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Developing a Sustainable Mobility Action Plan for University Campuses

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Abstract

University campuses are a microcosmos of the urban landscape and an excellent testbed for implementing and evaluating novel mobility policies. However, no scientific contribution has ever aimed to provide a template for university mobility managers to develop an action plan for an efficient and effective sustainable university mobility plan tailored to the needs and characteristics of the campus. Based on the above, the present research has two main objectives. The first is to present the state of the art regarding mobility plans that have been implemented in universities in Europe. The second and core of the overall research is to present a template of an action plan that can be used by universities as a guide for the planning and implementation of a comprehensive mobility plan. The proposed action plan is a strategic guide with a sequence of steps that planners are encouraged to follow in order to create a sustainable university mobility plan. This plan takes into consideration both universities situated within the urban area as well as campuses located outside the city centre. The proposed action plan offers suggestions to satisfy, particularly the needs of students and university staff members considering the technical, economic, social and environmental sustainability of the proposed mobility solutions. Moreover, the action plan considers the fact that a University Campus is embedded into the overarching mobility context that see other end-users of the mobility services sharing with the University's end-user's infrastructures and services.

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1. Introduction

While the need for more sustainable and integrative planning processes as a way of dealing with the complexity of urban mobility has been widely recognized, Sustainable Urban Mobility Plans (SUMP) have become a very important tool in order to define a set of interrelated measures designed to satisfy the mobility needs of cities and people. SUMP are an integrated planning approach that address all modes and forms of transport in cities and their surrounding areas. The objective of a SUMP is to improve the mobility and accessibility of urban areas and to provide high-quality and sustainable modes for mobility and transport to, through and within the examined area. It supports the needs of the 'functioning city' and its hinterland rather than the narrow municipal administrative region (Wefering et al., 2014).

Focusing more narrowly on university campuses, a special characteristic concerns the fact that universities are unique places functioning in specific contexts, many of which as part of larger urban areas (Toley and Green, 1996; Balsas, 2003; Gamberi et al, 2015). Universities populations are characterized by the fact that they represent a cross section of the population from different socio-economic backgrounds and ages, generate irregular schedules and constant movements of people and goods throughout the day. This is even more noticeable in university campuses with daily commuting of the university population, longer distances travelled, and the predominance of private car use over non-motorised means of transport (Miralles-Guasch and Domene, 2010).

Although the concept of a SUMP is a recent one, there are several examples of university campuses that have developed mobility plans, emulating features of the SUMP framework (and guidelines) developed just over a decade ago for cities and urban area. It should however be mentioned that a key parameter which affects the entire mobility system of a campus is its location, that is whether it is based in the city center, in the suburbs or outside the urban area. More specifically, most campuses located to the city centers face mobility problems linked to the city's levels of traffic and congestion, the lack of space for parking, and the space or lack of it, for active modes of transport. However, there are also advantages in terms of accessibility as they are within reach of public transport systems and infrastructures for soft modes (walking, cycling) (Lah et.al. 2015). Recently, there has been a tendency to move Universities outside cities, based on the worldwide trend to establish new or relocate campuses to city outskirts or rural areas, to move away from congested city centers. Such decentralized locations offer advantages, such as additional space for facilities and infrastructure, and an environment of improved quality to members, suitable for research and academic endeavors. Throughout the years, these institutions have been transformed into independent communities with the size, infrastructures, and activity levels of small cities (Tsirimpa et.al. 2015).

Based on the above, the present research has two main objectives. The first is to present the state of the art regarding mobility plans that have been implemented in universities in Europe while the second and core of the overall research is to present a template of an action plan that can be used by universities as a guide for the planning and implementation of a comprehensive mobility plan. In order to achieve these objectives, the paper is structured as follows. In section 2 an extended review on mobility plans that have been already implemented in university campuses is presented followed by an analytical template of the proposed action plan (section 3). In section 4 the temporal framework of the different steps of the action plan is presented. The last section concludes with a discussion and further work.

2. Mobility plans in University Campuses

Several plans and practices in universities have been conducted aiming at enhancing the general quality of mobility around campuses using several strategies and initiatives adapted and inspired by local characteristics and mobility needs.

The municipality of Turin in Italy and its polytechnic university overcame several mobility problems that existed by developing a university mobility plan based on the one adopted by the city. The focus of the university mobility plan was to study and assess the actual transport habits of the university members along with their needs and requirements. This university exploited such information to regulate the cycle paths and car parking areas so as to improve sustainable mobility from and to the university area (Vlahogianni et al., 2018).

A further successful example of integration between the city and university mobility plans is represented by Barcelona. The principal objective of the urban mobility plan was to achieve the implementation of the well-known superblocks. Other secondary objectives were the compliance with European regulatory parameters and environmental quality, the reduction in noise level and number of road accidents as well as the increment of the pedestrian road space.

At university level, for each strategic line of the municipality mobility plan, different actions were identified to be implemented and adopted with focus on sustainable solutions for the university mobility (Miralles-Guasch and Domene, 2010).

University of Malta has had a Green Travel Plan (GTP) in operation since 2010 (Attard et al., 2011). This has contributed to rationalizing certain aspects of parking on campus. In the context of this GTP, numerous awareness-raising activities have taken place regarding the use of Public Transport, cycling or walking to University. There is an interactive web-based bike facilities map for use by students and staff which demonstrates the whereabouts of bicycle racks, shower facilities, drinking water fountains and bike repairing services. The main activity for 2017 was pedestrian awareness which included the creation of pedestrian route maps from different localities and the start of a walking ambassador community. The GTP is steered by a dedicated Manager who relies on a Committee with different experts and stakeholders from within the University Community.

University of Glasgow has been operating a Green Transport Policy since 2006 with objectives that are easily identifiable and in line with the SUMP approach. Some of the objectives of this SUMP include (i) identification, support and promotion of alternatives to single occupancy car travel, (ii) improvement of amenity and access routes around university premises for sustainable travel, and (iii) positively influencing the health and fitness of staff and students by encouraging walking and cycling. This SUMP has been implemented through several Travel Plans (with a current “University of Glasgow Strategic Transport and Travel Plan 2016–2025”). This travel plan provides very interesting insights into travel pattern study methodology. Baseline mobility reviews, and very clear definition of targets (KPIs) are a key component of these plans (Brett, 2016).

The University of Bristol (UK) is situated in several buildings or faculties in the city of Bristol, most of which are within the urban area. This University started adopting green travel policy since 1998, when they started collecting travel data. An important element of their work has been the continuous improvements in the data collection methods and analysis. For example, in 2007 they began weighing the samples according to whether travelers studied or worked in the University on a full time/part time basis. Their current “Combined Staff and Student Travel Plan” covers all locations and both staff and students, focusing on the key transport issues that affect the University’s strategic aims, it amalgamates the previously separate travel plans into a combined staff and student travel plan. Its approach is kindred to the other plans mentioned above, although it is interesting to look at their surveys, which have been refined through the years to successfully monitor the implementation of measures and evolution of behaviour towards transport (University of Bristol, 2014).

The University of La Coruna in Spain operates between two venues (Coruna and Ferrol). This university started a very coherent plan in 2010, with an interesting combined perspective of public space and mobility. The proposals draw up a new mobility model in which the number of trips by private car would be reduced in favour of more sustainable modes. The plan also includes the redesign of public space, the elimination of surface parking and a number of parking spaces. It is a very socially conscious model with a participatory approach in which the overall objectives were decided through a participative methodology with the university community (Papantoniou et al., 2017).

The mobility management project in the University of Milan intended to identify, define and test intervention policies to reduce environmental impacts derived from the mobility of students and staff at the University. The output of the plan was to elaborate and to implement mobility action plans in the various university sites in order to control and to optimize flows and to develop a methodology to approach the mobility management problems (Silva and Ferreira, 2008).

Furthermore, Roma Tre University worked on a sustainable mobility plan in collaboration with the Municipality of Rome and managed to reduce the use of private car in favour of collective transport modes, to offer solutions and sustainable means of mobility such as collective public transport, low environmental impact means such as bicycles or electric motorcycles and the development of an application for car-pooling and car-sharing within the university (Papantoniou et al., 2018).

Finally, the mobility policy of the National Technical University of Athens is guided by the NTUA traffic and mobility study carried out in 1998 and updated in 2003, by the Department of Transportation Planning and Engineering. However, the only measure that has been implemented is a car pooling system for the members of the university campus, with predefined pick up locations aimed to enhance mobility from/to campus, to reduce the number of cars inside the university and to connect the university with major public transport stations. This carpooling system

was established in 2011 but no longer exists due to the lack of supporting ICT solutions and monitoring systems (Vlahogianni et al., 2017).

Based on the above review a key gap that exists concerns the fact that no scientific contribution has ever aimed to provide a template for university mobility managers to develop an action plan for an efficient and effective sustainable university mobility plan tailored to the needs and characteristics of the campus. Furthermore, in the state of the art review of the technical documents examining actions plans, the majority of studies (i) deal with different levels of maturity among cities in terms of SUMP and mobility planning at University level, (ii) have limited accessibility to data and documents (for example local language, reference only to plans, poor level of detail, fragmented information), and lastly (iii) most university mobility plans are limited to provide practical information on available transport solutions from/to campus. In the next chapter, the action plan template is presented including all different steps that are required for the smooth planning and implementation of such a plan.

The preparation of this action plan took place within the framework of the CAMP-sUmp (CAMPus sustainable University mobility plans in MED areas) project, a European research project co-financed by the European Regional Development Fund under the INTERREG MED Programme aiming to improve sustainable urban mobility planning instruments through innovative mobility strategies for students' flows inside the MED Area University Campus and their integration with the urban areas. The overall work took place in the following universities: University of Catanzaro, National Technical University of Athens, University of Malta, University of Valencia, University of Split, University of Cyprus, University of Bologna.

3. Campuses in the MED region

The CAMP-sUmp project allowed for a comparative analysis of a number of MED region campuses in order to identify particular characteristics that would inform the development of an effective action plan for university mobility planners. Before the presentation of the results, a summary table is provided to give an overall picture of the universities and campuses that are involved in the project.

Table 1. CAMP sUmp campuses characteristics

	University	Location	Area (m ²)	Students	Personnel	Mobility From/To campus	Mobility Inside campus	Mobility plan
1	University of Catanzaro	Outside	260.000	11.000	500	Train, Bus, Car, Motorcycle	Car, Motorcycle, Walking	No
2	National Technical University of Athens	Outside	1.000.000	13.500	3.400	Metro, Bus, Car	Bus, Car, Bicycle, Walking	Yes
3	University of Malta	Inside	194.452	11.500	600	Bus, Car, Motorcycle, Bicycle, Walking	Car, Motorcycle, Bicycle, Walking	Yes
4	University of Valencia (1 campus)	Outside	1.000.000	10.000	2.000	Tram, Bus, Car, Bicycle	Tram, Walking	Yes
5	University of Valencia (2 campuses)	Inside	400.000	35.000	5.000	Metro, Bus, Bicycle, Walking	Walking	Yes
6	University of Split	Inside	245.000	24.000	1.500	Ferry, Train, Bus, Car, Motorcycle	Car, Motorcycle, Bicycle, Walking	No
7	University of Cyprus	Outside	1.200.000	7.000	1.100	Bus, Car	Car, Bicycle, Walking	Yes
8	University of Bologna	Outside	6.570.023	85.000	3.000	Train, bus, Car	Bicycle, Walking	Yes

Table 1 includes information for 9 campuses from the seven Universities examined. It should be noted that 4 campuses are located inside the city centers while the rest 5 campuses are located outside urban area indicating a counterbalancing in the analysis.

Furthermore, table 1 indicates that the University with the highest number of students amongst the second in the University of Bologna with 85.000 students while in the second place is the University of Valencia with a total of 45.000 student in all three campuses. Finally, information regarding the current mobility situation from/t and inside the campus as well as regarding the existing mobility plans are presented.

4. Action plan

The proposed draft action plan is a strategic guide with a sequence of steps that planners are encouraged to follow in order to create a sustainable university mobility plan. It should be noted that this plan takes into consideration both universities situated within the urban areas and campuses located outside the city centre. Furthermore, the proposed action plan considers several other features relevant for the definition of an appropriate action plan. The most significant university characteristics considered are: university size, existing transport infrastructures, public transportation services, geographical location and university population openness to sustainable mobility solutions.

The Action Plan template follows four main steps which start with (i) Study, (ii) Plan, (iii) Do, and (iv) Act and Check. Each of the steps then leads to a number of sections which help to define the context, operationalize the development of the plan, implement the measures and monitor (Fig. 1). This section describes all the steps and actions in detail. The proposed template is defined with a circular approach to foster the continuous improvement of the developed Action Plan. Indeed, once the final Act and Check step is completed, the Authors suggest the university mobility manager to proceed with the adoption of a second Action Plan round to further improve the developed sustainable mobility solutions for the university community.

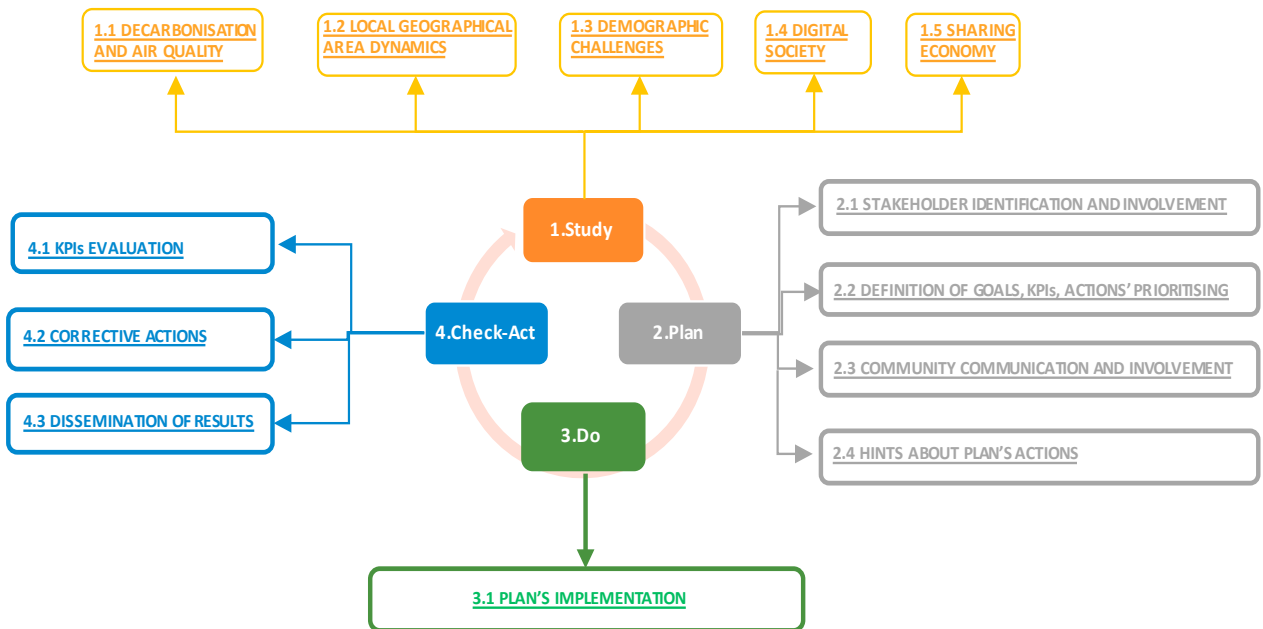


Fig. 1. Proposed Action Plan overview

In the present chapter all the above-mentioned steps including each main activity are presented.

4.1 Study

The first step focuses on the context analysis, a part that is fundamental to understand which are the main features and characteristics of the campus, its situation and its history. It includes the following subsections which are further presented below.

Decarbonization and air quality

The aim is to analyse the overarching European, national and local legislation and regulatory framework and the current policy and operative actions (i.e. experiences and good practices) to mitigate climate change at local level in University Campuses. Following this analysis, the university mobility planner should study the local air quality through a list of preselected KPIs determined during the first phase of the analysis. This concerns primarily the air quality surrounding the University campus areas.

Local geographical area dynamics

As a first step it is important to contextualize the Campus by relating it to the surrounding environment, establishing links to the urban and suburban Master Plans already in place and the suburban development context. Furthermore, the overall plan has to relate with the projected future suburban demographic and residential patterns (related also to zoning and building management) and service/infrastructural dynamics (locations of public transport stations, airports, commercial activities, and so on) should be taken into consideration. Secondly, it is important to determinate which are the University's current dynamics and future projections. Such information about the University's institutional regulations and regulatory local framework, zoning and building management is critical. Finally, the third step of this study is to analyse the public transport offers, and possible future plans, the existing transport infrastructures and others mobility measures already implemented by the universities (car rental services, special tariffs for students, and so on).

Demographic challenges

The demographic context in which the University lies is crucial, both with reference to present and future scenarios. This information would contribute significantly to the understanding of future suburban and territorial development. It is also important to determinate the University's socio-demographical features in order to better adapt University's future mobility measures. The final action aims to understand mobility habits of University's users and workers such as time scheduling and mobility preferences (with a particular focus on multimodal mobility preferences).

Digital society

The objective of this activity is to guide the planner to better understand the impact of technologies on the University Campus's sustainable mobility, in order to integrate its choices with current and future technological trends. The willingness of the university members to use on daily basis mobile applications for transportation purpose is of major importance to lead the future decisions for the development of adoptable mobility solutions. A major driver of this analysis is the population segmentation considering its age.

Sharing economy

Planning of societal trends and suburban mobility scenarios go in parallel with the development of the sharing economy, and specifically on the sharing mobility solutions. For this reason, the objective of this section is to understand the preferences and take up of shared systems, behavioural aspect of the users and the framework for mobility as a service. Upon the behavioral aspect, this analysis should consider the willingness to shared mobility solutions considering the typical user habits while reaching and leaving the campus, e.g. multi-destination route before reaching its house.

4.2 Plan

This section describes mainly the stakeholder's involvement. It is likely that the presence of contrasting interests among different stakeholders will result in long discussions. However, this is what determines the projects acceptance and feasibility. It includes the following subsections which are further described below.

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Stakeholder identification and involvement

The aim of this section is to select and activate the stakeholders in order to involve them into the project. Their participation ensures the whole project effectiveness. In this section the Stakeholders (subdivided in three groups: local authorities and external stakeholders, university authorities, and University community and users) have to be identified. Round table discussions are more suitable for decision-makers, forums are more suitable for both decision-makers and end-users. Finally, interviews, exhibitions, information activities thought media (e.g. web) and alternative form of involvement are suitable only for end-users. It might be highlighted that the kick-off meetings are organised in order to collect stakeholders will, availability, opinions and habits (these two last aspects are more linked to end-users) and to inform them about the intention to create a University sustainable mobility plan.

Definition of goals, KPIs, Action Priorities

At the same time as the analysis of the context and stakeholder engagement, the goals, key performance indicators (KPIs) and Action Plan priorities should be identified. Firstly, goals and targets have to be strategically selected in order to mainstream the plan's process into specific planning choices. Once goals are defined, corresponding KPIs are selected in order to evaluate the plan's effectiveness. KPIs should be measurable, quantitative and comparable to foster as much as possible an objective evaluation of the monitored process. Later, actions are defined in order to give concrete measures to the plan. This phase should involve key stakeholders and consider their needs. Once actions are defined, these have to be prioritised.

Community communication and involvement

This section focuses on end users' community involvement in order to inform and ensure project acceptance and effectiveness before the implementation of the plan. When data from the context is gathered, the mobility planner of the university can value the project's effectiveness and address issues through corrective actions.

Hints about plan's actions

This section gives some guidance about measures, which have to be implemented into the action plan. These SUMP actions should be selected through a participative process and through agreements among all stakeholders in the University. This ensures successful implementation and lessens resistance.

4.3 Do

This step is fundamental for the execution of the project, since it assigns roles and responsibilities to anyone who collaborates with the project and each action is divided in each operative task.

More specifically, this action determines a deadline for each action in order to avoid any postponement and delay. Furthermore, this action assigns roles and responsibilities to anyone who collaborates on the measure and each action is divided in operative tasks. Moreover, communication activities have to be run in order to inform the involved stakeholders. Finally, the plan's future improvements have to be considered in order to improve its effectiveness and potential corrective activities.

The way of proceeding in this step consists of the following activities

- (Relevant to 1st Step) Deadlines: the mobility planner of the university with its collaborators determines a deadline for each action in order to avoid any postponement and delay.
- (Relevant to 2nd Step) roles and responsibilities: the mobility planner of the university with its collaborators assigns roles and responsibilities.
- (Relevant to 3rd Step) operative action and tools definition: each action defined in action 2 Plan of sustainable university mobility is divided in tasks. Moreover, MPUs and its collaborators have to define proper tools,

which have to be used during the project execution in order to ease the implementation of certain actions. ICTs and mobile-based applications represent valuable tools to facilitate the communication amongst the decision makers and the end-users.

- (Relevant to 4th Step) communication: communication activities have to be run in order to inform the involved Stakeholders.
- (Relevant to 4th Step) Finally, future plan improvements have to be considered in order to improve its effectiveness and potential corrective activities.

2.1. 3.3 Check and act

This step gives specific guidelines to the mobility planner of the university for monitoring measures which would have been implemented and reporting on their progress. If the mobility planner of the university finds out some deviation with predicted goals and targets (in others words the plan's impacts) the mobility planner of the university would be in a position to provide suitable corrective actions and maintaining constant communication with the relevant stakeholders. Moreover, in order to promote the diffusion of project results dissemination activities are implemented. It includes the following subsections which are further presented below.

KPIs evaluation

The goal of these actions is the action plan implementation and the assessment of results. KPIs are evaluated by comparing forecasted values with those resulting from the effective implementation of the measures, in order to compare the plan's objectives and obtained results based on technical, economic, social and environmental performances. This paragraph is connected with Section 2.3 Community communication and involvement and 3.1 Plan's implementation. In general, it monitors the implementation of the plan and expected.

The comparison between the current and forecasted KPI values could result in two possible outcomes (i) KPI value within the forecasted range. No gap between the forecasted and project implementation results., or (ii) KPI value outside the forecasted range. Gap between the forecasted and project implementation results. The University mobility planner has to understand the possible deviation causes and develop potential solutions.

If gaps are modest, then the mobility planner and its collaborators continue to monitor with the pre-set modalities, as it is possible that those gaps are due to particular temporary conditions. If on the other hand gaps are strong, then mitigating measures should be implemented. Hence, the mobility planner should analyse the causes and eventually strengthen the monitoring through potential responsibilities of failure to implement measures and revision of measures; potential responsibilities of already implemented activities with some mitigating measures to improve performance. In extreme cases where activities are ineffective, these should be stopped.

Corrective actions

After the evaluation of KPIs, the mobility planner decides the most suitable countermeasure. In order to select the proper corrective action a four-step procedure should be followed:

- Identification of major drawbacks and weaknesses
- Prioritisation of future actions
- Implementation of most relevant corrective actions
- Feedback loop for further improvement

Prioritization step is of major importance since the university mobility planner typically has a limited budget for the implementation of mobility actions, e.g. financial, infrastructure, human and competences resources. Thus, an accurate evaluation of those actions with the highest expected impact – invested resources ratio is of major importance to maximize the efficacy of the implemented corrective actions.

Results dissemination

The last activity of the Action Plan is the dissemination of the achieved results. The aim here is to suggest a procedure that maximises the impact of the actions aimed at sustainable mobility on campus. At the end of the plan's implementation this phase collects the best practices developed during the course of the project. Furthermore, appropriate round tables, seminars and events have to be organized to appropriately communicate to the different

stakeholders the project outcomes most relevant for each of them. Any feedback to the different organizations and people which provided useful input and data for the Action Plan development is strongly encouraged to maximize their engagement in future similar activities

5. Action plan time plan

The Action Plan includes four sequential sections. From a temporal aspect, each section can start immediately after the previous one is finished. This criterion does not apply in the case of the Check & Act section. Table 2 summarizes the approximate duration of each section of the Action Plan and the entire plan. These are indicative estimations which are meant to guide the University mobility planner towards achieving the final plan. As Table 2 shows, the Study section is the most time consuming with an expected duration of 10 months equally distributed between the different activities. The Plan section is distinguished by the remarkable duration of 8 months. Between its activities, the “community communication and involvement” has approximately the duration of the whole plan implementation as it constitutes a monitoring and information activity. The Do action lasts about 4 months, whereas the Check & Act section is comprehensive of the whole duration of the action plan, since the activities involved are highly integrated with different parts of the Action Plan. In total the proposed Action Plan has an estimated duration of about 22 months.

Table 2. Duration of each Section of the Action Plan and their activities.

Section	Activity	Duration
1 - Study societal trends and urban mobility scenario	1.1 Decarbonisation and air quality	1
	1.2 Local geographical area dynamics	3
	1.3 Demographic challenges	2
	1.4 Digital society	2
	1.5 Sharing economy	2
	total	10
2 - Plan of sustainable university mobility	2.1 Stakeholder identification and involvement	2
	2.2 Definition of goals, KPIs, action prioritising	3
	2.3 Community communication and involvement	Approximatively the whole duration of the plan implementation as it constitutes a monitoring and information activity
	2.4 Feedbacks on plan's actions	3
	total	8
3- Implementation of planned solution		total 4
4 - Monitor implemented sustainable university mobility solutions	4.1 KPIs evaluation	Its duration is comprehensive of the whole duration of the plan's implementation.
	4.2 Corrective actions	The duration depends from the monitoring plan. It is strongly dependent from the type of corrective action to plan
	4.3 Dissemination of results	This phase takes the whole plan duration and activities related to stakeholder communication
	total	Its duration is comprehensive of the whole duration of the action plan
ACTION PLAN	Total	22

6. Conclusions

Although Sustainable Urban Mobility Plans are considered useful and important tools to define the necessary set of interrelated measures designed to satisfy the mobility of people, a very important gap in the literature has been identified and consists of the lack of a standardized plan that a university mobility manager can follow to develop an efficient and effective sustainable university mobility plan tailored to the campus' needs and characteristics.

Based on this gap, the present research proposes an Action Plan including a comprehensive methodology, guidelines and tailored studies to simplify the adoption of sustainable urban mobility measures by the decision maker or mobility planners of universities. The proposed action plan is a strategic guide with a sequence of steps that planners are encouraged to follow in order to create a sustainable university mobility plan. This plan takes into consideration both universities situated within the urban area as well as campuses located outside the city centre.

The proposed action plan offers suggestions to satisfy, particularly the needs of students and university staff members considering the technical, economic, social and environmental sustainability of the proposed mobility solutions. Moreover, the action plan considers the fact that a University Campus is embedded into the overarching mobility context that see other end-users of the mobility services sharing with the University's end-user's infrastructures and services.

Further research includes the development of a road map to act as a ready-to-use guide for decision makers who intend to implement a plan for sustainable urban mobility in the University and to apply the appropriate measures. This road map should take into account the steps and tools required and guarantee the commitment of those responsible for the social, economic and environmental sustainability of the plan.

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