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CAMP-sUmp

CAMPus sustainable University mobility plans in MED areas

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Deliverable D3.5.2: ICT tools, models and requirements for communication between different actors and planning instruments

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Executive summary

CAMP-sUmp (CAMPus sustainable University mobility plans in MED areas) is a European research project co-financed by the European Regional Development Fund aiming to improve sustainable urban mobility planning instruments as SUMP (Sustainable Urban Mobility Plan), through innovative mobility strategies for students' flows inside the MED Area University Campus and their integration with the urban areas.

Following the indications from the Application Form this deliverable will include: A description of technical requirements and of institutional settings for an integrated ICT platform model including Data-warehouse, DSS, ITS, enabling data collection, planning, management and monitoring.

Moreover, for this proposed model different approaches and information sources have been considered, such as an extensive scientific literature review, I+D+I related projects and platforms, their inner know-how processes as well as success practices on diverse scenarios. On the other hand, the architecture of the CAMP-sUmp e-Core System, considers the results and findings of all these aforementioned reviews, European approaches and previous CAMP-sUmp findings.

The **objectives** of the present report are:

- Carrying out a comprehensive review to address most of the critical areas and variables related to ICT and Sustainable Mobility at MED Universities.
- Proposing and integrated ICT Model for the implementation or else improvement of Sustainable Mobility at University.

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Glossary of terms

AIOTI	Alliance for Internet of Things Innovation
API/S	A set of functions and procedures that allow the creation of applications which access the features or data of an operating system, application, or other service
APS	Advanced planning and scheduling
AVM	Automatic Vehicles Monitoring
IT	Information Technology
CAI	Common Agreed Standardized Interface
CAT	Configuration Assistant Tool
CCTMO	Century City Transportation Management Organization
CEF	Connecting Europe Facility
CEN	European Committee for Standardization
CENELEC	European Committee for Electro technical Standardization
CUNY	The City University of New York
DG MOVE	Directorate General for Mobility and Transport of the European Commission
DSM	Digital Single Market
DSS	Decision Support System
EC	European Commission
DSS	Decision Support System
DSIs	Digital Service Infrastructures
EC	European Commission
Eduroam	Education Roaming
ELTIS	European Local Transport Information Service
EMT	Enterprise of Municipal Transport
ERP	Enterprise Resource Planning
ETSI	European Telecommunications Standards Institute
EU	European Union
EUNIS	European University Information Systems
EV	Electrical Vehicle
FRAME	
FTS	Flexible Transport Services

GIS	Geographic Information System
GPS	Global Positioning System
GTFS	General Transit Feed Specification
GTP	Green Travel Plan
GUNI	UNESCO Global University Network for Innovation
HSL	Helsinki Region Transport
ID	Identify Document
IdP	Identity Provider
IEEE	Institute of Electrical and Electronics Engineers
iOS	Operating System developed by Apple Inc.
IoT	Internet of Things
IPS	Indoor Positioning System
ICT	Information and Communication technologies
ITS	Intelligent Transport Systems
KPIs	Key Performance Indicators
LAN	Local Area Network
MED	Mediterranean Area
MPU	Mobility Plan University
MVG	Münchner Verkehrsgesellschaft
NFC	Near Field Communication
NGOs	Non-Governmental Organizations
NSO	National Statistics Office
NTUA	National Technical University of Athens
OSM	Open Street Map
PPP	Public Private Partnership
PR	Public Relation
PT	Public Transport
QoS	Quality of System
QR	Quick Response code
RADIUS	A specific Data Server
RDI	Research Development Innovation
REST	Representational State Transfer
ROs	Roaming Operators
RRI	Responsible Research and Innovation
UJI	University of Jaume Primer
SMEs	Small and Medium-size enterprises
SoS	System of Systems
SP	Service Provider

SUMP	Sustainable Urban Mobility Plan
SWOT	Strengths, Weaknesses, Opportunities and Threats
TSoS	Technical Systems of Systems
TICAL	Technology Information Conference for Administrative Leadership
UCISA	Universities and Colleges Information Systems Association
UJI	University Jaume I
UM IT	University of Malta Information Technology Services
UOM	University of Malta
UV	University of Valencia
V2I	Vehicle to Infrastructure
V2V	Vehicle to Vehicle
VLAN	Virtual Local Area Network
WiFi	Wireless Fidelity
WSNs	Wireless Sensor Networks

1. Introduction

The integrated model of sustainable mobility proposed in this deliverable aims to address the different guidelines and steps to develop a SUMP, applying it to the Med (Mediterranean) Campus area.

One of the aims of this proposal model based on the Information and Communication technologies (ICTs) is to be consistent with the objectives and findings that were specified within all the previous deliverables of the CAMP-sUmp project.

In addition, this ICT proposed system is carrying out due to the lack of scientific knowledge about the planning of policies aimed at achieving sustainable mobility on university campuses. So that, this deliverable proposes an objective scientific methodology for evaluating different ways of encouraging the use of alternative sustainable transport through ICT solutions. Specifically, for journeys based around higher education, especially journeys to/from and inside the University Campus.

1.1 Challenges and structure

This deliverable is structured to tackle the following challenges:

Challenge 1: Being updated with other projects and practices (including University and other European strategies).
Challenge 2: Connecting and making the communication between the stakeholders easier; universities, authorities, transport operators, users and decision makers.
Challenge 3: Enhancing and raising awareness about sustainable mobility at Med Universities.
Challenge 4: Top-level description of a hypothetical Sustainable Mobility system (CAMP-sUmp e-Core System) so that each University can follow this general scheme to plan and implement their own system.

The **structure** of this Deliverable is given also by the strategic framework of the CAMP-sUmp project. This report counts with four clearly differentiated parts, namely: The State of the Art, containing all the reviewed studies, projects and European framework; The State of Play, where it can be read all the specific results concerning ICT within the previous deliverables of the Project; The CAMP-

sUmp e-Core System, the description of the proposal including its architecture, figures, inputs, outputs and infographics; and the SWOT analysis conveying how would be address this hypothetical proposal into seven real MED campuses contexts.

Lastly, and more specifically to develop and sort the ICT Model within the context of Mediterranean universities, this deliverable will contemplate both, the steps to develop a Sustainable Urban Mobility Plan, stemming from ELTIS SUMP´s guidelines and the FRAME architecture framework.

2. State of the art

The state of the art presented in this paper aims to determine the guidelines, before establishing or improving a University Smart Mobility System. Also, with the objective of facilitating the acquisition of relevant information related to sustainable and smart commuting in the Med campuses.

The initial step taken in developing this report, was carrying out a complete review of scientific literature, addressing ICT and sustainable mobility within the scenario of university campuses, on the way to establish a scientific basis for the work developed in the design of the CAMP-Sump e-Core System. Finally, this section completes the fourth chapter within the CAMP-sUmp Deliverable D3.3.3, the State of the Art.

2.1 Information and Communication technologies at Universities

Similar to the concept of Smart Cities, researchers have tried to characterize the concept of a Smart University as a set of several key parameters. Although cities and universities are distinct environments with different objectives, they often share a similar socio-economic, environmental and geographical context and thus they share similar services, infrastructures, communication channels, transport networks, and even some challenges, needs and requirements. Unquestionably, education and knowledge are key dimensions of a Smart University, in addition Coccoli et al. (2014) also includes other crucial areas such as Communication, Transport and Governance, areas that had also been studied in the previous deliverables of the CAMP-sUmp Project. Along the same lines, Ng et al. (2010) proposed the term Intelligent Campus along six “e” dimensions: Learning, Governance, Green, Health, Social, and Management. For Owoc and Marciniak (2013) Smart People, Smart Building, Smart Environment, Smart Governance and Knowledge are the five elements of a Smart University and also, they mentioned governance as a crucial piece of a Smart University.

In the following pages, some initiatives to show the importance of the convergence between universities and the information and communication technologies will be presented. These platforms have been developed by different worldwide institutions to summarize all the information regarding ICT at Universities, platforms in order to share the experiences, best practices and technologies developed or already implemented in the campuses. These following initiatives are listed in alphabetical order.

- The **AMUE**, in France, is an agency dedicated to developing software resources to support university management and hold an annual conference to share best practices. AMUE is the product of the collective goal to develop an organization devoted to the modernization of higher education institutions. One of the functions of this institution include the management of ICT tools in universities, highlighting the research actions. The services of the Agency are aimed at contributing to policy that considers the numerous needs and assets linked to technology.
- In Italy, **CINECA** is a consortium that develops most of the software used by its universities and promotes local meetings and conferences, as well as supports international initiatives. CINECA offers support to the research activities of the scientific community through supercomputing and its applications.
- **EDUCAUSE**. It is an organization servicing United States colleges and, among its many products, also has its own tool for the analysis and comparison of ICTs in universities. This initiative is also open to universities around the world. EDUCAUSE's starting point is a very comprehensive questionnaire in which questions are asked and specific indicators are requested. Much qualitative information is also collected, and enough questionnaires are included on degrees in good practices or technology implementation. Another one of EDUCAUSE's strengths is the excellent results production and the reports on specific domains as well as a very interesting report on strategic trends in ICT.
- In addition to the national European examples, there are many other national initiatives, and all of them converge in **European University Information Systems** (**EUNIS**), Europe's most important ICT network. The objective behind EUNIS is to coordinate with the universities of the continent regarding information and communication systems and was built with the idea of creating a catalogue of indicators available to all European universities that allows "trans-national" comparisons, starting from the common points of the initiatives already under way.
- **RedClara** in Latin America, except for promoting ICT training for its associates and they also organize several events, the most ambitious one being the event which gathers more than 500 managers from universities all over Latin America every year at a conference called TICAL. This conference presents good practices and promotes networking in the face of implementation of collaborative initiatives in the field of ICT in universities.
- **UCISA.** Universities and Colleges Information Systems Association represents most of the universities and colleges in the United Kingdom and aims to become a network for the exchange of experiences and become a lobby in relation to information systems in British universities. It provides a national and international presence for the people who make information systems and services

work. It helps them to share best practice, maximize cost effectiveness, develop ideas and inform and support policy making within their institution, nationally and internationally.

- **UNIVERSITIC** in Spain. The Sectoral Commission on the Information and Communications of Crue Spanish Universities, contains an analysis of the overall situation of ICT in Spanish universities, through indicators of good management and practices in this field. A detailed inventory of ICT elements presents on their campuses and addresses an analysis of good practices in the management, using a catalogue of indicators grouped into two levels: ICT description and the indicators of ICT management.

In addition, the Global University Network for Innovation (**GUNI-UNESCO**) developed a report in 2012, by more than 500 experts from around the world, dealing with the challenges and commitments of universities with sustainability. This report attempted to identify the main barriers and difficulties that higher education institutions face in order to be able to intervene in an effective way to introduce changes in a society based on unsustainable principles. Some of the limitations identified in this study are based on the excessively disciplined and compartmentalized structure that persists in most universities. Which does not facilitate an approach to an integrating and globalized analysis of the challenges. Another conclusion points out that there is an important commitment to solutions based on ICT advances without discussing the limitations implied by their application.

The common denominator across the universities and the networks named above, it must be said, is that it is difficult to find a fixed strategy for Smart mobility. Nevertheless, within other scopes of their experiences you can easily find some valuable concepts to manage and develop Mobility Systems to improve sustainability while commuting to/from and inside the campus. The following issues in which they have been focused may be helpful to achieve the goal of the CAMP-sUmp, namely: blended data centers (on-premises and cloud-based), technologies for triggering interventions based on student behavior, data management, governance and data collection for decision making.

Finally, and to conclude this section it is worth highlighting that most of the previous initiatives are aimed towards being more sustainable through ICT tools as a means to an end in defining, developing and sharing their strategies and solutions.

2.2 Sustainable Mobility and ICTs

In 2000 Grant & Berquist, launched the following hypothesis: "ICT networks would play the same role in the 21st century that streets and highways played in the 20th century".

Over the years, researchers have been trying to find how transport, traffic, mobility and telecommunications affect each other. A notable point of reference is the early work of Salomon (1986) and Mokhtarian (1990) who identified four different kinds of relationships between them. The first relationship would be the substitution of telecommunications use for decreasing commuting. The second relates to the stimulation of more travel caused by the use of telecommunications. The third is about the improvement in operational efficiency of the transport system using telecommunications. The fourth type is about the indirect and long-term impacts upon travel via other changes (e.g. to spatial configurations of people and activities) encouraged through the use of telecommunications (Lyons, 2009).

Additional relationships can be added to the aforementioned ones: telecommunications can supply travel (increasing levels of access and social participation) e.g. Kenyon et al., 2002; telecommunications can redistribute commuting, influencing traffic flow (e.g. Lyons and Haddad, 2008); and finally, telecommunications can enhance the commute adding a positive meaning and utility of the time used to travel (Redmon and Mokhtarian, 2001; Lyons and Urry, 2005).

The term **Information and Communications Technologies (ICT)** associated with the concept of **Mobility**, has been used to define the various technologies that have been used in the field of transport since the mid-80s. This term includes many systems, including different stages of development from prototypes, to integral and wearable applications. During the 90s, notions such as "real time traffic monitoring" were introduced to express the increasing intelligence and dynamic nature of those systems. After this, the "smart concepts" were introduced in most fields; cities, mobility, transport and Campuses amongst others. A smart campus comprises a smart classroom, which benefits both teaching and learning processes, to an intelligent campus that provides lots of pro-active services in a campus-wide environment. However, many contexts such as location and user profiles are adopted to provide and improve all kind of services.

From the evidence provided by these studies, it is apparent that the interaction between ICT use and human mobility behaviour is highly complex. It cannot be simply described in terms of substitution and/or generation.

Mokhtarian (1990), made the spotlight in the added flexibility that can be achieve travelling through the ICTs usage. As well as she highlighted the multidisciplinary involved and the wider scope of the matter if it is included e.g. decision making, location and timing among others. As a final point, she said that studying them (ICT and mobility behaviour) that way, will likely be more profitable than focusing on one particular piece of such interaction.

Apart from that, Lenz and Nobis examined how ICT use may lead to a reorganization of human activities in space and time. The fragmentation of activity, as Couclelis (1998) suggests, may lead to an increase in travel requirements for the reason that activities are no longer constrained to specific locations or times.

Mobility, ICTs and Behaviour

The analysis of the interaction between ICT and mobility behaviour indicates the ways in which ICT affects mobility behaviour are inherently complex, and it is not possible to draw any generalized conclusions regarding ICTs specific outcomes. Evidence suggests, however, that ICT may have set powerful processes in motion which are affecting commute, mode choices and mobility modes demand because of value and behaviour patterns changes. To quantitatively assess these particularities, mobility systems and integrative transport apps, remains a key objective for future research and decision making.

Wihtin this proposal of an integrated system to support, promote and enhance Sustainable Mobility, special attention may be paid to **Gamification** as a key strategy to initiate behavioural change, though bearing in mind that gamification can also foster unsustainable patterns. Gamification refers to the use of game elements in non-game contexts to enhance user engagement and learning effects (Hamari, Koivisto and Sarsa, 2014). Gamification has considerable relevance for transport behaviour, as it enhances sustainable values, for instance with regard to health (affective value) or mobility planning (instrumental value). Weiser et al. (2016) argue, that gamification is an effective way to inducing habits. As shown by Kazhamiakin et al. (2015), gamification can incentivize sustainable forms of urban mobility. There is already much evidence of apps seeking to support sustainable choices (Huber and Hilty, 2015).

Findings indicate, however, that ICT can support mobility choices from sustainability viewpoints, by making public transport, cycling or walking more attractive. Innovations can also foster some developments that may be seen as barriers to sustainability, and all those developments must be taken into account to prevent it and avoid it. Gamification already has an important role in mobility

contexts, usually related to motivational affordances, using elements such as scores, coins, points, achievement, ratings and ranking, statistics or comparative maps. Without forgetting the outcomes of the system can affect motivation, attitude and enjoyment (Hamari et al., 2014).

Apart from the economic incentives, and to conclude this sub-section, it must be remarked that the exchange of information itself, can be a very useful and motivating in order to generate engagement with university community and end-users, e.g: CO_2 emitted by each mobility choice, Carbon footprint, calories burned while commuting and travel times to get to the Campus.

2.3 University' Scenario

Since the 1990s, campus managers have struggled to provide access and sustainable mobility because of increasing congestion, lack of land for parking, the impact of traffic on surrounding neighborhoods, and limits on financial resources. Many universities have been exploring a range of environmentally interesting solutions to reduce the car choice and improve safety for all campus users (Poinsatte and Toor, 2001). It has long been suggested and hoped that ICTs can offer solutions that reduce university dependencies on the motorized (not clean neither green) private modes. The diffusion of ICT and the move towards an information society with ubiquitous computing is now, transforming daily campus life.

It seems clear that nowadays, ICTs in Universities are indispensable to the students' experience at many different levels. Academic institutions and education research organizations use data to make decisions about student services and academic technologies. For example, e-surveys or smart devices can show how long each student commutes to/from the campus. As an example, Smale and Regalado (2014) studied some aspects of how students use ICT in six colleges at CUNY (University of New York). The main conclusions in the study regarding mobility were that CUNY students have an average commute time of 45–60 minutes each way and typically use public transport, making commuting a defining piece of undergraduate life at CUNY that offers both opportunities and challenges.

Shannon, Giles-Corti et al., (2006) at the University of Western Australia presented a study about mobility patterns, disposition to change and the barriers and encouragement at the time of choosing a mode of transport (including students and staff). Their results suggested one of the policies aimed at achieving the desired change was a reduction in public transport fares for students and employees and also, the increase in number of available apartments to students in the area around the university, along with higher parking charges and improved bus services; frequencies, routes, and so on.

To finalize, another significant transformation in transport behaviour affecting University community is the decline in drivers' licenses among younger people in many industrialized countries. There is also evidence that nowadays, young people drive less (Delbosc and Currie, 2014) which could be seen as a good opportunity for implementing sustainable mobility at Campuses' context.

2.3.1 Review of relevant aspects

Within this literature review, this section defines eight meaningful subsections to give a lecture on the most appropriate aspects concerning Mobility, ICTs and Universities that have been studied previously by expert researchers on these fields. In addition, the aim of this section is to talk the main aspects relating the State of the Art that each University should carry out before planning the implementation of the CAMP-sUmp e-Core system.[1]

a) *Accessibility and Equity*
b) *Active and Soft Modes*
c) *Governance*
d) *Parking Management*
e) *Public Private Partnership*
f) *Public Transport*
g) *Sharing Systems*
h) *Teleworking*

All these following aspects are addressed using an overall approach, to provide the universities or mobility managers a general review. After considering this information, each University must analyze their own situation and go abroad towards more specific approach or else, considering further characteristics that are not included in this review. Another important issues could be Freight Management including dynamic routes, e-scheduling among other solutions and Mobility Inside the Campus which must be included in SUMPS, concerning inside building location and intra campus mobility.

a) Accessibility and Equal Mobility

A critical notion to improve sustainable mobility through ICT tools at Universities is the accessibility concept. Clouclelis (2000) proposes the following definition: the ability to access, either physically or electronically, at the appropriate time, all the locations that are necessary or desirable for participating in each activity. Thus, for the study of accessibility of ICT to enhance mobility from/to and inside the campuses the characteristics of the access-enabling technologies in the universities must be considered, both physical and electronic, but contemplating the real accessibility that final users can have. This scenario has led scholars to measure accessibility not just with respect to mobility (physical transport) but to combine mobility options and the spatial structure, along with accessibility via ICT modes (Shen, 1998), and integrate and incorporate transport planning and ICT policy in urban policy to enhance accessibility (Couclelis, 2000; Horan & Jordan, 1998).

[1] The reader can find within the 5.4 subsection of this report, the general steps to guide the Universities before facing the CAMP-sUmp e-Core System, where the State of the Art is mentioned. Deliverable D3.5.2 – ICT Tools, models and requirements for communication between different actors and planning instruments

There is no doubt that aspects of the traditional relationships between accessibility, and mobility are changing rapidly within the context of the technological and cultural changes.

ICT tools and mobility systems from universities must also assist to fill the gender gap and digital divide related to security, accessibility and access to resources to make the daily commute possible and easier for all women or any person in situation of discrimination. On the other hand, European Commission published a proposal for a law in December 2015 - the European Accessibility Act - that seeks to make products and services in the EU more accessible to people with any functional diversity.[2]

b) Active and soft modes

It is also well known that university students cycle at much higher rates than the general population (Pucher et al., 1999). There are different characteristics that make students the perfect target of active commute modes. Generally, they are usually more environmentally conscious and receptive to new ideas, they usually have restricted budgets, they have fewer health problems, they normally live close to campus and already own a bicycle. Pucher (2011) assumed that cycling is concentrated in central cities, especially near universities and in gentrified neighborhoods near the city center. Thus, efforts to enhance active and soft modes using ICT solutions towards students' population should be very welcome.

The research agenda for smart velo-mobility (Behrendt., 2016) can cover crucial interactions between cycling apps, smart bikes and smart accessories, users' behavior, public or private networked fleets and linking them with other modes of transport.

To conclude, it must to be highlighted the work of Koglin and Rye (2014) and Koglin (2015) they focus their studies on the importance of cycling in a "smart" context in order to avoid the exclusion of cycling from innovation, where cars seem to be the "smartest" vehicles, with its inherent consequences for mobility and pollution.

c) Governance and Communication

Many universities that have experience with a SUMP gave governance a very substantial role in their plans, however, some of these institutions, have realized the importance of good management and mobility governance after trying to implement it. Of course, all universities should identify innovation and deployment of

[2] Within the section 2.4 European Framework the reader can find an extraction of the Declaration Women in Transport by the European Union)

governance needs supported by regulatory framework conditions and protection of privacy and personal data that will have to be developed in parallel with the wider use of information technology tools. An imperative question relates to the need of devising an innovative strategy identifying appropriate governance and financing instruments, in order to ensure a rapid deployment of research results.

Within the Annex 1 of this report: Technical Resources, the reader involved in these questions can find some key technological concepts related e-management. Also, good practices of mobility governance can be found into the section 4. ICTs Solutions for Sustainable Mobility and within the glossary of terms.

Communication is becoming more and more crucial concerning Campus sustainable mobility. The ICT integrated system and all its data involved may produce awareness and communication campaigns focused to end users as well as to inform potential ones. On the other hand, the mobility network at Universities need to expand their communication protocols at a higher level; neighbours, communities, authorities, traffic managers and European institutions on everything related to mobility from/to and inside the campus.

In addition, according to the CAMP-sUmp Action Plans, communication must be a participative approach promoting transparency and providing accessible and understandable information about the process, its objectives and results to all involved actors. New technologies can strongly support these processes. Also, within the Roadmap of the project, the reader can find a Communication Plan and a Social Media communication Roadmap to involve, enhance and engage the university community based on their own CAMP-sUmp.

d) Parking related Issues

Nowadays and particularly inside and around cities, managers and public institutions are considering that the parking space solutions are going to reduce their traffic problems. Parking policies, services, innovations and parking fees can contribute to a more efficient use of private cars as an economical instrument for determining the overall mobility demand, optimizing space that is a precious commodity to integrating different mobility modes and revitalising urban areas (European Parking Association, 2017).

Smart parking is an innovative business platform that allows users and university managers to inquire about parking availability, booking a space, and even pay for parking (Halleman, 2003; Hodel and Cong, 2003). Users of the University could access the central system via smartphone or website reducing search time, fuel expenses, reducing traffic congestion and environment pollution, facilitating

parking payment, offering personalized information, before and during a trip, improving use and management of existing spaces and increase security of payments (Hodel and Cong, 2003; Geng et al., 2012).

The literature about parking pricing demonstrate that charging for parking can result in substantial decreases in single-occupant vehicle modal share (Willson and Shoup, 1990). However, it is possible that users may be more agreeable to paying for parking if they feel they are getting an advanced benefit from it (Kolosvari and Shoup, 2003) and ICTs can easily add some extra benefits or motivations to pay.

Early examples of smart parking management included parking guidance information (PGI) systems that attempted to minimize cruising in large parking facilities and central cities by dynamically monitoring available parking (Griffith, 2000).

Finally, as Rodier et al., (2010) stated, that regular commuters appear to be more receptive to parking information because this type of real-time information has more applicability to their commute trip, for example next metro or bus information. This is also linked with multi-modal initiatives such as Park+Ride, Park+Walk, or Park+PublicTransport, that aim to reduce pollution around and inside the urban areas, increasing green infrastructures to enhance walking and cycling to work or study.

e) Public Private Partnership

A Campus mobility system that works for everyone must be complex at multiple levels which means that there are a multitude of potential roles for private sector involvement. In almost every aspect of mobility innovation, private efforts are hammering into the field. There is a sense of great entrepreneurial possibility in addressing the myriad problems created by the current angle toward the single-occupancy vehicle model. The European Commission fosters cooperation between public and private actors at early stages of the research and innovation process in order to allow people in Europe to access innovative and trustworthy European solutions (ICT products, services and software). These solutions it will be addressed taking into consideration fundamental rights, such as the right for privacy because around 315 million Europeans citizens use the Internet everyday across all areas of the digital society (Health, commerce, smart mobility...). Only 22% of Europeans however have full trust in search engines, social networking sites and e-mail services.

f) Public Transport (PT)

A well-organized public transport service linked to the University context is established on several factors, but information and communication technologies are gaining more and more importance. ICT systems can play an important role in managing the service from the organizational point of view and providing real time information provider to its users.

ICT systems for PT are distributed systems composed of three main integrated subsystems:

- The information systems
- The e-ticketing system
- The Automatic Vehicles Monitoring (AVM) system

With the help of innovative approaches, PT around Universities can easily increase modal shift against private modes of transport mainly through:

- Integrating of different PT services
- Improving quality (more reliable and on demand services)
- Equity of pricing
- Being linked with University Schedules
- Improving information to passengers

g) Sharing systems

These measures and tools are one of the most common and popular in the context of University campuses. Collaborative forms of consumption, in which assets are shared between users, have grown rapidly over the past decade, including a wide range of services for shared-use mobility such as bike sharing, carpooling or bike sharing, taxi services, and also parking spaces.

Free bicycle sharing was first introduced in Amsterdam in 1965 (without success), and in the early 1990s in various Danish communities (DeMaio, 2009). Metrobike, a consultancy firm offering services related to the implementation of bike-sharing systems, estimates that as of January 2016, there were almost a thousand cities offering more than 1.25 million share bicycles.

Car sharing was first tested in Switzerland in 1948, to make a car available to a collective of owners not wealthy enough to purchase their own car (Shaheen et al., 1998). By 2010, car sharing systems had spread to 1,100 cities in 26 countries (Shaheen and Cohen, 2013), with many cities now introducing several car-sharing

operators. ICT is a key management basis for car sharing systems, as it facilitates reservations, e-payment and the relocation of their fleet.

The ridesharing service is growing with the development of ICT and the extension of smartphones usage and embedded geolocation devices. The ability of dynamic ridesharing to successfully provide an instant matching basically depends on, the characteristics of the environment in terms of geographic density of users, traffic patterns and availability of roadway and transit infrastructure, on the efficiency of implemented algorithms to tackle the underlying decision problems, such as optimal instant matching of drivers and riders and efficient route-planning algorithms. ICT is also used to optimize the location of stations in sharing programs (García-Palomares et al., 2012), including e-bikes. ICTs also help to assess use frequencies of the sharing vehicles. [3]

h) Teleworking

Working from home, in a train or during the weekend when the University could be remaining close is nowadays practically fully depending on ICT. Teleworking may increase effectiveness, achieve better work-life balances, or to reduce commuting needs (Valenduc and Vendramin 2001).

The effects of ICTs on mobility have long been discussed, in relation to teleworking. Salomon (1986) presents three possible outcomes of the interaction between ICTs and transport namely: Substitution, the replacement of journeys as a result of the use of ICTs; Complementarity, where technologies and transport work together and there is no trade-off between the two; and finally, Enhancement, where the number of trips increases as a result of the use of ICTs.

Meanwhile, the challenge for University managers and policymakers is how to respond to the changing habits increasing flexibility concerning workday or lessons and the implications these may have on environmental matters or campus mobility flows.

To address this question, it could be grouped three different attitudes: To be proactive, believing teleworking and e-learning can benefit employees or students as well as benefit sustainability; Reactive, responding to trends concerning teleworking or e-teaching; or Inactive, deciding, in relation to commuting, that is outside the purview of their matter, whether or not it may be impacting upon mobility flows.

[3] The reader can fin more sharing information within the Annex 3. Sharing Economy

2.3.2 Eduroam

To end this chapter, it should be remarkable a successful ICT system and well-doing example that currently works at worldwide Universities, a model of standardization and e-security which certainly reduces the workload of the University computer science' departments: eduroam

The crucial agreement underpinning the foundation of eduroam involves the mechanism by which authentication and authorisation works: The authentication of a user is carried out at their Identity Provider, using their specific authentication method. The authorisation decision allowing access to the network resources upon proper authentication is done by the Service Provider, typically a WiFi hotspot on University campus among other locations.

Most of which institutions own and operate the service's infrastructure. The national and international coordination of this infrastructure is undertaken by the Roaming Operators and a central eduroam Operational Team that is funded by the GÉANT Project.

Particularly for educational institutions the service results in significant cost savings through reduced ICT department workload.

eduroam is based on 802.1X (an IEEE Standard for port-based Network Access Control and provides an authentication mechanism to devices wishing to attach to LAN, a local area network or Wireless LAN) and a linked hierarchy of RADIUS servers containing users' data (usernames and passwords).

eduroam can be set up in three easy steps:

1. Set up a RADIUS server connected to institutional identity server
2. Connect the university access points to the RADIUS server.
3. Federate the University RADIUS server.

The easily configuration, is also a very good fact to take into account in order to choose the appropriate technologies to define the CAMP-sUmp e-Core system.

On the other hand, the eduroam Configuration Assistant Tool (CAT) has been developed to help organisations offering their users eduroam access. The tool is customised to support the campus's individual configuration and implements this across a variety of platforms providing a better service both for institutions and end-users. The aim of eduroam is to provide a single solution that accommodates all the mobile connectivity requirements of an institution.

A similar architecture, definition and easily configuration of the CAMP-sUmp e-Core system will be crucial to implement and equalize the system at Mediterranean or broader level, allowing end-users to do their sustainable trips in any Campus which has configured it. Besides this, it is very promising the idea of creating an assistant tool to help mobility managers and institutions to implement the e-Core and integrate it to their structural strategies.

To conclude, the construction that makes eduroam possible is based on a number of technologies and agreements, which together provide the user final experience: "open your laptop and be online".

2.4 European Framework

This section aims to elaborate an introductory framework tackling ICTs from a European approach (at the level of basic legislative concepts, but more in depth on the strategic vision of the EU and from its own institutions).

First, the definition of sustainability adopted by the European Union's Ministers of Transport at their meeting in 2001 defined a sustainable transport system as one that: "Allows the basic access and development needs of individuals, companies and societies to be met safely and in a manner consistent with human and ecosystem health and promises equity within and between successive generations. Is affordable, operates fairly and efficiently, offers choice of transport mode, and supports a competitive economy, as well as balanced regional development. Limits emissions and waste within the planet's ability to absorb them, uses renewable resources at or below their rates of generation, and, uses non-renewable resources at or below the rates of development of renewable substitutes while minimizing the impact on land and the generation of noise."

The main objective of the European Transport Policy as described in the White Paper is to achieve "a modern transport system which is sustainable from an economic and social as well as an environmental viewpoint" (EC, 2001, p.10).[4]

2.4.1 Europe's Internet of Things (IoT) Policy

In March 2015 the Alliance for Internet of Things Innovation (AIOTI) was launched by the European Commission to support the creation of an innovative and industry driven European Internet of Things ecosystem. This has showed the intention of the European Commission to work closely with all Internet of Things stakeholders and actors towards the establishment of a competitive European IoT market and the creation of new business models to support them. Today AIOTI is the largest European IoT Association.

In the last two years a set of supporting policy actions have been adopted by the European Commission to accelerate the take-up of IoT and to unleash its potential in Europe for the benefit of European citizens and businesses.

In May 2015 the Digital Single Market (DSM) Strategy was adopted. The DSM strategy includes elements which take Europe a step further in accelerating

[4] The reader can find more information about the European framework within the Deliverable D3.3.3 State of the art

developments on Internet of Things. In particular, the strategy underlines the need to avoid fragmentation and to foster interoperability for the IoT to reach its potential.

On the other hand, the Connecting Europe Facility (CEF) supports trans-European networks and infrastructures in the sectors of transport, telecommunications and energy. The European Commission has proposed a series of guidelines for telecommunications covering the objectives and priorities for Digital Service Infrastructures (DSIs) and broadband networks.

Another related issue with the IoT is the **Open Data** concept. The European Commission supports open data for 4 reasons:

- Public data has significant potential for re-use in new products and services;
- Having more data openly available will help discover new and innovative solutions to address societal challenges;
- Public administrations will achieve more efficiency gains by sharing data between them;
- Open data fosters participation of citizens in political and social life and increases transparency of government.

And the European Commission has set up a legal framework to allow the reuse of public sector information through the Directive 2003/98/EC.

Behrendt (2016) said that there is a lack of research regarding a crucial area for smart mobility concerning bicycle policies and industry standards around the IoT, Smart City at local, national and global level. For example, these could be reviewed to highlight how cycling is considered and to identify opportunities to include cycling in future versions. Though a crude measure, a count of key terms gives an indication:

- The European Commission's 'Definition of a Research and Innovation Policy Leveraging Cloud Computing and IoT Combination' (2014) mentions "car" 14 times and "vehicle" 19 times, "cycling" and "bicycle" 0 times with "shared bikes" (p 46) the only reference to cycling in the entire document.
- The 2014 "Operational Implementation Plan: First Public Draft" of the "European Innovation Partnership on Smart Cities and Communities" (2015) mentions "bike", "bicycle" and "cycling once each, while "car" or "cars" is mentioned 21 times and "vehicle" 36 times.

2.4.2 Rolling Plan for ICT Standardisation released 2017

The Commission proposes to focus standard-setting resources and communities on 5 priority areas: 5G, Internet of Things, cloud computing, cyber-security and data technologies because they are essential for wider EU competitiveness. Action in these areas can accelerate digitization and have an immediate impact on competitiveness in domains such as e-Health, intelligent transport systems and connected/automated vehicles, smart homes and cities, and advanced manufacturing.

In the last decades, many of the most commonly used ICT technical specifications are produced by forums and consortiums that have become leading ICT standards development bodies. Article 13 of the Regulation allows the Commission to identify ICT technical specifications to be eligible for referencing in public procurement. This allows public authorities to make use of the full range of specifications when buying IT hardware, software and services, allowing for more competition in the field and reducing the risk of lock-in to proprietary systems.

The Commission financially supports the work of the 3 European standardization entities:

- ETSI – the European Telecommunications Standards Institute
- CEN – the European Committee for Standardization
- CENELEC – the European Committee for Electro Technical Standardization

Cyber security is one of the priority areas together with 5G, cloud computing, the Internet of Things, data technologies, of the European Commission initiative on ICT Standards, which is part of the *Digitizing European Industry strategy* launched on 19 April 2016. The aim is to identify the essential ICT standards and present measures to accelerate their development in support of digital innovations across the economy.

2.4.3 Roadmap for EU-wide multimodal travel information, planning and ticketing

For delivering genuine EU-wide multi-modal travel information, planning and ticketing services must be addressed. These specified barriers should be coordinated and coherent with the aim of setting up a framework that supports the creation of these services. This would benefit travelers, by enabling them to make more informed choices and by promoting more inclusive mobility; the environment, by improving modal integration and the sustainability of the transport system; the economy, by offering new business opportunities and contributing to the creation

of new jobs, thereby enhancing the competitiveness of the European transport sector.

2.4.4 FRAME. European ITS Framework Architecture

FRAME was created to provide a minimum stable framework necessary for the deployment of integrated and inter-operable ITS within the European Union. It was developed through the recommendations of the High-Level Group on transport telematics, which were supported by a resolution of the Council of Ministers.

It was created by the EC funded project KAREN (1998-2000) and first published in October 2000. The underlying aim of this initiative was to promote the deployment of ITS in Europe by producing a framework which would provide a systematic basis for planning ITS implementations, facilitate their integration when multiple systems were to be deployed, and help to ensure inter-operability.

The FRAME Architecture is not intended to be used in its entirety, instead users select the applications and services that they want for their Nation, Region, City and create a sub-set that conforms to their requirements.

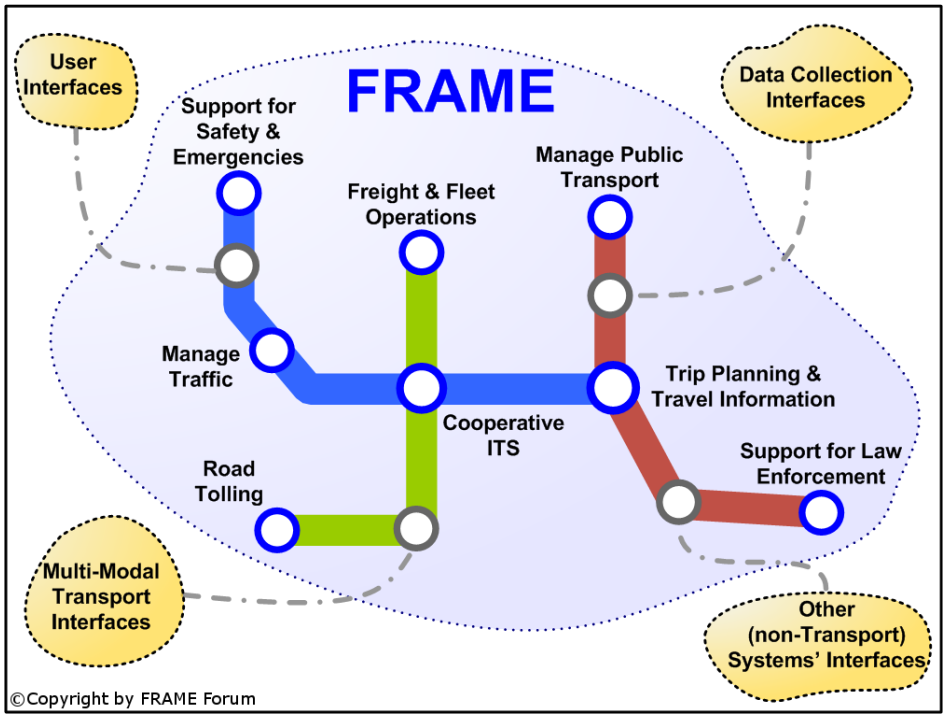


Figure 1. FRAME General Scheme

An Intelligent Transport System (ITS) Architecture is a set of high level viewpoints that enable plans to be made for integrating ITS applications and services. It

normally covers technical aspects, plus the related organisational, legal and business issues.

ITS Architectures can be created at national, regional or city level, or relate to specific sectors or services. They help to ensure that the resulting ITS deployment: can be planned in a logical manner; integrates successfully with other systems; meets the desired performance levels; has the desired behaviour; is easy to manage; is easy to maintain; is easy to extend and finally, satisfies the expectations of the users.

Applying the FRAME Architecture to Universities could have two big advantages:

- There are free Tools available
- If adjacent authorities or institutions both have ITS architectures based on FRAME, it is easy to identify commonalities and possibly integrate services.

It must be said that FRAME Architecture does not provide detailed designs for equipment. It only describes what is required[5].

2.4.5 Women in Transport

With only 22% of women, the transport sector is not gender balanced. The objective of the Women in Transport - EU Platform for change on 27 November 2017, is to strengthen women's employment and equal opportunities for women and men in the transport sector thanks to the actions brought about by the Platform members. It will also serve as a forum to discuss and exchange good practices.

On the webpage Women in Transport, included in the Useful Websites subsection at the end of the References, the reader can sign the Declaration to ensure equal opportunities for women and men in the transport sector, get Information about the Platform and exchange good practices.

Universities should know these unbalanced percentages, sadly not only occurring in the transport sector, and they should work to establish an equal mobility system in their campuses. Based on the following European Declaration, this report encourages that this will be considered and applied to any sustainable mobility system that will be implemented or improved at Mediterranean universities.

[5] The reader interested in FRAME can find the website link into the References, Useful Websites.

Extracted from the Declaration on equal opportunities for women and men in the transport sector:

Whereas non-discrimination and equality between women and men are among the European Union's founding values; Whereas Transport is not a gender-balanced sector in Europe; Whereas improved gender balance contributes to more diverse workplaces, with positive effects both internally and externally. Moreover, it positively influences the attractiveness of jobs and the competitiveness of the sector.

The signatories of the declaration, agree that: Gender disaggregated data should be collected and analysed to provide a sound basis for planning policies and measures, monitoring progress and assessing the impact of targeted actions among other multidisciplinary statements.

We strongly encourage stakeholders to use the EU Platform for Change to make their individual endeavours more widely known and to share good practices across modes of transportation and countries.

To conclude and summarize this European framework, it must be said that most of the content of the guidelines mentioned above, including the set of objectives and purposes from the EU are derived from these three following and crucial statements, namely:

- Placing users at the heart of transport and mobility policies.
- Managing the globalization of transport.
- Achieving a Sustainable Mobility System.

To achieve these goals, the EU can make use of several instruments as a financial support, standardization initiatives, legislative and non-legislative measures that managers and mobility planners from Med Universities should know before start developing its own integrated mobility plans or mobility applications.

3. State of Play: ICTs at Universities of the CAMP-sUmp Project

This chapter reviews the work carried out as part of the various deliverables of the project by the partners in 2017. In this section it is going to detail all the relevant evidence related to Information and Communication Technologies within the following deliverables.

3.1 Deliverable D3.2.1: Quantitative data

The Camp-sUmp questionnaire, was designed to include questions on the mobility of faculty, staff and students across the campuses. This section will highlight the global results from the questionnaire, in order to name and briefly outline, the main ICT solutions related the problems found.

Firstly, results regarding **vehicle preference** indicated that, being a passenger in a private car is the preferable mode of transport in campuses located outside urban areas while for campuses located inside the city, the percentage of walking and cycling is significantly higher.

Hence, it would be reasonable to think that investments on car sharing solutions or apps to contact passengers and drivers will be more effective in campuses outside urban areas. On the other hand, there is a need to implement digital measures to enhance and to incentivize active commuting like walking or cycling in campuses located inside urban areas.

Secondly, the results highlighted that, within the perceived ranking of **problematic areas,** specifically in campuses located outside urban areas, public transport is the key mobility problem. Campuses located inside the cities identify parking management as a key mobility problem.

ICT solutions should aim to improve, update and connect all the public transport operators, giving the users (in a simple and quick way) the most accurate information to balance the weaknesses of the public transport system and the lack of inter-modality. Inside the city the ICT efforts would be needed to solve parking issues. For example, adding parking applications or APIs from the university, creating an intelligent parking network, well connected to the campus with clean modes and public transport and lastly, rewarding and giving preference to people who share their private car (reminding and exploiting the popularity of the carpooling measure at universities).

Results regarding the importance of specific measures with focus on mobility areas, indicate that in campuses located outside urban areas, measures should be taken with a focus on public transport and soft modes infrastructure such as walking and cycling. On the other hand, on campuses located inside urban areas, measures should be taken with emphasis on walking as well as environment.

Once again, public transport, appears to be the critical theme, ICT should help filling this Gap regarding information and communication possibilities. Secondly, the interest of walking, cycling and environment should be rewarded, engaged and enhanced, taking advantage of the opportunities offered by the connectivity through smartphones and apps.

Lastly, one of the most critical **measures/policies and tools** concerning information and communication technologies were found that ICT tools must help to improve information to passengers (referring Public Transport) especially in the campuses located outside urban areas, agreeing with one of the conclusions that it will also found through the GAP analysis.

3.2 Deliverable D3.2.2: Qualitative Information

CAMP-sUmp partners were asked to record the mobility status as well as specific policies and tools regarding their campuses. For this purpose, a special survey was developed, and all 7 universities participated providing useful information concerning mobility issues within MED area.

The survey was structured in three parts: In the first part, a list of Campus Mobility Stakeholders was engaged including students, employees, visitors, decision makers within University but also in the city (e.g. operators). In the second part, each partner aimed to describe the *Current Situation* with a focus on mobility to / from the City as well as inside the Campus. In this section, Campuses were separated into those that are located inside urban areas and those that are in the suburbs. In the third part, Campus Mobility Practices were reviewed, including existing policies and tools. With respect to **ICT solution**s, car sharing, as well as bicycle sharing programs, are the most common practices implemented and planned related our consortium of campuses.

Most campuses engage with mobility plans in their campuses, which could facilitate the inclusion of the ICT measures, ideas and solutions proposed in this report. The University of Malta have already developed the *Vjagg* Mobile App (mobility collector app); the technology for a Shared Demand Responsive Transport Service at the Institute for Climate Change and Sustainable Development in collaboration with the Faculty of Information and Communication Technology. Lastly, most of the

universities use external transport operators or private companies to develop mobility applications.

3.3 Deliverable D3.3.1: SWOT Analysis

Within this D3.3.1 deliverable, the location of the campus resulted crucial to describe the strengths, weaknesses, opportunities and threats. In the following paragraphs the focus will be on ICT to contextualize the global view of information and communication issues in these campuses.

The SWOT analysis regarding ICT tools and Campus Mobility **Inside Urban areas** showed that there is insufficient development of ICT tools. This was the primary weakness. A common strength was found about the integrated ICT tools ability to leverage the existing transport network and city's mobility solutions. The potential of ICT tools to integrate mobility systems was seen as an opportunity. Finally, it was concluded that engagement and resistance to change (people, institutions and different mobility actors) and bureaucracy as well, are common threats that Mediterranean universities must solve. So that, it must to be said that ICT solutions are currently very associated to all these threats helping to face them.

The SWOT analysis regarding ICT tools in Campuses located **Outside Urban areas** showed that ICT's Strengths are less visible in outside campuses, on the other hand, the main Weaknesses are the insufficient development of ICT solutions regarding sustainable mobility and the costs associated with the potential development of ICT tools for such campuses. Finally, regarding common Opportunities and Threats we have found that are exactly the same as those founded in campuses inside urban areas.

3.4 Deliverable D3.3.2: GAP Analysis

The GAP analysis carried out in this deliverable, analyzed the current situation of all university partners per thematic areas regarding the mobility from/to and inside the campus based on experts' opinion from all the universities of the consortium

Related **mobility to/from the campus** with focus on "ICT tools" thematic area, Universities of Valencia and Bologna obtained the highest scores while NTUA and Catanzaro University got the lowest scores.

Specifically, related **mobility inside the campus**, as in the previous analysis, the University of Valencia obtained the highest score and NTUA the lowest one. It should be noted at this point that Universities of Malta, Split and Bologna didn´t score

anything in this thematic area. This fact could be linked with the circumstance that most of the time mobility inside buildings or campuses has not being traditionally included in mobility and transportation management. Recently, new technologies and applications are helping to change this situation, in this deliverable some examples of how inside mobility is important to overall mobility are described.

To conclude, the findings in this GAP analysis suggest the location of the campuses **inside urban areas** could facilitate the implementation of ICT strategies in order to improve sustainable mobility. On the other hand, some challenges are identified in the adoption of ICT tools in campuses located **outside urban areas**. This is particularly relevant for two thematic areas: mobility management and public transport. Experts also insisted on the necessity of ICT in order to improve information to the passengers, ticketing systems and actions to implement Intelligent Transport Systems (ITS). Finally, it has to be said that ICTs could also have an important role in helping management to set up a Mobility Center.

In conclusion, it must to be said that the above ICT analysis has helped to define the context as well as to look for the most appropriate ICT solutions for Mediterranean universities before defining a proposal of an integrated mobility ICT system.

4. ICTs Solutions for Sustainable Mobility

This section aims to review different projects, applications and platforms in order to define the state of the art in ICT linked to Sustainable Mobility. The first section, *4.1*, defines projects that can help to develop or improve a SUMP. In the section *4.2*, the reader can find platforms and applications, first with integrated and multimodal viewpoints and then applications with specific solutions to implement or improving mobility systems at Universities.

At the end of each subsection, the information related to the projects will be grouped in different tables with three or four columns, namely: Name of the project, Specific Area, Keywords (these concepts will be differentiated with a hashtag in order to place the reader with the thematic areas or main goals of each project) and Website where obtain more information.

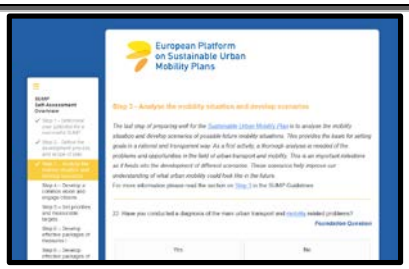
This section is a large part of the work reviewing the existents project s to give the reader or mobility office of the university a general overview of what could include in their mobility system, which nodes, APIS, features or objectives they want to include and achieve

It must to be said that the criteria of selecting the following projects and platform is not influenced by any commercial interest or else monetary relationship.

4.1 Projects to enhance a SUMP

This section aims to summarize some relevant projects to address the use of ICT for sustainable mobility at University Campuses. These are displayed in alphabetical order.
Balsas (2002) highlighted need of consult and check success practices while supporting and enhancing new projects

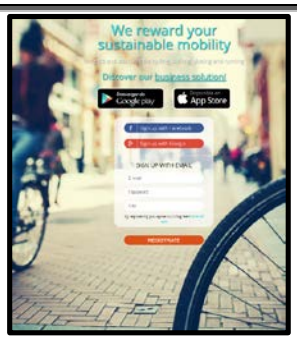
CH4LLENGE and the Sump Self-Assessment Questionnaire



The CH4LLENGE project supports mobility practitioners in improving local transport planning processes and developing quality Sustainable Urban Mobility Plans. It addressed the four most pressing challenges in sustainable urban mobility planning: participation, cooperation, measure selection as well as monitoring and evaluation. Systematic monitoring and evaluation increases the efficiency of the planning process and implementation of measures, helps to optimize the use of resources and provides empirical evidence for future planning and appraisal of transport measures.

The Sump Self-Assessment Questionnaire tries to assess the compliance of a SUMP with EU requirements, based on the EC's SUMP concept and guidelines as presented in the Urban Mobility Package. It is s an online self-assessment tool (free of charge) that cities or institutions can take at their own pace and provides a clear and transparent assessment of the SUMP preparation process and of the plan's content. This questionnaire has been developed in close cooperation with DG MOVE (Directorate-General for Mobility and Transport of the European Commission).

Ciclogreen. ACTION in the spotlight.



Ciclogreen encourages users to make use of sustainable modes of transport. The app allows users to earn points (called CICLOS) by tracking activities such as cycling, walking, running and skating. These points can then be turned into exclusive discounts with participating businesses. Rewards range from free breakfasts to

waterproof sport cameras, free "glamping trips" while promoting sustainable mobility to reduce CO2 emissions. Moreover, it helps to increase productivity and reduce absenteeism of employees, promote exercising and a healthy lifestyle with gamification, allows to create your own challenges and rewards and have a control panel where the sustainable mobility data are tracked and follow the evolution of the program.

FLIPPER Feasibility Studies of the project

FLIPPER stems from the need of some partners who do not have experience in running FTS (flexible transport services) to assess their potential and how to integrate them in the overall Mobility and Transport policy. The project also takes into account the need of other partners, who already run FT Services but lack a co-ordination center (ICT platform) able to provide a more complete information to the citizens (unique number, information center, web interface, etc.) and networking the different transport operators.

The traditional fixed route services are ideal for clustered travel demand areas but the changing residential patterns and nature of work activities in today's society have created different mobility needs to which conventional transport has become neither suited nor cost-effective. FTS are complementary to the conventional passenger transport and usually serve no scheduled mobility needs, either in low demand time periods and in weak demand areas.

CIVITAS DYN@MO

The strategic aims of CIVITAS DYN@MO are to develop 'Mobility 2.0' systems and services by applying web 2.0 technologies, implementing city and citizen-friendly, electric mobility solutions, using new electric and hybrid vehicles and engaging in a dynamic citizen dialogue for mobility planning and service improvement. The specific objectives of the project are outlined on four levels:

- Strategic level: to create a culture for interactive mobility planning in which citizens and other stakeholders can actively participate in planning through innovative dynamic processes.
- Technical level: to use clean, energy efficient, especially electric vehicles, and advanced ICT and Intelligent Transport Systems the basis of innovative transport services.
- Service level: expose citizens and travelers in the cities to innovation hotspots with exciting new mobility services.

European level: to enable politicians and technical decision makers from CIVITAS DYN@MO cities to actively contribute to European exchange and learning through summer schools and trainings by developing competence centers for Sustainable Urban Mobility Planning and electro mobility.

FRONTIER CITIES. European cities driving the future internet

FrontierCities is an EU funded project which supports SMEs and start-ups to develop Smart Mobility applications for cities across Europe.

FrontierCities has run a series of boot-camps both to ensure the Grantees competency in using FIWARE technologies and the uptake and business success of the developed applications.

It has also helped to pair interested cities with web-developers, SMEs and start-ups, giving the Grantees a space to test and deploy their smart mobility application. At the end, 594 applications from 10 European countries were submitted.

NISTO. Evaluation Toolkit User Guide

The aim of NISTO is to develop an evaluation and planning toolkit for mobility projects which is applicable transnationally and can be adopted by planners.

The NISTO project developed a new and smart toolkit to evaluate smart mobility concepts. Focusing on the integration of different transport modes it includes all initiatives which enhance the traffic flow.

New Integrated Smart Transport Options – is a transnationally cooperative project consisting of seven partners (United Kingdom, Belgium, France, Netherlands, Germany) who were supported by the European commission in the INTERREG IVB North-West Europe

The NISTO toolkit has been designed for transport planners, local and regional authorities, researchers and non-governmental organizations who want to appraise different options to solve a mobility-related problem in the urban or regional context.

It is particularly suited for the early assessment of alternatives when detailed data is not yet available about the impacts of the interventions. The NISTO evaluation toolkit can be used to evaluate small-scale mobility projects for sustainability and stakeholder preferences and monitor policy targets.

Roadmap Online Tool

The Urban Transport Roadmaps project provides you with an online tool to help develop the first scenarios for your Sustainable Urban Mobility Plans (SUMPs).

The study carried out by Urban Transport Roadmaps, with the support of DG Move, provides a web support tool with the aim of helping European cities to explore the options of the different policies for their Sustainable Urban Mobility Plan.

The policy support tool is aimed at small and medium-sized European cities that may not have the resources for the evaluation of the main policies and modeling work

With its simplified approach the tool serves as a first step for people with non-specialized knowledge on sustainable mobility and will allow you to:

- Explore and identify appropriate sustainable transport policy measures;
- Quantify the transport, environmental and economic impacts of these measures;
- Consider the preparation of a plan (roadmap) for the regulatory scenario.

STARS

The Sustainability Tracking, Assessment & Rating System™ (STARS®) is a transparent, self-reporting framework for colleges and universities to measure their sustainability performance. STARS is intended to engage and recognize the full spectrum of colleges and universities - from community colleges to research universities - and encompasses long-term sustainability goals for already high-achieving institutions as well as entry points of recognition for institutions that are taking first steps toward sustainability.

STARS is designed to:

- Provide a framework for understanding sustainability in all sectors of higher education.
- Enable meaningful comparisons over time and across institutions using a common set of measurements developed with broad participation from the international campus sustainability community.

- Create incentives for continual improvement toward sustainability.

Facilitate information sharing about higher education sustainability practices and performance.

- Build a stronger, more diverse campus sustainability community.

Any college or university in the world can register to begin tracking, managing and sharing information about its sustainability efforts using the online STARS Reporting Tool. There are two levels of access available:

- Use the basic access option to track progress and share data. Basic access is available at no cost for institutions that are just getting started in sustainability or that would like to use STARS internally before making the commitment to pursue a rating. Basic access includes the option to share data with third party organizations and to earn public recognition as a STARS Reporter. A STARS Reporter can tailor its public report to focus on those impact areas that are most material to the institution.

- Use the full access option to benchmark against other institutions and earn a STARS rating. Whenever your institution is ready to take the next step, you can purchase a full access STARS subscription. In addition to the basic features outlined above, full access users also have access to automated scoring, are able to benchmark their performance against institutions of a similar type, and have the option to earn a STARS Bronze, Silver, Gold or Platinum rating (valid for three years). Rated institutions are featured in the annual Sustainable Campus Index, which highlights top performers and best practices.

Table 1 Synthesis Table: Projects to Enhance a SUMP

Name	Keywords	Website
CH4LLENGE	#stakeholders #governance #monitoring #assessment #planning #e-questionnaire	www.sump-challenges.eu
CityGoRound	#open data #mobility apps #walk scores #bike scores #EEUU	www.citygoround.org
Civitas Dyn@mo	#citizens #stakeholders #ICT #ITS #planning	www.civitas.eu/content/dynmo
Flipper	#cooperation #FTS #regions	www.interreg4cflipper.eu
Frontiers Cities	#smart mobility #developers #transnational #gallery of apps	www.fi-frontiercities.eu www.fi-frontiercities.eu/gallery
NISTO	#evaluation #planning #integrated toolkit #mobility managers	www.nisto-project.eu
ROADMAP ONLINE TOOL	#planning #roadmap #mobility managers #decision making	www.urban-transport-roadmaps.eu
STARS	#universities #sustainability #international	www.stars.aashe.org

4.2 Platforms and Applications

In this section, a selection of existing integrated platforms and application that address most of the variables will be described, as a real example on how to manage and monitor mobility at Universities. These platforms could help to assist the Universities accomplish more sustainable commuting to/from the Campus. This section is extremely relevant for mobility managers and decision makers at campuses.

4.2.1 Integrated & Multimodal

This subsection provides information about applications and platforms created for targeting sustainable mobility with the peculiarity that are applying an integrated and multimodal approach.

APP&TOWN

It is a free application that provides the user with the best route to go to/from the campus in any of the available transport modes. It provides real-time information about public transport schedules, incidents that may occur and, if necessary, calculates alternative routes, assisting the user from beginning to end. It is multimodal and exhaustive, including all modes of transport in the metropolitan area. This application allows the user to be constantly informed, throughout the journey, and where and when to alight. To achieve this, App & Town uses two sources of information, namely: The information offered by transport operators and the information that the users provide directly and in real time.

The aim of this app is to save time when commuting providing security in unusual trips, guiding the user through the fastest or the most attractive routes, according to their preferences.

APP&TOWN Compagnon

This App fulfils the Smart City concept of using technology to improve the quality of life of citizens and making society a place where all people enjoy the same opportunities. This innovative intelligent guidance system allows people with mild or moderate cognitive disabilities to travel autonomously in public transport, continuously monitored and in a secure manner.

This is one of the examples of how innovation boosts social inclusion of people with special needs.

This new technology is a daily tool which enhances not only the mobility and self-esteem of the end users, but also the quality of life of their families.

CityGoRound

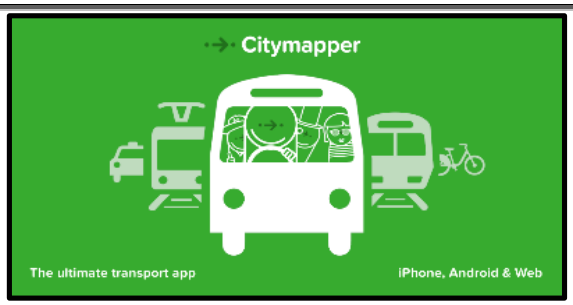
City-Go-Round helps you find useful transit applications near you.

City-Go-Round also encourages public transit agencies to open their data to software developers. Their mission is to help make public transit more convenient. For example, an app that lets you know when your bus will arrive is way better than standing outside waiting for 20 minutes.

- Is a catalogue with a 292 open data apps to help people get around
- Divides Public transit apps, cycling apps, walking apps, Driving apps

- If it's possible make public transit more convenient, more people will ride public transit
- More people riding public transit equals less driving
- Less driving equals a healthier planet.

Citymapper



With the aim of reinventing urban transport apps, Citymapper was built for the daily needs of the habitual traveler covering around 40 cities worldwide using public transport. Their algorithm combines all means of transport to find the best route: metro, trains, buses, Uber / taxi, Car2go and bicycles.

Some advantages are:

- Find the best route
- Real time information
- Customize your city
- Smart commute
- Offline Maps and schedules
- Step by Step trips
- Share it with your friends

Commute Greener

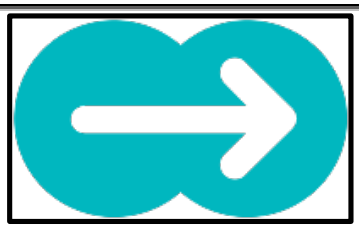
This app helps users change their daily commuting patterns. This applications is su pported by the European Union and used for traffic campaigns worldwide.

For every improvement you see the impact on saved CO2, travel time, cost and health. One can collect points and badges along the way: compete with your friends and unlock badges like the “bicycle hero”. Create or participate in challenges and make the city a more livable place.

Some Key features:

- your commuting baseline and options to improve
- ride share suggestions
- crowd based traffic information
- public transport time tables
- map routing
- CO2, health and fuel cost visualization
- commuting challenges, badges and rewards

Moovel



Moovel offers new ways to connect the urban mobility ecosystem with three complementary products: Moovel app, Moovel transit and Ride Tap. Inside Moovel one can search, book and pay for rides. Inside Moovel transit offers ticketing and

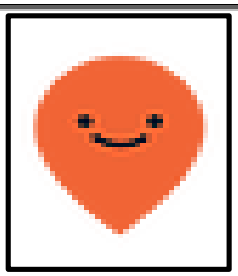
payment solutions and also, smart routing and pooling. The software platform can be integrated into existing transport operators' services. Moovel aims to discover how ICT affect the way people move and connect the ever-changing state of urban transport working in Europe.

Advantages of Moovel:

- Multimodal mobility offers thanks to the integration of other mobility service providers
- State-of-the-art connection search with real-time information
- Easy integration of other mobility service providers
- Quick registration via e-mail, Facebook, or Google
- An intuitive and easy-to-use app

Health and environment implications: Moovel grants half-price travel on buses and trains in Stuttgart, Germany, in order to encourage travelers not to use cars (initiative in January 2016).

Moovit



This is an integrated Public Transport Application. More than 1800 cities and 79 countries are connected with this app. The main features are an Urban Mobility Analytics, Transit Surveys, Transit Data Studio, Real-Time Bus Locator, Trip Planner API. Web-based platform to create, manage and distribute transit data to everyone

This app has a comprehensive transit data management tool with an easy-to-use web interface that enables one to create, edit and manage public transit information. Based on the GTFS global standard (defines a common format for public transportation schedules and associated geographic information) the data for transit stops, lines, shapes, trips, schedules, and more, can be accessed and used immediately by any external website or application.

Moovit generates hundreds of millions of data points daily from users and 180,000 local editors. Another interesting tool within Moovit are the transit surveys, an

online system which creates, distributes and analyzes transit related surveys answered by non-incentivized, targeted Moovit app users. These rider surveys are managed in real time and provide results visualization as well as the anonymized, detailed answers.

MoveUs Platform

A cloud-based mobility management platform integrating different transport and traffic management components which are able to collect heterogeneous data and process these data to infer valuable information of the traffic status and users' mobility patterns, ensuring data privacy and security all along the handling process.

The data is collected in different formats and come from different sources: from the user through the mobile application (e.g. mobility patterns, preferences) or synchronously (position in real time), from conventional sensors and ITS systems and from historic databases (e.g. public transport schedules) or mobility companies.

The main aspects of the service delivery platform are:

- Cloud-based Mobility Service Platform architecture definition
- Flexibility on the allocation of functionalities, aiming to cover the most possible implementation scenarios and use-cases not only in the pilots but also in other adopting cities:
  - Local (provided by existing local data/service servers and used internally)
  - Fully supported by the MoveUs platform (cloud located) and/or
  - External (new City Services apps/webs)
- Business-models according cloud and functional deployment scenarios
- Platform middleware and enablers
- Data adaptors: heterogeneous input formats into internal model
- Common Agreed Standardized Interface (CAI)
- Different communication models: pull, publish/subscribe

COMMUTE 900067

This app provides matching facilities for commuters. Commute 90067 matches users with others who have a similar travel plan. Users can search and view potential trip matches that are based upon a specific radius from the origin, destination and along the route. Once an original search has been entered, users are able to easily modify their search, save it for later, or go back and review their recent searches. Users should save and share trips as "favorites", so others can match with them.

- Commute 90067 provides a range of travel options for a user's trip and the impacts associated with each choice. This help the user to make an informed decision about their trip.

- Users can track their trip choices to see the impact on their costs and local environment, receive rewards, and compete with fellow residents and employees your area. By tracking travel choices in a diary, users will receive digital badges that can be shared on social media for actions such as "first alternative trip logged" or "first bicycle trip." Top performers for each travel mode will also be displayed on a digital leaderboard. Tracking trips may also enter a user in a contest or campaign.

Limassol Mobility App

The Limassol Tourism Company (Cyprus) within the European programme, Civitas Destinations in terms of Horizon 2020 offer you the "Mobility Limassol" app. Find the most efficient route from one point to another in terms of energy consumption and, in turn, lead to a decrease emission of pollutants.

The app contains comprehensive information about Cycling routes, EV charging stations, Parking places and Public Bus service including routes, stops and maps. Also it has integrated trip planner with location search functionality to help you figure out the most efficient routes to reach your destination with expected duration of travel. This application aimed at residents, citizens and visitors that includes all functionalities that may be needed when prefer to move sustainable.

The app is available free of charge in Google Play and iOS App Store under the name "Limassol Mobility"

The main **challenges** that Limassol and this App want to face are:

- Increase the use of the urban public transport by tourists and locals
- Increase the use of rural public transport by tourists, to encourage visits to the countryside
- Increase cycling in combination with special interest tourism
- Decrease the number of cars in the old town
- Decrease congestion
- Increase interest in walking and cycling routes
- Decrease noise level and improvement of air quality
- Encourage tourists to explore the region using economic and sustainable modes
- Encourage locals to use sustainable modes in their travels

MatkaHupi: Persuasive Application

The MatkaHupi application has been developed for Android devices and provides the user with the following core components:

• A journey planner for public transportation in Helsinki, making use of the open API provided by HSL (Helsinki Region Transport)

• Automatic detection of trips taken and transport modes applied by the user, utilizing sensor fusion including positioning technologies and the accelerometer in combination with openly available public transportation route and schedule database

• Trip history, with which the users can review past journeys

• Visual feedback on the CO2 emissions of the user during the current week and the past three weeks

• A set of challenges designed to motivate the user to make sustainable traveling choices

Opendata. EMT Madrid

In this OPEN DATA portal, you can find relevant information about the different services provided by EMT (Enterprise of Municipal Transport) bus, public bike, mobility, parking), as well as instructions on how to integrate with your own applications following some easy register steps. It also offers statistical information which can be downloaded from their website.

For example, related static data they offer different formats and metadata of each content, namely: Calendar of the weeks, type of season, Groups: returns data about the different types of EMT lines networks (regular lines, university lines, night lines, etc.). Concerning incidents through this feed you can get all the incidents and notifications relating to EMT service, Lines and Bus stops.

Besides this, they offer five types of Web services, namely:

• Bus services provide information of the lines structure and the route, as well as timetables and other elements related to the service planning

• Geo services provide contextual information related to the requested localization. You can also use them to get bus estimated waiting time.

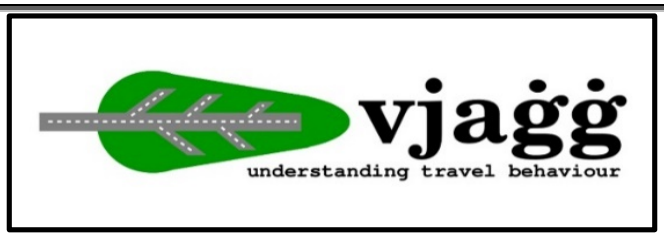
• Media services provide three different types of real time information: Estimated waiting time; Service incidents or changes; Calculation of routes on foot or by bus. All the results include the optional availability of audio streaming.

• Info Parking: service layer-oriented. It provides information on public car parks in the city of Madrid (depending on their level of integration in the system). From its location, to access, schedule, additional services and available seats in real time. In addition, detailed information on attractions is offered (museums, monuments, ...)

• Bicimad: It is a layer of services that allow you to know the status and availability of the Base Stations of the Rental Bike of Madrid (BICIMAD)

Open Data Madrid, also offers a list of Mobile Applications, Open codes and sources, official apps, other kind of App's devices (Smart watches or integrated devices).

vjaġġ App.



This software is provided by the University of Malta and developed with the support of the Vodafone Malta Foundation.

The application was designed to collect data about journeys carried out by the user throughout the day. The information provides valuable insight into the travel needs of individuals and the population, which are essential for our research in transportation planning.

The Application gives the user complete control to start and stop the logging process, and the journey data is not sent automatically to our servers but requires the user's active intervention, at which point certain journeys may be annotated and sent, or simply deleted.

• This mobile application seamlessly collects data about journeys carried out by the user throughout the day

• The information gives us valuable insight into the travel needs of individuals and the population, which are essential for our research in transport

• The user gives us only general personal information, namely gender, age group, relationship to the University, and whether they have access to a car (this information is collected once, when the user signs up to the App)

• The data will only be used for statistical and demographic purposes in relation to the study. Once provided, this information, is tied with the journey data in our database only through a unique code, and is never transmitted again

• The data is completely anonymous. A user can also choose to reset the unique identifier code and create a new one at any point

• The App also gives the user complete control to start and stop the logging process, and the journey data is not sent automatically to our servers but requires the user's active intervention, at which point certain journeys may be annotated and sent, or simply deleted.

RideAmigos

This platform is a web-based commuter management solution, providing an industry-leading interactive platform for regional, corporate, and campus commuter networks, with multi-modal travel dashboards, incentive and reward systems, intelligent ride matching, automated trip tracking, certified transportation and air quality surveys, GIS reporting tools, and more. RideAmigos brings together your transportation resources, data, and programs all in one place, creating measurable impact, and increasing efficiency month over month.

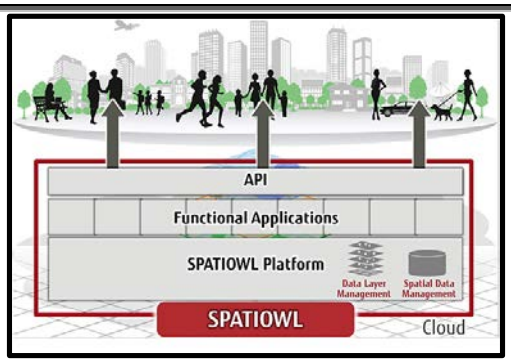
• The CCTMO created by RideAmigos does not just compare the cost and time of different travel modes

• It also does a carbon dioxide and health-benefit analysis, and awards points to members on a tiered basis (biking to work gets more points than carpooling)

• Users with the highest point totals are awarded free bikes, transit passes, and other goods funded by the local government, businesses, and nonprofits that have joined in the effort

• These insert a social component into what had been purely individual decisions.

SPATIOWL



It designates a service for the integrated management of many types of transport-related data using Big Data analytics and Cloud Computing technology.

The service can deal with large amounts of data coming from multiple sources such as public transport, vehicles, and pedestrians' smartphones in urban areas through sensors. It aggregates and analyzes across various data layers and provides new insights from the analyzed data to identify relevant actions in the user context.

SPATIOWL is a computing platform incorporating the following key architectural components:

- A Data Layer Management: Apache Hadoop-based Big Data management database
- Functional Applications: Specific applications such as urban traffic management, telematics and analytics functionalities
- API: Standardized REST (Representational State Transfer) Architecture API for integration with external systems
- Map: OSM (Open Street Map) based maps for the rendering of information to users, etc.

Table 2. Integrated and Multimodal

Name	Keywords	Websites
APP&TOWN	#start up #multimodal #universities #commuting	www.appandtown.com
APP&TOWN Compagnon	#equal society #universal Accessibility #multimodal	www.appandtown.com/compagnon.html
Citymapper	#all transports #travel time #smart bus	www.citymapper.com
COMMUTE 900067	#multi-modal #carpool #rewards system #environment #awareness #social media	www.commute90067.com
Commute Greener	#C02 emissions #sustainable modes	www.commutegreener.cm
Limassol Mobility App	#tourism #sustainable modes #Cyprus #traffic*- congestion	www.limassoltourism.com
MatkaHupi	#journey planner #Schedule #trip history #environment #awareness #motivational #challenges	www.ubicomp.org/ubicomp2013/adjunct/adjunct/p227.pdf
Moovel	#connected #route planner #customized #behavior	www.moovel.com
Moovit	#public transport #real time #trip planner #transit surveys	www.moovitapp.com
OPENDATA	#public transport #transnational #open access #apps	www.opendata.emtmadrid.es www.muevetepormadrid.es
RideAmigos	#interactive #commuter Management #rewards system	www.rideamigos.com/platform

SPATIOWL	#big data #sensors #urban traffic #analytics #open street map	www.fujitsu.com/global/solutions/business-technology/intelligent-society/smart-mobility/spatiowl
Tripzoom App	#incentives #behavior #management #community	www.tripzoom.nl
Vjagg App	#university #behavior #data collection #commute	www.um.edu.mt/iccsd/projects/demandresponsivetransport/vjagg

4.2.2 Platforms with Specific Focus

This subsection provides information about applications or platforms created for specific objectives but then again targeting sustainable mobility.

AutoPilot

AUTOPILOT

This project brings together relevant knowledge and technology from the automotive and the IoT value chains in order to develop IoT-architectures and platforms which will support automated driving.

The main objectives are:

- Enhance the driving environment perception with IoT sensors enabling safer highly automated driving
- Foster innovation in automotive, IoT and mobility services
- Use and evaluate advanced vehicle-to-everything
- Involve users, public services, business players to assess the IoT socio-economic benefits
- Contribute to the IoT standardization and eco-system

Beeline

Is a device for cyclists, connected with an app count with a compass and route mode in order to make journey easier by planning for bicycles. The user has to enter the destination and waypoints and beeline provides the distance and direction as the crow flies.

Key Features:

- Intuitive Navigation
- Speedo
- Clock
- 30-day battery life
- Super sharp display
- Fits any bike
- Weather resistant
- Bluetooth

CAR2GO

An international App working in China, Canada, USA and Europe, which solves the problem of needing a car without actually owning one.

- Car2go is a flexible car sharing service without fixed rental stations.
- Users can rent and park everywhere in the home area of their cities with a low tax per minute validating their driver license in the app.
- With the car2go app you can easily find and reserve every available car2go.

How does it works? Reserve the car2go with the app up to 30 minutes before departure. If a car is not immediately available, just activate the radar feature in the app. The car2go radar notifies you as soon as a car becomes available in your area.

CHUMS: Carpool Site Appraisal Tool

The CHUMS project for carpooling works simply when a driver shares their vehicle with others travelling to a similar destination. The universities are large trip generator catchments, therefore this can save fuel costs and reduce the single occupancy of vehicles and thus can be crucial in reducing congestion and traffic jams around the campuses.

The CHUMS project tries to demonstrate that carpooling is a viable and convenient option that overcomes traditional social, behavioural and cultural barriers associated with sharing, and helping people change their travel habits regarding commuting. For that reasons, universities are one of the best options to test the effectiveness of the carpool.

Eccentric. Visual impairment App

The CIVITAS ECCENTRIC project is seeking expressions of interest to join a network of 'Observer Cities' interested in replicating project measures relating to sustainable mobility and urban planning.

The Observer Cities Group will be an active network of 20 cities across Europe, China, India and Latin America, which will engage closely with the five main project partner cities' activities as 'Living Labs' for various aspects of urban mobility of freight and people. The use of clean vehicles, innovative regulatory approaches and emerging technologies will be tested as part of the ECCENTRIC project.

Specifically, Munich's public transport operator, the Münchner Verkehrsgesellschaft (MVG), has been testing a new concept to improve public transport accessibility. The millions of people within in the European Union (EU) who are blind or visually impaired often face greater challenges when using the metro or public transport. This includes difficulties with orientation, navigation, and accessing information.

In Münchner Freiheit metro station, people who are blind and visually impaired can use an app that helps them navigate and use public transport services within the station. The beacons locate the user, thereby enabling them to receive position-specific information.

Some of the app's features include:

- Providing routes to points of interest within the station, including lifts, exits, and platforms;
- Disclosing the departure times of metro services;
- User orientation and location within the station;
- Identification of the metro station.

The presence of multiple beacons around the station ensures the above information is constantly updated and subsequently relayed to users.All features are available via voice output that reads aloud all information on the phone screen of users. App functionalities can also be customised according to individual user needs.

In March, 2018 the app it was tested in the Münchner Freiheit station. Following the initial six-month trial period, the results will be evaluated and a decision made as to whether to roll it out further.

Google Indoors Maps

Visitors can spend less time searching for building directories and more time discovering new points of interest. This app provides a zoom in and out of buildings and allows the end- user to go floor to floor with indoor maps.

Zooming in the user can see the indoor floor plan of a building to search and locate within the building once you are fully zoomed in.

Some of the main features are:

- Improved location accuracy
- Digital directory in the palm of your hand. Switch floors with a tap
- Use the level switcher in the bottom right-hand corner to move from floor to floor in the building.
- Universal icons. Easily recognizable symbols represent different points of interest inside

- Enhance mobile APPs or Site. In addition to making the content available to our users in Google Maps, your indoor map will also be available through the Google Maps
- Available APIs for use in mobile applications or website

MazeMap

This application Has a specific API that could help making campus life easier and more efficient for everyone. MazeMap improves the student experience by reducing stress and uncertainty.

Main Features:

- Indoor map
- Wayfinding
- Indoor positioning
- Automatic updates
- Map export
- IoT platform.

Mytaxi

Mytaxi connects with 10 million worldwide users and 45.000 taxis in 40 cities. The users can use the website or the app to book, pay and give assessment of the taxi service. Some advantages:

- Get your taxi with one touch.
- Follow the taxi driver's route in real time.
- Rate the driver and save your favorites for future trips.

BikeCitizens

Bike Citizens is an app which provides the user cities' or companies' cycling solutions through navigation tools, promotion cycling tools and data analysis.

Some advantages are:

- Digital guidance system for citizens
- Display existing cycling infrastructure
- Safety and guidance for beginners
- Increase motivation
- Maintain motivation over the long term
- Develop local cycling communities
- Graphically display bicycle traffic
- Prepare data for traffic planning
- Demonstrate unrealized possibilities & obstacles

This company organizes specific campaigns with benefits and rewards such as Safe Cycling and Bike2Work campaigns.

Oroeco

Oroeco automatically tracks user climate impacts with the world's best carbon footprint calculator.

- Personalized tips show you which climate actions will reduce the most pollution
- Saving money information
- How driving connects to global warming?
- Comparing, collaborating and inspiring the community.
- See how your climate impacts and actions compare with your friends and neighbors
- Inspiring everyone to become a Climate Champion.
- Within this app the user can win cash and prizes by inviting their friends and being proactive.

ParkMe

This application is used in 123,000 locations, in 9,700 cities, on 7 continents. ParkMe help users to park their private cars in a smarter and faster way. With this app the user can find the cheapest, closest parking space and sometimes a guaranteed parking spot in advance with integrated credit card payment.

Main features:

- View informative maps of parking areas and garages in your area.

- Check daily & monthly parking rates, see prices laid out on the map and compare costs.
- Set our parking timer to help you avoid overstaying, overpaying or getting a ticket.
- See real-time info on exactly how many spots are open in a garage or lot.
- When you decide on a space or garage, get directions to the nearest driveway not just the street address.

Safety pin

SafetiPin is a social enterprise providing a number of technology solutions to make our cities safer for women and others. They use applications to collect information and engage with individuals, providing back end solutions for large scale data collection and analytics.

This company works with governments, NGOs, city planners, international agencies and corporates, to provide and use safety data for change.

At the core of the app is the Safety Audit. It consists of a set of 9 parameters that together contribute to the perception of safety. Each audit results in a pin on the specific location where the audit was performed and also records the time and date. The colour of the pin is red, orange or green based on the measure of the parameters. Based on audit data in an area, a Safety Score is generated.

Safety pin parameters:

Lighting in the Area; Openess of the Area; Visibility in the Area; People Density; Security; Walk Path; Transpotation in the Area; Gender Diversity in the Area and the general Feeling. Any user can do an audit or post their feeling at a particular place. Users can agree to posts, put up their own comments, and even post it on Facebook, Twitter and Google Plus.

This data is shared with users of SafetiPin and with key urban stakeholders such as planning departments and the police to provide inputs into improving safety conditions. Users can add comments while doing Audits. They can report problems

such as poor/no lighting, broken/blocked footpath, open wiring etc. While travelling, they can view Safety Audits to view safe and unsafe locations, and plan their routes accordingly.

They provide information to public service providers nad authorities with access to information from the data collected such as non-functioning streetlights and unsafe areas, to help them improve the safety of the area.

They also have, two different APIs: **SafetiPin Track** and **Camera Safetipin Nite** with these following main goals:

Safetypin Track. Set rules on to let friends know only if something unusual happens. Decide safe places to stay or visit at night after checking on My SafetiPin.

Safety pin Nite. Is an app that can be installed on any android mobile phone witth a good low light camera. The phone can be mounted on your car windshield and help capture night-time images.

SmartUJI APP

This IPS is based on existing Wi-Fi signals, and is realized as a service in a broader, open smart university platform called Smart UJI, which is a modular, extensible cartography-based platform to store, access and manage all the data, resources, common services and functionalities required to build a wide range of applications in a smart campus context.

Specific services include:

- Finder: allows searching for a specific university member, subject, space, department, or facility. It consumes other services to access external data sources and the internal geospatial contents to link the results to locations on the map

- Route calculation: calculates the optimal route for a set of points. This functionality has been implemented for three dimensions (longitude, latitude and altitude) to reach any space, interior or exterior, on the campus using stairways.

• This service uses geo-processing capabilities through the information services.

• Speech recognizer: supports the interaction of users with mobile applications and is thus an example of a specific (device-dependent) service. It is able to distinguish 4279 relevant campus locations which were extracted from the SmartUJI platform.

SUNSET PROJECT. Sustainable social networking services for transport.

The mobile Tripzoom-app has been developed as a proof-of-concept to improve the personal mobility of travelers and to share information in three pilot areas:

Enschede (NL), Gothenburg (SE) and Leeds (UK) to investigate and test how we can help travelers to get better insight in their own mobility pattern; what kind of incentives people value; and finally, how we can use social networks to share mobility profiles and create a social experience.

The project will connect urban mobility managers with users and users with one another through a smartphone app, allowing users to receive information tailored to their particular travel behavior with the aim of the more use of the app the more is learned about mobility patterns.

Sunset explores the impact that incentives and gamification might have, also includes providers of location-based services and mobile-phone operators, as well as local and national governments and university research centers.

VIAJEST. Miguel Hernández University

As an example of own carsharing system the MHU (Miguel Hernández University), in Elche, Spain, developed the Viajest App.

Viajest is an App to sharing the car or motorbike within the University members. To access the system requires you the following information:

- Relationship with the UMH:
- Your name; Your Surnames; Your ID or equivalent; Your email address; Your phone;
- If you are a student, what do you study;
- If it is a PAS or PDI, in what Service or Dept. do you work;
- OTHER DATA: Do you want to receive more information about the Environment? Yes/No
- Leave a comment (optional);

On the other hand, it is a great example of use of own University's resources. Was created by a professor at the UMH, in collaboration with a software company and the Environmental Office of the University.

It includes an internal system of communication between users through instant messaging, interactive map, and, allows sharing travel expenses through cash, PayPal or credit card.

It is available for free in Play Store, App Store and Viajest.com (only for Android devices).

Table 3. Platforms with Specific focus

Name	Specific Area	Keywords	Website/ Links
AutoPilot		#automatic driving #IoT #compilation	www.autopilot-project.eu
Beeline	Bicycle	#compass #navigation #safety #route planning	www.beeline.co
Bike Citizens	Bicycle	#international #rewards #customized #offline #cyclists' needs	www.bikecitizens.net
Car2go	Flexible Renting	#rent car # e-car #car sharing	www.car2go.com
CHUMS	Carpool	#carpool #habits #sharing system	www.chums-carpooling.eu
ECCENTRIC	Accessibility	#blind people #metro #Munich #accessibility	www. civitas.eu/eccentric
Google Maps Indoor	Inside Mobility	#indoor #navigation #route	www.google.com/maps/about /partners/indoormaps/
MazeMap	Indoor	#inside mobility #indoor navigation	www.mazemap.com
mytaxi	Taxi	#taxi #transnational	www.mytaxi.com
Oroeco	CO2 emissions	#footprint carbon #rewards #awareness #community	www.oroeco.com
ParkMe	Smart Parking	#pay system #international #real time	www.parkme.com
Safetypin	Women	#woman #safety #gender perspective	www.safetipin.com

Sunset	#Changing Habits	#multimodal info #management #users #gamification	www.sunset-project.eu
SmartUJI APP	Indoor	#indoor mobility #smart campus #map based	
SmartUJI AR	Indoor	#augmented reality #facilities #interact	
Viajest	Carpooling	#carpooling #UMH University #environmental office	www.umhsostenible.com/coche-compartido

To finalize this section, it is must say at this point that the list of applications, ICT solutions, projects and platforms supporting sustainable mobility one way or another, could be almost infinite. Apart from the projects above, and the main keywords highlighted within the grouping tables, it can be remarkable to conclude this section with some of the main thematic areas related mobility and ICT, not specifically contained within the above sub sections which have also helped us to design our proposal.

Regarding **teleworking,** there are very many applications allowing connect better the workers with their work outside their offices and allowing to simplify their work as for example; *Weekdone, Any.do, GotoMeeting, join.me, Trello, Slack*, etc.

Regarding **awareness and learning** processes, there are different apps designed to enable children and young people to map their route to school and register positive and negative spots along the way. At the same time there are a game for children and there are helping transport planners to improve road safety, with the final purpose of motivating a greater number of children to actively commute to school.

Regarding **freight and shopping management**, the reader can find some and diverse apps similar as *Bringbee*, a home delivery service, intended to make shopping trips redundant. The app matches a customer at home with someone shopping, who will then also deliver the purchases. The service explicitly mentions reduced travel as an environmental benefit.

Flexible renting of electrical motorbike systems are also well accepted throughout the university community, so that different companies and city authorities are working within the MED area as for example Muving or eCooltra.

Related **health issues**, we can find a lot of types of monitoring information and health's indicators. We are going to briefly define some of them. *Move app* calculates distances, and can be used for walking, running, skiing or bicycling. The app measures the distances covered, while also visualizing routes on maps, and estimating calories burnt. Map my walk can also be synchronized with heart rate monitors, sleep measures, pedometer measures, etc. Other applications as for example, Jawbone *Up or Moov,* include bracelets connected to apps: these systems are designed to control activity levels, and to encourage increasing activity based on training programs. In addition, there are also applications to prevent road accidents, since educational apps to commute to school for children or applications which allowing the register of road traffic crashes or aggregate and provide statistical information concerning black spots.

Regarding **environmental conditions**, the ICT applications can offer as well, such crucial measures associated with active or sustainable mobility as for example, air pollution, environmental noise, light, weather and traffic conditions. Finally, and increasing their popularity there are different apps allowing you to calculate your Carbon Footprint depending on the mode of transport you choose.

Related other interesting found projects promoted by Eurocities and Sharingcities are:

- TRACE, providing Walking and Cycling Tracking service.
- Move Smart, concerning renewable mobility services in Smart Cities.
- Carma, Cycling Awareness Raising and Marketing tool.

Finally, **universal accessibility and gender equality** concerning sustainability and transport disciplines are being addressed through new technologies and innovative projects, as the reader could see in the above sections. Allowing mobility and transport community evolve to become a fairer system, including people with or without functional diversity, with or without a specific gender.

New technologies, specifically from universities, should give voice of those who cannot be heard.

5. CAMP-sUmp e-Core system: A Proposal of an Integrated Model for Sustainable Mobility in Mediterranean Universities

This section is a description of the top-level specifics of what this system should include, defining the architecture of the system, the nodes and subsystems of the Mobility Platform and its main functions, stages, requirements, inputs and outputs.

The proposed model is based on scientific publications, RDI projects, applications and platforms and also existing best practices which take place at universities. The CAMP-sUmp results have also guided the structure of this proposal, as well as the structure of this entire deliverable.

This proposal includes some key concepts and technical specifications of what an ideal Mobility platform for Universities should embrace, with the objective of promoting, improving and developing Sustainable Mobility in the campuses of the Mediterranean Area.

It must be added at this point that, these concepts and specifications should not be a simple list of different technologies, but, in short, they must answer, both explicitly and implicitly, the following objectives:

- Enabling communication and accessibility to all actors and users
- Ensuring the commitment of stakeholders and decision makers
- Enhancing campuses to be more accessible and people focused
- Proactively raising awareness of sustainability and promoting the exchange of knowledge
- Becoming a cycle of continuous improvement

One of the major motivations for developing a Campus Mobility System derives from a critical issue at the heart of most Universities: the lack of communication and many a times no specific protocol to facilitate communication between parties specifically related to mobility. Campus initiatives do not normally integrate the different Smart initiatives they offer in a common platform to homogenize access to data and services, and this is one of the crucial goals while defining the **CAMP-sUmp e-Core System.**

5.1 System Architecture

The CAMP-sUmp e-Core System architecture is based on European frameworks for standardization and ITS design. Concerning its technical definition, the e-Core can be defined as: (stemmed from the FRAME Architecture)

- a set of top-level assumptions; variables, actors, stages and nodes.
- a strategic plan for designs a integrated sustainable mobility system;
- a top-level approach;
- technology independent;
- it states "What is needed" and not "How it is to be implemented";
- non-deterministic;

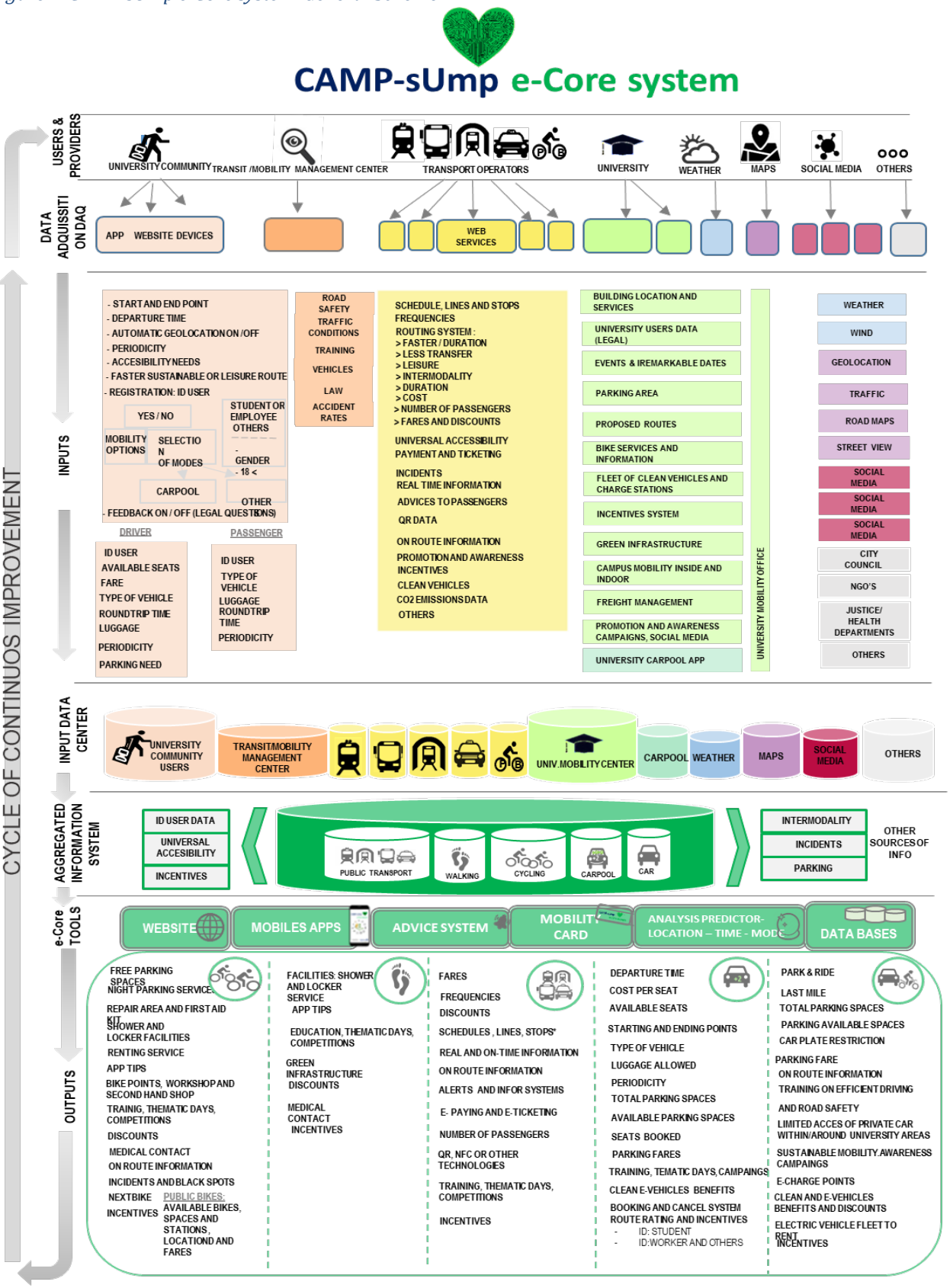
Using the FRAME Architecture, that were described at the section 2.4 of this report, Universities can enjoy three main benefits:

- Most of the work has already been studied and planned.
- There are available tools helping managers and technicians.
- An organizational and operational level linked with the ICT implementation.
- If other institutions or Campuses have Architectures based on FRAME services can be integrated to provide inter-operability.

Therefore, its architecture can be defined as well as a Connected system of systems (SoS). A SoS consists of clusters of systems whose activities are coordinated and integrated, in order to provide services and additional value with respect to their original procedures. The CAMP-sUmp e-Core System describes the integration of many independent and self-contained nodes to satisfy needs and purposes of sustainable mobility at Universities.

While this system has been defined, the CAMP-sUmp e-Core System main outcome was understood as an integrated Application, mainly for mobile devices, since we are talking about the usefulness of ICT concerning mobility. As well as other products could be taken into account, namely: The Website, Advice Systems, Mobility Card, its own Data Bases, Monitoring system, or the Analysis Predictor System among others. To end, it must to be said it is not only defined to provide among end-users but also data providers, mobility managers and authorities.

Figure 2. CAMP-sUmp e-Core system. General Scheme



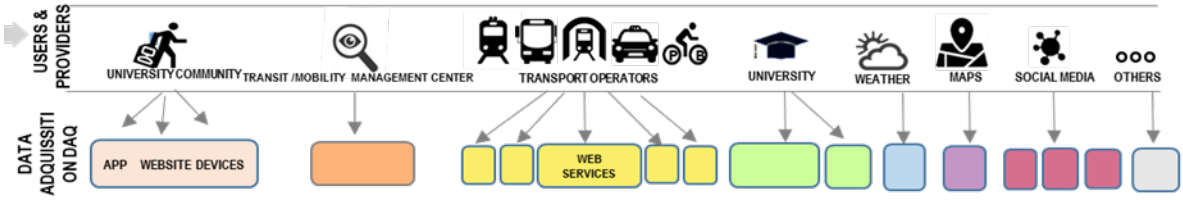
5.2. General Scheme

Looking at the infographics of the system, seven stages can be differentiated where actors, variables, inputs and outputs among others are organized.

In the first stage of the system, the reader can find **USERS & PROVIDERS**, with diverse profiles which provide vital information to the system through different methods.

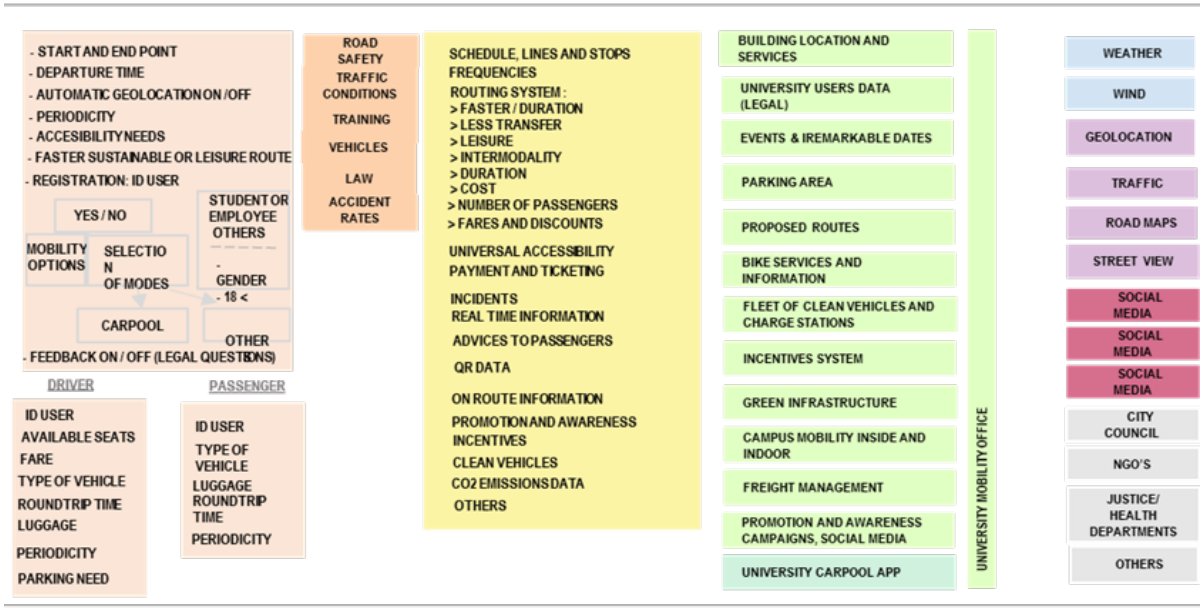
- The **University Community** (students, professors, different staff who commute to the Campus as well as, visitors or people who travel once to the Campus.
- Transit/**Mobility Management Center**: Each city, region or country counts with an institution which aims to control the transit, traffic and/ or mobility. This type of organizations usually has cameras, infrastructure and facilities related to mobility. Another positive aspect is its direct link with the emergency and security bodies and with the city council or government.
- **Transport Operators:** In this cluster the public and private collective transport companies can be found, which provide transport services around a specific area. As for example: Bus, Train, Metro, Public Bicycles, Taxi operators, flexible renting car without a driver.
- **University:** as an entire institution, including its administrative, mobility, informatics, legal or logistic departments, should integrate the significant data for sustainable mobility within a Sustainable Mobility Center/Service.
- **Weather:** The weather conditions providers are very convenient related to sustainable mobility issues. Each region or country can have its own meteorological station.
- **Maps:** Geo-localization technologies are helping to solve crucial mobility questions.
- **Social Media:** this source of information could be very innovative clearing up mobility patterns, in a general way and also explaining or predicting specific
- events where mobility is being affected.
- **Others:** Within this nonspecific source of information, the University managers
- should include particular issues related to its mobility campus idiosyncrasy.

In the second stage, **DAQ (Data Acquisition),** the reader can schematically find how the providers of the first stage can provide the information to the CAMP-sUmp e-Core System grouping the information gathered through data providers, to make the data more understanding and accessible to the system.



Each operator or information source will provide the system different types of data as for example though Web Services or other technologies as for example, sensors or ticketing know-hows. The end-user can provide data though the App, Website, GPS devices, through NFC system and so on.

The third Stage of the system, is built of the main **INPUTS** of the system:



Starting with the column on the left you will find namely:

- **University Community:** Through the CAMP-sUmp e-Core APP the user can share and introduce the following data: Starting and Ending point, Departure Time, Geolocation (which can be activated or not), Periodicity of their trip (e.g. if the user commute to/from the campus once, twice or daily), Accessibility Needs (users can introduce luggage, or any handicap related their mobility). Finally, the user can choose between the "Fastest, Leisure or most Sustainable trip".

The user must be registered with University ID (assuming each university has computerized the relative data of their community). If not exist, it should be produce an external register by adding gender variables and choosing the user' profile (student, worker or others). Gender data input, responses to address mobility inequality and inaccessibility's, improving the services and security related to every user who can be discriminated against.

After this step, the user can introduce the input about mobility options, which can be done by two different ways: the first option would be the Selection of modes, where the user can select the specific modes for their trip (Bus, bicycle, etc.,) and the second, selecting All Mobility Options, in order the system can offers every mobility choice to go to/from the Campus.

- **Carpooling:** Only if the user chooses the carpooling system of the University, the system will require additional data, and this option will only be available to University ID Users. This restricted input is based on safety and privacy issues. The user must introduce their University ID, and after this, choose their profile as either a Driver or a Passenger. If the user is the driver, it will be introducing into the system the following inputs: Available Seats, Fare, Type of Vehicle, Roundtrip time, allowed luggage, Periodicity or single trip and Parking need (to be linked with the University Parking which will give priority to users who share their trips). On the other hand, the Carpool passengers could introduce the following inputs: Luggage, Roundtrip time and Periodicity. The system processes the data, based upon the special requests introduced by the user and will aggregated these special needs to the carpool app.
- **Traffic/Mobility Management Center:** Usually depends on governmental institutions and can also provide crucial information about for example, Road Safety, Traffic conditions, Training and awareness on specific key areas that affect commute to/for the campus. Besides this, it will be a useful source information related vehicles, regulation and transit's law, traffic accident' rates or providing a statistical overview.
- **Transport Operators**: Within this cluster of transport modes, the system will require specific data to the operators and companies which collaborate with the CAMP-sUmp e-Core System, namely: Schedule, Lines and Stops, Frequencies, each own Routing Systems, Trip Duration, Cost, Number of passengers on real time, Fares and available Discounts, Universal Accessibility facilities, Payment and Ticketing System

integration, Incidents on real time and other type of On-route information on real time, Information alerts or info integration, and its own Promotion and Awareness Campaigns, Incentives systems, the availability of Clean Vehicles in their fleets, CO2 emissions data and Other issues that Universities can consider relevant to their community.

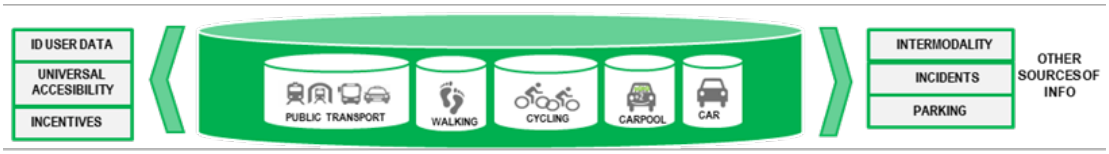
- **University:** as an entire institution, including its administrative, information and technology department, and legal or logistic departments can provide lot of substantial information for the CAMP-sUmp e-Core System. All this data must be organized and integrated within its Sustainable Mobility Center, as for example the following inputs, namely: Building and Services Location (sports, offices), University Community Data (e.g. schedules, gender) taking in to account legal and privacy aspects, asking always for the user's permission. Events and Remarkable Dates or periods (e.g. exams, bank holidays, University conferences, cultural or awareness days). Parking Areas (information related infrastructure, fares, availability and conditions about parking spaces), dedicated University Carpool App, Bike services and Bike Points (e.g. available bike fleet, where they are located, availability, Bike parking spaces). Also, the university will provide the system with the available Clean Vehicles Fleet. Incentives and Rewards system, integrating it with sustainable mobility and Promotion and Awareness Campaigns, which also have an important role here, related to communication processes between university Community and the Social Media used to enhance these sustainable Campaigns. University must inform about its freight management system and Green Infrastructure (where people can walk most green or cycle around the University areas). Regarding Campus Inside/Indoor Mobility, university must map their buildings and offices, e.g. entrances, emergency exits, number of rooms, within the mobility app. On the other hand, the University can provide its own Proposed Routes, apart from transport operator or formal routes, according to the most popular ones chosen by the university community choices.
- **Weather:** The weather predictions are very convenient related to sustainable mobility choices. Each region or country can have their own meteorological stations beside this, there are working the called Personal Weather Stations. Nowadays there are a lot of options as for example wind or rain precisely websites where the user can find accurate parameters and weather details of their own location. The university will decide the technologies needed and the

agreements with internal departments and/or external companies to provide the weather information.

- **Maps:** Each university must study their own options in order to integrate geo-localization systems that execute legal and privacy requirements. There are a Map's Bases to provide the most exhaustive and updating information. Some of the crucial data for the University can be: Improving navigation through the community with new roads and developments, bike routes and walking infrastructure; Updating the main landmarks, natural elements and places of interest near the area and making sure crucial infrastructures, within Universities such a medical service, libraries, or accesses are represented.
- **Social Media:** these types of information could be very innovative clarifying mobility patterns, predicting them and analyzing them. It could be addressed in a general way concerning commute patterns or awareness campaigns and as well they can be useful for predicting specific events, traffic congestion and so on, where mobility is being affected or where mobility can be improved.
- **Others:** Within this non-specific source of information, University managers should include particular inputs related to its mobility campus idiosyncrasy. Within this proposal it have been included namely: City Council, as a crucial source of information which can collaborate also obtaining benefits and crucial data of their citizens patterns. NGO's as a non-profit performer focused on contributing to the evolution of societies and Justice Departments which will add useful information in order to guarantee the legal and privacy issues.

The fourth stage is the **Aggregated Information system (AIS)** where all the data of the above stages represented with their own data bases are aggregated gathered and organized in different blocks. Aggregated information, refers to the compilation of information that when combined, holds a greater value then each component holds individually. A common aggregation purpose is to get more information about clusters based on specific variables. The information about such groups can then be used for personalization to choose content and awareness information. Another strength is using the user-based approach, the

system can offer the end-user a single point for collection all of their personal mobility information from other websites (including transports, schedules, incentives, etc.).



The AIS is built including the following sources and data bases, namely: ID user information; Universal Accessibility; Incentives system, including the agreements with sponsors, companies and its regulation; Intermodality, Incidents and Parking information among other possible data bases. Looking into this stage on the figure, the reader can find the following data bases inside the e-Core aggregated system: Public Transport, besides this, Walking, Cycling Data base (joining private and public bike system), University Carpool Data Base and Private and Motorized Transport.

The fifth stage covers the **dissemination tools or products** of the e-Core System.

The aim of these e-Core System tools or products is to disseminate its own data and the system' outputs.

Starting from the left of the above figure; The website; Mobiles Apps and Apis e.g. Carpool, Scheduling, Games, Rewarding, Routing and so on.); Advice System uses information, alarms and reminders with all the aggregated data; Mobility Card, it could be virtual or analogic card, which can be used to pay public transport or summarize the rewards or Core-Coins; Analysis and predictor system, that takes into account location, the time and the mode of transport, and finally, the e-Core Data Bases, are one of the main products because of its relevance to give feedback to Data Providers to improve the system and because of the crucial contents of the data bases' essence.

Within the sixth stage are setting the main **Outputs** of the CAMP-sUmp e-Core There are differentiated by the main fifth transport modes belonging of the aggregated data bases and mobility options.

The system will produce specific outputs for each commute or trip selection as well as outputs that will be always available without depending on the selection of transport modes.

- **Bicycle and Public Bicycle**: The system should inform users about free parking spaces, night parking services, repairing area and first aid kits (around the campus area), shower and locker facilities, (location and availability), renting service, (university renting system) app tips (e.g. where and how to lock safely, how to change a wheel and so on), bike points, workshop and second hand shop (the campus should count on related bike facilities to promote cycling as a convenient transport choice, as Bike provide both useful services and information, as well as bicycle renting, tool borrowing, and finally, the system and application should therefore offer and promote these services). training, thematic days, competitions (e.g. The system should inform the user about specific dates or events, bike competitions, trainings, etc.,). discounts (e.g. free breakfast at university, sport material discounts, discounts in the second-hand bike point, etc.,). medical contact, bike commuters should have direct contact with their university medical services (for example physiotherapists or sport's coaches linked with e.g. The sports campus and its professionals). On route information, there are specific devices to follow without risk (in the case of bicycles or other active and fast modes) the indications to find the destination. The app could be linked and synchronized with them. Incidents and black spots, the system should inform of this type of information, sometimes changing info and sometimes static data (black spots). Incentives, the bike users can find

specific incentives, as for example, wheel discounts.

Some specific outputs are needed for the public bike users, who need to know the real time data related available bicycles, spaces and stations to go to/from/inside the campus and the fares of the service and their location.

- **Walking:** users who commute or visit the Campus on foot might need information related to shower and locker services, some app tips, e.g. related health questions, the suitable footwear, etc. discounts, as well as cyclists, e.g. in sports material, free or priority in some services. medical contact, with physiotherapists, chiropodists and so on. And incentives, the walkers can haven a specific reward or incentive system integrated into the general one.
- **Transport Operator Choice:** people who commute or choose the transport operator services should know the information related to schedules, lines and stops (location, timetables), frequencies, fares (different kinds of transport cards, tickets, options), discounts, users should have a section where they can find students and other tyoes of discounts. Real and on time information, alerts and on-route information systems, e-paying and e-ticketing integrated information, number of passengers in each mode of transport, information about QR, NFC or other technologies which are significant for integrating and providing information to the end users. Also, training, thematic days and competitions related to these transport modes and companies, with the objective to involve and inform their users. (e.g. bus day, metro campaigns). Finally, transport users can have a specific incentive, rankings and reward system.
- **University Carpool System**: The ID users of the Carpool should know the starting and ending points, departure time, and user profile if the user is a student or employee available seats, cost per seat, type of available vehicles, luggage (allowed by the owners and carried by the passengers), periodicity (if the passenger or owner want to share its regular trips), the owners should also know the total parking spaces and available parking spaces for carpool users, seats booked, parking fares for users who share their car, training, thematic days and campaigns, e.g. culture day exchange at carpool. The users should be able to access the booking and cancel system, the routes rating option, which allow the users to rate their trip, vehicle, owner or passengers. Linked to the carpool system users can have and specific incentives program, where they can find discounts, share punctuations and so on.
- **Private Vehicle** (car and motorbike): the users of these private and non-clean vehicles should get access to information through the APP or Website related to: park & ride infrastructures and benefits, last mile options, total parking spaces, available spaces, car plate restriction (if the University has this policy), parking fares, on-route

information, information of existing efficient driving and road safety training, reducing CO2 emissions and incidents, outputs about limited access of private cars within/around university areas if the university has this policy. An important aspect is sustainable mobility awareness campaigns, this target of users' needs to be informed and change their changes. Also, e-charge points, for clean drivers, clean and e-vehicles benefits and discounts, information related to the electric vehicle fleet for rent, if the university has one for their staff, students or visitors. Then, the **Incentive and Rewards System** needs to encourage these users to commute by sustainable modes and reducing the use of private vehicles.

The following **Outputs**, that we are going to explain, will always be available to the user upon selecting a specific mode of transport or when the system displays to the end-user all mobility options.

- **Calculation of the route**: Showing the fastest, most sustainable or leisure route.
- **Multimodality:** The system will show the interconnections through the different modes of transport. E.g. the user can choose the less interconnection routes.
- **E-Renting;** the options to share or rent a clean vehicle
- **Competitions:** Develop games and competitions. Using Gamification in order to create different user' levels, since for example the amateur sustainable gamer to the pro categories. It is also well know that making teams also can enhance competitiveness, so that it would be a great idea make sustainable team throughout the university faculties or departments.
- **Health report:** The system will show kilometers walked or cycled, calories burnt per type of exercise, pulses, etc., to improve motivation and knowledge about physical variables. (Awareness)
- **E-learning or teleworking options.** It would be appropriate include the possibilities of the users to work or study without being physically at their universities.
- **CO2 emissions saved:** the system will report information about the CO2 emissions regarding the user's commute data. (Awareness)
- **Duration** will indicate the duration of each of the proposed routes. It can include a statistics of time saved on traffic jams and so on.
- **Money:** the system will indicate the money costs of each proposed route. And the saved money because of sustainable mode choices.
- **E-payment and integrated ticketing:** The system will allow buying or managing the trips related to the different modes of transports.
- **Universal accessibility:** The e-Core System must provide the necessary

information related to accessibility services and facilities.

- **Incidents:** The system should integrate all type of incidents acquired through the providers and show it as an output.
- **Suggestions service**: This output is reserved for users' opinion and feedback contributing with the improvement of the system.
- **Rating:** The system should have an output for the rating (by the user) of each proposed route. This rate will provide an input to the system as well to consider and maybe reorganize its proposals.
- **Incentives:** the incentives related to sustainable commute will appear as an output to the user, where they can look up their points, discounts, rewards and other university benefits. It is also linked with Gamification developments (e.g. sports center discounts, free breakfast or lunch, priority bike parking, priority in library services and so on.)
- **Statistics and Graphics:** it is useful to enhance and engage people providing personal progress reports with an overview provided by statistics or cluster graphics.
- **Related links:** it is important to create community and awareness so that sustainable mobility related topics can be included in a specific section within the App.
- **Do you want to make us a sustainable proposal?** The user should have an area where participate and make their own contributions, developing related forums, etc.,
- **Professional network and Employment Opportunities**, the University could develop their own professional network with a multidisciplinary approach, creating employment exchanges, agreements of professional practices and including research works or PhD programs.
- **Legal and privacy** aspects must be always available to the end user.
- **Linked with personal social media** to share their results, competitions, levels, progresses and so on.
- **Feedback inputs:** The end user must provide the system with descriptions of incidents, pictures or another audiovisual material including their user experience. Some parameters should be provided by the e-Core system to make easier this input processes (e.g. traffic jam, black spot, unsafety area and so on. Also, providing feedback concerning the app, devices or e-Core website).
- **Events, Weather, Maps among others.**

In the following two pages the reader will find the figures 3 and 4. Two examples of how the CAMP-sUmp e-Core website or the APP 'dashboard could be designed. Figure 3, is an infographic including the above and other available information sources and services. Besides this, the figure 4, shows a general design of the App, including its tagline "Open your e-Core towards sustainable mobility".

Figure 3.Example of e-Core Website or App' dashboard.

Figure 4. Example of CAMP-sUmp e-Core App, Logo, Tagline and general design.

5.3. Implementation and Assessment of the CAMP-sUmp e-Core System

The different Action Plans (D3.4.1 & D3.4.2) of the CAMP-sUmp project, comprised a strategic plan to carry out a Sustainable Mobility Plan at Universities. Within this section, the strategic view of those Plans is adapted in order to give the reader a general example of how implementing and assessing the CAMP-sUmp e-Core System. Due to the idiosyncrasy related the different resources and needs of each University it is not reachable to define the time or budget needed to implement the e-Core System, so that, this section allows the reader to estimate the overall steps and actions before and while implementing the e-Core.

Establishing a well-connected system of sustainable mobility at universities will take time, effort, resources, technology and people which must be located in their precise position.

This Action Plan of the CAMP-sUmp e-Core is organized into four main phases namely; Study, Plan, Do and Check-Act.

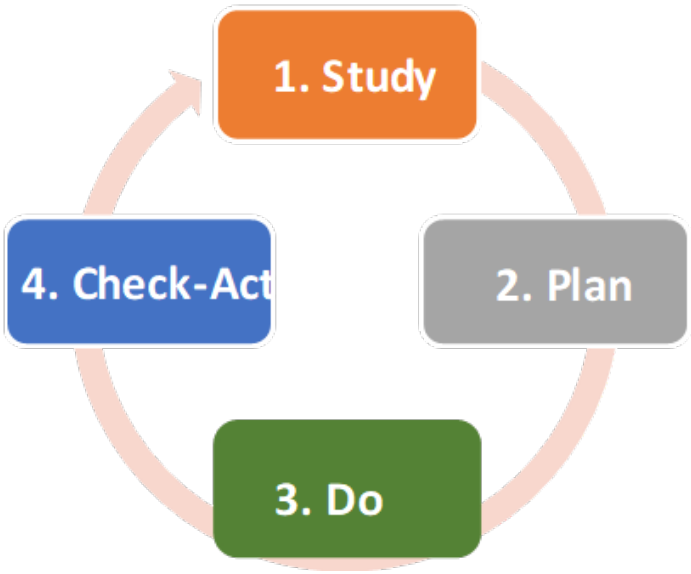


Figure 5. General Scheme of the CAMP-sUmp Action Plans,

1. Study

1.1 State of the Art. It will be analyzed information related ICTs at University, European context, Projects, Platforms and Applications addressing sustainable mobility and its main areas.[6]

1.1.1 Digital Society, Including technology trends, Web Access through mobile devices, Adoption rate on mobile devices and Paperless payment and e-commerce.

1.1.2 Sharing Mobility and Sharing Economy Acceptance and take up, Behavioral aspects of users Profile of the user, Behavioral analysis

1.2. SWOT analysis will help to know the reality of each context before facing an ICTs integrated system to support sustainable mobility.[7]

1.3 Funding and Resources, looking for opportunities. (at regional, European level and within international networks for example open data networks.)

2. Plan implementation of the CAMP-sUmp e-Core System

2.1 Stakeholders, the University must identify who could collaborate with the implementation of the e-Core. The University must classify these stakeholders.

2.2 Technical and Human resources, describe the availability of the resources, trying to include the students, researchers and institutes within the University that are experts on computational, environmental sciences, marketing, psychology, telecommunications and so forth. Human Resources

2.3 Specifying the Budget needed.

2.4 Definition of Goals, KPIs, Actions, Priorities, etc. Once goals are defined, corresponding KPIs (Key Performance Indicators) are selected in order to monitor and evaluate the plan's effectiveness, finally, the actions will be defined in order to give concrete measures to the plan.

[6] This report offers the reader a wide catalogue of the main information to support the establishment of this State of the Art.
[7] Within this report the reader can find a SWOT analysis developed by the seven Universities which are part of the CAMP-sUmp project.
Deliverable D3.5.2 – ICT Tools, models and requirements for communication between different actors and planning instruments

3. DO: Implementation of Planned ICTs Solutions

3.2 Defining the roles and responsibilities of the university, users, mobility managers, authorities, data providers and so on. Likewise, the system should support the connection and coordination between them.

3.3 Defining the Time Plan for the implementation of the system (of the entire structure or else of the specific nodes).

3.3 e-Core monitoring and engagement. Community communication activities must be defined and then assessed along the system with proper feedbacks loops (preferable within the e-Core) to monitor and evaluate the implemented actions as for example a specific feature in order to understand the end user's acceptance and usage. Also named Quality of System. (QoS) that could be disaggregated within different sections e.g. Safety' scores, Accessibility' Scores. There are at least, five different sources of feedback's namely: end users; universities, transport operators a/o other companies, city council or public authorities and lastly from the e-Core system itself. [8] Finally, incentives system, engagement actions and gamification should be included along the entire system.

4. Check-Act

4.1 Evaluation of CAMP-sUmp e-Core KPIs. Considering quantitative and qualitative approaches. The aim of this section is to assess the ongoing system to check if the system's pre-set objectives are going to be achieved or if there are some potential gaps.

4.2 Deviation causes' explanation.

4.3 Corrective Actions. Including the identification of drawbacks and weaknesses, defining and prioritizing future actions, implementation of improvements, feedback looping for further advances. The goal is to obtain a continuous' improvement system.

4.4 Dissemination of Results, Solutions the dissemination of the achieved results. Aim of this section is to suggest a procedure to be followed to maximize the impact of the implemented action aimed at a sustainable university mobility. **4.5 To ensure commitment** of stakeholders, data providers, institutions and users. On the other hand, amplify and create new agreements as well, to keep the process living and continuously evolving.

[8] Within the Roadmap of the project (D.3.5.1) the reader can find a specific communication Roadmap and Social Media proposal to disseminate the CAMP-sUmp at Universities.

5.4 Institutional principles for CAMP-sUmp e-Core system's specifications

The adoption of specifications, the issuing of mandates for standards and the selection and deployment of ICT framework and services within each University will be based upon an evaluation of mobility needs involving all relevant stakeholders and decision makers. But we should not forget all those and other crucial decisions could be guided by their own institution's mission, values and vision.

Besides this idiosyncrasy, within this proposal it could be reasonable to list the following principles stemmed from the Guides to develop and Intelligent transport system of the European Union, adapted to the implementation of the CAMP-sUmp e-Core System at Universities.

Table 4. Institutional Principles for Specifications

Principles for Specifications	*Brief description*
Be effective	Making a tangible contribution towards solving the key challenges affecting Campus mobility (e.g. reducing congestion, lowering of emissions, attaining higher levels of safety and security including vulnerable road users).
Be cost-efficient	To optimize the ratio of costs in relation to output regarding meeting objectives.
Be proportionate	Providing appropriate, for different levels of achievable service quality and deployment, considering the local, regional, national and European specificities.
Deliver interoperability	Ensuring that the system and the underlying processes have the capacity to exchange data and to share information and knowledge to enable effective service delivery.
Digital inclusion	This is made possible through some of the activities supported by the European Commission to make ICT more accessible for all and fostering new methodologies for technology development.
Ethical issues	Must follow private and safety EU standards.

Facilitate inter-modality	Consider the coordination of various modes of transport, when deploying an ICT system.
Integrated	A well-connected system of systems must enabling users to easily move from point A to point B regardless of mode, service provider, etc.
Massively Networked	Ubiquitous connectivity throughout the transportation system between vehicles (V2V), between vehicles and their surrounding infrastructure (V2I), and between transportation systems and their users
Promote equality of access	Do not impede or discriminate against access to e-Core outputs neither e-Core applications and services by vulnerable users.
Public-Private collaboration	ICT system towards improving Sustainable Mobility needs will be met by an increasingly diverse ecosystem of public, private and nonprofit entities among other Stakeholders.
Respect the existing national infrastructure and network characteristics	Considering the inherent differences concerning the mobility and transport network characteristics.
Support backward compatibility	To ensure the capability for the e-Core systems to work with existing structures that share a common purpose, without hindering the development of new technologies.
Support maturity	Demonstrating, after appropriate risk assessment, the robustness of innovative e-Core system, through a sufficient level of technical development and operational exploitation.

6. SWOT analysis of the CAMP-sUmp e-Core System

In this section every partner of the Camp-sUmp Project has contributed with a SWOT analysis, related to the situation of their own University. This section has the aim of bringing the reader the current situations and contexts of each campus while they study how to improve sustainable mobility through ICT solutions.

SWOT analysis is appropriate for the strategic analysis of the mobility system and can lead to a realistic design and implementation of CAMP-sUmp e-Core System by allowing all the different aspects to be identified with respect to the objectives to be achieved, and by allowing decision makers to identify the most suitable measures for the local situation.

The SWOT analysis can assess the strengths, weaknesses, opportunities and threats of each measure and provide valuable information related to mobility and ICT at the University. It may also identify the potential opportunities and threats (internal or external) to the implementation of the ICT solutions. The SWOT analysis can also provide useful support information for the University to adopt a specific solution by overcoming specific barriers (i.e. need of support infrastructures, etc.).

Another inherent objective of this section, is to show within the comparison between Universities if the weaknesses or strengths are identical or totally different in the Mediterranean campuses and if the opportunities and threats share similarities or they differ depending on the location, country, characteristics of the campuses and so on.

6.1 University of Catanzaro

Table 5. Summary of responses related to the campus mobility of the University of Catanzaro

Strengths	• Both the public road transport operator and the rail services provider have their own ICT application; • Favorable attitude expressed by the University's Authorities; • Familiarity that all the potential users of the transport system to access the University (or in any case their large majority) have with information and communication technologies;
Weaknesses	• Organizational barriers, e.g. the lack of a mobility manager office with dedicated human, material and financial resources; • Lack of internal competencies and skills in engineering;
Opportunities	• The backbone of the public transport system for accessing the University is made by only two public operators: the provider of rail transport services and the public company operating the urban road transport services of the city of Catanzaro; • All the public transport services of Calabria Region are geocoded; • Integration of information on the Campus accessibility system with that concerned with mobility inside the Campus (even within the buildings), with particular attention to the mobility needs of disabled people. • The possibility of finding the financial resources necessary for the development of the ICT application through the participation in European territorial cooperation projects;
Threats	• Transport operators do not seem to cooperate in synergy in order to improve the mobility system. • Lack of political will supporting the creation of an market for travel information.

6.2 National Technical University of Athens

Table 6. Summary of responses related to the campus mobility of the NTUA University.

Strengths	• An easy to use Application for mobile phones/tablets • Includes all mobility levels (strategic, tactical, operational) • Multimodal travel planning • Cost/time-oriented solutions • Improves traffic from/to and inside the campus • Compatible with maps
Weaknesses	• Lack of existing similar e-mobility systems • Free to students/employees • Lack of an updated university mobility plan • Lack of a mobility office
Opportunities	• Exploitation of technology for mobility issues • Awareness of students and employees • Enhance campus to be more accessible • Increase of commuter's awareness on more environmentally friendly modes of transport • Participation of private sector
Threats	• Greek Legislation that makes it difficult to implement changes • Time-consuming procedure • Difficulties to collect data from different data providers • Financial and investment problems due to financial recession • Security/safety problems should be solved

6.3 University of Malta

Table 7. Summary of responses related to the campus mobility of the University of Malta.

Strengths	• Pre-existing software applications such as 'Vjagg', 'Tallinja App' and the KSU's (Student union) Carpooling app, may be integrated within the system to facilitate the collection of user travel behaviour data. • The previous deployment of Travel data apps with UOM students (such as 'Vjagg', KSU Carpooling app and 'Tallinja App') may provide guidance on how travel data applications should be presented to the niche end user of UOM students and staff • The existence of an operational mobility plan (GTP) May provide information on the best ways to integrate the e-core system • The Faculty of ICT at UOM may provide valuable consultation and support during the primary integration phases • The existence of a Mobility office/mobility management entity (GTP coordinator within the Institute for Climate Change and Sustainable Development) may facilitate the integration of the E-core system • The small size of the UoM campus can be a strength in itself for the e-core system to be more widely used by students and staff. It can be promoted in an easier manner when compared to larger universities • The application's ability to plan multimodal trips would reflect well on the multimodal population of UOM students (UOM student multimodality indicated through CAMP-sUmp survey) • The availability of information on-demand may encourage students to use alternative transport modes other than the private car. • Opportunities of EU funding towards sustainable development may facilitate the integration of the system • Compatibility with other mobility apps (Google Maps, Maps.me, open street map etc. may improve the E-core system's popularity among users of these map based apps. • The provision of economic incentives for the use of alternative transport, may allow for increased popularity with students • The end user (students mostly, less within staff) responds well to incentives and is technologically affluent, ready to adapt to change. The public want for change is fuelled by the local transport problem. • One single major public transport operator exists on the island; therefore any dialogue with PT service providers

	would require input of a single entity and not multiple, thus streamlining the process to achieving a functioning e-core system • Most university services are already listed on a single platform (UM IT Account Services) and therefore transportation apps or otherwise could easily be integrated into this student ID system. • Financing of incentives has the added advantage of the Maltese government being the majority shareholder of the university.
Weaknesses	• Financial capital required for project start-up may be an issue for smaller universities. • In the case of UOM, garnering funding for the e-core system implementation would require long bureaucratic procedures to obtain funds from government entities and authorities overseeing university activities. • Certain user information (such as luggage being carried, number of free seats available in vehicle etc.) will be dependent on user input- thus solely relying on a limited response rate. • Elements dependent on voluntary user input might result in low response rates, thus leading to redundancy. • Voluntary user input also raises the question of whether the information inputted is actually factual. • The pressing issue of soft-mode inaccessibility at UOM may ultimately be too strong a barrier for the E-core system to make any significant changes in mobility • Lack of existing supporting infrastructure for e-core system to be real-time including: Public Transport operators not in a position to provide real-time data, departure and arrival times, etc... This results in reliability of Public Transport becoming a significant issue (Refer to CAMP-sUmp results Q2.2.1.4 where 80% of respondents raised this issue) • Real-time data on traffic situation not presently possible due to lack of ITS infrastructure on a National scale (National Transport Control Centre has been in the pipeline for the last 12yrs) • Lack of SMART Infrastructure at UOM which leads to poor parking management, emmissions, energy consumptions, etc. Might be strong barriers limiting the effectivness of the e-core system.
Opportunities	• Can be a strong and innovative tool for further awareness dissemination on the benefits of sustainable mobility decisions and the risks of doing otherwise.

	• The reduction in car-use as a result of the E-core system and joint efforts may have a large impact on the quality of life at UOM as well as its surrounding neighbourhoods. • If successfully employed within the UOM, it may have a spill-over effect onto governmental facilities and office complexes further expanding the outreach of the sustainable mobility movement. • Data collected from end-users may be utilised to improve and address the notorious issues relating to the Maltese public transport situation (especially relating to issues with peak-overcrowding and bus schedules) • Increased effort than previous attempts at UOM in providing worthwhile rewards for the use of Mobility Apps may be carried out to entice the less than enthusiastic student population. • The need for the management of large amounts of data may require the assistance of third party providers/private sector. This has the potential to create further employment and development opportunities within the field of transport management. • If through the efforts of the e-core platform the benefits of sustainable mobility are made tangeable (e.g. CO2 reduction, time savings, lowered trip cost etc.), it will be easier for the University to implement new schemes such as teleworking, flexible hours etc. • Use of the e-core platform could facilitate the use and integration of car sharing inititatives (Car2Go has signed an MoU with the Maltese Governement, national network to be in place by 2020) • Having data related to trips distance, duration, costs, locations, on a single platform managed by the university would create a highway of information allowing the decision maker to better justify and introduce SUMP measures affecting campus
Threats	• The need for a Data Management centre to consolidate travel behaviour data requires technologically qualified manpower. The need for third party operators might be required and thus issues of feasibility, profitability and user charging may become a possibility • The integration of multiple commercial service providers (Malta Taxis, Taxify, NextBike etc.) as well as governmental institutions (NSO, Transport Malta, Malta Public Transport/Autobus De Leon etc.) may be a difficult task due to the fragmentation between entities and their potential conflicting/diverging interests • Knowledge Sharing between entities: Transport Operator, Decision Makers, Shareholders is relatively poor in Malta

	• Older generations (staff and mature students) may see the use of mobility applications as a time-consuming and complicated task. They might not foresee its benefit as a sustainable mobility tool. More so, some people may not have the skill to use the technological app too. • If integration within UOM community is not effectively managed and advertised (through PR) it might be labelled as yet another app, creating the risk of falling through the cracks just like the large number of start-ups, indie and corproate apps intoduced to the UOM communityh in the last 10 years or so. Without integration, it will most likely fail. • Another threat is the strong car-dependent culture in Malta. (Uncontrolled vehicular ownership levels, now highest in Europe [excluding San Marino] and comparable to large sprawling US Cities). The advertisement and promotion of the system needs to be very strong and well planned in order to try and create a shift in culture • The background collection of personal data through applications may be perceived as a threat to data protection rights. Insurance protocols should be put in place to ascertain the security of personal data collected to prevent its use by third-party commercial service providers. • The integration of data collected by different service providers may cause inconsistencies within information collected due to different data collection techniques, applications and procedures. Issues relating to lack of communication and bureaucratic procedures rampant within local governmental institutions may also be a threat to the efficiency of the system. • The provision of free parking at UM may inhibit users from experimenting with different modes of transport.

6.4 University of Valencia

Table 8. Summary of responses related to the campus mobility of the University of Valencia.

Strengths	• UV has a University Application with schedules, main options, directory of buildings among other features. • Transport operators with open data systems • Sustainable Awareness within University community and within the entire city • Government of Valencia actively involved in sustainable mobility • The University have expert personnel to develop applications, UV have degrees in computer science, as well as a technology park or the robotics institute. • The University has enough students and resources to launch competitions for the development of applications • It has computers powerful enough to aggregate the information into their computer center. • Public transport communication concerning the campus inside the city is a very good service. • They have improved a lot the bike lanes in Valencia
Weaknesses	• Financial issues • The information and skills are not clear, there is no specific figure or department that deals with sustainable mobility in a unique way • There is no a specific working group to enhance sustainable mobility • There is no a specific sustainable mobility department or a figure with the power to decide, centralize and bring together the departments that could participate to develop the system. • It was necessary to contract external companies to do a mobility study • Information on mobility is scattered among different web pages of the University and it can be difficult to access it • A strong investment in public transport is necessary • The maintenance and attention of the system can be a problem; it would be necessary to create a multi-disciplinary department dedicated exclusively to work on it.

Opportunities	• European funding for pilots or implementing ICT to enhance sustainable mobility • Active Policies and measure to improve sustainable mobility in our City • UV has an Environment Unit that could centralize the system information • Good relationship with transport operators • Agreements with Public Transport operators • The University of Valencia has a sufficient number of students and staff to carry out and manage a car sharing application. • Facilitation of creating a sustainable community • The city council proactive involvement • The University has a free cost (to drivers) wide parking area that would allow us to obtain financial resources to invest in the mobility application if they determine a parking fares • Many events in the city of Valencia addressing sustainable mobility • The continuous development of IoE • A mobility study is going to be carried out during this year
Threats	• Engage people • Connect university managers • Lack of communication between departments that have sufficient skills to develop the system • Lack of agreements, negotiation • Lack of knowledge of the UV capacities • Governance issues • The staff of the UV is not aware enough. Need for awareness campaigns addressed to the different users. • It is difficult to manage the mobility of 65,000 people. • Many students and staff come from outside the urban areas • Achieve Standardization towards Med Area • The multidisciplinary approach of this system (including the entire community • The lack of UV success experience working through different departments, institutes or even individual profiles within the University context. • Strong network in Valencia concerning sustainability, but not within the University. It should be actively involved in these networks

6.5 University of Split

Table 9. Summary of responses related to the campus mobility of the University of Split

Strengths	• Campus land area is rather small compared to the majority of other campuses in MED cities, thus enabling higher mobility and in the same time demanding less specific measures dedicated to solve special mobility issues for achieving better and sustainable mobility, i.e. special solutions for disabled persons, for placing e-charge points etc; • Several public city bus stations around Campus area perimeter; • University decision makers awareness for benefits of implementation of e-Core System for Campus mobility; • High level of ability of students and Campus professionals to use various ICT tools; • High interest of the participants in saving time and money when arriving, leaving and communicate within Campus area.
Weaknesses	• Absence or incompleteness of road, pedestrian and parking infrastructure which are the basic precondition for e-mobility system implementation; • Insufficient availability of ICT platforms and applications related with general mobility including bus information system; • Low level of integration between University and faculties, as they are different legal entities; • Public passenger transportation modes are limited only to buses; • Transportation and related infrastructure within Campus is reduced only to personal cars; • The absence of bike infrastructure network within the city of Split or Campus; • University ID cards purpose is limited only for food and public city bus discounts; • Free Wi-Fi is available only for students and faculty professionals in faculty buildings and not in whole Campus area.

Opportunities	• Carpooling applications become more and more interesting between potential users; • Introducing bike related programs will contribute to University attractiveness for students and professors; • Reduction of traffic congestion and pollution improves working and living conditions in Campus and brings benefits to overall health and pleasure of Campus community; • University ID for obtaining discounts could be easily used for public transportation as well as for other means of transport i.e. city bikes, carpooling, etc. • Google Maps APIs use will improve University website to provide indoor map for better effectiveness of users in searching directions within Campus; • Measures taken to improve mobility inside the Campus present good practice and can be scaled up and implemented in the entire city of Split to improve its sustainable mobility; • Further accelerated development of innovative and useable ICT tools, internet and mobile applications motivates students, professors and citizens to learn and accept new knowledge in order to embrace and use it for their own benefits.
Threats	• Scarce data available related to urban and campus mobility; • Weak organizational integration between University and faculties as well as with other consistent parts of University (i.e. dormitory); • Questionable motivation of data providers and Campus community to collect and share information and data.

6.6 University of Cyprus

Table 10. Summary of responses related to the campus mobility of the University of Cyprus

Strengths	• The application availability will encourage University members to use alternative modes of transport • The small size of the University of Cyprus campus is ideal for the implementation of the e-Core application • The incentives offered make the application more attractive within the University community • Public transport in Cyprus is consisted of only bus services making the implementation of the application easier
Weaknesses	• Poor cooperation between University, Governmental Bodies and transport Operators • Risk of the application not being supported by the University and eventually being redundant • Voluntary input could not reflect reality
Opportunities	• The system would be an innovative tool for the University of Cyprus • If successfully employed, it can be proposed for implementation by other universities of the island, or other governmental bodies • The already existing car-sharing scheme of the University of Cyprus can be integrated within the system • The data collected through the system could be used by the University for enhancing its mobility strategies, as well as other governmental bodies
Threats	• Lack of funds for the implementation of the system • Lack of willingness for stakeholder engagement • Lack of sufficient data from public transport operators vital for the implementation of the system • Risk of the car-oriented society of the University of Cyprus not recognizing the benefits of the system • The provision of free parking at the University Campus does not create the need for students and staff to use softer modes of transport

6.7 University of Bologna

Table 11. Summary of expert responses related to the campus mobility of the University of Bologna

Strengths	• Maximize the adoption rate by university members • Digitalization of the tools which offer mobility solutions. • Endorsement of the European Commission increase the project reputation. • Reduce the CO2 emission of the University. • Increase the air quality inside the campuses.
Weaknesses	• Technical integration between the proposed ICT tools with the existing ones. • Competition between the organization which support the developed tools with the organization which support the tools currently used. • Lack to resources to be invested to ensure the awareness of the developed ICT tools between the University members.
Opportunities	• Provide an unique ICT tools related to all the mobility services provided to the University members. • Foster the concept of "mobility as a service" in the university communities. • Facilitate the development of related ICT tools for university mobility to be integrated to the developed one. • Support sustainable mobility solutions for the university members.
Threats	• Low adoption rate by the university members, especially the oldest. • Fear of espionage or threats to the user privacy. • Obsolete tools due to limited resources for maintenance and updates. • Limited changes to the current mobility habits of the university members.

7. Conclusions

Within this deliverable, the wide catalogue of ICT notions, links, Swots analysis, settings and solutions, figures and tables among others, has no other major purpose than to serve as a guidance report to support the development of innovative sustainable transport approaches. And helping those responsible of the related Campus policies, to understand the variety of actions and phases to achieve a successful sustainable mobility system at MED universities.

Campuses are a good example of a 'people's place' as Engwicht, 1993 said. There are places where exist a community of people with different backgrounds and attitudes. At universities people come together to live, study, move, work, research, and last but not least to construct their social, affective or friendship network.

Nowadays, and specifically in this project, we have a great opportunity, since Universities are considered perfect places to experience with new approaches of sustainability and to transfer them. Specifically, concerning mobility matters it is widely believed that trends in campuses can compare to those experienced by the entire society. Also, campuses can help society to decide where to look at and what to consider. (Balsas, 2003, Colonna, 2009).

Besides this, there is another decisive issue, students do not have as many options to access to private and motorized vehicles, because of their age and because of their economic situation. Added to this, they are more open-minded related to habit' changes and innovations, as well as to commuting healthier. So that, it is a great chance because they can easily achieve the awareness related to sustainable mobility and be critical with the current and future transport modes choices, taking a more critical point of view regarding transport and energy policies. However, most of the ICT mobility trends of the information society, are not exploiting this potential (Som, et al., 2004; Hilty, et al., 2006). Most of the times the technology or specific tool exists but it is not used or disseminated enough to achieve the sustainable purposes.

To end, there is evidence that new technologies can increase sustainable and inclusive mobility choices. As well as ICT can encourage people, creating commitment, facilitating communication and evolving towards people' needs. As for example demonstrate the progress of the concept *Mobility as a Service* (MaaS), nowadays commonly known *Mobility as a Right* (MaaR). So that, yes, ICT systems along with MED universities can also contribute with new mobility behaviors, turning these new solutions into reality, turning them into people's rights supporting a fairer and more inclusive society.

"You cannot get through a single day without having an impact on the world around you. What you do makes a difference, and you have to decide what kind of difference you want to make". Jane Goodall.

Annex

Annex 1. Technical Resources

This annex aims to bring closer the reader to the nomenclature of some technical issues, meanwhile it is a top-level proposal, it could be interesting to read some of these concepts before facing or planning to implement an integrated system to address sustainable mobility, especially if the person is not an expert in new information and communication technologies.

Firstly, the mathematical technique most commonly applied to strategic mobility planning is linear programming as well as for network optimization and mixed programming. This technique is extended to include decisions on the location of new facilities, acquisition of clean vehicles fleet, resources and implementation of mobility strategies.

On the other hand, operational level applications use mostly heuristic algorithms. These algorithms can find a near-optimum solution for complex and multi-parameter problems in a short time. Today, the advanced computer programming languages and the powerful hardware supports the use of these algorithms in advanced planning and software systems.

Name	Brief description
DAQ	Data Acquisition, typically convert analogical waveforms into digital values for processing. The components of data acquisition systems include: • Sensors, to convert physical parameters to electrical signals. • Signal conditioning circuitry, to convert sensor signals into a form that can be converted to digital values. • Analog-to-digital converters, to convert conditioned sensor signals to digital values.
Data collection	All data gathered concerning process mapping, constraints, empirical optimisation rules, and the information systems infrastructure. For example, Database marketing uses data from users to generate personalized communications and promote services among them, it emphasizes the use of statistical techniques to develop models of customer behaviour.
Decision support system (DSS)	Has emerged as a computer-based approach to assist decision makers in order to address semi-structured problems by allowing them to access and use data and analytic models. Such a system does not replace the

	decision-maker. It supports the decisions where part of the analysis can be systematised for the computer, so that the decision makers' insight and judgement are improved. The selected software applications should be integrated in order to support the decision support system.
Demand-responsive transport services (DRTS)	It pprovides a mechanism whereby passengers can be picked up and dropped off at their chosen locations, at a price usually associated with fixed route bus services.
Distribution Management System (DMS)	Collection of applications designed to monitor & control the entire distribution network efficiently and reliably. It acts as a decision support system to assist the control room and field operating personnel with the monitoring and control. DMSs access real-time data and provide all information on a single console at the control center in an integrated manner.
Dynamic reconfiguration	Components may switch on vs off, enter vs leave.
FAST Flexible Authentication via Secure Tunneling.	a Cisco protocol that establishes a TLS tunnel, and sends usernames and passwords in a custom way inside
Geographic Information System (GIS)	Is a system designed to capture, store, manipulate, analyze, manage, and present spatial or geographic data.
Geolocation	Geolocation is the process of finding, determining and providing the exact location of a computer, networking device or equipment. It enables device location based on geographical coordinates and measurements. Geolocation commonly uses Global Positioning System (GPS) among other technologies.
Geospace data	we need sensors that monitor people and their environments, a network for collecting sensor data (IoT), and data analysis technology that understands and predicts people's intentions, situations, and environment from the collected sensor data. Here, sensors include positioning mechanisms to pinpoint locations, which are important for mobility, in addition to those that monitor biometrics, cameras, and device sensors.
Human Machine Interface (HMI)	Is a component of certain devices that are capable of handling human-machine interactions. The interface consists of hardware and software that allow user inputs

	to be translated as signals for machines that, in turn, provide the required result to the user. The basis of building HMIs largely depends on the understanding of human physical, behavioral and mental capabilities.
Information acquisition (DAQ)	There are a lot of devices to acquire information concerning mobility: mobility sensors, time monitors, incidental detection, automatic vehicle identification, data processing from different sources.
Information distribution	Information distribution remains one of the most challenging aspects of high-speed communications. Within a ICT mobility system, it can be crucial how we disseminate the information.
NFC	NFC stands for "Near Field Communication" and, as the name implies, it enables short range communication between compatible devices. This requires at least one transmitting device, and another to receive the signal. A range of devices can use the NFC standard and will be considered either passive or active.
Real time information	Technologies can provide on real time information and can be dispatched to travelers through the web or through mobile devices. AVM systems are generally interfaced (directly or through other systems like the traffic supervisor) with a special purpose on an information platform: they can deliver information on portals but also on roads mainly via smartphone through a specific app that sometimes also automatically identify the stop through the smart phone GPS or SMS.
Smart Lighting and Intelligent Poles	Saving on actual energy consumed and safety. Wi-Fi technology can be applied on infrastructures to control lighting and install a wide variety of sensors (control cameras, traffic sensors, pollution sensors, etc.).
Software market research.	International software market research is the next procedure in order to examine suitable solutions for distribution management and more specifically automation and optimisation of dispatching processes. System requirements specification. After the completion of the software market research, a list of features of the most specialised software concerning the current problem is deployed.
TDM	Transportation decision making, it can be defined as a package of planning strategies, incentives and

	disincentives, which emphasize alternatives towards sustainable mobility.
TLS	Transport Layer Security is a protocol that authenticates users with certificates.
Transportation Management Systems	Must help to plan and run the transport system efficiently.
Travel Planners/ Multimodal Travel Planners	The optimal travel planner for a Campus should offer: 1) Better modal integration and more sustainability by enabling travellers to select the most suitable combination of transport modes for the journey and could lead to an increase use of public transport, cycling or walking in urban environment. 2) More flexibility in the event of congestion as travellers can received accurate information on alternative routes, allowing better use of existing transport infrastructure. 3) More resilience in the event of major disruptions and should hence, improve mobility continuity.
Traveler information systems	The key characteristic is to assist the traveler with basic information (travel time, routes, traffic conditions, etc.).
Universal Design (UD)	Universal Design is the design and composition of an environment so that it can be accessed, understood and used to the greatest extent possible by all people regardless of their age, size, ability or disability. An environment (or any building, product, or service in that environment) should be designed to meet the needs of all people who wish to use it.
User Relationship Management (URM)	An approach to manage an institution's interaction with current and potential users. It uses data analysis about users' history to improve the system and the relationships and engagement with its users. It is using with Social Media interaction, location-based services, DWH, SaaS, eCommerce among others.
Vehicle-to-infrastructure (V2I)	Applications, which can be generally defined as a wireless cooperative interaction between vehicles and infrastructure, based on systems that can improve safety and traffic management.

Vehicle-to-vehicle (V2V)	Applications, leading to tighter integration among vehicle operations and disclosing a wide range of important transport services to the traveller, in particular concerning safety, mobility and efficient infrastructure use.
Wireless Sensor Network (WSN):	Has been used widely for many applications over the last few years. For these applications, different mobility models were proposed to imitate the movements of real mobility nodes of these networks where mobile nodes change their speed and direction in reasonable time slots. A variety of mobility models have been proposed to model the mobility of nodes of WSNs.

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- European Parking Associations: www.europeanparking.eu
- Google Maps Indoor: www.maps.google.com/help/maps/indoormaps/faqs.html
- WHITE PAPER Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system.
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