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How do SUMPs Consider Factors Influencing Walkability and Cyclability? A Review of Literature and Planning Tools

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Abstract

Improving active mobility in settlements is one of the EU's core objectives to improve people's quality of life. EU guidelines indicate Sustainable Urban Mobility Plans (SUMPs) as strategic planning tools to achieve sustainable results through the definition of objectives and the provision of actions. Scientific research has extensively explored numerous factors in the built environment and active mobility infrastructures that influence mobility features and demands. However, a gap exists between research and urban plans employed to promote sustainable mobility. This paper examines whether these identified factors from scientific literature have implications for enhancing active mobility actions in Sustainable Urban Mobility Plans. First, a literature review highlights recurring factors in assessing active mobility networks. Then, an overview of actions supporting walkability and cyclability within Sustainable Urban Mobility Plans applied in the Emilia-Romagna Region in Italy is conducted. The two reviews comparison points out the expected implementation gap between research and practice.

Keywords: Active Mobility Networks, Walkability, Cyclability, Sustainable Urban Mobility Plans.

1. Introduction

The planning of networks for walking and cycling has gained significant attention due to its potential for sustainable urban transportation and community well-being in cities (Pezzagno and Richiedei, 2022). Over the past 10-15 years, there has been a notable surge of research in the field of urban planning, even more in recent times in response to the COVID-19 pandemic. This growing interest suggests the need for a paradigm shift towards sustainable mobility, emphasising the reduction of car dependency in favour of shared and active modes of transport. Therefore, the provision of adequate infrastructure for active mobility and optimised urban spaces become pivotal, also from an urban

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planning perspective, to create safer, more accessible, inclusive, and liveable spaces that promote physical activity and social interactions (Tira, 2018).
In the framework of academic research, numerous scientific studies aimed to identify distinctive factors of the urban environment and active mobility infrastructure that exert an influence on walkability and cyclability (i.a., Ewing and Handy, 2009; Gehl, 2010; Jacobs, 1995; Ignaccolo et al., 2020).
In urban planning practice, particularly in the context of the European Union, the task of moving towards more environmentally friendly transport is delegated to Sustainable Urban Mobility Plans (SUMPs), which play a crucial role in formulating sustainable mobility strategies and actions (Torrisi et al., 2020).
Within this framework, this study aims to compare the factors influencing walkability and cyclability, as defined by the existing scientific literature, and the actions promoting walkability and cyclability within the SUMPs of the Emilia-Romagna region, trying to highlight the eventual gap between the SUMPs and the existing, evolving knowledge. The paper is organised as follows: Section 2 provides an overview of key factors from a comprehensive literature review employing research approaches that integrate urban infrastructure and space assessments using technologies such as Geographic Information Systems (GIS). Section 3 presents an overview of actions geared towards enhancing walkability and cyclability from the SUMPs implemented by the cities of the Emilia-Romagna Region (Italy). This analysis provides valuable insights to draw suggestions for improving the efficiency of current planning instruments. Lastly, Section 4 starts from the highlighted limitations and obstacles and proposes a possible approach for the future aimed at a better integration of research and practice. In addition, suggestions for improving planning tools are outlined.
By improving the effectiveness of SUMPs and leveraging technologies, such as GIS, cities can foster urban environments that promote walking and cycling, enhance social cohesion, and ultimately improve the overall quality of life for citizens.

2. Factors Influencing Walking and Cycling Networks: a review

The literature review concerned factors that influence walkability and cyclability, i.e., which are widely acknowledged as significant characteristics in urban networks for active mobility. The review employed specific search criteria, including the use of relevant keywords, a defined timeframe, a preference for English-language publications, and a focus on research that conducted performance evaluations of infrastructures and spaces for active mobility using GIS tools. To ensure comprehensiveness, multiple academic databases and search engines were consulted to identify the most relevant articles published in academic journals within the field of urban planning. The research identified four macro-categories of factors: (i) urban accessibility by proximity, (ii) safety and security, (iii) inclusive design, and (iv) enjoyment. These indicators have been extensively discussed and examined in the existing literature and play a crucial role in assessing the quality and effectiveness of urban infrastructures and spaces.
Urban accessibility by proximity implies convenient access, both on foot and by bicycle, to paths leading to significant destinations. Numerous studies emphasised the importance of ensuring accessibility to public services and facilities through adequate infrastructure, thus paying particular attention to spatial and temporal planning (Carra and Ventura, 2020). Several conceptual models, from Clarence Perry's "Neighbourhood Unity" (Perry, 1929) in 1929 to Carlos Moreno's recent "City in 15 Minutes" model (Moreno et al., 2021) in 2021, underscored the significance of minimising distances and ensuring proximity to

essential services, facilitating intermodal travel, and connectivity requirements. Overall, factors such as land use, built environment, and service locations were adopted to identify urban mobility challenges (Caselli et al., 2021a; Bowie et al., 2019). Several models were used to assess these issues, including the Walk Score by Carr, Dunsiger, and Marcus (2010), Walkability Explorer by Blečić et al. (2014), OS-WALK-EU by Fina et al. (2022), IAAPE by Moura, Cambra, and Goncalves (2017), and IAPI by Pucci, Carboni, and Lanza (2021).

Safety and security are closely tied to the users' experience and are derived from the urban environment. Safety encompasses the exposure level to road risks and motor vehicles, while social protection focuses on factors related to the prevention of micro-crimes, e.g., theft or vandalism. The most recognised issues were found in the geometric and constructive features of the paths and the built environment. Enhancing these elements can effectively contribute to reducing accidents, traffic volume, and speed, thereby promoting active mobility (Forsyth, 2015; Giuliani and Maternini, 2017; Annunziata and Garau, 2020). The factors most strongly associated with pedestrian and bicycle safeness, generally included in literature and digital assessment models, encompass protection from motorised traffic (accident rates), exposure to hazards (natural or artificial barriers), crime, street lighting, and other environmental issues within urban areas. Some approaches, e.g., T-WSI by Appolloni et al. (2019) and Walkability Index for Historical Centres by Caselli et al. (2021b), evaluated these issues.

Inclusive design, or universal design, aims to ensure that infrastructures and spaces are accessible and suitable for all users, including those most vulnerable due to factors, e.g., age, gender, disability, and social, physical, and cognitive abilities (Gargiulo et al., 2018; Pinna et al., 2020). Its focus lies in accommodating the diverse needs of citizens who encounter common challenges in their travel experiences. To achieve inclusivity, it is crucial to identify factors that eliminate inconveniences by considering the existing urban design, removing barriers, and adapting pedestrian and bicycle paths to make city spaces usable for individuals of all categories. GIS models developed, e.g., by Gaglione, Cottrill, and Gargiulo (2021) and Ewing et al. (2016) identify factors in achieving inclusive design. Models incorporated socio-demographic data related to the quality of the built environment and infrastructure to identify deficiencies and critical issues that need to be addressed. Specifically, several features of the user-friendly design were considered, e.g., pavement conditions, provision of perceivable and legible signs for individuals with sensory limitations and individuals with different levels of experience and literacy (through pictorial, verbal, and tactile means), recognisability of hazardous elements, and paths width to adapt to different physical characteristics, postures, assistive devices, and mobility requirements of users.

Finally, enjoyment refers to the aesthetic aspect, comfort, and quality of the urban infrastructure and space. It includes factors that can enhance the quality of urban design by increasing the satisfaction of integrated pedestrian and cycling networks within the urban environment, thereby promoting social interactions. An aesthetically pleasing design has a positive impact on users' perception and their psychological well-being, engaging them emotionally (Johnson et al., 1995). To promote walkability and cycling in cities, meticulous attention to land use and detail in the design of public spaces is crucial for encouraging leisurely movement and attracting both residents and visitors (Carra, Pavesi, and Barabino, 2023). This helps create available, versatile, captivating, and liveable cities. Environmental factors, e.g., visual harmony among buildings, green elements and spaces, urban furniture, protection from weather conditions, attractive ground-level facades, colours, and functional diversity, collectively contribute to a more enjoyable journey (Ghel, 2013; Fan et al., 2016). Many of these factors were reflected in assessments, e.g., pedestrian environment by D'Orso & Migliore (2020) and urban spaces attractiveness by Telega, Telega, & Bieda (2021).

3. Planning tools and SUMPs in the Emilia-Romagna case

Cities of the Emilia-Romagna Region implemented SUMPs and Bici Plans to support active and sustainable transportation modes. These plans consider many actions to promote walkability and cyclability. Therefore, the analysis aims to identify whether the various factors identified previously in the literature (section 2) are considered within these actions. To this end, the analysis clustered the main actions of fifteen cities and metropolitan areas in the region, using the previously defined categories: urban accessibility by proximity, safety and security, inclusive design, and enjoyment. Selected plans available for consultation were identified through the SUMPs Observatory (L'Osservatorio - Osservatorio PUMS) within the 18 municipalities in Emilia Romagna that have adopted, approved, or initiated the approval process for a SUMP. The consulted SUMPs and Biciplans of these 18 municipalities are listed in Table 1.

Table 1: List of SUMPs and Biciplans, currently in force, consulted for the present research.

City/Metropolitan area	Population[1]	SUMP	Biciplan
Bologna metropolitan area	387.971	2019	2019
Carpi	71.869	2020	2013
Castelfranco Emilia	33.054	2020 (drafting stage)	-
Cattolica	16.543	2016 (drafting stage)	-
Cervia	28.983	2022 (not available)	-
Cesena	95.778	2022	2021
Distretto Ceramico	112.945	2019	2020
Faenza	58.710	2021	-
Ferrara	129.340	2019	-
Forlì	116.440	2020	-
Misano Adriatico	13.948	2019	-
Modena	184.153	2020	2016 (not available)
Parma	196.764	2017	2008
Piacenza	102.465	2020	2022
Ravenna	155.751	2019	2012
Reggio nell'Emilia	169.545	2019	2008
Rimini	149.211	2018	2018 (not available)
Santarcangelo di Romagna	22.148	2022	-

[1] Source: ISTAT (2023). Istituto Nazionale di Statistica. Popolazione residente al 1° gennaio 2023: http://dati.istat.it/Index.aspx?DataSetCode=DCIS_POPRES1; Regione Emilia-Romagna, Autonomie locali, Distretto Ceramico - Unione Comuni. (2020). Banca dati Enti Locali in Rete: https://wwwservizi.regione.emilia-romagna.it/autonomie/anagraficaeellconsultazione/VisualizzaEnte.aspx?ID=537. (accessed on November 2023)

Lastly, it is significant to mention how some of the actions identified by the analysis are repeated within the tables due to their interconnected impact on the various categories being investigated.

Table 2: Main SUMPs-defined actions for urban accessibility by proximity cluster.

	Bologna metropolitan	Carpi	Cesena	Distretto Ceramico	Faenza	Ferrara	Forlì	Misano Adriatico	Modena	Parma	Piacenza	Ravenna	Reggio Emilia	Rimini	Santarcangelo di
Define an Urban Accessibility Plan				•											
Regenerate urban spaces and increase *mixité*			•												
Establish Zones 30 towards a City 30 concept	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Define the primary cycling network	•	•	•	•					•	•	•		•	•	•
Extend and connect cycling and pedestrian paths	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Enhance pedestrian and bicycle connections near major public transport nodes	•			•	•	•	•				•		•	•	
Ensure continuous walking paths near school	•			•		•									
Implement cyclists' wayfinding/signage	•		•	•		•	•	•			•	•	•	•	•
Implement pedestrian wayfinding/signage system	•		•			•	•		•					•	
Increase the supply of bicycle parking	•		•	•	•	•			•		•		•		
Establish bicycle stations near major railway stations				•	•						•				
Plan for a "Park and Walk" system			•												
Implement bike sharing	•		•		•	•	•	•	•	•	•	•	•	•	•
Create "Metrominuto" maps	•						•		•				•		
Enhance cyclists/pedestrians' accessibility to facilities	•	•					•	•					•		•
Tactical urbanism actions			•		•		•								

The analysis of SUMP-defined actions in clusters revealed interesting findings. Notable actions in the "Accessibility by proximity" cluster included the implementation of Zones 30 towards a "City 30" concept, dedicated signage for cyclists, a bike-sharing system, and the expansion and connection of cycling and pedestrian paths (Table 2).
Primarily actions in the "Safety and security" cluster focused on reducing vehicular traffic within the Zones 30, enhancing the visibility of pedestrian and cycling crossings, and establishing secure routes for home-school and home-work travel (Table 3). However, it is worth noting that security-related actions remain limited within SUMPs.
Most frequently employed actions in "Inclusive design" involved implementing Architectural Barrier Removal Plans and ensuring disabled access to public transport stops. Plans for the Elimination of Architectural Barriers (PEBAs) are a tool for monitoring, planning, and designing interventions to achieve optimal use of public buildings and urban spaces for all users. They are regulated in the Italian legislation by law n. 13/1989 for public buildings and law n. 41/1986 for public urban spaces. However,

Table 4 shows a considerable variation in the selection of actions among SUMPs, with five cases devoid of measures to improve infrastructure accessibility for people with disabilities.

Table 3: Main SUMPs-defined actions concerning safety and security cluster.

	Bologna metropolitan	Carpi	Cesena	Distretto Ceramico	Faenza	Ferrara	Forlì	Misano Adriatico	Modena	Parma	Piacenza	Ravenna	Reggio Emilia	Rimini	Santarcangelo di
Expand Pedestrian Priority Zones (PPZ), Residential and “ZTL” Zones	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Improve Zones 30 with urban regeneration and traffic calming interventions	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Prioritise completing of pedestrian/cycling paths in high vehicular traffic roads	●			●	●	●	●						●		
Design pedestrian paths along the outermost part of the road section and separate them from cycling ones	●					●									
Ensure continuous walking paths near schools	●		●	●	●	●							●		●
Define safe home-school/home-work routes	●	●			●	●	●		●	●	●	●		●	
Limit speed/ban motorised traffic near schools	●			●	●	●			●			●		●	
Increase the visibility of pedestrian/cycling crossings	●	●	●	●	●	●	●	●		●	●		●	●	●
Create continuous cycling paths and remove conflicts with motorised vehicles	●					●									
Design bike-boxes at traffic light intersections	●					●			●	●					●
Implement the lighting system	●					●	●			●					
Widen footpaths and add greenery	●		●												
Reduce roadside car parking	●	●	●	●		●									
Monitor and maintain pedestrian/cycling pavements	●					●			●			●		●	
Address high-risk road segments with targeted interventions				●		●			●	●		●	●		
Develop Emergency Mobility Plans also using tactical urbanism			●						●		●				

Table 4: Main SUMPs-defined actions concerning inclusive design cluster.

	Bologna metropolitan	Carpi	Cesena	Distretto Ceramico	Faenza	Ferrara	Forlì	Misano Adriatico	Modena	Parma	Piacenza	Ravenna	Reggio Emilia	Rimini	Santarcangelo di
Establish an Architectural Barrier Removal Plan (PEBA)	●		●			●			●					●	●
Create the Urban Accessibility Plan (PAU)				●								●			

	Bologna metropolitan	Carpi	Cesena	Distretto Ceramico	Faenza	Ferrara	Forlì	Misano Adriatico	Modena	Parma	Piacenza	Ravenna	Reggio Emilia	Rimini	Santarcangelo di
Define an inclusive routes network	•		•			•	•								
Design an orientation system for disabled	•					•									
Install devices for disabilities (LOGES code)	•		•			•									
Install Accessible Pedestrian Signs (APS) at traffic lights	•					•									
Equip public transport stops for disabled access	•			•		•			•			•	•		
Widen pedestrian paths and remove obstacles and bottlenecks			•										•		
Monitor and maintain pedestrian/cycling pavements	•					•			•						
Place charging columns for motorised wheelchairs												•			
Improve universal accessibility near public facilities												•		•	

Actions in the "Enjoyment" cluster highlighted common practices, i.e., implementation of bike sharing, support services and facilities for the cycling network, installation of street furniture along pedestrian paths, and improvement of pavements and signage in pedestrian and cycling paths (Table 5).

Table 5: Main SUMPs-defined actions concerning enjoyment cluster.

	Bologna metropolitan	Carpi	Cesena	Distretto Ceramico	Faenza	Ferrara	Forlì	Misano Adriatico	Modena	Parma	Piacenza	Ravenna	Reggio Emilia	Rimini	Santarcangelo di
Enhance urban space attractiveness by urban plan (PUG) and focusing on city centres and Zones 30	•		•			•							•		
Place additional street furniture along pedestrian paths	•	•	•		•		•		•		•	•			
Widen footpaths and add greenery	•	•	•		•		•		•						
Improve pedestrian/cycling paths pavement and signage	•		•		•	•			•	•		•		•	
Provide cycling network support services and facilities (e.g., storage, shops, and pumps)	•		•		•	•	•	•	•	•	•	•	•	•	•
Implement bike sharing	•		•		•	•	•	•	•	•	•	•	•	•	•
Assess enjoyment factors via public participation		•													
Apply tactical urbanism to revitalise urban spaces			•												
Draft a Bicycle Parking Plan				•	•								•		

Establish bicycle parking standards and office sanitation requirements	•	•

Lastly, a keyword search was also carried out within the analysed documents related to the drafting of SUMPs to identify specific references to the use of GIS methodologies for the analysis and monitoring of interventions, which did not yield any relevant results.

4. Discussion and Conclusions

Overall, the analysis of SUMPs revealed a clear emphasis on actions toward the enhancement of cyclability rather than walkability. This is even evident through the inclusion of a dedicated instrument like Bici Plans, which focuses on cycling. However, it is crucial to recognise the significance of pedestrian mobility as the primary and essential mode of transport for people, even when complemented by other modes. Therefore, there is perhaps a need to place greater attention on pedestrian mobility enhancement within SUMPs.

Moreover, the actions within the SUMPs addressing inclusive design are limited. Thus, it might be good practice for SUMPs to refer to some of the specific plans dealing with this issue (i.e., PEBAs) with reference to the main actions defined within them.

Additionally, despite the capabilities and potential of GIS-based techniques and methodologies implemented by researchers, their practical use in the analysed SUMPs is rather limited and need to be more explicit.

The application of GIS-based methods and techniques can potentially refine the management, analysis and monitoring of urban data in the development of SUMP's active mobility actions. However, there is a lack of insight into how these rigorous analytical approaches can best be integrated into urban planning and transport practice and also why the steps of research and practice are still not so convergent.

Finally, future developments will involve a comprehensive exploration of GIS-based models for evaluating cycling and walking with respect to the categories previously defined. By aligning the results of the present study with GIS-based models applied, it will investigate GIS effectiveness and applicability in assessing the impact of SUMPs actions in improving cycling and walking.

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Credit authorship contribution statement

The authors jointly designed and contributed to the paper. Conceptualisation, all authors; methodology, B.C., S.R.; formal analysis, L.J.M., F.S.; data curation, L.J.M., F.S., validation, M.C., B.C., S.R.; writing—original draft preparation, F.S. (§ 1, 2, 4) and L.J.M. (§ 1, 3, 4); writing—review and editing, M.C., B.C., S.R.; supervision, B.C., S.R.

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