Towards a More Informed Multimodal Travel Shopping

Mario Scrocca, Marco Comerio, Damiano Scandolari, and Irene Celino

Cefriel, Milan, Italy `name.surname@cefriel.com`

Abstract. Current travel planning applications provide only a limited support to users for an informed selection of travel solutions. The categorization of travel offers contributes to solve this limitation complementing basic information and creating awareness on the selection. This paper reports the work done for the conceptualization of offer categories and proposes a solution for enabling their usage in multimodal travel shopping.

Keywords: Travel Planning · Travel Shopping · Offer Categories · Multimodal Transportation

1 Introduction

Current travel planning applications support users in identifying existing travel solutions to move from a place A to a place B, ordered according to their main characteristics (i.e., price, length in Km, and duration in hours). The categorization of travel offers could complement this basic information to support a more informed travel shopping and to create awareness.

This paper reports the work done in the context of the Ride2Rail project[1], within the Shift2Rail IP4 innovation program[2], where the main scenario targets a user looking for a door-to-door multimodal travel solution. To improve the user experience and to create awareness about more sustainable solutions, Ride2Rail aims to provide a conceptualization of offer categories as labels conferred to particular characteristics of a travel offer (i.e., *offer features*).

Figure 1 describes the reference travel shopping process and how Ride2Rail is enhancing it through the adoption of offer categories. The proposed diagram is based on the *Shift2Rail IP4 reference ontology* [1] defined to overcome the technical challenges of involving different Transport Service Providers (TSPs) in the multimodal travel shopping flow. Through a Personal Application (PA), the user creates a *mobility request* specifying origin, destination, expected date-time departure/arrival and additional search options. The PA sends the generated mobility request to the *Travel Solution Aggregator (TSA)* that is responsible for providing a set of travel solutions by invoking multiple *Travel Experts (TE)*. Each TE, managed by a TSP or by an intermediary selling TSP solution, may return

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[1] `https://ride2rail.eu/`

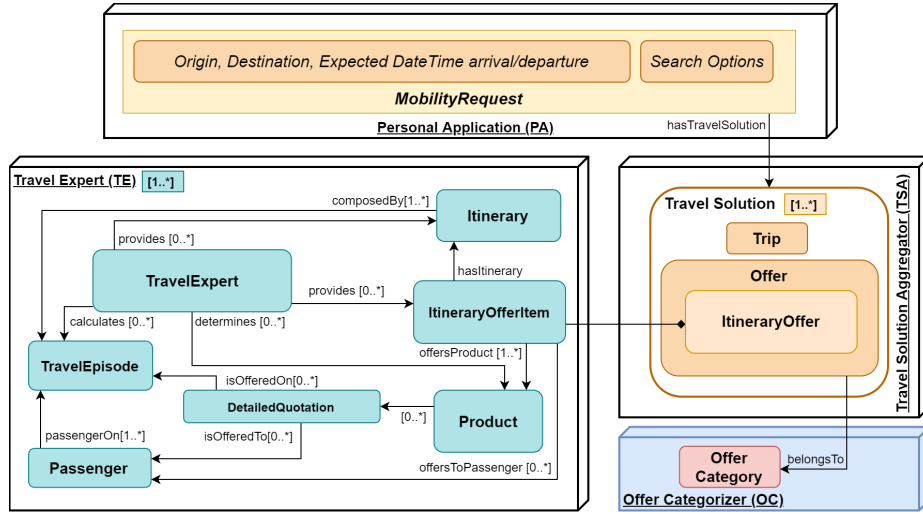[2] `https://shift2rail.org/research-development/ip4/`

Fig. 1: Offer Categories in the Travel Shopping process.

zero, one or more *itinerary offer items*, each defined as the relation between three concepts: a *travel episode* (i.e., the segment of the itinerary supported by the TSP), the *product*, and the *passenger(s)* involved. After receiving these itinerary offer items from the different TEs, the TSA composes them in a set of *travel solutions* that are then displayed on the user's PA in the form of *trips* and *offers*. Trips defined by the TSA are bound to one or more related offers (e.g., first class and economy offers for the same trip). The described flow can be enhanced by an additional component defined in Ride2Rail, the *Offer Categorizer*: an external service used by the TSA to determine the offer categories associated with each offer before sending them to the PA.

The next sections describe the analysis of the state-of-the-art on the definition of offer categories, the conceptualization and the catalogue produced by Ride2Rail, the final remarks and the next steps.

2   Analysis of the State-of-the-art on Offer Categories

From the analysis of the state-of-the-art, the following patterns to support the Ride2Rail conceptualization of offer categories emerge:

– **Types of Variables**: contributions (e.g., [2,10]) dealing with the identification of the types of variables that can be used to describe a multimodal travel offer;
– **Actual Variables**: contributions (e.g., [2,10,5,6,7,9,8]) dealing with the identification of actual variables describing a multimodal travel offer that can be used to define offer categories;

– **Multiple Variables**: contributions (e.g., [6,9,8]) dealing with the identification of multiple variables that can be used to define offer categories considering different characteristics of a travel offer.

Integrating the models proposed in [2,10], it is possible to identify the following macro-areas to categorize variables describing a multimodal travel offer:

– **Instrumental**: variables related to the measurable characteristics of the travel solution (cost, time, etc. . .);
– **Perception**: variables related to the users' perception while travelling (comfort, safety, etc. . .);
– **Symbolic**: variables related to the personal value attributed by a user to a specific travel solution (prestige, status, etc. . .).

The performed analysis of the state-of-the-art highlighted a set of actual variables, belonging to the identified macro-areas. However, while instrumental variables are objective and easily measurable, the same does not hold true for perception and symbolic variables. The difficulty of obtaining an unambiguous definition of the concepts makes these factors harder to be appropriately defined. Nevertheless, a quantification of perception variables could be evaluated through feedback collected from an adequate statistical sample of users, e.g., measuring the feeling of personal safety or the level of comfort. Symbolic variables are more subjective and, for this reason, cannot be considered to objectively characterize offers. Therefore, instrumental and perception variables represent potential *determinant factors* for an offer category, i.e., the variables that can be used to determine the membership of an offer to an offer category.

From the analysed state-of-the-art, we selected a list of actual variables describing an offer that can be used as determinant factors of *low-level offer categories*, i.e., classes that can be easily associated to an offer given its objective characteristics. For example, the total travel time variable is the determinant factor for a low-level offer category that minimizes the total travel time and identifies the quickest travel solution. The complete list of low-level Offer Categories identified and the related determinant factors is reported in [3].

The assignment of specific categories identified in the state-of-the-art analysis, like *comfortable* or *environmentally sustainable*¸ is not straightforward and not possible using a single variable describing an offer. For this reason, contributions from [6,9,8] are extremely valuable to define offer categories determined by multiple variables.

The identified patterns have been used to support the conceptualization of the term offer category, while the preliminary analysis of variables and low-level offer categories have been used to define a first catalogue of concrete offer categories for multimodal travel offers (briefly described in Section 3 and fully reported in [4]).

3   Conceptualisation of Offer Categories

In this section, we report the conceptualization of the *Offer Category* term and its related concepts.

- **Offer Feature**: An offer is described by a set of objective variables (such as transportation mode, level of CO2-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, such as information 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., CO2-emission).
- **Offer Category**: it identifies a set of offers having specific shared characteristics. An offer is assigned to a given *offer category* considering a set of offer features, namely the *determinant factors* for that 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] , where 0 means "no membership", and 1 indicates "full membership".
- **Offer Categorizer**: a component offering a service that implements a set of functions to compute the CS of an offer with respect to a set of given offer categories. Different offer categorizers can be created with different characteristics, e.g., adopting different strategies, and/or external data sources to compute the offer features, or implementing different algorithms to compute the CS.

A first catalogue of offer categories has been extracted from the state-of-the-art analysis and subsequently framed considering the provided definitions. The completeness of the catalogue and the interest in each proposed category have been tested though a survey filled by 609 European travelers[3]. Rather than computing an exhaustive list of all the possible offer categories, the goal of this catalogue is to elicit the ones that resulted from the survey as the most relevant to provide a comprehensive clusterization of travel solutions obtained in response to a mobility request. In the following, we report the final Ride2Rail catalogue of offer categories describing the most relevant determinant factors for each of them. The offer categories are ranked according to the relevance attributed by the respondents of the survey. New offer categories, elaborated thank to suggestions collected though the survey (i.e., *Panoramic* and *Healthy*), are mentioned at the end of the list since we cannot provide an estimation of the relative relevance for the travellers.

- **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 is available, it can be taken into account.
- **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

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[3] The complete description of the survey and its results are available in [4]

offer a small window to change the mode of transport that could cause massive idle times. For this reason, the frequency of the service for involved solutions should be 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 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 is associated with offers that cover the first and the last mile of the mobility request. It is measured by the amount of walking or driving distance the user has to cover.

– **ENVIRONMENTAL FRIENDLY**: The *environmental friendly* category covers the green aspects of the trip, taking into account the amount of CO_2 emissions measured per kilometre/traveller for each mean of transport included in the offer, and factoring in relevant data such as the distance covered and the number of passengers. If available, additional determinant factors can be considered, e.g., the energy consumption, the NOx emissions 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. It takes into account the amount of space available, the presence of business areas, internet connection and/or plugs. 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 the possibility to 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).

– **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.

4   Conclusions and Next Steps

The state-of-the-art analysis has supported the identification of a set of patterns considered for the conceptualization of the term Offer Category: (i) the assignment of an offer to a given category should consider the specific values assumed by each variable that describes the offer and the associated trip; (ii) offer categories should be assigned considering a set of objective variables of the offer and should not be conditioned by the characteristics and preferences of a specific user; (iii) offer categories can be defined considering multiple variables of the offer. The described conceptualization and the provided catalogue of offer categories is guiding the next step of the Ride2Rail project: the implementation of an offer categorizer component and its testing in four demo sites.

As future work, the definition of a vocabulary (thesaurus and/or ontology) for offer categories based on the proposed conceptualization would support the provision of enriched interoperable descriptions of travel solutions.

Acknowledgments

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