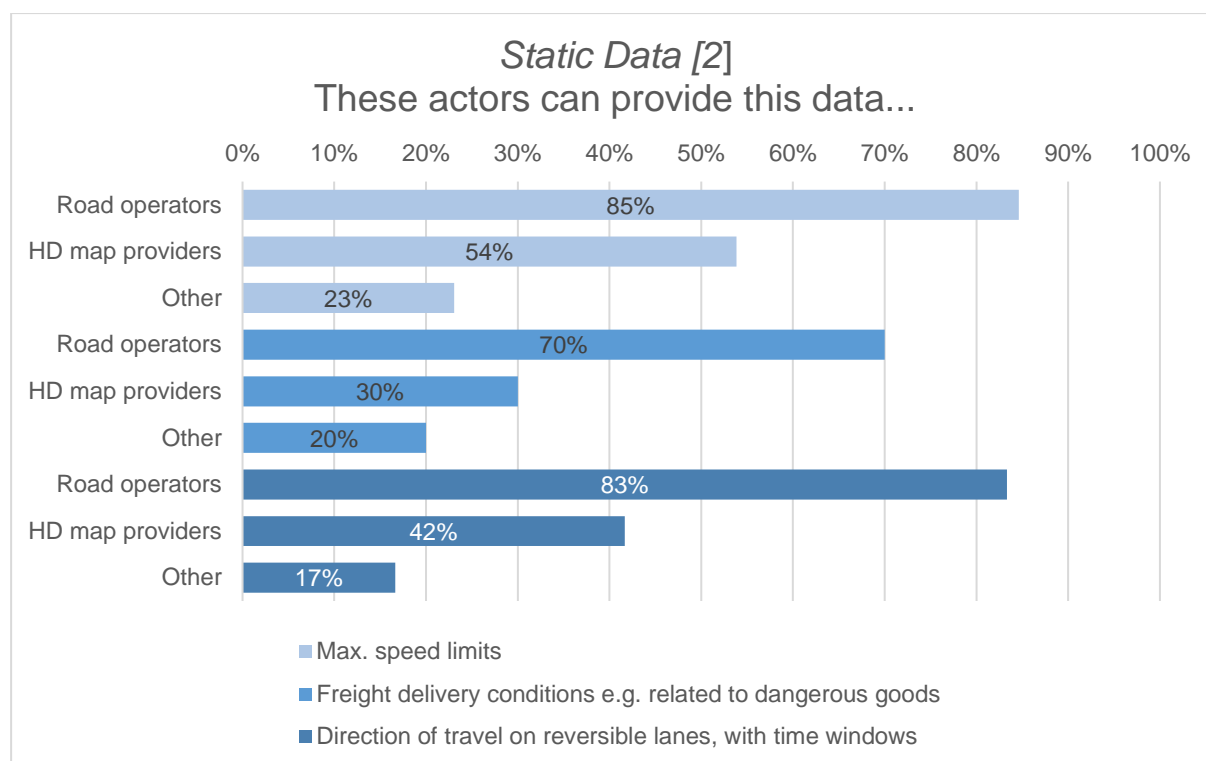
Figure 43: Assessment of providers of static data (2/2)

Also for the semi-dynamic and dynamic data, Road Operators are the most expected data providers (with 92% / named 10-12 times). For the road/lane/bridges closure again "highway authorities", the "National Access Point (NAP)" and "traffic data providers" were named as "other" potential data providers. For information on road works, the road works service providers could also be expected as potential providers of the data. Also the "NAP" was mentioned in the category "other". For the dynamic speed limits C-ITS and ITS service providers are expected, next to the Road Operators, to provide that data, but also "others" like "highway authorities" and again the "NAP".

Looking at the national background of the "other" actors, we can see that the "**NAP" was mentioned only by Dutch respondents**, while the **"highway authorities"** were added by **respondents from United Kingdom**. These national different characteristics are an interesting fact, when it comes to the further data platform concepts in WP5 and WP6**. Because it shows that certain institutions and national organisational structures have an important impact on the processes to be defined for the Management of Electronic Traffic Regulations.**
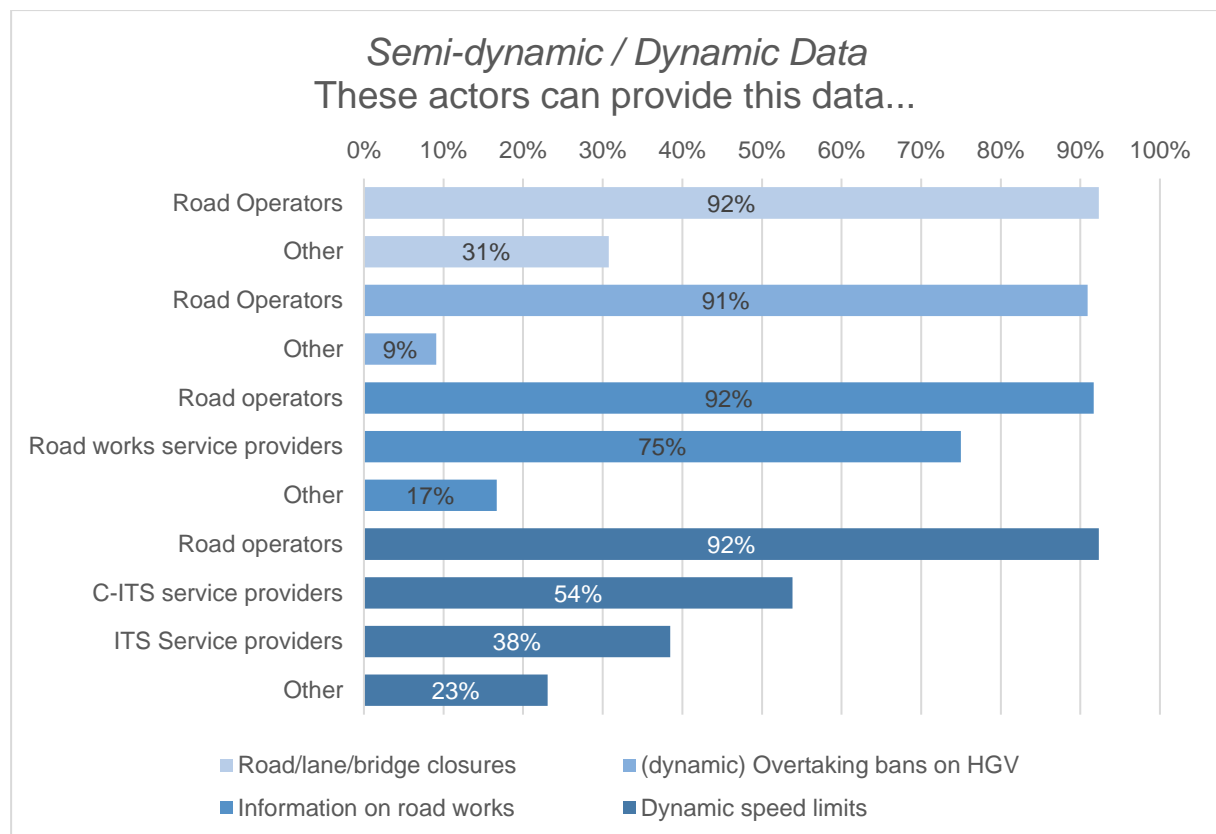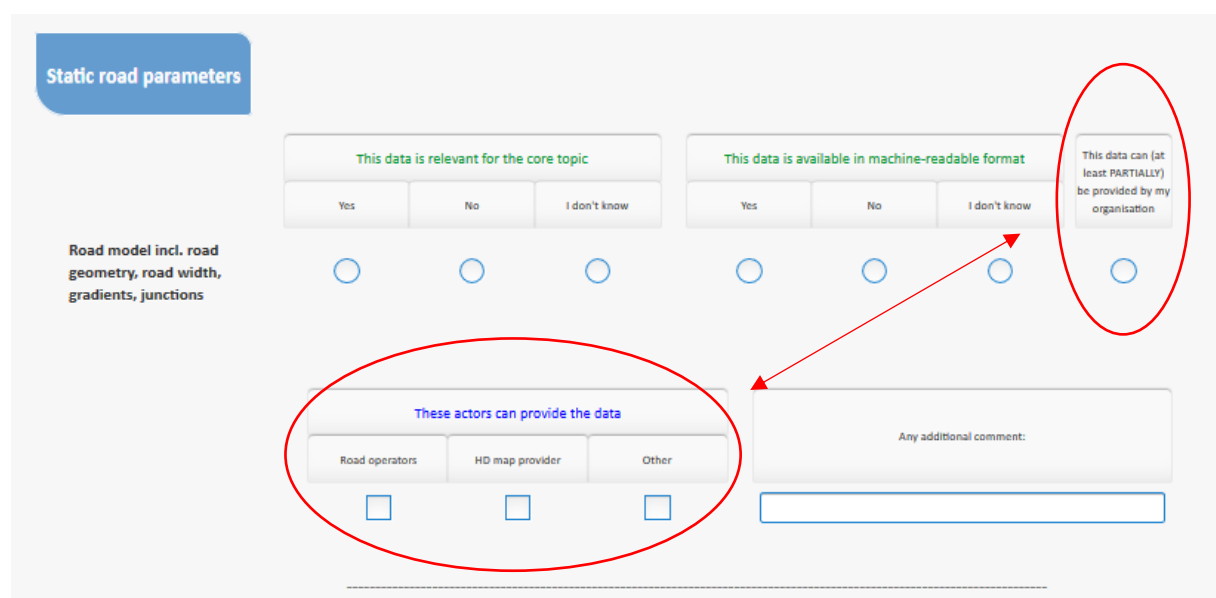
Figure 44: Assessment of providers of semi-dynamic/dynamic data

5.3.6.4 Cross-analysis "Expected data providers" and "I could provide this data at least partially"

As in core topic 1 the consortium cross-checked the section "*These actors can provide the data*" with the section "*This data can (at least PARTIALLY) be provided by my organisation*".

Figure 45: Screenshot of questionnaire for cross-check of the sections "This data can (at least PARTIALLY) be provided by my organisation" and "These actors can provide the data"

Having a look at the previous tables and the aggregated table on responses based on "*This data can be provided by my organisation*" (see Table 7), one can see that they match in wide parts. Even when we consider the fact that some national differences might exist (which cannot be displayed here due to GDPR reasons) we can conclude **that the expectation on data providers and the basically willingness to provide the specific data under certain conditions match on an overall level**. This is a positive sign for the further development in this core topic.

Road Operators also stated that they are able to provide the static data (except freight delivery conditions and direction of travel on reversible lanes), as well as the semi-dynamic and dynamic data. For the above mentioned categories that are not covered by Road Operators other options have to be evaluated, e.g. the National Transport Authorities. As HD Map providers did not participate in this core topic unfortunately their willingness to provide data can't be cross-checked. Furthermore, it is interesting that the **National Transport Authorities are willing to provide a majority of the data needed for the core topic** (besides overtaking bans on HGV).

Stakeholder group	Static data						Semi-dynamic/dynamic data			
	Traffic regulation (ban/restriction/ facilitation route/section-related, vehicle category related, time-related)	Access conditions for tunnels/ bridges: height, width, max weight	Permanent access restrictions	Max. speed limits	Freight delivery conditions e.g. related to dangerous goods	Direction of travel on reversible lanes, with time windows	Road/lane/ bridge closures	(dynamic) Overtaking bans on HGV	Information on road works	Dynamic speed limits
National transport authority / administration	x	x	x	x	x	x	x		x	x
OEM				x						
Public Road operator	x	x	x	x			x	x	x	x
Regional transport authority / administration				x			x	x	x	x
Related platform/association (e.g. PIARC, ASECAP,...)				x			x		x	x
Research / scientific institution			x	x			x		x	x

Table 7: Aggregated responses "My organisation can – at least partially – provide this data" (aggregated on all responses from the stakeholder groups – some respondents of one stakeholder group might not provide all marked data types)

5.3.6.5 Access conditions for the data provision

For each data type that respondents marked as "*This data can be (at least partially) provided by my organisation",* they had the chance to answer if "*this data can be shared – yes/no/conditionally".* "*Please describe the potential use and access conditions and used data format*".

The responses give a good indication, if certain data types needed for core topic 2 will be in principle available for sharing. On an overall level, in Austria and Sweden there are almost all types available for sharing (in principle), according to the responses, followed by Germany and the Netherlands, which have a majority of the data available according to the statements given in the questionnaire. In the UK and Greece, some data are available under certain conditions.

Examining the different data types:
- **Traffic regulations** can, according to the responses, be shared in Sweden and Austria. In Sweden these data (like most of the other data types) are available as open data on https://www.trafikverket.se/en/
- **Access conditions for tunnels/bridges** are available according to the responses in Austria and Sweden (here again as open data).
- **Permanent Access Restrictions** are available in Austria and in Sweden (as open data). In Greece they might be available conditionally ("*depending on the possible contract terms which may vary from client to client*").
- **Maximum speed limits** seem to be available again in Austria, in Sweden as open data and in the Netherlands in form of DATEX II and as open data. Further, these are data available conditionally in the United Kingdom ("*If dynamic - will be useful to share changes that are not permanent*"), Germany ("*Currently only available in distributed files per authority, no common database, no common standards*") and Greece ("*Depending on the possible contract terms which may vary from client to client*").
- **Freight delivery conditions** and **Direction of travel on reversible lanes** seem to be only available in Sweden (as open data).
- **Road/lane/bridge closures** are according to the statements available in Sweden via variable message signs and APIs (Application Programming Interfaces), in Austria, in Germany (freely available in DATEX II), in the Netherlands (as well as DATEX II and as open data), and conditionally in the United Kingdom *("Unknown at this time - requires investigation")* and Greece ("Depending on the possible contract terms which may vary from client to client").
- **(Dynamic) overtaking bans on HGV** are available in Austria and Germany (freely available in DATEX II).
- **Information on road works** seems to be available in Sweden as variable message signs and APIs, in Austria, in Germany (freely available in DATEX II), in the Netherlands (in DATEX II format and as open data) and finally in Greece conditionally *("Depending on the possible contract terms which may vary from client to client").*
- **Dynamic speed limits** are available in Austria, in Sweden as variable message signs, in Germany freely in DATEX II format, as well as in the Netherlands in form of DATEX II and as open data. Also these data are conditionally available in the United Kingdom ("*Unknown at this time - requires investigation*") and Greece ("*Depending on the possible contract terms which may vary from client to client*").

Unfortunately, no one of the respondents had some sample contracts.

5.3.6.6 Cross-border aspects related to the data availability and the service availability

Two different aspects of changes and challenges related to cross-border aspects were analysed: the data availability and the service availability.

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The respondents were asked *"How will it affect your answers if the end-user/vehicle uses the same service in another country? Will there be any changes e.g. regarding the available data availability and the data quality?"* and *"Do you see any challenges or issues regarding access conditions and use of data for CROSS-BORDER service availability (meaning your organisation's data made available abroad OR that type of information (from other organisations) made available abroad)?"*

Three different respondents (National Transport Authorities and OEMs) gave some indication on the changes they expect regarding the cross-border service availability:

- "*All data have gone through information security control and if deemed safe to share it can also be shared for cross border services.*"
- *"Yes, greater commonality of implementation of traffic regulations"*
- *"IP protection is a concern."*
- *"GDPR concerns on user information."*
- *"All access must go through OEM - for security and safety protection."*

Another respondent from the Netherlands did not expect any changes. All other respondents didn't include any expectation here.

5.3.7 Risks and Challenges for core topic 2

The experts were asked to mention issues, risks or challenges they expect in regard to the security aspects, privacy aspects, data protection, cross-border service availability, as well as additional aspects not covered before.

It is interesting that in contrast to core topic 1 on the HD maps, **many respondents stated that they do not expect many risks and challenges**. Nevertheless, some important issues were raised like the challenge of **securing that the data provided to autonomous vehicle is not manipulated**, as well as **privacy issues** (especially related to probe data). Furthermore the topic of **different profiles (even when using the same format as DATEX II**) could be a problem in the implementation of the core topic.

Security related risks and challenges (e.g. in terms of Trusted Information Provision)
- "*Securing the data provided to autonomous vehicles is not manipulated.*"
- *"Application of a workable but robust, cost effective, scalable, security paradigm."*
- *"There are no real issues regarding security."*

Risks and challenge related to privacy aspects
- *"When coming from probes, the usual privacy issues. When coming from road side systems (MTM, loops etc.) of regulations: no issues"*
- *"None."*
- *"Few - if this is limited to public data."*

Risks and challenges related to data protection
- *"When coming from probes: conditions for uses"*
- *"Few - if this is limited to public data"*
- *"Securing the data provided to autonomous vehicles is not manipulated."*

Risks and challenges regarding cross-border service availability
- *"Critical for CCAM."*
- *"Data exchange formats (maybe all is in DATEX II format, but different profiles?)"*
- *"None."*

In addition to all the risks and challenges mentioned above, the respondents had the possibility to give a comment on other potential risks and challenges they expect. Here the respondents added various aspects, like the **need for incentives from public side to push C-ITS in legacy vehicles**, **data quality and the general availability of data** needed for the core topic and also **liability issues** that come up especially in regard to the topic of METR.

Other risks and challenges expected in core topic 2
- "*Challenges with legacy vehicles in aiming to move towards fully dynamic road systems- needs support of after-market devices, needs heavy incentives by authorities to push use of C-ITS systems in legacy vehicles, including integrating with internal vehicle CAN bus.*"
- "*Data quality.*"
- "*Standardized contracts between data providers (authorities) and ITS service providers and map makers.*"
- "*Poor central availability of data, poor digitization, poor development of NAP's in Europe.*"
- "*More or less the same as in the other two topics, but also some more legal issues about access and use of data concerning liability in case of a security breach but also in case of incidents/accidents.*"

Numerous tasks and open issues can be derived from these risks and challenges that should be considered by actors, when defining the next steps. In this regard, this will be of major importance for the DIRIZON WP7 recommendations.

5.3.8   Opportunities and Benefits for core topic 2

In contrast to the risks the respondents were also asked about their expectations of the opportunities coming from the implementation of core topic 2: *"What are opportunities from implementing the core topic? Who will benefit?"*

Aggregating the responses, it was evident that respondents expect numerous benefits such as:

- "*Better usage of road system, reduction in cost to expand capacity.*"
- "*Improvement of citizen services.*" and "*Enhancement of quality of service to road users*".
- "*Better follow-up behaviour of road users, because of reliable information.*"
- "*Traffic and road layout regulations.*"
- "*Cost of traffic regulation otherwise going through a bureaucratic procedure.*"
- "*Improved (road) safety.*"
- "*Better control of traffic, fewer accidents.*"
- "*Essential for efficient CCAM operation.*"
- "*Efficiency in deployment and acceptance of CCAVs.*"
- "*More predictable journey times.*"
- "*Cost effective implementation of digital infrastructure.*"

They also added who will benefit from the implementation, from their point of view?

- "*Taxpayers*", "*citizens*", "*the society*"
- "*Road users and drivers*", "*passengers*"
- "*Traffic managers*"
- "*Highway/road authorities*"

- *"Service providers"*
- *"OEMs"*
- *"All stakeholders from OEMs, consumers to administrative officers"*

What we can see from the collection of benefits is, that the **expected improvements in safety and efficiency are assumed to lead to better services for the individual**, with the effect that the various stakeholders, as well as the society as a whole can benefit from the implementation.

5.3.9 Summary of the results of core topic 2

While in total **14 experts have** <u>**participated in the questionnaire**</u> for core topic 2, we can see that **ALL the major target groups** - as described in chapter 4.2 (Identification of relevant stakeholders, associations and platform) – **were reached. Primary actors** related to METR - meaning all types of authorised authorities as traffic regulation authorities or implementing authorities (like Road Operators, administrative bodies, police, etc), as well as (C-)ITS service providers (and Map Providers) or (public/private) contractors of NRAs that have an active role in the provision of the service - were **around 50%** (7 out of 14) of respondents. Other emergency services (like the police) are currently not represented in the analysis, which might give a bias.

As for core topic 1 **almost all respondents represent large enterprises (12 out of 14).** Similar to the analysis of HD maps (see core topic 1) this could lead to the assumption that this core topic is driven especially by larger size organisations (or those larger ones are the ones that are active in the networks that were reached with the questionnaire distribution). As all types of public authorities, Road Operators as well as OEMs and communication network providers are by nature larger sized organisations, this could make sense. However, **(C)-ITS service providers also medium- and small sized enterprises are active in Europe. These smaller service providers could not be reached appropriately with the questionnaire, which might bias the results in this specific aspect. This fact should be considered, when deriving the conclusions from the results.**

Having a look at the geographical coverage of the responding organisations we can see that over a third of the respondents come from the United Kingdom (5 out of 14). The remaining participants come in equal numbers from Austria, Sweden and Germany (2 each) and one participant each from Greece, Belgium and the Netherlands. North and Central Europe are therefore better represented than the South of Europe.

On an <u>overall level, the process flow chart and the included storyline</u> received an average rating of 7,5 in the evaluation. This result shows that the respondents agree in wide parts with the presented storyline and the presented process for core topic 2. This result is very similar to the overall evaluation of core topic 1 with an average score of 7,6.

The process as described seems to match very well with the view of the communication network providers, the Public Road Operators and the Research and Scientific Institutions. NRAs are missing some details and activities in the flowchart that need to be better fine-tuned. And for the related platforms, with an overall score of 6, the complexity of a multi-actor-environment is not fully represented in the kind of presentation of the flowchart.

These results give the impression that the views of some stakeholder groups are already well represented. We see that differences exist between the various stakeholder groups and have some first impressions where these contradicting views are. In principle, this means that this is a valid basis for the further discussion and drawing variants based on the view of the different stakeholder groups.

On an overall level the acceptance of the suggested process flow for core topic 2 is quite high, we see that for some phases and certain activities within the phases a bit of fine tuning might be needed.

The **validation of the activities needed for core topic 2** showed that while for some activities uncertainties exist in form of a considerable rate of "I don't know", some activities (in Phase 1,2, 4 and 5) have to be investigated more thoroughly, as there is a number of clear responses indicating "No, this activity is not part of the core topic", that give some indications on contradicting views:

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While for *Phase 1: Content Creation* the activity Defining the need of the traffic regulation a principle approval (71%) was collected, one comment explains that this activity is not relevant for the core topic, as the respondent would assume that the process of the core topic itself starts, when the decision on the traffic regulation has been taken. This might be of consideration in the future work of DIRIZION. In this case the cut of the core topic is after the regulation trigger box.

For *Phase 4: Service Presentation* the provision of information via an end-user service is not seen as part of the core activity by 15% (2 out of 13) of the respondents, including an OEM and a National Traffic Authority, while 77% approved this activity as part of the core topic. The comments show that those respondents don't see a real end-user service in practice ("End-user service for whom? For an automated vehicle?") and the "Risk of service abuse by citizens, which will undermine the objective." These are important considerations that will be taken into consideration in the next phase to further define the service. Furthermore, this aspect will be added to the risks related to the core topic. Due to general approval of this activity this will be kept for the further work.   The reason that especially OEMs and National Transport Authorities are only partly approving this activity is an interesting aspect that should be further investigated. The reasons for that are not clear from the responses so far.

Phase 5: Feeback Loops, which mainly covers the notification to the traffic regulation authority that the traffic regulation, has a principle approval of 77%. Looking at the "No" responses we can see from the comments from a National Transport Authority that the volume of data to be verified could be problem for some organisations. On the other hand, comments added from respondents stated "Yes, this is part of the core topic" is "This is essential for the quality of a future robust electronic service - it is an area of weakness of current processes." Furthermore the "assessment of compliance bodies" was mentioned. **So in principle, we can assume from the responses given in the questionnaire that respondents coming from the group of (C-)ITS providers, regional transport authorities, OEMs, Public Road Operators and Research and Scientific Institutions agree with the need for the notification on implementation, while communication network providers and national transport authorities are not fully convinced.** Considering the comments this might be related to the need for verifying the feedback. This should be considered in the further work to detail how the process for the notification is done at the moment and can be done when considering electronic traffic regulations. It has to be investigated further if such notification processes (e.g. for traffic sign installations) already exist on the level of the national transport authorities or handled elsewhere. For the communication network providers it might be one reason that they are not primary actors for this action and therefore do not consider this as part of the core topic.

For *Phase 6: Enabling and regulation* the second activity "Development of commonly agreed map matching procedures" has a high uncertainty in all stakeholder groups, especially the core target group of Public Road Operators, as well as communication network providers answered that they "don't know, if this is part of the core topic". For national transport authorities only 50% of each group (1 out of 2 respondents) agreed with the fact that this activity is something that is part of the core topic. As no further comments were added this could not be verified or further investigated. Maybe this topic is very specific, which leads to a high degree of uncertainty of the respondents.

In addition, there were important aspects that get even more visible:

In the last *Phase Enabling and regulation*, we can see that the action "Provision of a standardised framework" is clearly one important task within this core topic that has been fully approved by all stakeholder groups.   This emphasized the need for even more efforts in the related standardisation groups (as CEN/TC 278 WG17).

Respondents were also **missing** some **activities** on provision of the infrastructure for latency-critical information layer, a feedback loop regarding data quality and a standardization/harmonization process of access restriction schemas.

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The **validation of roles and responsibilities** showed some interesting aspects that will need to be considered in the matching of the views of the different stakeholder groups:

Moreover, for this core topic, one could expect from the responses given an important role for the Road Operators in many of the phases. It is true that Road Operators are named as potential actors in all of the phases. But looking at the overall picture they are the clear number one actor only in the Phase of Content Aggregation. So regarding the major actors we can see in the first phase (*Content creation*) **(Local) Planning Administrations** (for the definition of the traffic regulation) and **regional/local authorities** together with **Ministries** (for the enactment of traffic regulation) **will be big players** with the same of even higher approval (as in case of the regional/local authorities).

For the following phase (on the *Content Aggregation*), Road Operators have clearly the highest shares when it comes to the organisations that will take over this role. There are also other options, but nevertheless we see here a clear role for ROs.

For the phases *Service Integration* and *Service Presentation,* (C-)ITS service providers come into play as actors with the highest approval. **As an interesting fact, only Road Operators indicated (with the self-assessment of the roles) that they could fulfil this activity. The (C-)ITS service providers did not mark themselves as active actors. This has to be investigated more in detail, but could be based on the fact the Road Operators fulfil also the role of a (C-)ITS service provider in some countries. Also for both activities related to the Phase Service Presentation, only Public Road Operators and Regional/local Transport Authorities indicated that they could fulfil this activity,** however, not the participating C-ITS service providers. **Again, this could be related to the fact the Road Operators, as well as some Transport Authorities are also fulfilling the role of (C-)ITS service providers in their country, which leads to a blurring of the roles.** It has to be investigated in detail, but the fact that those who indicated themselves as active actors also ticked the box that (C-)ITS service providers are potential actors fulfilling this activity would support this hypothesis.

Regarding the phase *Feedback Loops* **(including the Notification on the implementation)** we see quite a **clattered picture,** with expected responsibilities for **Road Operators** and their **contractors,** as well as for **Administrative bodies,** the **Police** and other actors like "*other road contractors, utility companies, map operators and mobile network operators*". It is interesting in this respect that regarding the **feedback loops C-ITS service providers indicated themselves as actors that can fulfil this activity, although they were not named as actors that could potentially fulfil this activity.** This is interesting, as this is exactly the contrary to what happened in the two activities before. **In addition, Road Operators and a Regional/Local Transport Authority indicated themselves as active actors** as well, which is in line with the given responses to the actors that are expected to fulfil this activity.

For **the last phase *Enabling and Regulation*** the picture based on the responses given is clearer. For both activities (*Provision of a standardised framework* and *Development of commonly agreed map matching procedures*) **Standard Development Organisations are clearly those actors that are seen in charge for the activities** by the respondents of the questionnaire. On the other hand, some Communication Service Providers, Regional/Local Transport Authority as well as National Transport Authorities and Public Road Operators marked that they could fulfil at least one of the activities taking place in this phase. **As it seemed to be clear from the previous question that Standard Development Organisations should be the active actors in this activity, this could lead to the assumption that those groups are already actively involved or plan to be actively involved in the Standardisation Activities that take place on European level related to the core topic.**

Also, we can see in some phases **national differences** when it comes to the organisation that can fulfil a certain activity.

However, for some respondents <u>important actors</u> are <u>missing,</u> such as law making bodies defining the framework and steering the direction, POLIS (the European network for cities and regions) for an inventory/harmonization of access restriction schemes, as well as Mobile Network Operators and a few more.

When it comes to the **<u>changes in regards to the core actors related to the cross-border availability of the service</u>** we could summarize that **77% of respondents** (10 out of 13) **do not expect any changes** related to the cross-border aspects. **15% of respondents** (2 out of 13), including National Transport Authorities and OEMs, **expect moderate changes** and 1 respondent (OEM) **(7%)** expects **significant changes**, which is related to the national differences that exist related to traffic in general and the **need for adapted national/local solutions, instead of one overall approach**. Regarding the moderate changes, main aspects are again the **need for interoperability and harmonisation processes** on the one hand and the aspect of **existing national legal differences** on the other hand, that have to be considered for a European, or even worldwide implementation concept for METR.   **The need for different solutions (or at least adaptions) needed for the different countries seems to be very tangible in the view of the OEMs and has to be considered in the further work**.

For the **<u>data types that are relevant for core topic 2,</u>** the list provided by DIRIZON seemed to be quite complete, if we take the responses into account. So **almost all data types suggested have a clear approval as necessary data from the respondents (92% to 100%).**

The only kind of data that **23% of the experts are not certain about** is information on *freight delivery conditions*, but still over 70% deem this data as relevant. Similar to core topic 1 we see that the **data and information related to freight delivery are an open issue** in this respect and that there is **a high degree of uncertainty within the group of respondents.** This could only be verified by investigating the freight related aspects with freight associations, which were not reached with the questionnaire. This clarification with the freight sector could be considered for future measures. In addition o*ne way streets, access restrictions (by type, by dimensions, by use)* and *dynamic environmental zones and other dynamic access restrictions* are **<u>missing in the list of data necessary</u>** for core topic 2 according to the statements of the respondents.

The analysis of the **expected data providers** revealed that – based on the given responses - for the *traffic regulations,* **regional/local authorities** are expected to provide these data types, followed by the **Road Operators** (named 9 times) and also Ministries and the Police that have a decent share. For **all other data types in the static data category, Road Operators** are expected as main data providers, **followed by HD Map Providers**. **This is interesting especially considering that HD Map Providers were only explicitly mentioned as active actors in the provision of an end-user service in the validation of the actor in the previous chapters. Also for the semi-dynamic and dynamic data, Road Operators are the most expected data providers**, but for certain categories also other organisations were named, as e.g. **highway authorities**", the "**National Access Point (NAP)**" (e.g. for the road/lane/bridges closure) or **C-ITS and ITS service providers** (for the dynamic speed limits). Looking at the national background of the "other" actors, we can see that the "**NAP" was mentioned various times only by Dutch respondents**, while the **"highway authorities"** were added by **respondents from the United Kingdom**. These national different characteristics are an interesting fact, when it comes to the further data platform concepts in WP5 and WP6 **because it shows that certain institutions and national organisational structures have an important impact on the processes to be defined for the Management of Electronic Traffic Regulations.**

The cross-checking of the answers to the question "This data can be provided by my organisation" showed that **on an overall level, the expectation on data providers and the basic willingness to provide the specific data under certain conditions match**. This is a positive sign for the further developments in this core topic.

Road Operators also stated that they can provide the static data (except freight delivery conditions and direction of travel on reversible lanes), as well as the semi-dynamic and dynamic data. For the above mentioned categories that are not covered by Road Operators, other options have to be evaluated, e.g. the National Transport Authorities. As HD Map providers did not participate in this core topic, unfortunately their willingness to provide data can't be cross-checked. Furthermore, it is interesting that the National Transport Authorities are willing to provide a majority of the data needed for the core topic (besides overtaking bans on HGV).

Looking at the responses of the **access conditions for data and information,** one could conclude that **in principle, a majority of the data types** needed for core topic 2 **are available** for sharing. **But major national differences exist**. On an overall level, almost all types are available for sharing in Austria and Sweden (in principle), according to the responses, followed by Germany and the Netherlands, which have a majority of the data available according to the statements given in the questionnaire. In the UK and Greece, some data are available under certain conditions.

However, this does not mean that the data are available in machine-readable format and therefore can be used as a basis for the further developments related to connectivity and Automated Driving. Looking at the responses regarding the **availability of the data in machine-readable format** we see huge differences between the different countries. Summarizing based on the responses we get the impression that **dynamic and semi-dynamic data categories seem to be available in machine-readable data format (which makes sense due to the constantly changing nature of these data), as well as max. speed limits**, **while for all other data types from the the static data category national differences have to be taken into account,** so that in some cases certain data types are not available at the moment for the further automated procession.

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In contrast to other core topics (e.g. core topic 1 on HD maps) **many respondents do not expect high <u>risks and challenges related to the distribution of digital traffic regulations</u>**. Nevertheless, some important issues were raised like the challenge of **securing that the data provided to autonomous vehicles is not manipulated**, as well as **privacy issues** (especially related to probe data). Furthermore, the topic of **different profiles (even when using the same format as DATEX II)** could be a problem in the implementation of the core topic.

Only a few responses were received on the changes and challenges related to cross-border service availability. In principle, major challenges in this respect are concerning GDPR aspects and IP protection, a general "information security control" will be even more in the focus when we talk about cross-border aspects.

On the other hand, stakeholders have high expectations on the **<u>potential benefits related to the implementation of core topic 2.</u> Different groups are expected to benefit** from the implementation of core topic 2, from **Traffic managers and highway authorities, over service providers and OEMs to road users.** Furthermore, a number of respondents expected that **society as a whole** can benefit from the core topic.

The **major benefits** expected are **improvements in safety**, but also in the efficiency of the transport system. According to the statements of the respondents, we could expect **improved services for citizens** and an **enhancement of the quality of the services road users** are provided with.

5.4 Analysis of core topic 3 – Infrastructure support for Cooperative Automated Driving

5.4.1 Overview of core topic 3 content

The following sections provide a summary of the storyline and the process flow diagram (Figure 46), as it was provided to the respondents within the questionnaire. As for Core Topic 1 and Topic 2, the process flow diagrams are future, generic implementations and as such are not country-specific:

Storyline:

The process flow diagram shows the process for the infrastructure support for Cooperative Automated Driving. Data on traffic, incidents and accidents and environmental data generated by various sources (loops, camera's, etc.) are collected and made available, either via the National Access Point (NAP) and/or the Traffic Management Center (TMC).

The Traffic Management Center makes use of the data on traffic, incidents and accidents and environmental data to carry out its traffic management functions. The binding traffic management measures are provided to the Trusted Electronic Regulation Access Point (TERAP). Traffic management data, advice, information and warnings (non-binding) are provided to the NAP. The Traffic Management Center also provides advice to individual CCAVs in order to extend their ODDs, using all available sources of data including PVD [Lytrivis, P., et al., 2018]. The Traffic Management Center provides its traffic management services in the traditional manner on VMSs or signs.

Content aggregators, (C-)ITS service providers and HD Map Providers enrich their own services using data from the National Access Point, providing these services to vehicles and smartphones. This information is "visualised" for the user. The user can be a driver or an automated vehicle. The final decision on how to use the advice or warning lies with the driver or vehicle. Regulations have to be followed.

Smartphones and CAVs provide vehicle sensor data (e.g. speed, type of vehicle). These data are collected via roadside stations and via (C)-ITS Service Providers.

The described core topic considers the dynamic development of both vehicles' ODD and infrastructure services over the short, medium and long term; during this transition period, automated and conventional vehicles coexist at different levels of (automation) technology.

Infrastructure support services and vehicle equipment can be used to collect dynamic or real-time data to extend the ODD of cooperative automated vehicles.

Considering the evolution of this core topic the following could be stated:

Generally speaking, the ability for Road Operators (RO) to support automated vehicles by extending the ODD will take into account agreements on where decision-making will take place (most likely within the vehicle). Under which conditions would the automated vehicle take data into consideration into an automated vehicle decision-making process? This information will inform which data is desired and the data quality criteria. Likewise, Road Operators will be able to use this information in achieving their own goals of improving road safety, traffic efficiency and reduced environmental damage from road users.

Additionally different aspects for the step by step evolution can be considered –

In the Short term (1-3 years) the following is expected:
- Introduction of standards pertinent to data format, quality criteria, and data exchange is expected
- Introduction of the capability automation at Traffic Management Centers to support the processing of the data flows and monitor the traffic flows.
- Agreements on which data to share, followed by implementation (see also above)
- Vehicles equipped with HD maps have the ability to share data with ROs and/or other vehicles.
- There are mixed traffic conditions on the infrastructure, i.e., there are various levels of automation in the short, medium and long term with increasing percentages of automated vehicles.

In the Mid-term (3-7 years) the following is expected:
- The automated traffic management system generates advice to vehicles based on microscopic traffic flow measurements.
- Cooperative Traffic Management is state-of-the-art

In the Long term (> 7 years until 2040) the following is expected:
- The automated traffic management system generates advice to vehicles based on microscopic traffic flow measurements, making use of its data on the penetration rate of automated vehicles in the traffic flow.

For some parts of the chain secure communication and provision of trusted information is necessary!
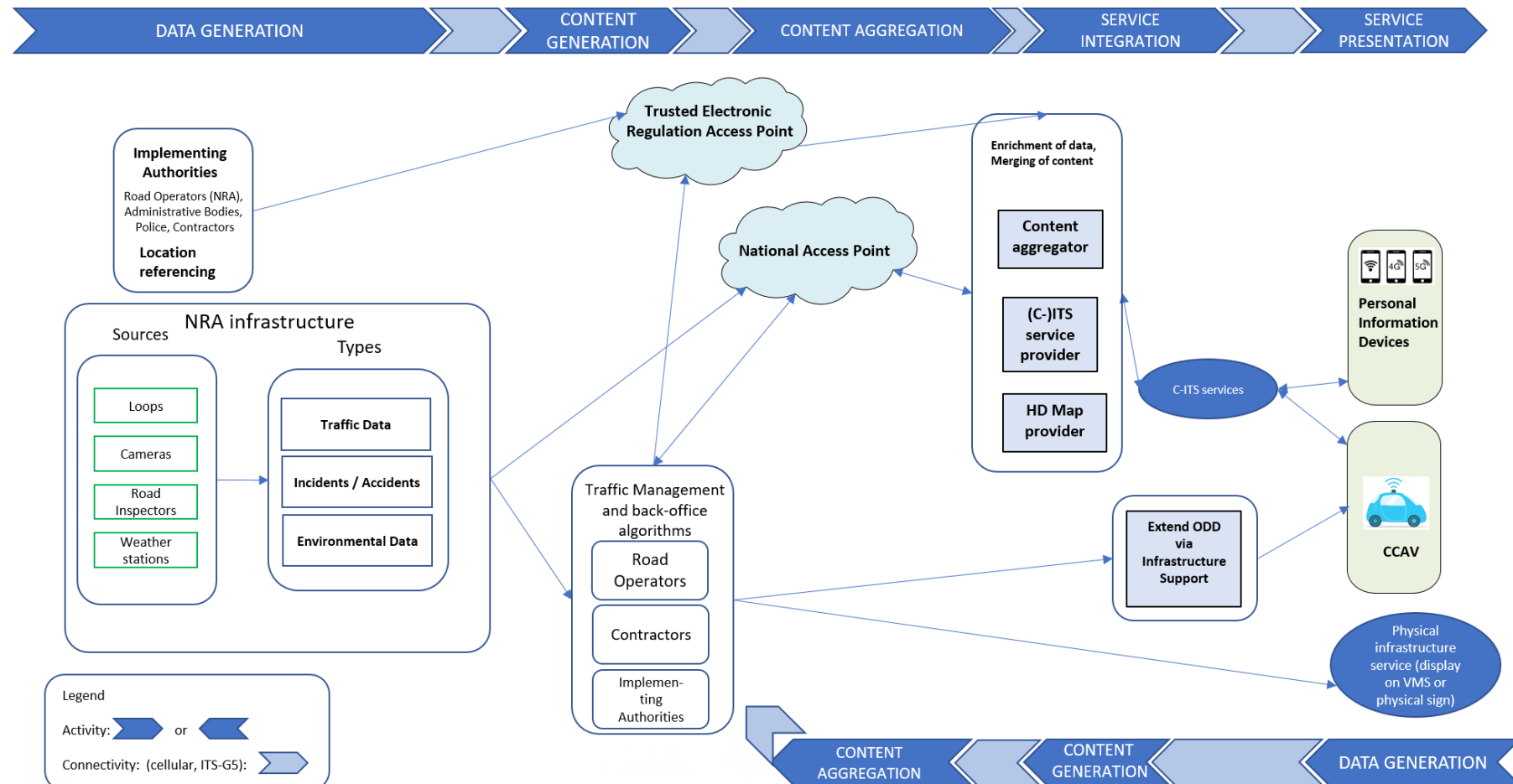
Figure 46: Process Flow Diagram for core topic 3

5.4.2 Core topic 3: Participation statistics

To set the results presented in the following subchapters into a context, this chapter provides an overview on the participating stakeholder groups, size of their organisations and the distribution of the organisations among different countries.

In total, 16 experts have participated in the core topic Infrastructure support for Cooperative Automated Driving. This number includes all those who have answered at least one question set of the questionnaire on Infrastructure support for CAD. In contrast, participants who only provided information on the organisation and country, but did not answer any question regarding the topic, were not considered in further evaluations (3 participants).

Overall, many different types of organisations and stakeholders participated in the survey. As already described in chapter 4.2, it is important to highlight that ALL the predefined major target groups could be reached in core topic 3 as well. According to Figure 47, which shows an overview of all participating stakeholder groups, Public Road Operators and OEMs constitute the two largest groups of participants (37,6%) on core topic 3 (3 out of 16 each).

In addition, it must be mentioned that this is the only core topic where infrastructure equipment suppliers actively participated. However, with only 6,3% of respondents the share could be higher, as infrastructure support for CAD has been expected as one of the high priority topics of this stakeholder group in the future.

Participating organisations/stakeholder groups

- (C-)ITS service provider 6,3%
- Communication network provider 12,5%
- European Commission 6,3%
- Infrastructure equipment supplier 6,3%
- National transport authority / administration 6,3%
- OEM 18,8%
- Public Road operator 18,8%
- Regional transport authority / administration 12,5%
- Research / scientific institution 12,5%
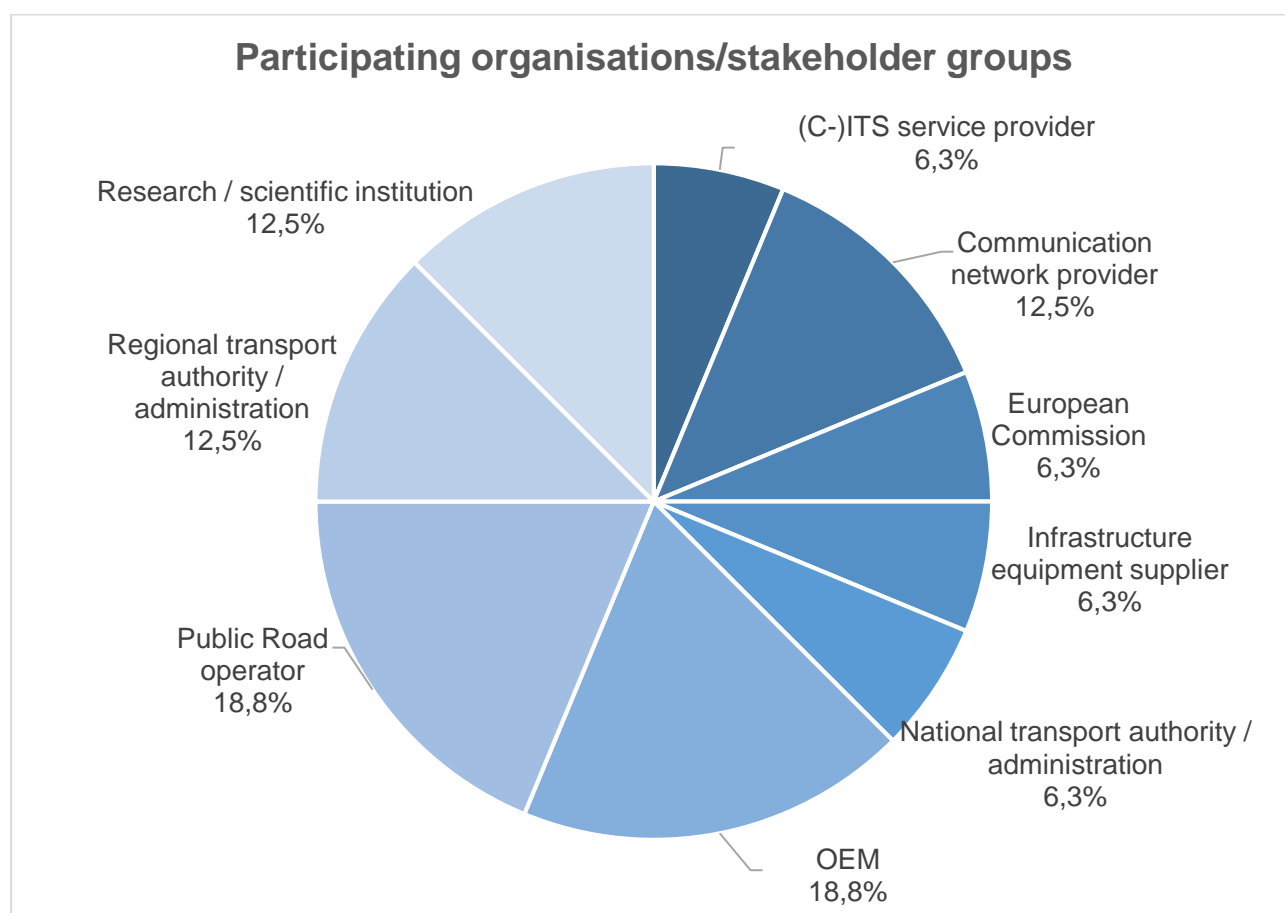
Figure 47: Overview of all participating stakeholder groups

Figure 48 shows the distribution of all participating organisations according to company size. According to the answers, mainly experts from large enterprises, which includes companies with more than 250 employees, have participated (75 %, 12 out of 16). This result could already be observed with the other two core topics, where almost no SMEs answered the questionnaire on infrastructure support for Cooperative Automated Driving.

Size of participating organisations
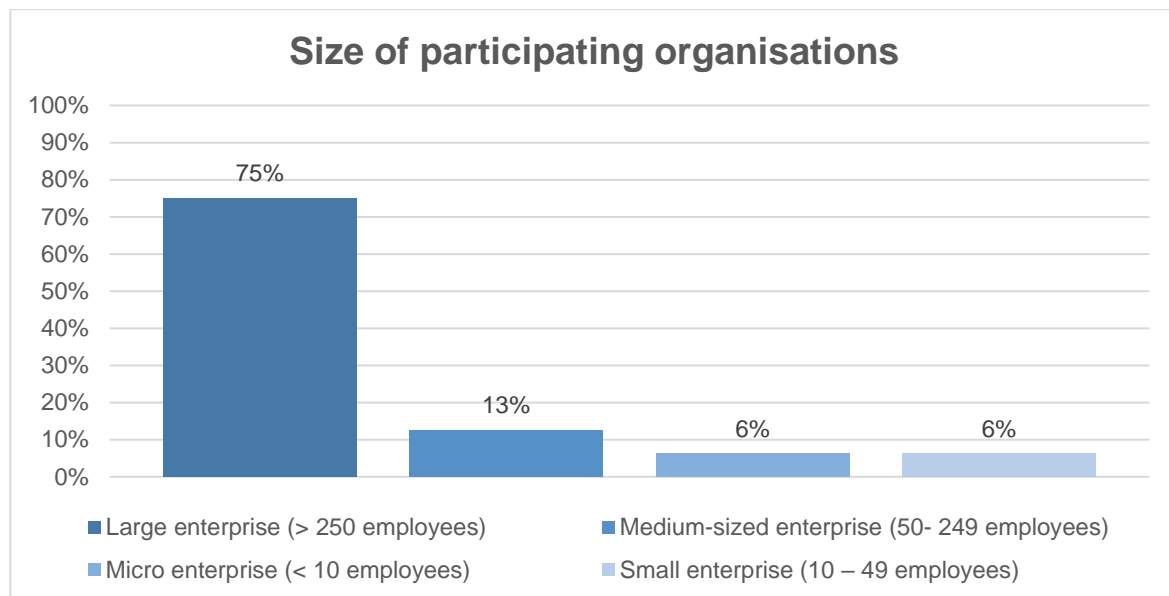
Figure 48: Size of the participating organisations in core topic 3

Having a look at the geographical coverage of the participating stakeholder groups, it has to be mentioned that with 63% more than half of them come from Germany, the United Kingdom and Austria. Especially Germany has to be highlighted with a share of 25%. The remaining participants can be assigned to the following states: Albania and Greece (2 each) and one participant from Italy and Sweden. In general, it is not possible to identify clear trends for one country.

Participants per country
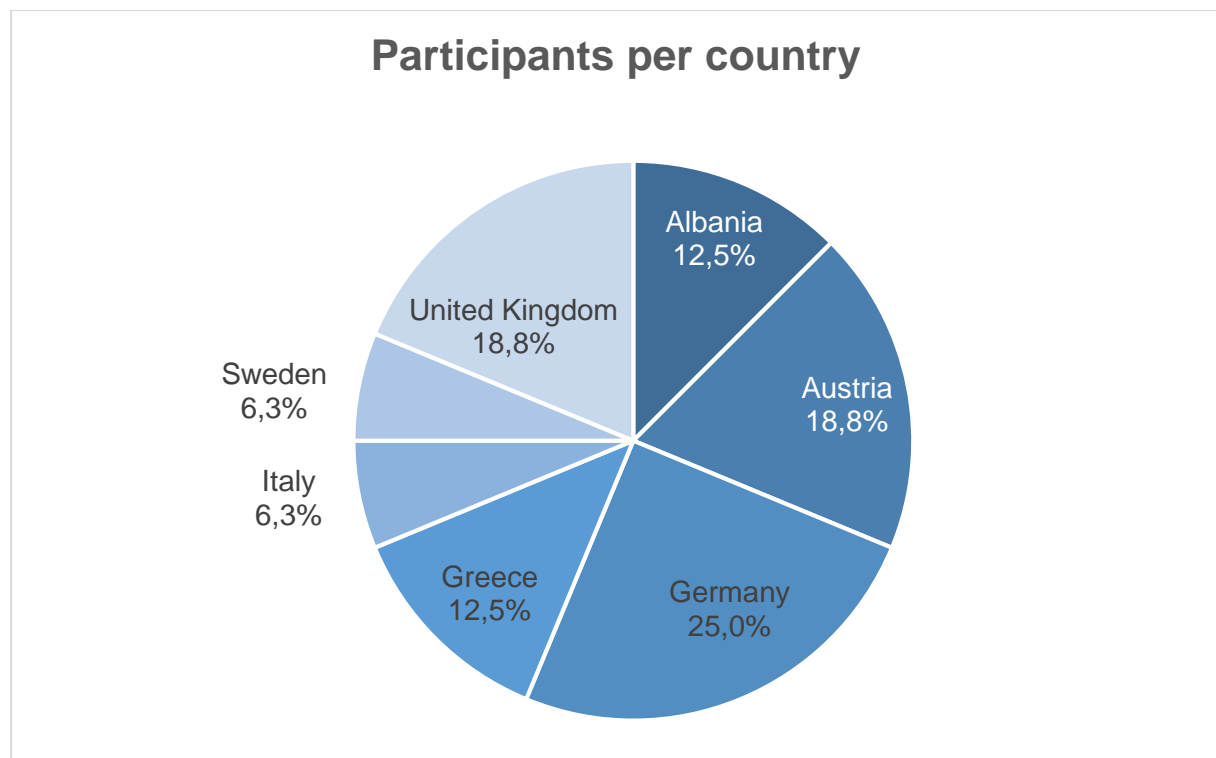
Figure 49: Participants per country

5.4.3   Core topic 3: Validation of process flow diagram – Activities and Actors

In the previous work packages within DIRIZON, some main activities and actors for the provision of Infrastructure support for Cooperative Automated Driving were already identified. In this context, an activity describes a small sub-part of each phase of the process (see Figure 46) and an actor is a certain type of organisation that fulfils activities.

To validate what has been described within DIRIZON and collect additional information on the role of the actors the participants were asked to evaluate the proposals on activities and actors involved by analysing their relevance for the core topic. Furthermore, they should indicate if their organisation could fulfil the proposed activities. Figure 50 is about the different activities and the question whether they are seen as a part of core topic 3 or not.

To make the step by step validation easier, the activities were structured into different phases, as they were used in the process flow diagram. Core topic 3 is split into the following four phases:

- *PHASE 1: Content Creation*
- *PHASE 2: Content Aggregation*
- *PHASE 3: Service Integration*
- *PHASE 4: Service Presentation*

In the following analysis of results we refer to these phases.
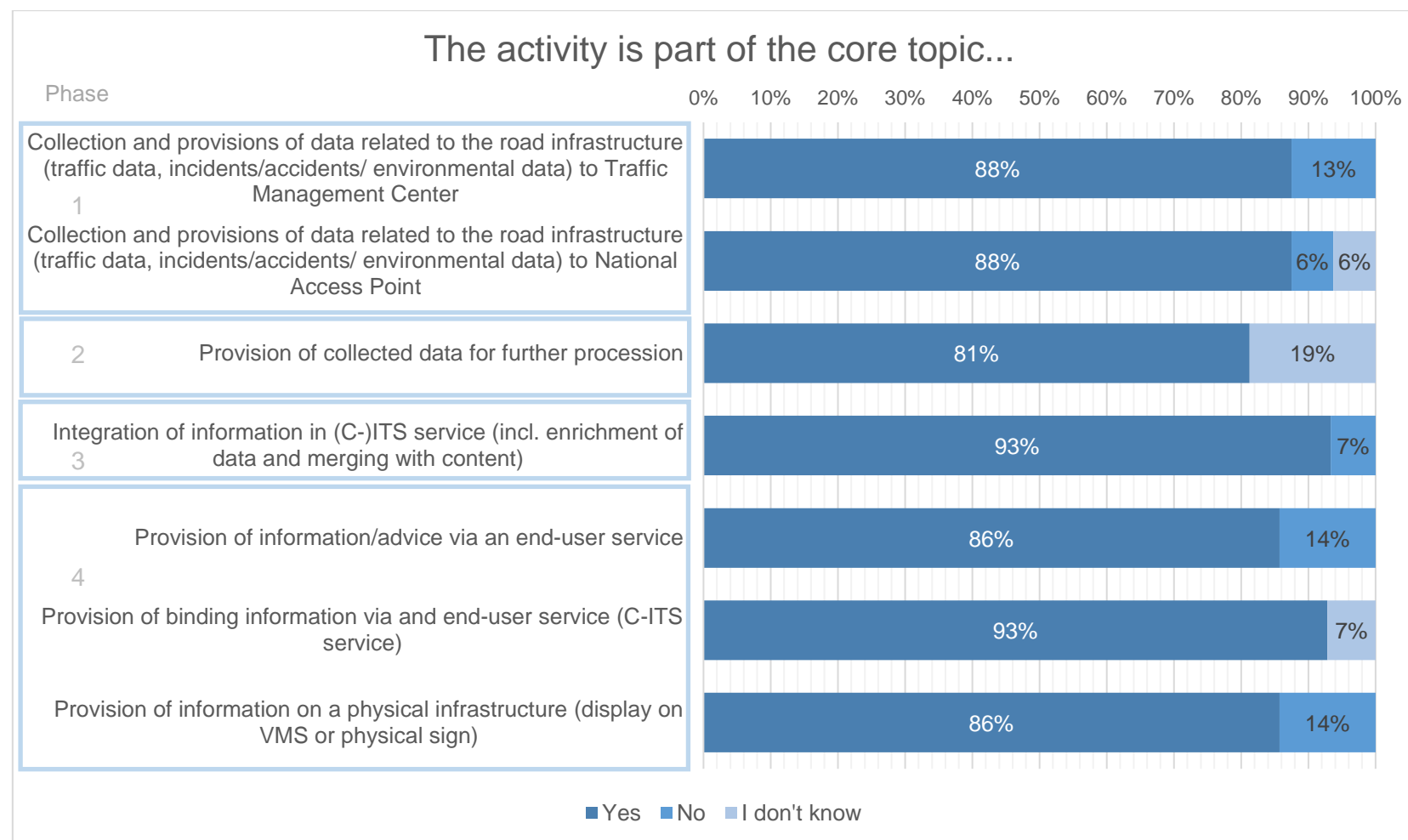
Figure 50: Overview of the acceptance rate regarding the process/flowchart in general (core topic 3)

Activities \ Stakeholder groups	(C-)ITS service provider	Communication network provider	Infrastructure equipment supplier	National transport authority / administration	Regional transport authority / administration	OEM	Public Road operator	Research/ scientific institution
Collection and provisions of data related to the road infrastructure (traffic data, incidents/accidents/ environmental data) to Traffic Management Center	100%	100%	100%	50%	100%	100%	50%	100%
Collection and provisions of data related to the road infrastructure (traffic data, incidents/accidents/ environmental data) to National Access Point	0%	100%	0%	100%	100%	100%	75%	0%
Provision of collected data for further procession	100%	100%	100%	0%	100%	100%	50%	100%
Integration of information in (C-)ITS service (incl. enrichment of data and merging with content)	100%	100%	100%	0%	100%	100%	75%	100%
Provision of information/advice via an end-user service	100%	100%	0%	0%	100%	67%	75%	100%
Provision of binding information via and end-user service (C-ITS service)	100%	50%	100%	0%	100%	100%	75%	100%
Provision of information on a physical infrastructure (display on VMS or physical sign)	100%	100%	0%	0%	100%	67%	75%	100%

Table 8: Overview of the acceptance rate by stakeholder group ("Yes, the activity is part of the core topic") regarding the process/flowchart by stakeholder groups

Figure 50 gives an overview of the acceptance rate of the participants regarding the process of core topic 3. In general, the results show a broad agreement with the process **as defined in the process flow diagram (accompanied by the storyline) by the DIRIZON consortium. In other words, the participants support the sequence of steps to enable infrastructure support for Cooperative Automated Driving. Therefore, the predefined process can be considered as a valid basis for the definition of further steps.**

Compared to the other two core topics, the degree of approval is even higher in average. Referring to Figure 50 we could see that at least 81% of the participants agree to every single activity of each phase of the process.

For *Phase 1: Content Creation,* we can see a general approval that the proposed activities are part of this core topic. Both activities within this phase received a consent of 88% from the respondents, which means 14 out of 16 participants agree with the phase as described.

When it comes to the differentiation between the stakeholder groups, it can be seen that the views differ as to whether the collection and provision of road infrastructure data is related to the Traffic Management Center or to the National Access Point (NAP), see Table 8. **Especially (C-)ITS service providers, Infrastructure equipment suppliers and Research/Scientific Institutions don't agree with the role of the NAP,** whereas the other stakeholder groups almost absolutely agree with the need for the NAP.

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When looking at *Phase 2: Content Aggregation* the acceptance rate is the lowest compared to all other phases. The results demonstrate that 81% of the participants suppose that the proposed activity is needed for core topic 3**. It is worth mentioning that 19% (3 out of 16 respondents) were uncertain of the real need of the activity Provision of collected data for further procession.** This might be accompanied by a lack of understanding regarding the activity when considering additional comments, where a public Road Operator added the question "*What do you mean by further procession?".* Especially National transport authorities/administrations do not have a clear opinion on phase 2.

Based on the responses received, it is obvious that *Phase 3: Service Integration* is needed to enable infrastructure support for CAD as there is a 93% approval that the proposed activity is essential. **When looking at Table 8, one can see that there are no big differences between the stakeholder groups**, only Public Road Operators do not show 100% acceptance in regards to *Phase 3.*

The statistics show that there is a broad agreement with *Phase 4: Service Presentation,* in general, for all participants. Nevertheless, the following figure shows that the degree of approval to the individual activities varies.

For the following two proposed activities *Provision of information/advice via an end-user service* and *Provision of information on a physical infrastructure (display on VMS or physical sign),* we can see 86% approval. **But it is remarkable that 14% of the participants see no need for these activities. There are some comments that give a more in-depth look, e.g. one OEM stated that the** *"system will be open to abuse"* **when an end user service is involved***.* **In addition, one infrastructure equipment supplier does not see both activities** *"related to CAD".*

When looking at the second activity *Provision of binding information via an end-user service (C-ITS service)* of *Phase 4* the results show 93% approval. Nevertheless, compared to the other activities within this Phase there is uncertainty (7%) to some extent.

For *Phase 4*, mainly Infrastructure equipment suppliers as well as national transport authorities had the feeling that these activities are not part of the core topic. OEMs and Public Road Operators were partly uncertain of the real need of the defined activities.

Having a deeper look on the different activities, especially communication network providers have an inconsistent view in regards to the need of Provision of binding information via an end-user service. So here the discussions and premises on the level of communication network providers are different, which means for the next steps that this has to be on the discussion agenda in future projects.

5.4.4 Core topic 3: Overall evaluation of process flow diagram and storyline

In the last part of the questionnaire respondents were asked "*Does the flow chart and the storyline as presented here reflect the process for this core topic correctly from your point of view*?"

The idea is to focus on the general feedback to the process as a whole, independently from some details respondents might not agree with. Respondents could rate the general flow on a scale (*0 – I totally disagree with the presented process* up to *10 – I totally agree with the presented process*).

On an overall level the process flow chart and the included storyline received a total rating of 7. This means that the respondents agree in wide parts with the presented storyline and the presented process for core topic 3.

Stakeholder group	Rating
(C-)ITS service provider	3
Communication network provider	8
Infrastructure equipment supplier	7
National transport authority / administration	2
OEM	7
Public Road operator	7,5
Regional transport authority / administration	8
Research / scientific institution	9
Total rating all stakeholder groups	**7**

Table 9: Results overall rating process core topic 3

On the level of the different stakeholder groups we see that the opinion on the presented process is varying. From the point of view of (C)-ITS service providers and national transport authorities there are some adaptions needed. It was argued that the *"Focus should be on automated. Inclusion of personal devices makes it too complex".*

In contrast, all other groups could align very well with the process.

The scientific institutions, which were, in principle, confident about the presented process (average rate 9), stated in addition to the opinion that the process is quite good and accurate that "*a big aspect (that couldn't be probably covered in a flow chart) is also the detailed definition of Physical and Digital Infrastructure*" and "*the new or enhanced capabilities that ISAD should provide, how far in teleoperation and not just guide by infrastructure we should go in the future, etc*".

It was also added that *"HD Map Provision, Content Aggregator and third parties cloud should considered as part of the infrastructure also, although probably not controlled, owned by the Road Operator."*
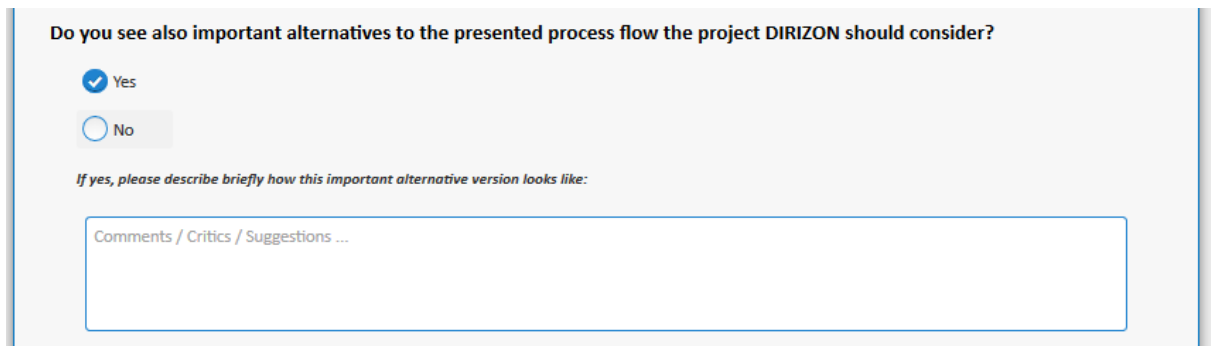
Public Road Operators who have an average rating of 7,5, commented on the flowchart that:

- *"Extend ODD via Infrastructure Support' is an overall result of the whole graph, rather than just a square in the flow chart. This rectangle and the two connecting arrows should be removed completely."*

Regional transport authorities and Communication network providers agree with the process as a whole (both have an average rating of 8), but highlighted some specific aspects in regard to participating actors within core topic 3:

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- *"OEMs and their partners will be more involved. Autonomous vehicles will use MEC for augmenting their performance. MNO coverage of roads to enable access to MEC will be essential here."*

- *"Unclear who is responsible for National access point etc."*

In addition, some respondents used the option to describe important alternatives to the proposed process.

Figure 51: Screenshot of questionnaire with option to describe alternatives to the presented process

One respondent answered with "Yes" and left some very fruitful additional comments on the described process flow, especially on how to deal with V2X technology:

- *"V2X technology has been designed to cover many of the aspects mentioned here. V2X allows vehicles, road furniture and communications industries to share road hazard data for the purpose of improving road safety. Keeping this data to the minimal is very important if the car is to be able to act quickly and accurately. Any additional non-vehicle related data will simply slow down the system and add noise within the vehicle architecture that may affect key safety related commands."*

- *"V2X is a broadcasting system where any roadside 'sniffer' unit can read what is going on. Road authorities will be able to provide this data."*

- *"Any data sharing outside of this is via OEM systems to make sure the vehicle is only sharing when it is safe to do so. Commercial setup will be required."*

Based on this result, considering the comments on the missing actors and activities and some fine-tuning, the described process can be considered as valuable for the further discussion within DIRIZON.

5.4.5 Core topic 3: Validation of roles and responsibilities

Another aim of this work package was to examine which responsibilities the stakeholder groups see themselves taking and which responsibilities they expect others to take.

In a first step in context of the questionnaire, the participants were asked to evaluate which actors can fulfil the proposed activities. Therefore, certain types of organisations were previously identified for each activity within the different phases of the process. The participants also had the opportunity to name additional actors who could fulfil the proposed activities according to their experience.

In case the activity was seen as part of the core topic, the acceptance towards proposed actors was analysed. The following figures give an overview of actors and their roles in the process of infrastructure support for Automated Driving.

As this was done together with the validation the activities the following analysis is also based on the phases:
- *PHASE 1: Content Creation*
- *PHASE 2: Content Aggregation*
- *PHASE 3: Service Integration*
- *PHASE 4: Service Presentation*

For the analysis of the roles and responsibilities only those respondents were considered that marked the relevant activities as "part of the core topic". Multiple actors for each activity were possible.

Furthermore, we considered in the following analysis the responses, where organisations indicated that they could be an actor to fulfil a certain activity (as described in chapter 9.1.3) for each activity.

Figure 52: Screenshot of the questionnaire "My organisation can fulfil this activity"

Core Topic 3: Overview of most important actors

Content Creation	Content Aggregation	Service Integration	Service Presentation
• Road Operators • Public Transport Authorities • Contractors	• Other	• (ITS) Service Providers • Road Operators • HD Map Providers	• (ITS) Service Providers • Road Operators • HD Map Providers
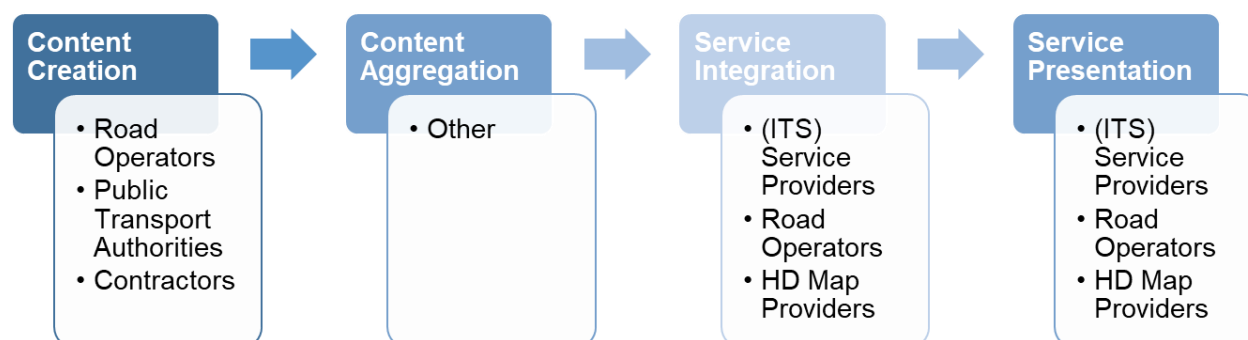
Figure 53: Overview of most important actors of Core Topic 3

This flow diagram, Figure 53, lists the most important actors in each of the four phases in the process of infrastructure support for Automated Driving. However, since this just serves as an overview only the three most important actors are included and only if more than 50% of the respondents see that they can fulfil activities within the phase. The following figures in this chapter show the results for each activity in more detail.

For all phases where experts could choose from provided answers, Road Operators were chosen as very important actors for Infrastructure support for Cooperative Automated Driving. It is also worth mentioning that the exact same actors were seen as essential in the last two phases Service Integration and Presentation.

Those who see the two activities of *Phase 1: Content Creation* as part of the core topic assume that **Road Operators will play a crucial role in the *Collection and provision of data related to the road infrastructure* (*traffic data, incidents/accidents/ environmental data)* (with 100%, 14 out of 14 respondents). Based on the responses received it does not matter whether this data transfer is to the Traffic Management Center (activity 1) or to the National Access Point (activity 2). **This is contradicting to the responses given according to the indication "*my organisation can fulfil this activity*".** For the first activity just 1 of the 3 Public Road Operators indicated themselves as an actor. This is different to the Regional transport authorities, where all respondents see themselves in charge of this activity.

What we can see from the analysis of Figure 54 is that the collection and provision of road related data to the TMC can be as well a task for contractors, named 9 times each by 14 respondents in total (64%). Also, other potential actors were named for activity 1 like service providers, Traffic data suppliers or Police.

For activity 2 of *Phase 1: Content Creation* also public transport authorities were seen as potential actors that can collect and provide data related to the road infrastructure to the NAP (with 79%, 11 out of 14 respondents).

Phase 2: Content Aggregation (which is referring to the provision of the collected data for further procession) is more complicated regarding the potential responsible actors compared to other activities of the process flow.

The results show clearly that different stakeholders should be considered when it comes to fulfilling this task. One respondent assumes that Road Operators play a crucial role in providing collected data for further procession. This suggestion may be attributed to their important part in *Phase 1: Content Creation*. At least one Public Road Operator indicated themselves as an actor as well.

It is notable that especially the stakeholder groups which marked that they could fulfil both activities of *Phase 1: Content Creation*, see themselves also in charge of the subsequent *Phase 2: Content Aggregation. This includes OEMs, Regional transport authorities or Research Institutions.* Also the option of HD Map providers or operators, Traffic data providers or ITS providers were added as potential actors.

For *Phase 3; Service Integration* it should be highlighted that the participants suppose that different actors are responsible for the Integration of information in (C-)ITS services (incl. enrichment of data and merging with content). According to the answers, ITS service providers, HD Map Providers as well as Road Operators could fulfil the proposed activity. This variety of possible actors is in line with the statements of the respondents, where different stakeholder groups stated that they could fulfil this activity.

All Regional transport authorities see themselves in charge of this activity. In addition, OEMs, Public Road Operators, and scientific institutions indicated themselves partly as fulfilling actor. For the last groups national differences were visible in the responses.
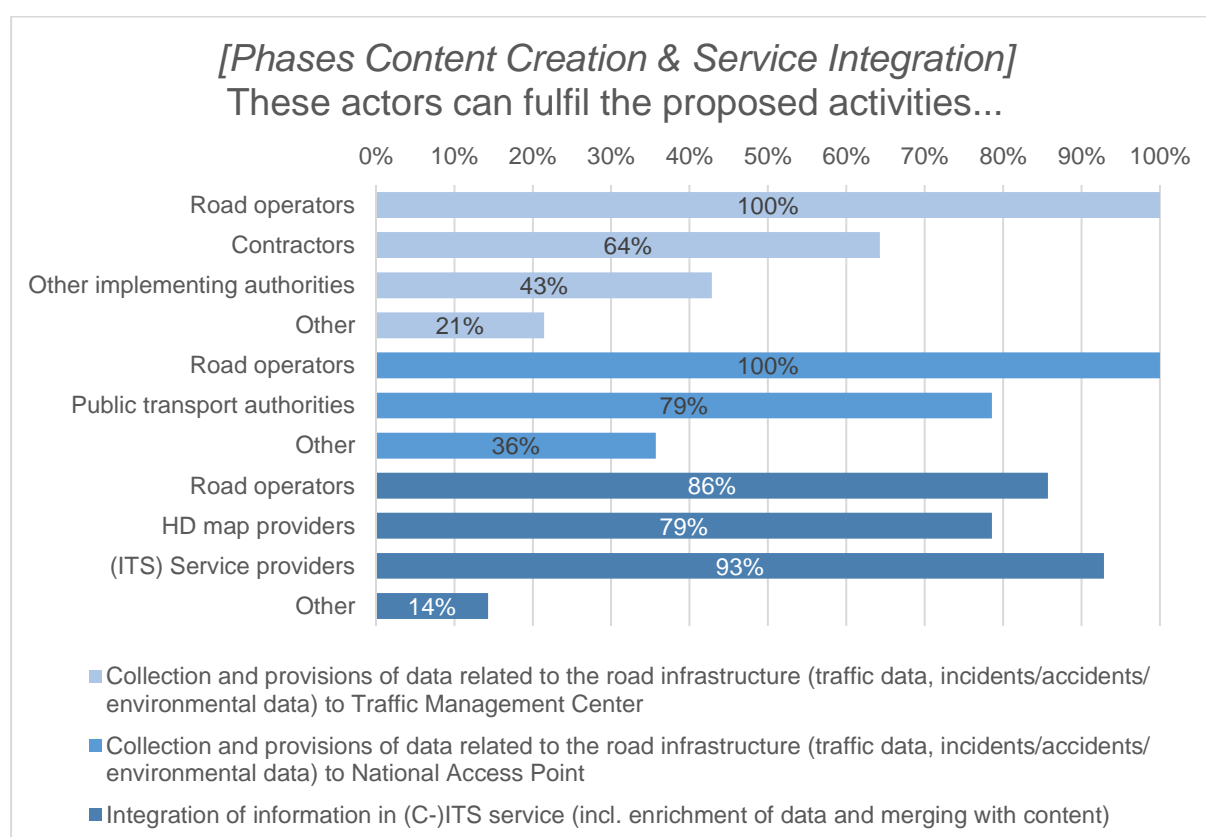
Figure 54: Proposed actors Phases Content Creation and Service Integration

Those who see the activities of *Phase 4: Service Presentation* as part of the core topic assume that Road Operators will play a crucial role in fulfilling all three proposed activities (Figure 55). **Especially for the activity *Provision of information on a physical infrastructure (display on VMS or physical sign)* the respondents assume Road Operators as actors that can**

fulfil this activity (with 100%, 12 out of 12 respondents). Equally, Public transport authorities might play an essential role, named 10 times each by 12 respondents in total (83%)**.** Aligned to this, 2 out of 3 Public Road Operators see themselves in charge of this activity. Considering the statistical data, Road Operators (85%) as well as Public transport authorities (85%) could also be responsible for the provision of binding information via an end-user service (C-ITS service). In addition, ITS Service Providers were named as another potential actor for activity 2.

For *Activity 1 Provision of information/advice via an end-user service of Phase 4 Service Presentation,* it should be highlighted that the participants suppose that different actors are responsible for the Provision of information or advice via an end-user service.

According to the answers, ITS service providers (100%), HD Map Providers (92%) as well as Road Operators (75%) could fulfil the proposed activity. This variety of possible actors is in line with the statements of the respondents, where different stakeholder groups indicated themselves as fulfilling actors. Also other potential actors were named like MNOs (mobile network operators) or OTTs.
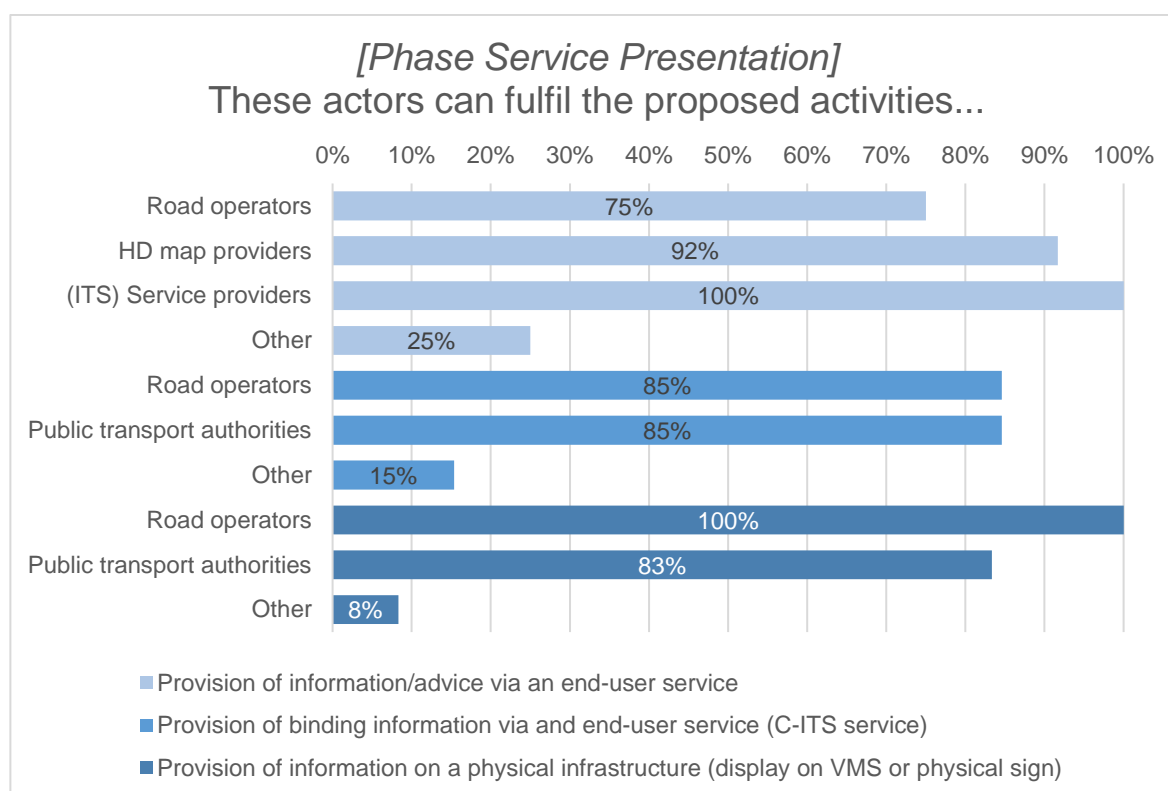
Figure 55: Proposed actors Phase Service Presentation

Cross-border aspects related to the responsible actors

The questionnaire also addressed necessary changes regarding cross-border interoperability. Specifically, respondents were asked *"How will it affect your answers if the end-user/vehicle uses the same service in another country? Will there be any changes e.g. regarding the activities or the related actors?"*

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Based on the responses received we see that **71% of participants** (10 out of 14) **do not expect any changes** related to the cross-border aspects. 14% of respondents (2 out of 14) estimate that minor changes may be expected, including (C-)ITS service providers and Public Road Operators. It is assumed that depending on cross-border differences, some adaptions would be necessary. This includes the need for "**Language adaptations**" as well as the consideration of "**legal aspects regarding non-EU members**".

At least 14% of respondents (2 out of 14), including Research Institutions as well as OEMs, expect moderate changes, which is related to the national differences that exist related to traffic in general and data availability and usage: *"**Public authorities have different capacities depending on the country."** and "**Data and extent of data will vary from one country to the next.** China will insist on end user data whereas other areas do not, due to end user data protection and GDPR."*

The analysis shows that consideration of different capacities and resources of traffic related organisations depending on the country has to be considered in the further work in regard to infrastructure support for Cooperative Automated Driving.

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5.4.6 Core topic 3: Validation of necessary data and data availability

In the course of the project, the consortium identified main data/data types that are needed to achieve the core topic "Infrastructure support for Cooperative Automated Driving". The participants of the questionnaire were asked to evaluate the proposed data needed as well as their availability. The different data types are:

1. Semi-dynamic and dynamic data

As a first step, the participants were requested to verify whether the proposed data is relevant within the core topic or not. In addition, they should evaluate if the data type is available in machine-readable format. In a further step, they were asked – similarly to the part on activities and actors - to analyse the proposed data providers.

5.4.6.1 Data types relevant for core topic 3

Figure 56 gives an overview of the evaluation of the respondents regarding the proposed data types. According to the statistics, it can be highlighted that the participants have a clear picture of which data is relevant for the implementation of infrastructure support for Cooperative Automated Driving.
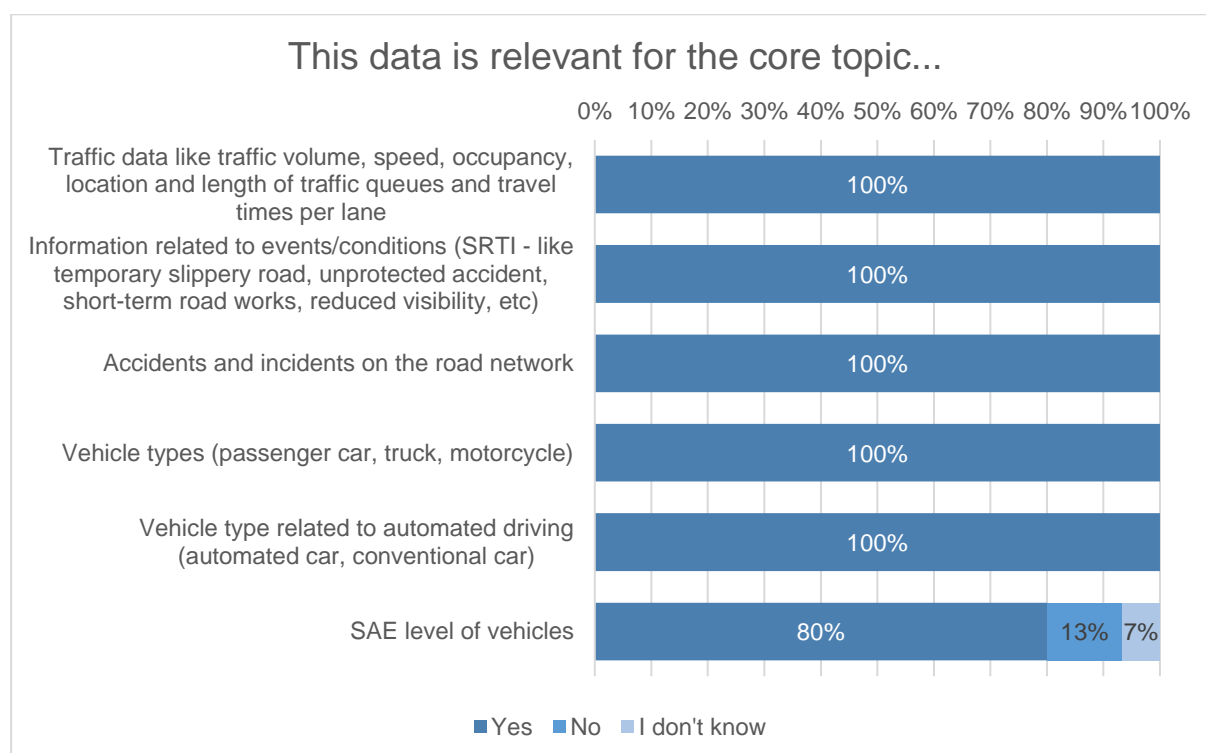
Figure 56: Acceptance rate of suggested data types

Almost all data types that were asked about in the questionnaire were seen as relevant for the core topic by 100% of the respondents. **The results show a general broad acceptance of the suggested data.**

Looking at the static data for core topic 2, **all respondents (13 out of 13 respondents)** agree on the **importance of Traffic data like traffic volume, speed, occupancy, location and length of traffic queues and travel times per lane.** One respondent added as a comment that one has to consider the fact of *"Limited accuracy as not all vehicles/nodes have the same*

level of localisation accuracy", which might be relevant when setting up the concept for the data platform as this could have an impact on the quality of data and information available.

The same broad acceptance applies to **Information related to events/conditions** as well as **accidents and incidents on the road network. 100% of those who answered the question see both data types as necessary parts of the core topic 3.**

For both data types, OEMs and communication network providers added challenges regarding **latency. In addition there has to be defined specifications for common use according to a respondent,** *"To make best use of this data, sharing needs to be mandated and low-latency infrastructure used for maximum benefit" and "Yes, but not always accurate, long latencies adding and removing when compared to real life situation".*

Another respondent commented in regards to data on accidents and incidents on the road network the following, which has to be considered for the further work:
"It won't just be eCall, 3rd party services will also be able to inform authorities of traffic incidents. Higher-level authentication will be required here".

The results reveal that information on vehicle data is essential according to the participating experts. It has to be highlighted that there is an acceptance rate of **100% towards information on vehicle type (passenger car, truck, motorcycle) and vehicle type related to Automated Driving (automated car, conventional car).** For the latter one, a respondent added as a comment that *"V2X will have this as part of its standard data",* which underlines the relevance of this information in the future. Based on the comments received, it has to be considered that it *"is currently not part of the CAM message"* at all.

The only kind of data with **less consent than 100% is information on the SAE level of vehicles.** But still 80% of all participating experts (12 out of 15 respondents) estimate that information on the SAE level of vehicles is relevant for core topic 3.

Both participants who stated that this data is not relevant for core topic 3 left an additional comment in regards to the core topic description. Therefore, the "*No*" related to the *information on SAE level of vehicles* is combined with the following comments: *"It is about automated vehicles. Not semi-automated"* and *"what is relevant is if and when and where the automation is ON".* This aspect shows that these experts assume that just fully automated vehicles were considered in this context and therefore information about SAE level is no longer considered.

Similar to the activities/actors section respondents had also the possibility to add data types that are missing the process flow so far, but no additional data types were added.

5.4.6.2   Availability of data for core topic 3 in machine-readable format

When it comes to the automation of the process and Automated Driving, the availability of data in a machine-readable format is the very basis to make this reality.

As explained in the introductory chapters (see 5.2.6), respondents were also asked about the availability of certain data types in machine-readable format. The analysis of the responses to this showed that there is partly no consistent opinion regarding the availability of the proposed data types in machine-readable format (see Figure 57). But the statistics show that the participants assume a higher availability of the proposed data in machine-readable format compared to core topic 1 and 2.

The majority of the respondents assume that traffic data like volume, speed, etc. (77%) will be available in machine-readable format, while at least 15% (2 out of 13) don't know if this is available.

The respondents were **most certain** about the availability of **information related to events/conditions (79%) as well as data on accidents and incidents on the road network (79%) in machine readable format.** 14% of the participants stated that this is not available, coming from OEMs and Research Institutions. 7% of respondents were not sure about this.

Based on the responses received, it can be assumed that information on **vehicle types will be available in machine-readable format, as 69%** (9 out of 13 respondents) marked the question with "yes". Compared to these findings, the availability of data on Vehicle type **related to Automated Driving in machine-readable format is still an open issue,** as only 54% (7 out of 13) marked it as available. While between 23% of respondents don't know if this is available and another 23% of the respondents are sure it is not accessible in machine-readable format.

Only 54 % (7 out of 13) are convinced that the proposed data on SAE level of vehicles can be provided in machine-readable format. 31% (4 out of 13) assumed that this information will not be available in machine-readable, coming from the categories OEMs, (C-)ITS service provider and Regional transport authority. This is connected to the relevance of the data at all, which was also mentioned in the previous chapter.

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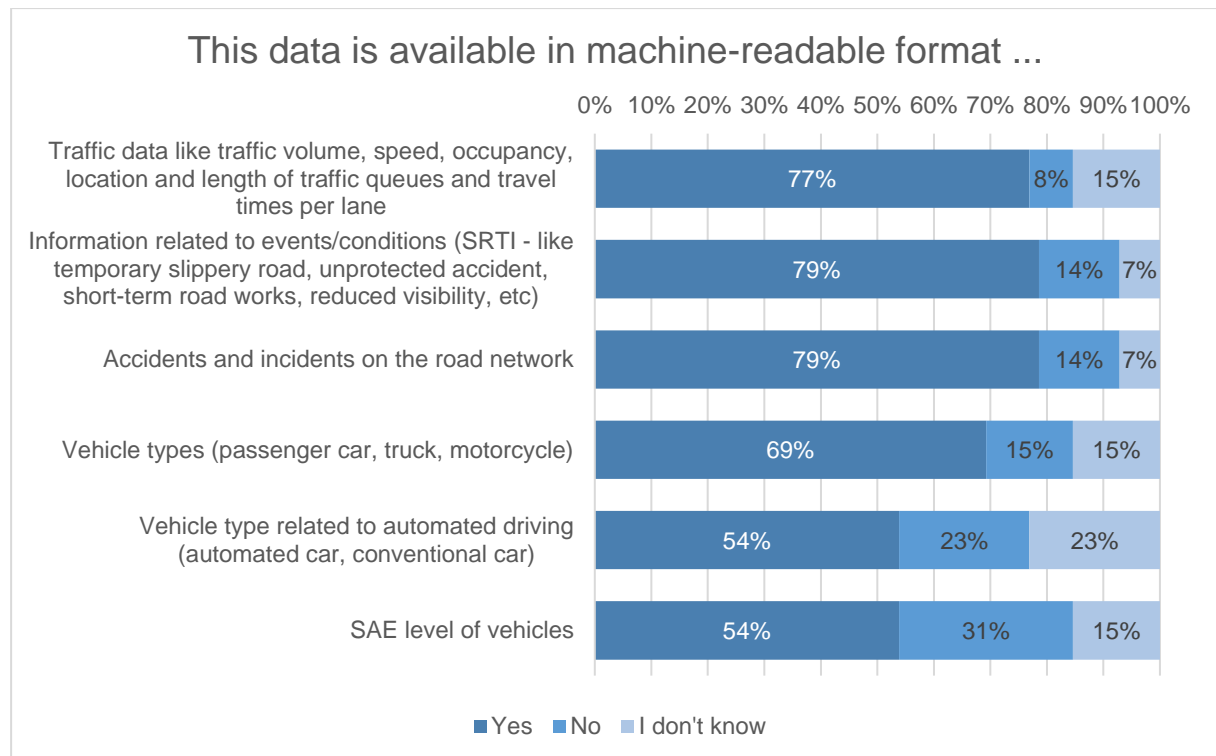
Figure 57: Assessment of respondents regarding the availability of data in machine-readable format

The data showed no clear differences between the different stakeholder types. Therefore we also had a look at national differences. If all respondents from a certain country answered "yes" we can assume that this data type is available in that country, while a "no" of all respondents of a country leads to the assumption that this is not available in this specific country (see Table 10).

	Traffic data like traffic volume, speed, occupancy, location and length of traffic queues and travel times per lane	Information related to events/conditions (SRTI - like temporary slippery road, unprotected accident, short-term road works, reduced visibility, etc)	Accidents and incidents on the road network	Vehicle types (passenger car, truck, motorcycle)	Vehicle type related to automated driving (automated car, conventional car)	SAE level of vehicles
Albania	/	/	/	/	/	Yes
Austria	Unclear (Yes+No)	Unclear (Yes+No)	Unclear (Yes+No)	Yes	No	Unclear (Yes+No)
Germany	Yes	Yes	Yes	Unclear (Yes+No)	Unclear (Yes+No)	Unclear (Yes+No)
Greece	Yes	Yes	Yes	Yes	Yes	Yes
Italy	Yes	No	No	No	No	No
Sweden	/	Yes	Yes	/	/	/
United Kingdom	Yes	Yes	Yes	Yes	Yes	Unclear (Yes+No)

Table 10: Overview of machine-readable data availability in the different countries (core topic 3) [5]

Having Figure 57 and Table 10 in mind, one could summarize that especially traffic data seems to be available in machine-readable data format (which makes sense due to the constantly changing nature of these data types), while for all other data types clear national differences can be observed.

In overall, we can see that, especially in **Austria and Germany,** there is **still a high insecurity in regards to the availabilty of data in machine-readable format.** For Italy we might consider for the further project that almost all proposed information cannot be provided in machine-readable format. In this context, there can be seen big differences in regards to the availability of the proposed data in core topic 1. **It can be highlighted – as already mentioned in core topics 1 and 2 – that experts of Greece assume that all data types will be available in machine-readable format.**

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[5] If all respondents from a certain country answered "yes" or "I don't know" it's "yes", if all respondents answered with "no" or "I don't know" it's "No", if there are both answers it's "Unclear (Yes+No)", if all respondents answered "I don't know" it's "Don't know". "/" = no answers received.

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5.4.6.3 Data providers for core topic 3

The acceptance towards proposed actors was further analysed among those, who see the data/data types as relevant for the core topic.

This analysis is helpful as it reveals the respondents' assessment, who is seen as a potential provider of the related data category (multiple responses were possible in the questionnaire), see Figure 58 .

For **traffic data, the expected data providers are the Road Operators** (100% meaning they were named 13 times by the respondents). Also "other" actors were named with a share of 46% (6 respondents), which includes *"Traffic and Map Providers", "Map operators" and "OEMs".* **This is interesting especially when considering that Map Providers or operators were not mentioned as active actors in the collection and provision of data related to the road infrastructure (like traffic data).**

It should be highlighted that the participants suppose that different actors are responsible for the Provision of Information related to events/conditions (SRTI - like temporary slippery road, unprotected accident, short-term road works, reduced visibility, etc). According to the answers, Automated Driving vehicles/users, OEMs, ITS service providers, C-ITS service providers, Road works service providers, Road Operators and the Police can provide the data. Also weather providers were seen as potential actors to provide this information. This result highlights the **importance of collaboration between actors**.

According to the statistics, for **data on incidents and accidents on the road network, Road Operators are expected as the main data providers (with 86% / named 12 times),** followed by the police (with 79% / named 11 times). Also, other potential data providers were named with a share of 36%. More specifically, National Transportation Safety administration, Traffic data suppliers and ITS providers, but also companies who equipped the road with additional technical infrastructure like cameras and further RSUs () should be considered.

Semi-dynamic / dynamic Data [1]
These actors can provide this data...
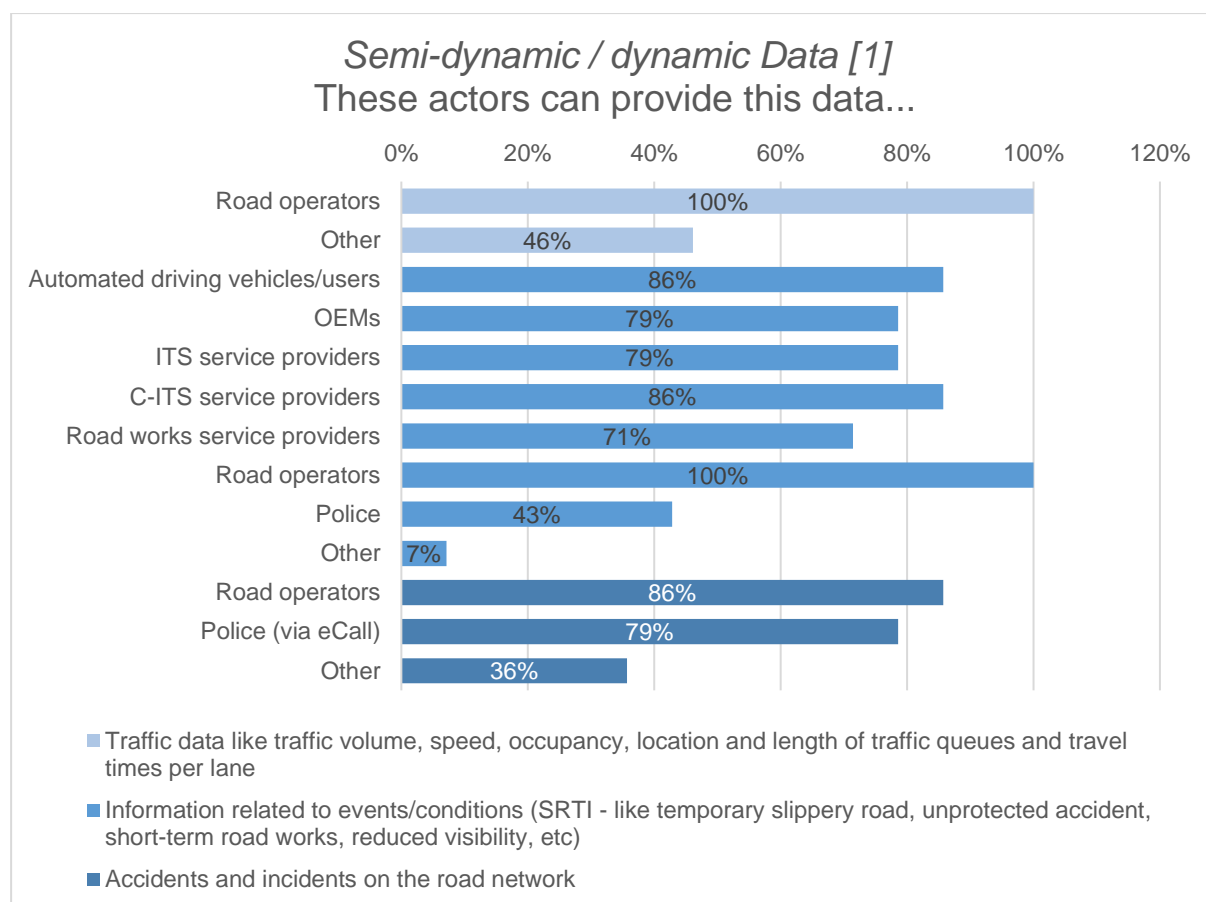
Figure 58: Assessment of providers of semi-dynamic/dynamic data (1/2)

For certain categories **OEMs play an important role in providing the data with a share of 64-85%**. This applies especially to the following data types: Vehicle types, Vehicle type related to Automated Driving and SAE level of vehicles.

Looking at the statistics (Figure 59), Road Operators (71%) and OEMs (64%) are the most expected data providers for information on Vehicle types (passenger car, truck, motorcycle), however other possible actors were mentioned from the respondents: (C)-ITS service providers and vehicles via a neutral server. Also, an additional comment was added in this context *"V2X data will have this information as part of ITS service",* this was also mentioned for the following two data types.

For the provision of **data on Vehicle type related to Automated Driving (automated car, conventional car) OEMs play a crucial role** (85% / named 11 times). For the proposed data, also other actors were named with a share of 38%. This includes Road Operators via CAM and C-ITS/ITS service providers twice. Looking at the national background of the other actors, we can see that **Road Operators were mentioned only by Austrian respondents**.

Also for data on **SAE level of vehicles, OEMS are expected as main data providers (83%).** But also again "others" like Road Operators via CAM and C-ITS/ITS service providers.

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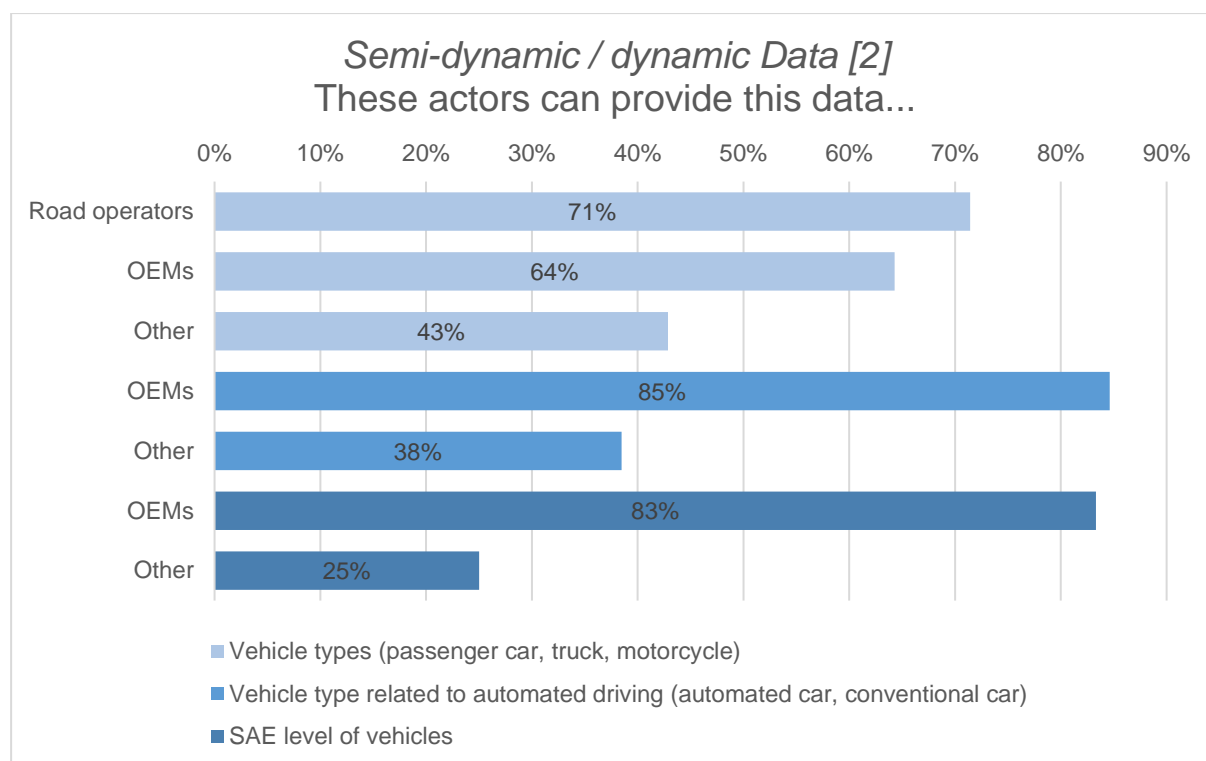
Figure 59: Assessment of providers of semi-dynamic/dynamic data (2/2)

5.4.6.4 Cross-analysis "Expected data providers" and "I could provide this data at least partially"

As in both previous core topics, the consortium cross-checked the section "*These actors can provide the data*" with the section "*This data can (at least PARTIALLY) be provided by my organisation*".

Figure 60: Screenshot of questionnaire for cross-check of the sections "This data can (at least PARTIALLY) be provided by my organisation" and "These actors can provide the data"

Having a look at the previous tables and the aggregated table on responses based on "*This data can be provided by my organisation*" (see Table 11Table 7) one can see that this matches (in wide parts) on an aggregated level.

Even when we consider the fact that some national differences might exist (which cannot be displayed here due to GDPR reasons) we can conclude **on an overall level that the expectation on data providers and the basic willingness to provide the specific data under certain conditions match**. This is a positive sign for the further development in this core topic.

Stakeholder group	Semi-dynamic/dynamic data					
	Traffic data like traffic volume, speed, occupancy, location and length of traffic queues and travel times per lane	Information related to events/conditions (SRTI - like temporary slippery road, unprotected accident, short-term road works, reduced visibility, etc)	Accidents and incidents on the road network	Vehicle types (passenger car, truck, motorcycle)	Vehicle type related to automated driving (automated car, conventional car)	SAE level of vehicles
European Commission						x
OEM						
Public Road operator	x	x	x	x	x	x
Regional transport authority / administration	x					
Research / scientific institution	x	x	x	x	x	

Table 11:   Aggregated responses "My organisation can – at least partially – provide this data" (aggregated on all responses from the stakeholder groups – some respondents of one stakeholder group might not provide all marked data types)

5.4.6.5 Access conditions for the data provision

For each data type that respondents marked as "*This data can be (at least partially) be provided by my organisation"* they had the chance to answer if "*this data can be shared – yes/no/conditionally"*. "Please describe the potential use and access conditions and used data format".

The responses give a good indication, if certain data types needed for core topic 3 will be available for sharing. **The statistics show that only in Austria, Germany and Greece the proposed data types are available for sharing (at least conditionally).** According to the responses, data on SAE level of vehicles can only be shared in Austria and Germany. But in this context, it should not be forgotten that not all European countries are covered by the questionnaire.

Examining the different data types it is noted that:

All data types can, according to the responses, only be shared in the three countries mentioned above. The following descriptions of potential use and access conditions and used data format were mentioned for almost all data types.

In Germany and Greece, the provision could be possible "*via an interface or service"* or "*via National Access Point in DATEX2"*. In addition, *"the Format can be specific to the agreed communication protocols".*

In Germany almost all data, with exception of data on accidents and incidents on the road network, is available in a *"restricted"* way according to the responses. The respondents from Greece also assume that *"a fee can be applied"* on all data, except information on Vehicle type related to Automated Driving and SAE level of vehicles.

Unfortunately, no respondent had some sample contracts.

5.4.6.6 Cross-border aspects related to the data availability and the service availability

Two different aspects of changes and challenges related to cross-border aspects were analysed: the data availability and the service availability.

The respondents were asked *"How will it affect your answers if the end-user/vehicle uses the same service in another country? Will there be any changes e.g. regarding the available data availability and the data quality?"* and *"Do you see any challenges or issues regarding access conditions and use of data for CROSS-BORDER service availability (meaning your organisation's data made available abroad OR that type of information (from other organisations) made available abroad)?"*

Four different respondents (Public Road Operator, Communication network provider and OEMs) gave some indication on the changes they expect regarding the cross-border service availability:

- *"High-level authentication will be required for information generation and exchange"*
- *"The platform will need to be scalable, with published open APIs enabling a number of contributors."*
- *"Common approaches to generating meta data will be required"*
- *"V2X standard data will cover all of these requirements without the need for the vehicle to send out any new data information."*

- *"Often players from countries with a less comprehensive data protection law are not willing to accept rules according to the data protection law from countries with more comprehensive data protection laws. That makes it difficult to share the data originating from a country with a very comprehensive data protection law to players in countries with a less comprehensive data protection law."*
- *"Challenges can arise due to GDPR restrictions, e.g. vehicle and/or driver must remain anonymised. Other challenges lie in sharing of data among other countries, non EU members."*

5.4.7 Risks and Challenges for core topic 3

The experts were asked to mention issues, risks or challenges they expect in regard to the security aspects, privacy aspects, data protection, cross-border service availability, as well as additional aspects not covered before.

As already highlighted for core topic 2, it is interesting that in contrast to core topic 1 on HD maps, the **number of respondents who expect many risks and challenges is much lower**. Despite this fact, some important issues were raised like the challenge of **security issues**, where common Public-Key-Infrastructures between different stakeholders are essential. Based on the responses received, new challenges related to **privacy legal issues** will appear, therefore GDPR expectations must be fulfilled. **Sharing among non-EU countries may also raise legal restrictions.**

Security related risks and challenges (e.g. in terms of Trusted Information Provision)

- *"The risks are related to the rather late introduction of security in ITS discussions. There are also other topics to be addressed, like common PKIs between different Road Operators and countries, the standardization and harmonization between countries etc."*
- *"System certification (data generation, data aggregation) is a challenge."*
- *"Hacker might change the information leading to completely different outcomes about for example critical situations and accidents might occur because of not mentioned incidents."*

Risks and challenge related to privacy aspects

- *"It is possible that new challenges related to privacy legal issues will appear. The increased monitoring of driving performance for safety, traffic efficiency and new services (e.g. Pay as you Go, Pay as you Drive) implementation."*
- *"GDPR expectations must be fulfilled."*
- *"The GPS position driven by a car is a problem when made available to the public if it is not sufficiently (early in the process) anonymized such that it can be retrieved by the original GPS track again. If information about the most often occurring starting point of a vehicle is available, it is possible to find out the person that travelled along the route by going to the house and reading the name from the person living there (as an example). By looking at the GPS track it is possible then to find out more about the adored destinations and his / her personal preferences. Security problems can then lead to privacy and data protection issues."*

Risks and challenges related to data protection
- The responses provided were the same as those provided for the risk and challenges related to security and privacy issues.

Risks and challenges regarding cross-border service availability

- *"Also a rather new, but so important feature for the ubiquitous connectivity to ITS services. Challenges related to virtual, not only physical, cross-border connectivity architecture models, agreement on these models between countries etc."*
- *"Sharing among non-EU countries may raise legal restrictions."*
- *"Mainly data protection issues or challenges as described before."*

Other risks and challenges expected in core topic 3

- *"Authentication for multiple data generators, scalable data exchange platforms. Localisation of data collection and processing using Edge Processing (MEC)"*

5.4.8 Opportunities and Benefits for core topic 3

In contrast to the risks, the respondents were also asked about their expectations of the opportunities coming from the implementation of core topic 3: *"What are opportunities from implementing the core topic? Who will benefit?"*

Aggregating the responses, we could see that respondents expect numerous benefits such as:

- *"Better traffic management in mixed vehicle network."*
- *"Synergies between countries, stakeholders and other sectors (energy, IT, fleet management),new packet services, steps forward Mobility and Smart Cities*
- *Improve road capacity."*
- *"Enabling CAD (Level 4), which implies societal benefits (reducing accidents, improving traffic flow, reducing CO_2 emissions)."*
- *"Commercial opportunities e.g. added value services."*
- *"By knowing the traffic flow and automated vehicles traffic can be optimized using control theory techniques."*
- *"Road safety."*
- *"Safer traveling by car by knowing hazards, accidents etc."*
- *"Reduction of traffic"*
- *"Less time consuming traveling by optimized traffic, traveling depending on known weather conditions."*

And who will benefit from the implementation from their point of view?

1. *Road users", "Drivers", "Society traveling by car"* (mentioned several times)
2. *"Cities"*
3. *"The environment"*
4. *"All the ITS Stakeholders , other industries stakeholders"*
5. *"Service providers may offer enhanced services with specialised content (e.g. alternative routes, discounts by local businesses, offers based on weather conditions, etc.)"*

5.4.9 Summary of the results of core topic 3

In total, **16 experts participated** on the core topic Infrastructure support for Cooperative Automated Driving. The statistics show that **Public Road Operators and OEMs constitute the two largest groups** of participants (37,6%). In addition, it has to be mentioned that this is the only core topic where **infrastructure equipment suppliers actively participated**. With 6,3% of respondents the share could be higher, as infrastructure support for CAD has been expected as one of the high priority topics of this stakeholder group in the future.

As for the other core topics, almost all respondents represent large enterprises (75%, 12 out of 16 respondents). Again, this could be explained by the fact that that ISAD is driven especially by larger size organisations since all types of Road Operators and OEMs are by nature larger size organisations. However, it is also possible also that smaller providers could not be reached with the questionnaire.

Having a look at the geographical coverage of the participating stakeholder groups it has to be mentioned that with 63%, more than half of them come from Germany, the United Kingdom and Austria. Especially Germany has to be highlighted with a share of 25%. The remaining participants can be assigned to the following states: Albania and Greece (2 each) and one participant from Italy and Sweden. To put the results in a nutshell it is not possible to identify clear trends for one country.

On an overall level, the respondents agree in wide parts with the proposed storyline and process flow, which received a total of 7. On the level of different stakeholder groups, one can see that **the acceptance rate on the process is varying. Especially from the point of view** of (C)-ITS service providers and national transport authorities there are some adaptions needed. In contrast, all other groups could align very well with the process.

In general, the responses show a broad agreement on the **activities proposed for core topic 3.** Compared to the other two core topics, the degree of approval is even higher on average. Having a look at the statistics, we could see that at **least 81% of the participants agree with the single activities of each phase of the process**, but when it comes to the differentiation between stakeholder groups some contradicting views can be seen.

For *Phase 1: Content Creation* **a principal approval** for both data collection and provision activities (88% acceptance) can be seen. Based on the responses received, one can see that there are **contradicting views between different stakeholder groups**. Especially (C-)ITS service providers, Infrastructure equipment suppliers and Research/Scientific Institutions don't agree with the **role of the NAP**, whereas almost all of the other stakeholder groups agree with the need of the NAP.

The results demonstrate that **81% of the participants assume that the suggested activity of *Phase 2: Content Aggregation* is needed** for core topic 3. Especially National transport authorities/administrations do not have a clear opinion on phase 2. It has to be highlighted that 3 out of 16 were uncertain about the relevance of the activity Provision of collected data for further procession. Considering the comments, this might be related to a lack of understanding regarding the activity ("What do you mean by further procession?").

Based on the responses received, it is obvious that *Phase 3: Service Integration* is needed to enable infrastructure support for CAD as there is a **93% approval that the proposed activity is essential**. When looking at the statistics one can see that there are no big differences between the stakeholder groups, only Public Road Operators do not show 100% acceptance in regards to *Phase 3*.

On an overall level, there is a broad agreement with *Phase 4: Service Presentation.* But at least 14% of the participants see no need for Provision of information via an end-user service as well as for providing information on a physical infrastructure. For *Phase 4* mainly Infrastructure equipment suppliers as well as national transport authorities had the feeling that these activities are not part of the core topic. OEMs and Public Road Operators were partly uncertain of the real need of the defined activities.

The **validation of roles and responsibilities** showed some interesting aspects that will need to be considered in the matching of the views of the different stakeholder groups:
Also for core topic 3, Road Operators will play a crucial role in the *Collection and provision of data related to the road infrastructure.* This is contradicting to the responses given according to the indication "*my organisation can fulfil this activity*". For the first activity (Content Creation to TMC) just 1 of 3 Public Road Operators indicated itself as an actor. This is different to the Regional transport authorities, where all respondents see themselves in charge of this activity.

The results for the second *Phase Content Aggregation* show clearly that different stakeholders should be considered when it comes to fulfilling this task. It is notable that especially the stakeholder groups which marked that they could fulfil both activities of *Phase 1: Content Creation*, see themselves also in charge of the subsequent *Phase 2: Content Aggregation.*

For *Phase 3: Service Integration* it should be highlighted that the participants suppose that different actors are responsible for the Integration of information in (C-)ITS services (incl. enrichment of data and merging with content). According to the answers, ITS service providers, HD Map Providers as well as Road Operators could fulfil the proposed activity. This variety of possible actors is in line with the statements of the respondents, where different stakeholder groups stated that they could fulfil this activity.

Those who see the activities of **Phase 4: Service Presentation** as part of the core topic assume that Road Operators will play a crucial role in fulfilling all three proposed activities.

When it comes to the **changes in regard to the main actors related to the cross-border availability of the service** we could summarize that **71% of respondents** (10 out of 14) **do not expect any changes** related to the cross-border aspects. 14% of respondents (2 out of 14) estimate that minor changes may be expected, including (C-)ITS service providers and Public Road Operators. It is assumed that depending on cross-border differences some adaptions would be necessary. This includes the need for "**Language adaptations**" as well as the consideration of "**legal aspects regarding non-EU members**".

At least 14% of respondents (2 out of 14), including Research Institutions as well as OEMs, expect **moderate changes**, which is related to the national differences that exist related to traffic in general and data availability and usage: *"Public authorities have different capacities depending on the country."* and *"Data and extent of data will vary from one country to the next. China will insist on end user data whereas other areas do not, due to end user data protection and GDPR."*

Almost all data types that were asked about in the questionnaire were seen as relevant for the core topic by 100% of the respondents. **The results show a general broad acceptance of the suggested data.** Looking at the static data for core topic 3, all respondents (13 out of 13 respondents) agree on the importance of Traffic data. **In regards to traffic data, the problem of "*Limited accuracy as not all vehicles/nodes have the same level of localisation accuracy"* has to be considered.**

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The same broad acceptance applies to **Information related to events/conditions** as well as **Accidents and incidents on the road network.** For both data types, OEMs and communication network providers added challenges regarding **latency (as already mentioned for HD Maps).**

The results reveal that information on vehicle data is essential according to the participating experts. It has to be highlighted that there is an acceptance rate of **100% towards information on vehicle type (passenger car, truck, motorcycle) and vehicle type related to Automated Driving (automated car, conventional car).** For the latter, one respondent added as a comment that *"V2X will have this as part of its standard data",* which underlines the importance of this information in the future. 80% of all participating experts (12 out of 15 respondents) estimate that information on the SAE level of vehicles is relevant for the core topic 3. Additional comments show that some experts assume that just fully automated vehicles were considered in this context and therefore information about SAE level is no longer necessary.

The analysis of the responses to this showed that there is partly **no consistent opinion regarding the availability of the proposed data types in machine-readable format**. But the statistics show that the participants assume a higher availability of the proposed data in machine-readable format compared to core topic 1 and 2.

The majority of the respondents assume that traffic data like volume, speed, etc. (77%) will be available in machine-readable format, while at least 15% (2 out of 13) don't know if this is available. The respondents were also **most certain** about the availability of **information related to events/conditions (79%) as well as data on accidents and incidents on the road network (79%) in machine readable format.** Based on the responses received, it can be assumed that information on **vehicle types will be available in machine-readable format, as 69%** (9 out of 13 respondents) marked the question with "yes". Compared to these findings, the availability of **data on Vehicle type related to Automated Driving in machine-readable format is still an open issue,** as only 54% (7 out of 13) marked it as available. Only 54 % (7 out of 13) are convinced that the proposed data on SAE level of vehicles can be provided in machine-readable format. 31% (4 out of 13) assumed that this information will not be available in machine-readable, coming from the categories OEMs, (C-)ITS service provider and Regional transport authority.

For **traffic data, the expected data providers are Road Operators.** Also "other" actors were named with a share of 46% (6 respondents), which includes *"Traffic and Map Providers", "Map operators"* and *"OEMs".* **This is interesting especially considering that Map providers or operators were not mentioned as active actors in the collection and provision of data related to the road infrastructure (like traffic data).**

It should be highlighted that the participants suppose that different actors are responsible for the Provision of Information related to events/conditions. According to the statistics, for **data on incidents and accidents on the road network, Road Operators are expected as the main data providers (with 86% / named 12 times),** followed by the Police (with 79% / named 11 times).

For certain categories **OEMs play an important role in providing the data with a share of 64-85%**. This applies especially to the following data types: Vehicle types, Vehicle type related to Automated Driving and SAE level of vehicles.

Looking at the responses of the **access conditions for data and information,** one could conclude that, **in principle, a majority of the data types** needed for core topic 3 **are available** for sharing. But the statistics also show that only in Austria, Germany and Greece the proposed data types are available for sharing (at least conditionally). Considering the fact that some

national differences might exist, we can still conclude **on an overall level that the expected data providers and their basic willingness to provide the specific data under certain conditions match**. This is a positive sign for the further developments in this core topic.

As already highlighted for core topic 2, it is interesting that in contrast to core topic 1, the **number of respondents which expect many risks and challenges is much lower**. Despite that fact, some important issues were raised like the challenge of **security issues**, where common Public-Key-Infrastructures between different stakeholders are essential. Based on the responses received, new challenges related to **privacy legal issues** will appear, therefore GDPR expectations must be fulfilled. **Sharing data among non-EU countries may also raise legal restrictions.**

Major benefits were seen in better **traffic management and improved road capacity.** Also *Commercial opportunities e.g. added value services* were mentioned by the respondents. Synergies between countries, stakeholders and other sectors could step forward in the fields of Mobility and Smart Cities. **Different groups are expected to benefit** from the implementation of core topic 3, from **ITS Stakeholders and industries stakeholder, service providers to road users.** Even more, a number of respondents expected that the **society as a whole** can benefit from the core topic.

6 Conclusions of the major results

6.1 Core topic 1 - Provision of High-Definition Maps for Automated Mobility

Summarising all the individual results, we can conclude the following on the evaluation of core topic 1:

- **The process and storyline presented are widely agreed on** by the respondents, so this is a valid basis for the further development of the data exchange platform and related business models.
- From the point of view of NRAs, there are **some adaptions needed**, while other groups like scientific institutions and Communication network providers could align very well with the process.
- In general, it should be **re-considered** whether **the provision of a NAP** (or TERAP) is really needed as an "active" part of the use case or if it could be handled as some source outside the process flow. In this context it should be mentioned, that the NAP serves a functional concept for a data aggregator/distributer/broker. This means that the function of a TERAP can be integrated anywhere, even in a NAP. The prerequisite is the integration into a network of trust. Considering that it might not have been completely clear for the respondents how the TERAP and NAP should be interpreted, the DIRIZON consortium would still recommend to keep them in the flow chart and as part of all three use cases.
- While in principle, *Phase 4: Service Integration* was agreed on by 86% of the respondents, there were some clear statements in this section, as well as in the overall evaluation that the **integration should not be seen as part of the core topic process flow**. For this phase needs to be a detailed re-evaluation.
- **The provision of feedback from different sources in *Phase 6: Feedback Loops* is one of the most contradicting issues so far and needs an in-depth inquiry,** especially as we can see that some groups clearly agree with the fact of using e.g. NAP data, while they don't see the need in providing feedback to raise the data quality. Furthermore, we learned that while it is clear for most of the stakeholder groups that the automated feedback from vehicles and users must be considered in the provision of the service, this is not that clear for other types of feedback.
- **100% of the Public Road Operators agreed that the provision of data via the NAP in an earlier phase is clear, while they don't see the feedback to the NAP as part of the process.**
- Based on the results it should be considered to include the Management/coordination of the use of frequency spectrum using frequency allocation plans and frequency usage plans as a framework condition, but not as a separate activity in the process.
- The analysis supported the assumption that **Road Operators will play an important role** in providing traffic regulations, road models, lane models and geo-referencing data, while the provision of HD maps is **clearly a task for the HD Map Providers**.
- Furthermore, the results show that for 60% of the respondents, cross-border service availability will not have an impact on their responses.
- For the rest **"language adaptions for different traffic signs"** as well as the need for an "**extra layer of checking/conversion**" have to be considered in the cross-border aspects. Related to this, the alignment between Road Operators becomes relevant. Especially OEMs and communication network providers expect moderate or even significant changes.

- On balance, **Interoperability is the key issue** if cross-border services should become more and more standard. In this context, it is important to emphasize that the general willingness to transfer knowledge and to cooperate between different stakeholder groups as well as countries is necessary in any case.

The following can be concluded on the data availability and accessibility:

- **The results show a general broad acceptance of the suggested data.**
- The data types location of delivery areas and costs of parking and road use should be deleted from the necessary list of data.
- On the other hand, data on different mobility services (e.g. shuttle bus stations in night, car-sharing stations as well as dynamic taxi information) as well as "immediate traffic warnings" e.g. from other cars should be considered to be included in the data list for this core topic.
- **Regarding the availability in machine-readable format national differences were identified.** So, for example, for traffic regulation it might be considered for further projects that this data is not available in machine-readable format in Belgium and Germany, according to the responses, while it would be available in the other respondents' countries (e.g. Greece, Ireland, Netherlands, Sweden and United Kingdom).. Due to a fragmented administration structure the availability might vary on regional/national level.
- **In conclusion, it can be assumed that static and semi-static information is (besides some aspects like charging point and delivery areas as stated below) in principle available in machine-readable format**.
- **In general, the availability of location and availability of charging points for electric vehicles in machine-readable format is clearly an open issue, same as the data on availability of parking spaces and charging points for electric vehicles** plus cost of parking or road use.
- Regarding the potential providers of the related data category, **Road Operators are expected to provide different types of static road parameters like road classification, location of tolling stations, HD lane model incl. number of lanes and link attributes (like access conditions, speed limits,…), and location of parking spaces and service areas, as well as the traffic regulations, which were categorised as legal boundaries. For certain categories HD Map Providers are the clearest option** (in case road models incl. road geometry or HD localisation models – beacons, landmarks) or the second option besides the Road Operators (e.g. for HD lane model, location of charging points).
- The cross-analysis showed that the expectation on data providers and the basic willingness to provide the specific data under certain conditions match. This is a positive sign for the further development in this core topic.
- When it comes to the availability of services abroad, the **majority** of respondents suggests that **no challenges** are to be expected. Also the **importance of international standards** and alignments were highlighted.
- Nevertheless, some aspects have to be considered like **language adaptions** e.g. traffic signs have to be realized when the same service is used in different countries and challenges that can arise due to **GDPR restrictions** or the **sharing of data among other countries, which are non-EU members**. Also meaning of **open data and fees for data in different countries** have to be taken into consideration.

Summarizing on expected risks, but also on benefits for the core topic the following can be stated:

- Especially in the area of HD maps **cybersecurity** is a major topic that will challenge the actors in the future. This is very much connected with the other major challenges like **privacy and data protection.** Next to these the **need for standards** and the **compliance with standards** is of highest importance and really a challenge for the core topic. Last but not least **latency issues can be seen as major risks**!
- On the other hand, the provision of HD maps for Automated Driving is seen as a **benefit regarding safety and comfort for the driver** and a **basic requirement for the implementation of Automated Driving in complex areas** that will enable more efficiency in the management of the related processes. Also it will foster new commercial opportunities e.g. for map or service providers.
- We can expect that **mainly drivers and road users will benefit** from the implementation of this use case. But also (HD) map service providers are assumed to gain benefits.

6.2 Core topic 2 - Distribution of Digital Traffic Regulations

Summarising all the individual results, we can conclude the following on the evaluation of core topic 2:

- The overall flow is a **good basis** to represent the views of **Road Operators, communication network providers and Research and Scientific Institutions**.
- For the NRAs and some other actors, the contradicting views in some activities have to be different. The contradictions for **NRAs are especially regarding the *Service Presentation* and the *Integration of the Service* and the *Feedback Loops*.** OEMs also have different views when it comes to the Provision of a regulation and the Presentation via end-user service.
- The *Phases 1 (Defining the traffic regulations), 4 and 5 (Service Integration and Presentation) and 6 (Feedback loops)* are most likely to be sketched with the different views because here the most contradictions exist. So for, as a final recommendation this could mean that these are the phases where we need the most activities related to **harmonisation and discussion for developing a harmonised view of the actors**.
- **Provision of a standardised framework** is one of the most important tasks within this core topic that has been fully approved by all stakeholder groups. This emphasized the need for even more efforts in the related standardisation groups (as CEN/TC 278 WG17).
- There are different "main actors expected" for the different phases, which should be the basis for further work. And the actors differ between the phases. Road Operators are not the only (one of the two) core actors for this core topic (unlikely other core topics).
- When it comes to the **actors, we have to find a solution to consider the different national organisational structures** that have major impact on the primary actors in each country. A transnational solution will not be easy to develop in this regard. Therefore, **a solution for linking different national solutions within one major concept is an important task for WP5 and WP6.**
- On cross-border level, the need for national/local solutions has been formulated, which is aligned with the previous conclusion.

The following can be concluded on the data availability and accessibility:

- **The list of data is quite complete for METR.**
- All data types related to the topic of freight (e.g. freight delivery conditions) are open issues for the respondents and need further investigation.

- **The view of HD Map Providers on this core topic could be important for the provision of data, as they are named many times as expected data providers, even if they are not seen as primary actors**.
- Regional/Local authorities/National Transport Authorities, Road Operators and HD Map Providers are those actors that need to provide data within the core topic.
- In provision and availability of data major national differences exist. A way to combine different national approaches for METR will be necessary.
- The **missing of machine-readable static data** needed for the core topic could be a crucial aspect when we think about Automated Driving. Making sure that the relevant data can be provided in machine-readable format must be one of the first measures.

Summarizing on expected risks, but also on benefits for the core topic the following can be stated:

- In principle, major challenges in respect to METR are concerning **GDPR aspects and IP protection**, a general "information security control" will be even more in the focus when we talk about cross-border aspects. On the other hand stakeholders have high expectations on the potential benefits related to the implementation of core topic 2. The major benefits are **expected improvements in safety, but furthermore in the efficiency of the transport system**

6.3 Core topic 3 - Infrastructure support for Cooperative Automated Driving

Summarising all the individual results, we can conclude the following on the evaluation of core topic 3:

- The overall flow chart is seen as a good basis for the implementation of infrastructure support for Cooperative Automated Driving.
- It is especially interesting that the acceptance rate on the process is varying on the level of different stakeholder groups. **(C)-ITS service providers as wells as national transport authorities would recommend some adaptions** in regards to the proposed storyline and flow chart.
- When looking on the different phases, one can see that **at least 81% of the participants agree with the proposed activities** of each phase of the process.
- In *Phase 1* there are contradicting views between different stakeholder groups when it comes to the role of the NAP.
- Overall, the majority (81%) of the participants assumes that the suggested activity of *Phase 2* is needed, but especially national transport authorities do not have a clear opinion on it.
- **High approval on the relevance of *Phase 3* as well as *Phase 4*.** But at least 14% of the participants see no need for Provision of information via an end-user service as well as for providing information on a physical infrastructure.
- There are different "main actors expected" for the different phases, which should be the basis for further work. And the actors differ between the phases.
- Also for core topic 3, **Road Operators will play a crucial role in the Collection and provision of data related to the road infrastructure** and also when looking on activities of *Phase 4* (service presentation).
- The results for the second and third phases show clearly that different stakeholders should be considered when it comes to fulfilling this task.

The following can be concluded on the data availability and accessibility:

- The results show a **general broad acceptance of the suggested data.** Almost all data types that were asked about in the questionnaire were seen as relevant for the core topic by 100% of the respondents.
- Based on the responses received different actors are responsible for providing the data. **Road Operators are seen as the main data provider not only for the provision of traffic data, but also for data on accidents and incidents.** For certain categories OEMs play an important role in providing the data with a share of 64-85% (e.g. Vehicle types, Vehicle type related to Automated Driving and SAE level of vehicles).
- Again we can conclude that **making sure that the relevant data can be provided in machine-readable format must be one of the first measures.**

Summarizing on expected risks, but also on benefits for the core topic the following can be stated:

- In future, it will be important for ISAD to consider **security and privacy issues**. In addition, legal restrictions may raise when sharing data among non-EU countries. In parallel some major benefits were expected, which **includes better traffic management and improved road capacity.**

7 Recommendations and next steps

This chapter deals in particular with the inputs regarding the proposed process flows. As already mentioned in the analysis of the individual core topics, there is a very high level of agreement with the proposed process flows of the three topics. The results show that the experts are mostly in line with the suggested activities and their actors.

In the following, those inputs and comments that suggest changes to the process are analysed in more detail. For this purpose, findings were included the original flow charts (see 5.2.1, 5.3.1, 5.4.1). In summary, short descriptions of the proposed modifications of the sequences are added. This chapter concludes with a summary of the most interesting adaptions and an insight into the next steps in DIRIZON.

7.1 Recommended changes of core topic 1 - Provision of High-Definition Maps for Automated Mobility

On an overall level the process flow chart and the included storyline received a total rating of 7,6. This means that the respondents agree in wide parts with the presented storyline and the presented process for core topic 1.

Some respondents used the option to add additional comments. In the section below, we summarize especially those that recommended some specific aspects and changes as basis for the further discussion within the project. These adaptations were then included into the flow diagram (see Figure 61) and highlighted accordingly. In addition, some conflicting views on the level of the different stakeholder groups can be seen.

For *Phase 1: Content Creation* there may be other potential actors for the provision of road and lane models like Research Institutions, Map Providers or Map operators and certain private companies relevant. In principle (Digital) Map providers commented that roles are overlapping in reality, e.g. Service providers are at the same time Map providers. Furthermore, map providers suppose that a content/delivery phase, which is included as additional phase in the flow chart, is needed alongside or within the content creation phase.

Communication network providers, which, in principle, were confident about the presented process, suggest that the description of a low-latency information layer for immediate traffic warnings is missing.

When looking at *Phase 2: Content Aggregation* it is notable that some respondents are not sure if the provision of a TERAP (Trusted Electronic Regulation Access Point) or NAP (National Access Point) is a necessary part for implementing HD Maps. What we can see from the differentiation between the stakeholder groups is that especially the regional transport authorities do not agree with the NAP and on the other hand national transport authorities do not fully support the idea of a TERAP.

However, it is important to mention that the flow chart shows a functional decomposition instead of a system architecture, which might have led to some confusion for the respondents. The TERAP is only a functional concept, not a system proposal. Moreover, although the NAP exists in reality, the NAP also serves as a functional concept for a data aggregator/distributer/broker within the use cases. This means that the function of a TERAP can be integrated anywhere, even in a NAP. The prerequisite is the integration into a network of trust. Considering that it might not have been completely clear for the respondents how the TERAP and NAP should be interpreted, the DIRIZON consortium would still recommend to keep them in the flow chart and as part of all three use cases.

For the enrichment of the HD map, Road Operators might play a role in addition to proposed HD Map providers. It should be considered that HD Map providers and service providers may be represented by just one organisation. Public Road Operators assume that "Some map layers might not require to be integrated in a HD map in the cloud but are directly exchanged between service provider and Road Operator". Therefore, we have tried to integrate this suggestion in the diagram. On the other hand, the idea of the flow chart was creating a functional decomposition (was already mentioned above), where it is quite possible that roles and functions can be aggregated. Therefore, the direct link can however already be considered as included in the case a Map provider covers both HD Map Production and Service Integration.

A Digital Map Provider assumed that "The Map update arrow between the Road Operators/authorities and HD Map providers is going in the wrong direction. Any public related changes that concern the map should be communicated to this." This feedback was highlighted by the yellow circle.

Some experts (including (Digital) Map providers, National Road Authorities and Public Road Operators) stated that the provision of an end-user service should be handled outside of the core topic. It was commented that the provision of ITS (end-user) services are added value services rather than core services.

Public Road Operators recommended to include the opportunity of direct communication including delta changes of the HD map.

As a different approach, one OEM suggested that "All data flow to the car is to be managed by the OEM - similar to how Apple manage all apps on the apple products. This minimises risk to drivers safety and security." Since OEMs would then act as service providers for their own fleet, this is already considered in the flowchart.

Moreover, the need of feedback loops is one of the most contradicting issues so far and need some further research. Some groups agree with the fact of using e.g. NAP data, while they do not see the need in providing feedback to raise the data quality (e.g. Public Road Operators). Based on the additional comments, the different stakeholders are still uncertain whether the provision of feedback to road authorities is needed or not, especially (Digital) Map Providers have inconsistent views. DIRIZON would still recommend to keep feedback loops in place in order to improve service and data quality.

There is a high uncertainty regarding the second activity in *Phase 6: Enabling and regulation* (which is not covered in the flow chart due to visualisation reasons) "Management/coordination of the use of frequency spectrum using frequency allocation plans and frequency usage plans", as one third of respondents (especially Digital) Map providers and the regional transport authorities) are not sure whether the activity is part of the core topic or not. It was added, that it should not be considered in the scope of HD map creation. As already mentioned above, the respondents assume that the focus should be on HD map management and not on the distribution to users.

Input from WP4 results is included

For some parts of the chain secure communication and provision of trusted information is necessary!

DATA/CONTENT CREATION
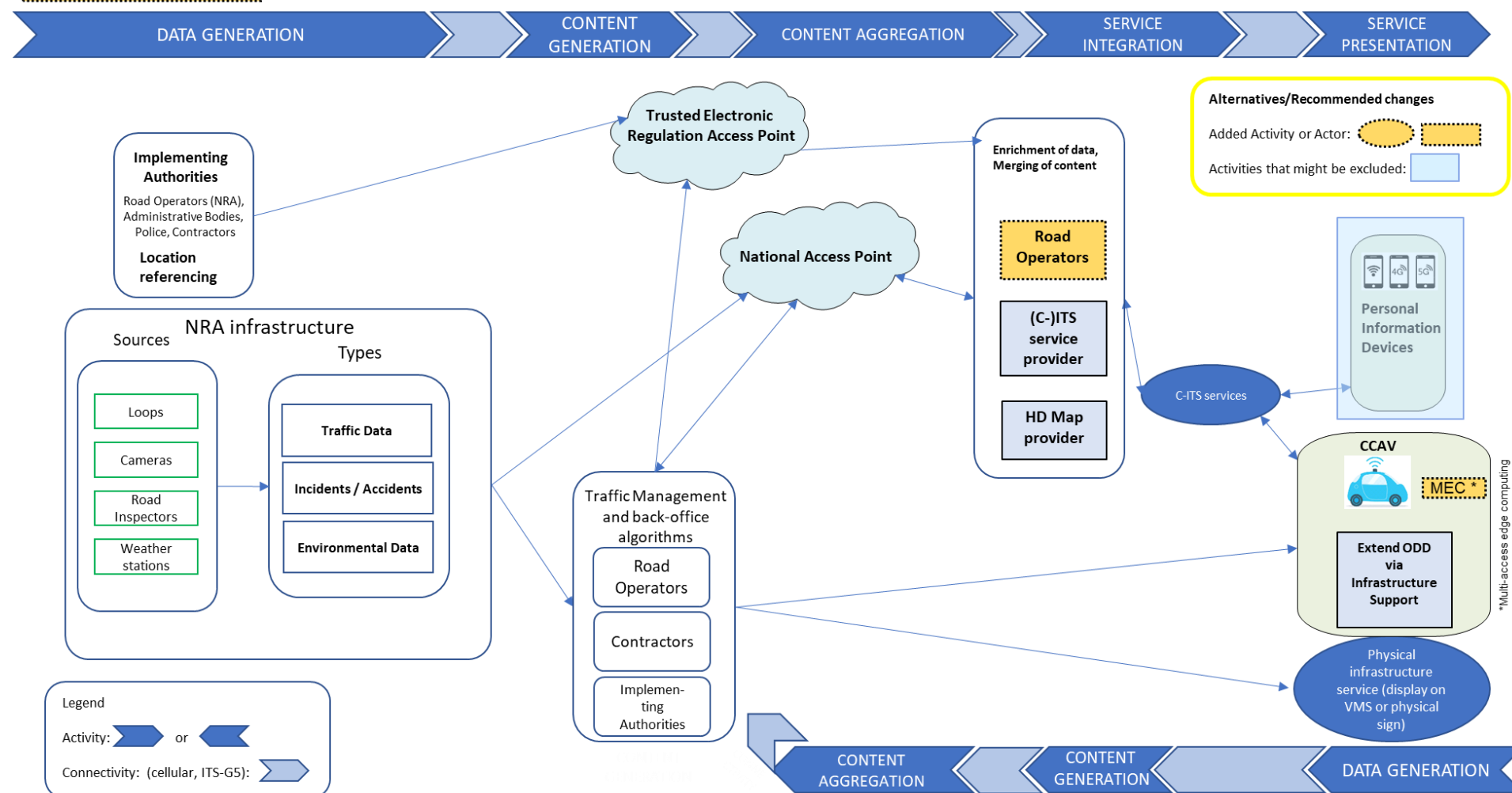
CONTENT AGGREGATION

HD MAP PRODUCTION

SERVICE INTEGRATION

SERVICE PRESENTATION

Additional Phase: Content Delivery

Trusted Electronic Regulation Access Point

Alternatives/Recommended changes

Added Activity or Actor:

Activities that might be excluded:

Trusted party connection

Road Operators and authorized authorities

Road Operators

Contractors

Implementing Authorities

Other potential actors

Option 3

Option 2 (trusted third party connection for ETR)

Option 1

map updates

Enrichment of data, Merging of content

HD Map providers

ITS Service providers

Road Operators

Identification of inconsistencies

Secure layer / „trusted communication"

Integration with other available data

HD Map providers

Service Providers

Personal Information Devices

map updates

CCAV

Depending on the different options different standards and communication protocols are used

Partly direct exchange

direct communication for delta changes

National Access Point

Legend

Activity: or

Connectivity: (cellular, ITS-G5):

CONTENT GENERATION

DATA GENERATION

Figure 61: Alternative Flow Chart of Core Topic 1 based on feedback from the participants of the questionnaire

7.2 Recommended changes of core topic 2 - Distribution of Digital Traffic Regulations

Similar to core topic 1, the respondents also show a general agreement with the proposed storyline and flow chart for core topic 2, the distribution of digital traffic regulations. The score in the overall evaluation is 7.5, which is almost the same as for core topic 1. Similarly to chapter 7.1, after the discussion of additional comments concerning the process flow, adaptions were included into the original flow diagram for this use case (see Figure 62).

In general, there have been some critical comments regarding the lack of details within the flow chart for METR, especially by NRAs and related platforms. NRAs stated that responsibilities are missing and that it is difficult to understand which activities are included in each part of the chart. The related platforms added that the content creators are not all displayed within the graphic and that complexity of a multi-actor-environment is not fully represented. However, since the visualisation of this complex process is quite difficult, we refer to chapter 5.3.5 where the most important actors for each phase are listed and also described in detail.

For *Phase 1: Content Creation*, almost 30% of the respondents show uncertainty or disagreement whether the first activity of defining the need for a traffic regulation is relevant for this core topic. An added comment suggests beginning the process with the definition and enactment of the traffic regulation, because the core topic itself starts, when the decision on the traffic regulation has already been taken (after the box "Regulation is triggered" in the flow chart). For the second activity within the first phase, NRAs stated that they are not the only responsible actors for distributing traffic regulations. While the analysis of the questionnaire clearly saw NRAs as the most important actors for this task, at least 50% of the participants saw Ministries as well as Road Operators, for example, as further possible actors. They were, therefore, included in the flow chart. NRAs also commented on the distribution of traffic regulation information in advance of their implementation and the distribution via open channels. However, the implication of a distribution via open channels would be that it does not have a binding character.

For *Phases 2 and 3*, there were no specific suggestions, so they were kept in the flow chart unaltered. However, in the overall evaluation, OEMs stated the possibility for all options to be implemented in parallel, which is important for the storyline and means that taking one option does not exclude implementing another option as well.

Comments for *Phase 4: Service Presentation* show that some respondents do not see a real end-user service in practice as the end-user is actually the automated vehicle. Moreover, there might be a risk of service abuse by citizens, which will undermine the objective of the core topic. These concerns are in line with a suggestion by NRAs that it would be better to only cover CCAV and not personal information devices.

One comment by a National Transport Authority suggested the inclusion of a feedback loop regarding the quality of the data from the service providers to the regulating authorities, which would fall into *Phase 5*. However, they also stated that this might not be possible with the amount of data that has to be verified and handled.

For the second activity in *Phase 6* Development of commonly agreed map matching procedures, a high uncertainty exists within all stakeholder groups as over 40% are unsure whether this is relevant for the core topic or not. There was only one comment that the model of TN-ITS implementation should be used for this action. Whether this activity should be removed or changed cannot be stated due to the lack of comments, but it is important to highlight that this needs to be looked at in more detail.

A (C)-ITS service provider added the provision of an infrastructure for a latency-critical information layer. Another respondent (Related Platform) commented that the Standardization/harmonization of access restriction schemas should be included. These additions would also fall under *Phase 6 Enabling and Regulation,* which is not visible in the flow chart, but the DIRIZON consortium will consider them for future steps.

Input from WP4 results is included

For the total chain secure communication and provision of trusted information is necessary!

DATA/CONTENT CREATION → CONTENT AGGREGATION → SERVICE INTEGRATION → SERVICE PRESENTATION

Alternatives/Recommended changes

Added Activity or Actor:

Activities that might be excluded:

Distribution via open channels

Trusted Electronic Regulation Access Point

Enrichment of data, Merging of content*

Regulation is triggered

Regulations from EC level

New national or regional framework conditions

Temporary traffic conditions ("not determined/ unforseen")

(Local) Planning Administrations, Road Operators, Other relevant bodies

Defining need for traffic regulation

Possible Actors e.g.:

Traffic Regulation Authorities

Road Operators

Ministries

Definition of regulation within their area of competence (long-term regulation or also temporary traffic regulations)

Enactment

Notification on implemen-tation

ETR (location referenced)

Option 2

Implementing Authorities
Road Operators, Administrative Bodies, Police, Contractors

Location referencing

Option 1
ETR (location referenced)

Option 3 (physical layer)

ITS Service Provider (incl. Map providers)

C-ITS service provider

NRAs in their role as a service provider or any contractor, other service provider (public or private)

information/ advice

Other ITS services

C-ITS services

Secure layer / „trusted communication"

Traffic order

Personal Information Devices

Traffic order (legally binding)

CCAV

Physical infrastructure service (display on VMS or physical sign)

Feedback Loop on Quality of data

CONTENT GENERATION ← DATA GENERATION

Legend

Activity: or

Connectivity: (cellular, ITS-G5):

Figure 62: Alternative Flow Chart of Core Topic 2 based on feedback from the participants of the questionnaire

7.3 Recommended changes of core topic 3 – Infrastructure support for Cooperative Automated Driving

On an overall level the process flow chart and the included storyline received a total rating of 7. This means that the respondents agree in wide parts with the presented storyline and the presented process for core topic 3. On the level of the different stakeholder groups we see that the opinion on the presented process is varying. Similarly to the last two use cases, after the discussion of additional comments concerning the process flow, adaptions were included into the original flow diagram for ISAD (see Figure 63).

Having a look on *Phase 1: Content Creation* the relevance of the National Access Point (NAP) is seen differently. Especially (C-)ITS service providers, Infrastructure equipment suppliers and Research/Scientific Institutions don't agree with the role of the NAP, whereas the other stakeholder groups almost absolutely agree with the need for the NAP. In addition, for Communication network providers it is unclear who is responsible for the NAP.

On an overall level it was mentioned that keeping the amount of data to the minimal is very important to allow the car to act quickly and accurately. Any additional non-vehicle related data will simply slow down the system and add noise within the vehicle architecture that may affect key safety related commands.

For *Phase 3: Service Integration* it should be highlighted that the participants suppose that different actors are responsible for the Integration of information in (C-)ITS services (incl. enrichment of data and merging with content) .Besides the proposed (C-)ITS service providers and HD map providers, Road Operators may play a role when it comes to service integration.

As already mentioned for core topic 1 Provision of HD Maps for Automated Driving the opinions differ in regards to the provision of information/advice via an end-user service and provision of information on a physical infrastructure (display on VMS or physical sign). Mainly Infrastructure equipment suppliers as well as national transport authorities had the feeling that these activities are not part of the core topic. Those (C)-ITS service providers and national transport authorities who do not see the need for these activities argued that the inclusion of personal devices makes it too complex and the core topic should focus on automation. One OEM stated that the system will be open to abuse when an end user service is involved.

The exchange of data via CCAV is essential. In addition, it was added that CCAV will use Multi-access edge computing (MEC) for augmenting their performance. It was highlighted that mobile network operators will play an essential role to enable access to MEC. In this context of CCAV one Public Road Operator assumes that the 'Extend ODD via Infrastructure Support' is an overall result of the whole graph, rather than just a square in the flow chart, therefore it was shifted to the whole service presentation phase.

Last but not least it was added that data sharing could work via OEM systems to make sure the vehicle is only sharing when it is safe to do so. Therefore commercial setup should be considered to make sure that safety issues can be minimized.

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Figure 63: Alternative Flow Chart of Core Topic 3 based on feedback from the participants of the questionnaire

7.4 Summary of recommended changes and next steps in DIRIZON

The purpose of this final chapter is to recapitulate the recommendations made in the previous sections and provide a preview of WP5 and WP6. This chapter should demonstrate to what extent the results of WP4 can be used in subsequent WPs of DIRIZON.

In summary, it can be highlighted that the processes of the three use cases described in the questionnaire was already well elaborated by the consortium, for details see deliverables of 2 and 3. The majority of the experts from different stakeholder groups agree in wide parts with the proposed phases and activities. Therefore it is a valid basis for the further development of the data exchange platform and related business models.

Nevertheless, the survey also provided suggestions for improvements in regards to the flow charts (see chapters 7.1, 7.2, 7.3). The overall evaluation of the process in addition to the comments is a very helpful input for the final fine-tuning of the use cases as a basis for the upcoming work packages.

It is particularly remarkable that some respondents commented that in contrary to the presented process roles are overlapping in reality. In this context it could be highlighted that the flow chart shows a functional decomposition, where it is quite possible that roles and functions can be aggregated. This fact that it shows a functional decomposition instead of a system architecture is also interesting when it comes to the relevance of TERAP and NAP. There was partly high insecurity in regards to the need of a TERAP and NAP, which may be related with their depiction in the flow chart. Although the NAP exists in reality, the NAP also serves as a functional concept for a data aggregator/distributer/broker within the use cases. This means that the function of a TERAP can be integrated anywhere, even in a NAP. The prerequisite is the integration into a network of trust. Although some respondents don't see a need of TERAP and NAP, the DIRIZON consortium would still recommend to keep them in the flow chart and as part of all three use cases.

Another interesting outcome considering the feedback of some experts is, that the provision of an end-user service should not be part of the use case. It was commented that the provision of ITS (end-user) services are added value services rather than core services. Moreover, there might be a risk of service abuse by citizens, which will undermine the objective of the core topic. These concerns are in line with a suggestion by NRAs that it would be better to only cover CCAV and not personal information devices.

The uncertainty regarding the feedback loops is high, which is especially interesting when considering that some groups support the idea of using NAP data, while they do not see the need in providing feedback to raise the data quality (e.g. Public Road Operators). Although different stakeholders are still uncertain whether the provision of feedback to road authorities is needed or not, DIRIZON would still recommend to keep feedback loops in place in order to improve service and data quality. It should also be remarked that from a business model perspective, that the complete value proposition as offered by the services together, might provide the incentive to also engage in data sharing. Therefore, it cannot be ignored.

Overall, these results are a good basis for the upcoming WPs in DIRIZON. These results are valuable input for WP5 concerning the different use case requirements and the related data streams to be focussed in order to derive appropriate data exchange options. In WP6, the DIRIZON consortium will develop scenarios that demonstrate how the service flows developed in the use cases are implemented on a European scale. There will be variants of the scenario that are "NRA-driven" (derived from the C-Roads example), "market-driven" (derived from the YourNow example) and "Hybrid" (derived from the MobiDS example). These scenarios will to a certain extent reflect the differences in opinions on roles and scope, as presented above. These scenarios will then be evaluated on defined criteria, in order to identify which approach provides which benefits.

Also the final WP7 of DIRIZON on step-by-step transition to full digitalisation of the road network will make use of what has been learned in WP4. The aim is to identify the sequence of steps the NRAs need to undertake to achieve digitalisation. This includes internal and organisational processes as well as stakeholder interaction needed. In this context WP4 results on roles and responsibilities will be considered.

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9 Annex
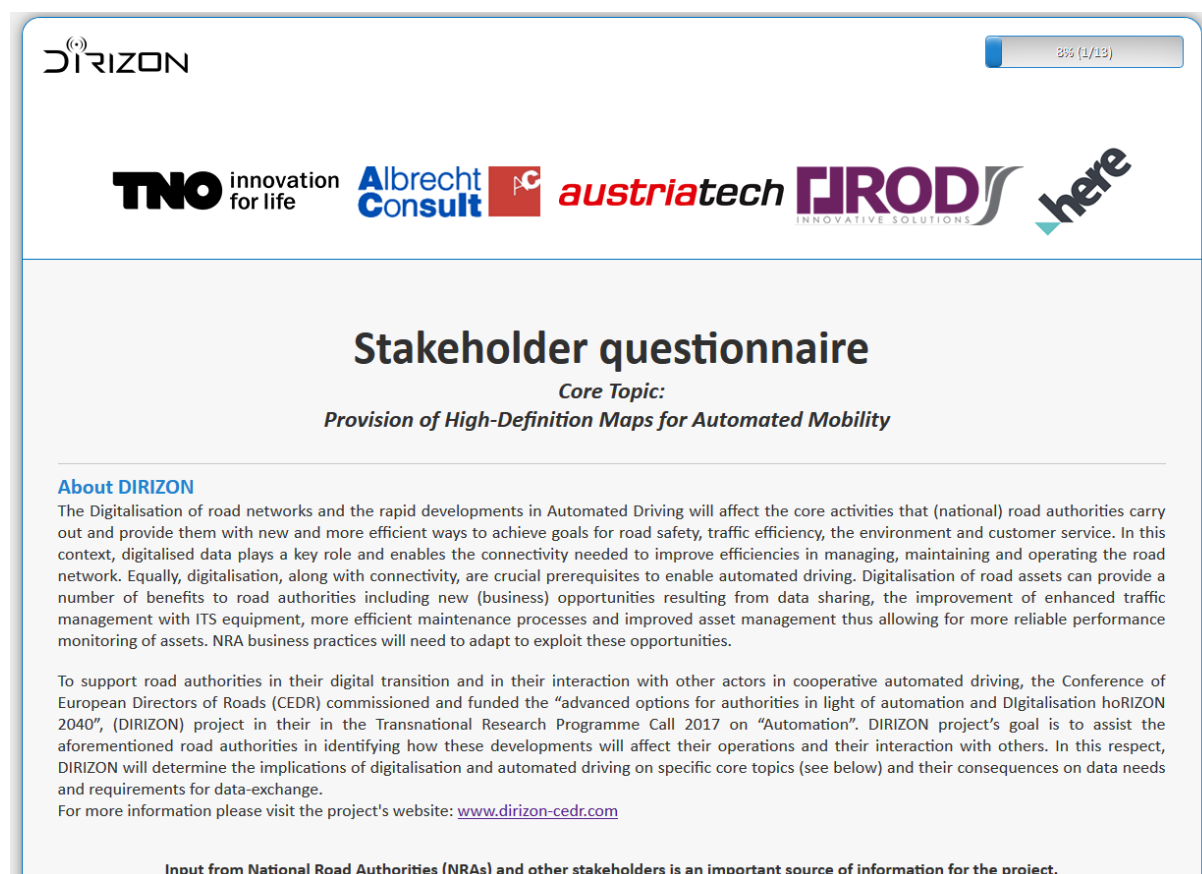
9.1 Annex 1: Exemplary implementation of the questionnaire

In this annex 1 some screenshots as exemplary implementation of the questionnaire should enable a better overview on the realisation of the web-questionnaire in the survey tool "LamaPoll".

After a short general introduction to the project the questionnaire was divided into seven main sections:

- **General Organisational Information on the respondent**
- **Description of the core topic incl. overview, process flow diagram, storyline**
- **Evaluation of activities and actors for each phases in the process flow**
- **Evaluation and feedback on data and data provision**
- **Risks and challenges & Opportunities and benefits for the core topic**
- **Overall evaluation of the process flow and storylines as basis for the reflected process**
- **Contact data / request for further information on the project**

9.1.1 Exemplary implementation of the questionnaire: Overview

Figure 64: Screenshot web-questionnaire introduction

After the short introduction (see Figure 64) the questionnaire starts with the organisational information part. Each respondent had to specify some general organisational information including country, type and size of the organisation. **This section is a crucial basis for the further analysis as it enables dividing the responses into different stakeholder groups and challenging the different views.**

Therefore this was the ONLY OBLIGATORY section in the whole questionnaire, to foster a response process that is as simple as possible.

Figure 65: Section 1 web-questionnaire

9.1.2 Core topic overview

The upcoming section is already dedicated to the respective core topic.
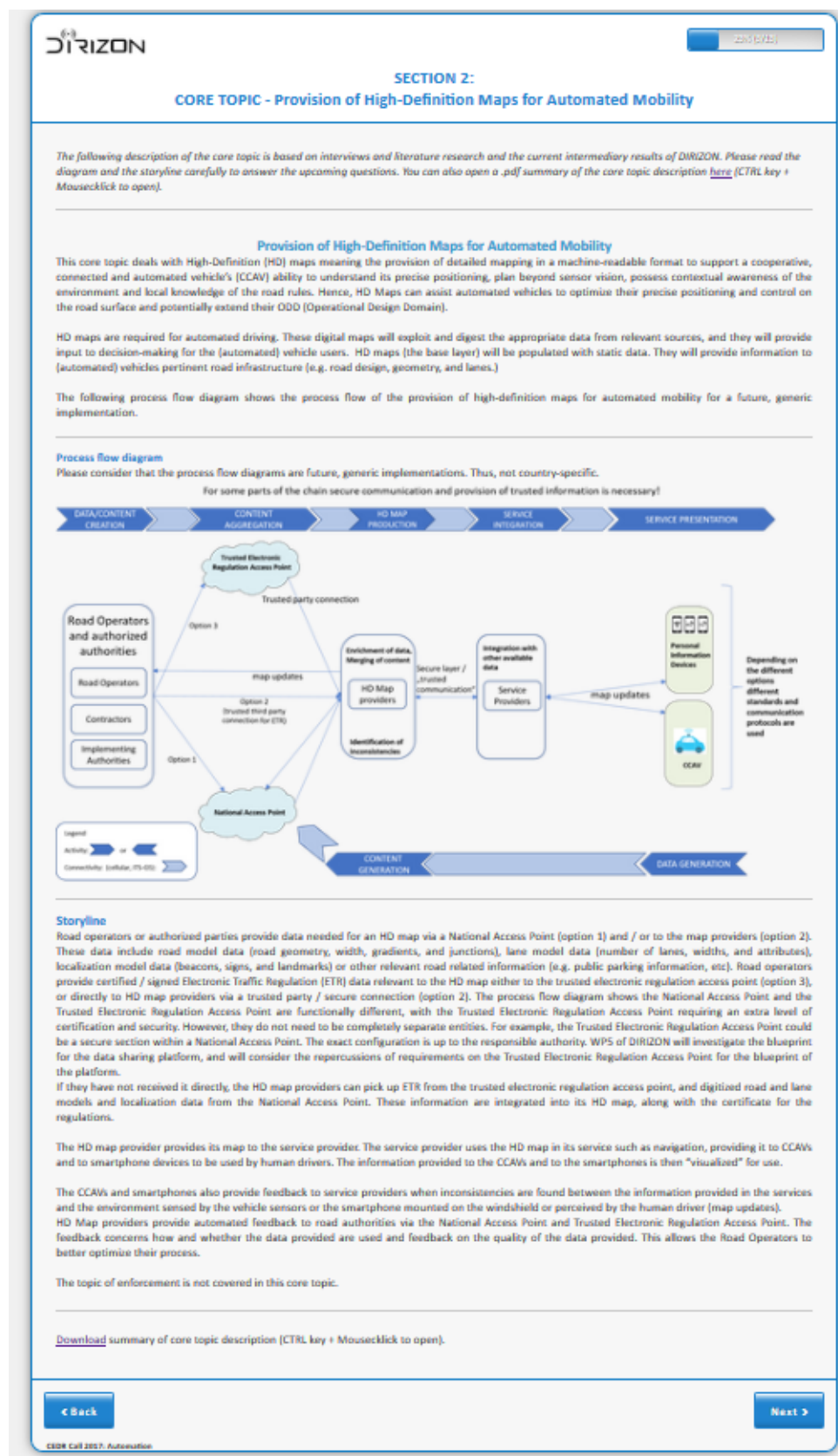
Figure 66: Overview of core topic

Each core topic included a short overview on the topic, a process flow diagram, which are future, generic and therefore not country-specific implementations, as well as a more detailed storyline, which was the basis for the evaluation. This was also **available as download** (on this page AND on EACH of the following pages) to ease the process of answering the questions.

Figure 67: Example download version of core topic description

9.1.3 Evaluation of Actors and Activities

In the next section the focus was on an important part of the questionnaire: The evaluation of main activities and actors related to the core topic.

Figure 68: Evaluation of activities and the fulfilling actors

The respondents were asked to evaluate the proposals on activities and actors involved given in the questionnaire (based on process flow and storyline):

• *Please check for each activity if you would agree that this is relevant within the core topic or not **(Single Choice Question).***
• *Please check if you agree with the proposed actor that can fulfil this activity **(Multiple Choice Question)**. If not, please add a comment.*
• *Please indicate if you your organisation is or could be an actor to fulfil this activity.*

Figure 69: Detailed example for evaluation of actors and activities

The questionnaire was structured according to the phases included in the process flow diagram which should make it easier for the respondents.
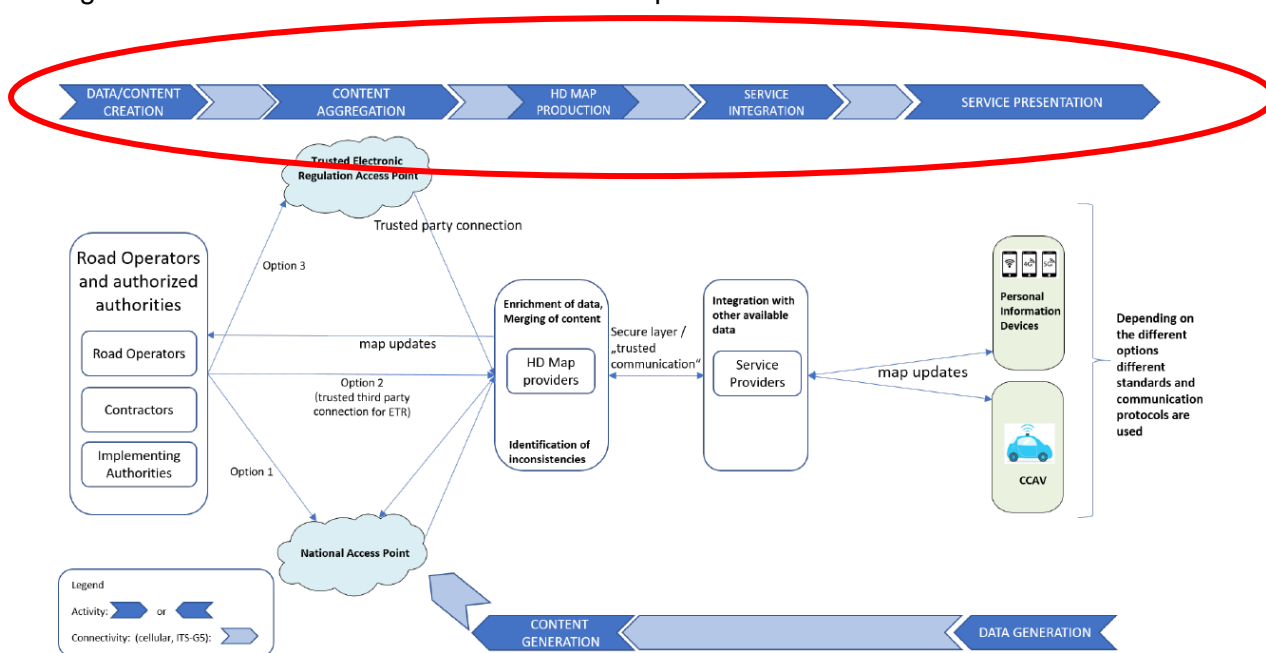
Figure 70: Example for Phases included in process flow diagram

Participants had also the possibility to include any missing actors or activities.

At the end of the section the consortium decided to introduce cross-border aspects and evaluate respective changes related to this.

How will it affect your answers if the end-user/vehicle uses the same service in another country? Will there be any changes e.g. regarding the activities or the related actors?

- ○ No changes
- ✔ Minor changes
- ○ Moderate changes
- ○ Significant changes

Please describe the changes briefly:
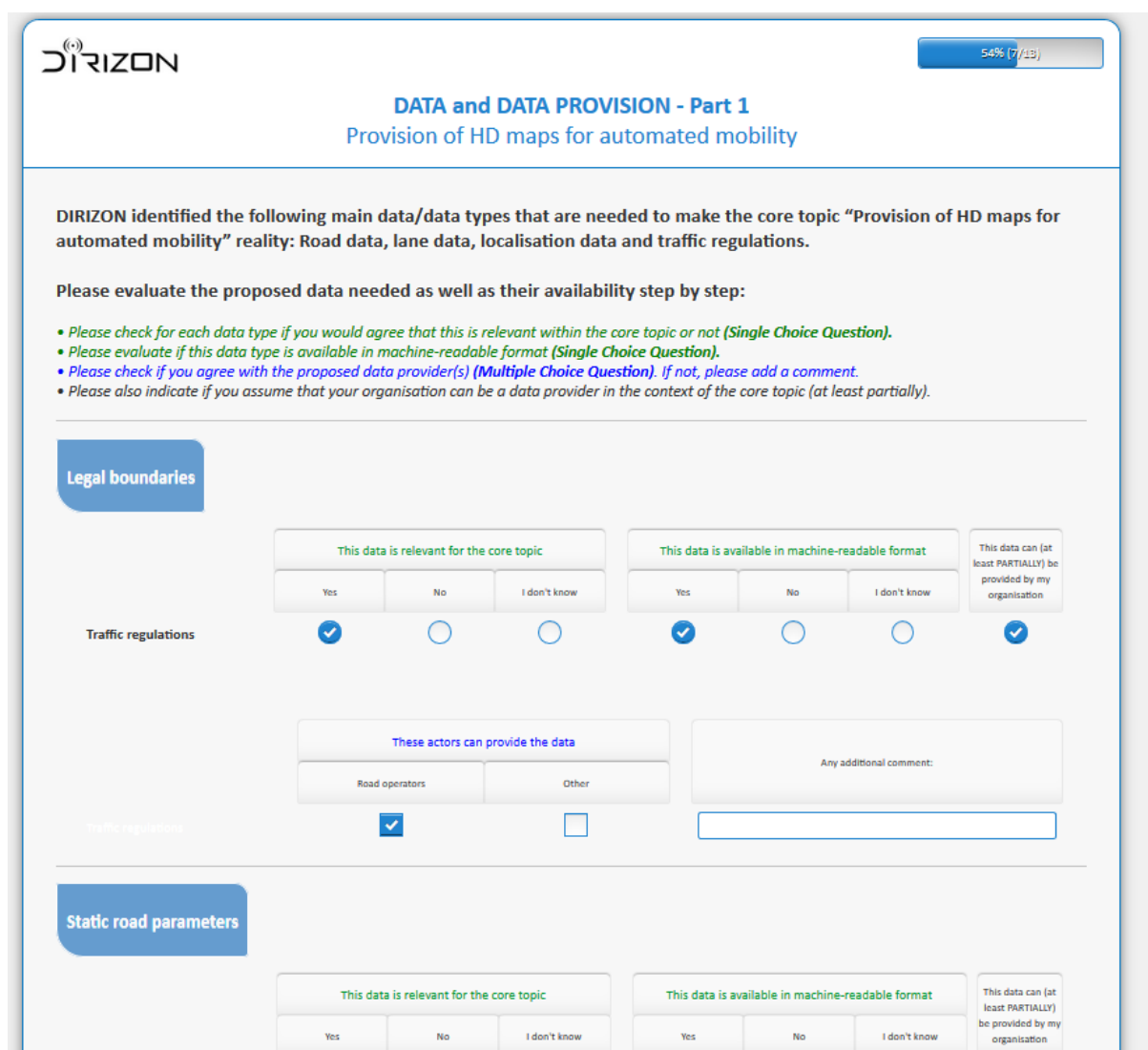
Comments / Critics / Suggestions ...

Figure 71: Evaluation of changes related to cross-border aspects

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9.1.4 Evaluation of data and data provision aspects

The second major aspect in the collection of data was to identify the data needed to provide the services represented by the core topics. The respondents should answer whether data standards exist for these data types and whether they are sufficient for the described services and what quality levels would be required. Based on the work done in WP3 (setting up a list of relevant data), participants were asked to evaluate the data in relation to the core topic and indicate the availability of the data in general and in machine-readable format. Some open questions left space for comments and thoughts on the use cases and further implications not covered yet. There was also the option to skip sections in the questionnaire if necessary.

The structure in this section followed the same principles as in the previous section on actors and activities. The data types were following the flow process provided in WP3. Similar to the previous section the respondents had the opportunity to add any missing data types.

Figure 72: Section on data and data availability

Again, changes related to cross-border aspects were collected.

Figure 73: Cross-border aspects related to data availability

As access conditions play an important role in the context of DIRIZON, the consortium introduced a subsection on access conditions.

For those data types that can potentially be provided by the respondents' organisation (selected before), respondents were invited to give additional information on the use and access conditions.

Access conditions for data:

For those data (types) that will be provided by your organisation (*selected before in the table "DATA and DATA Provision Part 1/2"*) please indicate:

- **use conditions** for the provision of the data (e.g. open or restricted, free or charge or subject to any fees like marginal costs, full costs, etc),
- **access options** either from
    - technical point of view (e.g. provision of raw data, provision via interface, provision via any type service) or from an
    - organisational point of view (e.g. through the National Access Point).

	Can this data be shared?		
	Yes	Conditionally	No
Traffic regulation	○	●	○

Traffic Regulation - Description of potential use and access conditions and used data format

Please describe the potential use and access conditions and the used data format.

	Can this data be shared?		
	Yes	Conditionally	No
Road model incl. road geometry, road width, gradients, junctions	○	○	●

Do you have any sample contracts regarding use and access conditions?

● Yes   ○ No

Are you willing to share them with DIRIZON?

● Yes   ○ No

Thank you for your willingness to share them!

Please upload the document(s) here (CTRL key + mouseclick to open) OR leave your contact details so that we can get in touch with you:

E-Mail	Click here to fill in
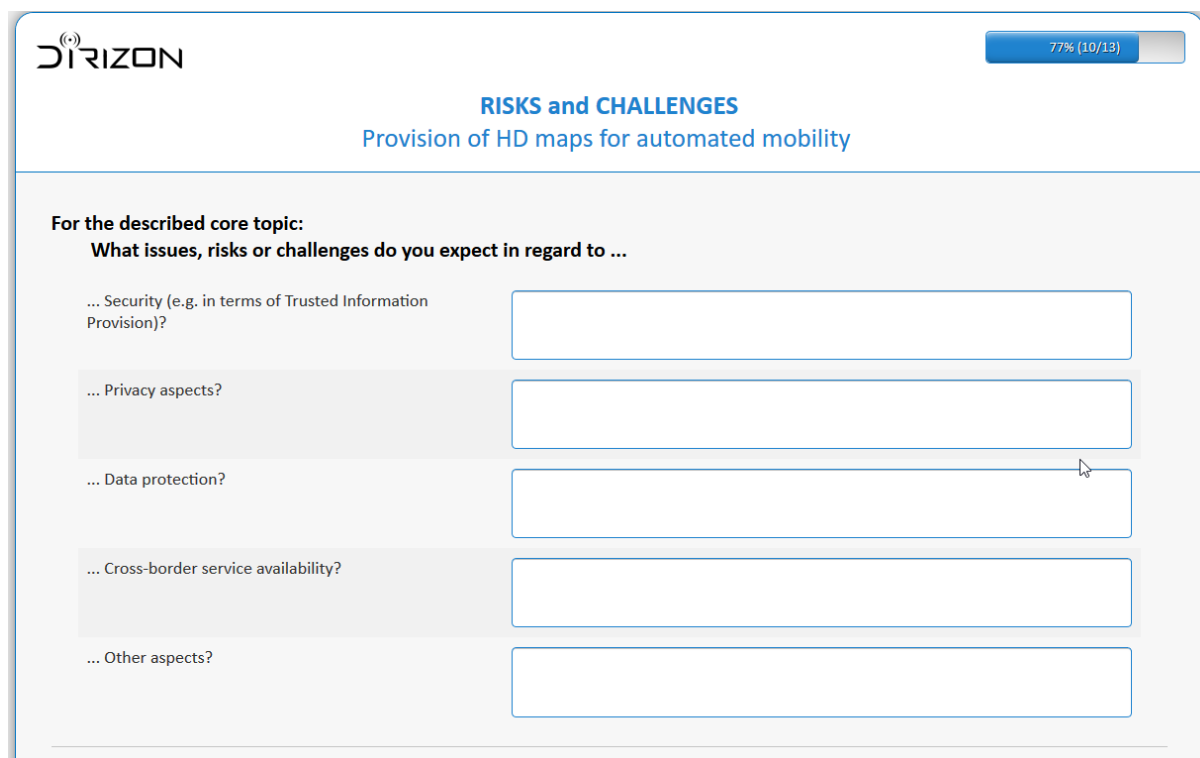
Figure 74: Subsection on access conditions

Where possible, DIRIZON tried to collect sample contracts. The tool offered the possibility to either upload the available samples or to fill in the e-mail address, so the DIRIZON consortium can get in contact with them directly outside the questionnaire.

9.1.5 Risks, Challenges, Benefits and Opportunities

Following, respondents had the possibility to comment on potential risks and challenges they expect in the respective core topic, e.g. in the area of security, privacy, data protection, cross-border service availability, etc. This was concluded by the possibility to include potential expected opportunities.
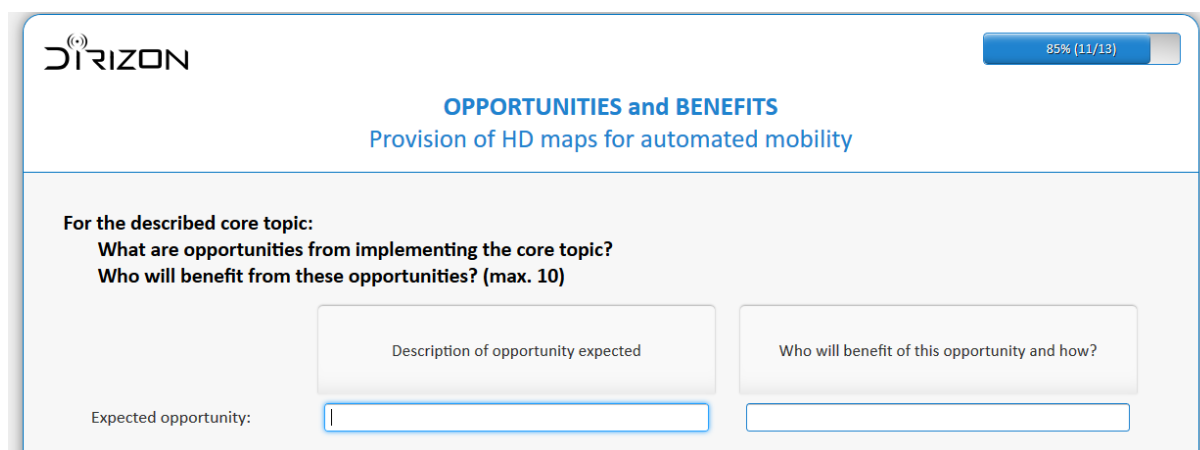
Figure 75: Risks and challenges section
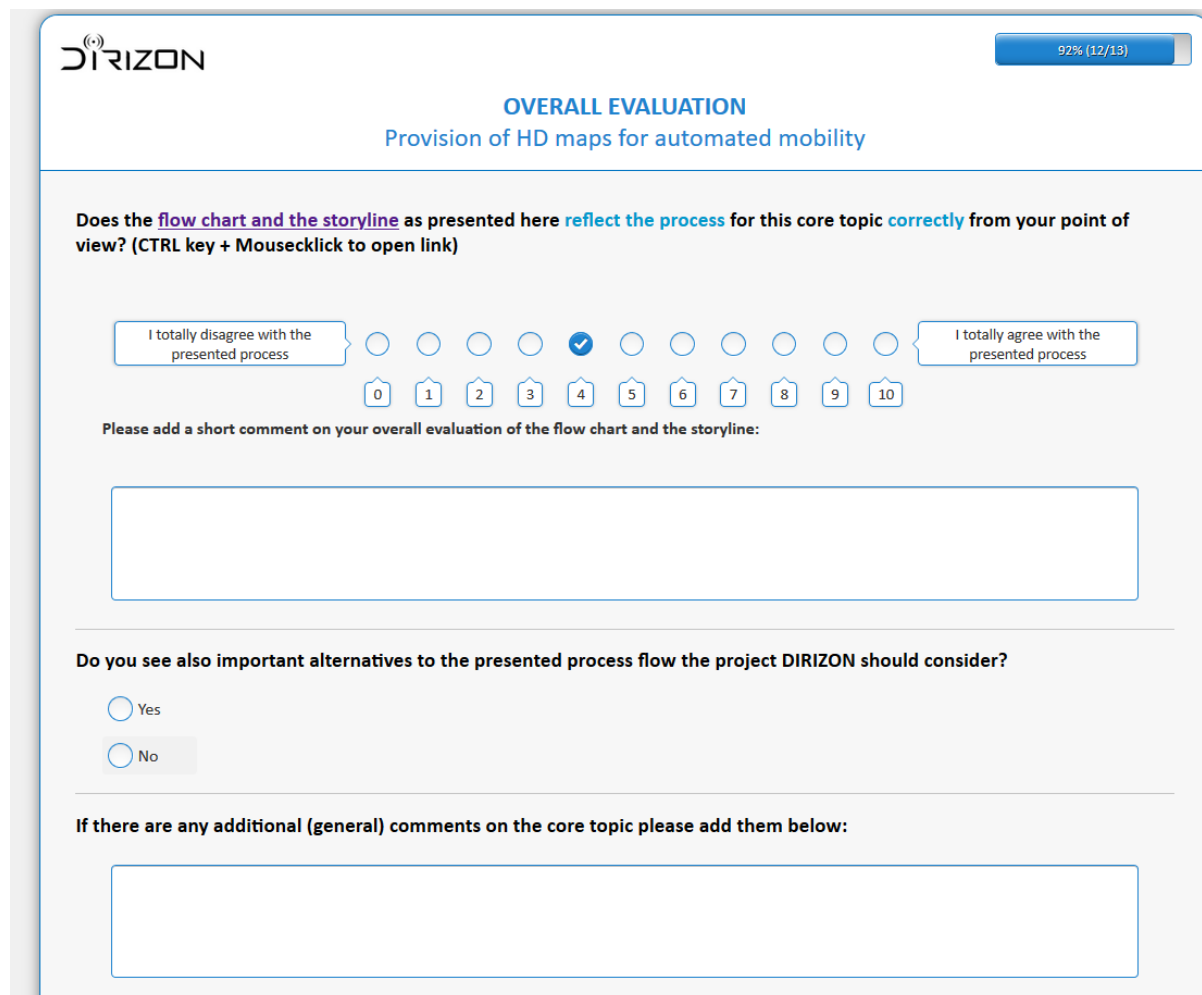
Figure 76: Section for expected opportunities

9.1.6   Overall evaluation and request for further information from DIRIZON
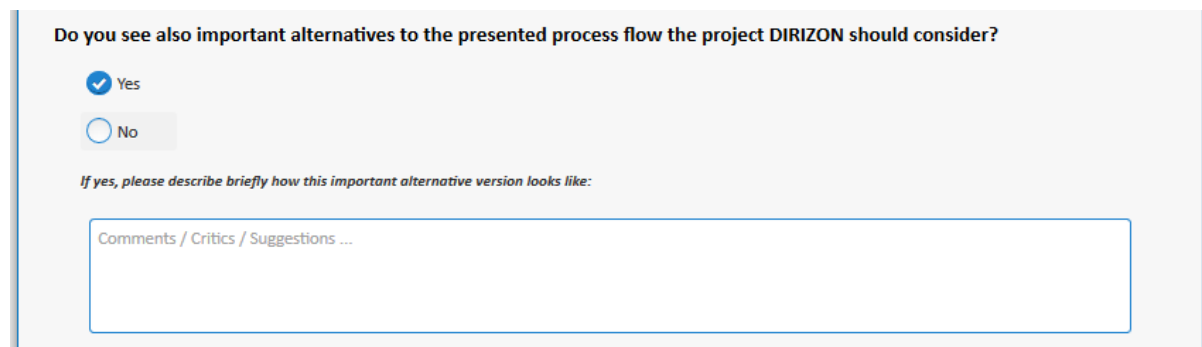
Last but not least, respondents were invited to give an overall estimation of how well the process described by the DIRIZON consortium reflects the process from their point of view. A simple scale with additional comments made this quite easy for the respondents.

Figure 77: Overall evaluation of the process presented

Respondents had the opportunity to give a comment on important alternatives to the process flow as presented by the DIRIZON consortium, which opened up a free text in case (which has been used more often throughout the whole questionnaire).
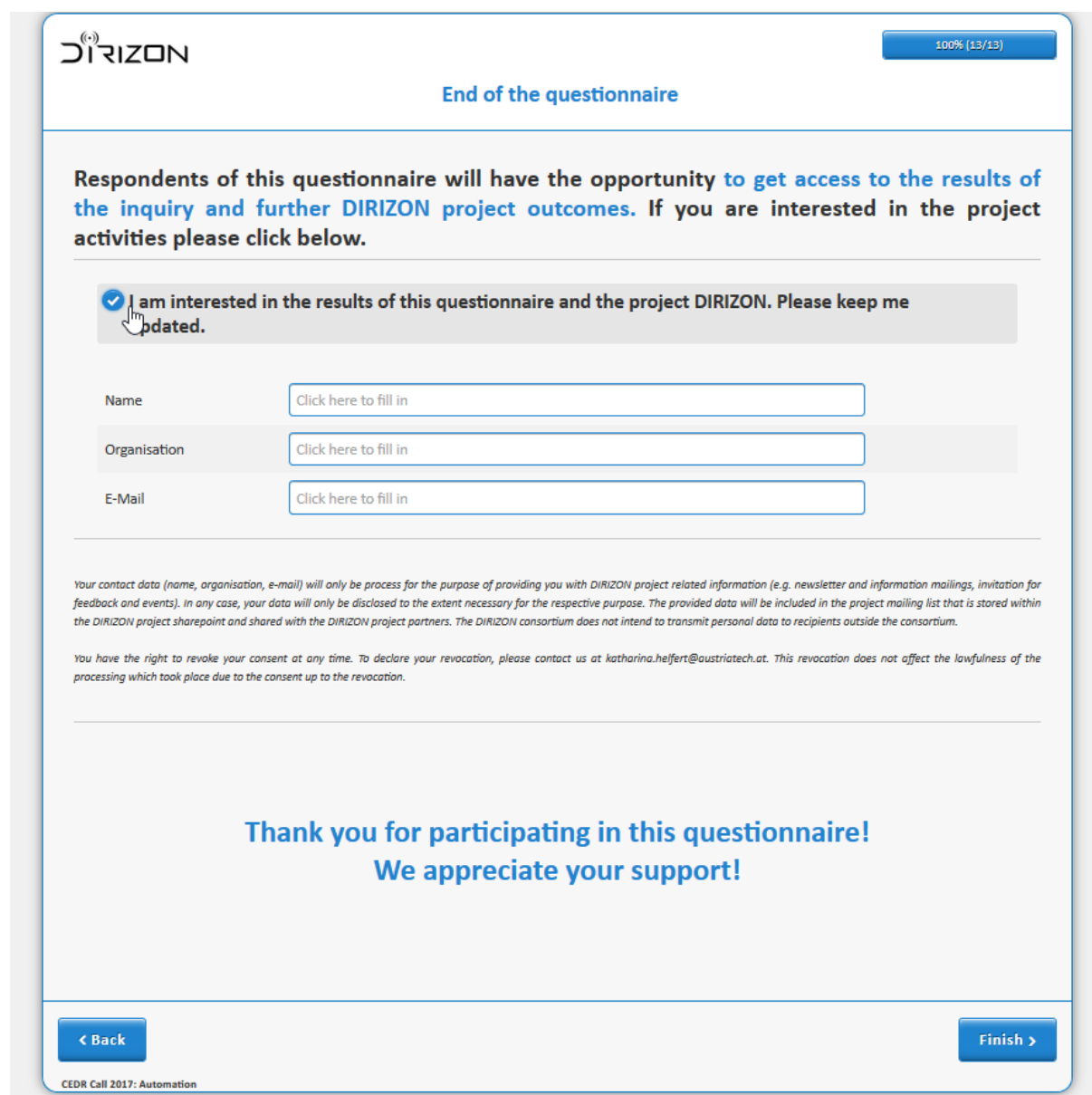
Figure 78: Additional alternatives with pop-up free text field possible

Finally, respondents could leave their contact data, if they were interested in the further DIRIZON results.

Figure 79: Contact section

As mentioned before, the only obligatory section was the „organisation information", as this was crucial to assign the responses given to the different stakeholder groups.