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Osvaldo Gervasi · Beniamino Murgante · Sanjay Misra · Chiara Garau · Ivan Blečić · David Taniar · Bernady O. Apduhan · Ana Maria A. C. Rocha · Eufemia Tarantino · Carmelo Maria Torre · Yeliz Karaca (Eds.)

Computational Science and Its Applications – ICCSA 2020

20th International Conference
Cagliari, Italy, July 1–4, 2020
Proceedings, Part VII

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Preface

These seven volumes (LNCS volumes 12249–12255) consist of the peer-reviewed papers from the International Conference on Computational Science and Its Applications (ICCSA 2020) which took place from July 1–4, 2020. Initially the conference was planned to be held in Cagliari, Italy, in collaboration with the University of Cagliari, but due to the COVID-19 pandemic it was organized as an online event.

ICCSA 2020 was a successful event in the conference series, previously held in Saint Petersburg, Russia (2019), Melbourne, Australia (2018), Trieste, Italy (2017), Beijing, China (2016), Banff, Canada (2015), Guimaraes, Portugal (2014), Ho Chi Minh City, Vietnam (2013), Salvador, Brazil (2012), Santander, Spain (2011), Fukuoka, Japan (2010), Suwon, South Korea (2009), Perugia, Italy (2008), Kuala Lumpur, Malaysia (2007), Glasgow, UK (2006), Singapore (2005), Assisi, Italy (2004), Montreal, Canada (2003), and (as ICCS) Amsterdam, The Netherlands (2002) and San Francisco, USA (2001).

Computational science is the main pillar of most of the present research, industrial and commercial applications, and plays a unique role in exploiting ICT innovative technologies. The ICCSA conference series has provided a venue for researchers and industry practitioners to discuss new ideas, to share complex problems and their solutions, and to shape new trends in computational science.

Apart from the general track, ICCSA 2020 also included 52 workshops in various areas of computational science, ranging from computational science technologies to specific areas of computational science, such as software engineering, security, machine learning and artificial intelligence, blockchain technologies, and of applications in many fields. We accepted 498 papers, distributed among 6 conference main tracks, which included 52 in workshops and 32 short papers. We would like to express our appreciation to the workshops chairs and co-chairs for their hard work and dedication.

The success of the ICCSA conference series in general, and of ICCSA 2020 in particular, vitaly depends on the support from many people: authors, presenters, participants, keynote speakers, workshop chairs, session chairs, Organizing Committee members, student volunteers, Program Committee members, Advisory Committee members, international liaison chairs, reviewers, and others in various roles. We take this opportunity to wholeheartedly thank them all.

We also wish to thank our publisher, Springer, for their acceptance to publish the proceedings, for sponsoring part of the Best Papers Awards, and for their kind assistance and cooperation during the editing process.

We cordially invite you to visit the ICCSA website http://www.iccsa.org where you can find all the relevant information about this interesting and exciting event.

July 2020

Osvaldo Gervasi
Beniamino Murgante
Sanjay Misra

Welcome to the Online Conference

The COVID-19 pandemic disrupted our plans for ICCSA 2020, as was the case for the scientific community around the world. Hence, we had to promptly regroup and rush to set in place the organization and the underlying infrastructure of the online event.

We chose to build the technological infrastructure using only open source software. In particular, we used Jitsi (`jitsi.org`) for the videoconferencing, Riot (`riot.im`) together with Matrix (`matrix.org`) for chat and asynchronous communication, and Jibri (`github.com/jitsi/jibri`) for live streaming sessions on YouTube.

Six Jitsi servers were set up, one for each parallel session. The participants of the sessions were helped and assisted by eight volunteer students (from the Universities of Cagliari, Florence, Perugia, and Bari), who assured technical support and smooth running of the conference proceedings.

The implementation of the software infrastructure and the technical coordination of the volunteers was carried out by Damiano Perri and Marco Simonetti.

Our warmest thanks go to all the volunteering students, to the technical coordinators, and to the development communities of Jitsi, Jibri, Riot, and Matrix, who made their terrific platforms available as open source software.

Our heartfelt thanks go to the keynote speakers: Yaneer Bar-Yam, Cecilia Ceccarelli, and Vincenzo Piuri and to the guests of the closing keynote panel: Mike Batty, Denise Pumain, and Alexis Tsoukiàs.

A big thank you goes to all the 454 speakers, many of whom showed an enormous collaborative spirit, sometimes participating and presenting in almost prohibitive times of the day, given that the participants of this year's conference come from 52 countries scattered over many time zones of the globe.

Finally, we would like to thank Google for letting us livestream all the events via YouTube. In addition to lightening the load of our Jitsi servers, that will allow us to keep memory and to be able to review the most exciting moments of the conference.

We all hope to meet in our beautiful Cagliari next year, safe from COVID-19, and finally free to meet in person and enjoy the beauty of the ICCSA community in the enchanting Sardinia.

July 2020

Ivan Blečić
Chiara Garau

Organization

ICCSA 2020 was organized by the University of Cagliari (Italy), University of Perugia (Italy), University of Basilicata (Italy), Monash University (Australia), Kyushu Sangyo University (Japan), and University of Minho (Portugal).

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“Sustainable Urban Mobility Plans”: Key Concepts and a Critical Revision on SUMPs Guidelines

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Abstract. Cities play a fundamental role not only in the growth processes under the sustainability paradigm, but also as a driving-force behind economy and they constitute places of connectivity and innovation. More than two thirds of the European population live in urban areas and this percentage is continuously growing. Therefore, cities are fundamental hubs of the transport system, since most journeys start or end within urban areas. The direct consequence is that many of the negative transport externalities, such as congestion, road accidents and pollution, have the greatest impacts in these contexts. The European Commission emphasized integrated planning at all mobility level to enhance new forms of sustainable urban mobility, in order to reduce externalities associated with transport sector. In this view, the aim of this paper is to analyze the European guidelines for the development and the implementation of Sustainable Urban Mobility Plan (SUMP) and the corresponding Italian guidelines for the preparation of so-called “Piani Urbani della Mobilità Sostenibile” (PUMS). A comparative evaluation is proposed to emphasize the new paradigm of sustainable transport planning and highlight critical evidence between the European legal tools and their transposition at national level, also in the light of their recent updates. The results of this analysis lay the basis for the critical assessment of best practices and the review of related SUMP, in order to identify the key elements to assist traffic planners and managers in their decision-making procedures for the identification of successful strategies and the implementation of effective actions towards sustainable mobility.

Notes. This paper is the result of the joint work of the authors. ‘Abstract’ ‘Urban Mobility and Transport Sector: Statistic Evidences’ and ‘Theoretical and legal framework: from the European to the Italian perspective’ with subparagraphs were written jointly by Vincenza Torrisi and Chiara Garau. Vincenza Torrisi wrote the ‘Discussion and conclusions’. Chiara Garau wrote the “Introduction”; Matteo Ignaccolo and Giuseppe Inturri coordinated the research.

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1 Introduction

In recent years, the scientific and technical interest in managing cities with principles of sustainable urban mobility grown significantly, not only because the technological innovations offer effective and possible real time solutions, but also because the transport sector continues to cause negative externalities (such as traffic congestion, climate-altering gases, etc.) in local contexts, which are no longer negligible.

However, the city governance, or more generally the governance of a territory, based on the principles of sustainable urban mobility, is a complex duty because of political and technical conflicts (which inevitably emerge in a multifaceted socio-technical framework) and it can be helped by considering adequate strategies and measures, also investigating citizen preferences and stakeholder engagement [1, 2]. These include, for example, effective solutions for public transport and accessibility [3, 4], adaptive transport services [5], adequate infrastructures [6, 7], technological devices for managing traffic [8–10], advanced automation techniques for raising peoples well-being and advanced intelligent transport system solutions [11–13], in order to satisfy the mobility needs of residents and, more in general, of the city users [14].

In Europe these issues are particularly felt starting from 1987 with the sustainable development concept - introduced by the Brundtland report [15] - and with several EU formal directives and regulations, focusing on the development of sustainable urban transport [16]. According to the traditional planning tool, strategies were defined and applied for enhancing urban mobility in cities over a medium/long-term period and the Italian transport planning was regulated by the Urban Mobility Plans - UMPs - (from Italian *Piani Urbani della Mobilità* – PUM), oriented by a cost-benefit approach.

Today, the concept of sustainability (or a sustainable city or sustainable urban development) is part of the broader concept of smart and sustainable cities [17–19]. In particular, Höjer and Wangel [19] rewrite the Brundtland definition, by considering a Smart Sustainable City a place "that meets the needs of its present inhabitants without compromising the ability for other people or future generations to meet their needs, and thus, does not exceed local or planetary environmental limitations, and where this is supported by ICT" [19; pag. 10]. However, in this context, the authors particularly consider the transport sector.

The sustainability concept introduces long-term goals for passenger and freight transport and environmental protection and considers a new human-centred approach, the UMPs have adapted to the new paradigm, becoming the Sustainable Urban Mobility Plans - SUMPs (from Italian: *Piani Urbani della Mobilità Sostenibile* - PUMS). The addition of the letter "S" of Sustainability is prominent for the future of our Communities, which is linked not only to the challenge of reducing emissions in the atmosphere, but it regards a wide-ranging viewing with also economic and social issues. It is an opportunity to reflect on habits and tangible actions to promote sustainable development, as evidenced in [20–21]. In fact, the PUMS is no longer focused on the concept of "mobility", as the realization of infrastructures, but is pursues the "sustainability", by proposing a human-centered approach that places the individual and his needs at the center of the project and not the physical infrastructures that derive from it.

The sustainability concept under the paradigm of smart and sustainable cities is inserted in specific strategic documents [22, 23] and the adoption of a SUMP in a particular context is supported by the definition of guidelines deriving by several projects and initiatives (e.g. CIVITAS, ELTISplus).

Considering this, the SUMPs highlight the importance of citizens' quality of life, proposing the integration of passenger and freight transport demands [24–27].

So, a SUMP can be considered as "a strategic plan designed to satisfy the mobility needs of people and businesses in cities and their surroundings for a better quality of life. It builds on existing planning practices and takes due consideration of integration, participation, and evaluation principles" [28, pag. 9].

In Italy, with the M.D. 4/08/2017, the SUMP is mandatory only for metropolitan cities, large area entities and single and aggregate municipalities with more than 100,000 inhabitants. However, it remains a useful tool for other typologies of cities for accessing different types of funding for mobility sector. Some examples are the Sustainable Urban Mobility Plan in European countries are, Hungary, France for its guidelines [29] and Portugal and Czech Republic for the way of monitoring and evaluation. In Italy, some best practices are Bologna, engaged in the drafting of the first metropolitan plan and the city of Padua which pays more attention to urban logistic [30].

Based on these premises, this paper proposes a critical analysis of European and Italian Guidelines for the drafting of SUMP, also in the light of the recent revisions and updates, emphasizing the new paradigm of sustainable transport planning. The paper is structured in four section: the first one introduces the principals of smart and sustainable mobility explaining the role of SUMP; the second section provides some statistic evidences about transport sector and shows the differences between the traditional and sustainable transport planning; the third section analysis the theoretical and legal framework from the European to the Italian perspective; the final section gives a critical review of SUMP Guidelines through a discussion and provides main conclusions and further research of the work.

2 Urban Mobility and Transport Sector: Statistic Evidences

Before starting to analyse the comparison between the (European and Italian) mobility plans, the authors believe it is necessary to focus on the evident problems that concern the transport sector in relation to the urban area.

In 2017, considering the transport and storage services sector, the Gross Value Added (GVA) accounted for about the 5% of the total GVA in EU-28. Figure 1 includes the GVA of companies whose main activity is the provision of transport (and transport-related) services and that own account transport operations are not included. The transport and storage services sector (including postal and courier activities) employed around 11.7 million persons, representing 5.3% of the total workforce. The percentage division between the various transport modes is as follows: 52% in land transport (road, rail and pipelines); 3% in water transport (sea and inland waterways), 4% in air transport and 27% in warehousing and supporting and transport activities (such as cargo handling, storage and warehousing) and the remaining 15% in postal and courier activities. Moreover, about the 13% of the total private household consumption was committed to purchasing transport-related items: around a third of the entire sum was used to purchase vehicles, around half was spent on the operation of personal transport equipment (e.g. to buy fuel for the vehicles) and the rest was spent for transport services (e.g. bus, train, plane tickets).

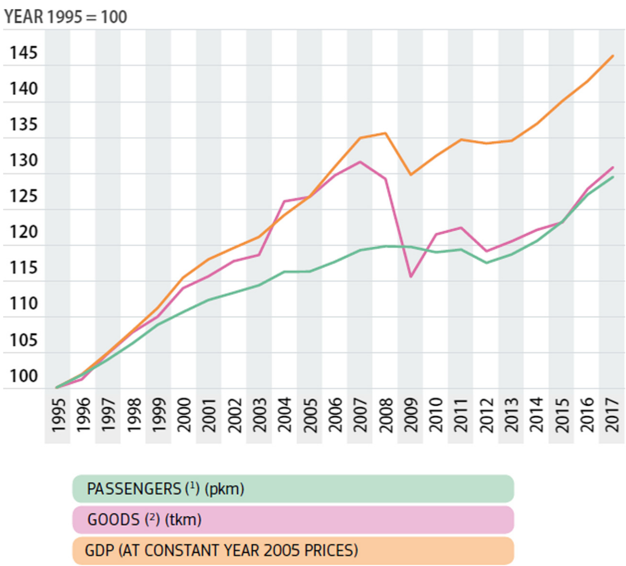

Fig. 1. Traffic and economic growth between 1995 and 2017 [31]

As regards the goods transport, for the year 2017, it was estimated to amount to 3731 billion of ton-kilometre (tkm) moved. Figure 1 shows the trend of goods, by considering only the European air and sea transport excluding the transport activities between the EU and the rest of the world. Goods transport by road represents the highest percentage (more than 50% of this total), followed by maritime transport (about 31%), by rail (11%) and the rest by inland waterways and oil pipelines. With reference to passenger transport, is was estimated an amount of 69133 billion of passenger-kilometre (pkm) with an average of around 13505 km per person. Passenger cars accounted for 70.9% of these total, powered two-wheelers for 1.8%, buses & coaches for 7.4%, railways for 6.8% and tram and metro for 1.6%. Intra-EU air and intra-EU maritime transport contributed for 11.2% and 0.4% respectively [31].

To face these issues, the promotion of smart and sustainable approaches, indicated in the previously paragraph, may represent the solution. However, in relation to transport and mobility sectors, a city cannot be considered smart if it is not sustainable, in which all priorities, strategies and actions are coordinated in an integrated system of several projects and intentions all aimed at sustainability [32–34]. The outcomes are addressed at improving the efficiency, the effectiveness and the environmental sustainability of cities.

This significant awareness of the sustainability concept under the paradigm of smart and sustainable cities has changed also the transport planning. In a nutshell, Table 1 shows the main differences (nine) between the traditional and the sustainable transport planning.

Table 1. Differences between the traditional transport planning and the sustainable transport planning (Source: Authors elaboration starting from [32])

	Traditional Transport Planning (TTP)	Sustainable Transport Planning (STP)
1	Planning for sectors	Integrated planning
2	Mobility	Accessibility
3	Motorized mobility	Soft Mobility
4	Street as movement artery	Street as a public space
5	Cost-benefits analysis	Multi-criteria analysis
6	Ownership	Sharing
7	Increasing supply	Demand management
8	Hight speed	Low speed
9	Segregation	Users integration

Therefore, two generations of transport plans are distinguished in Table 1 and the nine differences concern:

1) The transport planning in general. With TTP, the transport planning was for sectors without dialogue with other planning tools. Instead, STP becomes integrated according to the logic of TOD (Transit Oriented Development). Namely, transport and territory must influence each other for having an efficient transport system [35];
2) The shift from Mobility (planning for cars) to Accessibility (planning for people, considering their movements) [36];
3) The STP is focalized on any non-motorized transport (human powered mobility) [37, 38];
4) The STP considers the streets and the squares in a more complex way: they are spaces for social interaction [39];
5) Cost-benefit analysis of TTP is in contrast with multi-criteria analysis of STP. The multi-criteria analysis also takes into account intangible costs (e.g. environmental cost) [40–42];
6) Ownership of the vehicle of TTP is in contrast with the vehicle sharing of STP [43];
7) Increasing the roads supply of TTP is in contrast with the managing of the demand of STP (for example, regulation of rush hour flows with congestion charge policies; optimize urban logistics) [44–46];

8) With the STP, great importance is given to the movement of the pedestrian, and therefore to the low speeds of the vehicles [47];
9) With the TTP the traffic components are clearly separated. Instead, the STP promotes the integration of road users (pedestrians and cars), in more accessible and sustainable contexts [48, 49].

From an operational point of view, the European Commission (EC) agrees to move in that direction and it is required long-term decisions on the basis of strategic plans [50]. Therefore, the SUMP, from Italian "Piano Urbano della Mobilità Sostenibile" (PUMS), is a strategic planning tool with a time horizon of medium-long term (10 years). It develops a new vision of urban mobility, as a "system of mobility", (preferably referring to a metropolitan city area), by proposing the achievement of environmental, social and economic sustainability objectives. In order to achieve them, the SUMP provides the definition of actions aimed at improving the effectiveness and efficiency of the mobility system and its integration with the urban and territorial planning and development.

3 Theoretical and Legal Framework: From the European to the Italian Perspective

In the EU context, attention to the urban scale has been growing through funding programs (e.g. CIVITAS), Horizon 2020 research projects, the construction of a European network (SUMP conference), and other several initiatives to boost sustainability. As regards the establishment of the right goals and the identification of strategies and actions for sustainable transport planning, the European Commission has launched a series of research and demonstration projects with the aim of promoting SUMPs. The European Guidelines for the development and implementation of these plans have been developed in 2014 within the European project Eltis and implemented at national level with a ministerial decree in 2017. Considering these regulatory tools, the methodological and operational contents of the SUMP and PUMS are similar, otherwise the procedural steps that characterize them are articulated and grouped in a different way. In addition, both guidelines have recently been revised and updated in order to better clarify the planning steps, also through numerous examples of cities and the inclusion of further insights. Based on this premise, this section presents a critical analysis of the European and Italian Guidelines in order to highlight the critical evidence and the differences between the two planning contexts and to identify the key elements to promote effective strategies and actions towards sustainable mobility.

3.1 European Guidelines for SUMP

The adoption of SUMP has been encouraged and recommended by the Commission's Action Plan on Urban Mobility [31]. The next year (June 2010), the EU Council also expressed its consensus, encouraging the development of incentives, such as the assistance of experts and the information exchange, for the creation of new SUMP. The subsequent 2011 White Paper [51] proposed that the drafting of SUMP might be a mandatory requirement for cities with a population of over 100,000 inhabitants, and that the allocation of regional and cohesion funds might be made conditional on the submission and auditing of such legal instruments.

The starting point is represented by the Community Guidelines “Developing and Implementing a Sustainable Urban Mobility Plan” [52], developed by Eltis and approved in 2014 by the EU General Directorate for Mobility and Transport. This document highlighted the assessment of SUMP implementation and the results deriving through the realization of measures envisaged by the Plan [53–55].

The link between the SUMP and sustainability can be found from a social, economic and environmental point of view. The SUMP focuses on environmental aspects considering the pollution deriving from the transport sector and the consequent need to reduce CO_2 emissions, noise and congestion and to improve air quality. Moreover, the SUMP aims at decreasing the private motorization rate, by promoting the use of public transport and encouraging soft mobility (i.e. walking and cycling). With reference to the social aspect, the key concepts of the PUMS consist in a greater accessibility and safety of urban areas, thus making cities more attractive and improving the citizens quality of life. Finally, as regards the economic aspect, the SUMP considers a multi-criteria approach, in order to improve the efficiency and cost-effectiveness associated to the transport of persons and goods, and at the same time taking into consideration a broader view social benefit.

Figure 2 shows a comparison between the two SUMP cycles, representing the complex planning process, respectively for the first edition of the European Guidelines (2014) and for the second edition published last year, in 2019.

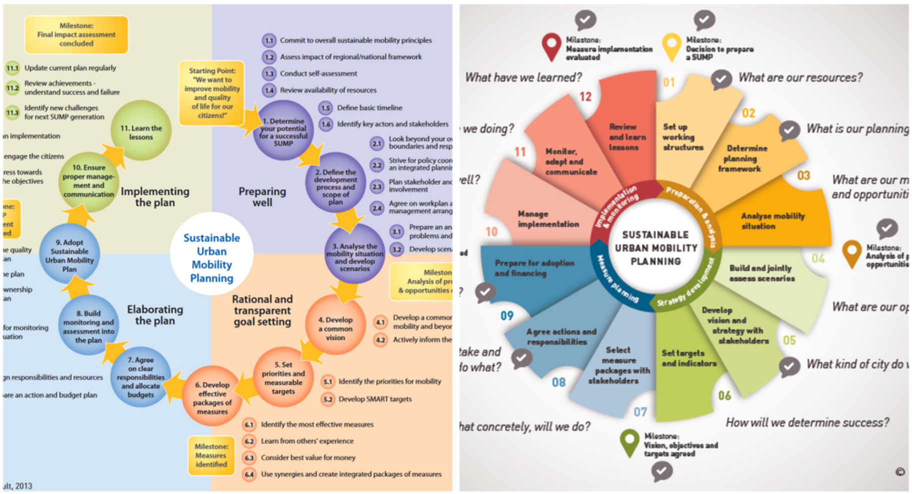

Fig. 2. SUMP cycle for the 1st edition of Guidelines (left) and the 2nd edition (right) [52]

The new SUMP cycle includes 4 consecutive phases that characterize the entire development of the plan. The articulation of the phases and their main contents are described in a concise but effective way in the following table (Table 2):

Table 2. Description of phases for the development of SUMP, according to the 2nd edition of Guidelines (Source: Authors elaboration starting from [53])

Phases	Description	Main contents and scope
Phase 1	Preparation and analysis	- Definition of geographical limits of intervention, considering the area of influence - Recognition of the planning tools - Identification of data (eventually available) for the reconstruction of the state of affairs
Phase 2	Development of strategies	- Definition of the vision, strategies, objectives, targets and indicators, based on the cognitive framework and the analysis of critical issues
Phase 3	Planning of actions	- Exploration of possible measures to be assessed and finalized in the plan
Phase 4	Implementation and monitoring	- Management of the plan implementation through the effective enactment of actions - Monitoring and review of the Plan according to the obtained results

This second edition of Guidelines is completed by 17 Topic Guides and Practitioner Briefings which investigate particular issues related to urban mobility, providing detailed indications and practical information that can support city administrations to develop even more effective SUMP.

3.2 Italian Guidelines for PUMS

Regarding the country Italy, the legislation has been transposed at national level through the ministerial decree of 4 August 2017 [56]. With this decree, the Ministry of Infrastructure and Transport has identified the guidelines for PUMS, with the aim of promoting the homogeneous and coordinated application of guidelines for the drafting of these plans, throughout the national territory. According to [57], to access state funding for the construction of new interventions regarding rapid mass transport (i.e. metropolitan railway systems, metro and trams), metropolitan cities must present three administrative tools: (i) Feasibility Projects; (ii) Report of consistency of proposed projects with the objectives of [41]; (iii) PUMS. Cities must proceed with the definition of their own PUMS, using the guidelines adopted with [56], recently updated by the M. D. 28/08/2019.

In line with the Annex I of [56], the different procedural steps for the drafting and approval of PUMS, reported are showed in Fig. 3:

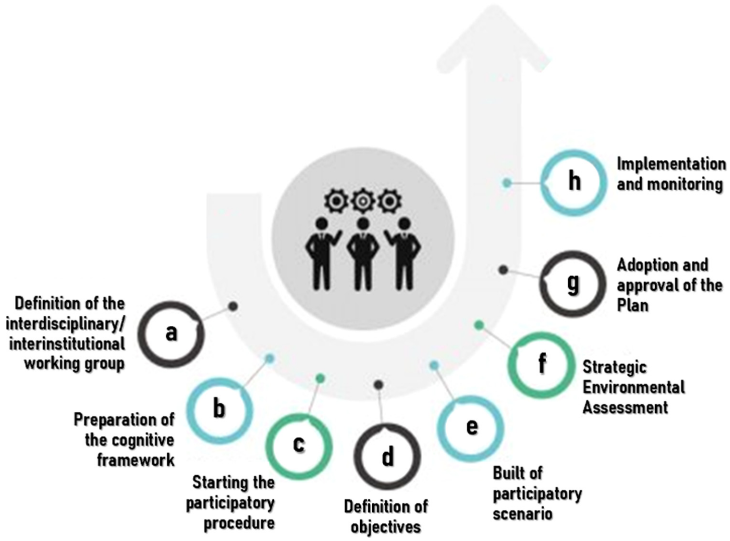

Fig. 3. Procedural steps for the drafting and approval of PUMS (Source: Authors elaboration starting from [40])

(a) Definition of the Interdisciplinary/Interinstitutional Working Group. The plan should be drafted by acquiring the knowledge of different disciplines from the various institutional actors involved in the planning process. Therefore, it is advisable the collaboration between various sectors within the municipal administration (i.e. urban planning, mobility, environment, tourism, municipal police, economic activities, etc.). The creation of the *interdisciplinary* working group also takes into consideration the possibility of appointing external technicians with consolidated experience, to identify the actions with the related economic and environmental costs and to manage the participation processes. Among the important factors, it emerges the presence of a mobility manager [58] in the working group and, at the *interinstitutional* level, the involvement of conurbations and neighboring municipalities within a local public transport service is provided.

(b) Preparation of the Cognitive Framework. This step involves the collection of data from different sources to provide all useful information to characterize the area and identify its critical issues. In this regard, the cognitive framework should contain information concerning the regulatory, planning and programmatic tools both at regional and local level and a territorial and socio-economic explanation of the Plan area. In addition, it should include a description regarding the transport demand and supply (with a focus on ITS systems for information, regulation and traffic control) and their interaction. Finally, it identifies the critical issues and impacts in terms of degree of accessibility, congestion, incidents and environmental pollution, including a SWOT (strengths and weaknesses, opportunities and threats) analysis.

(c) Starting the Participatory Procedure. In this context, the participatory process takes on a particularly important role. It already begins in the previous procedural step with the identification of critical issues highlighted by citizens and stakeholders and contributes to the subsequent definition of the objectives of the Plan. However, the selection of approaches and techniques for introducing this procedure it is delegated to the administrations, on the basis of what it considers most appropriate in relation to the territorial characteristics and available resources and by considering also the most innovative techniques, such as VGI [59].

(d) Definition of Objectives. This is a fundamental procedural step because the outline of strategies and actions for the scenario construction derives from a clear identification of the objectives. Specifically, macro-objectives are identified in response to the general interests of the efficacy and efficiency of mobility and the social, economic and environmental sustainability of the system. They are associated with the results and the relative target values to be achieved within 10 years. Then there are specific objectives with a lower hierarchical level, functional to the achievement of macro-objectives. In relation to them, a biennial monitoring activity through defined indicators is crucial to evaluate their achievement and confirm their relevance

(e) Build of the Participatory Scenario. The starting point for the construction depends on the strategies and actions identified following the previous steps. Then, follows the definition of different alternative scenarios compared with the Reference Scenario (RS) (i.e. configured if the PUMS strategies are not implemented). From a comparative evaluation of the alternative scenarios, through ex-ante indicators, the Plan Scenario (PS) is identified, including the list of priority interventions and a time schedule of its implementation in the short term (e.g. 5 years) and long term (10 years). To define the effectiveness of these interventions, it is important to indicate a costs estimation and possible financial coverage, highlighting the available resources in the municipal budget.

(f) Strategic Environmental Assessment. This evaluation, (from Italian Valutazione Ambientale Strategica - VAS) accompanies the entire planning process until its approval. Indeed, according to [57], being the PUMS a strategic plan and considering that it may have a significant impact on the environment, its eligibility for the VAS procedure must be evaluated in order to guarantee a high level of environmental protection and promote a Sustainable Development.

(g) Adoption and Approval of the Plan. These two actions follow a well-defined procedure, which envisages a first phase of adoption of the Plan; then its publication for 30 days in order to collect any observations; finally, subsequent approval of the plan.

(h) Implementation and Monitoring. To evaluate the pursuit of the objectives and the effectiveness and efficiency of the actions and interventions identified in the Plan, the monitoring activity is considered indispensable. Its periodicity, through a biennial report analyzing the state of implementation of the PUMS, allows a possible critical reconsideration of the interventions and revision of the targets to be achieved. For this purpose, it is appropriate the definition of a system of indicators and realize their ex-ante and ex-post comparison. In this step, the participation is also expected to ensure the progressive achievement of the objectives and to identify any issues that hinder the regular implementation of the Plan.

4 Discussion and Conclusions

The hitherto given work consisted in a comparative analysis between the traditional transport planning and the new paradigm of sustainable urban and transport planning by considering the sustainable development, in the context of the smart cities paradigm.

In addition, the paper provided an analysis of the European and Italian guidelines for the development and the implementation of SUMP, in order to highlight the main contents and the critical evidence of these legal tools and their transposition at national level, also in the light of recent revisions and updates.

By analysing the structure of SUMP (and PUMS at the national level) with its relative contents, it emerges that the main principles on which these plans are based are the following [52]:

- develop the Plan taking into account the functional urban area, which in some cases may extend beyond the administrative boundaries of the municipality;
- cooperate across institutional boundaries, in accordance with what is described in the first point;
- involve citizens and stakeholders in the preparation of the Plan;
- evaluate the current and future performance deriving from the identification of strategies and the implementation of actions, by using indicators;
- define a long-term vision, so as to have a clear implementation plan;
- promote the inter-modality and intra-modality through actions that aims to integrate all transport modes;
- provide the monitoring and evaluation phases of the Plan, which are fundamental for assessing its actual effectiveness and for identifying any corrective actions;
- ensure a quality plan, that leads to tangible benefits.

The previous European Guidelines drawn up in 2014 represented a determined "turning point" in the debate on urban mobility planning, constituting a fundamental methodological reference for city initiatives and anticipating approaches and operational guidelines. The second edition of 2019 Guidelines considers the novelties of a rapidly evolving sector and new challenges, arising from extensive consultations with stakeholders and expert contributions. Moreover, thanks to this, a series of new thematic guides have been produced, in order to further encourage the development and implementation of SUMPs with content related to the new urban logistics, the electrification, the role of ITS, the road security, the harmonization of approaches between climate and energy policies, the financial aspects and funds for actions, etc.

Going into more detail, the main changes compared to the first edition of the Guidelines essentially concern a different articulation of the phases of the Plan, as highlighted in the previous section. The SUMP cycle is completely updated and more balanced. There is a clear separation of the strategic planning phase (1st and 2nd phase) and the operational one (3rd and 4th phase), often having different time horizons: the strategic objectives have a medium-long term time horizon, while the measures can be updated more frequently. This allows a greater formal balance of the process, reporting a division of the SUMP cycle into four phases with three steps each, always ending with the achievement of a milestone. Furthermore, there is an additional focus on sectors of particular interest (e.g. accessibility, health, social inclusion, road safety), accompanied by numerous examples of cities and various insights.

Likewise, at the national level there was an evolution which have seen the update of these guidelines by the Ministry of Infrastructure and Transport in 2019. One of the main differences on rewriting this document concerns significant changes to the result indicators, in particular those associated with the macro-objectives, which are more detailed than the initial formulation. In addition, some terms and conditions have been changed relating to the compliance with the Guidelines by institutions, i.e. municipalities with more than one hundred thousand inhabitants have the requirement for the drafting of PUMS as an essential condition for accessing state funding in new interventions for rapid mass transport (i.e. metropolitan railways, metro, trams). This obligation was previously envisaged only for Metropolitan cities. Therefore, the aspect linked to financial funding meant that many municipalities decided to invest in the drafting of PUMS. In this vision, it is significant to observe the state of the art in Italy about the elaboration and implementation of PUMS. From the database provided by the National Observatory of PUMS is emerges that 164 cities have (or are working to have) their own Plan. Specifically, considering the data updated in February 2020, the approved plans are 36, while those adopted are 35; the remaining part (i.e. 93) are drafting Plans. These last are classified "in drafting" when the plan has officially started, by drafting the address lines or publishing the notice for its assignment; or even when the drafting has ended but the plan has not yet been adopted.

The results of this analysis lay the basis for the critical assessment of best practices and the review of related SUMP, in order to identify the key elements to assist traffic planners and managers in their decision-making procedures for the identification of successful strategies and the implementation of effective actions towards sustainable mobility.

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