On User Perception of Mobility Patterns, Problems and Efficient Measures for University Campuses in Mediterranean Countries

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Abstract

University campuses are a microcosmos of the urban landscape and an excellent testbed for implementing and evaluating novel mobility policies regarding public transport and multimodality. Nevertheless, reality shows that the mobility tools and policies implemented on campuses are not always efficient, nor consistent with the needs of the faculty, students, and staff. The objective of this paper is to develop two multivariate structural equation models to identify the most efficient measures based on user perception of mobility patterns and several other parameters including the type of area in which the campus is located (inside/outside) and the demographic characteristics (gender, affiliation, age group, residence, yearly income etc.). Data comes from a questionnaire survey that took place in seven University Campuses. In order to efficiently represent the interactions between the problems and the relevant measures, two latent variables have been developed describing the perception of users for mobility problems, as well as measures needed to enhance mobility. Results indicate that in campuses located inside urban areas the perceived measures needed to enhance mobility are correlated with the perception of users for existing mobility problems in relation to the accessibility of campus, the gender of the user and two transport modes. Regarding campuses located outside urban areas indicative results include that the yearly income of the user affects the use of passenger cars, that trip duration affects walking and motorcycling, and that cycling is affected by age whereas the use of public transport is correlated with the duration of the trip and the yearly income.

Introduction

The Mediterranean region presents a quite diverse set of urban mobility characteristics, mainly characterized by rapid urbanization, failure of the public transport system to meet the growing demand, high fatality rates accounting for sustainable transport modes as well as increasing incomes and rates of car ownership (ARLEM, 2013; Ufm, 2011). For this purpose, Urban Mobility Plans define a set of interrelated measures designed to deal with mobility problems and satisfy the people's mobility needs. They consist of an integrated planning approach and address all modes and forms of transport in cities and their surrounding areas (Wefering et.al., 2014).

University campuses are also a microcosmos of the urban landscape and an excellent testbed for implementing and evaluating mobility and novel mobility policies. Universities constitute a generator and attractor of highly variable demand for travel with significant mobility needs in terms of magnitude and extent to the environment in which they are located (Miralles-Guasch and Domene, 2010). A special characteristic of university campuses is that they are unique places functioning in specific contexts (Toley, 1996; Balsas, 2003; Gamberi et.al., 2015). Universities are characterized by the fact that they represent a cross section of the population from different socio-economic backgrounds and ages, generate irregular schedules and the constant movement of people throughout the day. This is even more noticeable in university campuses located in suburban settings: Daily commuting of the university population, longer distances travelled, and the predominance of private car use over non-motorised means of transport (Miralles-Guasch and Domene, 2010, Silva and Fereira, 2008).

Given this, it is important to identify common problems and establish innovative approaches and policies, particularly in terms of transport and mobility. The present work therefore attempts to correlate the mobility problems and efficient measures for university campuses in Mediterranean countries with respect to the following factors: the type of area in which the campus is located (inside/outside), and the demographic characteristics (gender, affiliation, age group, residence, yearly income etc.). To this end, two multivariate structural equation models are developed using questionnaire data from different Mediterranean universities. The proposed modeling approach is structured in such a way that it can be used as a managerial tool to assess the awareness and acceptability of different mobility tools and policies.

Methodology

Survey

For the purposes of the present research, a mobility questionnaire was developed including questions on the following topics:

- Current mobility - to present current mobility of the participants both regarding mobility from/to and inside the Campus
- Desired Mobility - to present the desired mobility of the participants both regarding mobility from/to and inside the Campus
- Mobility problems - to identify mobility problems

- Proposed measures/policies/tools - to evaluate specific measures, policies and tools that are already implemented regarding the mobility from/to and inside the campus

- Participant information including age, gender, affiliation etc.

Universities were asked to collect questionnaires based on the following sample criteria. Faculty members: 10%, Administration personnel: 20%, Students - postgraduate: 20% Students – undergraduate: 50%

The above percentages were decided upon in order to achieve a representative sample in all universities with a focus on the affiliation of the participants. The questionnaire's data collection took place for approximately one month and resulted in 1090 questionnaires as presented in Table 1. The university campuses were further categorized as being inside or outside an urban setting.

Analysis Method

Structural equation models belong to latent model analysis. This type of analysis is used to deal with several difficult modelling challenges, including cases in which some variables of interest are unobservable or latent and are measured using one or more exogenous variables (Washington et al. 2011). In the present research, the case of the unobserved on user perception of mobility problems and measures is attempted to be investigated through this type of analysis.

Structural equation models have two components, a measurement model and a structural model. The measurement model is concerned with how well various measured exogenous variables measure latent variables. A classical factor analysis is a measurement model and determines how well various variables load on several factors or latent variables. The structural model is concerned with how the model variables are related to one another. Structural equation models allow for direct, indirect, and associative relationships to be explicitly modelled, unlike ordinary regression techniques with implicit model associations (Washington et al. 2011). Furthermore, a very useful tool regarding the interpretation of the results is path analysis as a method for studying the direct and indirect effects of variables. How the paths are drawn determines whether the explanatory variables are correlated causes, mediated causes, or independent causes. Finally, although model Goodness-of-Fit measures are an important part of any statistical model assessment, Goodness-of-Fit measures in structural equation models are an unsettled topic, primarily because of a lack of consensus on which Goodness-of-Fit measures serve as “best” measures of model fit to empirical data (Arbuckle and Wothke, 1995). Several studies are implemented discussing these debates and a multitude of SEM Goodness-of-Fit methods such as Mulaik et al. (1989), One of the most common Goodness-of-Fit measures is Standardized Root Average Square Residual (SRMR) which is an index of the average of standardized residuals between the observed and the hypothesized covariance matrices (Chen, 2007). Values of the SRMR range between zero and one, with well-fitting models having values less than 0.08.

Results

Within the framework of the present research two distinct SEMs – one for campuses inside and one for campuses outside urban areas – have been developed and presented below. For efficiently representing the interactions between the problems and the relevant measures, two latent variables are introduced: the first latent variable (Problems) aims to describe the perception of users for the importance of existing mobility problems in relation to the accessibility of campus. The second latent variable (Measures) attempts to describe the perceived importance of the measures needed to enhance mobility in campus areas. Both problems and measures are estimated by the different thematic areas of the questionnaire (parking, walking, cycling, public transport, road infrastructure, environment, car related issues, mobility management, freight management).

Results are presented through the path diagrams in figures 1 and 2. It should be also noted that the Standardized root mean square residual value (SRMR) is in both models less than 0.08 (0.071 and 0.074 respectively), indicating the statistical significance of both models. In figure 1, the SEM graph for the campuses inside urban areas is presented.

Figure 1 presents several models regarding the mode of transport, problems, and the respecting measures for campuses inside urban areas. Regarding the problems that were assessed through the questionnaire, a latent variable is developed and is mostly correlated with three indicators, mobility management, walking and road infrastructure. The second latent variable regarding measures is estimated based on all the thematic areas of measures with small differences in the coefficients. Finally, in the structural part of the SEM the new unobserved variable representing the perception of users on measures is correlated with the problems that users identify, with the gender and with two different modes of transport (bicycle and motorcycle). In figure 2, the SEM graph for the campuses inside urban areas is presented.

Results are quite different regarding the campuses located in the suburban or outside urban areas as presented in Figure 2. A key difference from the previous model are the predictors of the overall measures that should be taken. More specifically, the unobserved variable of measures is predicted by the problems that are identified by the users, the frequency, and the gender of the participants. As a result, it is very interesting that none of the assessed transport modes in a predictor in the perceived importance of the measures needed to enhance mobility in campus. In addition, several regression models are developed regarding each transport mode.

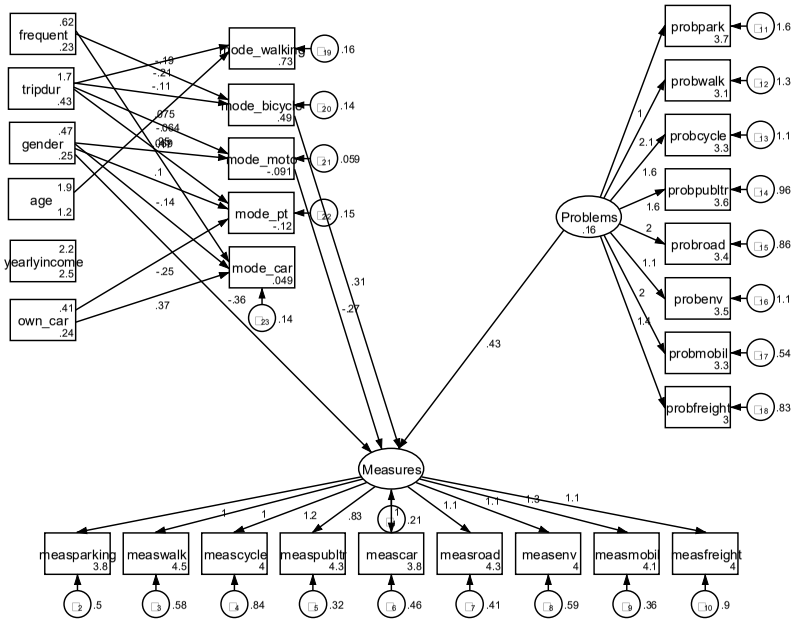

Fig. 1: SEM graph for the campuses inside urban areas

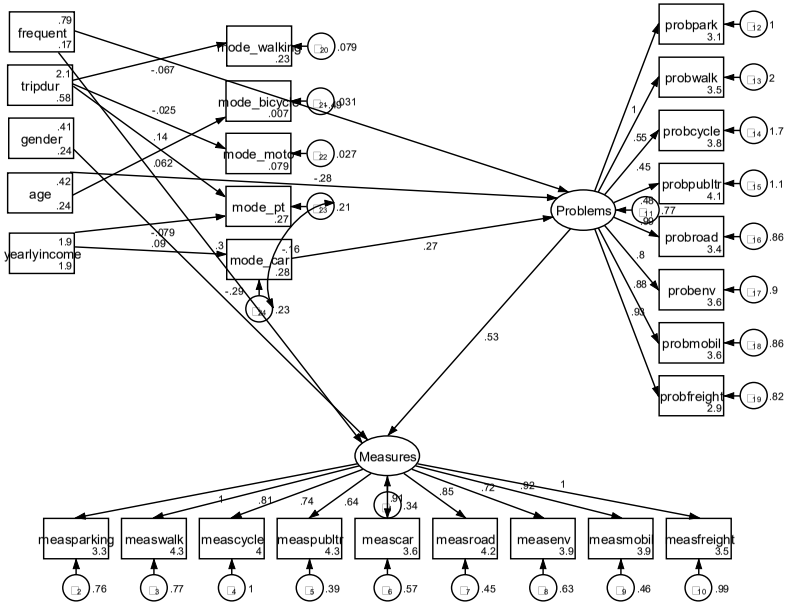

Fig. 2. SEM graph for the campuses outside urban areas

	University	Location	Area (m^2)	Students	Questionnaires
1	University of Catanzaro	Outside	260.000	11.000	104
2	National Technical University of Athens	Outside	1.000.000	13.500	124
3	University of Malta	Inside	194.452	11.500	250
4	University of Valencia (1 campus)	Outside	1.000.000	10.000	227
5	University of Valencia (2 campuses)	Inside	400.000	35.000	100
6	University of Split	Inside	245.000	24.000	100
7	University of Cyprus	Outside	1.200.000	7.000	85
8	University of Bologna	Outside	6.570.023	85.000	100

Table 1. Campuses characteristics

Conclusions

Considering that latent model analysis and especially structural equation models have been rarely implemented in the field of mobility patterns, the objective of the present research is the development of multivariate models relating mobility patterns of users with their perception on mobility problems and efficient measures. A key contribution on the present research concerns the successful development and application of latent model analysis through structural equation models. Considering that mobility perception is a multidimensional phenomenon, the results of this analysis allowed an important step from piecemeal analyses to a sound combined analysis of the interrelationship between several user characteristics and mobility problems and measures. Based on the analysis, two distinct SEMs - one for Mediterranean campuses inside and one for Mediterranean campuses outside urban areas - were developed.

Results indicated several differences with respect to the location of the campus. Regarding campuses located inside an urban area the perceived measures needed to enhance mobility on campus are correlated with the perception of users for existing mobility problems in relation to the accessibility of campus, the gender of the user and two transport modes, which indicates that users have different opinion on the measures that should be undertaken based on the transport mode that they use. The above statement, however, does not apply in campuses located outside urban areas where the users' perceived measures are not correlated with the mode of transport of the users, indicating that problems in these campuses are much more general.

Moreover, the most important measures that are evaluated on campuses located inside urban areas include the increase of safety on crossings, the increase of frequency of public transport and the improvement of the density and extent of the public transport network, all measures regarding soft modes infrastructure and public transport. On the other hand, in campuses located outside urban areas four out of the five most critical measures concern public transport (increase of frequency, coordination, improvement of the density and extent of the public transport network, and actions to improve the comfort of the vehicles) proving that public transport is the key mobility issue in campuses located outside the city.

To conclude, as several mobility plans and policies in universities will be implemented with the aim of enhancing the general quality of urban areas in terms of mobility and sustainability, it is highly important for the policy makers to identify appropriate measures for each campus. Based on the above, the present research can act as a guide to identify measures that better deal with mobility problems based on the location of the campus, and consequently, to better improve the quality of life for the campus and the wider area.

Acknowledgements

This paper is based on "CAMPus sustainable University mobility plans in MED areas" research project under the Interreg Med program, co-funded by the European Regional Development Fund.

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Keywords

Campus mobility, Problems, Measures, Structural Equation Models

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