GECKO

GOVERNANCE FOR NEW MOBILITY SOLUTIONS

GECKO Impact Assessment

DEFINING METRICS AND UNDERTAKING IMPACT ASSESSMENT

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LIST OF ACRONYMS

AHP – Analytic Hierarchy Process

CAV – Connected and Automated Vehicles

EV – Electric Vehicles

ICT – Information Communications Technology

KPI – Key Performance Indicators

MaaS – Mobility as a Service

MCA – Multi-criteria Analysis

OECD – Organisation for Economic Co-operation and Development

WEF – World Economic Forum

IPD – Institutional Profiles Database

TM2.0 – Traffic Management 2.0

TNC – Transportation Network Companies

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1. EXECUTIVE SUMMARY

The main objective of this document is to illustrate the methodology and actions undertaken for the impact assessment of different regulatory frameworks, following the process carried out to assign values and weights to the Key Performance Indicators (KPIs, already identified in Task 3.1) and to perform an overall evaluation through the Multi-Criteria Analysis (MCA) according to the following evaluation criteria:

- Infrastructure
- Political
- Data
- User/consumer awareness and acceptance
- Safety
- Balance between pilots or contracts requirements and achievement of relevant results or sustainability of business models
- Environment
- Social
- Cooperation
- Other

Results of the MCA will be meaningful for representing to what extent the regulatory frameworks will enable the societal, environmental and economic impacts achievable through the implementation of newly emerging disruptive innovations, while at the same time safeguarding adequate level of security, safety, data privacy, and social protection.

The values and weights assessment of KPIs has been performed in cooperation with three main overarching categories of external stakeholders involved in WP3, namely:

1. Policy makers at all levels from local to supra-national;
2. Professionals with a direct business interest in new mobility solutions, who would be directly affected by any new policies or guidelines that will be enacted;
3. Researchers, lobbyists, NGOs and others subjects that have a particular interest in new mobility solutions, other than business-related.

Furthermore, stakeholders have been engaged according to their particular interest or experience with respect to each mobility solution to gain their qualified opinion on challenges, constraints and expectations about not only existing regulatory frameworks but also the foundational principles of future regulations and policies making processes (see WP5 for more details).

The document is structured as follows:

- in chapter 1 metrics for Impact assessment are introduced, providing formal definition of KPIs, the methodology of their association to each regulation and the selected KPIs per mobility case study;
- in chapter 2 the Multi-Criteria Analysis is presented, describing the logical approach for identifying the elements considered for the evaluation and the actions undertaken for their assessment.
- In chapter 3 the main conclusions have been derived.

Following, the overall workflow is illustrated.

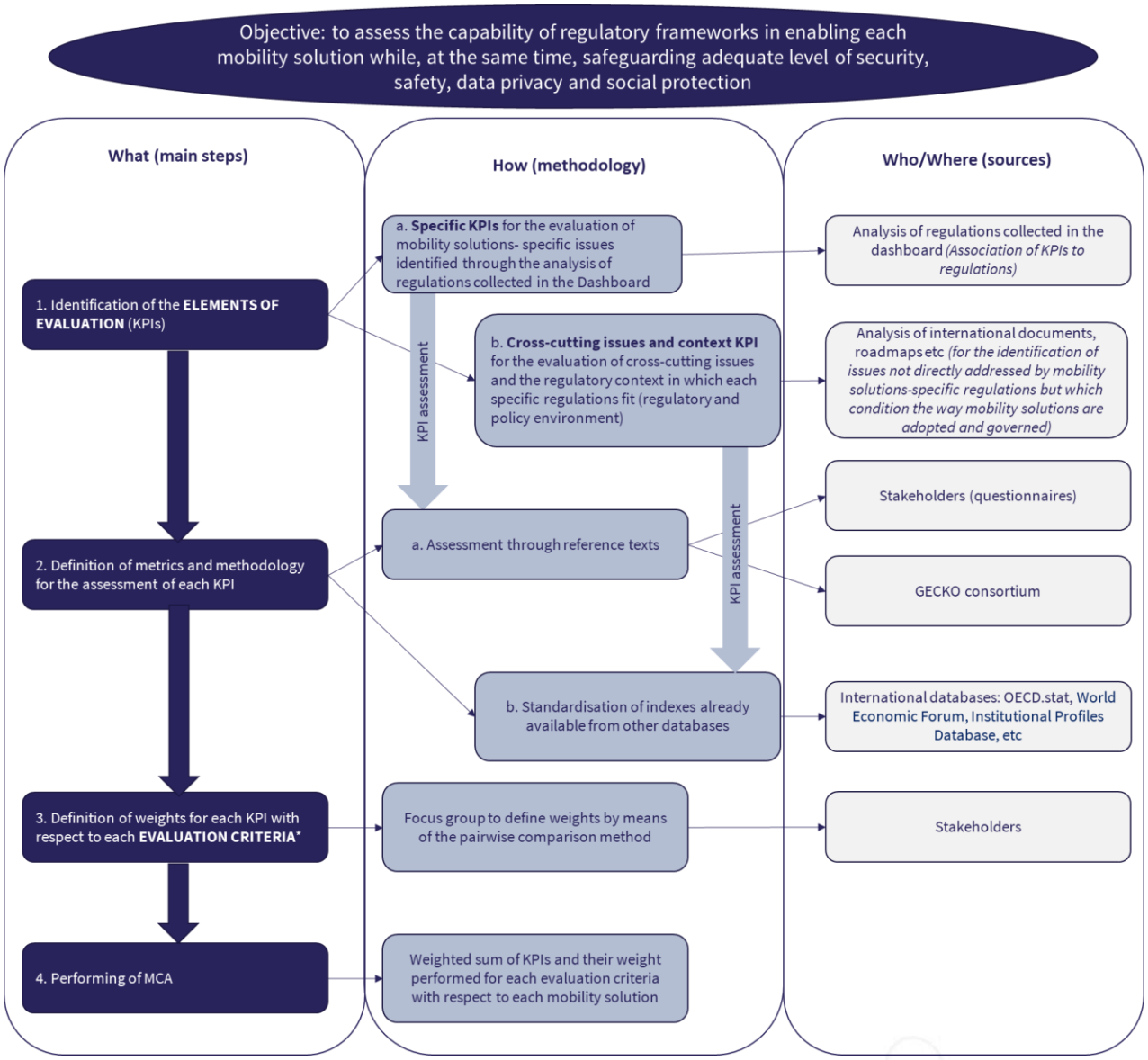


Figure 1 T3.2 Overall workflow

2. INTRODUCTION

GECKO (Governance principles and mEthods enabling deCision maKers to manage and regulate the changing mObility systems) aims at supporting authorities with tools and recommendations in order to create a new regulatory framework, suitable for the transition to a new mobility era.

To achieve this objective, an important activity carried out is the definition of a method to assess the impacts generated by regulatory schemes toward the implementation of disruptive mobility solutions.

To this end, an impact assessment methodology was designed in T3.1, with the choice of the relevant parameters or Key Performance Indicators (KPI), criteria of success for the implementation of regulations.
This process continued in Task 3.2 with the definition of metrics and the related impact assessment carried out and reported in the present deliverable.

3. DEFINITION OF IMPACT ASSESSMENT METRICS

3.1 KPIs in GECKO

KPIs are indicators that generally quantify the performance of a service with respect to the set objectives. Therefore, KPIs are mostly expressed in quantitative terms and derived from direct on-field measurements of significant parameters to describe the performance of the service.

In GECKO KPIs are not used to evaluate transport services but the capability of the regulatory schemes to measure their effectiveness in relation to the capability to enable the uptake of innovative transport services and innovations (in the project called mobility solutions) while at the same time safeguarding adequate level of security, safety, data privacy, and social protection. This methodology was chosen also in consideration of the fact that the mobility solutions analysed in WP3 (derived from WP1) have a highly innovative character and different TRLs and different market readiness: in some cases, they have not been implemented yet and are still at an embryonic level or even under study (e.g. Hyperloop), while in others are already widespread in the market (e.g. Bikesharing)
Furthermore, Ex-Post indicators that provide insights on the state of transport services and their performances are not only influenced by the regulatory framework: economic, cultural, structural, political, geographical and other factors may intervene. Measuring outputs of regulatory schemes would not adequately capture the preferences of different policy makers for one or another instrument. For example, for mitigating greenhouse gas transport emissions, a local authority may limit the access of vehicles below a set standard emission level, another imposes road charging, a third implements information campaigns or subsidizes climate-friendly mobility solutions. In each of these cases, the expected impact will be reducing transport emissions of GHGs. The indicator is influenced, however, by the industrial structure, natural conditions, level of income and other factors that are not, or not directly, impacted by regulatory schemes.

For this reason in this project KPIs have been mainly outlined as qualitative assessment of a sufficient number of stakeholders through an appropriate adaptation of the Likert scale.

The Likert scale is a psychometric measurement technique invented by psychologist Rensis Likert. This technique is mainly distinguished by the possibility of applying methods of item analysis based on the statistical properties of measuring scales at intervals or ratios. Likert's method is still adopted by many areas of applied research. This technique mainly consists of developing several statements - called items. Respondents are asked to indicate their degree of agreement or disagreement with the statement.

3.2 Association of KPIs to regulations

GECKO consortium performed the association of one or more KPIs to each regulation collected in the dashboard. To follow a common approach for identifying the regulation objectives and strategy (measures, requirements etc.) that allows such an objective to be achieved the main steps followed have been:

STEP 0.1: **Understanding the requirements of the KPIs**
Indicators can be considered as a set of information with the characteristic of being explanatory, synthetic - as expressed by a simple or compound variable -, meaningful - accurately representing the phenomenon under analysis - and essential - enclosing the substantial indications of the aspect considered.
Fundamental requirements of the indicators are:

- **Relevance**: each indicator must be an assessment criterion, to have a significant importance for the evaluation process for the selected event to be quantified/assessed.
- **Completeness**: the set of indicators must consider all aspects of the system/concept under evaluation.
- **Availability**: check if the indicator is existing on the ground and can be retrieved.
- **Measurability**: the identified indicators are structured in their definition/formula and can be measured objectively or subjectively.
- **Reliability**: indicators must be clear in their definition, easy to be aggregated and their measurements accurate.
- **Familiarity**: the indicators must be intuitive and easy to understand.
- **Non-redundancy**: indicators should not measure the same aspect of other indicators.
- **Independence**: small changes in the measurements of an indicator should not impact preferences assigned to other indicators of the evaluation framework.

STEP 0.2: **Understanding how KPIs are organized and structured**

- The implementation of emerging and disruptive technologies in passenger and freight mobility depends on the pursuit of different categories of objectives, addressed by the various regulations (Institutional, Legal, Political, Economic, Social, Safety, Security, Environmental, Data Management, Technological, Infrastructures). These categories of objectives constitute the first hierarchical level of identification of the KPIs and are called "**category**". Each category of objectives is in turn divided into several specific objectives, identifiable within the regulation, and which are called **sub-category**. The effectiveness with which each sub-category (or specific objective) is addressed by the regulation is directly measured by one or more KPIs. It should also be specified that some sub-categories (and related KPIs) may refer to more than one category: e.g. Liberalization of the market is both a political and an economic aspect, therefore the relative KPIs can be retrieved by selecting from the dashboard either category "political" or "economic".

STEP 1: **Identifying the purpose of the regulation.**
Why has a certain regulation been enacted?

Generally, the purpose of the regulation is contained in the title itself or in the introductory paragraphs (Context, Scope etc). Understanding the purpose of the regulation and reading the introductory paragraphs can be useful especially if the subject of the regulation is not well managed by the reader (for example, it can be useful to read the definitions provided at the beginning of the document).

EXAMPLE:

- Purpose→*The deployment and operational use of cooperative intelligent transport systems*. From reading the policy context we learn what V2V, V2I and V2X communications are, but also what the potential negative and positive effects of the adoption of C-ITS can be:

"*New technologies aimed at improving the efficiency, safety and environmental performance of road transport are playing a significant role in achieving the Commission's goals in this area. One emerging field is that of cooperative intelligent transport systems (C-ITS), which enable vehicles to interact directly with each other and the surrounding road infrastructure. In road transport, C-ITS typically involves vehicle-to-vehicle (V2V), vehicle to-infrastructure (V2I) and/or infrastructure-to-infrastructure (I2I) communication, and communication between vehicles and pedestrians or cyclists ('vehicle-to-everything', V2X). This enables a wide range of information and cooperation services"; "The benefits of C-ITS span a range of areas and include better road safety, less congestion, greater transport efficiency, mobility and service reliability, reduced energy use, fewer negative environmental impacts, and support for economic development"*

STEP 2: Identifying the objectives of the regulation.

A first approach to identify regulatory objectives has been to analyse the table of contents (or article titles). The first aim was to understand what are the aspects that the regulation wants to regulate to pursue the purpose. Generally, it was possible to place each specific objective within some of the KPIs categories or find it directly among the sub-categories.

EXAMPLE:
Objective→Interoperability
From article 1 we read: *"This Regulation establishes specifications necessary to ensure compatibility, **interoperability** and continuity in the deployment and operational use of Union-wide C-ITS services based on trusted and secure communication"*

STEP 3: identifying requirements, measures and aspects that allow the objective to be achieved (and its success factors measured through KPIs) from each different point of view (safety, economic, organizational…)

Generally, to assess a KPI it is not enough to identify the regulation main objective. For the stakeholder to attribute a value to the KPI, such a regulation should make explicit requirements, measures or aspects allowing the objective to be achieved. Only in this case the KPI can be assigned.

EXAMPLE1:

- Objective→Interoperability
  *"This Regulation establishes specifications necessary to ensure compatibility, **interoperability** and continuity in the deployment and operational use of Union-wide C-ITS services based on trusted and secure communication"*
- Requirements/measures/aspects that allow the objective to be achieved→

"The practical implementation of the hybrid communication approach, combined with the need to ensure the interoperability and continuity of services, imposes certain technological choices. These are reflected in a minimum set of functional and technical requirements for the interoperable exchange of messages between C-ITS stations. As this should not hinder further innovation, this Regulation ensures that future technologies can be integrated in the 'hybrid communication' mix"

EXAMPLE 2:

- Objective→Congestion (reduction of)
  *"The benefits of C-ITS span a range of areas and include better road safety, **less congestion**, greater transport efficiency, mobility and service reliability, reduced energy use, fewer negative environmental impacts, and support for economic development"*
- Requirements/measures/aspects that allow the objective to be achieved→
  Not further specified
  →therefore, the KPI "congestion" should not be attributed.

Step 4: reporting the reference text in the dashboard

The final step has been to report the reference text in the dashboard. As agreed within the consortium, the reference text is an abstract from an article of the regulation or a summary of it that immediately makes the stakeholder aware about the strategy adopted by the regulation.
Considering the significant heterogeneity of the regulations analysed, the selection of the reference texts and their requirements have followed an iterative definition process.
The reference text is what stakeholders will assess through the KPI quantification (for example, if the objective is to ensure the safe circulation of e-scooters, the strategy adopted by some cities is to allow circulation only on cycle paths, while others simply make the helmet mandatory or limit its speed).

In conclusion, what has been done is a text analysis performed through a discretization that allowed the most relevant aspects of each regulation to come up. A KPI has been associated with each of these parts of the text.
The assessment of the excerpt or summary (i.e. the reference text) by stakeholders through the Likert scale is the value of the KPI.

3.2.1 KPI selection analysis

After the association of one or more KPIs to each regulation, an analysis on the selected KPIs has been performed, providing an overview on aspects addressed by the collected regulations and issues which regulations focus more on.
In this sense, the KPI selection analysis provides an insight on **what is currently regulated** for each case study identified in the WP1.

3.2.2 Pre-workshop questionnaires and documents analysis

Several weeks before the workshop, questionnaires were sent to stakeholders considering their competences and skills. For each mobility solution and for each KPI, stakeholders were asked to assess how important it is the inclusion of each indicator **in an ideal regulatory framework** (see D5.3 for more details). This has made it possible to gain an overview of the aspects that regulatory frameworks **should address** and therefore the areas on which they should be assessed.
Further investigation of the aspects that regulatory frameworks should address has been conducted through the analysis of studies, news, papers, roadmaps, and guidelines (giving priority to those of international relevance).

4. MULTI-CRITERIA ANALYSIS (MCA)

This chapter briefly analyses the different MCA techniques and proposes the most effective one selected for GECKO's purposes.[1]
In order to figure out the most suitable technique in GECKO framework, a brief introduction about MCA is presented.

Multi Criteria Analysis (MCA) is an evaluation technique which allows the decision makers to make rational choices taking in account different criteria (economic/monetizable criteria, non-economic criteria measurable in physical or qualitative terms) sorted according with their priorities. Therefore, **MCA considers different aspects of a problem, both qualitative and quantitative, and offers a systematic methodology of choice**.

In MCA all the information, consequences and perspectives are considered in the decisional process to achieve a unique possible choice which optimizes the fulfilment of the established criteria. The evaluation is formed by two different but complementary processes:

- **Individuation of the alternatives** with relevant objectivity;
- **Estimation and sorting of the different alternatives**.

Therefore, **MCA aims to obtain satisfactory and justified choices**. The evaluation can be represented by an evaluative function:

$$V = f(O, C, A)$$

The evaluation results (V) depend on objectives (O), criteria (C) and alternatives (A).

Specifically, the decisional process of MCA consists of several phases:

- **Definition of the problem and individualization of the decision makers**: the aim is focusing on the main problem to solve, consequently the individuation of the main goal to achieve, and to identify all the decision makers to involve (relevant decision makers and non-institutional stakeholders);
- **Identification of the alternatives:** alternatives define the framework of the decision, that is the subject of decision makers choice. Alternatives must be feasible, ordered, numerable and they can include more actions or solutions which are not in conflict each other;
- **Identification of the criteria:** criteria represent all the variables that can cause conflicts in the value judgements and the goals pursued by the decision makers and they allow to measure the goals and to compare them with the alternatives. To construct criteria three characteristics must be defined: semantic (meaning of the specific criteria), metric (measurement mode of the criteria) and the response function (the arbitrary objective with which the criteria can allow to prefer an alternative respect to another). Criteria must

[1] http://eprints.lse.ac.uk/12761/1/Multi-criteria_Analysis.pdf

be independent and include all the decisive aspects of the choice. Furthermore, the criteria set used in an evaluation must be exhaustive and non-redundant. They can be divided in sub-criteria and they can be expressed by qualitative and quantitative indicators;

- **Construction of the Evaluation Matrix:** starting from the phases just discussed it is possible to elaborate the evaluation matrix, that is a scheme that contains all the necessary elements to decide in the MCA. The figure below shows the relations among the different elements. The core of the matrix are the values, which represent the value of the alternative *i* respect to the indicator *j*. Each decision maker has a subjective evaluation matrix. Another important element is the weights vector, which represents the preference of the decision makers in numerical terms;

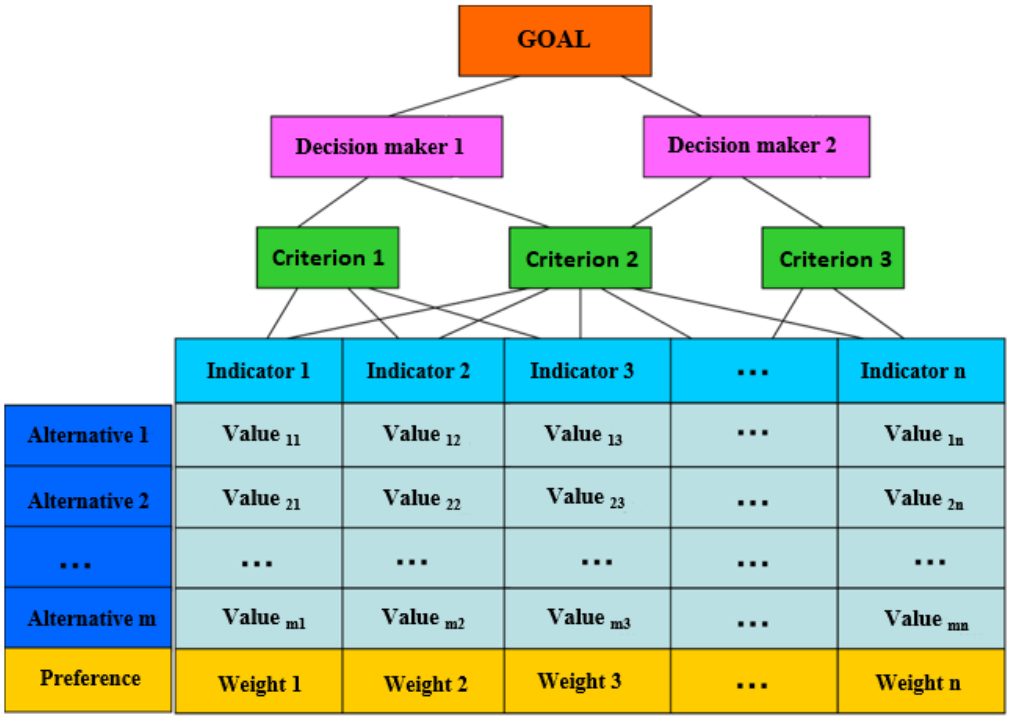


Figure 2 MCA Evaluation Matrix showing relations among different elements

- **Standardization:** it is necessary to use the same numerical scale to make all the evaluations expressed by the alternatives compatible for different criteria. The most common method used is the **division for the maximum value**, which allows to obtain a vector formed by elements with value between 0 and 1;
- **Ponderation:** it is the definition of the preferences. Since it represents the estimation of the weights, that is the importance assigned by the decision maker to every evaluation parameter, this is the most important phase of MCA. This evaluation can be done with an indirect estimation method (ponderation based on past choices of the decision makers) or with direct estimation methods (trade-off, ranking, rating);
- **Calculation:** it is the practical part that follows the ponderation. In order to be effective, the correct weights set must be figured out by the evaluator.

- **Sensitivity analysis:** it is the last phase, used to solve the problems founded in the ponderation. The sensitivity analysis is an iterative verification, done together with the decision maker, to assess the validity of ponderation. This process allows the decision makers to explain in a scientific mode the formation of the preferences.

Despite it cannot replace the monetary methods, MCA can strengthen the potential of the evaluation methods of infrastructure projects if correctly used. To summarize**, the positive aspects of MCA are**:

- Allow to compare, classify and cluster different project solutions;
- Allow the evaluation without the need to monetize the impacts;
- **Allow a continuous and dense exchange of opinions between the researcher and the decision maker in order to evaluate the priorities of the latter.**

The negative aspects of MCA are:

- it is not commonly used;
- it is not immediately understandable for the decision maker, especially in the assignment of weights;
- it is difficult to identify the correct decision maker who knows how to figure out and then include all the objectives and the will of the community in his value judgments.

Despite these negative aspects, Multicriteria Analysis is a tool particularly suitable for GECKO's purposes as it allows to provide an assessment of the effectiveness of regulatory frameworks (with respect to the pursuit of the objective of enabling the new mobility solutions identified in WP1), which cannot be judged by quantitative (or at least not exclusively) indicators.
Regarding the stakeholders' understanding of the method, especially in the assignments of weights, it was decided to carry out individual interviews, which allowed, after a brief presentation of the aims of the project and of the MCA (in which technical aspects and definitions were left out), to create a confidential climate with the stakeholders and to respond in real time to any doubts they might have.
Finally, with regard to the identification of the most appropriate stakeholders to be interviews or surveyed, each stakeholder has been engaged according to his/her particular interest and experience with respect to each mobility solution in order to gain their qualified opinion on challenges, constraints and expectations about not only existing regulatory frameworks but also the foundational principles of future regulations and policies making processes (see WP5 for more details).

4.1 Overview of multi-criteria analysis techniques

MCA can give a significant contribution to solve the following decisional issues:

- To Choose the best alternative and/or to discard the worst alternative;
- To subdivide the alternatives in clusters;
- To classify the alternatives from the best to the worst.

Different methodological approaches can be used according with the issues which focus on. The **partial aggregation methods** focus on the first two decisional issues. The main partial aggregation methods are the ELECTRE methods and their evolutions. The **classification methods** focus on the last decisional issue. The most important are the weighted sum method, the MAUT (Multiple Attribute Utility Theory) method and the AHP (Analytic Hierarchy Process) method. The articulation of the different methods depends on the status of the evaluation criteria used, that is if they have or not a reciprocal compensatory feature which works as rebalancer. Therefore, **MCA method can be compensator** (it takes in account of an eventual trade-off), **partially compensator** (it takes in account of trade-off limitedly) **non-compensator** (it does not use any compensation of the criteria).

4.1.1 ELECTRE

ELECTRE is a partial aggregation method developed by Bernard Roy in 1968 which belongs to the "French school" methods and it is a non-compensator method. **In ELECTRE the result is the choice of the best alternative since it outclasses all the other choices or because it is not outclassed by any other choice**.

Specifically, a choice *a* outclasses a choice *b* when there are enough reasons to justify the outclassing (concordance) and sufficiently weak reasons against the outclassing to avoid the regret for the elimination of *b* in favour of *a* (discordance). The first step of the analysis is the definition of concordance and discordance indices which allow to determine the outclassing.

The concordance index C_{ab} represents the set criteria for which the alternative *a* is preferred to the alternative *b* while the **discordance index D_{ab}** represents the set criteria for which the alternative *b* is preferred to the alternative *a*. If C_{ab} > CONCORDANCE THRESHOLD and at the same time D_{ab}< DISCORDANCE THRESHOLD there is the outclassing.

$$C_{ab} = \sum_{j\in} C_{ab}\,\pi_j$$

$$D_{ab} = max_{j\in} D_{ab}\,\left|X_{bj} - X_{aj}\right|$$

The problem with ELECTRE method is that usually there is no outclassing at the first attempt, therefore it is necessary to repeat the whole operation with less stringent thresholds. In other words, **more the thresholds are strong, more the result will be meaningful and credible**.

The concordance threshold must be at least major than 0,5 since it represents a weighs sum that the alternative *a* has to overpass. A strong threshold is considered 0,75, while a weak threshold is 0,66. **The discordance threshold** must be high enough, since lower the threshold higher is probability that there is no outclassing. Indeed, there is an outclassing if the alternative *a* has a lower value than the threshold for at least one criterion for which *a* is worse than *b*.

4.1.2 WEIGHTED SUM

The weighted sum is a classification method in which **the result is a ranking of the alternatives from the best to the worst**. The method consists in an evaluation of the alternatives through a **value function with several attributes.**

In the value function the evaluations of each alternative (measured with quantitative data) for every weighted criteria are summed in order to obtain an **overall measure of evaluation X_i**. Each overall measure of evaluation founded for the alternative *a* is compared with the corresponding of the other alternatives to achieve a total classification.

$$X_i = \sum_j \pi_j x_{ij}$$

Despite is the simplest and more used method, the weighted sum risks to make the analysis too simple and mechanic, above all if it is not used together with other methods.

4.1.3 MAUT

MAUT is a classification method in which **the result is a ranking of the alternative from the best to the worst**. The method consists in an evaluation of the alternatives through a **utility function with several attributes.** MAUT is the first method of the "American school", developed by Keeney and Raiffa in 1976, and it assumes that each individual has his own utility function to be maximized.

In the utility function the evaluation of each alternative is measured according with the utility associated to an alternative by the decision maker for certain criteria.

The evaluations X_{ij} are inserted in the corresponding utility functions $U_{ij}(x_{ij})$. The classification is founded with the same process of the weighted sum method.

$$X_i = \sum_j \pi_j U(X_{ij})$$

4.1.4 PAIRWISE COMPARISON METHOD

This chapter will go into more detail about the selected MCA technique, describing how has been used in GECKO.
The chosen methodology is the binary comparison method, also known as **pairwise comparison method**. This procedure allows to make choices based on the comparison between two elements per time.

Starting from this pairwise comparison technique, the **Analytic Hierarchy Process (AHP)** is developed. AHP is a classification method which allows to compare more alternatives using multiple criteria, both quantitative and qualitive, and then to achieve a global evaluation for each of them. This process permits to order the alternatives according to an axis of preference, to select the best universal option and to assign alternatives to predefined subsets. AHP is based on three logic operations:

- **Hierarchical structuring:** the problem to evaluate is structured in a hierarchical form, setting at the higher level the objectives and at the following levels respectively the criteria and the alternatives;
- **Comparative judgements:** all the elements of each level are pairwise compared with every element of the following level;
- **Summary of the judgements:** the comparative judgements are summarized to draw up an ordering of the alternatives.

The hierarchical structuring is an evaluation problem which implies that the elements (objectives, criteria and alternatives) have to be arranged in an upward direction according to the level of abstraction. In other words, the elements at the top of the hierarchy are general and abstract while the elements at the bottom are concrete and particular. Therefore, the construction of the hierarchy provides the following collocation:

- Level 1: Objectives;
- Level 2: Criteria;
- Level 3: Alternatives.

The hierarchy can be complete if there are only the three levels described or incomplete if there are sublevels.

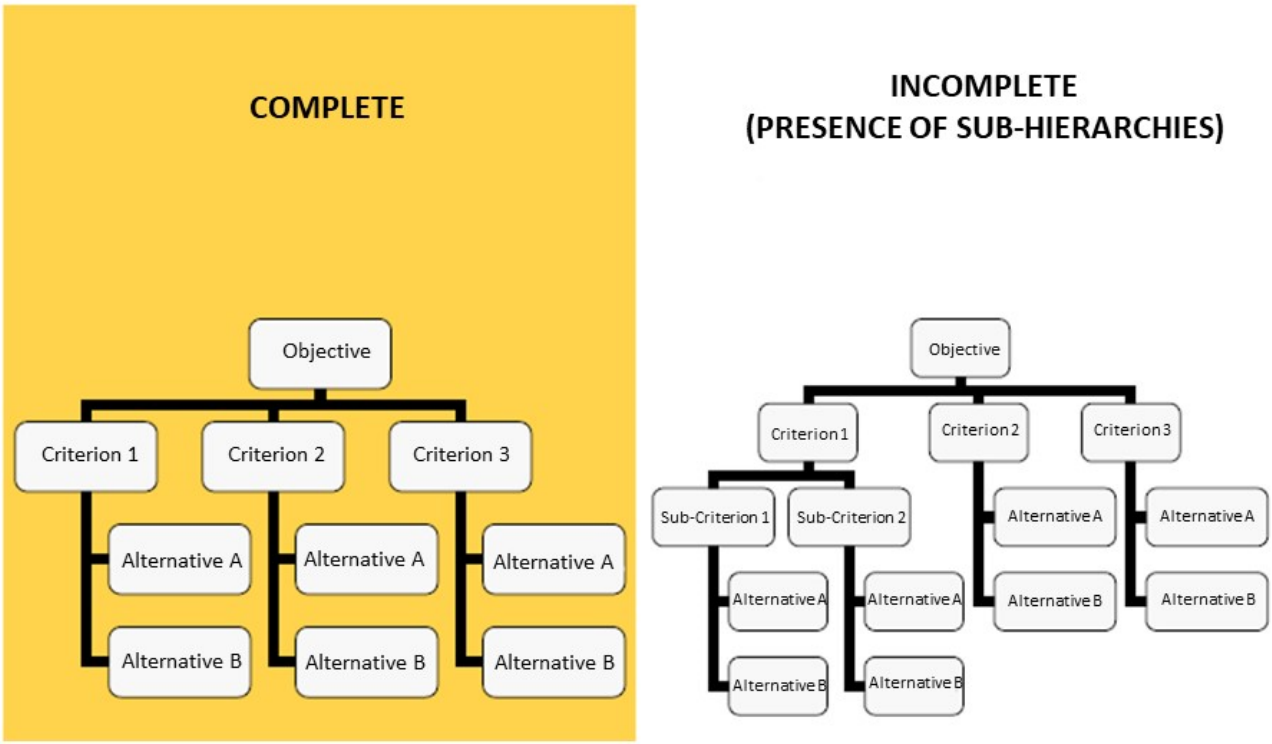


Figure 3 MCA- AHP method - Hierarchical structure

After the structuring of the evaluation problem in a hierarchical form and in a downward direction thanks to AHP method, the formulation of judgments occurs in an upward direction.
In the comparative judgements the elements of the lowest level are pairwise compared to each other according to each element of the following higher level. The comparison is made for every element going up the entire hierarchy. **In the pairwise comparison, the preference of one element respect to another is never absolute, but always relative** (according with the element of the upper level).
Therefore, **through the pairwise comparison method the decision maker expresses and quantifies the preference of one alternative respect to another one according to a single criterion used for the judgment**. In other words, the same comparison between the alternative *a* respect to the alternative *b* can have as best choice the alternative *a* using the criterion 1, while it can be preferred the alternative *b* using the criterion 2.

To quantify the preference between two alternatives, different measurement scales can be used. In this way it is possible to give a score to each comparison and choose the alternative that has obtained the higher value in the comparison.

Finally, the summary of the judgements is made going back in a downward direction through the hierarchy. Indeed, **the overall scores attributed to each alternative, founded through the pairwise comparison of that alternative with all the others, must be multiplied by the weight attributed to the criteria** (directly or by another pairwise comparison). After this step, it is possible to draw up an ordering of the alternatives.

4.1.5 OTHER MULTI-CRITERIA ANALYSIS TECHNIQUES

Beyond the main multi-criteria analysis methods previously discussed, there are other techniques which can be mentioned:

- **Fuzzy Set Theory**: research approach used to solve problems related to ambiguous, subjective and imprecise judgments thanks to the quantification of preferences for individual or group decision-making and the linguistic facet of available data;
- **Analytic Network Process (ANP)**: it is a general form of the AHP in which a decisional problem is structured as a network. This method allows to consider the interdependence of the elements and allows the decision criteria to be affected by them;
- **Case-based Reasoning:** method which provides solutions for a problem based on solutions used to solve past problems;
- **Data envelopment Analysis:** linear programming method used to solve problems related to cost data and to situations in which the production process presents a structure of multiple inputs and outputs thanks to the measurement of the efficiency of multiple decision-making units.

- **Simple Multi-Attribute Rating Technique:** linear additive model used to predict the value of each option through the calculation value of each attribute multiplied for the weight of that criterion as the total sum;
- **Goal Programming:** method based on the linear programming model used to handle multiple, normally conflicting objective measures;
- **PROMETHEE:** method that allows the construction of an outranking between different alternatives and it is characterized by the limited degree to which a disadvantage on a particular viewpoint may be compensated by advantages on other viewpoints;
- **Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS):** method of compensatory aggregation that identifies weighs for each criterion thanks to a comparison of a set of alternatives. It aims to find the calculation of the geometric distance between each alternative and the ideal alternative, that is the best score in each criterion, though a normalisation of the scores;
- **Additive Ratio ASsessment (ARAS):** method which uses a utility function value in situations where the complex relative efficiency of a feasible alternative is directly proportional to the relative effect of values and weights of the main criteria considered in a project.

4.2 MCA in GECKO

Considering that, in accordance with the purposes of this WP, the aim of this task is the evaluation of the effectiveness of each regulatory framework in enabling new mobility solutions according to different evaluation categories (Safety, Social, Environmental, etc.), and considering also that too articulated methodologies for a qualitative evaluation would have added unnecessary complexity, it was decided to use the weighted sum motion for the calculation of the MCA and the pairwise comparison for the assignment of the weights of the indicators that contribute to the definition of each evaluation category.

Therefore, this chapter will go over the steps of the MCA describing them according to the objectives of GECKO and specifying, where necessary, which method has been used for each step. As highlighted at the beginning of Chapter 2, the Multicriteria Analysis is an evaluation that can be represented by an evaluative function:

$$V = f(O, C, A)$$

And the decisional process of MCA consists of several phases:

- **Definition of the problem and individualization of the decision makers:** in GECKO the objective is to evaluate the capability of regulatory frameworks in enabling each mobility solutions identified in WP1 while, at the same time, safeguarding adequate level of security, safety, data privacy, and social protection; decision makers are the GECKO stakeholders (policy makers, private sector and researchers).
- **Identification of the alternatives:** in GECKO alternatives are the different regulatory schemes and approaches.

- **Identification of the criteria:** in GECKO the criteria coincide with the aspects that must or should be addressed to create an ideal regulatory framework for each mobility solution. With the pre-workshop questionnaires propaedeutic to the second workshop, stakeholders were provided with the list of these criteria and for each of them they were asked if, for each mobility solution, that aspect should be regulated or not. In fact, these criteria coincide with KPI categories, namely: legal, political, economic, social, safety, security, environmental, technological, infrastructure and transport.
- **Construction of the Evaluation Matrix:** starting from the phases just discussed, with the specifics of GECKO, figure 2 becomes:

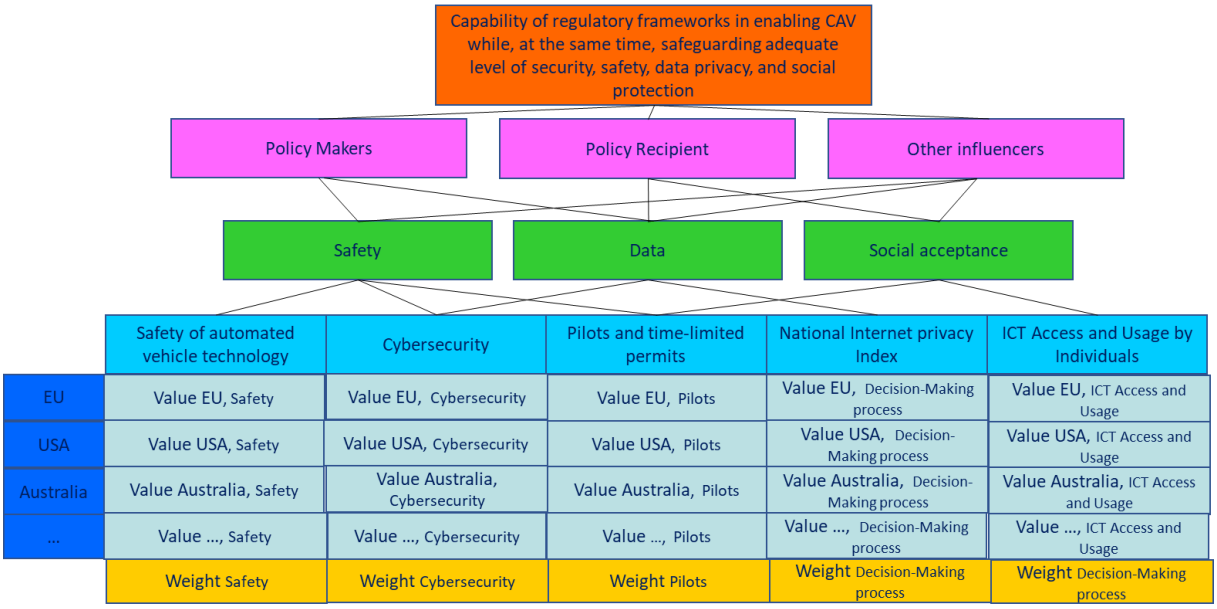


Figure 4 MCA Evaluation Matrix, example for Connected and Automated Vehicles

- **Standardization:** to obtain the same numerical scale, the method of **division for the maximum value**, which allows to obtain a vector formed by elements with value between 0 and 1, has been used.
- **Ponderation:** the estimation of the weights has been done through the **Pairwise Comparison method.** For each criterion (green rectangle) the pairwise comparison has been performed at the KPI (light blue rectangle) level. The pairwise comparison has been carried out through the conduction of specific online interviews.
- **Calculation:** once the values of each KPI and the respective weights have been obtained, the assessment of each regulatory scheme against each criterion has been got as a weighted average of the KPIs for that criterion and the respective weights.
- **Sensitivity analysis:** the sensitivity analysis has been performed as described in the previous paragraph.

4.3 MCA elements – KPI used for each mobility solution

In the previous phases of WP3, specific regulations have been collected for each of the mobility solutions analysed, identified in WP1. In the framework of Task 3.1, these regulations have been included in the dashboard and KPIs have been associated for each of them to assess the specific strategy adopted for the deployment of the mobility solution covered by the regulation.
However, if the objective is to evaluate the effectiveness of the regulatory frameworks with respect to their capacity to implement these mobility disruptive innovations, evaluating only the single regulation as a standalone element would not provide a comprehensive and effective assessment. In fact, each regulation is part of an interdependent framework of regulations and policies and the ability to adopt a mobility solution depends on a commonality of objectives shared by the elements of this framework. For example, to assess the extent to which a city guarantees safety for e-scooters, assessing only the specific regulation of e-scooters (which could just establish whether they should be driven wearing helmets or whether they should be driven on dedicated lanes), one cannot ignore the assessment of the actual supply of cycle paths (which could depend on previous policies).
Therefore, at this stage, it was decided to abandon the reference only to individual regulations and rather consider the system of regulations and policies pertaining to each jurisdiction level under assessment (e.g. a city or a country).

Therefore, starting from the set of KPIs identified in the first phase of the analysis concerning the regulations collected (see 1.2.1 - Association of KPIs to regulations), the following aspects have been considered for the final identification of KPIs to be assessed for each mobility solution (also considering the need to limit the number of KPIs to be used the MCA pairwise comparison):

- Most relevant and **specific elements of each mobility solution**; to select them, reference was made to:
    - KPI selection analysis;
    - stakeholder consultation during the second workshop (pre-workshop questionnaires);
    - authoritative studies, news, papers, roadmaps, guidelines of international relevance.

  The quantification of the KPIs was carried out through reference texts already identified in the "association" of KPIs to regulations (paragraph 1.2).

- Elements of the **regulatory framework "context" and cross-cutting issues**. These include:
    - Particular aspects, which the collected regulations refer to, and that define the general principles the specific regulations are based on (e.g. Privacy or environmental policies).
    - Elements directly affected by regulatory frameworks such as digital infrastructures or cybersecurity standards.

- Efficiency of the overall legal framework in addressing challenging regulations and digital business models.

The quantification of the KPIs has been carried out by standardising the assessments performed by the most recent databases and indexes already available.

The following table shows the selected KPIs for each mobility solution representing the elements of the MCA assessment. The different colours of KPIs describe the evaluation criteria (those that in D3.1 have been called KPI categories). Some of the KPIs are relevant for more than one evaluation category, so the cell is filled in with all the colours of the evaluation categories for which that KPI is relevant.

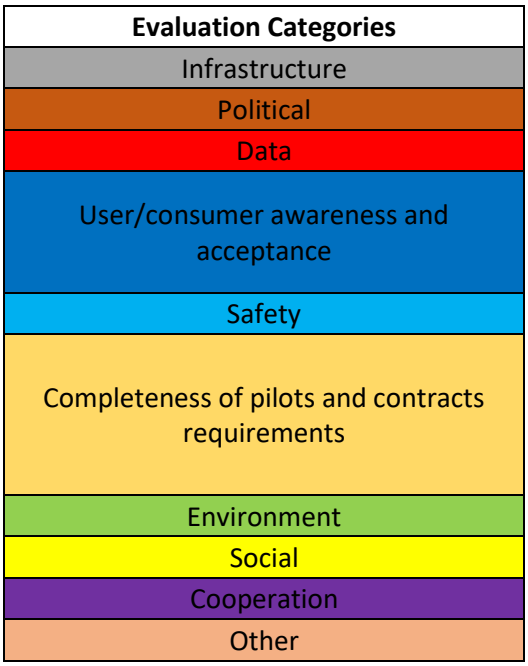


Figure 5 Evaluation Categories

Use Case	Specific KPIs					Context and cross-cutting issues KPIs									
Connected and Automated Vehicles	Safety of AV technology	Pilots and time-limited permits	Liability			National Cybersecurity	National Internet privacy Index	Adaptation of the training supply and of the higher education system to business needs	ICT Access and Usage by Individuals	Public-Private cooperation	National Digital infrastructure	Environmental Policy Stringency Index	Efficiency of the legal system in challenging regulations	Density of electric charging stations	National Datasharing environment in transport	Number of government-funded AV pilots
Drone last mile delivery	Safety	Operating Requirements (requirements to operate)				National Cybersecurity	National Internet privacy Index	Adaptation of the training supply and of the higher education system to business needs	ICT Access and Usage by Individuals	Public-Private cooperation	National Digital infrastructure	Environmental Policy Stringency Index	Efficiency of the legal system in challenging regulations	Legal framework's adaptability to digital business models	National Datasharing environment in transport	
Big data for transport and mobility	Data sharing	Data Management	Data Protection			National Cybersecurity	National Internet privacy Index	Adaptation of the training supply and of the higher education system to business needs	ICT Access and Usage by Individuals	Public-Private cooperation	National Digital infrastructure	Environmental Policy Stringency Index	Efficiency of the legal system in challenging regulations			
Network and traffic management	Agreement among operators	Data Sharing	Data Standardisation	Accidents		National Cybersecurity	National Internet privacy Index	Adaptation of the training supply and of the higher education system to business needs	ICT Access and Usage by Individuals	Public-Private cooperation	National Digital infrastructure	Environmental Policy Stringency Index	Efficiency of the legal system in challenging regulations			
MaaS and MaaS platforms	E-Ticketing	Data sharing	Public transport			National Cybersecurity	National Internet privacy Index	Adaptation of the training supply and of the higher education system to business needs	ICT Access and Usage by Individuals	Public-Private cooperation	National Digital infrastructure	Environmental Policy Stringency Index	Efficiency of the legal system in challenging regulations	Legal framework's adaptability to digital business models		
Car-sharing	Parking	Requirements to operate				National Cybersecurity	National Internet privacy Index	Adaptation of the training supply and of the higher education system to business needs	ICT Access and Usage by Individuals	Public-Private cooperation	National Digital infrastructure	Environmental Policy Stringency Index	Density of electric charging stations	Legal framework's adaptability to digital business models	National Datasharing environment in transport	
Bike sharing	Parking	Requirements to operate				National Cybersecurity	National Internet privacy Index	Adaptation of the training supply and of the higher education system to business needs	ICT Access and Usage by Individuals	Public-Private cooperation	National Digital infrastructure	Environmental Policy Stringency Index	No Car Day	Legal framework's adaptability to digital business models	National Datasharing environment in transport	Bicycle roads length per population
E-scooter sharing/ Micromobility	Parking	Safety	Pilots and time-limited permits	Requirements to operate		National Cybersecurity	National Internet privacy Index	Adaptation of the training supply and of the higher education system to business needs	ICT Access and Usage by Individuals	Public-Private cooperation	National Digital infrastructure	Environmental Policy Stringency Index	No Car Day	Legal framework's adaptability to digital business models	National Datasharing environment in transport	Bicycle roads length per population
Ride-hailing and TNC	Requirements to operate	Competition with existing services	Environmental measures			National Cybersecurity	National Internet privacy Index	Adaptation of the training supply and of the higher education system to business needs	ICT Access and Usage by Individuals	Public-Private cooperation	National Digital infrastructure	Environmental Policy Stringency Index	Density of electric charging stations	Legal framework's adaptability to digital business models	National Datasharing environment in transport	
On-demand ridesharing and carpooling	Requirements to operate	Pilots and time-limited permits	Financial accessibility	Persons with disabilities	Accessibility in rural areas	National Cybersecurity	National Internet privacy Index	Adaptation of the training supply and of the higher education system to business needs	ICT Access and Usage by Individuals	Public-Private cooperation	National Digital infrastructure	Environmental Policy Stringency Index	Density of electric charging stations	Legal framework's adaptability to digital business models	National Datasharing environment in transport	

Figure 6 KPIs selected for each mobility solution

Depending on the mobility solution analysed, the same KPI can be assessed according to different evaluation criteria: for example, the KPI "National Cyber security" has been considered relevant for both the evaluation criteria "Data" and "Safety".

With respect to each of these evaluation criteria, the stakeholders will define the weight of each KPI belonging to that category through the pairwise comparison. (See paragraph 2.5 KPI Ponderation).

4.3.1 Context and cross-cutting issues KPIs

Some of the KPIs available from other sources have been used for the assessment of all of the mobility solutions analysed in order to define the regulatory environment in which each specific regulation for each mobility solution fits. Other KPIs were then added according to the relevance with respect to each mobility solution.
These KPI are:

- **Efficiency of the legal system in challenging regulations** (2019)- This World Economic Forum's index is based on an assessment performed by private businesses how easy it is in the country to approve the necessary regulations for development and deployment of an innovation? [1 = extremely difficult; 7 = extremely easy]".

This KPI has been used for the assessment (from a political point of view) of the most innovative and technological related mobility solution and for those that imply a strong cooperation among stakeholders: CAV, drones for last mile delivery, Big data for transport and mobility, Network and traffic management, MaaS, Hyperloop and Passenger urban air mobility.

- **Public-Private cooperation** (2016) – This Institutional Profiles Database" (IPD)'s index is based on an assessment performed through a survey completed by country Economic Services of the Ministry for the Economy and Finance answering the questions: "Degree of cooperation between the public and private sectors? [0 = no cooperation; 4=strong cooperation]"; "Degree of involvement by the State's highest authorities in the cooperation between public and private stakeholders? [0 = no involvement; 4=strong involvement]". "Does this cooperation allow account to be taken of the interests of key economic and social stakeholders in the country? [0 = no consideration; 4= strong consideration]". "Are there public or private "think tanks" producing analyses, forecasts and proposals on the major national issues? [0 = no space for reflection; 4= many spaces for reflection]".
  As outlined in D2.3, Public-Private cooperation has been considered very important for the adoption of mobility disruptive innovations from the stakeholders surveyed. Therefore this KPI has been used for the assessment of all the mobility solutions analysed from a cooperation point of view.
- **Legal framework's adaptability to digital business models** (2019)- This World Economic Forum's index is based on an assessment performed by private businesses answering the question: "In your country, how fast is the legal framework of your country adapting to digital business models (e.g. e-commerce, sharing economy, fintech, etc.)?" [1 = Not fast at all; 7 = Very fast].
  This KPI has been used for the assessment (from a political point of view) of mobility solutions more focused on services rather than technologies: drones for last mile delivery, MaaS, Car-Sharing, Bike sharing, E-scooter sharing, Ride-hailing and TNC, On-demand ridesharing and carpooling.
- **Adaptation of the training supply and of the higher education system to business needs** (2016)- These two "Institutional Profiles Database" (IPD)'s indexes are based on an assessment performed through a survey completed by country Economic Services of the Ministry for the Economy and Finance answering the questions: "Share of the workforce benefiting from continuous vocational training? [0 = none of the work force; 4=high proportion of the population]". Does the vocational training provision meet business needs? [0 = not met; 4=met]; Does the higher education system meet business needs? [0 = not met; 4=met].
  This KPI has been used for the assessment (from a social point of view) of all the mobility solutions analysed in order to assess the capacity of each regulatory framework to match the labour market with the needs of the new and disruptive business system.
- **Environmental Policy Stringency Index** (2015) - The OECD Environmental Policy Stringency Index (EPS) is a country-specific and internationally-comparable measure of the stringency of environmental policy. Stringency is defined as the degree to which environmental policies put an explicit or implicit price on polluting or environmentally

harmful behaviour[2]. The index ranges from 0 (not stringent) to 6 (highest degree of stringency) and is based on the degree of stringency of environmental policy instruments, primarily related to climate and air pollution.
This KPI has been used for the assessment of all the mobility solutions analysed in order to assess the overall environmental policy approach of each regulatory framework.

- **Individuals using the Internet in mobility (**2019)– The indicator is based on "2nd revision of the OECD Model Survey on ICT Access and Usage by Households and Individuals[3]" and is defined as the proportion of individuals using the Internet in mobility within the last 3 months (%).
  Since the access to internet and the capacity of using it are enabling factors of all the mobility solutions analysed, this KPI has been used for the assessment of all the mobility solutions (from the user acceptance point of view)
- **Internet privacy Index** (2019) – The index is a composite score between 0 and 100, based on the weighted sum of several variables mainly based on the assessment of national data privacy laws. The index has been developed by the Bestvpn.org an adopted by the International Chamber of Commerce[4].
  This KPI has been used for the assessment (from social and data point of view) of all the mobility solutions analysed.
- **Data sharing environment in transport** (2016) - The World Wide Web Foundation's Open data barometer for 2016[5] assesses governments on readiness for a) open data initiatives, b) implementation of open data programs and c) impact that open data is having on business, politics and civil society. The index is a composite score between 0 and 100 and has been evaluated for several areas, including transport.
  This KPI has been used for the assessment (from the data and cooperation points of view) of all the mobility solutions analysed, except for Big data for transport and mobility, Network and traffic management, and MaaS, for which the regulations collected focus very much on datasharing; therefore, for these three mobility solutions the KPI datasharing has been evaluated directly through the reading of reference texts.
- **Mobile Connectivity Index** (2019) - This index is developed by the GSM Association, and assesses availability of high performance mobile internet network coverage, speed, the number of servers and network bandwidth, given AVs need to receive and transmit data.
  This KPI has been used for the assessment (from the infrastructural point of view) of all the mobility solutions analysed.
- **Global Cybersecurity Index** (2018)- The Global Cybersecurity Index (GCI)[6] is a composite index developed by the International Telecommunication Union (ITU) combining 25 indicators into one benchmark to monitor and compare the level of the cybersecurity

[2] https://www.oecd-ilibrary.org/environment/data/oecd-environment-statistics/environmental-policy-stringency-index_2bc0bb80-en#:~:text=The%20OECD%20Environmental%20Policy%20Stringency,polluting%20or%20environmentally%20harmful%20behaviour.

[3] https://www.oecd.org/sti/ieconomy/ICT-Model-Survey-Access-Usage-Households-Individuals.pdf

[4] https://bestvpn.org/privacy-index/

[5] https://opendatabarometer.org/?_year=2017&indicator=ODB

[6] https://www.itu.int/dms_pub/itu-d/opb/str/D-STR-GCI.01-2018-PDF-E.pdf

commitment of countries regarding the five pillars of the Global Cybersecurity Agenda: 1. Legal: Measures based on the existence of legal institutions and frameworks dealing with cybersecurity and cybercrime. 2. Technical: Measures based on the existence of technical institutions and framework dealing with cybersecurity. 3. Organizational: Measures based on the existence of policy coordination institutions and strategies for cybersecurity development at the national level. 4. Capacity building: Measures based on the existence of research and development, education and training programmes, certified professionals and public sector agencies fostering capacity building. 5. Cooperation: Measures based on the existence of partnerships, cooperative frameworks and information sharing networks.
This KPI has been used for the assessment (from the data and safety point of view) of all the mobility solutions analysed.

- **Density of electric charging stations** (2018)- This index has been developed by KPGM for the definition of the "Autonomous Vehicle Readiness Index 2019"; data for most countries is from the International Energy Agency's Global EV outlook 2018 136 while information for
other countries is gathered from the US Bureau of Transportation Statistics and country-specific data sources. Numbers of chargers are scaled by length of paved roads in each country, using data from the CIA's World factbook.
This KPI has been used for the assessment (from the infrastructural and environmental points of view) of the mobility solutions concerning road transport (cars and buses): CAV, Car-sharing, Ride-hailing, On-demand ridesharing and carpooling.
- **Number of government-funded AV Pilots** (2019) - This index has been developed by KPGM for the definition of the "Autonomous Vehicle Readiness Index 2019"; it is scored out of seven and is based on a review of media articles, government press releases and government regulations.
This KPI has been used (from the pilots point of view) for the assessment of CAV.
- **Bicycle roads length per population** (2019) – This is an indicator of the Bicycle Cities Index 2019.[7] Bicycle roads length per population. Sources: Open Street Maps Overpass API responses: km of ways (highways) tagged for bicycle usage (allowed and specific).
This KPI has been used for the assessment (from the infrastructural point of view) of bikesharing and e-scooters sharing.
- **No Car Day** (2019) - This is an indicator of the Bicycle Cities Index 2019. Score dependant on the existence of a car-free day, where motorists are encouraged to give up their car for one day. 1 - Has No Car Day. 0 - Does not have a No Car Day.
This KPI has been used for the assessment (from the user acceptance and environmental point of view) of bike-sharing and e-scooters sharing.

[7] https://www.coya.com/bike/index-2019

4.3.2 Specific KPIs

As mentioned above, in the original framework of the regulations collected in the dashboard, KPIs addressing specific issues of each mobility solutions have been selected. This selection consisted in an iterative process, in order to define a limited set of the most significant KPIs compatible with the submission of questionnaires to stakeholders for their assessment. In fact, the first phase of KPI selection (see paragraph 1.2 “Association of KPIs to regulations”) defined too many KPIs for each mobility solution and this was not compatible with the time demanded to stakeholders for the completion of the questionnaires. For this reason, through the pre-workshop questionnaires, stakeholders were asked what elements (i.e. what we’re calling “KPIs”) need to be regulated in order to define an ideal legal framework for each mobility solution. Finally, a further selection has been made through the consultation of authoritative studies, news, papers, roadmaps, and guidelines of international relevance for each mobility solution. This allowed to define a limited set of KPIs specific for each mobility solution compatible with the timeframe available to stakeholders and the consortium (see chapter 2.4 "KPI assessment" for more details).
For the questions asked in the questionnaires, please see Annex I.

4.4 KPIs assessment

As anticipated in the previous paragraphs, from a metrics point of view, KPIs used in GECKO can be evaluated in two ways:

- For the **specific KPIs**, by reading the reference text and assessing – through the Likert scale – the strategy adopted by the regulations to enable the adoption of the new mobility solutions. These KPIs will be valued directly by stakeholders, for some of the regulations presenting the most different approaches, through questionnaires. The same KPIs referred to the rest of the collected regulations have then been valued by the GECKO Consortium according to the indications provided by stakeholders in the same questionnaires.
- For the **Context and cross-cutting issues KPIs**, through the standardisation (with the method of the division for the maximum value and multiplying the result by 5 so as to obtain for all indicators a value from 1 to 5) of data and indexes collected from international databases already available. Hereafter an example showing the standardisation of the “Public-private cooperation” KPI (for which 4 is the maximum score):

IPD 2016 Variables		Indicator code	A500	Standardised value for the GECKO's MCA
		Indicator	Public-private cooperation	
Code ISO-3	Country	Year		
DEU	Germany	2016	3,33	4,16
ISR	Israel	2016	3,00	3,75
ITA	Italy	2016	3,00	3,75
PRT	Portugal	2016	3,67	4,59
GBR	United Kingdom	2016	4,00	5,00
RUS	Russian Federation	2016	2,33	2,91

Figure 7 Example of standardisation

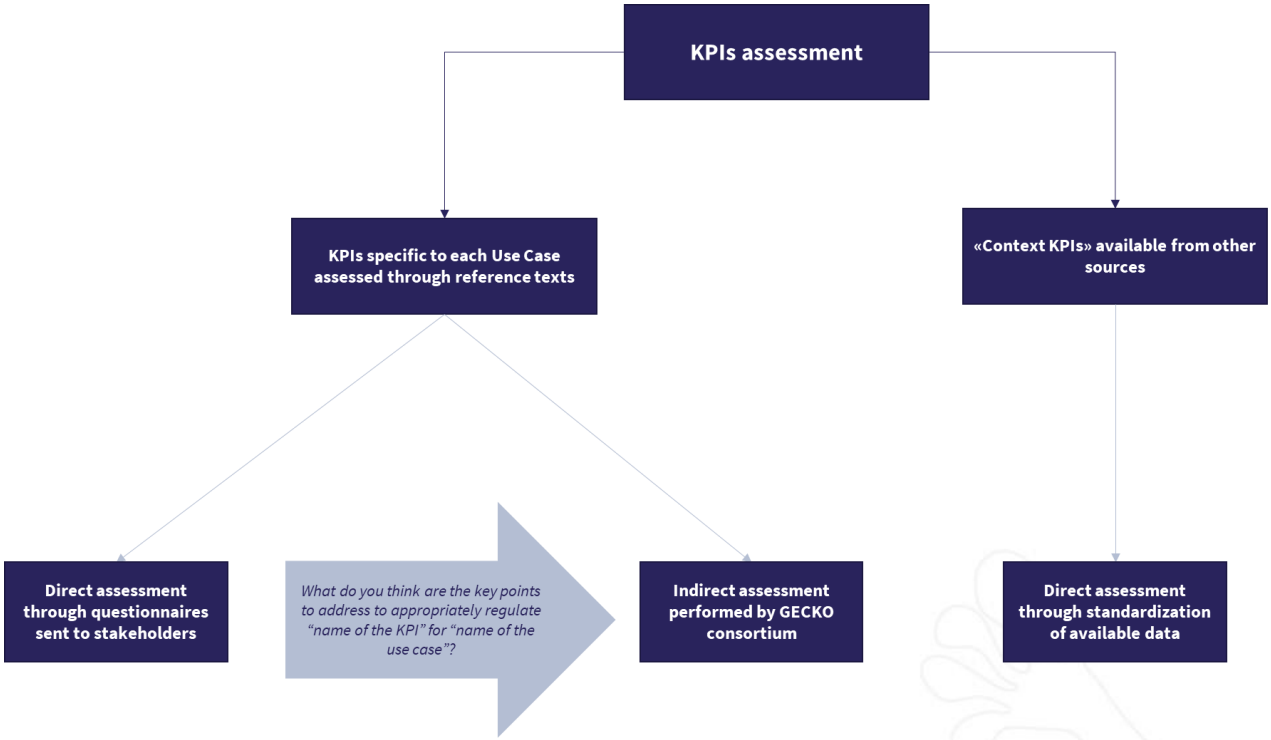


Figure 8 KPI assessment framework

4.4.1 Online questionnaires – direct assessment from stakeholders

Questionnaires to be sent to stakeholders for the assessment of KPIs has been drafted: the approach was to illustrate to respondents a set of reference texts (i.e. the abstract or summary of an article of the regulation) regarding different regulations addressing the same issue. In this way stakeholders were able to assess the strategy of each regulation also by making a comparison among them.

Given the size of the database of regulations collected, it was not possible to request stakeholders to evaluate how every regulations collected address the KPIs. For this reason, the most different regulatory approaches were shown in the questionnaires for each KPI. In addition, at the end of each section (one questionnaire section for each KPI) it was asked to indicate which key points should be addressed in order to better regulate that aspect described by the KPI. In this way it was possible to derive a qualitative assessment (based both on the effectiveness of the approach and on the verification of the presence of the key points that should be addressed) that allowed the GECKO consortium to assess the KPIs that have not been directly evaluated by the stakeholders. The questionnaires also took into account the stakeholders knowledge on the whole regulation and if that regulation has a direct impact on his/her job/business. An example of questionnaire can be found in Annex I: Questionnaires.

4.5 Questionnaire analysis

GECKO stakeholders have been engaged according to their particular interest or experience with respect to each mobility solution in order to gain their qualified opinion on challenges, constraints and expectations about not only existing regulatory frameworks but also the foundational principles of future regulations and policies making processes.

The table below provides an overview of the questionnaires sent and responses received. The questionnaires were made available for completion for 15 days; during this period two reminders were sent to remind stakeholders to fill in the questionnaires.

Mobility Solutions	Sent	Responses
Connected and Automated Vehicles	23	5
Drone last mile delivery	19	2
Big data for transport and mobility	19	5
Network and traffic management	20	4
MaaS and MaaS platforms	21	6
Car-sharing	19	4
Bike sharing	20	10
E-scooter sharing/ Micromobility	19	3
Ride-hailing and TNC	20	5
On-demand ridesharing and carpooling	18	4

Figure 9 Overview of questionnaires and rate of responses

The final value of the KPIs associated with the regulations has been calculated as an average weighted on the level of more or less direct and in-depth knowledge of the stakeholders of the regulation to be evaluated; in particular the following weights have been associated:

Level of knowledge of the regulation declared by the stakeholder	Weight assigned
The respondent stated that his/her work is directly influenced by the regulation to be assessed.	2,00
The respondent stated that he/she read the entire regulation (link to the full text provided in each section of the questionnaire).	1,50
The respondent stated that he/she heard about the regulation (e.g. through media, news)	1,25
The respondent stated that he/she has no knowledge of the regulation to be assessed.	1,00

Figure 10 weights assigned to each level of knowledge

In this way it was possible to take into account the validity of the specific stakeholder opinion in relation to each regulation analysed: the opinion of those who know the regulation in depth (because it affects their work) weighs twice as compared with those who have defined their assessment solely on the basis of reading the reference text.
As can be seen from the table in Annex II, the KPI values obtained from the simple average of stakeholders' opinions do not differ much from those gained taking into account the weight given to the knowledge of the individual regulation; this indicates that the level of knowledge of the stakeholders' regulations was similar and/or that they provided agreed opinions. This last observation is confirmed by the low values of the standard deviation, which only in 25% of the cases exceeded the value of 1.

4.4.1 Assessment of remaining regulations from GECKO Consortium

Guidelines have been shared with partners involved in T3.2 in order to complete the assessment of KPIs addressed by all of the regulations collected in the dashboard.
The guidelines allowed partners to:

- carry out a final review of the reference texts, so that they were sufficiently comprehensive to assess the KPIs;
- provide an assessment of the KPIs addressed by the regulations based on stakeholders' indications.

The indications provided by stakeholders in the questionnaires on the key points to be addressed in order to regulate in the most appropriate way each specific issue for each use case, reported in the guidelines, can be consulted in Annex 2.

4.6 KPI Ponderation

The definition of weights to be associated to each KPI belonging to each evaluation criteria (namely Infrastructure, Political, User/consumer awareness and acceptance, Safety, Completeness of pilots and contracts requirements, Environment, Social, Cooperation and other), has been performed by conducting online interviews to stakeholders, aimed at assigning weights to different assessment criteria, by means of a pairwise comparison.

4.6.1 Online interviews

The approach used to engage stakeholders for online interviews was the same as that used for the questionnaires. The interviews were conducted in two rounds, the second after sending a reminder to encourage stakeholders to collaborate.
The table below provides an overview of the requests for interviews sent and actually performed.

Case studies	Requests sent	Interviews 1° round	Interviews 2° round
Big data	4	2	
Bike sharing	4	4	
CAV	4	1	
Drones for last mile delivery	4	1	+2
E-scooters & Micromobility	4	1	
MaaS	4	1	
O.D. Ridesharing and carpooling	4	3	
Ridehailing	4	1	
Traffic management	4	2	+2

Figure 11 Overview of stakeholders interviews

The interview was introduced to the stakeholder by explaining her/him the main purpose of WP3 and how her/his input will be of great importance also within the valorisation of the so-called Compliance Map (for more details refer to D3.3).
Below, an example of the interview structure for On demand ridesharing and Carpooling is reported.

Step 1: presentation of the Pairwise comparison

Objective: To assess the extent to which the regulatory frameworks enable the societal, environment and economic impact possible with the implementation of newly emerging disruptive innovations, while at the same time safeguarding adequate level of security, safety, data privacy, and social protection.

The interview is aimed at collecting weights assigned by stakeholders to different assessment criteria, by means of a pairwise comparison, intended as methodological element of an AHP (Analytical Hierarchy Process), propaedeutic to the development of the MCA.

Hence, it has been asked to assign scores to each couple of KPIs belonging to the same category, to assess the relative importance of one category compared to another. **This has been done by asking stakeholder to split a total score of 100 between the two categories in each couple** *(e.g. 50-50 if you consider one category as important as the other one, 80-20 if you consider the first category strongly more important than the other one, and so on)*.

An explanation of the meaning of each KPI has been given verbally in case the name of the KPI resulted to be not self-explanatory.

Evaluation category: Infrastructure

Category	Digital infrastructures	Density of electric charging stations
Score	70	30

Evaluation category: Environment

Category	Density of electric charging stations	Environmental Policy Stringency Index
Score	10	90

Evaluation category: Data

Category	National Data sharing environment in transport	National Cybersecurity
Score	60	40

Category	National Data sharing environment in transport	National Internet privacy Index
Score	40	60

Category	National Cybersecurity	National Internet privacy Index
Score	40	60

Evaluation category: Cooperation

Category	National Data sharing environment in transport	Public-Private cooperation in the definition of national strategies to take into account the interests of key economic and social stakeholders
Score	20	80

Evaluation category: Social

Category	Employment: Adaptation of the training supply and of the higher education system to business needs	Privacy: National Internet privacy Index
Score	20	80

Category	Employment: Adaptation of the training supply and of the higher education system to business needs	Financial accessibility
	30	70

Category	Employment: Adaptation of the training supply and of the higher education system to business needs	Persons with disabilities
Score	50	50

Category	Employment: Adaptation of the training supply and of the higher education system to business needs	Accessibility in rural areas
Score	30	70

Category	Privacy: National Internet privacy Index	Financial accessibility
Score	60	40

Category	Privacy: National Internet privacy Index	Persons with disabilities
Score	70	30

Category	Privacy: National Internet privacy Index	Accessibility in rural areas
Score	60	40

Category	Financial accessibility	Persons with disabilities
Score	60	40

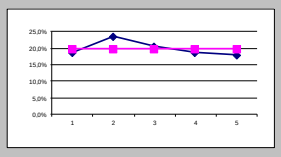
Category	Financial accessibility	Accessibility in rural areas
Score	50	50

Category	Persons with disabilities	Accessibility in rural areas
Score	30	70

Interviews elaboration

An example of the elaboration of matrixes of the pairwise comparison obtained for interviews conducted for on demand ride-hailing and carpooling is reported below. The sum vectors of each KPI obtained for each respondent (anonymized in the table below) are summed and standardised to obtain the weight of each KPI in the overall evaluation of the regulatory framework effectiveness in addressing the social aspects of on-demand re-hailing and carpooling. In this specific case, no KPI resulted to be strongly prevalent (i.e. considered by stakeholders to be significantly more important than the others).

On demand ride sharing and Carpooling - Evaluation category: Social



CRITERIA	Standard	
Employment: Adaptation of the training supply and of the higher education system to bu	18,6%	20%
Privacy: National Internet privacy Index	23,6%	20%
Financial accessibility	20,8%	20%
Persons with disabilities	18,9%	20%
Accessibility in rural areas	18,1%	20%
	100,0%	

5

Weighter expert: X

	Employment: Adaptation of the training supply and of the higher education system to business needs	Privacy: National Internet privacy Index	Financial accessibility	Persons with disabilities	Accessibility in rural areas	Sum vector	Standard
Employment: Adaptation of the training supply and of the higher education system to business needs		20	30	50	30	130,00	**13,0%**
Privacy: National Internet privacy Index	80		60	70	60	270,00	**27,0%**
Financial accessibility	70	40		60	50	220,00	**22,0%**
Persons with disabilities	50	30	40		30	150,00	**15,0%**
Accessibility in rural areas	70	40	50	70		230,00	**23,0%**

Weighter expert: Y

	Employment: Adaptation of the training supply and of the higher education system to business needs	Privacy: National Internet privacy Index	Financial accessibility	Persons with disabilities	Accessibility in rural areas	Sum vector	Standard
Employment: Adaptation of the training supply and of the higher education system to business needs		45	55	45	45	190,00	**18,8%**
Privacy: National Internet privacy Index	55		55	50	50	210,00	**20,8%**
Financial accessibility	45	45		40,00	55	185,00	**18,3%**
Persons with disabilities	55	50	60		55,00	220,00	**21,8%**
Accessibility in rural areas	55,00	50,00	55,00	45,00		205,00	**20,3%**

Weighter expert: Z

	Employment: Adaptation of the training supply and of the higher education system to business needs	Privacy: National Internet privacy Index	Financial accessibility	Persons with disabilities	Accessibility in rural areas	Sum vector	Standard
Employment: Adaptation of the training supply and of the higher education system to business needs		70,00	40,00	50,00	80,00	240,00	**24,0%**
Privacy: National Internet privacy Index	30,00		50,00	70,00	80,00	230,00	**23,0%**
Financial accessibility	60,00	50,00		60,00	50,00	220,00	**22,0%**
Persons with disabilities	50,00	30,00	40,00		80,00	200,00	**20,0%**
Accessibility in rural areas	20,00	20,00	50,00	20,00		110,00	**11,0%**

Figure 12 Example of elaboration of matrixes for the pairwise comparison

Below are the results of the pairwise comparison. By analysing how the weights of the common KPIs are distributed among the majority of the use cases with respect to the different assessment categories we can observe that:

- As regards the evaluation category Data, the aspect of data-sharing is considered to be the most relevant in all the existing service use cases; in particular for the ride-hailing and TNC the weight of data-sharing exceeds 50%.
- As regards the evaluation category Social, the employment aspect with the need to adapt the training supply and of the higher education system to business needs is considered

particularly relevant for Drones for last mile delivery, Big data for transport and mobility, Network and traffic management and for Bike sharing. On the other hand, the respect of privacy is considered more relevant for MaaS but especially for e-scooter sharing (80%).

- For the evaluation category Cooperation, there is no particular imbalance between the two main aspects of data-sharing and Public-Private cooperation in the definition of national strategies to take into account the interests of key economic and social stakeholders; this with the exception of drones for last mile delivery, where the latter KPI assumes the weight of 80%.

Evaluation Category	KPIs	Use Cases									
		Connected and Automated Vehicles	Drone last mile delivery	Big data for transport and mobility	Network and traffic management	MaaS and MaaS platforms	Car-sharing	Bike sharing	E-scooter sharing/ Micromobility	Ride-hailing and TNC	On-demand rideshare ing and carpooling
Infrastructure	National Digital infrastructure	70,0	100,0	100,0	100,0	70,0	50,0	35,0	50,0	55,0	66,7
	Density of electric charging stations	30,0					50,0			45,0	33,3
	Bicycle roads length per population							65,0	50,0		
	E-Ticketing					30,0					
	Parking										
Political	Efficiency of the legal system in challenging regulations	100,0	51,7	100,0	100,0	50,0					
	Legal framework's adaptability to digital business models		48,3			50,0	100,0	100,0	100,0	100,0	100,0
Data	National Data sharing environment in transport / Specific Data sharing assessment	36,7	26,7	25,0	21,9	25,0	33,3	37,5	36,7	50,8	38,3
	National Cybersecurity	30,0	46,7	18,3	29,4	33,3	33,3	34,2	30,0	23,3	26,1
	National Internet privacy Index	33,3	26,7	25,0	24,2	41,7	33,3	28,3	33,3	25,8	35,6
	Data Management			6,0							
	Data Protection			25,8							
	Data Standardisation				24,6						
User/ consumer awareness	Safety during the conduction of pilots	90,0				100,0					

and acceptance	No car day							55,0	0,0		
	ICT Access and Usage by Individuals	10,0	100,0	100,0	100,0	100,0	100,0	45,0	100,0	100,0	100,0
Safety/ Security	technology/service - general safety requirements	36,7	45,0	Not relevant		Not relevant			18,3		
	safety during the conduction of pilots	46,7									
	National Cyber security	16,7	55,0		58,8		100,0	22,9	15,0	100,0	100,0
	Collection of accidents data				41,3						
	Parking requirements (safety for pedestrians)							44,2	26,7		
	Bicycle roads length per population							32,9	40,0		
Completeness of pilots and contracts requirements	Pilots and time limited -permits	50,0	100 or 0	n.a.			100 or 0	100 or 0	100 or 0	100 or 0	100 or 0
	Requirements to operate		100 or 0				100 or 0	100 or 0	100 or 0	100 or 0	100 or 0
	Number of government-funded AV pilots	50,0									
Environment	Density of electric charging stations	0,0								38,3	36,7
	Environmental Policy Stringency Index	100,0	100,0	100,0	100,0	100,0	50,0	75,0	50,0	28,3	63,3
	No Car Day						50,0	25,0	50,0		
	Specific environmental measures									33,3	
Social	Employment	50,0	68,3	55,0	71,7	40,0	50	62,5	20,0	33,3	18,6
	National Internet privacy Index	50,0	31,7	45,0	28,3	60,0	50	37,5	80,0	26,7	23,6
	Competition with existing services									40,0	
	Financial accessibility										20,8
	Persons with disabilities										18,9
	Accessibility in rural areas										18,1
Cooperation	National Data sharing environment in transport / Specific Data	20,0	51,7	50,0	31,7	35,0	50,0	50,0	60,0	45,0	38,3

	sharing assessment										
	Public-Private cooperation in the definition of national strategies	80,0	48,3	50,0	36,7	65,0	50,0	50,0	40,0	55,0	61,7
	Agreement among operators				31,7						
Other	Liability	100,0									
	Public Transport					100,0					

Figure 13 Weights obtained from the Pairwise Comparison

4.7 MCA results

The results of the Multi-Criteria Analysis are presented in Annex IV and commented in the following paragraphs. It is worth noting that the update of the regulations in the dashboard, still in place at the time of submission of this deliverable, will provide a more comprehensive and up-to-date view and comparison of how regulatory frameworks enable the new mobility solutions analysed by GECKO and the graphical visualisation of the Compliance Map (T3.3) will provide more immediate information.

Connected and Automated Vehicles

The MCA shows that currently the evaluation categories which a particular attention has been paid to when analysing the existing regulatory frameworks are Environment, Data and Cooperation. In these three evaluation categories, the United Kingdom is the country with the highest assessment: Cross-government and private sector collaboration is one of the strengths of the UK regulatory framework. Australian regulatory frameworks, on the other hand, address in a particularly effective way the social aspects related to the adoption of autonomous vehicles (Social, Consumer Acceptance, Safety and Liability).

Singapore achieves the highest scores in terms of infrastructure and Completeness of pilots and contracts requirements: the Singapore government has funded the largest number of AV pilots and created the Centre of Excellence for Testing and Research of Autonomous Vehicles at Nanyang Technological University (CETRAN), planning to launch AV buses as a public transport service soon[8].

As regards the comparison among the average values obtained by regulatory frameworks at country level, Australia takes the first place, thanks to its great effectiveness in addressing the social aspects linked to the CAV; in the second place comes France, which obtains high but never maximum scores in all the evaluation categories, with the exception of liability that scores lower,

[8] https://www.cnbc.com/2020/09/22/singapore-hopes-to-take-its-driverless-ambitions-to-the-public.html

together with the USA and Australia. In the third place comes the United States, which obtains the highest score in the evaluation categories Political and Liability.

Drones for last mile delivery

The MCA shows that currently the evaluation category best addressed by the existing regulatory frameworks are Digital infrastructure, Data and Political. United Kingdom regulatory framework scores best in 5 out of 7 evaluation categories. In 2016, Amazon performed its first commercial drone delivery in the UK - from Amazon' fulfilment centre in Cambridge to a local resident, 13 minutes after receiving the order and in April 2020, the UK government announced larger unmanned aerial vehicles (UAVs) would deliver essential hospital supplies from the mainland to the Isle of Wight[9]. Social and Consumer acceptance aspects are better addressed by Sweden. In this respect, it should be pointed out that Swedish regulations do not specifically address the delivery aspect. However, since May 2020 the Swedish company Everdrone, in collaboration with SOS Alarm, Sweden's national emergency call centre, has been deploying a drone system that delivers Automated External Defibrillators (AEDs) to the scene of cardiac arrests.

Big Data

The MCA shows that currently the evaluation category best addressed by the existing regulatory frameworks are Safety, Infrastructure and Environment. This mobility solution does not have one particularly effective regulatory framework compared to others analysed, with the United Kingdom, Germany and Singapore achieving very similar scores.

Network and traffic management

At the moment only regulations at EU level have been collected in the Dashboard for this use case, so the MCA could not provide a meaningful comparison on different approaches of the regulatory framework. In this regard, ERTICO, an organization aiming at promoting and accelerating the Intelligent Transport Systems in Europe created in 2014 the traffic management 2.0 (TM2.0),an innovative platform, aimed at creating a Collaborative and Interactive Traffic Management System, by developing synergies between the public authorities, the private service providers and the drivers.

"The TM 2.0 concept is based on the:

- Provision of individual communication channels between TMC's and road users/service providers;
- Development of a new interface for data exchange between TMC's and service providers, necessary for individual and collective traffic information and signage;
- Cooperation and information exchange with other transport modalities;
- Development of (new) business cases with benefit to all stakeholders"[10].

Four cities will be pilots for testing TM2.0 concept in the framework of the European project SOCRATES2.0: Amsterdam, Copenhagen, Munich, Antwerp. This is a first step towards the deployment of this cooperation framework and new business model development. These pilots

[9] https://www.bbc.com/news/technology-54102580

[10] Contractual Agreements in Interactive Traffic Management – looking for the optimal cooperation of stakeholders within the TM 2.0 concept, Tiffany Vlemmings & al., Paper number ITS-TP0785

will be the first experience regarding C-ITS for network traffic management. The lessons that will be learnt from that will allow this cooperation model to be improved and deployed at a larger scale by 2040.

MaaS

The MCA shows that currently the evaluation category best addressed by the existing regulatory frameworks are Environment, User/consumer awareness and Acceptance and Cooperation.
This mobility solution does not have one particularly most effective regulatory framework compared to others analysed, with the United Kingdom, Sweden and Finland achieving very similar scores. Again, Cross-government and private sector collaboration is one of the strengths of the UK regulatory framework; the Swedish regulatory framework better addresses social policy aspects, while Finland clearly regulates the data aspect and the evident identification of the role that Public Transport has to play within the MaaS environment.

Car-sharing

The MCA shows that currently the evaluation category best addressed by the existing regulatory frameworks are Data, User acceptance and Safety. The highest average score is achieved by Germany, which is the biggest car sharing market in Europe[11]. With its "Act on the priority of carsharing (Carsharinggesestz - CsgG)", Germany enabled measures to give priority to car-sharing to promote the use of car-sharing vehicles within the framework of station-independent or station-based service models in order to reduce the effects of motorised private transport on the climate and the environment for example through special parking privileges for car share vehicles. The same score was obtained by Australia's regulatory framework. After a slower start in service, Australia is now seeing strong growth in the Car-sharing market (from 2014 to 2019 the industry doubled, growing by 26.2% annually. In 2019 it was valued at $54 million[12]) and Australian property developers are partnering with carshare service providers with the aim to embed their vehicles into new apartment complexes to reduce the number of private car parking spaces[13].

Bike- sharing

The MCA shows that currently the evaluation category best addressed by the existing regulatory frameworks are Data, Cooperation and Completeness of pilots and contracts requirements. This mobility solution does not have one particularly most effective regulatory framework compared to others analysed, with Chicago, Toronto, Sidney, Vienna and Barcelona achieving very similar scores. With regard to the individual evaluation categories, it is worth pointing out that the Vienna regulatory framework achieves greatest scores in Infrastructure and Safety categories; this because the Austrian capital is developing a good cycling network, consisting of different kinds of

[11] https://www2.deloitte.com/content/dam/Deloitte/de/Documents/consumer-industrial-products/CIP-Automotive-Car-Sharing-in-Europe.pdf

[12] https://blog.carnextdoor.com.au/car-sharing/car-sharing-industry-trends-a-new-era-of-mobility/#:~:text=The%20Car%20Sharing%20Industry%20In%20Australia,-Car%20sharing%20arrived&text=Over%20the%20past%20five%20years,%2C%20Perth%2C%20Canberra%20and%20Adelaide.

[13] https://movmi.net/shared-mobility-australia-new-zealand/

cycle routes such as cycleways, cycle lanes, cycle paths, combined pedestrian and cycle paths, multiple purpose lanes, and traffic-calmed zones[14].

E-scooter sharing/ Micromobility

The MCA shows that currently the evaluation category best addressed by the existing regulatory frameworks are User/consumer awareness and acceptance, Social and Data. The highest average score is achieved by the City of Portland conducted two pilot permit programs to better learn how e-scooters fit into city's transportation landscape and whether they help advance the city's goals for mobility, climate, equity, and safety. Now the Portland Bureau of Transportation (PBOT) is aiming at creating deeper partnerships with fewer companies[15]. Right after Portland, the highest average score is obtained by Chicago: the city has granted permission to three shared e-scooter companies to operate in the 2020 e-scooter pilot. Companies will be allowed to operate citywide and each vendor is limited to no more than 3,333 devices, and vendors will be required to deploy at least 50% of their devices within the Equity Priority Area[16]; A novelty regarding the second pilot is a requirement that all e-scooters must be equipped with locks that prescribe riders to lock the device to a fixed object to end their trip. This new requirement aims to reduce dangerous sidewalk clutter and maintain clear pathways and unobstructed sidewalks, especially residents with disabilities.

Ride-hailing and TNC

The MCA shows that currently the evaluation category best addressed by the existing regulatory frameworks are Cooperation, Data and User/consumer awareness and acceptance. The highest average score is achieved by United Kingdom. Cities' regulations are controlled by the national government based on the "Private-Hire Vehicles London Act" but cities can set their own licensing standards. In London, Transport for London conducts continuous checks on criminal background and driving history on ride-hailing drivers. Additionally, every three years drivers have to submit medical clearances; while other conditions for issuing licences include the need to pass vehicle inspections and commercial insurance coverage. Furthermore, in April 2019 London expanded application of the daily charge to include ride-hailing vehicles which are also subject of payment of an additional £12.50 charge per day to enter into the Ultra Low Emission Zone if they don't meet the required engines standards. This is not required for traditional taxi services and for this reason ride-hailing drivers are challenging this distinction in litigation. Indeed from the MCA it results that the social evaluation category, which includes the aspect of competition with existing services, is better addressed by the Canadian regulatory framework; the city of Toronto, for example, imposed some price controls for ride-hailing services: in order to both protect the traditional taxi city's services and to ensure adequate income for ride-hailing drivers, ride-hailing services cannot charge less than $3.25 per trip (approximately the equivalent of the base taxi fare). In addition, the city allowed traditional taxis to use booking apps to charge below or above

[14] https://www.wien.gv.at/english/transportation-urbanplanning/cycling/cycle-network.html
[15] https://www.portland.gov/sites/default/files/2020-09/pbot_escooter_report_final.pdf
[16] https://www.chicago.gov/content/dam/city/depts/cdot/Misc/EScooters/2020/Chicago 2020 E-Scooter Pilot Map.pdf

the metered rate, enabling them to compete with ride-hailing service providers on price flexibility[17].

On-demand ridesharing and carpooling

The MCA shows that currently the evaluation category best addressed by the existing regulatory frameworks are Safety, Completeness of pilots and contracts requirements and User/consumer awareness and acceptance. The highest average score is achieved by United Kingdom. With its "Registration of flexibly route local bus services" UK allowed an element of flexibility in the provision of local bus services; in particular "to qualify and register as a flexible service, each passenger must be able to leave the bus within 24.15kms (15 miles) (measured in a straight line) from the place at which they were picked up". However, social aspects, including Accessibility in rural areas, Persons with disabilities and Financial accessibility, are better addressed by the Spanish regulatory framework, which sets out precise requirements on prices and availability of the service for people with disabilities; for example, through periodic plans, the city of Madrid ensures that the group of disabled people has sufficient adapted vehicles to cover their needs. Finally, the infrastructural aspect is better addressed by Singapore: the City-state is investing a lot to digitalize the city and make it one of the most advanced smart city models. Since On-Demand Ridesharing involves a system that matches riders and drivers to share transportation at random times and locations and relies on recent technological advances such as GPS navigation devices to determine a driver's route and arrange the shared ride, this aspect is an important enabling factor. In 2018 Singapore launched a 6-month on-demand public bus service (ODPB) operational trial exploring the utilisation of dynamic routing and matching algorithms to optimise limited resource[18].

[17] E-Hail Regulation in Global Cities (nyu.edu)

[18] https://www.smartnation.gov.sg/what-is-smart-nation/initiatives/Transport/on-demand-shuttle

5. CONCLUSIONS

From the results of the MCA it can be deduced that both at European and extra-EU level there is increasing ferment in wanting to "keep up" with innovations in transport and this is bringing nations to develop new regulations responding to new needs related to the innovative transport solutions. One example is the UK. In March 2020, the Department for Transport drafted the document "Future of Transport Regulatory Review, Moving Britain Ahead", with which the United Kingdom wants to confirm its role as "world leader in shaping the future of transport" through "a robust but innovative, flexible and data-driven regulatory framework for transport" and opening the dialogue with "all those with an interest in what an innovative and flexible regulatory framework looks like for emerging transport technologies and business models, recognising their benefits to society, the environment and the economy but also the risks they potentially pose if left unmanaged"[19]. Countries are then seeking to address areas of regulation that are now somehow obsolete and so acting as an obstacle to innovation, or not envisaged towards innovative technologies and new business models. This to take advantage of new regulations for managing new technologies and services by guaranteeing a development in accordance to a user-centric approach and with the involvement of relevant stakeholders and decision makers.

[19] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/936129/future-of-transport-regulatory-review-call-for-evidence-document.pdf

ANNEXES

Annex I: Questionnaires

GECKO
GOVERNANCE FOR NEW MOBILITY SOLUTIONS

Connected and Automated Vehicles

Dear GECKO stakeholder,

Many thanks for taking the time (roughly 10 minutes) to complete this survey. Your feedback will inform the creation of the GECKO Regulatory Frameworks Dashboard, a tool being developed to allow policy makers (and others) to search for existing regulations based on given criteria to help them understand the possible effects of such regulations.

You will be asked to evaluate how effectively 6 different regulations/policy documents enable the adoption of connected and automated vehicles - with a particular focus on 3 specific indicators. Short excerpts from the regulations describe their relationship to the indicator in question. You are also very welcome to read the full regulations at the links provided. You may find them valuable to you (but note: some of them are quite long and in some cases you may need a translation tool).

Thank you again for your input! As always, we're grateful for your support of the GECKO project and will keep you up to date as the Dashboard develops.

* Required

Your name *

Your answer

Your organisation *

Your answer

Are you: *

- ◯ a public policy maker
- ◯ someone from the private sector who creates or offers new mobility services or technologies
- ◯ a researcher, NGO representative or other with a (non-business interest in new mobility technologies, issues, or solutions

Connected and Automated Vehicles

* Required

The safety of automated vehicle technology

The following 2 regulation excerpts address aspects of ensuring that the automated vehicle technology does not cause danger to people, property or animals.

Jurisdiction level: Supra national - Full text at:
https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/13069a-ads2.0_090617_v9a_tag.pdf

Regulation USA _ "AUTOMATED DRIVING SYSTEMS 2.0: A VISION FOR SAFETY"

Extract of the regulation:

"In this document, NHTSA offers a nonregulatory approach to automated vehicle technology safety. Section 1: Voluntary Guidance for Automated Driving Systems (Voluntary Guidance) supports the automotive industry and other key stakeholders as they consider and design best practices for the testing and safe deployment of Automated Driving Systems (ADSs - SAE Automation Levels 3 through 5 – Conditional, High, and Full Automation Systems). It contains 12 priority safety design elements for consideration, including vehicle cybersecurity, human machine interface, crashworthiness, consumer education and training, and post-crash ADS Behavior. Given the developing state of the technology, this Voluntary Guidance provides a flexible framework for industry to use in choosing how to address a given safety design element. In addition, to help support public trust and confidence, the Voluntary Guidance encourages entities engaged in testing and deployment to publicly disclose Voluntary Safety Self-Assessments of their systems in order to demonstrate their varied approaches to achieving safety."

GECKO

How well does the regulation achieve the balance between facilitating the introduction of automated vehicles and ensuring the safety of the automated vehicle technology? *

	1	2	3	4	5	
not at all	○	○	○	○	○	very well

How familiar are you with this regulation? *

- ○ My work is affected by it
- ○ I've read the full regulation
- ○ I've heard of it
- ○ Not at all

Jurisdiction level: Supra national - Full text at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52018DC0283

How well does the regulation achieve the balance between facilitating the introduction of automated vehicles and ensuring the safety of the automated vehicle technology? *

	1	2	3	4	5	
not at all	○	○	○	○	○	very well

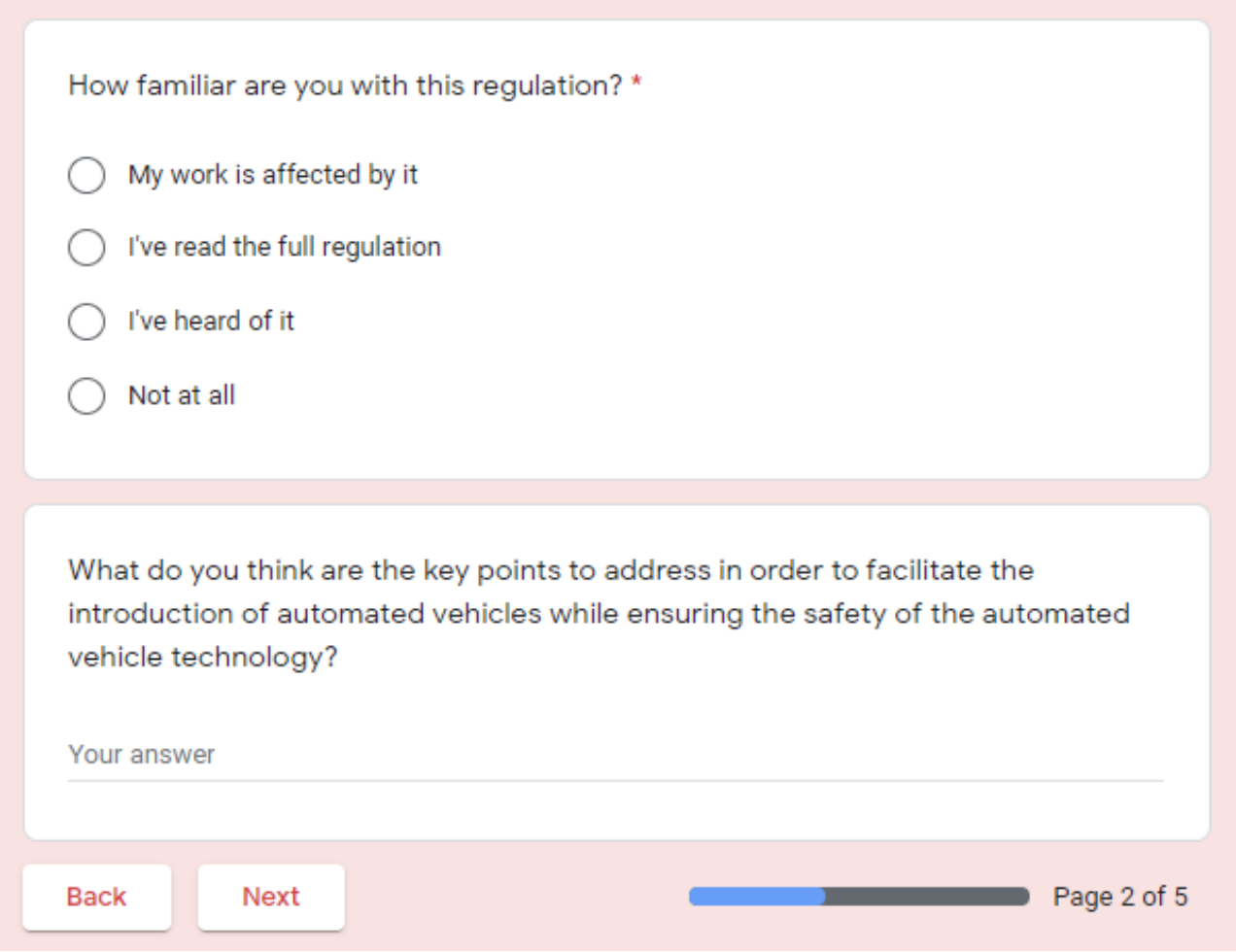


Figure 14 Example of questionnaire sent to stakeholders

Annex II: Questionnaire analysis

Use Case	Regulation	KPI	KPI Value (simple average)	KPI Value (weighted with the stakeholders' knowledge of the regulation)	Standard deviation
Big Data	Directive 2019/1024	Data sharing	4,0	4,0	0,7
	Federal Open Data Act of May 2017	Data sharing	3,8	3,8	0,4
	The Re-use of Public Sector Information Regulations 2015	Data sharing	3,4	3,5	0,9
	Act on the Protection of Personal Information	Data management	3,4	3,4	0,9
	Directive 96/9/EC	Data management	3,2	3,2	0,8
	Personal Data Protection Act 2012	Data Protection	3,6	3,5	1,1
	Directive 2002/58/EC	Data Protection	3,2	3,2	0,8
Bike sharing	Regulation of the magistrate of the city of Vienna concerning stationless rental bicycles	Parking	3,8	3,7	1,0
	Guidelines for dockless bike share operators	Parking	3,2	3,1	1,0
	Dockless bikeshare code of practice for Operators in London	Requirements to operate	3,3	3,3	1,3
	Call for tender to submit the implementation and management of bike sharing services	Requirements to operate	2,8	3,0	1,1
	Deliberazione n.191/2018	Requirements to operate	2,4	2,3	1,1
	Guidelines for dockless bike share operators	Requirements to operate	3,6	3,5	1,0
Car sharing	Shangai Guidance to promote the development of shared new-energy vehicles	Parking	4,0	4,0	0,8
	Bremen car sharing regulations	Parking	4,5	4,7	1,0
	Sydney car sharing policy	Parking	4,3	4,3	1,0
	Leuven: Digital municipal parking card for residents, car sharers and care providers	Requirements to operate	4,0	4,0	0,0
	Recognition conditions and procedures for car sharing organisation in Ghent	Requirements to operate	3,3	3,4	1,7

	Certification of enrollment: engrossed substitute house bill 2384 Personal Vehicle Sharing Programs	Requirements to operate	2,8	2,8	1,3
CAV	Automated driving system 2,0: A vision for safety	Safety of automated vehicle technology	3,0	3,0	0,7
	COMMUNICATION FROM THE COMMISSION on the road to automated mobility: an EU strategy for mobility of the future	Safety of automated vehicle technology	3,4	3,5	1,1
	COMMUNICATION FROM THE COMMISSION on the road to automated mobility: an EU strategy for mobility of the future	Liability	3,8	3,8	0,4
	Automated and Electric Vehicles Act 2018	Liability	3,0	3,0	0,0
	Guidelines for trials of Automated Vehicles	Pilots and time-limited permits	3,4	3,4	0,9
	Adopted Regulatory Text for Driverless Testing Regulations	Pilots and time-limited permits	3,4	3,4	1,1
Drones for last mile delivery	TSFS 2017:110 The Swedish Transport Agency's regulations for unmanned aircraft	Safety	2,5	2,5	
	Australian Government approval to service provider to use drones in North Canberra (ACT) and Logan (QLD)	Safety	1,0	1,0	0,0
	Commision Implementing Regulation (EU) 2019/947 of 24 May 2019	Safety	1,5	1,6	0,7
	Germany Regulation governing the operation of unmanned aerial vehicles From 30 March 2017	Operating requirements	2,5	2,5	2,1
	UK Civil Aviation Authority CAA - Regulations relating to the commercial use of small drones	Operating requirements	3,0	3,0	1,4
	Belgium Civil Aviation Authoriry BCAA - Regulations	Operating requirements	2,5	2,5	0,7
	Federal Aviation Administration FAA - Commercial Rules- Flying for Work	Operating requirements	2,5	2,4	0,7
MaaS	Remaining challenges for EU-wide integrated ticketing and payment system	Public transport	3,7	3,7	0,8
	MaaS Services and Business Opportunities	Public transport	3,3	3,3	0,8

	Communication 2018/232	Data Sharing	3,2	3,5	1,2
	Directive EU 2019/1024	Data Sharing	3,5	3,5	0,5
	An Activity in the Innovation Partnership Programme-The Next Generation of Travel and Transport	E-ticketing	3,3	3,1	1,4
	Remaining challenges for EU-wide integrated ticketing and payment system	E-ticketing	3,3	3,4	1,2
Network and traffic management	Regulation 2017/1926	Data Standardisation	3,8	3,7	1,0
	Regulation 886/2013	Data Standardisation	3,5	3,5	0,6
	Regulation 2015/962	Data Standardisation	4,5	4,5	0,6
	Regulation 886/2013	Data Sharing	3,3	3,3	1,0
	Regulation 2015/962	Data Sharing	3,5	3,7	1,3
	The changing roles of Road Authorities and Services Provides in Traffic Management 2,0 deployment: A guidelines Document	Agreement among operators	4,3	4,4	1,0
	Directive 2008/96/EC	Accidents	2,8	2,8	0,5
On demand ride sharing and carpooling	Regulation UK: Registration of flexibly route local bus services	Accessibility in rural areas	3,3	3,4	1,0
	City of Los Angeles: Mobility on Demand (MOD) Sandbox Program	Pilots and time-limited permits	3,3	3,3	0,5
	Regulation UK: Registration of flexibly route local bus services	Financial accessibility	4,0	4,0	0,8
	City of Madrid_Decreto 35/2019	Persons with disabilities	4,0	4,1	0,8
	Incentivization for carpoolers (for commuting)	Requirements to operate	3,3	3,4	1,3
	Road Traffic Act 2015 - Exemption for car pools	Requirements to operate	4,3	4,3	1,0
Ride-hailing and TNC	NY State - Ride-sharing Driver Applicants: important information about background checks	Requirements to operate	3,6	3,5	1,1
	Point-To-Point passenger transport industry act 2019	Requirements to operate	3,0	3,0	0,7
	London - Private Hire Vehicles (Operators' Licences) Regulations	Requirements to operate	3,6	3,6	0,5
	Toronto - Licensing of Vehicles-for-hire	Competition with existing services	3,0	3,0	1,0
	China- Interim measures for the Administration of Online Taxi Booking Business Operations and Services	Competition with existing services	3,4	3,4	0,9

	California - Clean Miles Standard and Incentive Program	Environmental	3,8	3,7	0,8
	São Paulo Decree on the usage of urban road for the exploitation of services of paid individual transportation of services	Environmental	3,6	3,5	1,3
	London - Emissions standards for Private Hire Vehicles (PHVs)	Environmental	3,8	3,7	1,1
	China - Shenzhen Blue Sky - Sustainable Development Action Plan	Environmental	3,4	3,4	1,1
E-scooters and micromobility	Decree on the experimentation of Micromobility	Safe driving	2,3	2,3	0,6
	Active Mobility Act	Safe driving	4,0	4,0	0,0
	Ordinance on the participation of microelectric vehicles in the road traffic	Safe driving	2,0	2,0	0,0
	City of Portland- Shared Electric Scooters Permit Application	Pilots and time-limited permits	4,3	4,4	0,6
	City of Chicago - 2020 E-scooter Share Pilot Program	Pilots and time-limited permits	3,7	3,7	0,6
	City of Amsterdam - Shared mobility, opportunities for the city	Pilots and time-limited permits	3,0	2,9	1,0
	City of Portland- City Code 3,12,010, Administrative Rule Portland Bureau of Transportation	Requirements to operate	4,3	4,3	0,6
	City of Oakland - Dockless Scooter Share Program	Parking	3,0	3,0	0,0
	City of Bellevue - 2020 Shared micromobility permit special conditions	Parking	3,7	3,7	0,6

Figure 15 Questionnaire Analysis

Annex II: Key points to be addressed to appropriately regulate specific issues for each use case

Use Case	Specific KPIs				
Connected and Automated Vehicles	**Safety of AV technology**	**Pilots and time-limited permits**	**Liability**		
Key points to address in order to regulate (name of the KPI) for CAV properly?	A better monitoring of the speed and distance for vehicles is key to avoid a bad integration of automated vehicles in the streets. In the other hand, it is somehow crucial to ensure non-automated agents (drivers, cyclist, pedestrians) that the automated vehicle has acknowledged their presence, this specially in ambiguous interferences such as cross-walks or give-ways.	A willingness from government authorities and citizens on adoption of CAV. Also genuine use cases that will actually serve to benefit people.	I think the liability should land by different actors depending on the type of negligence. For the case an automated car does not stop due to a technical problem the liable may be the manufacturer. However is the "driver" the one who would decide which road/street the car will drive in. Deciding to take a given street when an event takes place (protest / sportif event... or simply a market day), may have repercusions on the "driver him/herself"		

	It seems that both regulations are afraid to regulate anything. It seems logical to set goal-based regulations, without specifying technology or features. Something like: "AVs shall outperform human drivers by 50% on average. This should be achieved within the first 10,000 km of test rides ..."		It seems to me entirely clear that when an AV drives in autonomous mode, the responsibility should lie solely with the manufacturer, who can subsequently insure itself against this risk if it wants to. The drivers can insure themselves for the case that they are driving in regular mode. In case of uncertainty of who was 'driving' the vehicle (the driver or the computer), the responsibility should always be assigned to the company. Like the EU regulation suggest, the insurance company should directly compensate the AV user as well any other involved. The insurance company can estimate the risks and translate this into the cost of the insurance (paid for by the car manufacturer). Like the EU regulation suggests, the insurance company can later on try to sue the car manufacturer if they did not behave according to the rules of the insurance or possibly the driver is the driver did something illegal. I think the sector makes too big an issue of this entire liability/responsibility issue. Car companies are large entities and insurance companies are covering much larger risks with ease. It should be no problem to get coverage for the small AV risks.		

	Creating a European standard for conditions that will allow for extensive regulation (Do or Not to Do). Such as the regulatory conditions to move from level 2 to level 3 from level 3 to level 4. so that public bureaucracy will not be exposed to moves that will freeze technological development	See my response to first question: set goal-oriented regulations.	Since a car accident is not one-dimensional, especially at the stage we are at, we need to build a mechanism of division of responsibilities and build flow charts at the appropriate level of draft, based on existing experience.		
		Consolidation of standards			
Drone last mile delivery	**Safety**	**Operating Requirements (requirements to operate)**			
Key points to address in order to regulate (name of the KPI) for Drones for last mile delivery properly?	Clear guidelines setting out exactly how drones should be used.	Too soon we must test			
	WAIT AND SEE				
Big data for transport and mobility	**Data sharing**	**Data Management**	**Data Protection**		
Key points to address in order to regulate (name of	Standardization, open API data availability and regulation	unified open stadards & frameworks	regulated framework on how to deal with personal data in real (technology&operations wise)		

the KPI) for Big Data properly?	common information model / APIs for specific areas	Again, standard definitions of terms related to big data are required. Further, strict rules that govern protecting personal information should be included - protecting PII should not be left up to the entities that are ingesting and using PII to facilitate mobility.	It is not enough to say that "reasonable" security measures must be put in place - what constitutes "reasonable" should be very clearly defined so it is not left up to the entities ingesting and using PII.		
	Regulating big data requires a standard set of definitions related to big data and data sharing as well as requiring that data used to facilitate mobility must be provided free of charge.	Who is the "author of the database"? The point is that more companies make use of public space to collect data (e.g. Uber cars monitoring traffic, e.g. FaceBook, Google, Amazon company apps working on phones that people take inside cars). You can't appropriately manage data in transport and mobility if you haven't organized what data companies are allowed to collect!	The regulation does not ensure that people have an easy way to opt out. In practice the only way to do that is to go through many layers and clicks to uncheck boxes. Companies have made it virtually impossible.		
	This only concerns PUBLIC data. Because freight transport is organized by private companies it does not ensure access to operational freight data. The only way to address this is by incentivizing (carrot or stick) companies to share relevant data publicly - directly or through public authorities. Carrot: SmartWay program in US. Sitck: French decree mandating	data protection, legal perspectives of data ownership	definition of personal data, communication/storage conditions of the data to ensure confidentiality, defining limitations on processing data and possible actions on collected data.		

	emissions reporting from energy including transport services (this would have been one you should include in your study)				
	abiding open standards, availability of public data				
Network and traffic management	**Agreement among operators**	**Data Sharing**	**Data Standardisation**	**Accidents**	
Key points to address in order to regulate (name of the KPI) for Network	Coordination and financing of the responsible authorities.	Dissemination and enforcement of the regulation. In practice we can not access to the data sources...	The regulation is quite sound now the focus should be moved to data provision and enforcement.	Must be more direct to ensure financing for black spot management.	

Traffic Management properly?	Public authorities should recognize their role in enabling value added Services of private Providers that do contribute to overall public value creation. However, public authorities should also be placed in a Position to excercise power when Conduct of service providers interferes with public goals. Authorities should thus indeed be developed into enablers for service creation but also excert the social and democratic responsibility for the systems in their jurisdiction, ensuring that their uses (by service providers and invidiuals) contribute sustainably to public development goals and having the power (and insight to support this power) of addressing issues where such alignment of private development with	The data streams from private mobility service provider but also Information service providers, fleet managers, OEMs etc. towards authorities need to be more clearly defined. There should be an understanding that a certain minimum set of data, that relates to insights regarding road-safety, Status of infrastructure, etc. (and thus relating to roles of the public sector on different jurisdiction levels) should be available for the respective public sector stekeholder for certain reuse purposes that contribute to public value.	Take into account all modes of transport and provide travel updates for all services in an integrated and consistent way (incl active modes)	A large number of near accidents or unsafe situations that do not lead to demage are not taken into account in the evaluation of infrastructure (not just the physical design of it but also it's state (e.g. ice on the road). In Vehicle data that monitors Vehicle behaviour could amend the insights authorities have over the safety of their infrastructure Prior to demage happening and should be made available for respective public sector parties to adress issues accordingly and to further improve infrastructure design guidelines for the long run.	

	public goals is not given.				
			Clearer definition of the rights and duties of the data owners/Producers of the data that is made available: More clarity regarding the conditions for re-use of data (e.g. for commercial Purpose), clear conduct and role assignment regarding the assurance of data varacity		
MaaS and MaaS platforms	**E-Ticketing**	**Data sharing**	**Public transport**		

	it should be compulsory, because they are the backbone of a successful MaaS framework	Equitable levels of data access for maas regulators. Maas Operator and mobility service provider operational contracts at a local level need to include specific data sharing requirements. Overarching legislation for data access, while important, will not satisfy all required local needs.	data sharing, contracts between operators, suitable mobility packages		
Key points to address in order to regulate (name of the KPI) for MaaSproperly?	The integration of e-ticketing services will require an EU-wide clearinghouse. It is not economically obtainable to force all ticketing providers to immediately comply with regulations (replacement of equipment, software development, maintenance, etc.). For the ease of operations and deployment, the EU needs to adot an EU-wide fare model that limits transport product options (not prices, but product types: i.e. monthly passes, flat fare, distance-based, discount-distance-based, etc.). This will reduce the time to implement and allow	an obligation on services and authorities to make this a workable and useful initiative	Financial incentive for use of public transport, while only incentivizing third party mobility operators for the purposes of last mile travel. Implementation of operational solutions to push passengers to third party mobility services in circumstances of public transport issues (i.e. bus breakdowns, overcrowding, etc.) to ensure customer peace of mind when selecting public transport as a means of travel.		

	for successful integration.				
	I think the second example is more specific in pointing out the many steps required, although the first appears more practical. As with all regulation, the key has to be understanding what you want to achieve, rather than simply opening or closing doors.	I'm not directly involved in these discussions so find it hard to respond	opening up of trip data to enable better planning of transport services, options and customer information		

	I think both mentioned regulations address many key points. What I like especially about the first one is that it addresses the need for physical printable tickets as well. These services should also be accessible at e.g. ticketing machines in train stations, so that people without internet banking or smart phone apps can still have access to these tickets.	Mainly that the data sharing happens in two directions, also transparency about what is shared, who it is shared with and for what purpose. Otherwise a situation could arise where government and industry are sharing a lot of data with one another without consent or knowledge of the citizen/consumer involved. There have been too many bad examples of commercial parties sharing data and using this data for all kinds of nefarious purposes (e.g. influencing elections, unethical advertising) to simply trust good intentions, so transparency must be key. Data on individual movements is amongst the most private as it tells you everything about a person's day, activities and interests. E.g. real-time geolocalisation of travellers or transaction data should never be aggregated per person or 'identifier', so that building patterns of invididuals is prevented. True non-personal data such as timetables, prices and schedules should be again shared in both directions in industry-standard formats.	National regulations are critical		

	To implement it, not only do Projects.		Integrated ticketing of course, but also interoperability: that e.g. schedules of the public transport system and availability of other mobility services can be seen in one app. I believe this is one of the topics that the MaaS alliance is working on. Another issue is that of cost of use. Private operators with deep pockets (often driven by venture capital) could offer their services below cost price for extended periods of time. This in turn could erode support for public transport, leading to cost cutting leading to less attractive public transport, et cetera. Then the operator can raise the prices. For a real-world example (except in this case a town chose to subsidise an operator over public transport): https://www.bloomberg.com/news/articles/2019-04-29/when-a-town-takes-uber-instead-of-public-transit		
			I think the key point is to regulate public transport in a way that makes it easier for MaaS operators to integrate public transport in their offer.		
Car-sharing	**Parking**	**Requirements to operate**			
Key points to address in order to	Dedicated parking at good locations	Little regulation, better Treatment than for individually owned cars			

regulate (name of the KPI) for Car sharing properly?	provision of on-street CS stations, which are highly visible, well accessible and well-functioning (= esp. no other cars being parked there); embedding in general parkign management (or better street space management) policies incl enforcement. CS station should look good but not overdesigned. It is more important to have CS stations where people live (and work) as alterntive to car ownership. The multi-modal hubs are rather for intermodal chains, less for multi-modal car-indpendent lifestyle - here it is much more important to have(smaller but more) stations in the neighbourhoods. Maybe add bike-sharing or cargo-bike sharing or e-scooter station to get all these vehicles off the	Depending on the purpose -P2P is different from the other examples. Important to define not only vehicle- but more service related requirements - including tarriff strcutre (no free milage), hourly rate (that are really hourly rates) to get distinction to car rental. See German eco certificate Blue Angel https://www.blauer-engel.de/en/products/home-living/car-sharing/car-sharing-edition-january-2018			

	sidewalks (- promoting walking)				
	The certainty of parking spaces available for carsharing vehicles, the CSOs are able to provide reliable quality mobility service and to fulfil the objective of giving the community a viable alternative to car ownership	To define the requirements to be qualified for carsharing service and service levels to be met.			

	- To extend the parking spots, instead of re-distributing the existing parking spots (unlike the Parisian current policy) - To be conditional with an efective impact on carsharing ownership and car usage (carsharing isn't specific enough) - To be simple (unlike the Sydney car sharing policy) - Not to be conditional to "new energy vehicles" (EVs, ...) (unlike the Shangai guidance)	- Rates per hour, proportionnal per time and km - Available 24 / 7 - One single contract, not 1 contract per rent - Not conditional reservation (the reservation is confirmed immediately, no need to wait for a validation from car owner)			
Bike sharing	**Parking**	**Requirements to operate**			
Key points to address in order to regulate (name of the KPI) for Bikesharing properly?	Geo-fencing is important but GPS accuracy may not be good enough.	Knowledge of where the bikes are and how they are being used. This should be compared to the regulations for us.			
	Geo-fencing, not causing a blockage to footpaths or become a public nuisance, no go areas, removal or redistribution of bicycles in congested areas	bike management, i.e. GPS, redistribution, safety and repairs and user information			

	clear guidelines regarding the parking, taking operators in responsibility (incl. also penalty fees)	a clear code of practice (parking allowance) & information on terms of use (information for the users) & set of responsibilities for the operator (monitoring....)			
	ideally placed nearby transport system's hubs as well as universities, hospitals, public offices. easy to spot and not in conflict with pedestrians or where they could pose a safety hazard. an on street Parking spot could be used to enlight the regained space to sustainable transport	vehicles must be available 24-h year round. clear guidelines			
	Regulations should prohibit free-standing parking outside geofenced areas because there is a risk a bike could be blown or knocked down. Outside geofenced areas, bikes should be locked up against a stand.	Clarity on how the companies must encourage appropriate behaviour from their customers. There is also a requirement for operators to have penalties in place in the event of customer infringement. Appropriate insurances must be in place. Clarity on the standards to be used to maintain the bikes in good working order is also essential.			
	Hub centric model, the city needs to build bike racks in every neighborhood so the bikes can be parked				

	properly everywhere and not be used only in the city center				
	The answer is not only about dockless systems, but for an integrated plan to address Public Bicycle Parking, BikeShare, Scooters and any shared Mobility device. The BikeValet Automated Bicycle Parking System, designed for the combined use for everything noted above, addresses every singe problem that cities encounter, including cluttered sidewalks, theft and vandalism.	1. Community based. Revenue is generated and shared locally within the community, for jobs, operation, service....etc. 2. Community feedback for types of bikes available, including a child's bike, adult, tandem, cargo and adaptive bikes for the disabled. 3. One system for all BikeShare, Public Bike Parking and for Scooters, including all E-Versions. 4. Secure off street parking 5. Fully functioning without the need of any reporting from the public, i.e. damaged or faulty bikes,			
E-scooter sharing/ Micromobility	**Parking**	**Safety**	**Pilots and time-limited permits**	**Requirements to operate**	
Key points to address in order to regulate (name of the KPI) for shared	This must be precise and practical and supported by the visual cues in the environment	Segregation from pedestrians, speed, only use authorised scooters	Have a time limit. Be clear on objectives and how they will be monitored. Above all safety.	Oversight by a public body	

micromobility properly?	There should be a description of the locations where the vehicles can park, and where they can't park, like in the ones above: leaving enough space for pedestrians. Geofencing when implemented well can work on a neighbourhood or block scale but is often said to not be precise enough to function on sidewalk scale. There should be incentives for users to park well, like Lime did by asking its users to take a picture of the parked vehicle in order to end the rental period.	The place of the vehicle on the road - where should it drive? The behaviour of the user during driving the vehicle. Speed limits. But also: technical characteristics of the vehicles, for example that braking is still possible even during electrical failure.	I think that there is still a lot of insecurity around the effects of (e.g.) e-scooters on various policy goals, most is still based on assumptions. In addition, because the mode of exploitation is new, we don't yet always know what criteria to judge them by. I'd say the burden of proof lies with the operator: they have to prove that their vehicles are an added value to the mobility offering of a city. So a temporary pilot would be a good start, this way we can decide on relevant criteria, observe both the positive and negative effects and decide what weight we want to attribute to each. The best would be a transparent and participatory process where relevant actors are involved. An interesting point for political debate would be if we want to hold these vehicles to the same or higher standards than existing modes of transport. E.g. bicycles and cars cause a lot of nuisance when wrongly parked, as well.	I think the Portland example addresses many of them, such as equity, data access and privacy, safety and more. Discussing with operators, sharing experience (such as through GECKO) and involving non-business actors is essential to determine what requirements are detrimental to the business model, and what requirements the operators just don't like because they cause extra effort on their part. In exchange for the use of public space, I'd say the standard for operating a commercial business should rightfully be high.	
	-role of desiganted parking areas/points; responsibility of operator, user and infrastructure manager; ensuring physical accessibility and safety;	The responsibilities of the user, the behicle's owner (e.g. rental company) other road/pavement users and the organisation responsible for the maintainance of the infrastructure.		inclusion and accessibility both physical and digital	

Ride-hailing and TNC	Requirements to operate	Competition with existing services	Environmental measures		
Key points to address in order to regulate (name of the KPI) for Ridehailing properly?	official licences, health checkups, monitoring drivers' working hours, regulations regarding the state of the vehicle, monitoring velocity, users' access to informaion about special type wehicles (for people using wheelchairs, for people who need special seats for small children, bigger cars for larger groups/cargo etc.)	Certain regulations regarding the safety and quality of the sevices (licences, state of the vehicle etc.) should prevent the possibility of dropping the ride-hailing prices dumpingly, but additional regulations regarding pricing should be included.	including them in congestion charges, requrements regarding vehicle standards (Euro 6, electric vehicles, other), including them in city emissions limits and climate policy		
	Ensuring that drivers are identified, managing driver hours	I don't really see much need for regulation on pricing	CO2 emissions, NOx and PM		
	As a starting point driver and passenger safety is key, but it is vital that regulations are developed and updated as the sector develops				
	Additional regulation for disinfection and user obligations (not just rights!)	For ride hailing some basic requirements should be kept: taxation, insurance			
	Unfortunately, I'm more interested in movements of goods	liberalization, authorization, information and communication technologies	traceability of demand and supply		

	rather than passenger mobility.				
On-demand ridesharing and carpooling	**Requirements to operate**	**Pilots and time-limited permits**	**Financial accessibility**	**Persons with disabilities**	**Accessibility in rural areas**
Key points to address in order to regulate (name of the KPI) for On-demand ridesharing and carpooling properly?	1. Ensure that maximum effort is put in to ensure that the car pooling cannot be manipulated by illegal / unlicensed private hire or taxi drivers. 2. Ensure the highest standards possible for safety can be applied, for example, then need for minimum inspection periods for vehicles, regular driving licence and criminal records checks etc.	Adaptation of existing legislation and bylaws, for example the need to update taxi and private hire legislation in order to factor in ride sharing in some regions. Local bylaws can be restrictive for new legislation, in that many have been around for decades and may be out dated, though still have relevance. The next key point is safety. The correct measures need to be mandated in order to ensure the safety of any parties using the service, or who may come in to contact with it. This may need to be bespoke, dependant on the mode of transport made available. Access to the market must be considered, there should be operator standards in place, ensuring that the highest possible levels of service are strived for in order to ensure growth and sustainability.	This legislation is appropriate in assisting the different requirments between the public service vehicle and taxi/private hire sector.	1. There needs to be sufficient provision to ensure that the disabled are not unfairly singled out. 2. There should be mandated requirements for vehicle features when used for specific on demand or ride sharing services, this ensures that disabled access users are not singled out during the booking process (for example asked to book further in advance than an able bodies service user). A good step forward is for all variants of a mode of transport to be standardised in the fitting of equipment. 3. There needs to be mandated requirements for driver and other	Territory coverage, fair pricing and service availability

				operator representative training in the assistance of accessible users using transport and in the use of any restraint or other relevant equipment.	
	Financial sustainability of the service providers, adaptation to reality and flexibility of the services	Safety, accountability, geographic and time set up	Price predictability, price limit and subsidies	Non discrimination regulation and technical capacity of vehicles	We miss a definition of target groups and a link with other modes. For us the distance isn't that import, it's more about the distance to the closest hub.
	Operators have to share the data: who, where, when...	I see too much focus on the business model. I miss modal shift analyses an demographic data. Who are you serving?	Are there exceptions on this for specific target groups, eventually with "3rd party payments or social vouchers?	Do they need to book a journey in advance? Often, people with a wheelchair need to make a reservation. A policy needs to include something	definition of the stops, flexibility of routes and stops

				about that also. And what about the accessibility of the bus stops?	
	required permits and legal issues, limitations on the number of trips, route constraints, fares, etc.	data security, accessibility, fairness, interoperability with other services	setting a maximum fare limit	providing exclusive space, providing necessary equipments to get on/off the ride	

Figure 16 Stakeholders identification of Key points to be addressed in regulatory frameworks for each use case

Annex III: Sources consulted

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Annex IV: MCA results

Connected and Automated Vehicles											
Regulatory frameworks	Infrastructure	Environment	Data	Cooperation	Social	User/consumer awareness and acceptance	Safety	Completeness of pilots and contracts requirements	Political	Other (Liability)	**Average**
Poland*	2,9	3,3	2,4	2,7	2,6	2,1	4,1	1,0	2,4	3,0	**2,7**
Singapore	3,6	3,3	3,3	4,4	2,9	4,0	3,8	4,5	4,3	4,0	**3,8**
Italy	3,0	4,3	3,2	3,4	3,1	3,9	3,7	3,0	0,2	4,0	**3,2**
France	3,2	4,7	4,3	3,5	3,6	4,0	3,6	4,1	4,1	5,0	**4,0**
Austria	3,3	3,8	3,7	3,3	4,1	4,0	3,7	4,1	4,0	4,0	**3,8**
Germany	3,4	4,1	4,0	4,0	3,9	0,4	1,9	2,1	4,6	4,0	**3,2**
United Kingdom	3,5	5,0	4,7	5,0	3,3	0,5	0,8	2,1	4,3	3,0	**3,2**
Spain	3,1	2,9	4,0	3,3	3,6	5,0	3,1	3,8	3,2	0,0	**3,2**
Finland	3,4	4,5	3,8	3,8	4,2	4,0	3,7	4,1	0,5	0,0	**3,2**
USA	3,4	3,5	4,2	4,8	2,5	3,0	4,1	3,8	4,7	5,0	**3,9**
Australia	3,5	4,1	4,5	4,1	4,3	5,0	5,0	3,8	3,8	5,0	**4,3**
Average	**3,3**	**3,9**	**3,8**	**3,8**	**3,5**	**3,2**	**3,4**	**3,3**	**3,3**	**3,4**	

*Datasharing missing

Drone last mile delivery											
Regulatory frameworks	Infrastructure	Environment	Data	Cooperation	Social	User/consumer awareness and acceptance	Safety	Completeness of pilots and contracts requirements	Political	Other	**Average**
France	4,5	4,7	4,5	3,7	3,4	4,2	4,1	3,0	2,1	n.a.	**3,8**
Germany	4,6	4,1	4,2	3,6	3,6	4,0	3,4	2,0	4,4	n.a.	**3,8**
Sweden	4,7	4,0	4,1	4,0	4,5	4,9	3,3	3,0	4,3	n.a.	**4,1**
United Kingdom	4,7	5,0	4,7	5,0	3,0	4,6	4,1	3,0	4,2	n.a.	**4,3**
Japan	4,6	4,1	4,2	3,6	3,4	2,3	3,9	3,0	3,9	n.a.	**3,7**
Belgium*	4,6	3,2	3,0	2,4	2,9	4,4	3,3	3,0	3,5	n.a.	**3,4**
Australia	5,0	4,1	4,6	4,0	4,1	4,5	4,0	3,0	3,7	n.a.	**4,1**
USA	4,7	3,5	4,4	4,4	2,1	2,7	4,1	3,0	4,9	n.a.	**3,7**
China	4,2	2,8	2,3	2,0	1,1	0,9	3,3	2,0	3,9	n.a.	**2,5**
Average	**4,6**	**3,9**	**4,0**	**3,6**	**3,1**	**3,6**	**3,7**	**2,8**	**3,9**		

Big Data											
Regulatory frameworks	Infrastructure	Environment	Data	Cooperation	Social	User/consumer awareness and acceptance	Safety	Completeness of pilots and contracts requirements	Political	Other	**Average**
Germany	4,6	4,1	4,3	4,1	3,8	4,0	4,6	n.a.	4,6	n.a.	**4,2**
Singapore	4,9	3,3	3,2	5,0	2,9	4,2	4,8	n.a.	4,3	n.a.	**4,1**
United Kingdom	4,7	5,0	3,1	4,5	3,2	4,6	5,0	n.a.	4,3	n.a.	**4,3**
Japan	4,6	4,1	3,4	1,9	3,5	2,3	4,7	n.a.	4,2	n.a.	**3,6**
Average	**4,7**	**4,1**	**3,5**	**3,9**	**3,3**	**3,8**	**4,8**	**n.a.**	**4,4**	**n.a.**	

MaaS and MaaS platforms											
	Infrastructure	Environment	Data	Cooperation	Social	User/consumer awareness and acceptance	Safety	Completeness of pilots and contracts requirements	Political	Other (public Transport role)	**Average**
Finland	4,3	4,5	4,7	4,5	4,3	4,1	n.a.	3,0	2,4	4,0	**4,0**
Sweden	4,2	4,0	4,2	4,3	4,6	4,9	n.a.	3,0	4,3	n.a.	**4,2**
Netherlands	3,3	4,7	3,3	3,3	3,9	4,6	n.a.	n.a.	2,4	n.a.	**3,6**
United Kingdom	4,5	5,0	4,6	5,0	3,4	4,6	n.a.	4,0	4,2	4,0	**4,4**
Average	**4,1**	**4,5**	**4,2**	**4,3**	**4,1**	**4,5**	**n.a.**	**3,3**	**3,3**	**4,0**	

Car-sharing											
	Infrastructure	Environment	Data	Cooperation	Social	User/consumer awareness and acceptance	Safety	Completeness of pilots and contracts requirements	Political	Other	**Average**
Portugal*	1,5	1,5	2,8	2,3	3,3	3,3	4,1	0,0	0,0	n.a.	**2,1**
Sweden	2,4	2,3	4,1	4,1	4,6	4,9	4,4	0,0	4,3	n.a.	**3,4**
USA	1,6	1,9	4,2	4,4	2,5	2,7	5,0	2,0	5,0	n.a.	**3,3**
United Kingdom	2,5	2,8	4,7	5,0	3,3	4,6	5,0	2,0	4,2	n.a.	**3,8**
Australia	3,0	2,1	4,5	4,0	4,3	4,5	4,8	4,0	3,6	n.a.	**3,9**
China	3,1	2,0	1,7	2,1	1,0	0,9	4,4	0,0	3,8	n.a.	**2,1**
France	2,9	2,5	4,4	3,7	3,6	4,2	4,9	4,0	0,0	n.a.	**3,4**
Germany	3,5	2,4	4,1	3,6	3,9	4,0	4,6	5,0	4,3	n.a.	**3,9**
Belgium*	2,9	1,7	2,7	2,5	3,1	4,4	4,4	4,0	3,0	n.a.	**3,2**
Average	2,6	2,1	3,7	3,5	3,3	3,7	4,6	2,3	3,1	n.a.	

*Datasharing missing

Bike sharing											
Regulatory frameworks	Infrastructure	Environment	Data	Cooperation	Social	User/consumer awareness and acceptance	Safety	Completeness of pilots and contracts requirements	Political	Other	**Average**
Barcelona	1,6	3,0	4,0	3,3	3,5	3,9	3,3	5,0	2,8	n.a	**3,4**
Bologna	2,8	3,2	3,2	2,8	2,9	1,2	2,6	5,0	2,3	n.a	**2,9**
Chengdu	1,5	2,1	1,7	2,1	1,1	0,4	3,3	5,0	3,8	n.a	**2,3**
Xi'an	1,5	2,1	1,7	2,1	1,1	0,4	3,2	5,0	3,8	n.a	**2,3**
Rome	2,0	3,7	3,2	2,8	2,9	2,2	3,1	4,0	2,3	n.a	**2,9**
Hamilton	1,7	3,2	4,6	4,7	4,0	1,9	1,1	n.a.	3,7	n.a	**3,1**
Toronto	1,7	3,2	4,6	4,7	4,0	1,9	3,4	4,0	3,7	n.a	**3,5**
Sydney	1,8	3,3	4,5	4,0	4,2	2,4	2,9	5,0	3,6	n.a	**3,5**
Canberrra	1,8	3,1	4,5	4,0	4,2	2,0	1,1	5,0	3,6	n.a	**3,3**
Vienna	4,9	3,4	3,8	3,2	4,1	3,0	4,9	0,0	3,5	n.a	**3,4**
Turin	2,2	3,2	3,2	2,8	2,9	1,2	1,4	0,0	2,3	n.a	**2,1**
New York	1,7	3,7	4,2	4,4	2,2	3,5	1,2	5,0	5,0	n.a	**3,4**
Pune*	1,1	1,8	2,7	2,6	1,5	0,0	2,7	5,0	0,0	n.a	**1,9**
Calgary	1,8	3,2	4,6	4,7	4,0	1,9	1,2	5,0	3,7	n.a	**3,3**
Chicago	1,7	3,7	4,2	4,4	2,2	3,6	2,9	5,0	5,0	n.a	**3,6**
Denver	1,7	2,6	4,2	4,4	2,2	1,2	3,4	5,0	5,0	n.a	**3,3**
Milwaukee	1,7	2,6	4,2	4,4	2,2	1,2	1,1	5,0	5,0	n.a	**3,1**
Average	**1,9**	**3,0**	**3,7**	**3,6**	**2,9**	**1,9**	**2,5**	**4,3**	**3,5**	**n.a**	

*ICT access missing

E-scooter sharing/ Micromobility											
	Infrastructure	Environment	Data	Cooperation	Social	User/consumer awareness and acceptance	Safety	Completeness of pilots and contracts requirements	Political	Other	**Average**
Singapore	4,6	2,0	3,3	3,2	3,2	4,2	2,6	0,0	4,9	n.a.	**3,1**
Boston	4,4	1,8	4,2	4,3	3,3	2,7	2,9	0,0	5,0	n.a.	**3,2**
Brussels*	3,8	2,6	2,6	2,0	3,5	4,4	3,3	4,0	3,0	n.a.	**3,2**
Portland	4,7	3,4	4,2	4,3	3,3	2,7	4,9	5,0	5,0	n.a.	**4,2**
Amsterdam	4,7	3,3	4,0	4,1	4,0	4,6	3,6	4,0	0,0	n.a.	**3,6**
Stockholm	4,3	2,4	4,0	3,9	4,7	4,9	2,2	3,0	4,3	n.a.	**3,7**
Lisbon*	3,8	3,3	2,6	1,8	3,8	3,3	2,0	3,0	0,0	n.a.	**2,6**
Montreal	4,0	3,1	4,5	4,6	4,4	4,2	2,3	0,0	3,7	n.a.	**3,4**
Paris	4,4	2,6	4,3	3,8	3,9	4,2	3,3	2,0	0,0	n.a.	**3,2**
Vienna	4,3	2,9	3,7	3,2	3,9	4,3	3,4	2,0	3,5	n.a.	**3,5**
Copenhagen*	4,7	2,7	3,0	1,8	4,8	4,8	2,5	3,0	0,0	n.a.	**3,0**
Detroit	4,4	2,6	4,2	4,3	3,3	2,7	3,9	4,0	5,0	n.a.	**3,8**
Chicago	4,2	3,9	4,2	4,3	3,3	2,7	4,5	5,0	5,0	n.a.	**4,1**
Montreal	4,0	3,1	4,5	4,6	4,4	4,2	2,6	4,0	3,7	n.a.	**3,9**
Average	**4,3**	**2,8**	**3,8**	**3,6**	**3,8**	**3,9**	**3,1**	**2,8**	**3,1**		

*Datasharing missing

Ride-hailing and TNC

	Infrastructure	Environment	Data	Cooperation	Social	User/consumer awareness and acceptance	Safety	Completeness of pilots and contracts requirements	Political	Other	**Average**
Canada ()	2,7	1,3	4,5	4,7	4,1	4,2	4,8	4,0	3,7	n.a.	**3,8**
Singapore ()	2,9	1,1	3,0	3,7	3,3	4,2	4,8	4,0	4,9	n.a.	**3,6**
China ()	2,8	2,2	1,2	2,3	1,8	0,9	4,4	4,0	3,8	n.a.	**2,6**
France ()	2,6	1,4	4,3	3,7	2,5	4,2	4,9	2,0	0,0	n.a.	**2,9**
Germany ()	2,9	1,5	3,8	3,7	2,3	4,0	4,6	0,0	4,3	n.a.	**3,0**
United Kingdom ()	2,9	3,0	4,8	5,0	2,7	4,6	5,0	4,0	4,2	n.a.	**4,0**
USA (California)	2,7	1,1	4,1	4,5	1,4	2,7	5,0	3,0	5,0	n.a.	**3,3**
Brazil (São Paulo)	1,9	1,5	2,8	2,5	2,5	2,3	3,1	3,0	2,1	n.a.	**2,4**
Belgium (Brussels- Capital)	2,6	1,3	2,0	2,8	2,2	4,4	4,4	1,0	3,0	n.a.	**2,6**
Brazil (Rio de Janeiro)	1,9	0,9	2,8	2,5	2,5	2,3	3,1	2,0	2,1	n.a.	**2,2**
Spain (Madrid)	2,4	1,5	3,9	3,3	2,1	4,5	4,8	1,0	2,8	n.a.	**2,9**
USA (California)	2,7	2,4	4,1	4,5	1,4	2,7	5,0	1,0	5,0	n.a.	**3,2**
Canada (British Columbia)	2,7	2,0	4,5	4,7	4,1	4,2	4,8	4,0	3,7	n.a.	**3,8**
Average	**2,6**	**1,6**	**3,5**	**3,7**	**2,5**	**3,5**	**4,5**	**2,5**	**3,4**		

On-demand ridesharing and carpooling											
Regulatory frameworks	Infrastructure	Environment	Data	Cooperation	Social	User/consumer awareness and acceptance	Safety	Completeness of pilots and contracts requirements	Political	Other	**Average**
Singapore	3,4	2,3	3,2	3,9	1,3	4,2	4,8	4,0	4,9	n.a.	**3,6**
United Kingdom	3,4	3,4	4,7	5,0	3,2	4,6	5,0	5,0	4,2	n.a.	**4,3**

Spain (Madrid)	3,0	1,8	4,0	3,3	3,5	4,5	4,8	5,0	2,8	n.a.	**3,6**
USA (Los Angeles)	3,2	2,3	4,1	4,6	1,5	2,7	5,0	4,0	5,0	n.a.	**3,6**
India* (Haryana)	2,1	1,5	2,6	2,9	0,8	n.a.	3,9	5,0	0,0	n.a.	**2,3**
France (Ille De France)	3,1	3,1	4,3	3,6	2,4	4,2	4,9	4,0	0,0	n.a.	**3,3**
Average	**3,0**	**2,4**	**3,8**	**3,9**	**2,1**	**4,0**	**4,7**	**4,5**	**2,8**		

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