TEACHING MATERIAL GUIDANCE

1) Title of the material

Arnaoutaki, K.; Bothos, E.; Magoutas, B.; Aba, A.; Esztergár-Kiss, D.; Mentzas, G. A Recommender System for Mobility-as-a-Service Plans Selection. Sustainability 2021, 13, 8245. https://doi.org/10.3390/su13158245

https://www.mdpi.com/2071-1050/13/15/8245

2) Which section of the SUMP it is relevant to?

This paper presents a recommender system for the selection of Mobility as a Service (MaaS) plans that support travellers to select bundles of mobility services that meet their daily transportation needs. Therefore, the article can be linked to the third, fourth, and fifth sections of the SUMP circle related, respectively, to the determination of planning framework, analysis of the mobility situation (in particular the analysis of problems and opportunities for all modes of transport - **Subsection 3.2.**), scenario building and joint evaluation (development of scenarios of possible futures - **Subsection 4.1.**) and vision and strategy development (arguments for stakeholders - **Subsection 5.1**).

3) Which Mobility Manager knowledge this material is the most relevant to?

It is related to Transport and mobility planning (section 1 of the Mobility Manager competencies) especially 1b (employment of ITS/ICT and smart measures) and Data analysis for mobility planning (section 5 of the Mobility Manager competencies) especially 5a (data collection and analysis) as well as Stakeholder involvement tools (section 7 of the Mobility Manager competencies).

4) Problem approached and content overview

Problem approach – general understanding of how to manage MaaS in smart cities. Transport and mobility in smart cities are undergoing a major transformation as new modes of mobility are being introduced that facilitate seamless travel by meeting travellers' needs in a personalised way. A novel concept that has been recently introduced is Mobility-as-a-Service (MaaS), where mobility services are bundled into MaaS plans and offered to end-users through a single digital platform. This paper presents a recommendation system for selecting MaaS plans, which supports travellers in selecting mobility service bundles. The recommender filters out unsuitable plans and then ranks the remaining plans based on their similarity to user characteristics, habits and preferences. The recommended approach is based on the Constraint Satisfaction Problem (CSP) formalism combined with cosine similarity techniques. The proposed method has been evaluated under experimental conditions and then embedded in real pilot MaaS applications (Fig. 1). The experimental results showed that the proposed approach provides a list of MaaS Plans that users would choose in a real MaaS environment, in most cases. Moreover, the pilot results showed that most of the participants chose the actual Plan from the first three places on the recommendation list.

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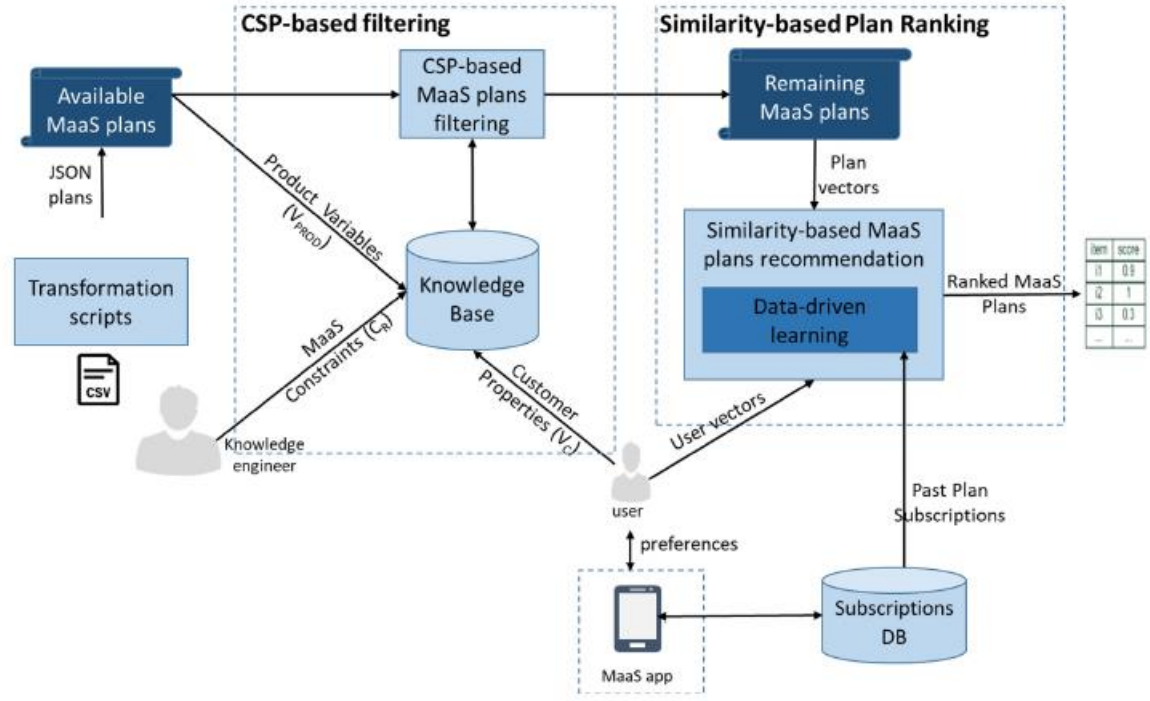

Figure 1. Overview of our approach toward personalizing the MaaS Plans selection process.

5) Who could be interested in this material?

The article is aimed at students and those looking for inspiration in the implementations of intelligent solutions to manage Mobility as a Service Plans when such measures are applied in SUMP.

6) What is worth mentioning as an innovative factor for the reader?

This paper presents a MaaS recommender designed and implemented to support MaaS end users in identifying and selecting mobility plans that meet their transport needs. The proposed recommender provides filtering features based on the concept of constraint programming by using user feedback in a knowledge-based implementation. This approach was chosen because of its ability to solve the so-called cold-start problem, which is seen in new research areas or a market with a lack of previous data, including MaaS. In addition, the recommender ranks the filtered MaaS Plans using a similarity formula that takes into account users' habits of using different transport modes as well as their willingness to include different transport modes in their plan. If past user choices are available, the recommender takes these into account and infers user preferences in a data-driven manner. The proposed recommender has been evaluated in experimental conditions as well as in real-life situations in the context of MaaS pilot projects that have been implemented in Budapest (Hungary), Luxembourg and Greater Manchester (UK). The experimental results showed that the proposed approach in most cases provides a list of MaaS plans that users would choose in real MaaS situations. Furthermore, the results of the real-world tests showed that most of the participants chose the actual MaaS plan from the top three places on the recommendation lists. The proposed recommender

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can be used and tailored for potential MaaS applications. When implementing a recommender system, practitioners must perform a proper configuration of the recommender service by performing a thorough analysis of the available transport modes and MaaS plans. In particular, the available mobility types and their attributes are elements that form the constraints of the recommendation model and should be configured and updated for the application. Furthermore, the mechanism that infers similarity between user preferences and MaaS Plans is based on capturing users' habits and willingness to include different modes of transport in the MaaS Plan. As the range of different types of mobility included in MaaS Plans depends on the application, the relevant coded information must be modelled and configured in Recommender Systems for each city.

Future research is needed to investigate the following aspects of the proposed approach. First, as already described, the proposed recommender system integrates a data-driven module that infers user preferences based on past choices.

7) Limitations

The pilot studies presented here were unable to capture enough repeated user choices to collect enough data to properly evaluate this aspect of the approach presented. Long-term and longitudinal studies are needed to ensure that users purchase a sufficient number of subscriptions and that the available data are adequate to generate recommendations based on past user choices to properly evaluate this aspect. Furthermore, such research could be used to understand the effects of seasonality and how user choices change in different seasons, which would in turn influence the recommendation process. Furthermore, in the presented approach, we have included item-based similarity measures to infer the similarity between user preferences and MaaS plans. As MaaS becomes mainstream and more data becomes available, future research should focus on analysing user-based similarity measures that could reveal the mobility habits exhibited by similar users, shaping potential community clusters within a MaaS scheme. Additionally, metrics such as distance, cost, safety, and traffic could potentially be incorporated into future versions of the recommender system and improve its personalisation capability.

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