Executive Summary

Transport and urban planning is vital to ensure appropriate spending of funds for infrastructure development and maintenance, to ensure sustainability and economic competitiveness. Implementing measures to improve transport systems requires in-depth knowledge of potential travellers' behaviour and underlying psychological factors. Transport planners are concerned to know the choices of people: their daily life and travel habits because insights into such choices, obtained from data, could assist in improving services offered to citizens.

Nowadays, there are several potential new sources and collection methods for travel data: mobile apps, innovative web surveys, payment methods, mobile network data, social media, in-vehicle equipment, and roadside equipment. Thence, data is identified as a new form of oil for future transport where information extraction and data analytics can improve the understanding of urban mobility by enhancing knowledge, improving customer service, and providing efficient operation. Therefore, understanding various available travel data sources and issues in data collection is fundamental by evaluating their quality, reliability, use and purpose. The understanding of available data sources helps to select appropriate data source for data collection and purpose of the study.

This research aims, at first, to identify various travel data sources, through a review and benchmark of mobility apps, identifying apps as a tool to understand if they can properly track the mobility patterns. Secondly, after the analysis of apps, the research work has focused on the selection of set of data allowing to: a) understand the travel behaviour through the market segmentation, identifying key factors behind the decision making; b) assess the General Ecological Behaviour (GEB) of users and obtain a valid measure of the attitude towards the environment to understand if pro-environment activism could be one of the important factors in the market segmentation; and finally c) statistically validate the identified (in market segmentation and GEB measure) main psychological determinants of modal choice. The focus of this research is to analyse the main determinants of travelling decision making mainly using attitudes and preferences to: a) better understanding the user's needs; b) developing targeted strategies to offer proper infrastructures, improve services, and travel solutions to support transport planners and decision makers; and c) better planning and programming transport systems with the main attention to Public Transport (PT) and soft modes.

The adopted methodology is composed by five main steps: (1) review and benchmark of current mobility apps to identify, through a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis, what could be used as a tool for travel data collection; (2) travel survey design; (3) survey administration and sample selection; (4) data analysis design to understand travel behaviour mainly using attitudes and preferences; (5) mode choice modelling to identify

the main psychological determinants behind the mode choice using Structural Equation Model (SEM).

The review of apps allowed to select Travel Surveys (TS) as the most suitable tool for the purpose of this research. Information was collected using a web survey called "Come Ci Muoviamo", which was an advanced survey compared to the traditional TS, allowing to collect detailed information related to cognitive aspects, attitudes, preferences, perceptions, habits together with geolocations and travel diary information.

Piedmont region (Italy) has been selected as the study area of the survey to perform the market segmentation, with focus on the Metropolitan area of Torino for both assessing GEB and mode choice modelling. A sample of 4473 respondents was collected administering a web questionnaire using multiple channels (e-mail, websites, social media).

The data analysis design provides a first descriptive analysis of socio-demographic characteristics and mobility patterns of respondents. Then, a cluster analysis has been carried out to identify different profiles suitable to a modal shift towards more sustainable modes of transport and to better understand their needs. To describe the identified profiles, Exploratory Factor Analysis (EFA) has been used to discover the major latent constructs on the attitudinal variables collected in the survey. Identifying pro-environment activism as one of the important factors present in all clusters, Rasch model analysis was used to obtain a valid unidimensional measure of pro-environment behaviour. Finally, SEM is used to identify and statistically validate the identified psychological determinants behind the mode choice decision making behaviour of users.

Results suggests that TS are the most reliable source of information to obtain a high level of detail and the only source able to collect stated preferences, perceptions, attitudes, and different cognitive aspects, as the automatic tools cannot capture the emotions of human beings.

The market segmentation shows that, among the six clusters formed according to 13 latent factors, trip chain is the most used mode for the most important trip, followed by car as a driver, except the cluster 2 (Pro-environment active car addicts). The main factor of choosing car is "Mode performance" that includes comfort, safety, and cleaning. Four factors – Travel pleasure, Improvement of onboard service quality, Pro-environment activism, and Mode pleasure – are present in all six clusters, showing the most important factors behind the decision making of users when choosing the transport mode. In contrast to this, presence in clusters of Pro-environment activism not impacting mode choice reveals that it is more an intention instead of a sense of respect towards environment. Comfort, cost, accessibility, reliability, and duration seemed to be the key attributes in choosing the travel mode. Moreover, the challenge for developing sustainable transport policies with respect to each identified travel group is discussed. The clusters are ranked according to the sustainability of their travel behaviour (mode choice) to show to policy makers how to focus on least sustainable groups to attract them towards more sustainable modes.

Using Rasch model, the proposed 26 items GEB questionnaire was able to effectively measure travellers' pro-environment behaviour. Unidimensionality, perfect level of item

reliability of 1 and huge item separation (34.22 with dichotomous scale and 43.39 with polytomous scale), absence of larger differential item functioning, local independence, and no overlap among item characteristics curves are all good indicators of a valid model. Comparing dichotomous and polytomous scale, polytomous scale gives higher item separation, revealing that more categories are better than only two categories to measure GEB.

Mode choice modelling using SEM allowed to obtain a good and acceptable model fit for both, binomial and trinomial mode choice model. The proposed hypotheses are found to be significant, proving the empirical support for model validation. Travel Pleasure (TP) and Mode Pleasure (MP) emerge as two important attitudes influencing travellers when choosing the mode because they prefer to use what they like and give them pleasure; such factors were also identified important in the market segmentation. In addition, residential location (Home), Perceived Accessibility (PAC), and AFF (I like to drive) variables were also found significant in affecting mode choice. In contrast to this, Subjective Norms (SN), Personal Norms (PN) and GEB do not influence the mode choice. This finding shows that the attitudes/preferences are the strong motivation for the population to select the mode.

Overall, we conclude that, the identification of main psychographic profiles and factors can help decision makers to plan a more sustainable mobility, tested on the population and on its specific living context.

At the end of the analysis, some suggestions and practical policy implications are provided, useful to decision makers and transport operators. Finally, some limitations and recommendations for future research are put forward.

Publications during PhD

1. Kumawat, P., Pronello, C., (**2022**) Validating Italian General Ecological Behaviour Questionnaire of Travellers using Dichotomous Rasch Model. Transportation Research Board 101st Annual meeting, Washington DC 9-13 January 2022.

2. Kumawat, P., Pronello, C., (**2021**) Validating Italian General Ecological Behaviour Questionnaire of Travellers Using Dichotomous Rasch Model. *Sustainability* 2021, 13, 11976. https://doi.org/10.3390/su132111976.

3. Pronello, C., Kumawat, P., (**2021**) Smartphone Applications Developed to Collect Mobility Data: A Review and SWOT Analysis. DOI:10.1007/978-3-030-55187-2_35. pp.449-467. In *Advances in Intelligent Systems and Computing* - ISSN:2194-5357 vol. 1251.