Exploring the Convergence of Sustainable Mobility and GIS data Processing in Urbanism Education and Research

Explorando la Convergencia de la Movilidad Sostenible y el Procesamiento de Datos GIS en la Educación e Investigación en Urbanismo

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Abstract- The utilization of spatial information technology presents a promising scene for students and practitioners in the field of Urbanism. The technological assistance that can be used in the urban planning brings together the diverse trends in research related to information within cities. This study works with different fields under the same umbrella, integrating Big Data on one side, and Urbanism, on the other. This study aims to provide a reflection over the use of technology through a practical approach. By doing so, it seeks to understand the benefits derived from the ongoing advancements in geospatial technology and foster a comprehensive understanding of its implications in the realm of urban design education and practice.

Keywords: Walkable Cities, Urban Design Education, Digital Data Sources

Resumen- La utilización de la tecnología de la información espacial presenta un escenario prometedor para estudiantes y profesionales en el campo del Urbanismo. La asistencia tecnológica que se puede utilizar en la planificación urbana reúne las diversas tendencias en la investigación relacionada con la información dentro de las ciudades. Este estudio trabaja con diferentes campos bajo un mismo paraguas, integrando Big Data por un lado y Urbanismo por otro. Este estudio tiene como objetivo proporcionar una reflexión sobre el uso de la tecnología a través de un enfoque práctico. Al hacerlo, busca comprender los beneficios derivados de los avances en curso en la tecnología geoespacial y fomentar una comprensión integral de sus implicaciones en el ámbito de la educación y la práctica del diseño urbano.

Palabras clave: Ciudades Caminables, Educación en Diseño Urbano, Fuentes de Datos Digitales

1. INTRODUCTION

As urbanization continues at a rapid pace, there is increasing attention on achieving sustainability objectives within cities. To achieve this, it is necessary not only to envision sustainable cities and implement strategies but also to assess progress in sustainable urban development (Cohen, 2017). Sustainable mobility and digital transformation have emerged as critical areas of focus in the pursuit of a more environmentally friendly and technologically advanced society (M. Sanchez-Sepulveda et al., 2019). Digital transformation refers to the significant changes occurring in society, industries, and organizations due to advancements in digital technologies such as Artificial Intelligence, Big Data analytics, Cloud Computing, and the Internet of Things (IoT) (Feroz et al., 2021; Sánchez Sepúlveda et al., 2019).

The COVID-19 pandemic has accelerated digital processes, allowing for a reconsideration of urban environments, movement, and existence through the employment of new technologies and solutions, with the global aim to achieve several goals, including reducing greenhouse gas emissions, improving urban livability, and creating more space by encouraging a shift from car usage to active modes of transportation. Fifteen-minute cities, investment in algorithms for public mobility, conversion of abandoned areas into green spaces, are only some of the solutions adopted around the world in both developed and developing countries (Freije, 2022).

The design and layout of cities greatly influence walkability, and it has profound implications for public health, transportation efficiency, and quality of life. Prioritizing pedestrians and promoting cycling are responses to a broader societal shift, and in this context, social innovation serves as a supplementary mechanism to address social issues that extend beyond the traditional focus of public policies centered on efficient mobility and environmental impact reduction. The health and well-being of a population are influenced by various factors, including biological and genetic factors, lifestyle choices, and socioeconomic conditions. However, research has indicated that environmental factors, such as the layout of access points, the design of facilities, and the utilization of green spaces, also play a significant role in determining the health outcomes of individuals within a community (M. Sanchez-Sepulveda, 2015).

Working throughout this topic, the project we are working on has the main objective to establish a data analysis that can accomplish the following: (1) provide an accurate assessment of the condition, distribution, and dynamics of street usage in Barcelona, (2) identify the urban design parameters that have the most significant influence on pedestrian traffic and

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cyclability, and (a) objectively classify the healthiness of each street for citizens, resources, and the environment, and (b) offer decision support tools for professionals and students in training to create healthier urban spaces.

To work on these objectives, we brought the challenge for students to explore and understand the complexities of urban planning, sustainability, and the role of mobility and different sources of data to shape the future of cities. We worked with the Town Planning subject that is taught in the undergraduate degree of the School of Architecture of La Salle – Ramon Llull University and to the Master's Degree in Data Science of the same university. The specific project serves as a case study for students to analyze real-world challenges and apply the concepts learned in class to propose solutions for sustainable urban development in a specific context. The work presented in this article are based on the initial phase, as the introductory research for the student's project development.

2. CONTEXT & DESCRIPTION

Cities such as Barcelona, characterized by concentrated populations and services, dense public transport networks, and dedicated pedestrian and cycling areas, tend to have more sustainable transportation patterns. However, the city also faces significant pollution issues, particularly regarding suspended particles and nitrogen dioxide, primarily caused by traffic. In fact, pollution levels in Barcelona exceed the air quality standards set by the World Health Organization (WHO), according to the 2021 report from the "*Contaminació.Barcelona*" portal. Pedestrians as the protagonists of mobility in the city through the transformation of public space into a friendlier, less polluted and safer environment are part of the series of measures that includes the Climate Emergency Declaration (*Declaració d'emergència climàtica*, s. f.).

Barcelona City Council commissioned La Salle-URL to develop a proposal for urban measures to improve health in Barcelona and to serve as a tool that can be extrapolated to other cities. The challenge is to analyze mobility in the different neighborhoods of Barcelona and design indicators and urban strategies to achieve an accessible, sustainable, and healthy mobility of people and goods in Barcelona that allow quantifying the potential of various areas for social and economic interaction within from the city.

The objectives explore the key principles and relationships between mobility and health with the goal of inspiring the need for change and formulating a comprehensive and innovative proposal to impact mobility habits. The project begins with the focus on relevant and contemporary issue of urban accessibility and diversity, that are so urgently needed to be advanced in the cities due to many factors and issues, such as climate change, air pollution, economic and gender inequality, and many others. The research project brings Barcelona, as a case study city to map and operatively discover a) the factors; b) the opportunities, and c) possible strategic solutions to the problems stated, that in the close future could serve as a practical research guide for any similar urban situations.

- Three main categories of city users were considered while thinking on variables to be mapped: pedestrians, cyclists, and vehicles.
- Three groups of users of the open spaces in the city: public spaces, sidewalks, and roads – the elements that form the core structure of the open spaces in any urban environment.

The pedestrians and vehicles are the two extremes, meaning the first, are in the minimal use of the private transport, that is to say, by the current urban standards, needs to be reduced in the amount because of environment pollution; and the vehicles users that are of 100% in demand of private transport.

To conclude, while pedestrians and vehicles users are the two extreme city users' groups: "*Cyclists have the same rights and responsibilities as motorists. In the eyes of the law, if you are riding a bicycle on the road, you are considered a vehicle on the road. When you dismount and walk alongside your bicycle, you are considered a pedestrian and have the same rights as a pedestrian.*" (*On the Road – AAA Exchange*, s. f.).

Considering all three groups of users, to have a bigger scope of work and more reliable conclusions made from the current research; the following three categories of mappings were considered: attraction points (A), safety and street continuity (B), and accessibility (C). (A) to be the most probable final-destination points for any user; (B) to be the path to those destination points; and (C) to be the quality of those paths to the destination points considered.

Furthermore, in order to be actually able to map more tangible topics, the five factors to each three categories were chosen (Figure 1). The Attraction Points are (A1) the bicycle related services; (A2) the "bicycle friends" buildings (*Edificios Amigos de la Bici de los equipamientos públicos de la ciudad de Barcelona - Open Data Barcelona*, s. f.); (A3) parks and gardens; (A4) CAPS and hospitals; and (A5) markets. Those attraction points were chosen to have quite close relation to the cycling, since it is one of the main objectives of this research, as well as the places that by the concept of 15-minute city, needs to have proximity to each other. The Street Safety and Continuity define (B1) biodiversity; (B2) roadside trees; (B3) current bicycle paths (lanes within the roads); (B4) streets in which it is possible to cycle because of the speed limits, but which do not have the proper bicycle lane yet; and (B5) drinking water fountains. And the last category of Accessibility is (C1) bicycle parking spots; (C2) air quality; (C3) noise levels; (C4) population age groups; and (C5) local and foreign population balance.

Figure 1. Variables.

		1	2	3	4	5
A	ATTRACTION POINTS	Bicing services	"Bicing friends" buildings	Parks and gardens	CAPs and hospitals (safety)	Markets
B	SAFETY & STREET CONTINUITY	Biodiversity	Roadside trees	Current bicycle paths (lanes within the roads)	Cycliable streets (no lane but correct speed)	Drinking water fountains
C	ACCESSIBILITY	Bicycle paking	Air quality (emissions)	Noise levels	Population age groups (2020)	Local vs foreign population

Using these more concrete factors, it was possible to produce various mappings using the following sources, mainly from the Open Data BCN, which is data publicly available. This source is a movement promoted by public administrations with the main objective of making the most of available public resources, exposing the information generated or guarded by public bodies, allowing its access and reuse for the common good and for the benefit of interested private and public entities.

3. RESULTS

Using the QGIS program the maps were produced and joined strategically. The maps are joined by related topics. It is used 2 topics to be mixed maximum, in order to have clarity of the resulted opportunity areas, and the bicycle paths map used as a base map. The following are three examples of case studies areas that have been studied.

Roadside trees contribute to the walkability and attractiveness of neighborhoods, providing shade and a pleasant environment for pedestrians and cyclists. The distribution of drinking water fountains ensures that residents and visitors have access to hydration points, encouraging walking and cycling and reducing the need for private vehicle use (Figure 2).

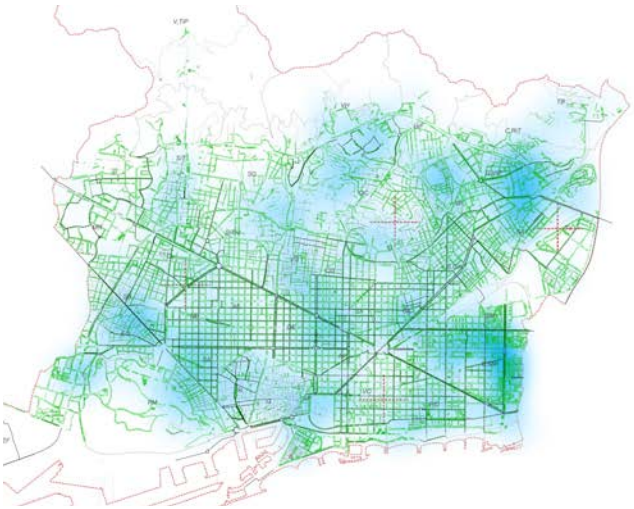

Figure 2. (B2) roadside trees in green + (B5) drinking water fountains in blue.

Mapping the locations of hospitals is crucial for understanding healthcare accessibility in different neighborhoods. Easy access to healthcare facilities is essential for the well-being and safety of residents. Analyzing population age groups provides insights into the diversity of the community, identifying areas with higher concentrations of older or younger residents who may have distinct mobility needs. Understanding demographic diversity and healthcare accessibility can help identify areas that require specific mobility solutions and services to cater to the needs of different population segments (Figure 3).

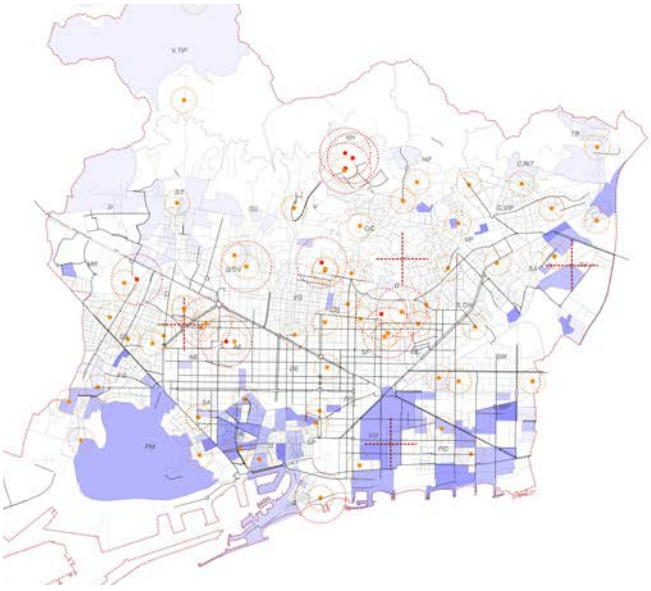

Figure 3. (A4) CAPs and hospitals in red dots + (C4) population age groups in purple (diversity).

Mapping bicycle parking spots helps assess the availability of secure and convenient parking options for cyclists, encouraging active modes of transportation and reducing car dependency. Noise levels play a significant role in urban livability. High noise levels can deter pedestrians and cyclists from using certain routes and impact the overall well-being of residents. By analyzing noise levels and bicycle parking availability, planners can identify areas where noise reduction measures and improved cycling infrastructure can be implemented to enhance the overall mobility experience. (Figure 4).

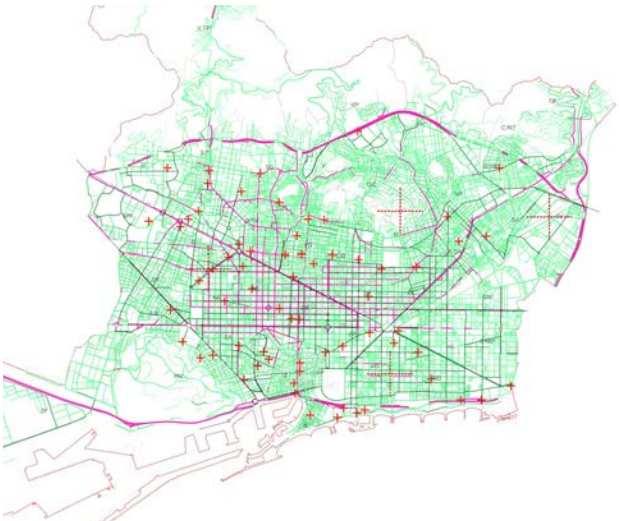

Figure 4. (C1) bicycle parking in red crosses+ (C3) noise levels in pink.

Once having the joined maps, it will be defined the indicators to measure the “hot points” found. To set a scale different literature will be analyzed. This allows us to understand the strengths and weaknesses of different neighborhoods in terms of mobility and accessibility. Based on this analysis, indicators can be developed to quantify the potential of each area for social and economic interactions, considering factors like walkability, cycling infrastructure, healthcare accessibility, noise levels, and demographics. Using this data-driven approach, urban strategies can be formulated to improve the mobility of people and goods, with a focus on creating inclusive and sustainable urban environments. These strategies may involve enhancing public transportation networks, expanding cycling lanes, improving pedestrian infrastructure, and implementing noise reduction measures.

Spatial information technology, including Geographic Information Systems (GIS) and data analytics, as part of the research and into the educational context, students and researchers can become more adept at leveraging data and technology to address urban challenges, ultimately contributing to the development of sustainable and walkable cities. The use of digital technologies and data analysis in the project enhances students' technical skills, fosters interdisciplinary thinking, and prepares them to address sustainability challenges in urban planning (M. V. Sanchez-Sepulveda et al., 2020). It also equips them with valuable practical experience and collaboration skills needed to create healthier and more sustainable urban environments.

4. Conclusions

Based on the results obtained in the present study, some clear recommendations for the educational context regarding walkability can be made:

Integrate Walkability Concepts in Urban Design Education: Walkability is a crucial aspect of urban design that significantly impacts public health, transportation efficiency, and overall quality of life. Therefore, it is essential to incorporate walkability concepts and principles into urban design education programs. This includes highlighting the significance of pedestrian-friendly infrastructure, street safety, and accessibility for creating healthier and more sustainable urban spaces.

Promote Interdisciplinary Perspectives: The study highlights the value of an interdisciplinary approach to understanding the complex relationships between urban design, mobility patterns, and public health. Educational institutions should encourage collaboration between urban planners, architects, public health experts, and transportation professionals to foster comprehensive solutions for walkable cities.

Emphasize the Role of Digital Transformation in Walkability: With the increasing importance of digital transformation in urban development, educators should educate students about the potential of digital technologies, such as Big Data and Geographic Information Systems (GIS), in analyzing urban mobility patterns and assessing walkability from open-data repositories. Teaching students how to leverage these tools can contribute to evidence-based urban planning.

Encourage Research and Case Studies: Educational institutions can encourage students to conduct research and case studies on walkability in their local contexts. These studies can focus on assessing the condition, distribution, and dynamics of street usage, identifying urban design parameters that influence pedestrian traffic and cycling, and objectively classifying the healthiness of streets.

Address Sustainability Challenges in Urban Mobility: As cities face challenges related to climate change and pollution, educational programs should emphasize the importance of sustainable mobility solutions. Students can explore and propose innovative strategies to reduce greenhouse gas emissions, promote active transportation modes, and improve air quality through sustainable urban mobility plans.

Advocate for Pedestrian-Centric Policies: Urban design education can play a crucial role in advocating for pedestrian-centric policies and creating cities that prioritize the needs and safety of pedestrians. Encouraging students to engage in urban design projects that prioritize pedestrians over vehicles can contribute to creating healthier and more livable urban environments.

Engage with Local Authorities and Urban Planning Initiatives: Educational institutions can collaborate with local authorities and ongoing urban planning initiatives to contribute expertise and research findings related to walkability. Such collaborations can lead to real-world applications of research findings and practical improvements in urban design and mobility.

By incorporating these recommendations into urban design education, students can develop a better understanding of the importance of walkability and play an active role in shaping healthier and more sustainable cities for the future. The case study areas will be used to later define which exact factors and variables are in a good condition and which need to be worked with.

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