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Strategies and Actions towards Sustainability: Encouraging Good ITS Practices in the SUMP Vision

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Abstract. Nowadays, cities are increasingly required to be smart, sustainable, resilient and adaptive and, particularly following the COVID-19 pandemic, an integrated approach to transport planning needs to be adopted. In fact, European policies have adopted a series of limitations in the transport sector that led the scientific community to put into question the traditional transport planning process, by accelerating processes close to sustainability, started some time ago. In fact, many efforts in terms of strategies, initiatives and research have been made in the last decade to enhance new forms of sustainable urban mobility, in order to reduce the externalities associated with the transport sector. To achieve this goal, the European Commission has emphasized the integrated planning at all mobility levels. Among the other instruments, it has been identified a key role in the writing of the Sustainable Urban Mobility Plan (SUMP), its management and also through Intelligent Transport Systems (ITS). Based on this premise, the aim of this paper is to present first results of a wider research aimed at investigating the methodological and practical approaches to boost the strategy of integration between transport systems and urban planning by using ITS technologies and infomobility systems. The research can support further investigations in order to define specific Key Performance Indicators (KPIs) to measure and monitoring the impacts of technologies on developing smart cities and promoting sustainable mobility approaches, facing the urban planning and transport mobility issues of modern society.
Keywords: Sustainable Mobility; Sustainable Urban Mobility Plan; PUMS; Intelligent Transport Systems, COVID-19.

INTRODUCTION

Since the beginning of 2020 following the COVID-19 pandemic, today's cities have had to adapt to emerging demands, becoming even more smart, sustainable and resilient [2,3], and re-inventing traditional urban and transport functions [4]. However, the COVID-19 pandemic has reshaped some processes already started. For instance, the transport sector had major repercussions and others issues were added to the more consolidated problems. Among the latter, it is important to underline that the transport sector generates a series of impacts on the surrounding systems with costs that are not directly perceived by the actors who satisfy their mobility needs, nevertheless representing a serious source of system inefficiencies. The attention towards the identification of these negative externalities has grown over time and takes on even more relevance in a historical period in which poor public resources require a careful evaluation of cost-benefits analysis deriving from planning processes and scheduling policies.

Literature review identifies four main external factors associated with mobility: atmospheric pollution, connected with emissions into the atmosphere by motor vehicles [5,6]; noise pollution, resulting from the population exposure to noise generated by both road, rail and air traffic, especially in the proximity of key infrastructural nodes [7,8]; accidents, especially associated to the road ones and congestion of infrastructural network with consequent loss of capacity linked to the additional time spent traveling compared to the optimal travel time [9,10]. Furthermore, the overall growth in movements, both related to people and goods, often based on the use of private vehicles determines an increase of these transport mobility impacts. The actual emergency situation caused by the COVID-19 pandemic, pushed this issue because on the one hand there is a reduction in the number of trips, but on the other

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hand the public transport system has been thrown into crisis due to social distancing, taking consideration the private car as a safer transport modes. Therefore, it is necessary to define strategies for the enhancement of sustainable mobility in Europe and actions that make these strategies operational at local level. This perspective, which suggests the need to link the different levels of public policy-making, seems extremely necessary with regard to the urban dimension. Hence, the need to pursue a common strategy, to be applied at different levels, and which takes as a priority objective the enhancement of sustainable mobility.

Transport policy represents one of the main pillars of the European strategy on urban sustainability [11]. Looking at the instruments adopted by European Commission in the transport sector, guidelines first Guidelines have been defined in 1992 within the White Paper “on the future development of the common transport policy”, which was subsequently updated by the White Paper in 2001. European transport policy for 2010: time to decide, and finally with the 2006 document Keeping Europe moving - Sustainable mobility for our continent. In 2007 the European Commission adopted the new Green Paper, specifically dedicated to urban mobility, “Towards a new culture of urban mobility, which is the reference for sustainable urban mobility policies”. The European Commission identifies the Sustainable Urban Mobility Plan (SUMP), from Italian Piani Urbani della Mobilità Sostenibile (PUMS), as a strategic urban tool that orientates mobility in a sustainable way The SUMP "ensures a variety of sustainable transport options for the safe, healthy and fluid passage of people and goods, with all due consideration for fellow residents and the urban environment" [12].

Based on this premise, the aim of this paper is to present first results of a wider research aimed at investigating the methodological and practical approaches to boost the strategy of integration between transport systems and urban planning by using ITS technologies and infomobility systems. The structure of the paper consists of 4 sections: Section 1 initially introduced the transport sector externalities and the vision of legal planning tools promoting sustainability through the use of ITS technologies; Section 2 enhances the role of SUMP towards sustainability by emphasizing the role of ITS technologies; Section 3 focuses on ITS and their impact as enabling technologies to boost sustainable mobility concepts of SUMPs; Section 4 provides discussions about the viewing of ITS within the SUMPs and heads for conclusions and implications for future research.

THE ROLE OF SUMPS TOWARDS SUSTAINABILITY

The SUMP proposes an organic vision with strategic content that targets its forecasts over a long-term horizon, usually over a ten-year. The main purpose that this legal tool follows up is to reduce the environmental mobility costs and at the same time to allow adequate accessibility levels, characterizing a series of strategic actions to make operational policies related to urban mobility and sustainability [13]. This plan integrates comprehensive urban mobility projects, which collect and coordinate different mobility systems including all public and road transport infrastructure interventions, interchange parkings [14], requalification of walkable urban spaces [15,16,17] and cycling through integrated approaches [18,19], use of technologies [20,21], vehicles, policies for demand management, mobility managers structure, traffic control and regulation systems, information to users, logistics and technologies for optimizing the distribution of goods in cities [22,23,24] in order to satisfy the mobility needs of residents and, more in general, of the city users [25]. The SUMP differs from the UMP (i.e. Urban Mobility Plan) for several elements including the participation which provides for the involvement of both stakeholders and citizens and the elaboration of implementation plans [26,27,28].

Among the contents of the plan there are also the objectives to be achieved and the indicators for evaluating the actions implemented by several instruments, establishing the guidelines for the next monitoring phase (Table 1).

TABLE 1. Areas of intervention and associated objects of SUMPs (Source: Authors elaboration starting from [12,29,30])

Areas of intervention	Objectives
Local public Transport	Improvements for the quality, safety, integration and accessibility of public transport services, including the infrastructures
Non-motorized transport	Adaptation and improvement of existing infrastructures or creation of new ones
Intermodality	Improve the integration between the various modes of transport and multi-modes
Road safety	Highlight the main problems related to road safety and risks
Focus Sharing mobility	Related to Coronavirus emergency Related to use during last year
Road transport	Optimize the use of the road even towards other modes or functions
Urban logistics	Improving the efficiency of logistics, reducing externalities in terms of emissions, pollutants and noise
Mobility Management	Widen the audience of possible recipients: citizens, workers, students and other relevant groups
Information Transportation Systems	Use technology for formulating strategies, implementing policies and measures of sustainable mobility monitoring

In this context, it is extremely important to consider ITS for supporting cities. In fact, ITSs play a significant role in determining innovative sustainable transport, for a better use of urban space and time [31], with a multi-faceted approach based on the three pillars of sustainability: environmental, economic and social ones. Experiences in different countries, both in the US and in Europe, report that in several ITS applications the following results have been obtained: reduction of travel time of around 20%, enhance the capacity of the network by 5-10%, decrease in the number of accidents by 10-15%, decrease congestion by 15-20%, reductions in pollutant emissions by 10-15% and reduction of energy consumption by 12%. [32].

ENABLING TECHNOLOGIES THROUGH COOPERATIVE INTELLIGENT TRANSPORT SYSTEMS

The application of ITS over the years has greatly changed since in the past they were used to ensure an improvement in traffic flows, in terms of service levels, encouraging the use of private means [33]. Today, the use of technology is to support smart cities and smart mobility searching to encourage the use of more sustainable alternative transport modes (e.g. public transport and soft mobility) and more in general enhancing quality of life [34]. Smart mobility aims to offer a seamless mobility experience, from the first to the last mile, which is flexible, integrated, safe, on-demand and convenient. The urban mobility can be innovated through new technologies and applications able to integrate public transport, better infrastructure [35,36] and all forms of sharing mobility [37]. The final purpose of introducing smart mobility in our cities is to reduce traffic and pollution, to create seamless and intelligent flows and to strengthen scale economies to promote accessibility to all [38].

In SUMPs, ITS are essential because they help to manage better the development of cities and ITS also help to use more efficiently infrastructures, vehicles, logistics platforms [39]. In order to serve SUMPs goals there are different ITS solutions that can collaborate to the achievement of sustainable mobility. In this regard, it is crucial to understand how these technologies operate and their effectiveness in relation to the sustainable goals they intend to pursue.

Table 2 lists the SUMPs goals from the general to the more specific one, classifying them by considering the three areas of sustainability. Nevertheless, it is evident the necessity to take into consideration the fact that some improvements towards one of these sustainable aspects (i.e. environmental, economic and social) can indirectly generates positive repercussions on others as well.

TABLE 2. SUMPs goal classified from a sustainable perspective (Source: Authors elaboration starting from [12,29])

SUMP goals	Environmental	Economic	Social
G1. Improve city liveability	X	X	X
G2. Improve air quality	X		
G3. Reduce noise emissions	X		
G4. Improve accessibility			X
G5. Improve safety			X
G6. Reduce congestion	X	X	X
G7. Boost economic growth		X	
G8. Unlock spatial opportunities			X
G9. Seamless journeys		X	X
G10. Boost public transport	X	X	X
G11. Boost active travel	X	X	X
G12. Boost electromobility	X	X	
G13. Better transport data	X	X	X

According to these goals, Table 3 summarizes the ITS measures that can be used or implemented to support related strategies and actions. The first measure is one of the most common in cities (i.e. TMC), until to consider the most complex one (i.e. MaaS). These measures can be applied both to private and public transport sector, by addressing different stakeholders, i.e. end-users (U), transport companies (C), enforcements (E) and municipalities and local authorities (A). Also in this case, the intervention of these measures can involve multiple stakeholders, and a further, and secondly further ones.

TABLE 3. ITS measures and its characterization (Source: Authors elaboration starting from [40,41])

ITS measures	Stakeholders
M1. Reactive traffic management and control (TMC)	U/C/E
M2. Predictive traffic management and control	C
M3. Public Transport and emergency vehicle priority	C/E
M4. Traveller information	U/C
M5. Parking management and information	U/C/E
M6. Red light and parking enforcement	C/E
M7. Map and location referencing	U/C/E
M8. Dynamic route guidance	U/C
M9. Floating vehicle data	C/M
M10. Road user charging	U/E/A
M11. Fleet management systems	C/M
M12. Demand-responsive transport (DRT)	U/C
M13. E-ticketing	U/C
M14. E-payment	U/C
M15. Mobility as a Service (MaaS)	U/C/M

Table 4 shows the correlation between goals and measures, in applying a Likert scale based on four evaluation steps, from 0 (i.e. non-existent correlation), to 3 (i.e. highest correlation), with intermediate values 1 (i.e. very little) and 2 (moderate). This analysis allows to highlight the effectiveness of ITS in relation to the SUMPs, which is subsequently the object of in-depth analysis and measurement in the third phase of the SUMPs cycle.

TABLE 4. Measure of ITS effectiveness towards the SUMP goals (Source: Authors elaboration starting from [42,43])

	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15
G1	1	2	2	2	2	1	2	2	-	1	1	1	3	3	3
G2	1	2	-	2	1	1	-	1	-	3	2	1	-	3	1
G3	1	2	-	2	1	-	-	-	-	3	2	1	-	-	2
G4	-	2	1	1	1	-	3	-	1	1	-	3	2	2	3
G5	1	2	2	2	-	3	-	1	-	2	-	-	2	3	-
G6	1	2	2	2	1	2	1	2	1	3	2	2	1	2	2
G7	1	2	1	1	2	2	-	-	-	2	1	1	2	2	2
G8	-	-	3	2	3	2	1	-	-	3	-	1	-	2	3
G9	2	2	2	3	1	1	2	2	1	1	-	2	3	3	1
G10	1	2	3	2	1	-	2	-	1	1	3	3	2	2	1
G11	-	-	-	2	-	2	2	-	-	1	-	-	3	-	1
G12	-	-	-	2	1	1	2	1	1	2	1	-	-	-	2
G13	1	2	1	3	1	1	2	2	3	2	2	1	1	1	2

DISCUSSION AND CONCLUSIONS

The topic of sustainable mobility in urban environments has acquired great centrality within legal planning tools at all levels. Moreover, there is growing attention towards urban quality which is strongly depending on the environmental performances that urban systems express. A satisfactory level of urban quality can ensure a healthy living environment for the inhabitants of European cities as well as greater overall competitiveness to the system since it is able to attract qualified functions and resources. Transport policies constitute one of the major foundations on which the European strategy on urban sustainability is based. In this regard, the SUMP represents a European legal tool, with its transposition at national level through PUMS, to achieve integrated planning at all mobility levels. The interest in transport urban policies is also to be traced back to the recent trends followed by the settlements which have tended to favor diffusion distribution methods on the territory with increasing motorized travels. Moreover, the current COVID-19 emergency, has emphasized and exasperated the use of private vehicle, especially in urban areas, as considered safer in relation to the social confinement. To face this emerging mobility issues, the role of smart mobility and ITS technologies has become even more fundamental to support actions and strategies towards the new transport mobility issues.

As emerged from the analysis, there are several measures to achieve the SUMPs goals. They may concern different strategies related to the demand mobility management, expansion of public transport, telematics, intermodality empowering soft mobility, urban logistics. The correlation between these measures and goals allowed to evaluate their effectiveness. The use of technologies associated to the *road user charging* and *E-ticketing* seems to represent the ITS measures with the best impact in term of effectiveness related to the SUMPs goals, since they obtained the maximum judgement for four of them. Road user charging, coinciding with “road pricing” or “congestion charging” meet the principle that “the user pays”. It is an operational management policy developed in many countries but the main issue is associated to user acceptance. Several applications have been adopted, based on the use of on-board microwave transponder (e.g. in France, Singapore and Florida), or fitting an in-vehicle unit based on GPS (e.g. in Germany), or using recognition cameras (e.g. in London). E-ticketing represents innovations in ticketing that have also coincided with innovation in payment technologies (E-payment). There are based on the use of smart cards or credit cards with different forms of pricing policies (e.g. single journey, pay-as-you-go, weekly or monthly travel pass). The associated advantages see reduced costs of handling cash, reduced fraud, increased business data available in real-time, greater flexibility in ticket pricing and implementing changes to fares. The development of a “universal” card constitutes the base for an interoperable package, which Maas requires.

In terms of spread of uses with respect to the satisfaction of these goals, there are *road user charging* and *traveller information.* The last one is able to deliver timely and accurate information to public transport passengers, drivers, travel planners and fleet managers so that route and mode choices can be adjusted in the light of the information. Traveller information systems generally receive data from other services and communicate to road users, representing a key element of an overall mobility demand management strategy. Both of these two measures are able to produce effects that can be associated with each goal as they provide outputs intended for the end-user in the logic of human-centered approach of SUMPs. Instead, as regards the measure relating to floating vehicle data, it performs a more targeted action, presenting a high efficacy in terms of congestion reduction and unlock of spatial opportunities. They often referred to as “probe vehicle data” which provide network managers details of traffic speeds at different places in the network. Therefore, even if the impact is not directly on the end-user, they represent a valid support for the provision of subsequent services. It is clear that the assimilation of the interventions listed above to the SUMP must also be established in relation to the organic nature and overall integration of the planned actions, given that it is a tool that preferentially deals with mobility in urban area and which is called "plan". Therefore, the more systemic the proposed vision is, both in terms of transport methods and in relation to the territorial context or the suburban areas, the greater the similarity that can be established with the SUMP.

The findings of this work create the basis for further research that will focus on the analysis of SUMPs and PUMS case studies, in order to assess the added-value given by the use of ITS technologies and to define specific Key Performance Indicators (KPIs) to measure and monitoring the effects of implemented actions and their impacts on developing smart cities and promoting sustainable mobility approaches, facing the urban planning and transport mobility issues of modern society.

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