FINAL CONCEPTUALIZATION OF CHOICE CRITERIA AND INCENTIVES

Deliverable D2.4

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1. EXECUTIVE SUMMARY

The deliverable describes the activities and the final outcomes of Ride2Rail T2.1 related to the conceptualization of choice criteria (i.e., offer categories and user preferences) and incentives for journey planning in the door-to-door multi-modal scenario addressed by Shift2Rail IP4.

In particular, this deliverable describes the survey designed, administered, and analysed by Ride2Rail to collect data from European travellers on their choice criteria when looking for a travel solution and on their potential interest in specific incentives to multi-modal travel offers. The collected data have been firstly analysed to validate and check the completeness of the first conceptualization of choice criteria and incentives (proposed in D2.1). Then, contextual and socio-demographic information of the respondents has been considered to better characterize the target users of a journey planning application in terms of choice criteria and potential interest in incentives. Finally, clustering techniques have been applied to the collected data with the goal to find mobility patterns (i.e., a common set of characteristics shared by a group of respondents in terms of travel behaviours).

The major findings and results of Ride2Rail T2.1, described in this deliverable, are:

- The terminology alignment with Shift2Rail IP4 and the final conceptualization of offer categories, user preferences, and incentives that represent the reference terminology for the Ride2Rail project and contribute to the definition of a reference glossary for Shift2Rail IP4 projects;
- Catalogues of concrete instances of offer categories and incentives to support the classification of travel offers and their promotion to target users;
- The travellers' preferences model that defines the dimensions to be used to collect and infer user contextual preferences, enabling filtering and ranking of multimodal travel offers;
- The identified mobility patterns and the overall results of the contextual and socio-demographic analysis of the data collected from European travellers through the survey to be potentially used for the definition of enhanced traveller profiles in the Travel Companion application.

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Abbreviations and acronyms

CFM	Calls for Members
CMMP	Contractual Management Market Place
CS	Category Score
CSV	Comma-separated Values
DCDT	Driver Context Dimension Tree
EU	European Union
IP4	Innovation Programme 4
MaaS	Mobility-as-a-Service
NeTEx	Network Timetable Exchange
NGO	Non-Governmental Organization
OC	Open Call
OS	Offer Score
PA	Personal Application
PW	Preference Weight
S2R JU	Shift2Rail Joint Undertaking
TC	Travel Companion
TCDT	Traveller Context Dimension Tree
TE	Travel Expert
TSA	Travel Solution Aggregator
TSP	Transport Service Provider
URL	Uniform Resource Locator
WP	Work Package

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2. BACKGROUND

The present document constitutes the Deliverable D2.4 “Final conceptualization of choice criteria and incentives” in the framework of the WP2, task 2.1 of Ride2Rail project (S2R-OC-IP4-01-2019).

It contributes as well to WP2, task 2.3 and WP3, tasks 3.1-3.2 of Ride2Rail project (S2R-OC-IP4-01-2019).

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3. OBJECTIVES/AIM

This document describes activities and outcomes on the second iteration of T2.1 (WP2) of the Ride2Rail project for the definition of choice criteria and incentives for journey planning in the door-to-door multi-modal scenario addressed by Shift2Rail IP4.

In particular, this document aims to describe the design, administration and analysis of the choice criteria survey on EU travellers' behaviours. Moreover, this document describes the final conceptualization of offer categories, user preferences, and incentives, defined considering the results of the survey and feedback collected from project partners and complementary CFM projects on the first T2.1 iteration. Finally, this document provides the results of applying clustering techniques on the data collected through the survey to identify mobility patterns.

The objectives of this document are:

- Provide the reference terminology for Ride2Rail project and contribute to the definition of a reference glossary (i.e., the MaaSIVE glossary) for the IP4 projects;
- Provide the final catalogue of offer categories and the results of the contextual and socio-demographic analysis of the data collected through the choice criteria survey on offer categories to support the development of algorithms to automatically classify travel offers (Ride2Rail T3.1);
- Provide the final version of the travellers' preferences model that enables the collection and inference of user contextual preferences to be used for the filtering and ranking of multimodal travel offers;
- Provide the final catalogue of travel incentives and the results of the contextual and socio-demographic analysis of the data collected through the choice criteria survey on travel incentives to better target the implementation of the Ride2Rail solution and its piloting at the demo sites;
- Describe mobility patterns identified applying clustering techniques to be potentially used for the specification of enhanced traveller profiles in the Travel Companion application.

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4. SURVEY DESIGN AND ADMINISTRATION

The main scenario analysed in Ride2Rail T2.1 targets a user looking for multi-modal travel solutions. To improve the user experience and to create awareness in regards to sustainable solutions, we aim to provide a conceptualization of choice criteria (i.e., offer categories and user preferences) and incentives to define the aspects that can influence the user behaviour in the considered domain.

In the deliverable D2.1 [6], we presented the first conceptualization of choice criteria and incentives for the Ride2Rail project. The proposed conceptualization resulted from a detailed analysis of the state of the art and an alignment with past and ongoing projects of the Shift2Rail IP4. In particular, the first conceptualization is presented as an extension of the glossary defined in the MaaSive project [4]. The main goal of the T2.1 survey, described in this section and analysed in the following sections (5, 6, 7), is to validate and finalize the first conceptualization, collecting data from European travellers. Within this deliverable, we will refer to the T2.1 survey as the *choice criteria survey*, or simply as *the survey*.

To clarify the terminology used in the survey and in the overall document, we provide a brief introductory description of the main terms defined in the first conceptualization:

- A user mobility request generates a set of travel solutions. A travel solution combines an *Offer* and one or more *Trip*(s), describing the itineraries associated to the *Offer*. An *Offer* is described by a set of characteristic expressed as *Offer Features*, i.e. a set of variable-value pairs.
- An *Offer Category* can be seen as a label attached to *Offers* having particular characteristics. An *Offer Category* is computed taking into account a set of *Offer Features*.
- A *User Preference* associates a subjective *Preference Weight (PW)* to a particular *Offer Feature*, representing the desirability of that specific characteristic for the user. The *Preference Weight* of a user can change considering *context-awareness*, i.e., under different conditions the user may have different preferences. *User Preference*s can be used to *filter* or *rank* the different travel solutions for a user.
- An *Incentive* is a technique to influence the behaviour of a user towards a specific travel solution. An *Incentive* is determined by an *Incentive Provider* that proposes it. The *Incentive Provider* defines the rules (*Incentive Conditions*) determining the applicability of the *Incentive* to a given travel solution, and the *Incentive Mechanism* specifying what is the benefit proposed to the user if the specific travel solution is selected.

The results of the survey contribute to the final conceptualization describing the consolidated definition, the catalogues for offer categories and incentives, and the model for user preferences (Section 8).

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In this chapter, we describe the goals of the survey (Section 4.1), the structure of the designed survey (Section 4.2), the tool that was chosen to implement it (Section 4.3) and the administration methodology (Section 4.4).

4.1. Goals of the Survey on Choice Criteria

The choice criteria survey aims to gather information on a travel shopping scenario considering the perspective of a user, with specific mobility needs, that would like to explore and choose among different travel solutions. In the first conceptualization, we described a set of definitions for the concepts of offer category, user preference and incentive. Moreover, we presented an initial catalogue of offer categories, the first version of the preference model, and an initial set of recommendations and examples for incentives targeting multi-modal travel solutions.
Considering the first conceptualization, the survey would like to explore:

- which offer categories a user would like to examine to select among the different travel solutions,
- which user preferences a user would like to express to filter and rank the different travel solutions according to her/his needs and,
- which incentives may influence the user's final choice among the different travel solutions proposed.

We are interested in validating the proposed catalogue of offer categories and the preference model to obtain insights on what are the choice criteria more relevant for the user. Moreover, we would like to assess the completeness of the identified catalogues asking the user to propose additional entries. This second aspect can provide valuable information also to understand if the proposed definition of the concept has been understood by the user. Considering incentives, similarly, we would like to investigate, through a set of examples, which of the approaches that emerged from the state of the art could be more attractive for a traveller. Moreover, we would like to obtain additional suggestions on incentives that can influence the behaviour of a user.

The complementary goal of the choice criteria survey is to perform the described analysis identifying and distinguishing different typologies of users and trips. In particular, we would like to associate with each collected answer a socio-demographic description of the user and a description of the travel context considered. These variables, allow us to contextualize the collected answers, and in particular the user preferences, for a specific type of trip or user. Moreover, these variables provide the needed information to understand if applying clustering techniques is possible to identify travellers with similar behaviours and mobility patterns. This can be useful to define a set of *traveller profiles* to feed algorithms that can improve the experience of a user suggesting more tailored travel solutions according to choices made by travellers with similar behaviours.

To summarize, the choice criteria survey has two main goals: *(i)* to validate and check the completeness of the proposed first conceptualization of choice criteria and incentives, and

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(ii) to provide data enabling clustering of travellers having similar characteristics and behaviour.

4.2. Survey Structure

This section provides an overview of the choice criteria survey structure describing the main ideas and decisions taken to define the structure and questions. In Section 4.2.1, we report the approach used to let the respondent describe the context of one of his previous trips. In Section 4.2.2, we discuss the type of questions designed to validate the first conceptualization of choice criteria and incentives. Last but not least, in Section 4.2.3, we report the socio-demographic questions elicited to obtain a description of the respondent.

In *Appendix A: Choice Criteria Survey* (Section 11.1), we reported the complete set of textual interactions, questions and possible answers composing the administered survey.

4.2.1. Travel context

The overall focus of the choice criteria survey is on the process of selecting a travel solution to fulfil a mobility need. As commented in D2.1, the choice criteria and incentives influencing the user behaviour depends on the specific user but also on the specific context describing the type of trip to be performed.

For this reason, we designed the initial part of the survey to let the user focus on a specific trip. Since the travel contexts can be extremely various, we decided not to propose pre-defined contexts to choose from. Instead, we decided to ask the user to focus on her/his last trip and then describe it considering a list of context dimensions. This approach allows the user to focus on a trip fresh in her/his mind and allows us to increase the number of potential contexts defined by the user and obtainable as answers.

Therefore, we have defined a set of travel context dimensions and potential values to let the user describe her/his last trip. To limit the number of overall questions and the length of the survey, we tried to focus on general dimensions and more detailed aspects relevant to the Ride2Rail project and useful for the intended analysis (e.g., to understand if there is any relation between a travel context dimension value and the selection of specific choice criteria).
We selected the *Reason of the trip* and the *Accompanying persons* as variables, identified in the literature analyzed in deliverable D2.1 [6], that can highly influence choices made in selecting a specific travel solution over another. E.g., travelling alone for work or travelling with children on holiday.

An additional relevant dimension is the *length of the trip*, in time or space. We chose the estimated distance in km as a travel context dimension since the estimated time highly depends on the transport network available and the means of transport used. For example, a trip of a few km on foot in an urban area can have the same duration of a long-distance

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trip by train, but the two trips cannot be compared in terms of alternative travel solutions available.

To obtain a basic idea of travel solutions available for a given trip and to identify potential target users of ride-sharing solutions, we also introduce the *Trip origin and destination* areas as context dimensions assuming one of the following values: *(i) urban area*, defined as a densely inhabited city, (ii) *suburban area*, defined as commuting zone, and (iii) *rural area*.

Last but not least, we decided to ask users a question on the *Means of transport used* to complement *Length of the trip* and *Trip origin and destination* information and better understand the type of trip chosen by the user in answering the survey.

To summarize, the travel context dimensions and related values considered in the survey questions have been:

- *Reason of the trip*: Leasure, Business, Commute, Other commitments;
- *Accompanying persons*: Partner, Family, Friends, Colleague, Alone;
- *Length of trip*: very short (10km or less), short (10km to 50 km), medium (50 km to 300km), long (300 km or more);
- *Trip origin*: urban (densely inhabited city), suburban area (commuting zone), rural area;
- *Trip destination*: urban (densely inhabited city), suburban area (commuting zone), rural area, the same area of origin;
- *Means of transport used.* Grouped in categories as follows: On foot, Bicycle or micro-mobility vehicles, Metro, Bus / Tram / Trolleybus, Private car / Private Taxi / Motorbike, Carpooling / Ridesharing / Shared Taxi, Train, Plane, Ferry.

4.2.2. Choice criteria and incentives

The central part of the survey has been designed to obtain useful insights to validate and finalize the conceptualization of choice criteria and incentives. As commented in Section 4.1, on one hand, we would like to investigate, for each type of traveller and considering different types of trips, which are the most relevant choice criteria and incentives. On the other hand, we would like to check the completeness of the proposed catalogues and preference model allowing the user to provide additional inputs.

We decided to ask the user to imagine that she/he is using a travel app to plan/optimize a trip similar to the one described at the beginning (see Section 4.2.1) by comparing different journey solutions. Then, we designed three-question blocks to collect data on choice criteria and incentives considering the usual interaction order in a typical journey planning application: definition of preferences with reference to travel solutions (user preferences), visualization of travel solutions (offer categories) and proposal of incentives for selecting different travel solutions or additional services (incentives).

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User preferences

The first block of questions addresses the characteristics of a travel offer on which the users would like to express preferences when looking for travel solutions. We considered the first version of the traveller preference model proposed in D2.1 to investigate the preferences that are more relevant for the travellers.

Considering the analysis of the state of the art, we decided to only place focus on the most common variables, describing a travel solution, that can be made available to the user to define preferences. We aimed to provide the respondent with a general set of characteristics applicable to different types of trips and users to obtain comparable answers. In particular, we selected the following: Transportation company, Time interval for the departure and arrival times, Number of transport changes, Travel class, Seat type (e.g. aisle, window…), Meal inclusion, Refundability, Live notifications on trip status updates, and Onboard connectivity.

To investigate also additional and more specific offer features on which a user may be interested in expressing preferences we decided to adopt a different strategy, starting from the user needs. If we consider, for example, a person with reduced mobility (PRM), it is extremely difficult to list all the possible user preferences that she/he would like to express since they mainly depend on her/his particular impairment. Moreover, specific variables may be interesting only by a few respondents but can be extremely important for people having specific needs. To address these issues, we provide to the respondents a set of potential additional needs to choose from, then, we ask with an open-ended question what are the user preferences related to the indicated needs that they would like to specify. This solution allows the user to reconsider her/his needs related to the trip and allows us to correlate these needs to an arbitrary set of offer features suggested by the user as potential user preferences. The additional needs considered have been:

- large/multiple baggage/s, special baggage (sports equipment, instruments, etc.), animal allowance, help needed because of reduced mobility, health-related needs, travel with an infant, other needs.

Offer categories

The second block of questions analyses the offer categories. In the survey questions, we asked users to indicate which are the offer categories that they consider more relevant to discriminate among different travel solutions. The objective of this section of the survey is to validate the list of ten categories elicited in the catalogue of offer categories proposed in D2.1. In the survey, asking the user to focus again on the type of trip chosen, we decided to collect a 1 to 5 relevance-score after presenting each offer category, and then to list all the categories asking the user to choose her/his top three options.

We presented the ten offer categories adopting the following definitions:

- Quick (minimizing the total trip time)
- Short (minimizing the distance covered)

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- Reliable (minimizing the chances of delays, breakdowns or last-minute changes)
- Cheap (having the lowest price)
- Door-to-door (minimizing the segments of the trip that are not covered by the solution)
- Social (facilitating new acquaintances)
- Multitasking (maximizing the possibility to perform other tasks while travelling: productivity, enjoyment, etc.)
- Environmentally-friendly (minimizing the trip's impact on the environment, such as NOx, CO2 emissions, energy consumption, etc.)
- Philanthropic (involving donations to charity or volunteering organizations)
- Comfortable (maximizing your comfort during the trip)

Considering offer categories, it is also important to understand what are the characteristics of an Offer that can determine its membership in a given category. While some offer category can be objectively determined, others can be assigned using different indicators that can be subjective. In the state-of-the-art analysis in D2.1, we highlighted, in particular, the problem of defining *comfortable* travel solutions. For this reason, we decided to add a further question to this block asking the user to select, among different characteristics of a travel solution, the ones that she/he would assign to the *Comfortable* offer category. The elicited list of options shown to the user is: having a comfortable seat, cleanliness of stations and vehicles, low number of different means of transport, minimum number of interchanges, high level of privacy, feeling of personal safety, and protection from the weather.

Last but not least, also for offer categories, we added an open-ended question asking the user to suggest additional offer categories to enrich the proposed catalogue.

Incentives

The third block of questions addresses incentives. Considering the first conceptualization of incentives, we identified different approaches in the state of the art and we proposed a distinction between *tangible* and *intangible* incentives. In the survey, we considered the elicited set of examples reported in D2.1 and we ask the user to rate from 1 to 5 how likely a given incentive is going to succeed in changing her/his final choice among the different travel solutions.

We included questions for each one of the following *tangible* and *intangible* incentives (for the definition see Table 9):

- *Tangible incentives*: Immediate price discount, Price discount on future purchases, Loyalty program with points collection to unlock different rewards, Being offered additional services (e.g. included meal), Discounts on complementary services (e.g. hotel, restaurants…), Free (or discounted) class upgrade;
- *Untangible incentives*: Provide more information about the positive aspects of a solution (e.g. sightseeing locations during the trip), Provide information on the solution's environmental impact, Challenge you to achieve a specific goal (e.g. trying

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ride-sharing for the first time), Competition with friends and a shared leaderboard with points assigned based on your travel choices.

The answers collected through these questions enable different levels of analysis that we will try to explore in the following sections: which is the incentive that could be more effective? it is better to adopt *tangible* or *intangible* incentives? Abstracting from the examples, what is the tangible and intangible mechanism that can be more effective?

To conclude the third block and check the completeness of the proposed incentives, we formulated an open-question asking users to suggest additional incentives to be taken into consideration.

4.2.3. Socio-demographic dimensions

To conclude the design of the survey, we selected a set of socio-demographic dimensions to be asked to the respondent before concluding the survey. This set of variables allows identifying the characteristics of the population answering the survey and checking if the sample is well distributed or unbalanced towards specific values, e.g., only young people answered the survey. Moreover, socio-demographic characteristics enable clustering of travellers, as described in Section 4.1.

The socio-demographic dimensions selected are:

- *Age*: less than 18, 18-24, 25-34, 35-50, 51-65, More than 65
- *Gender*: Male, Female, Prefer not to say
- *Country*: open-ended question
- *Education*: Basic education, Higher education, Bachelor's Degree, Master's Degree or higher, Prefer not to say
- *Employment Status*: Employed full time (40-more hours/week), Employed part-time (max 39 hours/week), Unemployed and looking for a job, Unemployed and not looking for a job, Student, Retired, Self-employed, Unable to work, Prefer not to say

4.3. Survey Tool: Coney and Conversational Surveys

In this section, we describe the Coney tool selected to design and administer the choice criteria survey. We discuss the approach based on a conversational survey and the different features offered by the tool.

4.3.1. Coney overview

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Coney[1], the CONversational SurvEY, is an innovative toolkit designed and developed by Cefriel to design and administer questionnaires and analyze the collected results.
Coney uses a conversational approach, disguising a quantitative data collection process as a qualitative interview by administering the survey in a chat-like interface that resembles an actual conversation with the goal of enhancing the user experience and the engagement of the compilers. The toolkit offers different web applications that cover all the stages of survey design and delivery processes, starting from the survey creation, its administration, and the subsequent data analysis.
Firstly, Coney Create is the editor used to create such questionnaires uses a drag-and-drop puzzle-like system that enables the creation of different conversation patterns, enabling the designer to create chat flows that depend on the answers of the compilers.
Once the survey is ready, it is administered via the Coney Chat web application that offers a clean interface, inspired by the most popular messaging apps. As aforementioned, the survey is presented as a conversation and offers several different input methods, supporting both closed questions, in the form of checkboxes, ratings or single-choice answers, and open-ended questions.
Lastly, the toolkit includes a live dashboard, Coney Inspect, to keep track of the completion progress with both generic data, such as the number of compilations or the drop-out rate, and an overview of all the answers. Furthermore, the gathered data can be exported in CSV format and used with any data visualization tool.

To better emulate the experience of having a *normal* conversation, the language used in the survey creation is fairly informal and, between the different questions, it is possible to add some simple text messages that help to set both the tone of the survey and the context of certain questions.
In the implementation of the designed choice criteria survey, as reported in Appendix A, we tried to engage the respondent adopting that conversation approach. Figure 1 shows (i) on the left, the support given by Coney Create, the drag-and-drop editor, to create the choice criteria survey and (ii) on the right, the resulting visualization in the Coney Chat web interface.
Moreover, as mentioned previously, the support for different input methods enabled the use of both standard open and closed questions as well as different rating mechanisms like start or sliders whenever a Likert scale question was needed.

[1] https://www.coney.cefriel.com

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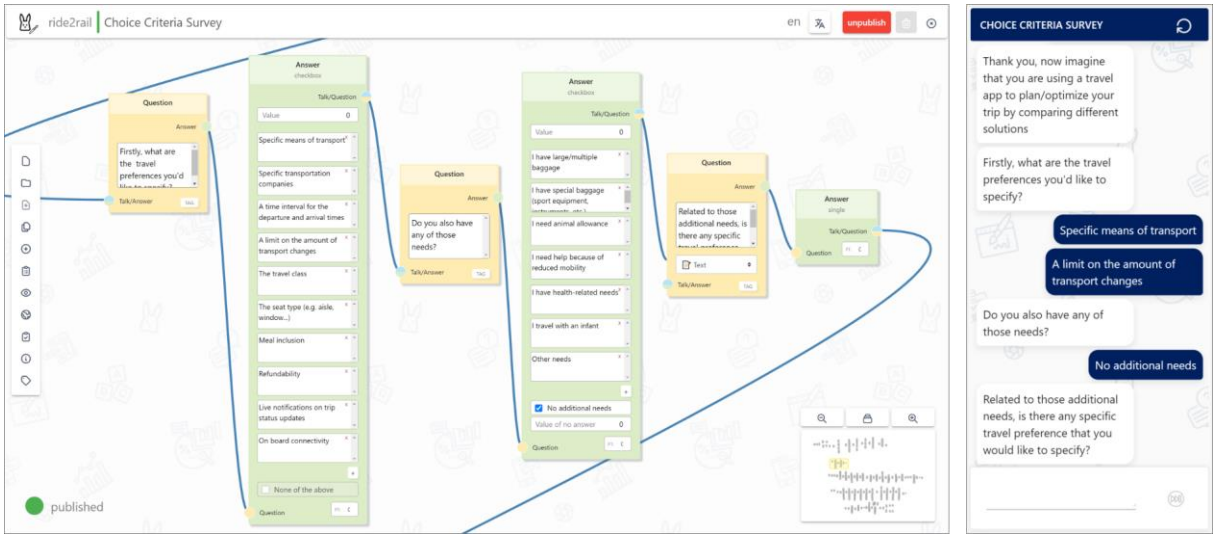

Figure 1: Editing and administering the choice criteria survey through Coney

4.3.2. Surveys connection

This survey, investigating different travel incentives and choice criteria, was distributed paired with the survey designed in the Ride2Rail T2.2 about ride-sharing. To ease the administration process, Coney offers the opportunity to link two different surveys and allow any user to fill one survey after the other, without closing the chat. Regardless of which of the two surveys was chosen as the "starting one", the last question asked the users if they agreed on starting a different survey and, if they agreed, the conversation would move forward seamlessly and start the following questionnaire.
When compiling both these questionnaires, the user identification is kept the same, even if anonymous. Therefore, socio-demographic questions are made only once.

4.3.3. Translation process and language availability

Coney also offers the possibility to translate the interface and the survey in different languages that can be selected at the beginning of the survey. The application detects the in-use language from the compiler's browser and, if available, selects it as default. The chosen language is then reported in the data exported and can be used in the analysis process.
For these surveys, complete translations for both the chat interface and the questionnaires were provided thanks to the cooperation of eight Ride2Rail partners. The accuracy of said translation was achieved with a period of testing and adjustments where, by trying a preview of the finalized version, the partners were able to tweak the wording of the questions and answers to better fit the context of the conversation.
The finalized surveys and the application were translated in a total of twelve languages: English, Italian, Greek, Finnish, Slovak, Czech, Spanish, French, German, Ukrainian, Portuguese, and Croatian.

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4.4. Survey Administration

The administration of the survey was done by using an URL that opened the chat application and started the survey. The URL was distributed to the partners and shared through several dissemination channels like mailing lists, social media, or websites. The list of the channels used by Ride2Rail partners for survey dissemination is in Appendix B (Section 11.2).
The starting date of the dissemination process was the 2nd of July 2020 and, while the survey remains available for future studies, the data analyzed in this deliverable was collected on the 7th of September 2020.
The shared link can embed different data such as a predefined identifier of the channel used to share the questionnaire. While the survey remained anonymous, this option was used by several partners to identify various clusters in the data analysis process as a specific area (e.g., a city or a region), the channel used to share the survey (e.g., social media, mailing list, etc.), or the target audience of the dissemination (e.g., students or experts).

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5. SURVEY RESPONSES

In this chapter, we report a set of statistic on the final dataset of answers obtained for the choice criteria survey. In Section 5.1, we provide information on the completions registered. In Section 5.2, we describe the data on socio-demographic characteristics of the population who answered the survey. In Section 5.3, we discuss the type of travels chosen by respondents in compiling the survey.

5.1. General Statistics

The data collection process was finalized on the 7th of September 2020. The total number of respondents that completed the survey is 609, while more than 787 users started the survey, registering a drop-out rate of around 22%.
As shown in Figure 2, most of the completed questionnaires were registered from the mid of July, with a clear slowdown, as expected, starting from the second week of August when the holiday period started.

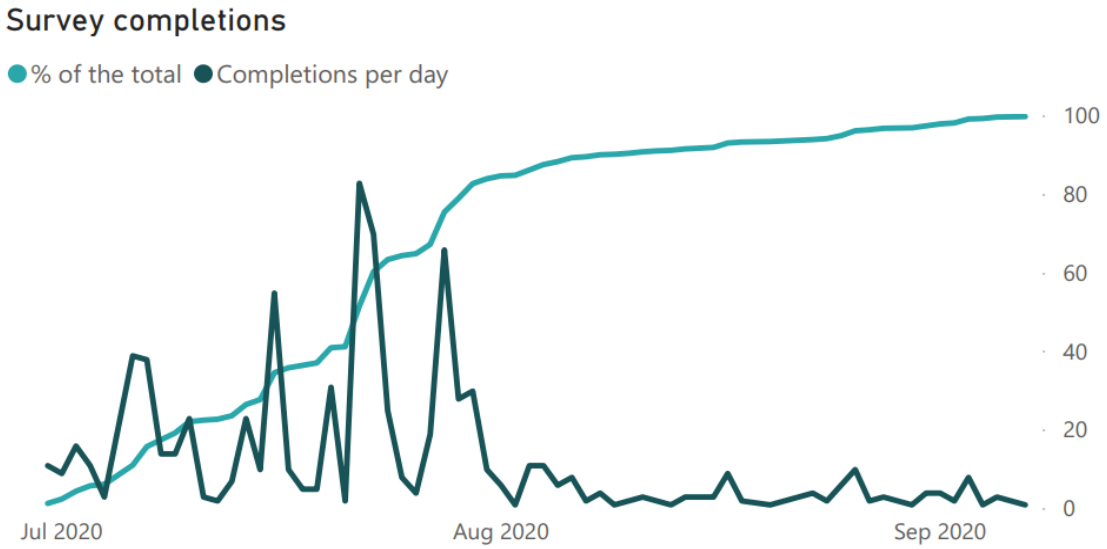

Figure 2 Choice criteria survey completion over time

The average time taken to complete the survey is 8 minutes and 58 seconds and all the twelve available languages were used. Further information on language distribution is shown in Figure 3.

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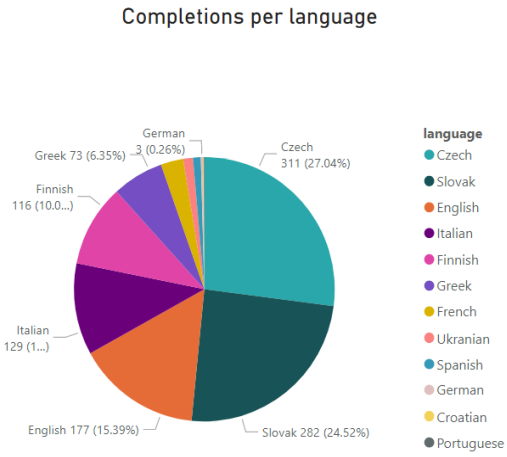

Figure 3 Choice criteria survey completions per language and specific channel

5.2. Socio-demographic Statistics

The survey featured several socio-demographic questions, to which the answers are reported in Figure 4 and Figure 5. The participants mostly identify as males or females, with a good balance between the two (52.7% males and 46.2% females). Most of the respondents were between 18 and 50 years old, with a good representation recorded for the 51-65 gap and very few answers collected from people below 18 or older than 65. Regarding the country of residence, among those recorded, the majority of the respondents are from Slovakia, Czech Republic, Italy, Finland, and Greece that are the countries more represented by the Ride2Rail consortium.

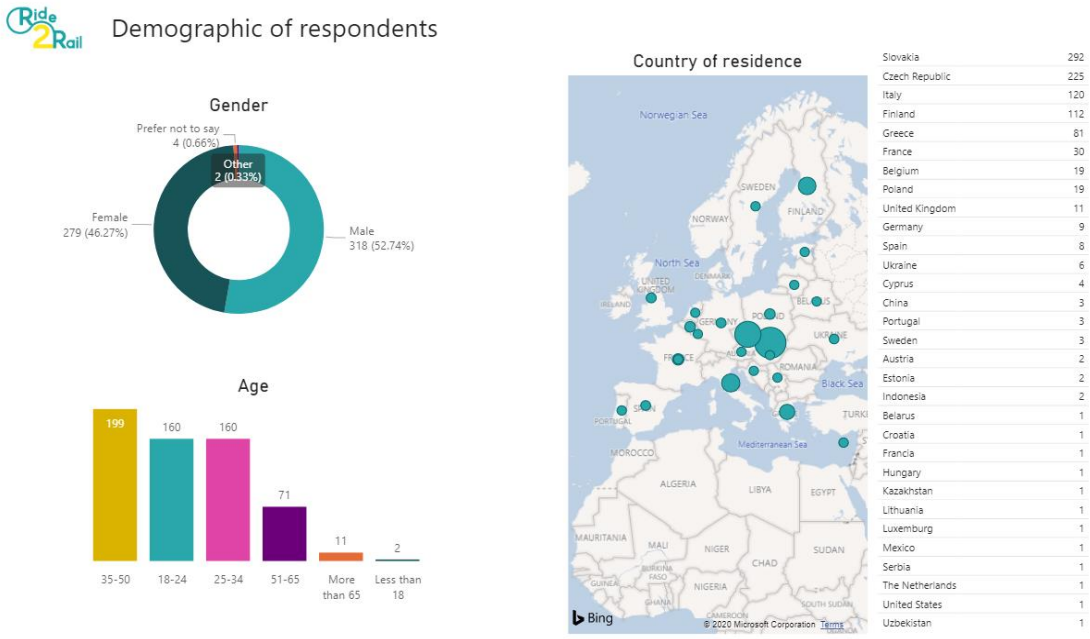

Figure 4 Choice criteria survey completions per gender, age, and country of residence

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While most of the respondents were full-time workers (57.2%), a significant amount of students (28.9%) were also recorded. With regards to education level, almost all the participants achieved at least a higher education diploma, with the majority of the participants having obtained a Master's Degree or more.

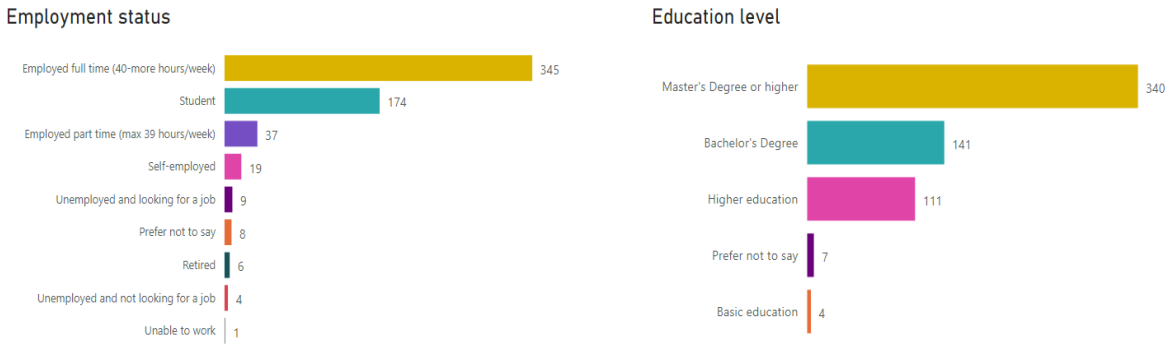

Figure 5 Choice criteria survey completions per employment status and education level

5.3. Types of Travel

In the survey, the respondents evaluated all the different choice criteria based on a specific trip they made. As described in Section 4.2.1, the trip was defined by a series of questions regarding its origin, destination, length, the motivation of the trip, the means of transport used, and the people the users were travelling with.

In Figure 6 we can see how most of the respondents analysed a trip where the destination was an urban area, and the same, even if in a slightly less dominant manner, can be seen when talking about the starting point. Most of the users were travelling either for leisure (40.2%) or business-related reasons (37.14%) and the vast majority of them were travelling alone (54.9%).

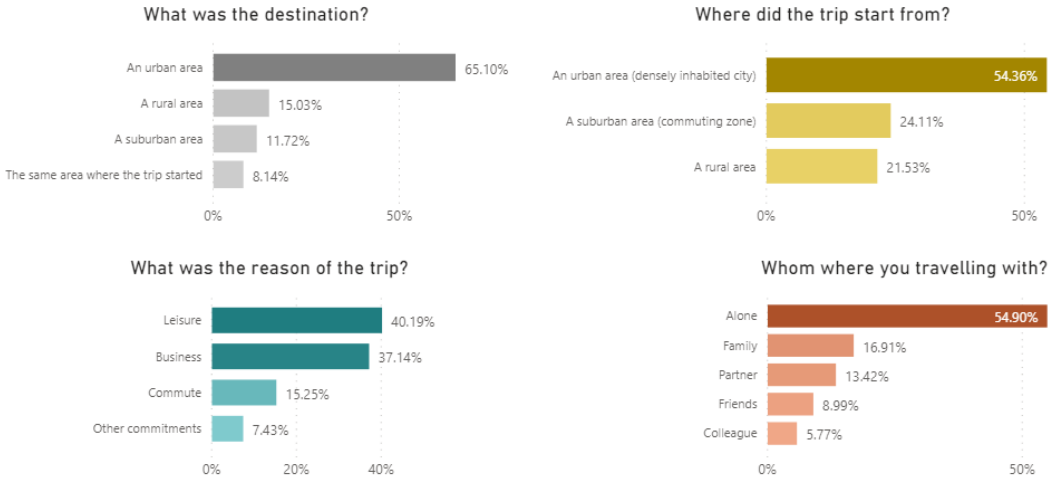

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Figure 6 Types of trips analyzed in the choice criteria survey. The charts report the percentage of users that chose each available option

Most of the trips fell into the short category (34%), ranging between 10km and 50km of length, but there was a good amount of variety as we recorded a high number of both medium (50km to 300km) and very short trips (10km or less), respectively around 29% and 22% of the answers. A shown in Figure 7, for the used modes of transport question, where the respondents could select more than one option, the "private, motorized vehicle" was, by far, the most popular answer, with trains and buses following. The *on-foot* option was selected by 39% of the respondents but was always associated with other means of transport. Very few respondents have selected "carpooling/ride-sharing/shared taxi", "plane" and "ferry".

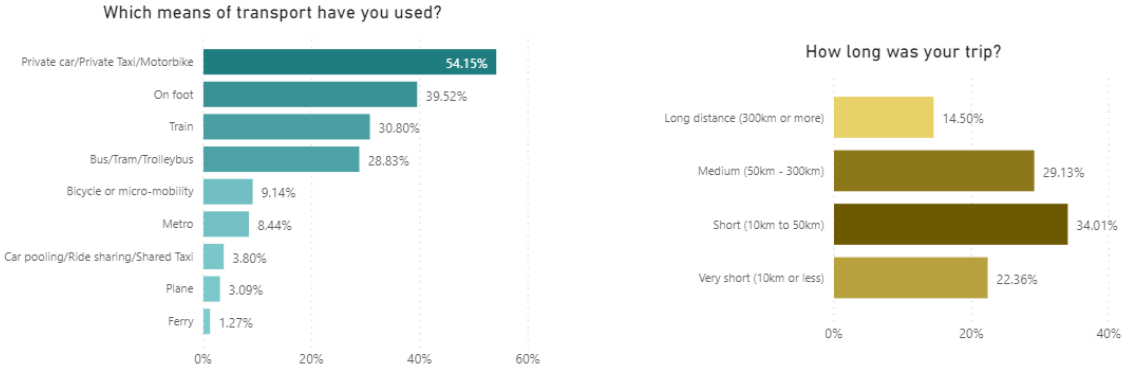

Figure 7 Types of trips analysed in the choice criteria survey. The charts report the percentage of users that selected each available option. Notably, the left chart on the means of transport used, was a multiple-choice question, meaning that the percentage shows the frequency with which an option has been selected rather than the number of different users.

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6. SURVEY RESULT ANALYSIS

In this chapter, we analyse the core survey results taking into account the main goals of the survey. In Section 6.1, we discuss the methodology adopted for the analysis. In Section 6.2, 6.3, and 6.4 we describe the performed analysis for offer categories, user preferences and incentives, respectively.

6.1. Adopted Method

As already explained in Section 4.1, the choice criteria survey has two main goals: *(i)* to validate and check the completeness of the proposed first conceptualization of offer categories, user preferences and incentives, and *(ii)* to provide data enabling clustering of travellers having similar characteristics and behaviour.

In this section, for each of the conceptualized concept, we provide:

- A **general analysis** of the portion of the survey dealing with its validation to rank the instances proposed in D2.1 w.r.t. the interest manifested by the respondents and to complement the catalogues and the preference model with new suggested instances.
- A **focused analysis** of the score (between 1 and 5) obtained by the different instances considering the most relevant socio-demographic information of the respondents (i.e., gender, age, employment status, country of residence), with the objective to better characterize the target users of a journey planning application. Moreover, the same analysis is proposed considering the trip type that the respondents have declared to refer to. The following trip types have been considered: Short business trip (< 50km); Medium-long business trip (> 50Km); Commuting trip; Leisure trip with the family; Leisure trip with partner or friends; Short leisure trip (< 50km); Medium-long leisure trip (> 50Km). The analysis of the data collected is done by looking both at the mean values and at the distribution of the answers. The differences surfaced between groups in terms of preferred offers categories and incentives are validated also from the statistical point of view, verifying that the different preferences do not occur by chance but are related to the particular characteristics of the respondents (i.e. age, gender, employment status, country of residence, trip type).

The analysis of the survey result is complemented by Section 7 with the travellers' clustering analysis.

6.2. Offer Categories

To validate the list of offer categories proposed in D2.1 and described in 4.2.2 of this deliverable, the respondents were first asked to rate each category based on its importance in the choice of a travel solution. The rating goes from 1 (not important) to 5 (very important). After evaluating each offer category individually, the respondents were asked to choose the three most important ones. This was meant to validate the previously given

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ratings and to establish a clear set of three "winners" since some of the options were bound to be evaluated equally.

As shown in Figure 8 and Figure 9, most of the categories proposed were values higher than 3 out of 5, hence above the median value. The *quick* and *reliable* categories are the clear favourites among the respondents, with users almost always evaluating them, on average, more than 4.5. On the other hand, *social* and *philanthropic* were widely regarded as less important, as factors that are not important in making the final choice.

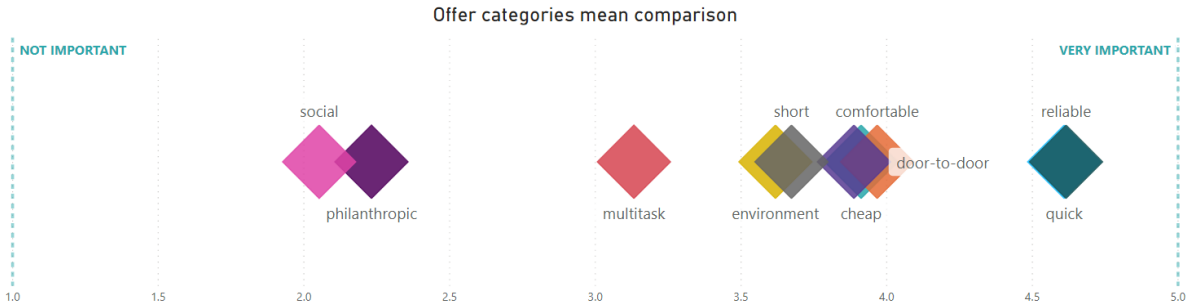

Figure 8 Comparison of the mean for offer categories

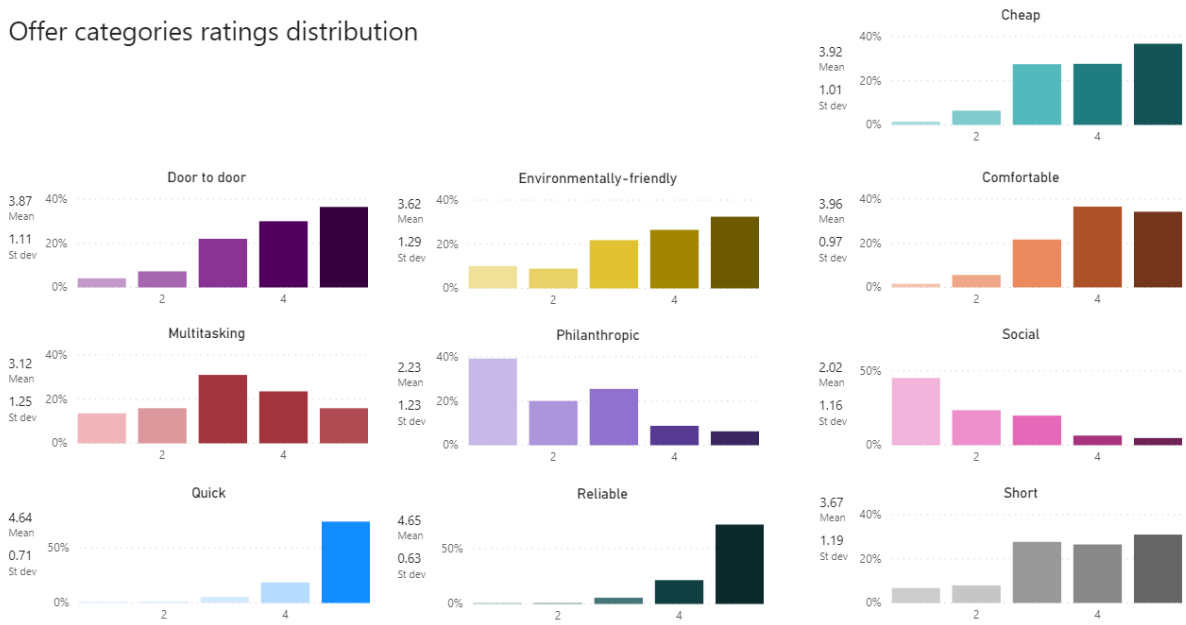

Figure 9 Offer categories ratings distribution

In the following question, where users had to pick the top three categories to express their value against each other, the same behaviour was registered. As shown in Figure 10, both

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quick and *reliable* were chosen by more than 74% of the respondents, while *social* and *philanthropic* were selected less than 4% of the time. The main difference, when compared to the previous rating, is the rise in popularity of the *cheap* category. While having a mean rating similar to the *comfortable* category, it was chosen by 20% more respondents in this direct comparison question.

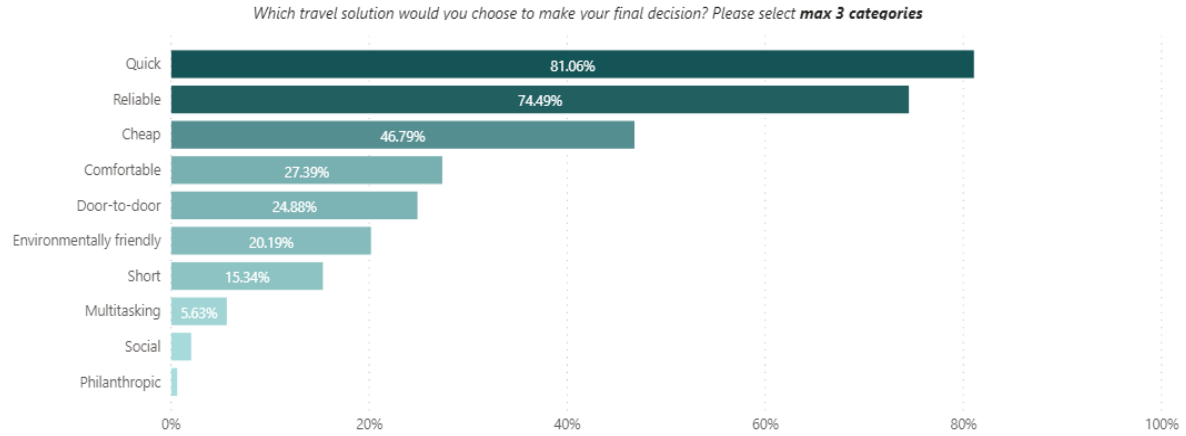

Figure 10 Offer categories preferences when chosen in among each other (multiple-choice, max 3). The percentage shows the frequency with which an option has been selected rather than the number of different users

Following these questions, to better define the *comfortable* option, the respondents were asked to pick the factors that they believe identify such a category. From the recorded answers (cf. Figure 11), the cleanliness of the spaces and the comfort of the seats, paired with a feeling of personal safety, are key aspects of the definition. One interesting outcome of the question is the difference between minimizing the number of interchanges and minimizing the number of different means of transport, with the latter being chosen by 35% fewer respondents.

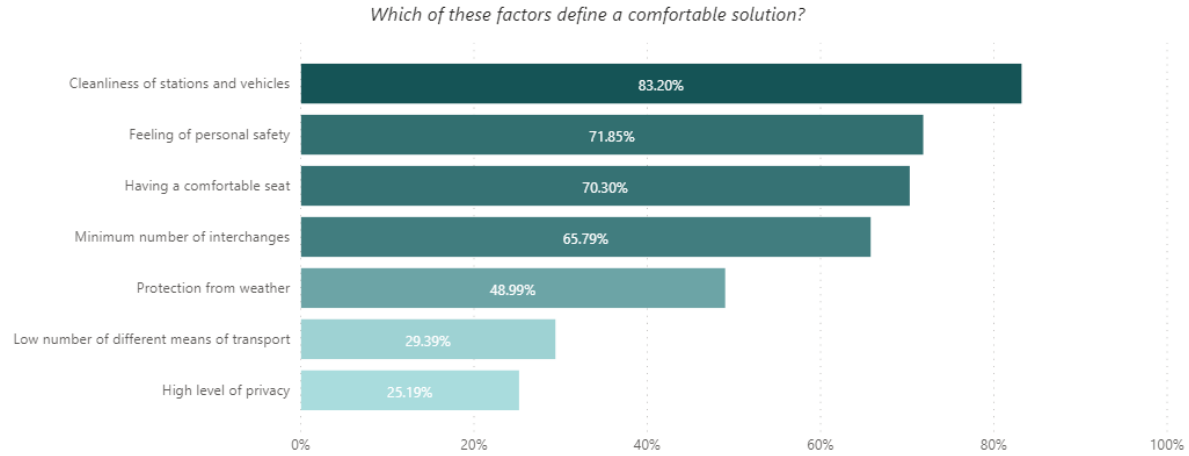

Figure 11 Factors that define a comfortable solution (multiple-choice). The percentage shows the frequency with which an option has been selected rather than the number of different users

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Lastly, the survey asked the users to state any additional category that they would like to be able to choose from in an open-ended question. While many of the answers could be fit into the aforementioned categories, some different ideas are worth mentioning. Notably, only answers about topics that appeared more than three times were factored into this analysis since the popularity of a category is a metric that we have to take into consideration.

- To begin with, some respondents stated that given the frequency of delays or other issues during trips when changes are needed, the frequency of the connections is as important as quickness. If that is not possible, choosing direct solutions with no changes of means is the preferred alternative.
- Another topic that surfaced from the answers is the accessibility of the solution when talking about features meant to help children, pregnant women, elders, or people with disabilities.
- Some answers suggest to define a "sport" category taking into account the number of calories that can be burned choosing a specific travel solution, e.g. a solution involving walking or cycling;
- A few other less popular mentions regarded the feeling of personal safety and the possibility to have a gluten-free or a vegan-friendly category, whenever meals are included. A respondent also mentioned a category for trying other, different routes that might take longer but follow another route through a more interesting or beautiful environment like a peculiar village or a forest.
- Lastly, several respondents highlighted the need to have, due to the COVID-19 pandemic, a category that certifies the presence of all the needed security measures to prevent the virus from spreading.

The presented results have been considered to define the final catalogue of offer categories, as discussed in Section 8.2.2.

6.2.1. Offer categories by demographics and trip type

In this section, we compare the score obtained by the 10 offer categories, considering the most relevant socio-demographic information of the respondents (i.e., gender, age, employment status, country of residence) and the trip type they were referring to.

We classify the offer categories in the following 4 groups by analysing the value distribution and the average value:

- Very high interest (average > 4)
- High interest (3 < average < 4)
- Indifferent (average ~ 3)
- Low interest (average <3)

Then, we analyze deeply the offer categories to validate if these differences are significant from a statistical point of view. We run the Chi-squared Test of Independence [5], with the

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goal of testing if the scores obtained by offer categories are independent from the socio-demographic information of respondent and from the trip type they were referring to. Notably, since the groups "under 18 yo" and "above 50 yo" did not contain enough answers to perform this analysis in a significant manner, it was decided to create a total of three age groups ("<35 yo", "35-50 yo" and ">50 yo") that all contained more than 80 entries.

Here is an example of the approach followed. We evaluate the "Cheap" offer category in relation to the different age groups. By calculating the average of the answers collected for each group, we obtain a mean greater than 4 for the "<35 yo" group and average between 3 and 4 for the "35-50 yo" and ">50 yo", as shown in Table 12 in Appendix C (Section 11.3). To evaluate if these differences are significant also from a statistical point of view, we run the Chi-square Test of independence to verify if the "Cheap" and the "Age" variables are independent of each other or if they are significantly associated. The test informs us that they are significantly different and so there is a relationship between the two variables. This association between the variables is shown in Figure 12, in which positive association (attractions) are shown in blue and negative associations are shown in red (repulsion). People younger than 35 yo strongly prefer a "Cheap" solution and this is evident from the strong association with rate 5 and negative associations with scores lower than 3. On the contrary, people older than 50 yo that express a lower average value (between 3 and 4) and have a strong association with score 1.
These findings tell us that the "Age" is a parameter that should be taken into account when proposing the "Cheap" offer category.

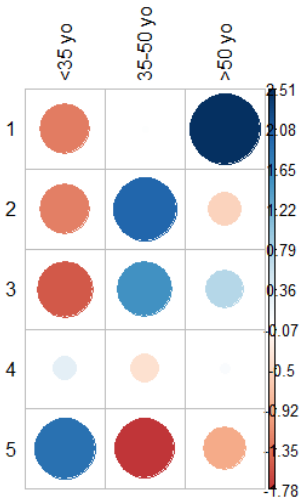

Figure 12: Visualization of the Pearson residuals extracted from the Chi-squared test of independence. Blue indicates an association, whereas Red indicates repulsion

The results of the classification of offer categories w.r.t. age, gender, and employment status of the respondents and the result of the study of the statistical difference are in Table 12 in Appendix C (Section 11.3). The main findings are:

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- All the categories of travellers would like to have a ***Quick*** and ***Reliable*** trip, which means minimizing the total travel time and the chances of delays, breakdowns or last-minute changes. These are the two most important categories for all travellers.
- ***Social*** and ***Philanthropic*** are two least-appreciated travel solutions. Travellers are not looking at travel solutions that involve donations to charity or volunteering organizations or that facilitate new acquaintances.
- ***Multitasking***. Respondents are quite indifferent to this category. It is not a decisive factor for the final choice but the possibility to perform other tasks while travelling may be appreciated.
- ***Short***. Everyone would like a short trip, but it is not the priority. People place more emphasis on the time spent travelling (more importance assigned to the *Quick* solution) rather than on the distance travelled.
- ***Cheap***. Students, young respondents (<35 yo) and female place the economic aspect of the solution at the top of their priority list. For the other groups of users having the lowest price is an important aspect, but it is not essential.
- ***Environmentally Friendly***. Female and students are more aware of environmental issues and, while selecting a trip option, they look at solutions that minimize the trip's impact on the environment, such as NOx, CO2 emissions, energy consumption, etc.. On the contrary, male and 35-50 yo people are the least concerned about it. Overall it is a topic important for all the categories of users.
- ***Door To Door***. Travellers older than 35 years old would like a solution that minimizes the segments of the trip that are not covered by the solution. Also, women and employed workers prefer this solution, probably for saving time in understanding how to reach their destination and being more efficient in the daily routine.
- ***Comfortable.*** The categories of travellers that prefer this travel solution are people younger than 50 years old, women, workers and students. If we analyze the "Comfortable" solution by Age groups we see that the average values are in different groups but this difference is not statistically significant (black text in Table 12 in Appendix C (Section11.3)).

The results of the classification of offer categories w.r.t. country of residence of the respondents are in Table 13 in Appendix C (Section11.3). Due to some of the options not having enough data, only the top 5 countries in terms of the number of respondents have been considered. The main findings are:

- In all countries, the most important features of a trip are the minimization of the total travel time (***Quick)*** and the minimization of the chances of delays, breakdowns or last-minute changes (***Reliable)***.
- Overall, ***Social*** and ***Philanthropic*** travel solutions are the least appreciated, except for the Greek travellers that give more importance to a travel solution that involves donations to charity or volunteering organizations.
- ***Environmentally friendly.*** Italians place the environmental issue at the top of the priority list for selecting a travel solution. On the contrary, Czech travellers are not very interested in minimizing the trip's impact on the environment.

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- Italians and Greeks want a solution that minimizes the segments of the trip that are not covered by the solution (***Door to Door***) and with the lowest price (**Cheap).** Greeks also want **Quick** travel solutions.
- **Comfortable** travel solutions are more appreciated by Slovakians and Greeks.

The results of the classification of offer categories w.r.t. the trip type (described in Section 6.1) are in Table 14 in Appendix C (Section 11.3). The main findings are:

- ***For all types of trips (business, commute and leisure)*** the most voted categories are *Quick* and *Reliable. Social* and *Philanthropic* are travel solutions not much appreciated in any context.
- ***Business trip***. A travel solution for a short business trip (<50 Km) should also be *Cheap*. A travel solution for a medium-long business trip should also be *Door-to-door* and *Comfortable*. The maximization of comfort during the trip and the minimization of the segments of the trip that are not covered by the solution are particularly appreciated for business trips longer than 50 km. Another difference between a short and a long trip is that, in short trips, people pay more attention to the length of the trip (Short) and on the environmental aspect.
- ***Commuting trip.*** A travel solution for a commuting trip should also be *Cheap* and *Comfortable*. Since this is a trip repeated many times in the week, travellers aim to find the best trade-off between the minimization of the price and the maximization of comfort. In addition, commuters attach more importance to the *Multitasking* aspect of the trip, since it allows them to maximize the possibility to perform other tasks while travelling (productivity, enjoyment, etc).
- ***Leisure trip.*** When people travel for leisure, they want to relax and minimize troubles and so they look also for *Comfortable* and *Door-to-door* solutions. Travellers also try to select solutions that also minimize the trip's impact on the environment (*Environmentally friendly*). For both long and short leisure trips, the preferences are more or less the same, as well as, in the cases of travels with family and with friends or the partner.

6.3. User Preferences

The following survey section asked the respondents to select the characteristics of the offer that they care the most about when they're looking for a travel solution. As shown in Figure 13, the factors that are most important to the respondents are being able to pick a specific mode of transport and a time interval for the departure and arrival times.
We see that respondents are also fairly concerned, as it emerged from the previous section's comments, about the possible delays and their connection with the planned transport changes.
All the other characteristics have been selected by a far lower percentage of users, starting with the on-board connectivity, chosen by 1 every 4 users, and ending with the inclusion of a meal, which was chosen by less than 10% of the respondents.

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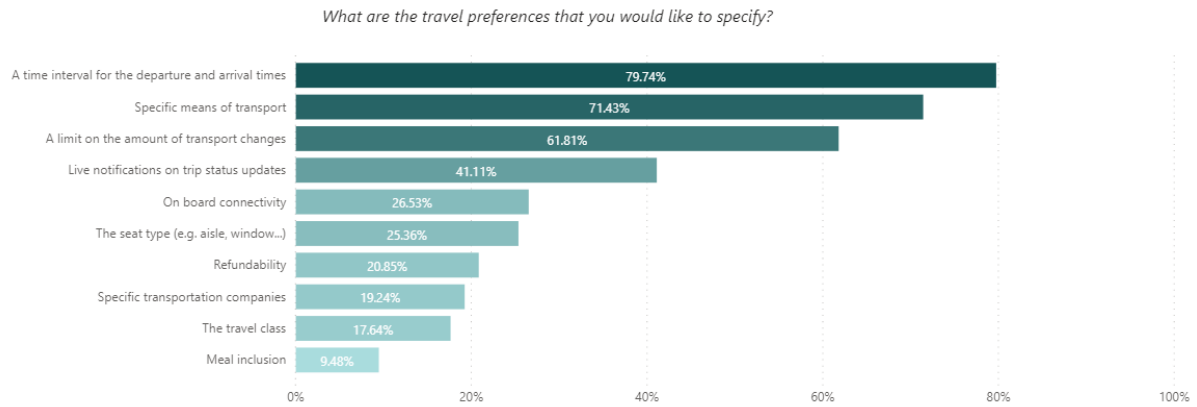

Figure 13 Characteristics of a travel offer on which the respondents would like to express preferences (multiple-choice). The percentage shows the frequency with which an option has been selected rather than the number of different users

Following the set of pre-defined choices, the users could highlight any additional need influencing their preferences and suggest any additional characteristic of the travel offer on which she/he would like to express a preference. For this analysis, we considered only the characteristics that appeared more than three times, and we then paired those suggestions, whenever possible, with the need they were mostly associated with.

Firstly, some users remarked their desire to have a guaranteed alternative connection whenever the planned one is lost due to delays or other unforeseen issues.
Regarding the comfort area, several respondents stated the importance of an on-board toilet, the presence of air conditioning, and the option of choosing the seat to make sure that there is enough room for the legs or that they face in the direction of travel. Moreover to cover the distance between the starting and ending point of the trip, and the stations where the means of transport start and end, some users would appreciate the presence of either some parking spots or a connection from their place to said station.
Finally, a few expressed the wish for a single ticket that would be valid among different railway operators to avoid having to purchase several different ones.

Regarding the additional suggestions of users with additional needs, we recorded a lot of requests from people travelling with infants. First, since they are travelling with a stroller, they need some space to store it for the duration of the trip. Secondly, depending on the age of the infant, a seat in a specific children's department with a breastfeeding room could ensure the privacy needed.
For people travelling with special baggage like instruments or sports equipment, most of the cyclists asked for either the change to reserve a place for a bike where it can be locked or, if that's not possible, the permission to transport bicycles without any additional expenses.
A similar point regarding the possibility to book a place for pets (or at least transport them) was made by the respondents travelling with animals, with the addition of requiring specific security measures such as the obligation of muzzling the dogs.

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For passengers with reduced mobility, the presence of entry and exit aids, as well as accessibility features in the toilet, is a crucial preference to be able to state.
Finally, regarding the Covid-19 pandemic, several users asked for the possibility to filter out the solutions that do not adopt the needed safety measures like the obligation to wear a mask or social distancing.

The presented results have been considered to validate and extend the Traveller Context Dimension Tree (TCDT) and in the final traveller preference model, as discussed in Section. Moreover, in Section 8.3.4, starting from answers collected we provide additional recommendations for user preferences.

6.3.1. User preferences by demographics and trip type

In this section, we analyze the answers that were selected by at least 33% of respondents when asking to indicate the characteristics of a travel offer on which they would like to specify preferences when using a journey-planning application. The cut-off point was added to ensure an amount of data sufficient to perform each analysis, with the percentage selected based on the number of answers recorded. In this case, 33% of the users amounts to a bit more than 150 answers, which was set as the minimum needed to then further divide the data w.r.t age, gender, and employment status of the respondents and still obtain large enough subsets.
Results are shown in Table 15 in Appendix C (Section 11.3).
The main findings are:

- The three most selected characteristics by all the groups are ***a time interval for departure and arrival time***, ***specific means of transport***, ***a limit on the amount of transport change.***
- All the groups, except for adults over 50 years old, would like to also have ***live notifications on trip status updates.***
- Young under 35 yo and women would like to also have ***onboard connectivity.***

The results of the classification w.r.t. the country of residence of the respondents are in Table 16 in Appendix C (Section 11.3). The main findings are:

- In all the countries analyzed the three travel offer characteristics most frequently selected to be expressed as preferences are ***a time interval for departure and arrival time***, ***specific means of transport***, ***a limit on the amount of transport change.***
- In Czech Republic, Slovakia and Italy people would also like to have ***live notifications on trip status updates*** and ***onboard connectivity.***
- The possibility to be refunded (**refundability**) is a characteristic selected only by Italians.
- The ***seat type*** **choice** is a preference that Czech travellers would like to express.

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The results of the classification w.r.t. the trip type (described in Section 6.1) are in Table 17 in Appendix C (Section 11.3). The main findings are:

- There are four travel offer characteristics in ***all types of trips (business, commute and leisure)*** on which respondents would like to specify preferences : *a time interval for departure and arrival time, specific means of transport, a limit on the amount of transport change* and *live notification on trip status updates.*
- In a ***business trip of medium-long distance***, travellers would like to specify also *the seat type* and *the travel class.*

In a ***leisure trip of medium-long distance and with the family***, travellers would also like to specify *the seat type* and they would like to have a *refundable* travel solution.

6.4. Travel Incentives

For the travel incentives analysis, we adopted an approach similar to the one used for the offer categories analysis, asking users to rate each technique, based on how effective it could be on them, from 1 (not effective at all) to 5 (very effective).
In this case, the average rating recorded is much closer to the median value but there are some clear favourites. As shown in Figure 14, while the highest-rated incentive is the immediate price discount, all the techniques that provide some sort of discount, except for the discounts on complementary services, scored more than the median value 3. On the other hand, both the gamification elements and the share of information regarding either the environmental impact or the positive aspects of the trip scored, on average, less than the money-related alternatives. Based on these results, the tangible incentives outscore the intangible ones in almost every form they are presented, with the exception of the discounts on complementary services that was the worst-rated tangible incentive.

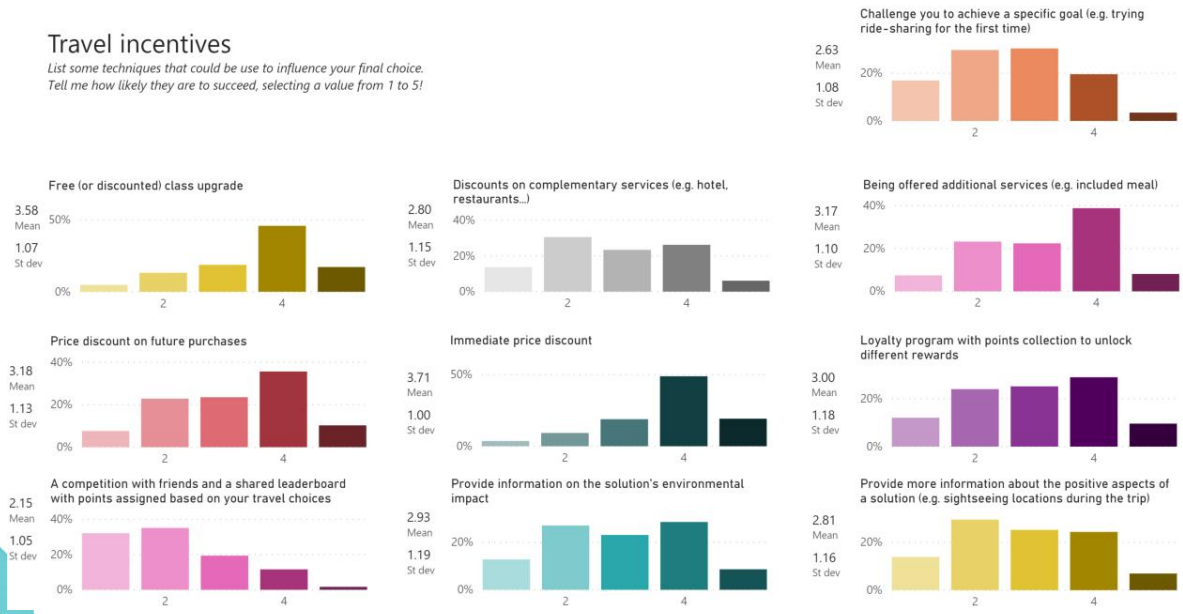

Figure 14 Travel incentives ratings distribution

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As for the previous sections, users were then asked to list any additional incentives that could change their minds about the means of transport chosen. Several respondents stated that the main incentive would be to get further discounts, especially the ones that target specific groups of people like students, youngsters, or elder people.
Another well-perceived incentive is to offer an included in the price insurance for the trip, whether for health issues for the trip itself in case of delays or cancellations. Similarly, several users mentioned a free cancellation policy or the chance to freely change the ticket with a different train.
Regarding the offer of additional services for the trip itself, some respondents valued the offer of free food during the trip, even more important if the options include gluten-free or vegan choices. Another service requested is the proposition of additional activities.
Several users pointed at the share of information as one factor that could influence their final choice. Specifically, being aware of all the details regarding the schedule, the route, the points of interest, and some peculiar events along the way. The chance to take some historic or newly adopted means of transport for a part of the trip was also reported.
Lastly, as with the previous sections, some users talked about security measures both related to Covid-19, like the commitment to maintain social distancing, and to the feeling of personal safety such as the presence of security personnel.

The presented results have been considered to define the final set of recommendations to incentivize multi-modal travel offers in Section 8.4.2. We pointed out the incentive mechanisms that are more likely to succeed, and we also incorporated additional examples of *tangible* and *intangible* incentives elaborating on additional entries provided by the respondents.

6.4.1. Travel incentives by demographics and trip type

In this section, we compare the score obtained by each travel incentive considering the most relevant socio-demographic information of the respondents (i.e., gender, age, employment status, country of residence) and the trip type they were referring to.

We classify the incentives in the following 4 groups by analysing the value distribution and the average value:

- Very high interest (average > 4)
- High interest (3 < average < 4)
- Indifferent (average ~ 3)
- Low interest (average <3)

Then, we deeply analyze the travel incentives that show differences among groups to validate if these differences are significant from a statistical point of view. We run the Chi-squared Test of Independence [5], with the goal of testing if the scores obtained by the

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travel incentives are independent from the socio-demographic information of the respondents and from the trip type they were referring to.

The results of the classification of travel incentives w.r.t. age, gender, and employment status of the respondents and the result of the study of statistical difference are in Table 18 in Appendix C (Section 11.3). The main findings are:

- Overall, travellers are not very interested in the incentives proposed for changing their initial choice. Actually, in almost every case, the average value of the incentive is lower than 4.
- *Free class upgrade* and *immediate price discount.* They are the two most promising incentives. All the groups consider them very important and so greater attention should be paid to them.
- *Points and leaderboard.* Adding a competition with friends and a shared leaderboard with points assigned based on the travel choices is not seen as an incentive for changing the travel solution. The same happens with the *challenge-goal* incentives. This means that setting up goals that users should achieve (e.g. trying the ride-sharing for the first time) just to challenge themselves is not enough to abandon the original travel solution and to change the current travel-style.
- Young (< 35 yo) consider the *discount on future purchase* an interesting incentive, in addition to the *immediate discount*. This confirms the findings in the travel offer section that states that the youngsters are looking for a cheap solution and so the economic aspect can be successful leverage to change their mind. The same conclusion can also be drawn for students that give a very high score to the *immediate discount* incentive.
- The groups that overall seem less interested in the incentives proposed are male and adults between 35-50 years old, since they express low interest for almost all the incentives. They seem to be unwilling to change their travel-style and initial choices.
- Giving discounts on complementary services (*discount complementary service*), providing information on the solution's environmental impact (*environmental impact*), setting up a loyalty program with points collection to unlock different rewards (*loyalty program*), offering additional services (*additional services*) and providing more information about the positive aspects of a solution (*positive aspect of solution*) seems to be not so successful since respondents are quite indifferent to these types of incentives.
- By analysing the travel incentives grouped by Age, we discover that young (< 35 yo) are more inclined to accept the *Free class upgrade* and *immediate price discount* than people older than 35 yo. The Chi-square test and the analysis of Pearson's residuals reveal that for young there is a strong attraction between the highest rating (blue dots) and these incentives, as shown in Figure 15. On the other hand, there is repulsion (red dots) for the highest rating for people older than 35.

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Figure 15: Pearson's residuals extracted from the Chi-squared test of independence for the incentives "immediate Price Discount" and "Free Class Upgrade". Blue indicates an association, whereas Red indicates repulsion

The results of the classification of travel incentives w.r.t. the country of residence of the respondents are in Table 19 in Appendix C (Section 11.3). The main findings are:

- The travellers of the analyzed countries are aligned in considering the ***free class upgrade*** and the ***immediate price discount*** as good incentives for changing their travel behaviours. ***Immediate price discount*** is the most voted incentive by Italian users, while the Czechs are less interested in it.
- In Greece and Slovakia offering ***price discounts on future purchases*** is a good incentive.
- The country that overall seems less interested in the incentives proposed is Finland since they express low interest for almost all the incentives. They seem to be unwilling to change their travel-style and initial choices.

The results of the classification of travel incentives w.r.t. the trip type (described in Section 6.1) are in Table 20 in Appendix C (Section 11.3). The main findings are:

- ***For all the trip types (business, commute and leisure)*** the most appreciated incentives are the ***immediate price discount*** and the ***free class upgrade.***
- ***Business and leisure trips of medium-long distance***. Travellers appreciate the inclusion of *additional services* (e.g included meal), probably to make the travel more enjoyable and comfortable. People that travel for business are not interested in receiving information about the positive aspects of a solution, since their main interest is to arrive at the destination as quickly and comfortably as possible.
- ***Commuting trip***. A good incentive is the *price discount on future purchases*. Since commuters travel a lot and very frequently, they will buy in the future new travel solution in which they can spend the discount voucher received.

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- *Discount complementary service, environmentally friendly, loyalty program and positive aspect of the solution* seem to be not so successful since respondents are quite indifferent to these types of incentives.

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7. CLUSTERING OF TRAVELLERS

The goal of the clustering activities explained in this section is to analyse the data collected through the choice criteria survey to find mobility patterns. With the term *mobility pattern,* we mean a common set of characteristics shared by a group of respondents (i.e., the cluster) in terms of travel behaviours.

7.1. Methods and Techniques

The main decisions to be taken when setting up a clustering activity are the selection of the distance metrics, the selection of the clustering algorithm and the definition of the features to be analyzed.

The core idea of clustering is to group the closest points, with the basic element of a clustering process being the dissimilarity measure that determines how different, or distant, the points in a data set are. The type of dissimilarity measure is strictly related to the type of data used as features. In this case, we decided to use both the data about the context of the trip (*reason of the trip, origin area, destination area, who you travel with, trip length* and *means of transport used*) and the socio-demographic data of the traveller (*age, gender, education level, employment status* and *country*). Since all these features are categorical variables, we decided to use the *Gower distance [3]* as a distance metric to compute the similarity between our data points. The Gower distance is based on the Dice coefficient and is computed as the average of partial dissimilarities across individuals.

Regarding the clustering algorithm, we selected an algorithm that can manage this type of distance measure. We used the *hierarchical clustering* [12] both in the agglomerative (bottom-up) and in the divisive (top-down) option. The former starts with *n* clusters (with *n* is the number of data points) and tries to find most similar data points and to group them to form clusters; the latter starts with a big cluster with all the data points and tries to divide most dissimilar ones into separate groups.

Once the similarity measure and the clustering algorithm has been defined, we set up two experiments in which we changed the variables used as features. In the first case, we only use the data about the context while, in the second case, we used both the context and the socio-demographic data. In both cases we tried to run both the agglomerative and the divisive hierarchical clustering.

To find the optimal number of clusters we relied on the *elbow method* [13] and on the *silhouette coefficient* [8], to evaluate both the compactness of clusters (similarities within groups) and the data consistency (how close each point in one cluster is to points in the neighbouring clusters). These metrics suggested considering 7 clusters in the first test and 10 clusters in the second one.

To determine if the clustering results are good we evaluate mainly two aspects: the size of the clusters (that should not be disproportionate) and the similarities between the elements

grouped. We perform both a qualitative and quantitative analysis by investigating the distribution of each feature in each cluster to find commonalities within the clusters and differences among different clusters.

7.2. Results

The best clustering result is obtained in the first test in which we use the context variables as features, performing an agglomerative hierarchical clustering with 7 clusters as the target.

We discard the results obtained in the second test (socio-demographics and context variables as features, agglomerative and divisive hierarchical clustering as algorithms, and 10 clusters as target) because the sizes of the resulting clusters were imbalanced, with some clusters very small (3 and 5 data points each) and two clusters containing more than two-thirds of all the data points. Furthermore, by looking at the distribution of the features of the clusters, the data points in the same cluster do not show strong similarities, which is a clue that the algorithm was not able to separate the data points in a meaningful way. This is due to the addition of the socio-demographic features that do not contain sufficient variance and distinctiveness.

7.2.1. Clusters identified

In this section, the clusters obtained in the first test are explained in detail. Each cluster has been analyzed focusing on the distribution of the following features:

- **Trip reason** (see Figure 16) distinguished between *business, commute, leisure, other commitments*;
- **Type of area of origin of the trip** (see Figure 17) as *rural, urban or suburban*;
- **Area of destination of the trip** (see Figure 18) as *rural, urban or suburban*;
- **The people the user was travelling with** (see Figure 19) distinguished between *alone, colleagues, family, friends, partners*;
- **The length of the trip** (see Figure 20) as *long* (300 Km or more), *medium* (between 50 and 300 Km), *short* (between 10 and 50 Km), *very short* (10 Km or less);
- **The means of transport used** (see Figure 21) distinguished between *bicycle/micro-mobility, bus/tram/trolleybus, car-pooling/ride-sharing/shared-taxi, ferry, metro, foot, plane, private car/taxi/motorbike, tram*. More than one mean of transport may have been used by a single respondent.

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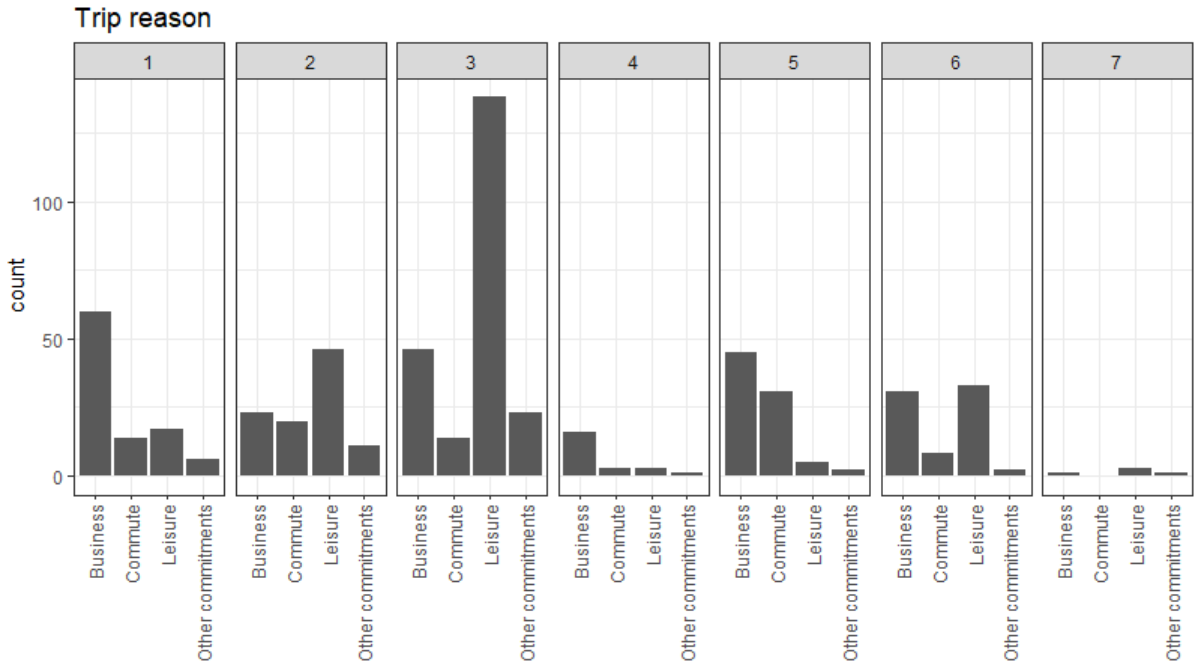

Figure 16: Distribution of the reason for the trip in the 7 clusters

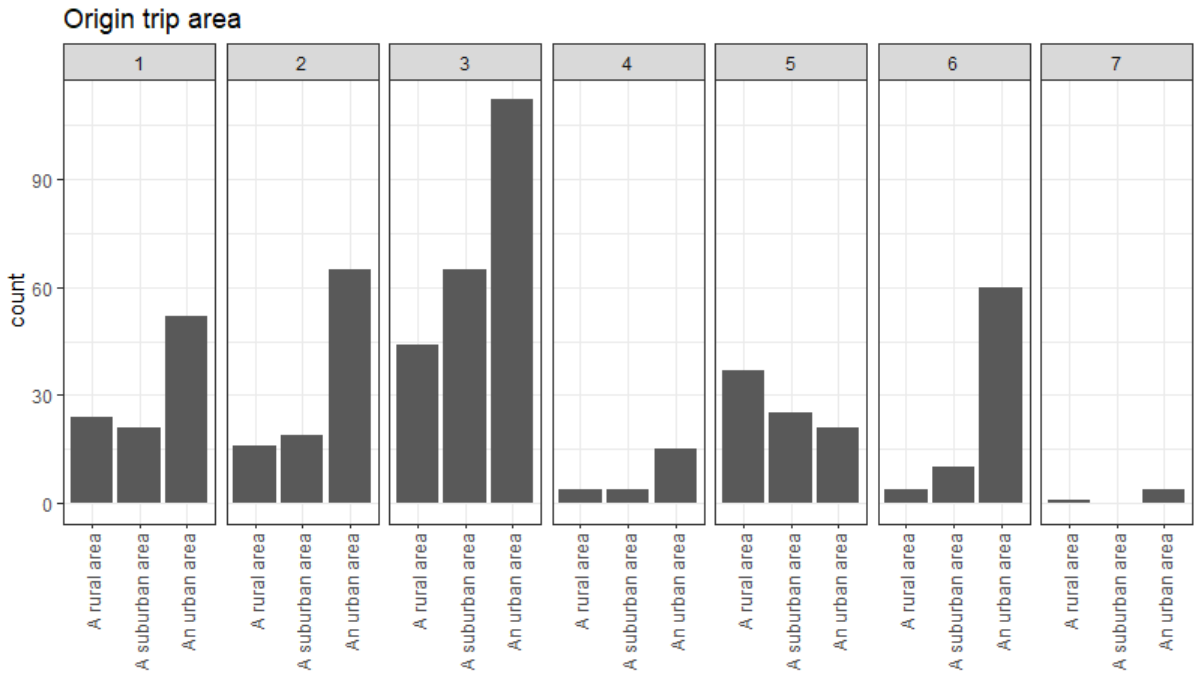

Figure 17: Distribution of the area of origin of the trip in the 7 clusters

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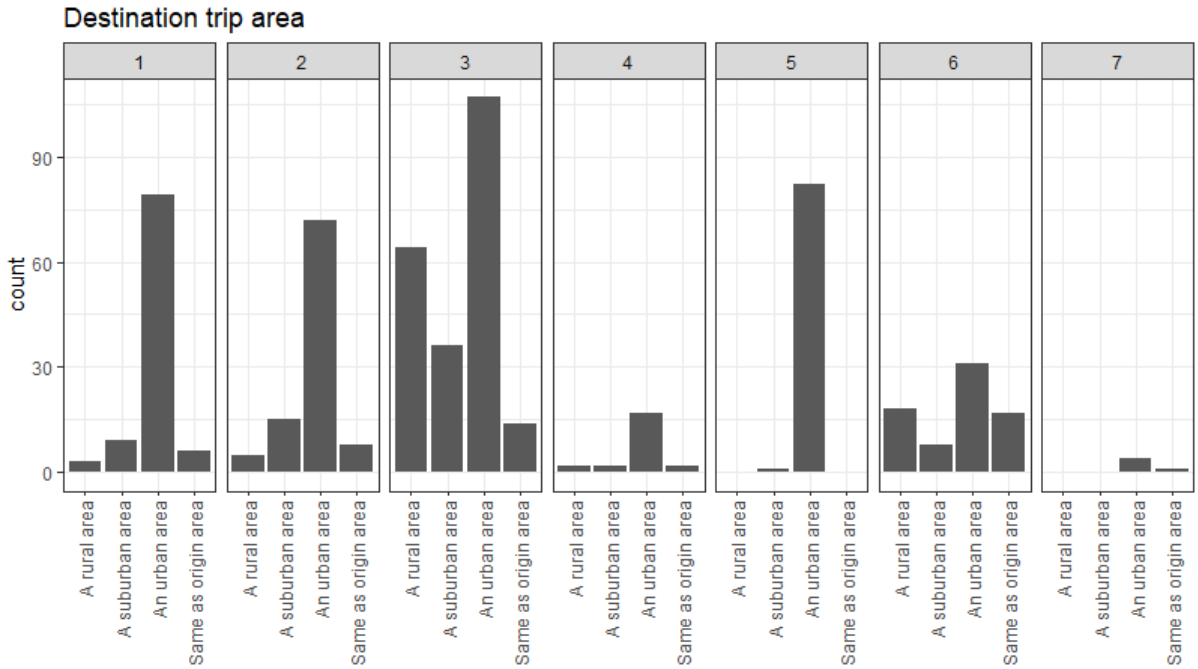

Figure 18: Distribution of the area of destination of the trip in the 7 clusters

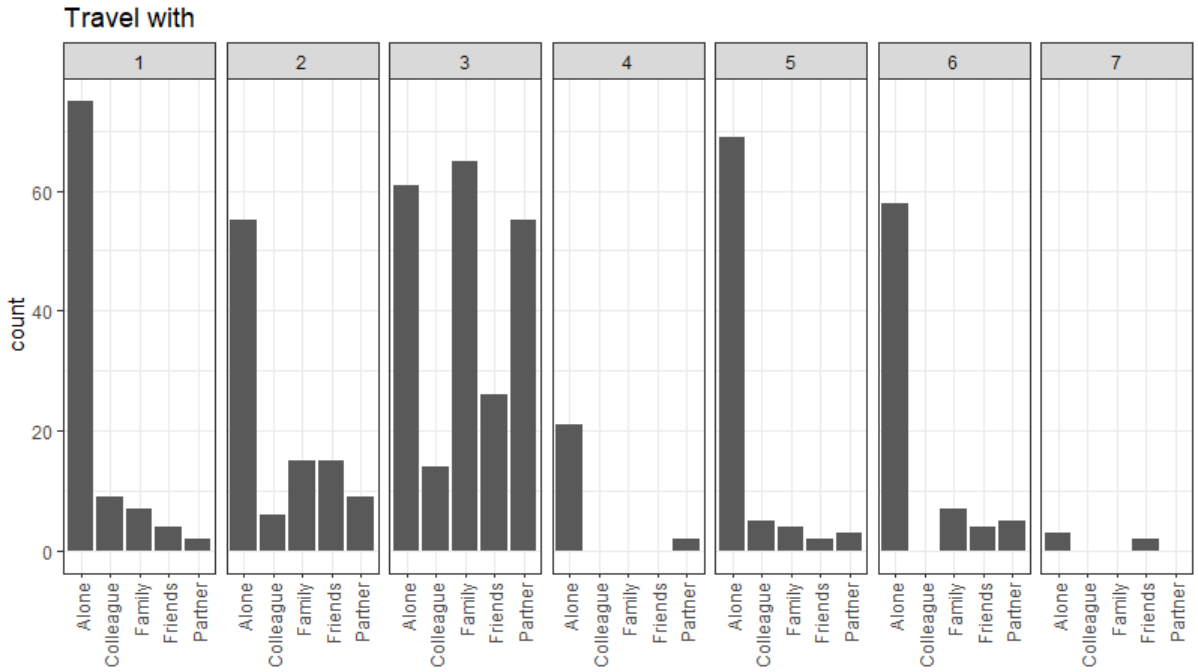

Figure 19: Distribution of "the people the user was travelling with" in the 7 clusters

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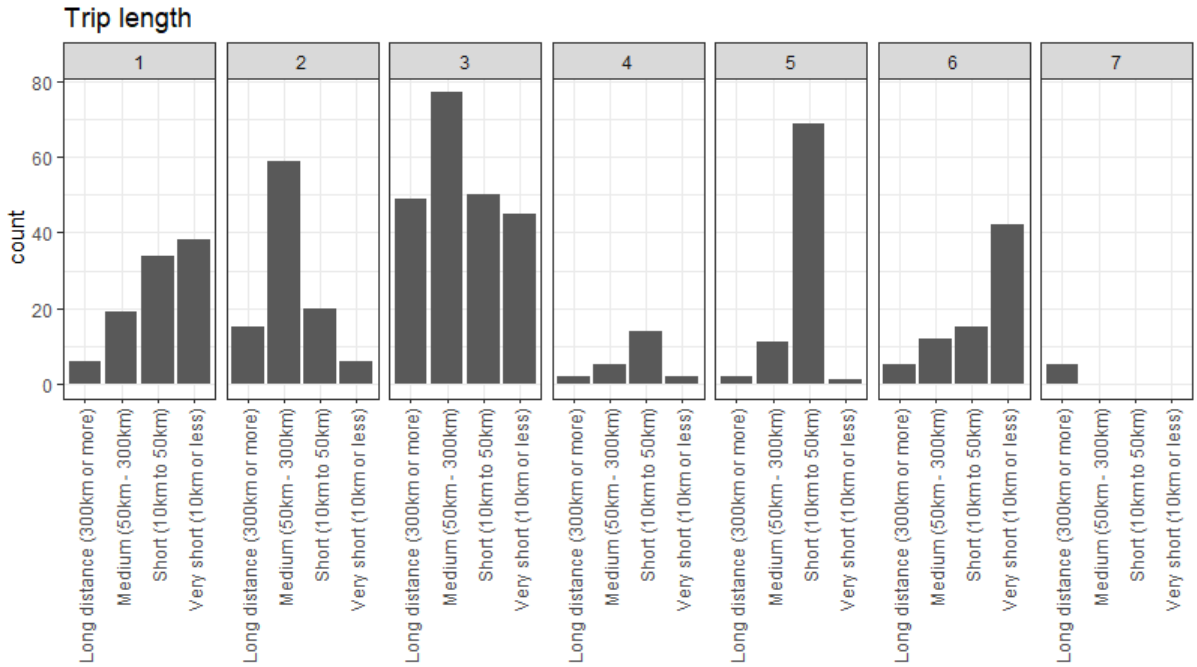

Figure 20: Distribution of the length of the trip in the 7 clusters

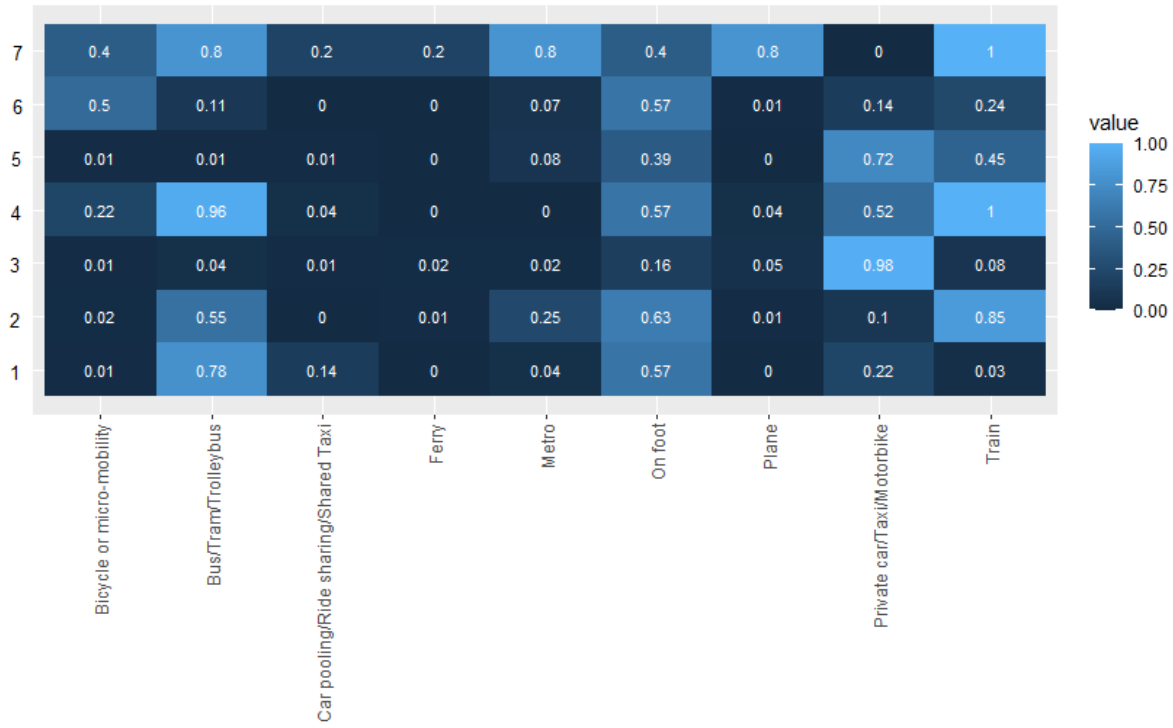

Figure 21: Percentage of means of transport used in the 7 clusters

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The analysis of Figure 16-Figure 21 enables the characterization of each cluster providing (i) a summary of the main features, (ii) the size of the cluster and (iii) a label that shortly describes the mobility pattern found.

Cluster 1 SHORT BUSINESS TRIP TO URBAN AREAS [population: 97]

- Business trip
- Alone (in some cases with colleagues)
- Mainly from an urban area (but also from rural and suburban areas) to urban areas
- Short trip, less than 50 km
- Means of transport: Bus/Tram/Trolleybus, On foot, Private car/Private Taxi/Motorbike, Carpooling/Ride-sharing/Shared-Taxi

Cluster 2 MEDIUM LENGTH TRIP BETWEEN URBAN AREAS [population: 100]

- Mainly leisure trips, but also a relevant number of business and commute trips
- Mainly alone, but sometimes also with family and friends
- From an urban area to an urban area
- Medium length trip (50-300 km)
- Means of transport: train, metro, Bus/Tram/Trolleybus

Cluster 3 LEISURE TRIP FROM SUBURBAN AND URBAN AREAS TO ANY AREAS [population: 221]

- Leisure trip
- Alone or with family or partner
- From suburban and urban areas to urban, suburban and rural areas
- Mainly medium-length (50-300 km), but also for short (<50 km) and long (>300 km) distances
- Means of transport: Private car/Private Taxi/Motorbike, on foot

Cluster 4 SHORT BUSINESS TRIP BETWEEN URBAN AREAS [population: 23]

- Business trip
- Alone
- Short trip (10-50 km)
- Trips from an urban area to an urban area
- Means of transport: train, Private car/Private Taxi/Motorbike, on foot, Bus/Tram/Trolleybus, Bicycle or micro-mobility

Cluster 5 COMMUTING TRIP TO URBAN AREAS [population: 83]

- Business and commute trip
- Alone
- From all the areas to an urban area
- Short distance (10-50 km)
- Means of transport: Private car/Private Taxi/Motorbike, train and on foot

Cluster 6 VERY SHORT TRIPS FOR BUSINESS OR LEISURE WITHIN URBAN AREAS [population: 74]

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- Business or leisure trip
- Alone
- From an urban area to an urban area
- Very short length (<10 km)
- Means of transport: on foot, Bicycle or micro-mobility, train, Bus/Tram/Trolleybus, Private car/Private Taxi/Motorbike

Cluster 7 LONG DISTANCE LEISURE TRIP BY PLANE [population: 5]

- Leisure trip
- Alone or with friends
- From urban area to urban area
- Long-distance (>300 km)
- Means of transport: train, plane, metro, Bus/Tram/Trolleybus, Bicycle or micro-mobility, ferry, Carpooling/Ride-sharing/Shared Taxi

In the identified clusters there are no significant differences in terms of socio-demographic data: (i) male and female are equally distributed (cf. Figure 22), (ii) people are spread over a very wide age range (cf. Figure 23), and (iii) full-time employees and students are equally distributed (cf. Figure 24).

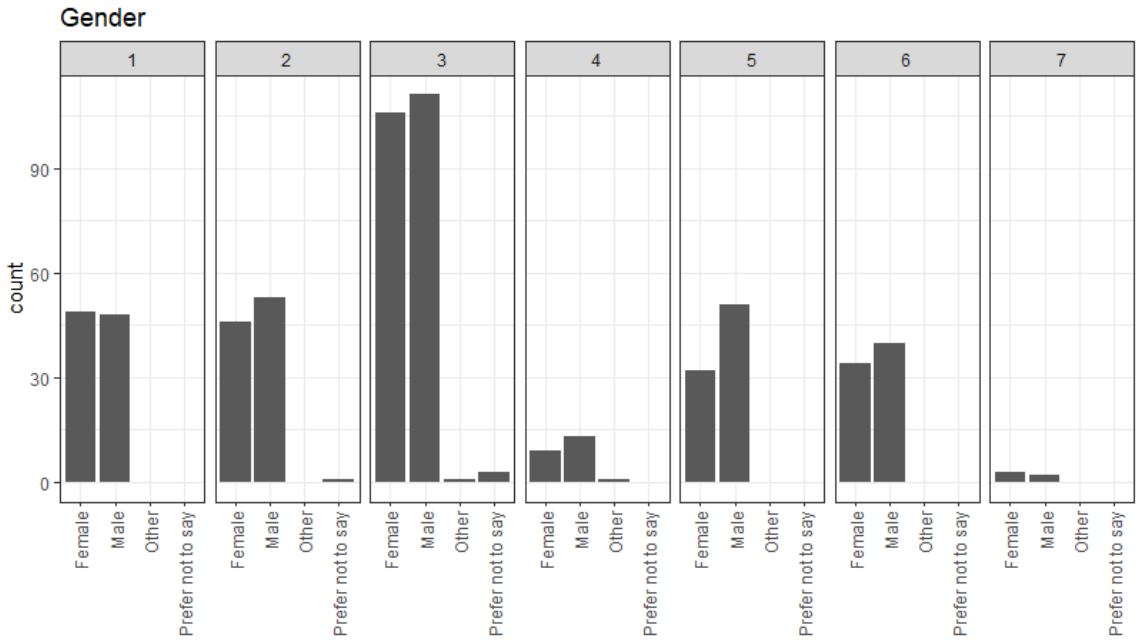

Figure 22: Distribution of the gender(Male, Female, Other, Prefer not to say) in the 7 clusters

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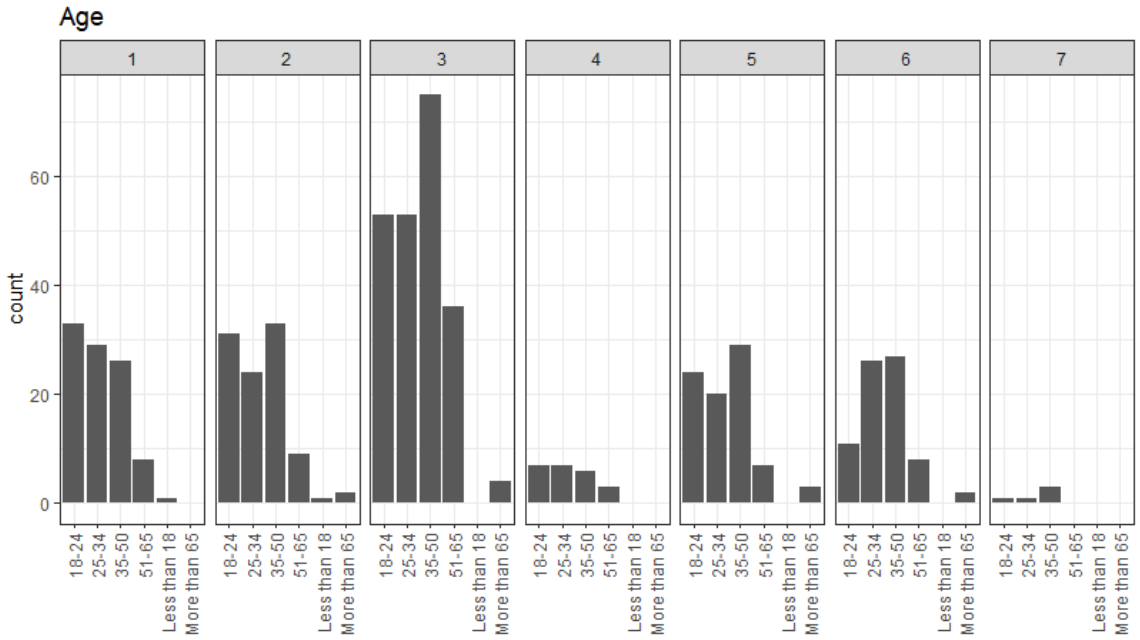

Figure 23: Distribution of the age in the 7 clusters

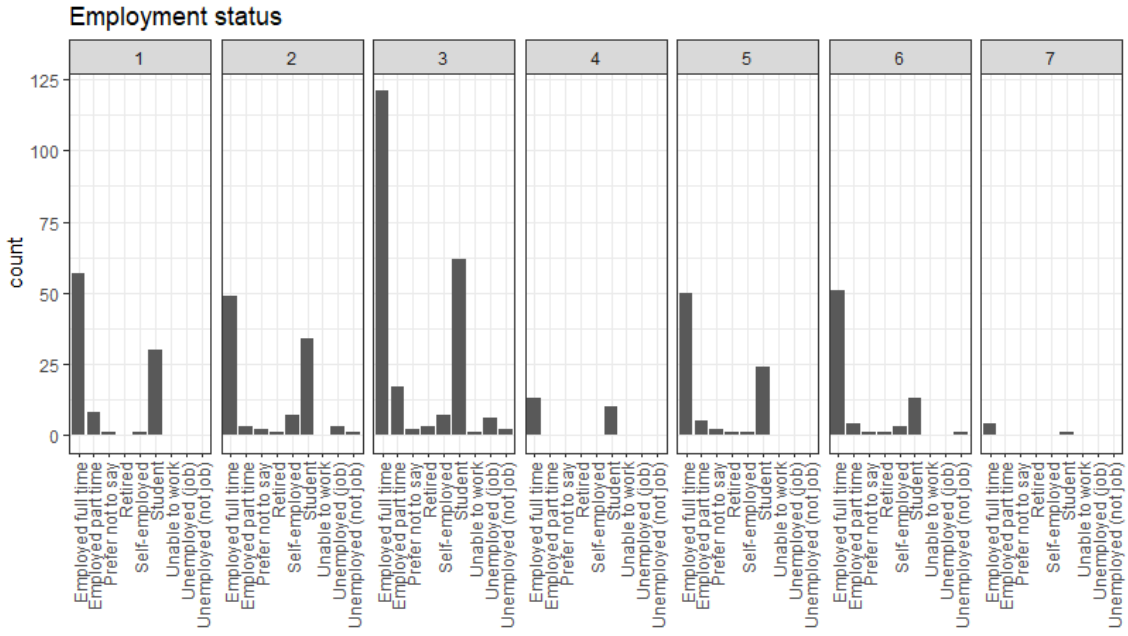

Figure 24: Distribution of the employment status in the 7 clusters

In the following section, we analyze the identified clusters in terms of the preferred offer categories (Section 7.2.2), the most appreciated incentives (Section 7.2.3), and the preferences the travellers would like to specify (Section 7.2.4). The aim of the analysis is to understand if there are significant differences among the different mobility patterns.

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7.2.2. Offer categories distribution in each cluster

For each offer category, we compute the mean score obtained by the users of each cluster and the standard deviation (*delta* in the following) from the average score computed considering all the respondents of the choice criteria survey (cf. Table 1 and Table 2). Green is used to mark a positive deviation from the mean; red is used for a negative deviation. The chromatic intensity is used to mark to most significant deviations.

Table 1: Offer categories scores for each cluster and deviation from the mean score (PART-A)

Cluster	Cheap		Comfortable		Door to door		Environmentally friendly		Multitasking	
	mean	*delta*	*mean*	*delta*	*mean*	*delta*	*mean*	*Delta*	*mean*	*delta*
1	3.96	0.04	3.98	0.02	3.77	-0.1	3.69	0.07	3.13	0.01
2	3.89	-0.03	4.01	0.05	3.57	-0.3	3.7	0.08	3.15	0.03
3	3.86	-0.05	4.08	0.12	4.11	0.23	3.57	-0.06	3.06	-0.06
4	4	0.08	3.7	-0.27	3.22	-0.66	3.91	0.29	3.52	0.4
5	3.98	0.06	4.02	0.06	3.98	0.1	3.57	-0.06	3.14	0.02
6	3.95	0.03	3.55	-0.41	3.78	-0.09	3.57	-0.06	3.09	-0.03
7	4.4	0.48	3.8	-0.16	4.2	0.33	3.8	0.18	3.4	0.28
All	3.92	0	3.96	0	3.87	0	3.62	0	3.12	0

Table 2: Offer categories scores for each cluster and deviation from the mean score (PART-B)

Cluster	Philanthropic		Quick		Reliable		Short		Social	
	mean	*delta*	*mean*	*delta*	*mean*	*delta*	*mean*	*delta*	*mean*	*delta*
1	2.26	0.03	4.71	0.08	4.62	-0.03	3.97	0.3	2.04	0.02
2	2.1	-0.13	4.59	-0.05	4.73	0.08	3.52	-0.15	1.83	-0.19
3	2.24	0.02	4.59	-0.04	4.62	-0.03	3.6	-0.07	2.13	0.11
4	2.74	0.51	4.78	0.15	4.57	-0.08	3.74	0.07	2.26	0.24
5	2.37	0.15	4.59	-0.04	4.67	0.03	3.73	0.06	2.18	0.16
6	1.95	-0.28	4.74	0.11	4.66	0.02	3.62	-0.05	1.69	-0.33

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7	2.8	0.57	4.4	-0.24	4.4	-0.25	3.4	-0.27	1.8	-0.22
All	2.23	0	4.64	0	4.65	0	3.67	0	2.02	0

Here is a summary of the main findings:

- Regarding the social and philanthropic travel offers, even if in some clusters there are significant variations from the global average, the cluster average remains always very low (under 3).
- Travellers of **Cluster 1** (Short Business trip to urban areas) attribute higher importance to a Short (+0.3) and Quick (+0.08) trip. Since the trip is undertaken by private car, carpooling or on foot, the length of the trip becomes an important aspect to be considered, and less attention is given to door-to-door solutions.
- In **Cluster 2** (Medium-length trips between urban areas), since the means of transport mainly used are public transports (train, metro and bus), less importance is given to the length of the travel in terms of kilometres (Short -0.15) and more relevance is given to the reliability of the service (+0.08) and the environmental aspects of the solution (+0.08). Travellers attribute less importance to the Door-to-door aspect (-0.3) since in an urban environment they can easily reach the final destination on foot.
- As for **Cluster 3** (Leisure trips from suburban and urban areas to all the areas), travellers tend to look for a comfortable (+0.12) and door-to-door (+0.23) solution to make a leisure trip as relaxing as possible.
- In **Cluster 4** (Short business trip from an urban area to an urban area) less importance is given to the comfortable (-0.27) and the door-to-door (-0.66) solution, probably because trips are short and within urban environments. On the other hand, the characteristics above the average are environmentally friendly (+0.29), multitasking (+0.4) and quick (+0.15). Since it is a business trip, travellers would like to arrive at the destination as quickly as possible, they would like to have the possibility to work while travelling, and appear to be more sensible in regards to environmental issues.
- For **Cluster 5** (Commuting trips to urban areas) more attention is placed on the door-to-door (+0.1) solution since it is a trip repeated frequently by travellers.
- As regards **Cluster 6** (Very short trips for business or leisure within urban areas), trips within the city made by bike or on foot should be quick (+ 0.11) but not necessarily comfortable (-0.41).
- **Cluster 7** is the cluster with the largest number of variations from the global average. This is due to the low cardinality of this group (only 5 elements) and so this variation is not significant.

7.2.3. Incentives distribution in each cluster

For each travel incentive, we compute the mean score obtained by the users of each cluster and the deviation from the average score is computed considering all the respondents of the choice criteria survey (cf. Table 3 and Table 4).

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Table 3: Incentives scores for each cluster and deviation from the mean score (PART-A)

Cluster	Achieve goal		Additional services		Class upgrade		Discount complementary services		Discount future purchases	
	mean	*delta*	*mean*	*delta*	*mean*	*delta*	*mean*	*delta*	*mean*	*delta*
1	2.69	0.06	3.12	-0.05	3.78	0.21	2.82	0.02	3.33	0.15
2	2.35	-0.28	3.17	0	3.34	-0.24	2.54	-0.26	3.11	-0.07
3	2.68	0.05	3.33	0.16	3.67	0.09	2.94	0.13	3.1	-0.08
4	3.17	0.54	3.17	0	3.83	0.25	3	0.2	3.74	0.56
5	2.67	0.04	2.89	-0.28	3.43	-0.14	2.82	0.01	3.28	0.1
6	2.58	-0.05	3.03	-0.14	3.42	-0.16	2.65	-0.16	3.04	-0.14
7	2.4	-0.23	3.6	0.43	3.6	0.02	3	0.2	3.2	0.02
All	2.63	0	3.17	0	3.58	0	2.8	0	3.18	0

Table 4: Incentives scores for each cluster and deviation from the mean score (PART-B)

Cluster	Immediate discount		Loyalty program		Points and leaderboard		Info on environmental impact		Info on the positive aspects of the solution	
	mean	*delta*	*mean*	*delta*	*mean*	*delta*	*mean*	*delta*	*mean*	*delta*
1	3.74	0.03	3.15	0.15	2.18	0.02	2.79	-0.14	2.71	-0.1
2	3.72	0.01	3	0	2.09	-0.06	2.83	-0.1	2.72	-0.09
3	3.79	0.08	2.86	-0.14	2.17	0.01	3	0.06	2.92	0.11
4	4.13	0.42	3.17	0.17	2.35	0.19	3.3	0.37	3.04	0.23
5	3.46	-0.25	3.11	0.11	2.17	0.01	2.9	-0.03	2.77	-0.04
6	3.53	-0.18	3.03	0.03	2.08	-0.07	2.95	0.01	2.72	-0.09

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7	4.2	0.49	3.2	0.2	2.4	0.25	3.4	0.47	2.6	-0.21
All	3.71	0	3	0	2.15	0	2.93	0	2.81	0

Here is a summary of the main findings:

- The incentives more important for **Cluster 1** (Short business trip to urban areas) are the class upgrade (+0.21) and the discount on a future purchase (+0.15). Since they use both public transport and carpooling, they are interested in receiving discounts for their trips in the future.
- In **Cluster 2** (Medium length trips between urban areas) there is less interest in the class upgrade (-0.24) and discount complementary services (-0.26), maybe because when using the metro and the bus there is no differentiation between the travel classes and the complementary services are very limited. Moreover, there is less interest in receiving an incentive related to goal achievement.
- In **Cluster 3** there are no significant variations from the global average.
- In **Cluster 4** (Short business trip from an urban area to an urban area), immediate discount (+0.42), discount future purchases (+0.56) and class upgrade (+ 0.25) are the incentives above the average. Since some travellers use bicycles and micro-mobility for the trips within the city they also give more attention to the solution environmental impact (+0.37) and to achieving goals (+0.54).
- In **Cluster 5** (Commuting trips to urban areas) commuters are less interested in additional services (-0.28), class upgrade (-0.14) and immediate discount (-0.25). On the other hand, they are more interested in a discount on a future purchase (+0.1) since they use the service repeatedly.
- In **Cluster 6** (Very short trips for business or leisure within urban areas), travellers give less importance to class upgrade (-0.16) and additional services (-0.14), since trips within the city are very short and are done by bicycle, on foot or by public transport.
- **Cluster 7** is the cluster with the largest number of variations from the global average. This is due to the low cardinality of this group (only 5 elements) and so this variation Is not significant.

7.2.4. Preferences distribution in each cluster

Table 5 reports the characteristics of a travel offer selected by at least 33% of respondents of each cluster as something they would like to specify as preferences when looking for a travel solution. This cut-off point, as reported in Section 6.3.1, is needed to ensure an adequate amount of answers, necessary to perform such an analysis.

The following shortcuts are used in the column names to refer to specific characteristics analyzed through the choice criteria survey: *Time interval* means "A time interval for the departure and arrival times"; *Means transport* means "Specific means of transport to be included in the travel solution"; *Limit changes* means "A limit on the number of transport

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changes"; *Status update* means "Availability on live notifications on trip status updates"; *Refund* means "Refundability of the travel solution"; *Connection* means "Onboard connectivity during the journey"; *Seat type* means "Possibility to choose the seat type (e.g. aisle, window…)"; *Meal* means "Meal included in the travel offer"; *Travel class* means "Possibility to choose the travel class"; *Specific company* means "Possibility to choose specific transportation companies".

Table 5: Preferences selected by at least 33% of respondents in each cluster

Cluster	Time interval	Means transport	Limit change	Status update	Refund	Connection	Seat type	Meal	Travel class	Specific company
1	x	x	x	x						
2	x	x	x	x						
3	x	x	x	x						
4	x	x	x	x		x				
5	x	x	x	x						
6	x	x	x							
7	x	x	x	x			x		x	

Here is a summary of the main findings:

- All the groups agreed on the following three characteristics: a time interval for the departure and arrival times, specific means of transport and a limit on the number of transport changes.
- All groups except cluster 6 (very short trips for business or leisure within urban areas) would also like to have live notifications with trip status updates. The reason for this difference is probably linked to the fact that the means of transport mainly used by these travellers are micro-mobility, bicycle and on foot.
- The cluster 7 is characterized by long-distance leisure trips with the plane and so it is reasonable that, on a plane, the travel class and the seat type are two characteristics that travellers would like to specify.
- Businessmen that travel alone by train between and within urban areas (cluster 4) would also like to have onboard connectivity to have the possibility to work while travelling.

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8. FINAL CONCEPTUALIZATION OF CHOICE CRITERIA AND INCENTIVES

In this chapter, we describe the final conceptualization of choice criteria (i.e. offer categories and user preferences) and incentives. The final conceptualization has the same structure proposed for the first one in D2.1 [6]: we propose a final set of definitions conceptualizing choice criteria and incentives, and then we focus on identifying concrete instances for the defined concepts. The proposed final conceptualization enables the enrichment of the IP4 glossary and terminology, and will then be used within the Ride2Rail project as an input to enable implementation tasks in WP3.

This final conceptualization updates the first one described in D2.1 taking into account the following main contributions:

- Comments and feedback collected during the 2nd Ride2Rail-IP4 CFM Collaboration Meeting (26th May 2020) from partners of ongoing CFM projects aiming to improve the IP4 terminology alignment and the proposed definitions of offer categories, user preferences and incentives;
- Inputs received from the first iteration of Ride2Rail T2.3, consolidated in the deliverable D2.3 [8], to validate the conceptualization considering the first set of requirements for the Ride2Rail components described in the document;
- Contributions and revisions from the Ride2Rail T2.2 leader to ensure that the proposed conceptualization, in particular user preferences, covers aspects specifically related to Ride-sharing;
- Additional revisions from Ride2Rail T2.1 participants. UIC has contacted different UIC working groups (the UIC Passenger Services Group, the Station Managers Global Group and the PASSAGE group which is the UIC PRM Group of Experts) with the preference model and no missing elements have been received;
- The results of the choice criteria survey described in Chapters 6 and 7.

The chapter is organized as follows: Section 8.1 presents the final Ride2Rail alignment with IP4 terminology, Section 8.2 discusses offer categories and the proposed catalogue, Section 8.3 describes user preferences and the preference models, and Section 8.4 incentives for multi-modal trips and the related catalogue.

8.1. Choice Criteria and Incentives in the IP4 Context

In this section, we describe the final terminology alignment for Ride2Rail with respect to the Shift2Rail IP4. We discuss an updated version of the diagram presented in Section 7.2 of D2.1, taking into account the feedback from CFM projects received during the 2nd Collaboration Meeting and the inputs related to the preliminary outcomes of the Ride2Rail task T2.3 presented in D2.3.

As reported in the CONNECTIVE Deliverable on the A-Rel Architecture [1], the IP4 ontology is currently undergoing an in-depth process of modularization and extension considering

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already standardized formats (e.g., Transmodel, NeTEx, TRIAS, etc.). For this reason, as discussed in D2.1, it has been decided to avoid focusing on an extension of the current ontology and to work instead for a conceptualization of choice criteria and incentives to be integrated with the latest release of the MaaSive Glossary [3]. The MaaSive Glossary contains a description of the IP4 terminology and offers a comprehensive view of concepts and components. Given the focus of choice criteria and incentives, we mainly considered concepts related to the *Travel Shopping* process, i.e., the process of a user with a mobility need and looking for multi-modal travel offers.

The defined diagram (Figure 25), does not use a standard specification but has been designed using a UML-based notation to enable a graphical visualization of the existing links among the different concepts defined in the MaaSive glossary and the newly proposed ones. The diagram focuses on the main components involved in the *Travel Shopping* flow and, for each of them, on the set of concepts and relations that are specifically instantiated or handled by that component. The presented diagram does not aim at providing a complete description of the IP4 architecture and focuses only on components introducing concepts relevant for Ride2Rail; indeed, components like the *Interoperability Framework*, handling data heterogeneity, are omitted for simplicity.
In this final diagram, we integrated CFM comments to better align the figure to the definitions in the MaaSive glossary. Moreover, we decided to remove flows of interaction between components since different approaches can be used to implement them. A detailed study on these aspects is presented in Ride2Rail D2.3 and will be finalized in D2.6.

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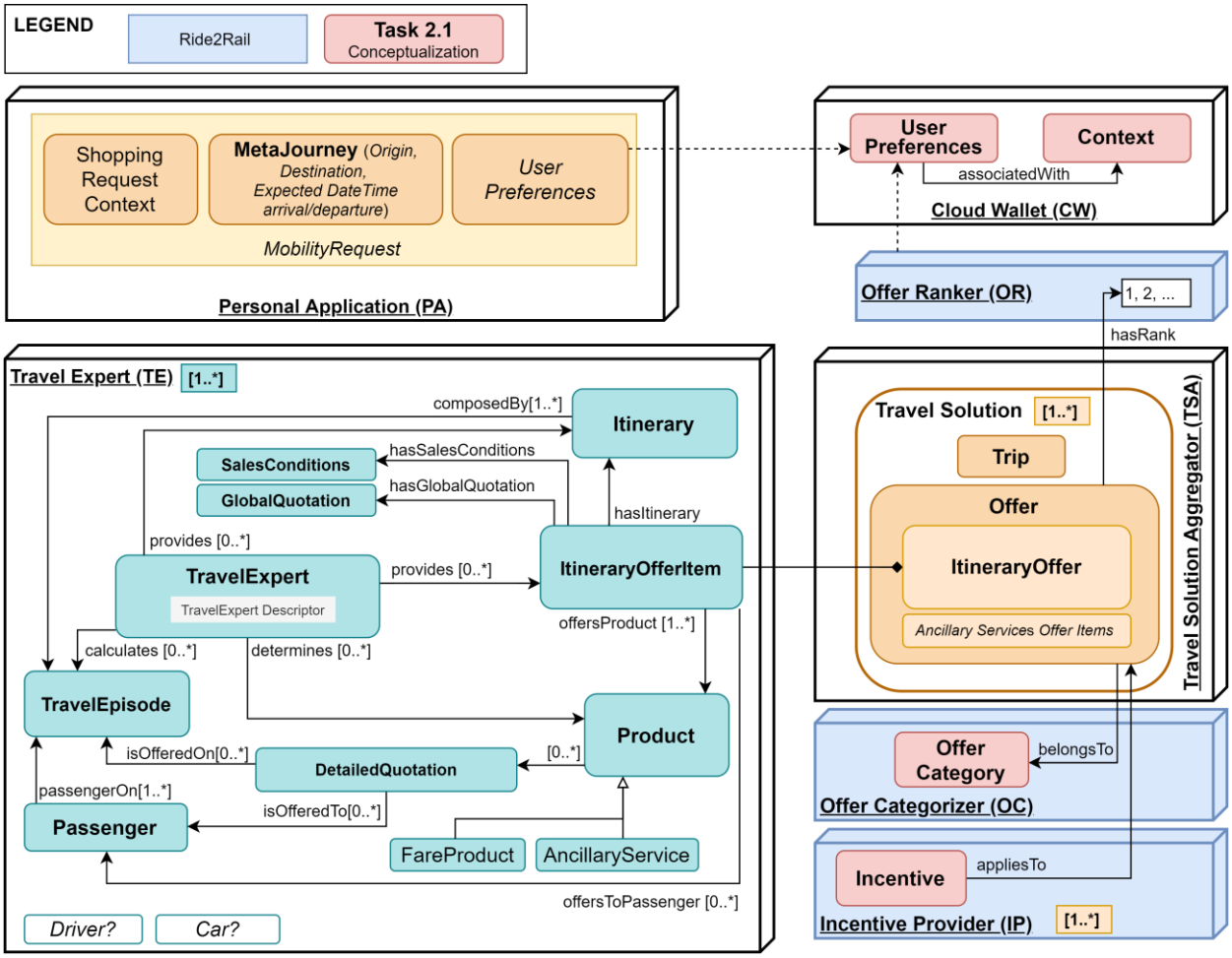

Figure 25 Ride2Rail final conceptualization of choice criteria and incentives in the context of IP4 Terminology.

In this section, we overview the components and concepts represented in Figure 25. For further and more detailed descriptions, please refer to the MaaSive glossary [3] and the final conceptualization of offer categories (Section 8.2.1), user preferences (Section 8.3.2) and incentives (Section 8.4.1).

The user interested in looking for multi-modal travel offers can access the Shift2Rail ecosystem functionalities using a *Personal Application (PA)*. The *Personal Application* aims at being a digital representation of a person in the ecosystem. It allows a user to set his/her personal preferences, to access all travel services needed for the journey (shopping and booking), to store the rights to travel, and to receive notifications on his/her trips (trip tracking). The *Travel Companion (TC)* is the technical demonstrator developed within Shift2Rail and it is composed of the *Personal Application* and the *Cloud Wallet*. The *Cloud Wallet* stores data and information about the user and, in particular, its *User Preferences*.

To initialize a *Travel Shopping* interaction through the *PA*, the user generates a *Mobility Request* containing data on the *Shopping Request Context* (metadata), the *Meta Journey* (origin, destination, expected date-time departure/arrival) and the *User Preferences*

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associated with a *Context*. The dotted line in Figure 25 represents the fact that we consider the specific "instance" of *User Preferences* associated with the current *Context*.

The *PA* sends the generated *Mobility Request* to the *Travel Solution Aggregator (TSA)*[2] that is responsible for handling the *Mobility Request* providing a set of *Travel Solution*s satisfying it. The TSA receives the *Mobility Request*, and will then invoke multiple Travel Experts (TE) to obtain travel solutions. A TE can be managed by a TSP or an intermediary selling TSP solutions. In detail, the TSA takes the *Mobility Request*, it analyzes the *Meta Journey* requested by the user and identifies the TE that can provide solutions for that request. Moreover, since TEs have different capabilities, the TSA analyzes the TEs Descriptors to determine which data, and in particular which *User Preferences*, can be understood by a given TE. In this way, the TSA can avoid receiving travel solutions that should be discarded, and the TE prevents receiving *User Preferences* that it wouldn't be able to process.

A single TE may return zero, one or more *ItineraryOfferItems* in response to a given request from the TSA. The main concepts defining an *ItineraryOfferItem* are the *Travel Episode*s (i.e., the segments of the *Itinerary* on a single-vehicle provided by a TSP and offered to cover the meta-journey), the *Products* (*FareProduct*, that identify the purchasable item offered by the TSP, or *AncillaryServices* that identify additional products, e.g., included meals) and the *Passenger*(s) involved (e.g., person, type/number of people, animal, bike). It is the relation between these three concepts that determine what the TE returns as an *ItineraryOfferItem*. In an *ItineraryOfferItem* there must be a *Product*, there may *be Travel Episode*s, there may be *Passenger*s. For example, a pass or metro ride for the whole network (a *FareProduct*) may be offered without referring to a particular *Travel Episode* and a specific *Passenger* (i.e., the "holder"). For a single *Product* in an *ItineraryOfferItem*, a TE may determine multiple *DetailedQuotation*s referencing different combinations of *Travel Episode*s and *Passenger*s in the *ItineraryOfferItem*. If a Travel Expert cannot provide *DetailedQuotation*s, or if they are not applicable, then a *GlobalQuotation* is instantiated (at the ItineraryOfferItem level). An *ItineraryOfferItem* is also associated with a set of *SalesConditions* determined by the TE.
The TE also provides additional information not reported to avoid overcomplicating the diagram. For example, a *TravelEpisode* is characterized only by start and end endpoints (can also be a GPS coordinate) and does not have timing information. This information is related to the *Transportation Service* concept identifying the operation of a given *Travel Episode* on a specific date/time.

[2] Sometimes Shift2Rail IP4 projects refer to the TSA as *Shopping Orchestrator*. In this deliverable, we decided to use *Travel Solution Aggregator* to be consistent with the MaaSive glossary.

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Once received *ItineraryOfferItem*s from the different TEs, the TSA should understand how to combine them to compose a set of multi-modal trips. In the context of Ride2Rail, a Ride-Sharing TE should also be considered as a potential provider of *ItineraryOfferItem*s.
The set of *ItineraryOfferItem*s returned by TEs is processed by the TSA to build a set of *ItineraryOffer*. In doing so, the TSA filters out all the possible solutions that do not fulfil *User Preferences* in the received *MobilityRequest*.
Finally, the TSA calculates a set of *Travel Solution*s that are the solutions provided to the customer, as the result of the *Travel Shopping* process, in the form of *Trip*s and *Offer*s. *Trip*s defined by the TSA are bound to one or more related *Offer*s and satisfy the *Mobility Request* of the user. An *Offer* is composed by *ItineraryOffers* for a given *Itinerary* of a *Trip*, and, eventually, additional *Offer Items* bound to *Ancillary Services* offered to the user.

The PA receives, as a response to the *MobilityRequest,* a set of *Travel Solution*s. The PA is responsible for displaying them to the user, eventually ranked using additional *User Preferences*.

The described flow can be enhanced by a set of additional components defined in Ride2Rail: *Offer Categorizer*, *Incentive Provider* and *Offer Ranker*. As anticipated, in Figure 25, we represented also these new components and the related concepts defined in the Ride2Rail final conceptualization of choice criteria and incentives. The components added are logically defined in the following sections as completely decoupled from the rest of the architecture. Indeed, it is outside the scope of this document to define how they interact with the already existing components and/or their implementation details (see deliverable D2.3). In general, we can describe the newly defined components offering services capable of *enriching* and *ranking Offer*s. However, an important aspect highlighted in the 2nd Collaboration Meeting is related to the fact that these components enrich and rank *Offer*s but needs to access the entire *Travel Solution*, i.e. also the *Trip*, to have all the information that may be needed.

To conclude this section, we report some concepts that we believe are missing, or require clarifications, in the current IP4 terminology. Although these aspects are not strictly related to the conceptualization of choice criteria and incentives, we pointed out these aspects to ongoing CFM projects suggesting possible modifications of the MaaSive glossary to better integrate the results of the Ride2Rail project.

- The first concept, as commented also in D2.1, is related to the *Passenger*. The definition currently provided in the MaaSive glossary simply defines the *Passenger* as a person using the PA and/or tokens to access a means of transportation. This definition should be improved to better model the concept of *Passenger*(s) in the *Travel Shopping* process. In particular, in a ride-sharing scenario, it should be possible to univocally identify and describe a passenger (e.g., to be recognized by the driver) so this concept must be modelled and cannot be simplified/omitted as in other standards (e.g., TRIAS) currently considered in IP4.
- The other two concepts, currently missing, are the ones of the *Driver*, i.e., the person offering a ride-sharing ride, and the *Car*, as a possible *Vehicle* for a *TravelEpisode*. These aspects need to be better conceptualized, together with *Passenger,* also

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because they can be used as user preferences to enable match-making algorithms in ride-sharing scenarios.

8.2. Offer Categories

This section describes the final conceptualization of offer categories. We present the final set of definitions for *Offer Category* and related concepts taking into account the final Ride2Rail-IP4 alignment, and the final catalogue of offer categories considering the results of the choice criteria survey.

8.2.1. Final conceptualization

We report in Table 6 the final set of definitions defining an *Offer Category*, the related concepts and components. Considering the set of definitions proposed in the first conceptualization, we slightly revised them to clarify the need for considering both the *Offer* and the *Trip* associated in the categorization. The column "status" specifies if the term is new (i.e., not previously available in the MaaSIVE glossary and *introduced by Ride2Rail*) or is a modification of an existing one (i.e., already available in the MaaSIVE glossary and *modified by Ride2Rail*).

Table 6 Final Conceptualization of Offer Categories

Term	Description	Status
OFFER FEATURE	An *Offer* can be described by a set of objective variables (such as transportation mode, level of CO_2-emission, cost, etc.). The values assigned to the objective variables for a specific *Offer* identify its **OFFER FEATURES**. For example, *<transportation mode=train>* can be a feature of an Offer. An *Offer Feature* can be computed considering data provided by the TSP (e.g., the price), and/or additional data, e.g., related to the *Trip*(s) associated to the *Offer* in a *Travel Solution* (e.g., length in km), or to the vehicle used in the *Offer* (e.g., CO_2-emission).	Introduced by Ride2Rail

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OFFER CATEGORY	An **OFFER CATEGORY** identifies a set of *Offer*s having particular shared characteristics. The membership of an *Offer* to a given *Offer Category* is computed considering a set of *Offer Features,* i.e., the *determinant factors* for the *Offer Category*. The membership of an *Offer* to a given *Offer Category* is defined by a ***Category Score*** **(CS)** in the range of [0,1][3], where 0 means "no membership", and 1 indicates "full membership".	Introduced by Ride2Rail
OFFER CATEGORIZER	An **OFFER CATEGORIZER** is a component offering a service to compute the *Category Score*s of an *Offer* with respect to a set of *Offer Categories*. It implements a set of functions that compute the *Category Score*s based on the *Offer Feature*s. The service receives as input the *Offer*s and produces the ranked list of *Category Score*s for each *Offer*.	Introduced by Ride2Rail

The *Offer Categorizer* component can be considered as an external service used by the TSA or by the PA to determine the offer categories associated with each *Offer*. Ideally, different *Offer Categorizer* services may exist and the TSA or the PA can use more than one service to cover a broader list of offer categories. Different *Offer Categorizer*s could be created with different characteristics, for example:

- different *Offer Categorizers* could adopt different strategies, and/or external data sources or services, to compute the *Offer Feature*s;
- different *Offer Categorizer*s could implement different algorithms and consider different *Offer Features* as *determinant factors* to compute the CS of an *Offer* for a given offer category.

The outcome of the *Offer Categorizer* can be represented through the instantiation of a *belongsTo* property connecting the *Offer* to the *Offer Category*. As defined, this property should be characterized by a *Category Score* (CS).

8.2.2. Final catalogue of offer categories

In the first conceptualization (D2.1), we proposed a list of offer categories identified from the state-of-the-art analysis and subsequently framed considering the provided definitions in three conceptual levels. In this final conceptualization, considering the survey results, we

[3] The range [0,1] is considered in all the definitions to indicate the normalization of a generic defined interval between a *min-value* and a *max-value*. Each interval may be used ensuring consistency.

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provide the final catalogue of offer categories. The goal is not to give an exhaustive list of all the possible offer categories, but to elicit the most common ones to provide to the user a comprehensive clusterization of travel solutions obtained in response to a mobility request.

Survey results

The analysis of survey results, described in Section 6.2, supports the identification of the following four main groups of categories considering the overall set of responses:

1. ***Quick, Reliable, Cheap:*** these categories emerged clearly as the most important for users when asked to pick their top three choices;
2. ***Comfortable, Door-to-Door, Environmentally Friendly, Short*:** these offer categories collected similar scores considering the 1-5 Likert scale question and they are above the average;
3. ***Multitasking*:** this category registered an average relevance for the users in the 1-5 Likert scale question but a lower number of preferences score in the direct comparison with other categories (top-three choices);
4. ***Social, Philanthropic*:** these offer categories resulted clearly as the less relevant for respondents considering both the 1-5 Likert scale and the top-three choices questions.

In the final catalogue of offer categories, we will highlight which should be the priorities in the implementation of an *Offer Categorizer* considering the results obtained. The minimum threshold is related to the categorization of ***Quick, Reliable,*** and ***Cheap*** Offers. The recommended set also included ***Comfortable, Door-to-Door, Environmentally Friendly,*** and ***Short.***
A complete set of offer categories should consider also ***Multitasking.*** We think that, even if this offer category obtained average scores, the results showcase that there is not a negligible percentage of users interested in it. Moreover, given the results registered in the user preferences block of the survey, we can assume that a different definition of the *Multitasking* offer category, e.g., in term of plugs available, silence areas and/or on-board connectivity, could have led to higher scores. We will highlight these aspects reformulating the definition of the related offer category in the final catalogue.
Considering the scores registered for ***Social*** and ***Philanthropic***, we decided to combine the two in a unique ***Social*** offer category taking into account both the possibility of socializing with other people and to contribute to social causes.

As stated in D2.1, some offer categories can be defined considering different determinant factors. To improve the definition of the ***Comfortable*** offer category in the final catalogue, we will highlight the results obtained from the survey and showcasing that, for an average user, four main aspects are identifying a *Comfortable* offer: *cleanliness of the stations and vehicles, feeling of personal safety, having a comfortable seat*, and a *minimum number of interchanges.*

To define the final catalogue, we also considered the collected answers for the open-ended question (described in Section 6.2) to formulate additional offer categories:

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- *frequency of the connections*: since it influences mainly the possibility of having alternatives in case of delays, we will stress this aspect as an additional factor determining the *Reliability* offer category;
- *direct solutions with no changes*: we already considered this aspect as a determinant factor for the *Comfortable* offer category, moreover a more precise filter on this can be expressed as a user preference;
- *accessibility of the solution*: we considered proposing an accessibility offer category but, since accessibility mainly depends on the specific need of a person, we concluded that it is not possible to characterize an Offer as the best solution in terms of *Accessibility* for a generic user. We investigated in detail this important theme in the definition of the preference model;
- *"sport" category*: we decided to define a new ***Healthy*** category to cluster offers involving walking or cycling and, therefore, taking into account the number of calories that can be burned choosing that solution;
- *feeling of personal safety*: we already considered this aspect as a determinant factor for the *Comfortable* offer category;
- *gluten-free or a vegan-friendly category*: it is not relevant to define such offer category since many travel solution does not include meals, a precise filter on this can be expressed as a user preference;
- *offers trying different routes that might take longer but follows a route through a more interesting or beautiful environment like a peculiar village or a forest*: we decided to define a new ***Panoramic*** offer category taking into account the mentioned aspects but also the solutions offering the possibility of sightseeing, e.g., for tourists;
- *a category that certifies the presence of all the needed security measures to prevent the COVID-19 virus from spreading due to the in-act pandemic*: we decided to not define a specific offer category for COVID-19 prevention measures, but to consider these aspects in the final preference model in Section 8.3.3.

Catalogue of offer categories

In Table 7, we report the final Ride2Rail catalogue of offer categories describing the relevant determinant factors for each of them. We ordered the offer categories highlighting the four groups mentioned above and emerged from the choice critera survey. We report newly defined offer category at the end of the table since we cannot provide an estimation of the relative relevance for travellers.

Table 7 Final Catalogue of Offer Categories

Offer Category	Description of Determinant Factors
QUICK	The ***Quick*** category measures how convenient and efficient the solution is in terms of time-related issues, considering the total travel time, the waiting time between legs and the number of stops required. If the solution includes a segment on-road (e.g., bus/car) and real-time data on traffic congestion are available, also these data can be taken into account.

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RELIABLE	The *Reliable* category concerns the likelihood of delays, traffic congestion, breakdowns or last-minute changes that could affect the travel time and comfort of the trip. Some solutions are inherently variable (e.g. traffic delays when crossing a city at rush hour), while other solutions might offer a small window to change the mode of transport that could cause massive idle times. For this reason, also the frequency of the service for involved solutions should be taken into account. Lastly, the influence of the weather on the trip is taken into account.
CHEAP	The *Cheap* category concerns the total price of a trip, the possibility of sharing part of it with others and the ease of payment, giving additional value to solutions that offer an integrated fare system and do not require the user to purchase different tickets from different platforms.
COMFORTABLE	The *Comfortable* category concerns objective factors such as the number of interchanges required or the possibility of having a comfortable seat but also covers a set of other elements about the quality of the trip that has to be evaluated through users' feedback. Relevant factors are the cleanliness of the stations and vehicles used and the feeling of personal safety.
DOOR-TO-DOOR	The *Door-to-door* category covers the distance of the user's start and endpoint from the beginning and destination locations of the solution provided. It is measured by the amount of walking or driving distance the user has to cover.
ENVIRONMENTALLY FRIENDLY	The *Environmentally Friendly* category covers the green aspects of the trip, taking into account at least the amount of CO_2 emissions measured per kilometre/traveller for each mean of transport included in the Offer and considering the distance covered and the number of passengers. If available, additional determinant factors can be considered as the energy consumption, the NOx emissions (nitrogen oxides) and the carbon footprint.
SHORT	The *Short* category focuses on minimizing the distance covered.
MULTITASKING	The *Multitasking* category concerns the extent to which the user can perform other tasks while travelling. These activities can regard productivity (personal or work), fitness, or enjoyment. This category considers the amount of space available, the presence of silence or business area, as well as whether the internet connection and/or plugs are provided. Lastly, the level of privacy might also influence the extent to which a person can work and could be considered as a determinant factor for this category.
SOCIAL	The *Social* category concerns the maximization of the number of people the user will share the trip with and his/her ability to network or socialize based on the context and means used. Moreover, it takes into account solutions that contribute to social causes or involves volunteering or charity activities (e.g., donations).

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PANORAMIC	The *Panoramic* category promotes solutions passing through beautiful landscapes (like a particular village or a forest) or historical sites. This category also takes into account the usual sightseeing itineraries for tourists to promote solutions passing near monuments or other interesting spots.
HEALTHY	The *Healthy* category concerns the involvement of walking and/or cycling in an offer.

8.3. User Preferences

This section describes the final conceptualization of user preferences and the final version of the traveller preference model defined in Ride2Rail. We considerably revised the first conceptualization (i) to better align the proposed definition to Shift2Rail IP4 current management of user preferences, (ii) to take into account feedback from Ride2Rail WP2 partners, and (iii) to consider the results of the choice criteria survey.

8.3.1. Validation of the first conceptualization of User Preferences

In the first conceptualization, we proposed a simplified model for user preferences describing each preference as a *preference weight* measuring the desirability for a user in having specific characteristics of an Offer. The set of *weights* is related to a specific *Context* describing the current situation in which the user is involved. Moreover, we introduced the *Offer Ranker* as the component responsible for implementing algorithms to rank Offers for a user given his/her *preferences weights* in the current *Context*. Finally, a preference model have been proposed through the introduction of the Traveller Context Dimension Tree (TCDT, revised in Section 8.3.3) and additional offer features have been identified from the state-of-the-art to extend the current set of preferences managed by IP4 components.

Before presenting the final conceptualization, we discuss the following main aspects emerged in the validation and addressed during the revision of the first conceptualization.

1. The need for introducing a logical distinction among different types of user preferences. While, from the point of view of a learning algorithm and/or an *Offer Ranker* component, it is important to provide a unique and integrated model of user preferences, in the design of the *Personal Application* and the interaction with the user it is also important to distinguish between user preferences that are: (i) stable for a user, (ii) associated to specific contexts, or (iii) associated one-time to a single mobility request. For this reason, we decided to keep our model based on contextual preference weights. However, we decided to provide more detailed definitions of different types of user preferences in our conceptualization. These aspects are indeed complementary, as described in Section 8.3.2, in the sense that the same user preference, described through a preference weight, can be set for a user as a stable, contextual or one-time preference.

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2. The need for better conceptualizing the concept of *Traveller Profile* described in Section 6.4 of deliverable D2.1 and currently under implementation and discussion in IP4 CFM projects. To address this aspect we propose a conceptualization of user preferences taking into account the distinction between the *User* and *Traveller* profile (see Table 8).

3. The need to enhance the conceptualization with more detailed user preferences related to ride-sharing covering, in particular, the *Passenger*, the *Driver* and the *Car*. To address this issue, we collaborated with Ride2Rail T2.2 introducing: *(i)* the Driver Context Dimension Tree (DCDT) model to specifically target user preferences that can be expressed by a driver, and *(ii)* an extension of the *TCDT* to accommodate preferences and context dimensions related to a ride-sharing passenger covering, among others, characteristics related to the driver and the car.

4. The need to clarify the distinction between user preferences, and offer categories and incentives. Offer categories and incentives are possible "enrichments" of an offer, and therefore, once associated with the offer can become an offer feature. This aspect allows the user to define user preferences associating a *PW* to a specific offer categories and/or incentives. We took into account this aspect in the definition of the final version of the TCDT.

5. The need to validate and check the completeness of the first version of the preference model proposed in D2.1, taking into account feedback from Ride2Rail WP2 partners, the current implementation status reported by IP4 CFM project, and the results of the choice criteria survey. These aspects led to the updated TCDT, and to the identification of a set of specific user preferences that results to be very relevant to be considered in the *Travel Shopping* process. In particular, as explained in Section 6.3, we collected the following set of suggestions for additional user preferences to be modelled and considered:
   - *guaranteed alternative connection whenever the planned one is lost due to delays or other unforeseen issues*: we decided to add *re-accommodation* as an offer feature that can be requested as a user preference;
   - *a large seat:* we added this as a possible offer feature for a user preference;
   - *on-board toilet, the presence of air conditioning, presence of parking spots in the starting station, breastfeeding room*: we added these as possible offer features for user preferences on the services in the travel offer;
   - *possibility of specifying a zone of the vehicle, e.g., to have a seat in the direction of travel, or a children/silence zone*: we considered a "seat category" variable to define a set of user preferences considering these offer features;
   - *avoid having to purchase several different tickets*: we added a dimension to express the user preference on recombined tickets;
   - *accessibility*: we extended the possible offer features for accessibility-related user preferences, e.g., to specify the need for an *accessible toilet* as requested by users;
   - *COVID-19 safety measures*: we considered a safety measure variable to let the user express preferences on solutions adopting specific measures.

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8.3.2. Final conceptualization of user preferences

This section describes the final Ride2Rail conceptualization of *User Preferences*. Differently from *Offer Category* and *Incentive*, the MaaSive glossary already contains a set of related concepts for user preferences: Profile, Profile Connected Preferences, Contextual Preferences, Search Options. In the final conceptualization, reported in Table 8, we tried to better align it to the already existing concepts proposing a set of new and modified definitions. As above, the column "status" specifies if the term is new (i.e., not previously available in the MaaSIVE glossary and *introduced by Ride2Rail*) or is a modification of an existing one (i.e., already available in the MaaSIVE glossary and *modified by Ride2Rail*).

The first change is related to the modification of the *Profile* concept to distinguish between *User Profile* and a *Traveller Profile* associated with the user. As a second modification, we decided to adopt a less technical definition of the *Context* taking into account the work described by Abowd et al. in [1]. Then, starting from the concepts already defined in IP4, we propose a set of definitions for different typologies of *User Preference* that can be applied with different semantics in the *Travel Shopping* process. To conclude, we report the *Offer Ranker* definition.

Table 8 Final Conceptualization of User Preferences

Term	Description	Status
USER PROFILE	A **USER PROFILE** represents a user registered to the *Personal Application* and it is associated with her/his socio-demographic characteristics.	Modified by Ride2Rail
TRAVELLER PROFILE	Each *User Profile* can be associated with one or more **TRAVELLER PROFILE**s. A *Traveller Profile* allows a user to keep separated historical data and *Preferences* for a specific typology of travels (e.g. business travels or family travels).	Modified by Ride2Rail
CONTEXT	A **CONTEXT** describes any information that can be used to characterize interactions between a user and a *Personal Application*, including the user and the application itself. For example, the *Context* associated with a *Traveller Profile* when specifying a *Mobility Request*.	Introduced by Ride2Rail

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USER PREFERENCE	A **USER PREFERENCE** is a subjective *Preference Weight* (PW) defined in the range [0,1][4], that represents the degree of desirability for an *Offer Feature* for a user.	Introduced by Ride2Rail
USER PROFILE CONNECTED PREFERENCES	**USER PROFILE CONNECTED PREFERENCES** are stable *User Preferences* associated with each *Context* of each *Traveller Profile* of a user. These type of *User Preferences* are usually inserted by the user and can be used both for *Offers* filtering and ranking. E.g., a user with a disability may want to always exclude a transportation mode despite the *Traveller Profile* selected and/or the current *Context*.	Modified by Ride2Rail
TRAVELLER PROFILE CONNECTED PREFERENCES	**TRAVELLER PROFILE CONNECTED PREFERENCES** are stable *User Preferences* associated with each *Context* for a specific *Traveller Profile*. These type of *User Preferences* are usually inserted by the user and can be used both for filtering and ranking. E.g., a user may want to filter *Offers* not accepting the credit card payment method when using the *Traveller Profile* "Business Trips" despite the current *Context*.	Modified by Ride2Rail

[4] The values 0 and 1 can be used as *Preference Weights* to express filter conditions, in this case: the value 1 represents a *mandatory requirement* and allows filtering out all Offers without the considered feature, while the value 0 denotes a mandatory exclusion and allows filtering out all Offers with the feature. This consideration is omitted from the definition since, in the general case, it is possible to assign specific PW outside the range to identify filter conditions and use the entire range to represent the desirability of the features for the user. In this case, 0 means "no interest for the feature", and 1 means "maximum interest for the feature".

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CONTEXTUAL PREFERENCES	CONTEXTUAL PREFERENCES are *User Preferences* associated with specific *Context*(s) for a *Traveller Profile*[5]. These type of *User Preferences* are usually used only to rank offers and they are automatically learnt from previous choices of the user in similar *Context*s, or from choices of users clustered as having a similar behaviour to the user when using the specific *Traveller Profile*. E.g., a user prefers to select *Offer*s including meal when travelling with the *Traveller Profile* "Business Trips", alone and with arrival/departure near to lunchtime.	Modified by Ride2Rail
SEARCH OPTIONS	SEARCH OPTIONS are *User Preferences* associated with a specific *Mobility Request* and therefore only applied to the current *Context* for a *Traveller Profile*. These type of *User Preferences* are usually inserted by the user directly when looking for travel solutions, and they are used mainly for filtering since they are mandatory requirements for the specific request. E.g. even if the *User Preferences* for the current *Context* and the selected *Traveller Profile* indicates preferences for the economic class, the user may want to filter out travel solutions not offering the first class in a specific *Mobility Request*.	Modified by Ride2Rail
OFFER RANKER	An OFFER RANKER is a component offering a service to determine a ranked list of Offers considering as input the Offers and the *User Preferences* in the current *Context*. For each possible *Offer*, an *Offer Score* (OS) is calculated according to the *Preference Weights* and the *Offer Features*. The service produces a ranked list of *Offers* considering the computed OSs.	Introduced by Ride2Rail

[5] It is possible to ask the user to associate fixed *Context* dimensions' values to a *Traveller Profile* indicating that all the *Mobility Request*s performed with that *Traveller Profile* can consider these values to determine the current *Context* (e.g. the "Business Trip" *Traveller Profile* can always be associated with the *Context* "travelling alone for work"). We omitted this consideration from the definition since different implementation decisions can be taken on this aspect.

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It is relevant to point out that *Traveller Profile*s are not pre-determined by the system but can be arbitrarily created by the user. On one hand, each *Traveller Profile* will be treated as a different traveller from the system in learning *Contextual Preferences* and will be associated with the defined *Traveller Profile Connected Preferences.* On the other hand, all the *Traveller Profile*s associated with a *User Profile* share the same socio-demographic information and *User Profile Connected Preferences*. We used in our examples the "Business Trips" or "Family Holidays" *Traveller Profile*, however, the *Traveller Profile*s can be defined considering arbitrary aspects and they are simply characterised by a label provided by the user and, eventually, a set of fixed characteristics for the *Context*.

Moreover, it is important to clarify the relationship between the proposed model, composed by the *User Preference* and *Context* concepts, and the introduced classification of different types of *User Preferences* (*User Profile Connected Preferences*, *Traveller Profile Connected Preferences*, *Contextual Preferences*, *Search Options*). We propose an example on the *Offer Feature* related to the *means of transport* involved. A *User Preference* can be defined through a *preference weight* for each admissible value (e.g. PW(train)=0.8, PW(bus)=0.6, etc.). However, the same *User Preference* can be specialized considering the different types of *User Preferences* defined:

- ***User Profile Connected Preference***. E.g., <PW(plane)=0>. The user never wants to travel by plane because he/she is scared of flying. This *User Preference* will be applied to any *Context* for any *Traveller Profile* associated with that *User Profile*.
- ***Traveller Profile Connected Preference***. E.g., <PW(train)=0.8> associated with *Traveller Profile* "Family Trips". The user prefers to travel by train if it is with her/his family. This *User Preference* will be applied to any *Context* if the *Traveller Profile* "Family Trips" is selected by the user.
- ***Contextual Preferences***. E.g., an algorithm learnt the *User Preference* <PW(carrier A)=0.9> associated with *Traveller Profile* "Family Trips" if the user is going to travel with a pet. The user prefers to travel with the Carrier A if it is with her/his family and her/his pet. This *User Preference* will be applied to the specific *Context* identified by the *Traveller Profile* "Family Trips" and the presence of an accompanying pet.
- ***Search Options***. E.g., <PW(private car)=0>. The user wants to filter out travel solutions involving the use of the private car since her/his car is damaged. This *User Preference* will be applied to the specific *Mobility Request* that the user is performing.

As a result, it is an implementation choice to select which *User Preferences* the user can set as *User Profile Connected Preference*, as *Traveller Profile Connected Preference* and/or as *Search Options*. Similarly, different algorithms can consider different *User Preferences* to be learnt as *Contextual Preferences*. Moreover, from an implementation perspective, it is advisable to define different strategies to let the user insert her/his preferences without using the [0,1] range (e.g. 1-5 stars scale mapped to *preference weights*).
Each *Mobility Request* is associated with an instance of the *User Preferences* related to the current *Context*. Different algorithms and techniques can be implemented to determine the current *Context* and to integrate different *User Preferences* when sending a *Mobility Request*. However, from a logical point of view we can define that filtering and ranking of *Offer*s should be computed taking into account:

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- the *User Profile Connected Preference*s of the *User Profile*;
- the *Traveller Profile Connected Preference*s of the *Traveller Profile* selected by the user;
- the *Contextual Preferences* learnt for the current *Context* for the *Traveller Profile* selected by the user;
- the *Search Options* selected by the user for the specific *Mobility Request.*

The *Offer Ranker* receives as input a list of *Travel Solution*s and outputs a ranked list of *Offer*s. The considered *Offers* may be already enriched, e.g., using an *Offer Categorizer*, and/or enriched directly by the *Offer Ranker* using external sources to gather additional information on the *Offer* useful for the ranking procedure.
Multiple implementations of the *Offer Ranker* service can exist and, ideally, the PA may let the user choose among different *Offer Ranker*s. Different *Offer Ranker*s can use different algorithms to compute the OS (e.g., a simple normalized average of PWs associated to *Offer Features* or more complex combinations), resulting in different ranked lists of Offers considering the same inputs.

8.3.3. Traveller and driver preference model

The Context Dimension Tree (CDT), introduced in IT2Rail and described in Ride2Rail D2.1 [6], is a generic methodology to describe a *Context*. In the first conceptualization (D2.1), considering the *Travel Shopping* process, we presented the first version of the traveller preference model, i.e., the Traveller Context Dimension Tree (TCDT), identifying the relevant dimensions to describe the context but also the potential characteristics of a travel offer on which a user would like to express preferences. The final release of the preference model defined in Ride2Rail is supported and enriched by an updated version of the Traveller Context Dimension Tree (TCDT) and the definition of a Driver Context Dimension Tree (DCDT).

The CDT is a tree-based model enabling a hierarchical representation through two kinds of nodes: *dimensions nodes* (black nodes) that represent the different variables that can be used to describe a context, and *concepts* (white nodes) that represent the admissible values for each dimension. The provided TCDT is a conceptual model designed to capture the context and user preferences for a Travel Companion (TC) user involved in a *Travel Shopping* process. Considering this scenario, the TCDT define the dimensions that can be used to collect and infer *Preference Weights* associated with the current context for a mobility request. The presented TCDT tries to provide a complete analysis of what can be considered and can support both: *(i)* the identification of user preferences that the user can directly express through the *Personal Application*, and (ii) the definition of strategies to automatically learn user preferences for a given context. Moreover, the model can act as the Schemas to define the data types and possible values that each variable can assume.

As the continuation of the works done in [10] and [11], which have been presented in the Ride2Rail D2.1 [3] (Section 7.4), the main advancements compared to the first model are as follows:

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- As described in the Ride2Rail D2.3 (Section 6.2), the Travel Companion will potentially be composed of two different applications, one for the *Driver* and one for the *Traveller* (Passenger). Considering the proposed approach and the differences between the contexts that *Traveller* and *Driver* are interacting with, the final conceptualizations composed of two separate preference models, namely the Traveller Context Dimension Tree (TCDT) (presented in Figure 27) and the Driver Context Dimension Tree (DCDT) (presented in Figure 28). We updated the TCDT considering a set of dimensions related to the ride-sharing scenario. Moreover, we designed a separated CDT for the *Driver* to enable the learning of the Drivers' preferences to automatically filter and/or select different Passenger(s) requests according to a set of Driver's Preferences. We defined the final TCDT and DCDT taking into account the outcomes described in Ride2Rail D2.2 [7].
- As a result of the validation of the first conceptualization of user preferences, the final TCDT takes into account, as possible dimensions, the preferences of a traveller considering offer categories and incentives.
- The proposed CDTs incorporate various suggestions collected through the choice criteria survey (see Section 8.3.1) in the form of new dimensions and concepts. To provide some examples, preference for a single ticket (CombinedTicket N_D), safety measures (SafetyMeasure N_D) ensuring some standards concerning special situations such as the COVID-19 situation (e.g., SanizedVehicle), and many others, which are detailed in Figure 26, Figure 27, Figure 28, and Figure 29.
- The final TCDT encompasses all the user preferences currently implemented in IP4 integrating related *dimensions* and *concepts*. As commented for the first conceptualization, *Trip Tracking* preferences are omitted since they are out of the scope of the CDTs but can be integrated as additional dimensions in the proposed models.
- The final CDTs contains a detailed description of data types and their corresponding values, which is a crucial element to support the implementation in Ride2Rail WP3.

The described CDTs neither aim to model all the dimensions that could be considered nor to state implementation choices, such as data structure to be used. The proposed models define the fundamental *dimension* and *concept* nodes in such a way that any further interesting variable can be added by increasing/decreasing the level of granularity of the model.

In the following paragraphs, we provide an overview of the main dimensions described in the TCDT and DCDT models. The complete details can be found in Figure 27 for the TCDT, and in Figure 28 for the DCDT. Since the TCDT and the DCDT share some dimensions, in order to avoid duplicating those in both models, in Figure 26, we reported two shared sub-trees: the *Profile Context Dimension Tree* (ProCDT) and the *Membership Context Dimension Tree* (MemCDT). In Figure 29, we reported a list of examples values for enumerations used in the two CDTs.

To better follow the description of the CDTs, the reader can consider the nodes (both black and white circles) as the conceptual representation of the variables and the leaf nodes as values that can be assigned to those variables. For example, in Figure 26, TOIVal is the possible value for the TopicOfInterest dimension node. As shown in the legend of Figure 26,

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is composed of two variables (TopicOfInterest, PS). The possible values of each variable are shown in Figure 29.

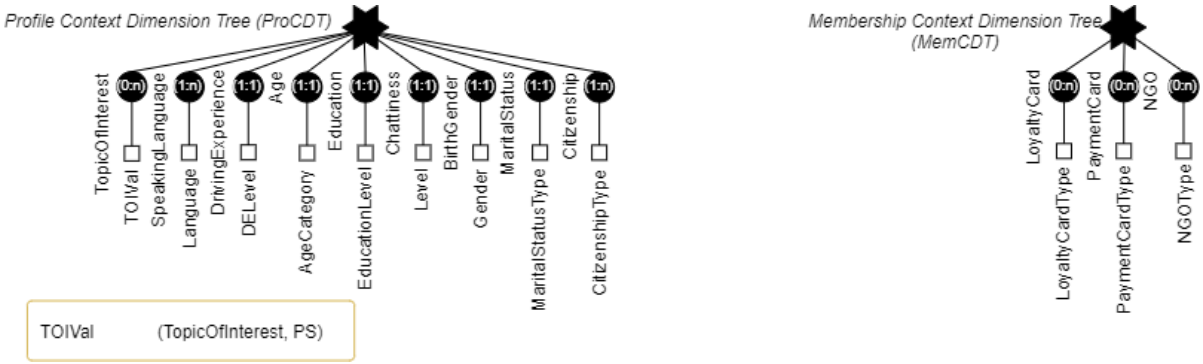

Figure 26: Profile Context Dimension Tree (ProCDT) and Membership Context Dimension Tree (MemCDT)

Traveller Context Dimension Tree (TCDT)

The proposed Traveller Context Dimension Tree (TCDT) represents the final traveller preference model defined in Ride2Rail. In the proposed TCDT, the PersonalData N_D contains sub-trees ProCDT and MemCDT, which have been shown in Figure 26. The ProCDT N_C values can be used to infer PWs associated with the Context from data of similar users based on different identifiable groups, such as users with the same geographical origin, the same profession, and so on. Considering an actual system, these dimensions can enable a warm start for a new user providing an initial set of preferences based on data collected during the user registration. As an example, consider two regions X and Y; for some reason, users from X might tend to choose certain means of transport much more frequently than users from Y; not having additional information on a user from region X, we can use this information to assign a higher PW to some means of transport for that user.

The MemCDT N_C captures the memberships of the user to some communities. For example, the LoyaltyCard N_D captures the user's membership in a community that provides specific discounts; the PaymentCard N_D describes cards owned by the user identifying the community of users using a given payment method (e.g., able to pay using a specific payment circuit). These types of values can be used directly as preferences (e.g., to promote Offers linked to TSP of which the user has a Fidelity Card), but can also be considered part of the context to infer PWs as explained for the ProCDT N_C. The same situation holds for users who are members of the same NGO, which can be potentially helpful for learning the users' preferences.

Particular attention is given to detailing the dimension describing the needs of people with disabilities and HealthRelated Issue; the Health N_D is defined for this purpose. The Issue N_D supports the specification of Type (e.g., Walking), Severity (e.g., 3 meaning that the person cannot walk without AidTool), EndsIn (to determine if the issue is temporary or permanent), HICategory (indicating if the Issue belongs to a *Person with Reduced Mobility* or not) and

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AidTool (to determine if any special space is required to carry the AidTool). Moreover, by allocating Constraint N_D, the model aims at capturing the actual constraints caused by the Issue or specified manually by the users. Capturing these constraints is essential to rank travel offers.

Among the other top dimensions, the BehavioralStatus N_D captures the current behaviour of the user. The Traveling concept captures the status in which the user is travelling or has purchased a travel offer and is waiting for the upcoming trip. Its two sibling N_C, drawn with dashed lines, are mutually exclusive: the Inactive N_C is true if the user is not interacting with the TC, while the Surfing N_C incorporates both implicit and explicit momentary user behaviours while interacting with the TC. More precisely, the Interface and Gesture N_D capture implicit behaviours that can be used to infer, for example, the type of the device (e.g., Smartphone or Computer).

Explicit behaviours, instead, are captured via the Request N_D describing the current Mobility Request. This information can be combined with their AllowedInterchanges, Segment, and other dimensions applicable to any Mobility Request.

The user might also specify the trip's purpose through Purpose N_D.

The user provides the locations they are going to visit (at least PlaceType as Source and Destination). In the TCDT, to capture the factors contributing to the user's decision, this value is transformed into appropriate concepts such as Country, City, AreaType (e.g., Urban), Weather, and so on. As mentioned before, since the new CDTs are intended to act as a complete model, we keep the locations' actual coordinates (GeoLocation), which will be used for retrieving the travel offers.

The user may have some Accompanying Item (e.g., a bike) and Pet, whose characteristics such as their *Type*, *Species*, *Size*, and *Number* can be considered to determine user's preferences. Also, accompanying Person not only affects travel choices from the logistic aspect but, if the Person is also a user of the Travel Companion (captured by TCMember value), their preferences should be considered for recommending trips.

Among the Mobility N_C children nodes,

To give some examples from the other dimension of the Ride N_c, Incentive N_D allows the Traveller to specify the type of incentive(s) (IncentiveType) they are more interested in. For example, Traveller might specify if they are interested in *intangible* and/or *tangible* incentives.

The RequestedService N_D encompasses the variety of Travel- and Meal-related preferences according to the user's PWs that can be directly provided by the user (*optional)* or generated analyzing user's historical data.

The purpose of the ReqModeService N_c is to enable the user to specify their desired services which are shared among all the transportation modes. As an example, ROfferCategory N_D, allows Travellers to specify their desired OfferCategories such as Quick, Cheap, Comfortable.

Moreover, TCDT enables users to specify their preferences concerning each mode of transportation (TransportationMode) individually. The values associated with each dimension are the actual values that might be present in the travel offers. One of the main improvement compared to the first version of the preferences models is allocating many nodes related to the ride-sharing. Concerning the ride-sharing requests which are captured through

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RCarService N_D, we divided this dimension into three main concepts. Through RPassenger N_C, a user might specify some preferences concerning the other passenger(s) that might be available in the shared-ride (e.g. the number of other Passengers in the car). RDriver N_C, enables Passengers to specify their prefered Driver. For example, a Passenger might request for English speaker Driver through RLanguage. Moreover, TCDT via RCar N_C enables the TC's user to request various characteristics of their prefered car (e.g. Seat, Safety and etc.)

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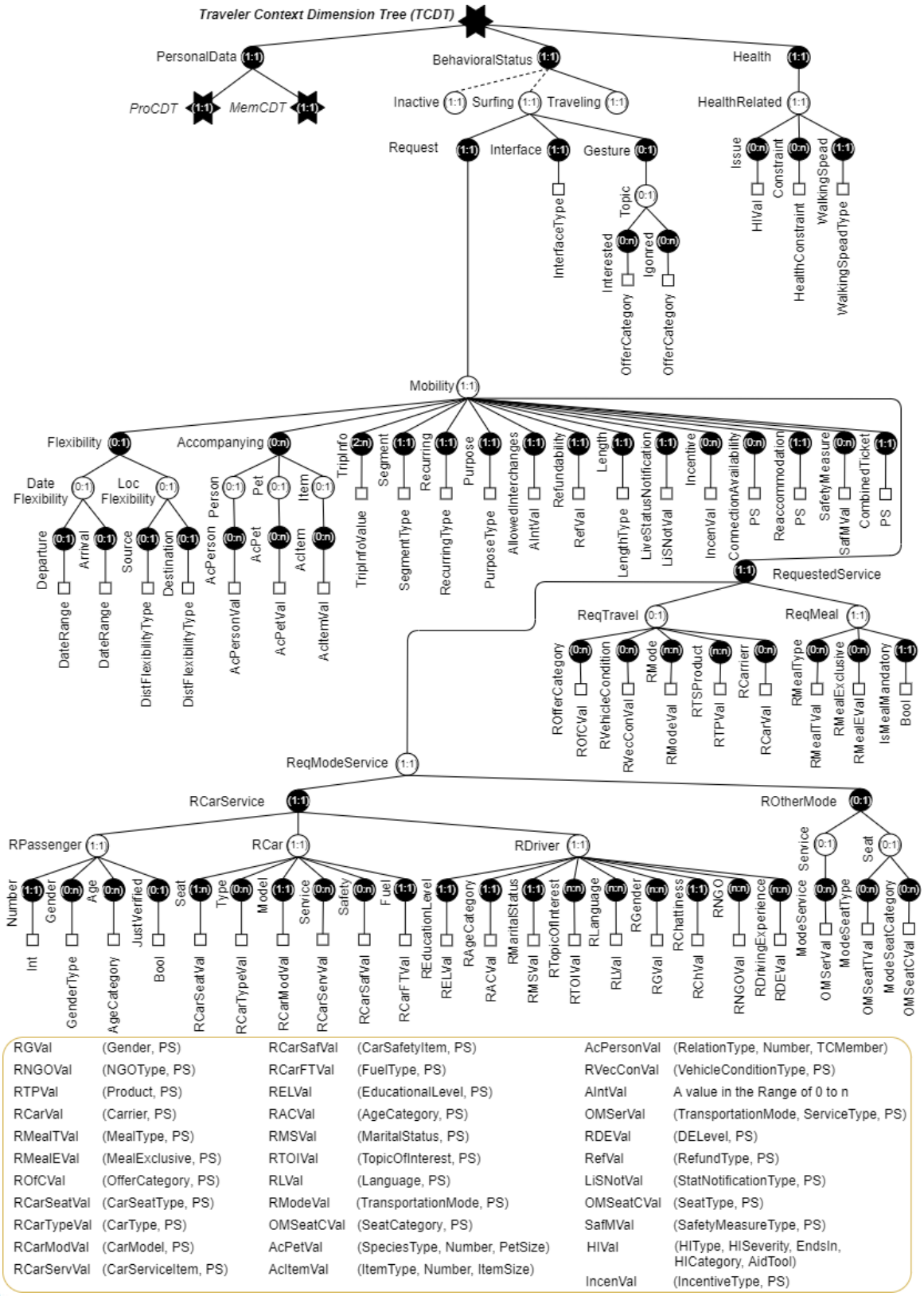

RGVal	(Gender, PS)	RCarSafVal	(CarSafetyItem, PS)	AcPersonVal	(RelationType, Number, TCMember)
RNGOVal	(NGOType, PS)	RCarFTVal	(FuelType, PS)	RVecConVal	(VehicleConditionType, PS)
RTPVal	(Product, PS)	RELVal	(EducationalLevel, PS)	AIntVal	A value in the Range of 0 to n
RCarVal	(Carrier, PS)	RACVal	(AgeCategory, PS)	OMSerVal	(TransportationMode, ServiceType, PS)
RMealTVal	(MealType, PS)	RMSVal	(MaritalStatus, PS)	RDEVal	(DELevel, PS)
RMealEVal	(MealExclusive, PS)	RTOIVal	(TopicOfInterest, PS)	RefVal	(RefundType, PS)
ROfCVal	(OfferCategory, PS)	RLVal	(Language, PS)	LiSNotVal	(StatNotificationType, PS)
RCarSeatVal	(CarSeatType, PS)	RModeVal	(TransportationMode, PS)	OMSeatCVal	(SeatType, PS)
RCarTypeVal	(CarType, PS)	OMSeatCVal	(SeatCategory, PS)	SafMVal	(SafetyMeasureType, PS)
RCarModVal	(CarModel, PS)	AcPetVal	(SpeciesType, Number, PetSize)	HIVal	(HIType, HISeverity, EndsIn, HICategory, AidTool)
RCarServVal	(CarServiceItem, PS)	AcItemVal	(ItemType, Number, ItemSize)	IncenVal	(IncentiveType, PS)

Figure 27: Traveller Context Dimension Tree (TCDT)

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Driver Context Dimension Tree (DCDT)

The Driver Context Dimension Tree (DCDT) is a preference model for a Driver that offers a shared-ride. Despite the focus of T2.1 is related to the traveller preference model, we decided to investigate these aspects since they can facilitate the implementation in WP3. Indeed, the DCDT can be used as the guide for the variables which should be captured by the *DriverApp* (discussed in D2.3 [8]). On one hand, it identifies the information that Drivers might provide while offering a shared-ride. On the other hand, it enables learning mechanisms to learn the Driver's preferences in filtering/ranking different passengers requests.

In the proposed DCDT, the Dimension Node (N_D) PersonalData captures the following three main concepts: MemCDT, ProCDT, and the PreferredPassengers. The MemCDT identifies the dimensions associated with various Driver's memberships such as LoyaltyCard and PaymentCard and non-governmental organization (NGO). The ProCDT aims at identifying the socio-economic characteristics (e.g., MaritalStatus) and general personal characteristics and interests of the user (e.g., TopicOfInterest).

Moreover, to enable the learning of Driver's preferences, the DCDT captures the Passengers' possible characteristics that might be of the Driver's interest through the PreferredPassengers N_C. To elucidate, please consider the PELValue under the PEducationalLevel N_D. This complex value is composed of one of the literals of the EducationalLevel enumeration and a value, PS, from the PreferenceStar enumeration showing how much having Passengers with the specified educational level is important for the Driver.

It should be noted that, since MemCDT and ProCDT are the concepts that are also part of the TCDT, instead of using white circles as a symbol, we defined them with the black star symbol to avoid replicating the same nodes and to refer the corresponding values in the TCDT.

The other top dimension, BehavioralStatus N_D, captures the current status of the Driver. There are three possible values for this dimension, which are the Traveling, Surfing, and Inactive nodes. As depicted in dashed lines, Inactive and Surfing behaviours cannot happen at the same time. While surfing the TC, the Driver can provide an offer. The Offer N_D models the various information regarding the shared-ride that the Driver is going to offer. The CarData N_D defines information about the Driver vehicle(s), such as the Type of vehicle, Fuel, and the ProductionYear, which can also be used to determine the vehicle's environmental sustainability.

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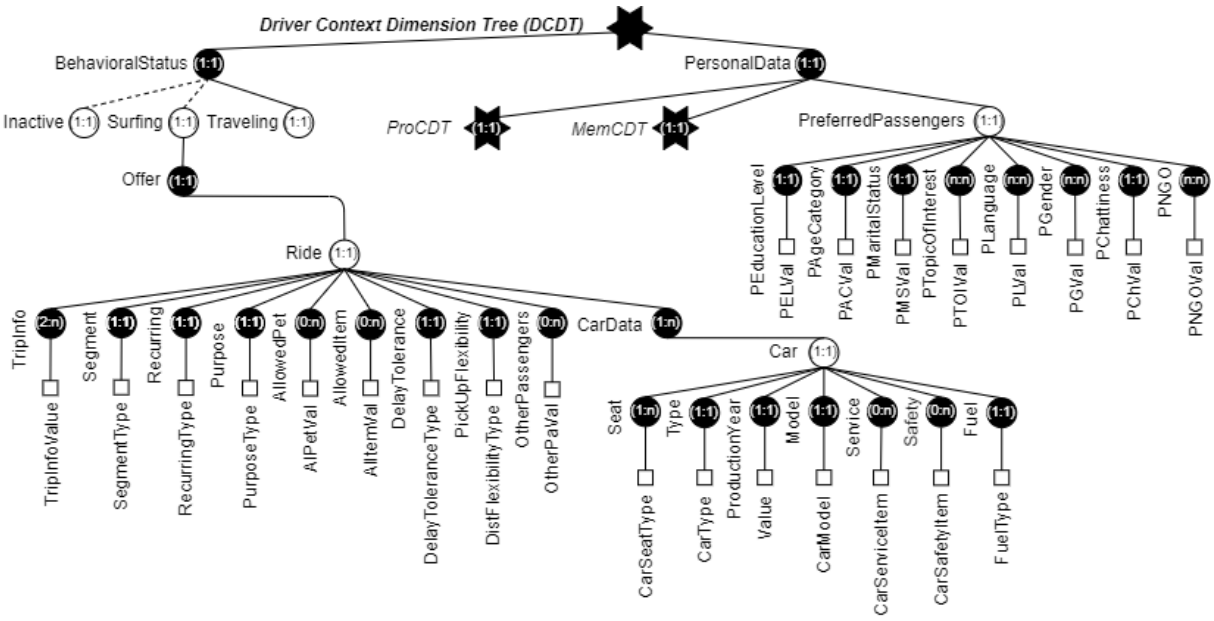

Figure 28: Driver Context Dimension Tree (DCDT)

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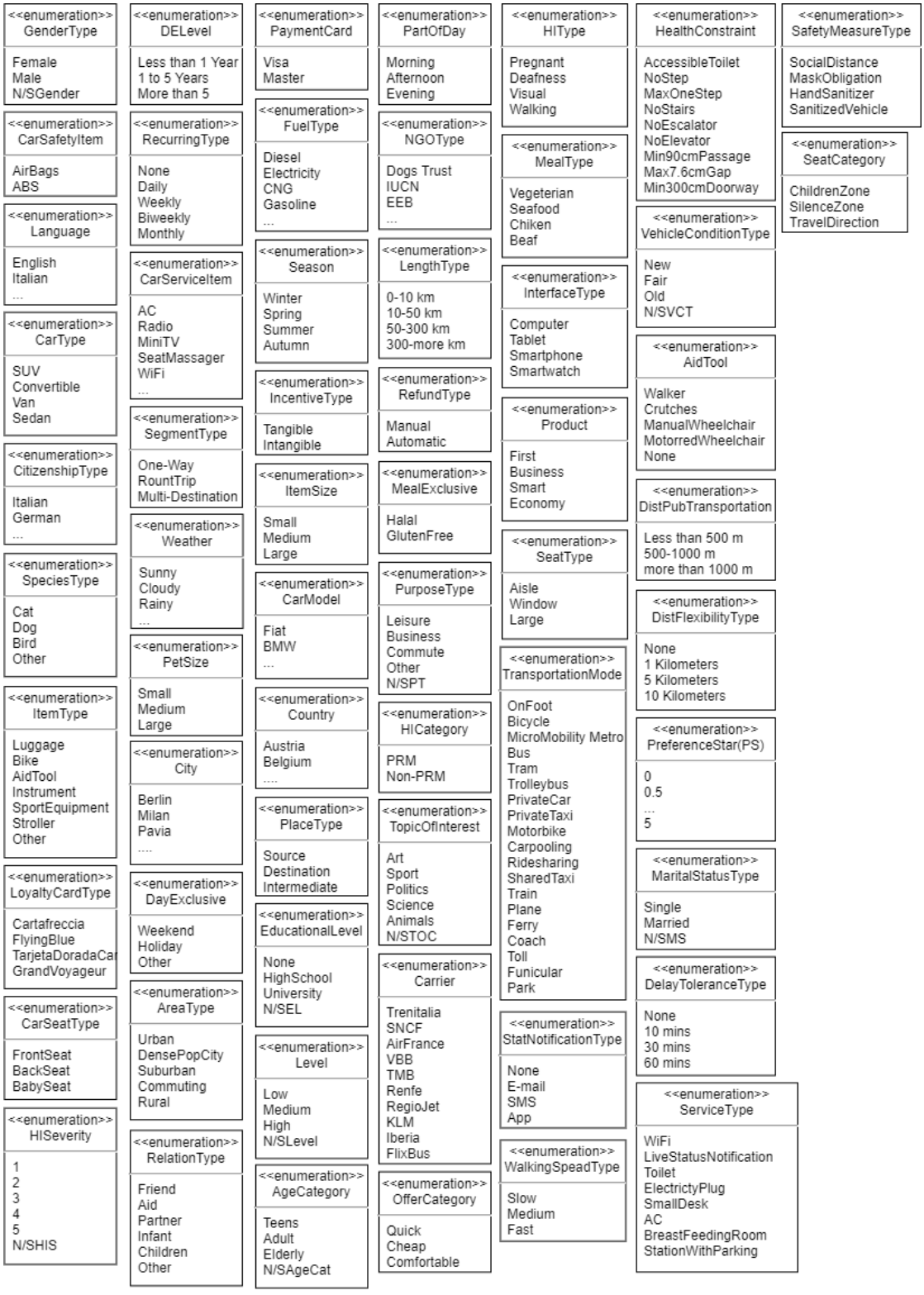

Figure 29: Various enumerations associated with the DCDT and TCDT

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8.3.4. Recommendations on user preferences

The analysis performed in Section 6.3 on the results of the choice criteria survey let us formulate some general recommendations about user preferences. Additional entries proposed by users allowed us to define a more complete traveller preference model. However, while having a complete overview of all the variables involved is extremely important to support algorithms, asking directly to the user to insert user preferences considering all the possible offer features identified wouldn't be a user-friendly experience. Questions designed for the user preferences block in the choice criteria survey, discussed in Section 4.2.2, let us investigate what are the user preferences that users would like to specify when looking for multi-modal travel solutions.
The following identified offer features can be seen as a recommendation for the set of user preferences that a user would like to directly express:

1. A time interval for the departure and arrival time
2. Specific means of transport that can be added to the travel solution
3. A limit on the number of transport changes
4. Solutions involving live notifications on trip status updates

The mentioned user preferences can be implemented as *Search Options*, allowing the user to insert them each time she/he compiles a specific mobility request, or also considered as *User Profile Connected Preferences* or *Traveller Profile Connected Preferences,* allowing the user to express them in the definition of her/his profile.

8.4. Incentives

This section describes the final Ride2Rail conceptualization of incentives. We present the final set of definitions for incentives and related concepts taking into account the final Ride2Rail-IP4 terminology alignment. Then, considering the results of the choice criteria survey, we describe the final catalogue of incentives for multi-modal travel offers,

8.4.1. Final conceptualization of incentives

We reported in Table 9 the final set of definitions defining an *Incentive* and the related concepts and components. The final conceptualization mainly relies on the definitions provided for the first conceptualization. Only minor modifications have been performed to better specify possible arguments of an *Incentive Condition* and to clarify the distinction between *tangible* and *intangible* incentives.

Table 9 Final Conceptualization of Incentives

Term	Description	Status

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INCENTIVE	An **INCENTIVE** represents a method used to promote an Offer or a set of Offers over the others. An Offer *Incentive* is characterized by an *Incentive Provider*, an *Incentive Mechanism,* and a set of *Incentive Conditions*.	Introduced by Ride2Rail
INCENTIVE PROVIDER (ENTITY)	The **INCENTIVE PROVIDER (ENTITY)** represents the entity proposing and responsible (also legally) for a given *Incentive*. The *Incentive Provider* may be a TSP or an organization, an association, or a governmental body. The *Incentive Provider* determines the *Incentive Mechanism* and the *Incentive Conditions* for the *Incentive*.	Introduced by Ride2Rail
INCENTIVE MECHANISMS	**INCENTIVE MECHANISMS** define which technique is used to promote an *Offer* or a set of *Offer*s over the others. Incentive *Mechanisms* can be of two main types: *Tangible* and *Intangible*. **TANGIBLE INCENTIVE MECHANISMS** foster a user in choosing a given *Offer* providing material or monetary benefits (e.g., an ancillary product). **INTANGIBLE INCENTIVE MECHANISMS** encourage the choice of a given *Offer* employing benefits that have no material or monetary value. For example, by simply providing additional information on the *Offer* to create awareness on the reason why a user should prefer it over the others.	Introduced by Ride2Rail
INCENTIVE CONDITION	An **INCENTIVE CONDITION** is a binary function determining the applicability of an *Incentive* to an *Offer* for a user. The function can take as input: *(i)* a subset of the *features* characterizing the *Offer*, and/or *(ii)* additional input data to target specific users and/or mobility needs, e.g., the user socio-demographic information and/or the *Mobility Request*[6]. Given the set of inputs, an *Incentive Condition* allows to deterministically compute the applicability of an *Incentive* to a given *Offer* for a *Mobility Request*.	Introduced by Ride2Rail

[6] Different scenarios can be identified between the two extremes: *(i)* The *Incentive* may be applied to any group of users and/or *Mobility Request*, and in this case no additional information are needed to determine the applicability, or *(ii)* the *Incentive* may be applied to any *Offer* related to a group of users and/or a specific type of *Mobility Request*, and *Offer Features* are not needed.

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INCENTIVE PROVIDER (COMPONENT)	An **INCENTIVE PROVIDER** *(Component)* is the component representing the *Incentive Provider (Entity)* and implementing the defined *Incentive Conditions*. Given a set of Offers, it determines the list of applicable *Incentives* defined by the *Incentive Provider (Entity)* to each *Offer* for a *Mobility Request* and retrieves the information needed to apply the associated Incentive Mechanisms.	Introduced by Ride2Rail

The *Incentive Provider* components can act similarly to the *Travel Experts*. A set of *Incentive Provider* can be available and can be called to determine *Incentives* that can be applied to the set of *Offer* generated. Differently from the *Offer Categorizer*, but similarly to the *Travel Expert,* this component may be interested in receiving additional information on the user and/or the *Mobility Request*. Assuming that *Incentive Providers* may have different capabilities and may be interested in different types of information to determine the applicability of an *Incentive*, a mechanism similar to the one of the Travel Expert Descriptor may be adopted to help the TSA in handling the communications.
The *Incentive Provider* implements the *Incentive Conditions* to determine the applicability of an Incentive to a given Offer, and the positive result can be conceptualized with the instantiation of an *appliesTo* property between the *Incentive* and the *Offer*.

To conclude the section we reported two open points, emerged in the alignment with the IP4, that are out of scope for the Ride2Rail task T2.1 but deserve further investigation.

- To provide some typologies of incentives the *Incentive Provider* may need to stipulate contracts with TSPs (e.g., a government body willing to provide discounts on some TSP Offers). This type of interaction may be managed similarly to what is currently implemented in the *Contractual Management Market Place (CMMP)* to generate multimodal agreements and MaaS packages. Intuitively, we can enhance the CMMP to act as an *Incentive Provider,* or we can imagine the CMMP as the component responsible for contacting the different *Incentive Providers* and for collecting all the applicable *Incentives* to a given set of *Offers*.
- In the context of the CMMP, the term *Benefit* has been introduced to represent which are the agreed options that make a MaaS package different from purchasing separately the different products., e.g. a discount. A *Benefit* can be compared to an *Incentive* since it represents a way of promoting a MaaS package overselling the products separately. Currently, the term *Benefit* hasn't been defined within the MaaSive glossary but we recommend an effort to align the proposed *Incentives* conceptualization when introducing the CMMP terminology in the glossary.

8.4.2. Final catalogue of incentives

In the first conceptualization of incentives, we considered the state-of-the-art analysis to propose a first set of recommendations to define incentives for multi-modal travel solutions. As discussed in D2.1, it is the responsibility of the *Incentive Provider* to determine

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mechanisms and conditions for the incentives. In the final conceptualization, we propose a catalogue of incentives for multi-modal travel offers, taking into account a set of potential incentives implementing the approaches identified in the first conceptualization, and the results of the choice criteria survey.

Incentivize multi-modal travel offers

In this paragraph, we summarize the approaches proposed to incentivize multi-modal travel offers and validated through the survey. The approaches considered are:

- ***Behavioural change.*** This research area studies the cognitive biases and factors influencing the decision-making process. It promotes the use of simplified and known options to increase uptake, implementing rewards to spark interest, exploiting social relationships to spread and support commitments and behaviours and, lastly, understanding the best moment to propose the action.
- ***Intrinsic and extrinsic motivation***. Intrinsic motivation describes actions taken simply because they are inherently interesting or enjoyable without the need to look for a secondary outcome. On the contrary, separable outcomes, such as monetary rewards, are categorized as extrinsic motivators. Intrinsic motivation leads to greater engagement and better results over a longer period but needs to be backed up by extrinsic motivators to incentivize people to do tasks that do not appear inherently interesting or enjoyable to them, thus expanding its reach and efficiency.
- ***Non-financial incentives***. On average, people tend to enhance their self-image by promoting their best behaviours concerning social, health or environmental matters as well as their ability to save time or money. At the same time, people are more influenced by negative impacts, or losses, rather than by gains. Is it more effective to highlight the bad aspects of a given behaviour instead of emphasizing the positive ones, like showing the increase of CO_2 consumption of a specific transport solution instead of the amount a different option would save.
- ***Personalized incentives***. Whenever an analysis of the user's behaviour is possible, personalized incentives can be constructed and customized based on the gathered information on the user's preferences and history.
- ***Gamification***. To increase users' engagement and interest in an offer, elements typically found in games can be applied to real-world or productive activities.

A more detailed description of the different approaches can be found in D2.1 [6].

As discussed in Section 4.2.2, we validated the first set of recommendations to incentivize multi-modal travel offers in the choice criteria survey through a set of examples. The results, shown and commented in Section 6.4, highlighted several important aspects to validate the proposed approaches and to gather additional inputs from users on possible incentives.

Based on the results analysed, we can state that **the *tangible* incentives outscore the *intangible*** ones in almost every form they were presented to the users. The *tangible* incentive obtaining the worst score is the one offering "discounts on complementary services" suggesting that users are more interested in gaining an immediate and measurable

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reward. Indeed, the incentives obtaining the higher score are the "immediate price discount" and the "free (or discounted) class upgrade" confirming the importance of *extrinsic motivators*.

Considering *intangible* incentives, *gamification* approaches collect the lowest scores. However, considering *gamification*, we can deduct that users are more incentivized by specific personal goals than by shared leaderboards. *Non-financial* incentives, like information on the environmental impact of a solution or the positive aspects of choosing an offer (e.g. sightseeing locations during the trip), collected the highest scores among the *intangible* incentives.

Catalogue of incentives

In Table 10, we provide the final catalogue of incentives for multi-modal travel offers, taking into account the results obtained in the choice criteria survey. The provided examples do not aim at providing a comprehensive catalogue but aim at offering concrete instances in the considered domain and at clarifying the distinction introduced between *tangible* and *intangible* incentives. We ordered the incentives considering the scores obtained in the 1-5 Likert scale questions. The catalogue is completed with incentives collected through the open-ended question in the survey. Some of them have been integrated with an already defined incentive, the others have been added at the end of the table (since we cannot provide an estimation of the relative relevance for travellers).

Table 10 Final Catalogue of Incentives

Description	Type
Immediate price discount on a given travel offer	Tangible
Discounted or free upgrade of the travel class	Tangible
Discounts on the following purchases	Tangible
Ancillary services offered for free or discounted (e.g., snack, meal, entertainment system)	Tangible
Point Accrual associating points with travel offers, points earned can be converted to prizes (e.g., Loyalty programme)	Tangible
Provide to the user information that can increase her/his awareness on the environmental sustainability of a travel offer (e.g. displaying the CO2 emissions)	Intangible
Provide to the user additional material promoting a given travel offer, e.g., include in an offer the images of city monuments that can be spotted during the travel. This can support e.g., to promote the usage of the bus over the underground, even if the second solution may be faster.	Intangible
Discounts on complementary services (e.g., hotel)	Tangible

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Adopt a gamification strategy assigning badges to award the achievement of pre-defined goals (e.g. trying a ride-sharing solution for the first time, or choosing the solution with the lowest environmental impact)	Intangible
Assign points to the users for virtuous choices in travel solutions (e.g. environmentally sustainable) and set up a daily/weekly/monthly shared leaderboard (e.g., among friends)	Intangible
For-free insurance for health issues/travel issues (delays or cancellations)	Tangible
Free cancellation or changes	Tangible
For-free possibility to get on-board on historical or newly adopted means of transport	Tangible
Provide information on the applicability of security measures both related to Covid-19, like the commitment to maintain social distancing, and to the feeling of personal safety, such as the presence of security personnel	Intangible

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9. SUMMARY AND CONCLUSIONS

This deliverable has described the activities and outcomes on the second iteration of Ride2Rail T2.1 (WP2) related to the definition of choice criteria and incentives for journey planning in the door-to-door multi-modal scenario addressed by Shift2Rail IP4.

In the first iteration, the first conceptualization of choice criteria (i.e., offer categories and user preferences) and incentives (D2.1) have been produced from a detailed analysis of the state of the art and an alignment with past and ongoing projects in the Shift2Rail IP4. The first conceptualization proposed definitions for offer categories, user preferences and incentives extending the IP4 reference glossary (i.e., the MaaSive glossary). Moreover, it presented a first version of catalogues of offer categories and incentives, and the traveller preference model to be potentially adopted by Ride2Rail and IP4 projects. In this second iteration, Ride2Rail has designed, administered, and analysed a survey to validate and check the completeness of the first conceptualization, collecting data from travellers living in Europe.

The starting date of the dissemination process was July 2nd 2020, and the data analyzed in this deliverable was collected on September 7th 2020. Different channels (e.g. social media, mailing list, etc.) of the Ride2Rail project partners have been used to reach the target audience. The total amount of finished compilations was 609, over a total of 787 users that started the survey. The participants mostly identified as males or females, with a good balance between the two (52.7% males and 46.2% females). Most of the respondents were between 18 and 50 years old, with a good representation recorded for the 51-65 gap and very few answers collected from people below 18 or older than 65. Regarding the country of residence, among those recorded, the majority of the respondents are from Slovakia, Czech Republic, Italy, Finland, and Greece, which are the countries most represented by the Ride2Rail consortium.

The collected data have been firstly analysed with the objective of ranking the instances proposed in D2.1 (catalogues of offer categories and incentives, preference model) w.r.t. the interest manifested by the respondents and to complement the conceptualization with the new suggested instances. Then, contextual and socio-demographic information of the respondents has been considered to better characterize the target users of a journey planning application in terms of choice criteria and potential interest in incentives.

Concerning offer categories, 10 different instances (i.e., *Quick, Short, Reliable, Cheap, Door-to-door, Comfortable, Social, Multitasking, Environmentally Friendly, and Philanthropic*) were proposed in the D2.1 catalogue. The results of the survey have shown that the *quick, reliable, and cheap* categories are the clear favourites among the respondents. On the other hand, *social* and *philanthropic* were widely regarded as less important, as factors that are not important in making the final choice. The contextual and socio-demographic analysis complemented these results with several additional findings to be taken into consideration by the Ride2Rail project.

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Concerning user preferences, 9 different instances of travel offer characteristics on which a user may want to express preferences (i.e., transportation company, a time interval for the departure and arrival times, number of transport changes, travel class, seat type, meal inclusion, refundability, live notifications on trip status updates, onboard connectivity) were selected from D2.1 traveller preference model. These characteristics were analysed through the survey, asking the respondents to select the ones that they care the most about whenever they're looking for a travel solution. The results of the survey have shown that the factors that are most important to the respondents are being able to pick a specific means of transport, a time interval for the departure and arrival times, and a limit on the amount of transport change. The contextual and socio-demographic analysis complemented these results with several additional findings, among them: (i) all the travellers, except for adults over 50 years old, would like to also have live notifications on trip status updates, (ii) young travellers under 35 years old and women would like to have also onboard connectivity, (iii) users looking for a business trip of medium-long distance would like to specify also the seat type and the travel class, (iv) a family looking for a leisure trip of medium-long distance would also like to specify the seat type and they would like to have a refundable travel solution.

Concerning incentives, the survey aimed to analyse both *tangible* and *intangible* incentives proposed in D2.1. The results of the survey have shown that the highest-rated incentives the ones that provide some sort of discount, with the exception of the discounts on complementary services. On the other hand, both the gamification elements and the share of information regarding either the environmental impact or the positive aspects of the trip scored, on average, less than the money-related alternatives. Based on these results, the tangible incentives outscore the intangible ones in almost every form they are presented. The contextual and socio-demographic analysis complemented these results with several additional findings to be taken into consideration by the Ride2Rail project.

Clustering techniques have been applied on the data collected through the survey with the goal to find mobility patterns (i.e., a common set of characteristics shared by a group of respondents in terms of travel behaviours). The *hierarchical clustering* both in the agglomerative (bottom-up) and in the divisive (top-down) option has been utilized together with the *Gower distance* as a distance metric to compute the similarity between our data points. To find the optimal number of clusters, the *elbow method* and on the *silhouette coefficient* have been adopted to evaluate both the compactness of clusters (similarities within groups) and the data consistency (how close each point in one cluster is to points in the neighbouring clusters). Two experiments have been conducted but only one produced significant results and it has been described in detail in this deliverable. The 7 resulting clusters have been characterized considering the following features: (i) trip reason (*business, commute, leisure, other commitments*); (ii) area of origin of the trip (*rural, urban or suburban*); (iii) area of destination of the trip (*rural, urban or suburban*); (iv) the people the user was travelling with (*alone, colleagues, family, friends, partners*); (v) the length of the trip (*long* (300 Km or more), *medium* (between 50 and 300 Km), *short* (between 10 and 50 Km), *very short* (10 Km or less)); (vi) the means of transport used (*bicycle/micro-mobility,*

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bus/tram/trolleybus, *car-pooling/ride-sharing/shared-taxi*, *ferry*, *metro*, *foot*, *plane*, *private car/taxi/motorbike*, *tram*). Then, each cluster has been associated with a label to shortly describe the mobility pattern found. Finally, each cluster has been further characterized in terms of choice criteria and potential interest in incentives of its population, done with a comparison with the overall characteristics of the survey respondents. The main characteristics of the identified clusters have been:

- Cluster 1 "**Short Business Trip to Urban Areas**": interested in *short* and *quick* travel offers; potentially influenced by the *class upgrades* and *discounts on future purchase* incentives.
- Cluster 2 "**Medium Length Trip between Urban Areas**": interested in *reliable* and *environmentally friendly* offers; limitedly influenced by the *class upgrades* and *discounts on complementary services* incentives.
- Cluster 3 "**Leisure Trip from Suburban or Urban Areas to any Area**": interested in *comfortable* and *door-to-door* offers.
- Cluster 4 "**Short Business Trip between Urban Areas**": interested in *environmentally friendly*, *multitasking* and *quick* offers; interested in *onboard connectivity*; potentially influenced by several incentives such as *an immediate discount*, *discounts future purchases*, *a class upgrade*, *information on the environmental impact of a solution*, and *the challenge to achieve a specific goal*.
- Cluster 5 "**Commuting Trip to Urban Areas**": interested in *door-to-door* offers; limitedly influenced by *additional services*, *class upgrades*, and *immediate discounts* incentives; potentially influenced by *discounts on a future purchase* incentive.
- Cluster 6 "**Very Short Trip for Business or Leisure within Urban Areas**": interested in *quick* offers; not interested in *live notifications on trip status*; limitedly influenced by *additional services* and *class upgrades* incentives.
- Cluster 7 "**Long Distance Leisure Trip by Plane**": interested in the possibility to specify preferences on *the travel class* and *seat type*.

The survey results, comments, and feedback collected during the 2nd Ride2Rail-IP4 CFM Collaboration Meeting (26th May 2020), and inputs received from Ride2Rail WP2 partners have been elaborated to produce (i) the final terminology alignment with Shift2Rail IP4, and (ii) the final conceptualization of offer categories, user preferences, and incentives.

The IP4 terminology alignment has identified the following concepts that resulted to be missing or require clarifications in the current IP4 terminology: (i) the current definition of *Passenger* should be improved to be adopted in a ride-sharing application where it must be possible to univocally identify and describe a passenger to be recognized by the driver; (ii) the concepts of *Driver*, i.e., the person offering a ride-sharing ride, and *Car*, as a possible *Vehicle* for a *TravelEpisode*, need to be better conceptualized to match Ride2Rail use-cases (D2.3).

The final conceptualization of offer categories and its catalogue has been presented in this deliverable together with the specification of priorities to be taken into consideration for the implementation of an *Offer Categorizer*. Considering the results of the survey, the ***Social*** and ***Philanthropic*** categories have been combined in a unique ***Social*** offer category taking

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into account both the possibility of socializing with other people and to contribute to social causes. Moreover, the definition of the ***Comfortable*** category has been improved to highlight the results obtained from the survey and showcasing that, for an average user, there are four main aspects identifying a *Comfortable* offer: *cleanliness of the stations and vehicles*, the *feeling of personal safety*, *having a comfortable seat*, and keeping a *minimum number of interchanges*. Finally, Ride2Rail took into consideration suggestions provided by EU travellers through the survey and decided to include two new categories in the catalogue: (i) The ***Panoramic*** category promotes solutions passing through beautiful landscapes (like a particular village or a forest) or historical sites. This category also takes into account usual sightseeing itineraries for tourists to promote solutions passing near monuments or other interesting spots; (ii) The ***Healthy*** category concerns the involvement of walking and/or cycling in an offer.

The final conceptualization of user preferences has also been presented in this deliverable. Differently from offer categories and incentives, the IP4 reference glossary (i.e., the MaaSive glossary) already contains a set of related concepts for user preferences: *Profile*, *Profile Connected Preferences*, *Contextual Preferences*, *Search Options*. In this final conceptualization, Ride2Rail has proposed new terms and modifications of the existing ones. The first change proposed is related to the modification of the *Profile* concept to distinguish between *User Profile* and a *Traveller Profile* associated with the user. Then, starting from the concepts already defined in IP4, the conceptualization has proposed different typologies of *User Preference* (i.e., *User Profile Connected Preferences*, *Traveller Profile Connected Preferences*, *Contextual Preferences*, and *Search options*) that can be applied with different semantics in the *Travel Shopping* process. The final version of the preference model is composed by an updated and extended version of the traveller preference model, i.e., the Traveller Context Dimension Tree (TCDT), and of the driver preference model, i.e., the Driver Context Dimension Tree (DCDT). They combine the different typologies of user preferences and have been designed to capture contexts of the Travel Companion users. Moreover, they can act as the schemas to define the data types and possible values that each preference can assume.

The final conceptualization of incentives described in this deliverable has confirmed the first conceptualization with only minor modifications to clarify the distinction between tangible and intangible incentives, and to better define the *Incentive Condition*. The deliverable also proposed an extended catalogue of incentives for multi-modal travel offers. This does not aim at providing a comprehensive set of incentives but aims at offering concrete instances in the considered domain and at clarifying the distinction introduced between *tangible* and *intangible* incentives.

9.1. Contributions to Ride2Rail and IP4 Complementary Projects

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The results described in the deliverable fully achieved the planned objectives for Ride2Rail T2.1. Moreover, the described results contribute to Ride2Rail and complementary projects, as follows:

- The IP4 terminology alignment and the conceptualization of offer categories, user preferences, and incentives represent the reference terminology for Ride2Rail project and contribute to the definition of a reference glossary (i.e., the MaaSIVE glossary) for the IP4 projects;
- The final catalogue of offer categories (Section 8.2.2) and the results of the contextual and socio-demographic analysis of the data collected through the choice criteria survey on offer categories (Section 6.2.1) are inputs for Ride2Rail T3.1 aiming at the development of algorithms to automatically classify travel offers;
- The travellers' preferences model (Section 8.3.3) defines the dimensions used to collect and infer user contextual preferences, enabling filtering and ranking of multimodal travel offers. This model is an input for Ride2Rail T3.2 that aims to provide a solution, based on learning algorithms, for the ranking of travel offers according to user preferences. Moreover, the proposed traveller preference model integrates the one currently implemented by IP4 complementary projects and can be used as an input in the future developments of the Travel Companion;
- The Driver Contextual Dimension Tree (Section 8.3.3) is a conceptual model that defines the dimensions on which ride-sharing drivers could express preferences related to their offered rides. This model and the preliminary definition of the components to be developed by Ride2Rail (i.e., *Offer Categorizer*, *Incentive Provider* and *Offer Ranker*) are inputs for T2.3 that, among others, aims to define specifications for Crowd-based Travel Expert Service (to be developed by T3.3);
- The final catalogue of travel incentives (Section 8.4.2) and the results of the contextual and socio-demographic analysis of the data collected through the choice criteria survey on travel incentives (Section 6.4.1) are inputs for Ride2Rail WP3 and WP4 to better target the implementation of the Ride2Rail solution and its piloting at the demo sites.
- The mobility patterns identified applying clustering techniques (Section 7.2) and the overall results of the contextual and socio-demographic analysis of the data collected through the choice criteria survey are inputs for Ride2Rail WP3 and IP4 projects for the specification of specific traveller profiles in the Travel Companion application.

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11. APPENDICES

11.1. Appendix A: Choice Criteria Survey

In the following, we report the text of the conversational survey on choice criteria, used to collected data from EU travellers.

- I would like to ask you some questions about your choice criteria when choosing travel solutions
- To begin with, let's focus on one of your last trips
- It can be anything, a commute to work or even a more unusual journey

1. What was the reason of the trip you chose?
   ◉ *options*
   - Leisure
   - Business
   - Commute
   - Other commitments

2. Whom were you travelling with?
   ◉ *options*
   - Partner
   - Family
   - Friends
   - Colleague
   - Alone

3. How long was your trip?
   ◉ *options*
   - Very short (10km or less)
   - Short (10km to 50km)
   - Medium (50km - 300km)
   - Long distance (300km or more)

4. Where did you start the trip from?
   ◉ *options*
   - An urban area (densely inhabited city)
   - A suburban area (commuting zone)
   - A rural area

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5. And what was your destination?
   ◉ *options*
   - The same area where the trip started
   - An urban area
   - A suburban area
   - A rural area

6. Select all the means of transport you have used in that trip
   ☑ checkbox *(multiple choice)*
   - ☐ On foot
   - ☐ Bicycle or micro-mobility
   - ☐ Metro
   - ☐ Bus/Tram/Trolleybus
   - ☐ Private car/Private Taxi/Motorbike
   - ☐ Car pooling/Ride sharing/Shared Taxi
   - ☐ Train
   - ☐ Plane
   - ☐ Ferry

- Thank you, now imagine that you are using a travel app to plan/optimize your trip by comparing different solutions

7. Firstly, what are the travel preferences you'd like to specify?
   ☑ *checkbox (multiple choice)*
   - ☐ Specific means of transport
   - ☐ Specific transportation companies
   - ☐ A time interval for the departure and arrival times
   - ☐ A limit on the amount of transport changes
   - ☐ The travel class
   - ☐ The seat type (e.g. aisle, window…)
   - ☐ Meal inclusion
   - ☐ Refundability
   - ☐ Live notifications on trip status updates
   - ☐ On board connectivity

8. Do you also have any of those needs?
   ☑ *checkbox*
   - ☐ I have large/multiple baggage
   - ☐ I have special baggage (sport equipment, instruments, etc.)
   - ☐ I need animal allowance
   - ☐ I need help because of reduced mobility
   - ☐ No additional needs

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- ☐ I have health-related needs
- ☐ I travel with an infant
- ☐ Other needs

9. **Related to those additional needs, is there any specific travel preference that you would like to specify?**
   📜 *open-ended*

- Now imagine that the travel app divides the available travel solutions into predefined categories (Quick, Short, etc.)
- I'm going to list these categories. For each of them please state how relevant it is for you!
- Let's start with the first category! From 1 to 5, how much are you interested in travel solutions that are:

★ *The following questions, from 10 to 19, are star-ratings (from 1 to 5 stars)*

10. ★ **Quick** (minimizing the total travel time)
11. ★ **Short** (minimizing the distance covered)
12. ★ **Reliable** (minimizing the chances of delays, breakdowns or last-minute changes)
13. ★ **Cheap** (having the lowest price)
14. ★ **Door-to-door** (minimizing the segments of the trip that are not covered by the solution)
15. ★ **Social** (facilitating new acquaintances)
16. ★ **Multitasking** (maximizing the possibility to perform other tasks while travelling: productivity, enjoyment, etc.)
17. ★ **Environmentally-friendly** (minimizing the trip's impact on the environment, such as NOx, CO2 emissions, energy consumption, etc.)
18. ★ **Philanthropic** (involving donations to charity or volunteering organizations)
19. ★ **Comfortable** (maximizing your comfort during the trip)

20. **Which of these factors, in your opinion, define a comfortable solution?**
    ☑ *checkbox*
    - ☐ Having a comfortable seat
    - ☐ Cleanliness of stations and vehicles
    - ☐ Low number of different means of transport
    - ☐ Minimum number of interchanges
    - ☐ High level of privacy
    - ☐ Feeling of personal safety
    - ☐ Protection from weather

- Awesome! Thank you for your input
- Now, if you could only choose some of these categories to make your final decision

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21. Which ones would you pick? Please select max 3 categories
    ☑ *checkbox*
    - ☐ Quick
    - ☐ Short
    - ☐ Reliable
    - ☐ Cheap
    - ☐ Door-to-door
    - ☐ Social
    - ☐ Multitasking
    - ☐ Environmentally friendly
    - ☐ Philanthropic
    - ☐ Comfortable

22. Is there any other category that you would like to have?
    📜 *open-ended*

- Perfect, thank you
- Now, imagine you are inclined towards a choice and the app would like you to select a different travel solution
- I'm going to list some techniques that could be use to influence your final choice. Tell me how likely they are to succeed!
- Let's start, just touch or move the slider!

— *Questions from 23 to 32, are sliders with values from 1 (Really unlikely) to 5 (Totally likely)*

23. — Immediate price discount
24. — Price discount on future purchases
25. — Loyalty program with points collection to unlock different rewards
26. — Being offered additional services (e.g. included meal)
27. — Discounts on complementary services (e.g. hotel, restaurants...)
28. — Free (or discounted) class upgrade
29. — Provide more information about the positive aspects of a solution (e.g. sightseeing locations during the trip)
30. — Provide information on the solution's environmental impact

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31. — Challenge you to achieve a specific goal (e.g. trying ride-sharing for the first time)
32. — A competition with friends and a shared leaderboard with points assigned based on your travel choices

33. Can you think about anything else that could influence your final choice?
    open-ended

- We're almost done! Before letting you go, I need to ask you a couple of questions about yourself

34. How old are you?
    options
    - Less than 18
    - 18-24
    - 25-34
    - 35-50
    - 51-65
    - More than 65

35. What's your gender?
    options
    - Male
    - Female
    - Other
    - Prefer not to say

36. In which country do you live?

    open-ended

37. What is the highest degree or level of education you have completed?

    select

    - Basic education
    - Higher education
    - Bachelor's Degree
    - Master's Degree or higher

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- Prefer not to say

38. What is your current employment status?

▾ *select*

- Employed full time (40-more hours/week)
- Employed part time (max 39 hours/week)
- Unemployed and looking for a job
- Unemployed and not looking for a job
- Student
- Retired
- Self-employed
- Unable to work
- Prefer not to say

11.2. Appendix B: Channels Used for Survey Dissemination

The administration of the survey was done by using an URL that opened the chat application and started the survey. The URL of the survey was distributed to the partners and shared through several dissemination channels like mailing lists, social media, or websites. The list of the channels used by Ride2Rail partners for survey dissemination is in Table 11.

Table 11: Channels used by Ride2Rail partners for survey dissemination

Partner	Dissemination Channel	Intended Audience
Cefriel	Shift2MaaS and SPRINT project partners	People involved in EU projects, partners.
Cefriel	Cefriel Social Media Channels (Twitter, LinkedIn, internal newsletter)	Various
FSTECH	Ca' Foscari mailing-list	Students from Ca' Foscari university
ATTIKO	Mailing list of multimodal hubs passengers	Multimodal hubs passengers
UNIZA	Mailing list of all employees and students	UNIZA employees and students
UNIZA	UNIZA Social Media channels (website, FB, Instagram,...)	University students and public

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UNIZA	Personal contacts with other European Universities focused on transport, transport companies, etc.	Transport experts
OLT	Internal channels of selected universities	Students and employees
OLT	Passengers using an integrated public transport system of the South Moravian Region	Mostly commuters
OLT	Long-distance passengers across the Czech Rep.	Czech Passengers
OLT	Long-distance passengers from Prague	Passengers travelling from/to/via Prague
OLT	Czech Railways internal channel	Railway employees
OLT	OLT internal channels	Oltis Group employees
OLT	IRFC conference mailing list	Researchers and transport experts
UIC	UIC mailing list and social media	Rail experts
UIC	UIC passenger working groups mailing lists	Rail experts
EUT	EUT, RailGrup and ERCI mailing lists and social media channels	Transport experts
CERTH	Hellenic Institute of Transportation Engineers	Transportation professionals
CERTH	University of West Attica	Students and employees
CERTH	Presonal accounts at LinkedIn and Facebook	Various
CERTH	CERTH mailing list	Researchers
UITP	RIDE2RAIL Website	People involved in EU projects, partners.
UITP	RIDE2RAIL Social Media (Twitter)	Institutions, Associations, Academia, People involved in Research.
UITP	UITP Social Media (Twitter, Facebook)	Operators, Authorities, Planners, Associations, Institutions, Policy Makers, Researchers, people involved in projects, Press (Global, different modes).
UITP	Other EU Projects mailing lists	People involved in EU projects, partners.
UITP	S2R Newsletter	S2R environment, Researchers, Institutions, Academia, people involved in projects, rail stakeholders, Associations.
Metropolia	Metropolia Social Media (Facebook, Linkedin, Twitter)	Various
Metropolia	Metropolia intranet	Stakeholders, staff, teachers, students

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UNIFE	UNIFE mailing list and social media (Twitter)	Rail stakeholders
EURNEX	Twitter	Various
EURNEX	EURNEX Newsletter	Researchers, Associations, people involved in projects.

11.3. Appendix C: Classification of Offer Categories, User Preferences and Incentives by Demographics and Trip Type

Table 12, Table 13, and Table 14 provide the results of comparing the score obtained by the 10 offer categories considering the most relevant socio-demographic information of the respondents (i.e., gender, age, employment status, country of residence) and the trip type they were referring to. Offer categories are classified in the following 4 groups by analysing the value distribution and the average value:

- Very high interest (average > 4)
- High interest (3 < average < 4)
- Indifferent (average ~ 3)
- Low interest (average <3)

The green colour is used to highlight offer categories that are statistically different within each group identified considering socio-demographic characteristics (Age, Employment status, Gender), countries of residence and the trip types (Business Length, Leisure Length and Leisure Companion). Notably, following the same reasoning as described in Section 6.2.1, the age groups have been reduced to three: "<35 yo", "35-50 yo" and ">50 yo".

Some offers categories are in different columns within the same group but are not statistically different (not coloured in green). This happens because the averages are close to the boundaries between groups (~3 or ~4), and so the differences are not relevant.

Table 12: Classification of offer categories w.r.t. age, gender, and employment status of the respondents

		Very high interest	High interest	Indifferent	Low interest

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	All	Quick Reliable Comfortable	Short Cheap Door-to-door Environmentally friendly	Multitasking	Social Philanthropic
Employment status	**Students**	Quick Reliable Cheap Environmentally friendly Comfortable	Short Door-to-door	Multitasking	Social Philanthropic
	Employed (full and part-time)	Quick Reliable Comfortable Door-to-door	Short Cheap Environmentally friendly	Multitasking	Social Philanthropic
Gender	**Female**	Quick Reliable Comfortable Door-to-door Environmentally friendly Cheap	Short	Multitasking	Social Philanthropic

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	Male	Quick Reliable	Short Cheap Door-to-door Comfortable	Multitasking Environmentally friendly	Social Philanthropic
Age	**< 35 yo**	Quick Reliable Cheap Comfortable	Short Environmentally friendly Door-to-door	Multitasking	Social Philanthropic
	35-50 yo	Quick Reliable Comfortable Door-to-door	Short Cheap	Multitasking Environmentally friendly	SocialPhilanthropic
	>50 yo	Quick Reliable Door-to-door	Short Cheap Comfortable Environmentally friendly	Multitasking	Social Philanthropic

Table 13: Classification of offer categories w.r.t. country of residence of the respondents

		Very high interest	**High interest**	**Indifferent**	**Low interest**
	Czech Republic	Quick Reliable	Comfortable Door-to-door Cheap Short	Multitasking Environmentally friendly	Social Philanthropic

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Country	**Italy**	Quick Reliable Cheap Door-to-door Environmentally friendly	Comfortable Short	Multitasking	Social Philanthropic
	Greece	Quick Reliable Short Cheap Comfortable Door-to-door	Environmentally friendly	Philanthropic Multitasking	Social
	Slovakia	Quick Reliable Comfortable	Cheap Door-to-door Short Environmentally friendly	Multitasking	Social Philanthropic
	Finland	Quick Reliable	Short Environmentally friendly Door-to-door Cheap Comfortable	Multitasking	Social Philanthropic

Table 14: Classification of offer categories w.r.t. the trip type

		Very high interest	High interest	Indifferent	Low interest
	Business trip	Quick Reliable	Door-to-door Comfortable	Multitasking	Social Philanthropic

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Business Length	Short (< 50km)	Cheap Short	Environmentally friendly		
	Business trip Medium-long (> 50km)	Quick Reliable Comfortable Door-to-door	Cheap Short	Multitasking Environmentally friendly	Social Philanthropic
	Commuting trip	Quick Reliable Cheap Comfortable	Door-to-door Multitasking Environmentally friendly Short		Social Philanthropic
Leisure Length	**Leisure trip** Short (< 50km)	Quick Reliable Comfortable Door-to-door	Short Cheap Environmentally friendly	Multitasking	Social Philanthropic
	Leisure trip Medium-long (> 50km)	Quick Reliable Comfortable Door-to-door	Cheap Environmentally friendly Short	Multitasking	Social Philanthropic
Leisure Companion	**Leisure trip** With family	Quick Reliable Comfortable Door-to-door	Environmentally friendly Short Cheap	Multitasking	Social Philanthropic
	Leisure trip With partner or friends	Quick Reliable Comfortable	Environmentally friendly Short	Multitasking	Social Philanthropic

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		Door-to-door	Cheap		

Table 15, Table 16, and Table 17 show the answers that were selected by at least 33% of respondents of the groups defined according to the approach described in Section 6.3.1. Since the respondents were allowed to select more than one answer, the percentages shown next to the preferences represent the amount of users that selected that option. The green colour is used to highlight user preferences that were chosen by all the analysed groups.

Table 15: User preferences w.r.t. age, gender, and employment status of the respondents

	Preferences
All *603 respondents*	A time interval for departure and arrival time - 80.93% Specific means of transport – 72.14% A limit on the amount of transport change – 63.85% Live notification on trip status updates – 43.28%
Students *174 respondents*	A time interval for departure and arrival time – 80.46% Specific means of transport – 76.44% A limit on the amount of transport change – 59.77% Live notification on trip status updates – 44.83%
Employed (full and part-time) *382 respondents*	A time interval for departure and arrival time – 83.25% Specific means of transport – 70.16% A limit on the amount of transport change – 69.06% Live notification on trip status updates – 43.19%
Female *279 respondents*	A time interval for departure and arrival time – 78.85% Specific means of transport – 72.76% A limit on the amount of transport change – 68.46% Live notification on trip status updates – 44.09% Onboard connectivity – 32.26%
Male *318 respondents*	A time interval for departure and arrival time – 82.70% Specific means of transport – 71.70% A limit on the amount of transport change – 60.38% Live notification on trip status updates – 42.45%
< 35 yo *320 respondents*	A time interval for departure and arrival time – 81.88% Specific means of transport – 76.69% A limit on the amount of transport change – 61.25% Live notification on trip status updates - 45.31%

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	Onboard connectivity – 32.19%
35-50 yo *199 respondents*	A time interval for departure and arrival time – 82.41% Specific means of transport- 72.86% A limit on the amount of transport change – 67.84% Live notification on trip status updates – 46.73%
>50 yo *71 respondents*	A time interval for departure and arrival time – 77.46% A limit on the amount of transport change - 70.42% Specific means of transport - 64.79%

Table 16: User preferences w.r.t. country of residence of the respondents

	Preferences
Czech Republic *99 respondents*	A time interval for departure and arrival time – 84.85% Specific means of transport – 74.74% A limit on the amount of transport change – 56.57% Live notification on trip status updates – 46.47% The seat type – 34.34%
Italy *88 respondents*	A time interval for departure and arrival time – 75.00% A limit on the amount of transport change 71.59% Specific means of transport - 67.05% Live notification on trip status updates - 51.14% Refundability - 46.59% Onboard connectivity - 34.09%
Greece *36 respondents*	A time interval for departure and arrival time – 63.89% Specific means of transport – 61.11% A limit on the amount of transport change – 61.11%
Slovakia *235 respondents*	A time interval for departure and arrival time – 85.11% Specific means of transport – 76.17% A limit on the amount of transport change – 61.70% Live notification on trip status updates – 45.53% Onboard connectivity – 34.04%
Finland *38 respondents*	A time interval for departure and arrival time - 84.21% A limit on the amount of transport change - 84.21% Specific means of transport - 73.68%

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Table 17: User preferences w.r.t. trip type

	Preferences
Business trip Short (< 50km) *166 respondents*	A time interval for departure and arrival time – 85.54% Specific means of transport – 70.48% A limit on the amount of transport change – 66.87% Live notification on trip status updates – 43.37%
Business trip Medium-long (> 50km) *56 respondents*	A time interval for departure and arrival time – 82.14% A limit on the amount of transport change – 66.07% Specific means of transport – 62.50% Live notification on trip status updates – 44.64% The seat type – 37.50% The travel class – 37.50%
Commuting trip *90 respondents*	A time interval for departure and arrival time - 80.00% Specific means of transport – 67.78% A limit on the amount of transport change – 51.11% Live notification on trip status updates – 40.00%
Leisure trip With family *74 respondents*	A time interval for departure and arrival time – 79.73% Specific means of transport – 72.97% A limit on the amount of transport change – 71.62% Live notification on trip status updates – 51.35% The seat type – 35.13%
Leisure trip With partner or friends *99 respondents*	A time interval for departure and arrival time – 77.78% Specific means of transport – 77.78% A limit on the amount of transport change- 68.69% Live notification on trip status updates – 41.41%
Leisure trip Short (< 50km) *84 respondents*	A time interval for departure and arrival time – 79.76% Specific means of transport – 72.62% A limit on the amount of transport change – 71.43% Live notification on trip status update – 41.67%
Leisure trip Medium-long (> 50km) *161 respondents*	A time interval for departure and arrival time – 77.64% Specific means of transport – 77.02% A limit on the amount of transport change – 67.08% Live notification on trip status updates – 45.96% Onboard connectivity – 34.16% The seat type – 31.68%

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Table 18, Table 19, and Table 20 provide the results of comparing the score obtained by each travel incentives considering the most relevant socio-demographic information of the respondents (i.e., gender, age, employment status, country of residence) and the trip type they were referring to. Travel incentives are classified in the following 4 groups by analysing the value distribution and the average value:

- Very high interest (average > 4)
- High interest (3 < average < 4)
- Indifferent (average ~ 3)
- Low interest (average <3)

The green colour is used to highlight travel incentives that are statistically different within each group identified considering socio-demographic characteristics (Age, Employment status, Gender), countries of residence and the trip types (Business Length, Leisure Length and Leisure Companion). As aforementioned, the age groups have been reduced to three: "<35 yo", "35-50 yo" and ">50 yo".

Some offers categories are in different columns within the same group but are not statistically different (not coloured in green). This happens because the averages are close to the boundaries between groups (~3 or ~4), and so the differences are not relevant. For the same reason, sometimes incentives classified by the average value in the same group are different with respects to the values' distribution.

Table 18: Classification of incentives w.r.t. age, gender, and employment status of the respondents

		Very high interest	High interest	Indifferent	Low interest
	All		Free class upgrade Immediate price discount	Environmental impact Discount complementary service Loyalty program	Points and leaderboard Challenge-goal

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				Additional services Positive aspect of solution Discount future purchase	
Employment status	**Students**	Immediate price discount	Free class upgrade	Challenge-goal Discount future purchase Environmental impact Discount complementary service Additional services Loyalty program Positive aspect of solution	Points and leaderboard
	Employed (full and part time)		Free class upgrade Immediate price discount	Discount future purchase Environmental impact Discount complementary service Additional services Loyalty program	Challenge-goal Positive aspect of solution Points and leaderboard

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Gender	**Female**		Free class upgrade Immediate price discount	Loyalty program Positive aspect of solution Discount complementary services Additional services Discount future purchase Challenge-goal Environmental impact	Points and leaderboard
	Male		Free class upgrade Immediate price discount	Loyalty program Additional services Discount future purchase	Points and leaderboard Discount complementary services Positive aspect of solution Environmental impact Challenge-goal
	< 35 yo	Free class upgrade	Immediate price discount Discount future purchase	Loyalty program Additional services	Challenge-goal Points and leaderboard

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Age				Discount complementary services Positive aspect of solution Environmental impact	
	35-50 yo		Free class upgrade Immediate price discount	Loyalty program Additional services Discount future purchase	Positive aspect of solution Challenge-goal Points and leaderboard Environmental impact Discount complementary services
	>50 yo		Free class upgrade Immediate price discount	Positive aspect of solution Environmental impact Discount complementary services Loyalty program Additional services Discount future purchase	Challenge-goal Points and leaderboard

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Table 19: Classification of incentives w.r.t. country of residence of the respondents

		Very high interest	High interest	Indifferent	Low interest
Country	Czech Republic		Free class upgrade	Immediate price discount Loyalty program Additional services Discount future purchase	Environmental impact Challenge-goal Points and leaderboard Discount complementary services Positive aspect of solution
	Italy	Immediate price discount	Free class upgrade	Environmental impact Additional services Discount future purchase Discount complementary services	Points and leaderboard Positive aspect of solution Loyalty program Challenge-goal
	Greece		Immediate price discount Discount future purchase Free class upgrade	Discount complementary services Environmental impact Additional services	Points and leaderboard

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				Loyalty program Positive aspect of solution Challenge-goal	
	Slovakia		Immediate price discount Free class upgrade Discount future purchase	Environmental impact Loyalty program Positive aspect of solution Challenge-goal Discount complementary services Additional services	Points and leaderboard
	Finland		Immediate price discount	Free class upgrade Discount future purchase Environmental impact	Points and leaderboard Additional services Discount complementary services Positive aspect of solution Loyalty program Challenge-goal

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Table 20: Classification of incentives w.r.t. trip type

		Very high interest	High interest	Indifferent	Low interest
Business Length	**Business** trip Short (< 50km)		Immediate price discount Free class upgrade	Additional services Discount future purchase Discount complementary services Environmental impact Loyalty program	Points and leaderboard Challenge-goal Positive aspect of solution
	Business trip Medium-long (> 50km)		Immediate price discount Free class upgrade Additional services	Discount future purchase Discount complementary services Loyalty program	Points and leaderboard Challenge-goal Environmental impact Positive aspect of solution
	Commuting trip		Immediate price discount Free class upgrade Discount future purchase	Challenge-goal Environmental impact Discount complementary services Additional services Loyalty program	Points and leaderboard

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				Positive aspect of solution	
Leisure Length	**Leisure trip** Short (< 50km)		Immediate price discount Free class upgrade	Discount future purchase Additional services Discount complementary services Environmental impact Loyalty program Positive aspect of solution	Points and leaderboard Challenge-goal
	Leisure trip Medium-long (> 50km)		Immediate price discount Free class upgrade Additional services	Discount future purchase Discount complementary services Environmental impact Loyalty program	Points and leaderboard Challenge-goal Positive aspect of solution
	Leisure trip With family		Immediate price discount Free class upgrade Additional services	Discount future purchase Discount complementary services Environmental impact	Points and leaderboard Challenge-goal

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Leisure Companion	**Leisure trip** With partner or friends			Loyalty program Positive aspect of solution	
			Immediate price discount Free class upgrade	Discount future purchase Additional services Discount complementary services Environmental impact Loyalty program Positive aspect of solution	Points and leaderboard Challenge-goal

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