Evaluating the use of ICT tools to the mobility management of University Campuses

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***Abstract*:** The objective of the present research is to analyze University Campuses in order to obtain a defined state of art of data, policies and ICT tools concerning mobility from/to and inside Campus. Within this purpose a survey has been developed consisting of 9 thematic areas as follows: Parking management, Soft modes Infrastructure, Public transport, Car related issues, Road infrastructure, Environment and energy, Mobility management, Freight Infrastructure and Management, and Sustainable Urban Mobility Plans (SUMPs). Furthermore, Information and communications technology (ICT) tools which concern a collection of useful ICT applications, services and tools are investigated for any of the above thematic areas. Results indicate that ICT tools apply in almost all thematic areas and play a crucial role for every campus sustainable mobility plan. More specifically, the application of ICT tools is wider in parking management and public transport while several differences occur regarding campuses located inside or outside urban areas.

Keywords: ICT tools, University Campus, Sustainable Urban Mobility Plan

1. INTRODUCTION

Sustainable Urban Mobility Plans (SUMPs) define a set of interrelated measures designed to satisfy the mobility needs of people. 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). A SUMP aims to create a sustainable urban transport system by addressing – at least – the following objectives: Ensure transport system accessibility for all, improve safety and security, reduce air and noise pollution, greenhouse gas emissions and energy consumption, improve the efficiency and cost-effectiveness of the transportation of persons and goods and enhance the attractiveness and quality of the urban environment (Veerle and Vincent, 2013).

University Campuses in MED Area, with a territorial average extension of 430.000 m^2 and an average of 35.000 between students and employees, are historically related with their urban area since they are always close to city center than built in the suburbs. A University Campus is then similar to an urban model and in most cases, it could be used as a test area for mobility policies related to public transport, multimodality or transport restrictions.

Focusing on university campuses, any effort that is made to achieve sustainability must consider that universities are unique places functioning in specific contexts (Tolley, 1996; Balsas,2003). 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).

Considering that the present research focuses on ICT tools, the term "Information and Communications Technologies (ICT)" is used to delineate the various Telecommunications and Information Technologies, which have been used in the field of Transport since the mid-80s. This term includes many technologies and systems in various stages of development from research prototypes or even concepts, to commercially available products and applications. In the decade of the 1990s notions such as "intelligent vehicle, or "smart real-time traffic monitoring and control", were introduced for the first time to express the increasing "intelligence" and dynamic nature of the systems that were introduced. Regarding EU framework, a research started in 1988 with the programme DRIVE. The main objective of the project was to assist in the application of new technologies in the field of Transport for safety and efficiency (Giannopoulos, 2004).

Transportation systems are complex entities that require substantial data to be monitored, controlled, maintained and improved, as well as various elaborate models to help a diverse group of agencies to operate the system. Data currently collected can be classified into the following types: planning, engineering and operational; a similar classification can be made for the models used. These data have certain similarities: (i) are concerned with the same network, traffic demand and control devices (ii) are all spatio-temporal (iii) are often used by more than one models for different applications. (Ziliaskopoulos and Waller, 2000).

A notable point of reference is the early work of Salomon and Mokhtarian (1998) who identified four different kinds of relationships between transport and telecommunications: 1) the substitution of telecommunications use for travel; 2) the stimulation of more travel because of telecommunications use; 3) the improvement in operational efficiency of the transport system through the use of telecommunications; 4) indirect, long-term impacts upon travel via other changes (e.g. to spatial configurations of people and activities) encouraged through telecommunications use (Lyons, G. 2009)

Finally, the adoption of specifications, the issuing of mandates for standards and the selection and deployment of ITS applications and services shall be based upon an evaluation of needs involving all relevant stakeholders, and shall comply with the following principles. These measures shall be effective, be cost-efficient, be proportionate, support continuity of services, deliver interoperability, support backward compatibility, respect existing national

infrastructure and network characteristics, promote equality of access, support maturity, deliver quality of timing and positioning, facilitate inter-modality and finally respect coherence (European Union, 2010).

Within this framework, the objective of the present research is to analyze university campuses in order to obtain a defined state of art of data, policies and ICT tools concerning mobility from/to and inside Campus. Within this purpose a survey has been developed consisting of 9 thematic areas including both a questionnaire for the general public and an interview for the experts. The paper is structured as follows. In the next chapter, the methodological approach of the research is presented including details both regarding the questionnaire and the survey. Then analysis results are presented, general conclusions are stated as well as ideas for further research.

2. METHODOLOGY

Within the framework of the present research a survey has been developed consisting of a questionnaire and an interview that are presented in the following sub-chapters. It should be noted that the present work takes place within the framework of CAMP-sUmp (CAMPus sustainable University mobility plans in MED areas) project, a European research project co-financed by the European Regional Development Fund aiming to improve sustainable urban mobility planning instruments through innovative mobility strategies for students' flows inside the MED Area University Campus and their integration with the urban areas.

Based on the above the overall survey took place in the following universities:

- University of Catanzaro
- National Technical University of Athens
- University of Malta
- University of Valencia
- University of Split
- University of Cyprus
- University of Bologna

2.1 Questionnaire design

Within the framework of the present research, a questionnaire has been developed. Self-reports and especially **questionnaires** present several advantages. They are less expensive than studies using an instrumented vehicle or a driving simulator, they provide quite more detailed information than observations, and they can reach a quite large number of people in short time. Representativeness of the sample is easy to establish and can be measured with direct statistical comparisons to driver population. Moreover, due to large samples, detailed and complicated statistical analyses can be conducted (Lajunen & Ozkan, 2011). It is clearly vital that a survey should be carried out using the correct sampling procedures, but also that the questionnaire used should be clear and unambiguous for both the interviewers and the respondents (Grosvenor, 2000).

For the purposes of the present research a mobility questionnaire has been 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 the mobility problems both regarding mobility from/to and inside the Campus.

- 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

Universities were asked to collect a minimum of 100 questionnaires per campus based on the following sample criteria.

- Faculty members: 10%
- Administration personnel: 20%
- Students – postgraduate: 20%
- Students – graduate: 50%

The above percentages were decided in order to achieve a representative sample in all universities with focus on the affiliation of the participants. The questionnaire's data collection took place approximately 1 month and the overall results per University are summarized in the following table:

2.2 Interview design

Qualitative survey methods, including interviews, are being used increasingly in research and policy studies to understand traveler perceptions, attitudes and behavior, as a complement to more established quantitative surveys. Qualitative research techniques can be used either as an independent research tool or as a part of a multidisciplinary project in association with more traditional quantitative techniques. In relation to quantitative research, qualitative techniques can be used at different stages as explained below (Grosvenor, 2000):

- Prior to quantification: Qualitative research can be used to explore the range of issues present within a given population, and that this can guide the design of subsequent quantification. This is particularly relevant in situations that are dynamic or new.
- In parallel with quantification: When respondents are completing questionnaires, either self-completed or interviewer-administered, there is an option to consider following these interviews directly with a more open-ended qualitative interview, to focus on some of the responses provided and to ascertain the frames of reference within which the questions were being answered
- Post-quantification: It is also possible to use qualitative research to illuminate the findings, particularly if there is a question mark over a particular set of findings. This represents a post-mortem use of qualitative research.

A main advantage of qualitative data analysis techniques is that they result in a rich and detailed contextual description of the phenomenon under investigation. However, this strength of qualitative data is also a drawback. The output of a qualitative inquiry is fundamentally different in nature from quantitative data. As such, analysis of qualitative information can be a difficult and arduous process (Clifton and Handy, 2001).

The sheer volume of information generated from techniques such as in-depth interviews, focus groups, and participant observation can seem intractable. Findings are often suspected of undue influence of the investigator bias and interpretation. However, proponents argue that qualitative methods can have the same rigor and credibility as quantitative methods if researchers follow a systematic process, paying attention to validity, consistency, and reliability issues during data collection and analysis (Miles and Huberman, 1994).

Within the framework of the present research, an interview has beevn developed aiming to collect qualitative data (experts' views) of each partner on local level concerning mobility in Campus area from/to and inside Campus and to investigate the respective gap. A key element in the interview process were the thematic areas that were created and are presented below:

- Parking management
- Soft modes Infrastructure
- Public transport
- Car related issues
- Road infrastructure
- Environment and energy
- Mobility management
- Freight Infrastructure and Management
- Information and communications technology (ICT) tools
- Sustainable Urban Mobility Plans (SUMPs)

Consequently, the interviews were structured in two parts as follows: The objective of the first part was to analyse the current situation in the campus under experts' responsibility regarding each of thematic areas. Experts were asked to provide all the specific measures, tools and policies that exist and discuss any mobility issues related the thematic areas regarding both from/to and inside campus. The second part referred to needs, future plans and priorities and the experts were requested to describe the needs, main plans, priorities and fields of interest in the Campus under their responsibility regarding the thematic areas.

3. RESULTS

Before the analysis, a summary table is provided aiming to give an overall picture of the universities and campuses that are investigated.

Table 1. Campuses characteristics

	University	Location	Area (m^2)	Students	Personnel	Questionnaires	Interviews
1	University of Catanzaro	Outside	260,000	11,000	500	104	9
2	National Technical University of Athens	Outside	1.000.000	13,500	3,400	124	8
3	University of Malta	Inside	194,452	11,500	600	250	2
4	University of Valencia (1 campus)	Outside	1,000,000	10,000	2,000	227	3
5	University of Valencia (2 campuses)	Inside	400,000	35,000	5,000	100	3
6	University of Split	Inside	245,000	24,000	1,500	100	6
7	University of Cyprus	Outside	1,200,000	7,000	1,100	85	5
8	University of Bologna	Outside	6,570,023	85,000	3,000	100	9

Table 1 indicates that from the 8 campuses that the overall survey took place, 5 were located outside the city centre while the rest are located inside the city. Moreover, 1.078 Questionnaires and 36 expert's interviews were collected aiming to define a state of the art of data, policies and ICT tools concerning mobility from/to and inside Campus.

It should be noted that the overall analysis relies on two parameters. The first concerns the location of the campus as campuses are divided based on their location (inside/outside the city). The second refers to the mobility, whether the examined policies/tools/measures concerns the mobility from/to or inside the campus

Beginning with expert's interviews, in Figure 1 the interviews based on universities located inside urban areas have been summarized in order to provide with valuable information regarding the mobility status of the thematic areas examined.

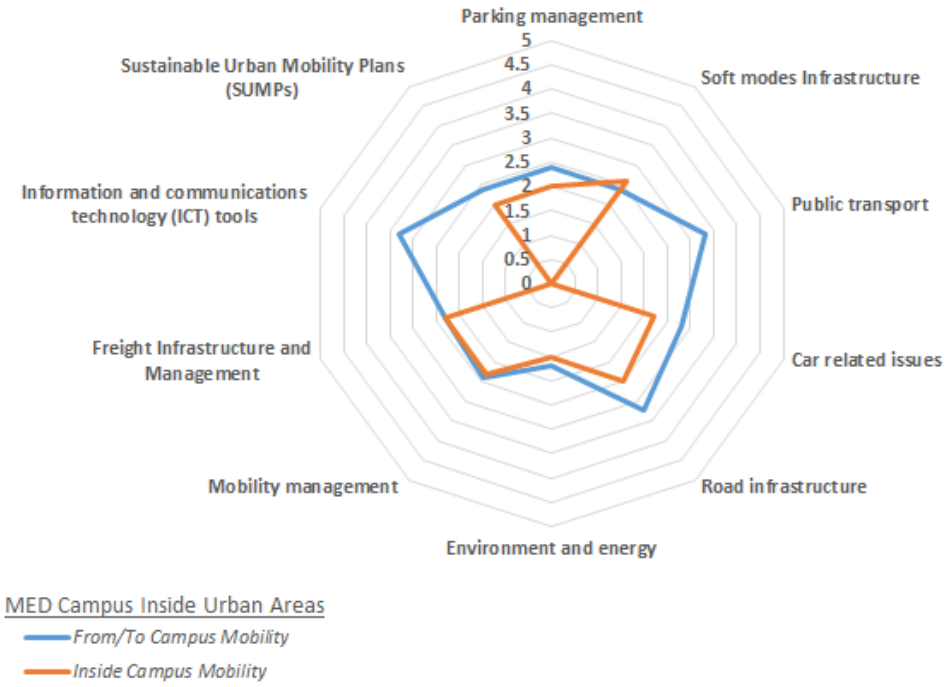

Figure 1. Mobility status per thematic areas for universities located inside urban areas

Regarding the mobility from/to the Campus, public transport is proved to be important considering the strategic place of the campus inside the city and the several ways that can be reached. The other two thematic areas that achieve high score in the analysis are Road infrastructure and ICT tools. For both areas, the location of the campus inside the city is an advantage for the implementation and planning of targeted strategies on these topics.

Regarding mobility inside the campuses, an interesting finding is that two thematic areas, namely public transport and ICT tools do not exist. Moreover, road and soft modes infrastructure are the best assessed areas.

In figure 22 the interviews of the experts based on Universities located outside urban areas have been summarized in order to provide with valuable information regarding the mobility status of the thematic areas examined in the present report.

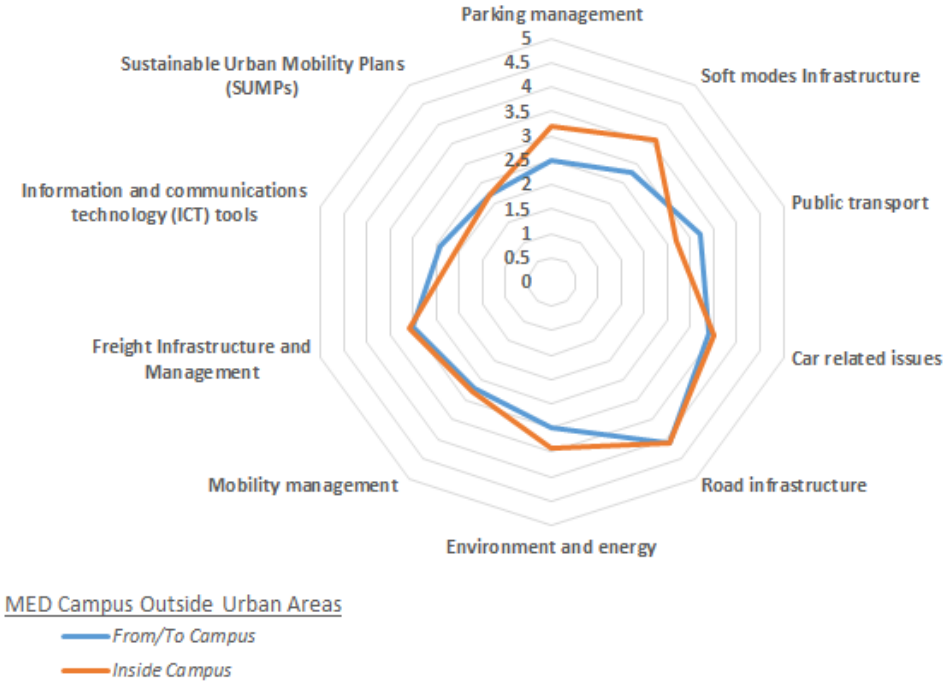

Figure 2. Mobility status per thematic areas for universities located outside urban areas

A first interesting conclusion illustrated by the above figure is that the overall picture of all examined thematic areas is very similar for the mobility from/to and inside the campus. This consists a first very interesting difference detected by the analysis between the universities located inside and outside urban areas.

Road infrastructure, any infrastructure related to road transport infrastructure, is the best performing area from the examined ones. This can be explained by the fact that campuses located outside urban areas are relatively new, with high quality road infrastructure. Measures that can further improve this area consist of better lighting conditions inside Campus, pavement maintenance, new infrastructure regarding disabled people as well as signage and road markings.

Regarding public transport, the gap analysis proved that several measures and policies should be implemented in order to decrease the gap between current and desired situation. Indicative measures include, the improvement of the density and extent of the public transport network, actions to improve comfort (stops, stations, and vehicles), actions to improve security (e.g. camera surveillance), ICT tools to improve information to passengers, actions to improve ticketing systems, actions to implement Intelligent Transport Systems (ITS) as well as to increase frequencies.

Mobility management is another thematic area, detected to have a gap in the current situation. Measures to decrease this gap include information and advice about travel options to travelers based on ICT tools, setting up of a mobility center in the University, awareness raising activities to promote and encourage sustainable mobility as well as promotion of travel plans for Regions.

Finally, the lowest score in both types of mobility is occurring in the thematic area of Sustainable Urban Mobility Plans, which is proved to be of high importance especially in Universities located outside urban areas. In general, a Sustainable Urban Mobility Plan should provide a strategy to enhance the quality, security, integration and accessibility of public transport services, covering infrastructure, rolling stock, and services. A main objective of

SUMP is to raise public awareness of sustainable transport options in order to improve take up of public transport, car sharing, cycling and walking as positive alternatives to single occupancy car use.

In the next step, through the 1.078 questionnaires collected, several measures/tools were assessed by the participants referring specifically on ICT tools. In figures 3 and 4 the above-mentioned tools are rated regarding their importance.

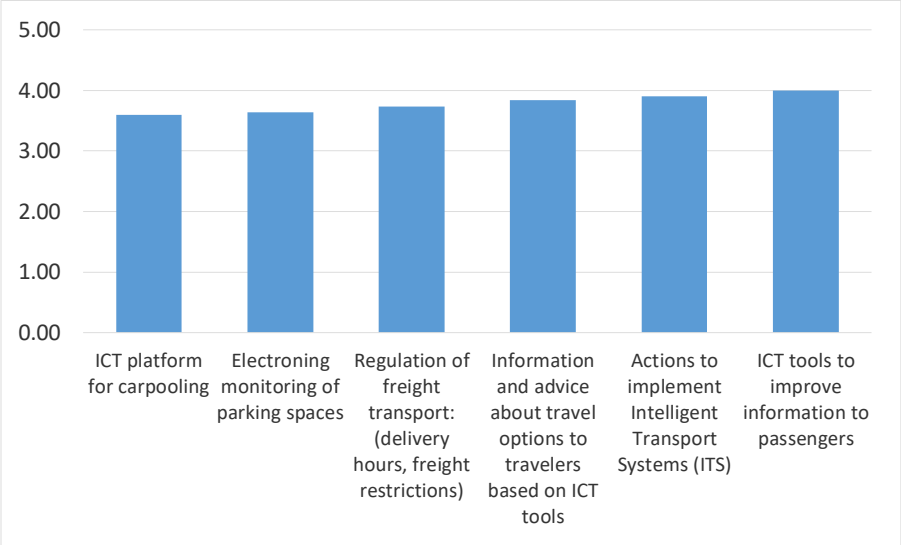

Figure 3. Assessment of ICT tools regarding campuses located inside the city

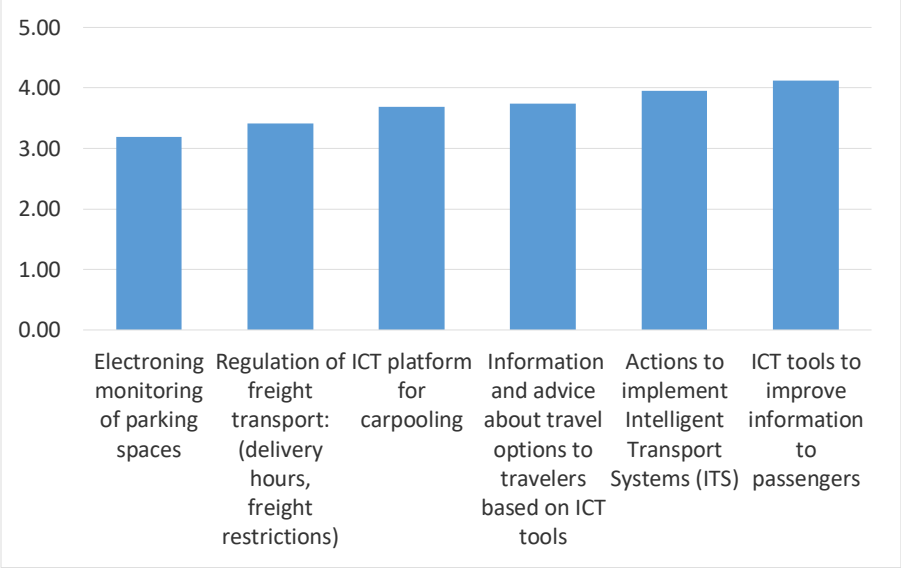

Figure 4. Assessment of ICT tools regarding campuses located outside the city

The above graphs indicate that in both types of campuses the most important type of measures is "ICT tools to improve information to passengers" showing the importance of providing information to the passengers. Furthermore, in the second and third place the same tools exist, namely "Information and advice about travel options to travelers based on ICT tools" and "Actions to implement Intelligent Transport Systems (ITS)".

On the other hand, differences are presented regarding the other ICT tools. More specifically, the lowest importance in campuses located inside urban areas occurs in an ICT platform for car-pooling which seems not to be essential in campuses located inside the city. Consequently, the lowest importance in campuses located outside the city refers to electronic monitoring of parking spaces as in these campuses, parking management is in a quit good level due to plenty of space that exists.

4. CONCLUSIONS

The objective of the present research is to analyze 8 university campuses in order to obtain a defined state of art of data, policies and ICT tools concerning mobility from/to and inside Campus. Within this purpose a survey has been developed consisting of 9 thematic areas including both a questionnaire for the general public and an interview for the experts.

Results indicate that ICT tools apply in almost all thematic areas and play a crucial role for every campus sustainable mobility plan. More specifically, the application of ICT tools is wider in parking management and public transport while several differences occur regarding campuses located inside or outside urban areas.

The gap analysis that was implemented showed that for the mobility from/to the campus, in campuses located inside the city, public transport is proved to be important considering the strategic place of the and the several ways that can be reached. The other two thematic areas that achieve high score in the analysis are road infrastructure and ICT tools. Road infrastructure is the best performing area ae well in campuses located outside the city which may be explained by the fact that campuses located outside urban areas are relatively new, with high quality road infrastructure and easy accessed by the users.

Focusing on specific ICT tools that have been assessed by 1.078 participants, results indicate the most important tool is "ICT tools to improve information to passengers" indicating the power of information in our society. On the other hand, the lowest importance in campuses located inside urban areas occurs in car-pooling confirming the initial hypothesis that in campuses located in city centre access to the campus in not a major problem. Consequently, the lowest importance in campuses located outside the city refers to smart monitoring of parking spaces confirming again experts view that parking facilities are high in those campuses.

In the next steps a SWOT (strengths, weaknesses, opportunities, and threats) analysis can be applies in order to reveal the current situation of mobility flows in campus areas and sustainable mobility planning instruments focusing on ICT tools. Furthermore, advanced statistical analysis techniques can be applied in the data extracted from the questionnaire in order to correlate the importance of the proposed measures/tools with participants affiliation and characteristics

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