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The importance of IoS (internet of services) for urban mobility, with emphasis on the shared bicycle service in São Paulo city, Brazil

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Abstract: The economic growth that took over major cities worldwide, including São Paulo in the 1950s, was followed by high population growth, urban sprawl, and pollution. The increasing number of motor vehicles circulating in cities is a major global concern as it raises the number of traffic accidents and alarmingly elevates the CO₂ (carbon dioxide) levels in the atmosphere, leading to a rise in the number of people with cardiorespiratory diseases. Urban mobility, air quality, and mortality rates due to traffic accidents have been discussed by the high echelons of global meetings on the subject, highlighting the importance of active mobility. In this sense, attention has been drawn to the use of bicycles as a mode of transportation. This article seeks to answer the question: How do bikesharing applications enable shared bicycle services in the city of São Paulo? The research objective is to identify, through a literature review, the importance of the Internet of Services (IOS) for urban mobility in providing bicycle-sharing services."

Keywords: Bikesharing; urban mobility; traffic jams; IOS.

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1. Introduction

The 1950s were marked by a significant industrial growth in various parts of the world. In Brazil, the region that received the highest number of industries was the Southeast region, with São Paulo standing out. The process of industrialization was accompanied by economic growth, an increase in population density, peripheralization, gentrification, leading to large commuting movements. Consequently, congestion, delays, and excessive pollution generated by the burning of fossil fuels, raised CO₂ levels in the atmosphere and increasing the risk of cardiorespiratory diseases.

According to the Brazilian Institute of Geography and Statistics [1] in 2010, São Paulo had 11.2 million inhabitants. In the year 2022, the same report indicated 11.4 million people relying on public transportation, getting stuck in traffic congestion as they strive to meet their needs for work, education, health, and leisure. The accelerated growth in the city's population is evident.

The substantial investments in public policies for roads and structures for the use of motor vehicles gradually led to the disappearance of other forms of mobility. In the year 2022, São Paulo had a fleet of 5.9 million vehicles occupying an area of 1521 km², with the aggravating factor that 32% of trips used individual vehicles with an occupancy rate of 1.5 persons per journey [2]. This phenomenon is repeated in major urban centers worldwide, becoming a topic of significant discussions at the United Nations summit with the aim of finding alternatives to alleviate the impact of this scenario on people's quality of life and the environment.

The UN 2030 Agenda [3], published by UN Member States, defined 17 Sustainable Development Goals. Notably among them are the reduction of traffic accident deaths, a decrease in the mortality rate from respiratory diseases, and the promotion of sustainable cities and communities, which propose reducing breathable particles in cities. To achieve these goals, the use of active mobility is highlighted as a sustainable mobility alternative, understood as a means of transportation powered by human propulsion, either by walking or cycling [4].

The use of bicycles as a mode of transportation has been widely embraced in European countries, particularly in the Netherlands, where bicycles have gradually taken over the streets in major urban centers. In São Paulo, in the year 2020, bicycle counters were installed in the South Zone, allowing for the observation of a 30% increase in cyclists during the month of April compared to the same period the previous year [5].

The Brazilian urban mobility plan [6], supported by the Brazilian National Urban Mobility Law, prioritizes pedestrians and cyclists in traffic, which strengthened the implementation of bike lanes, cycle paths, bike routes, bike racks, bike shelters, among others essential structures for promoting the use of bicycles as a key player in active mobility.

The change in legislation and technological advancements were two fundamental factors for the emergence of new businesses related to sustainable transportation: bike-sharing services.

From this standpoint, the main objective of this research is to identify the importance of the Internet of Services (IoS) for urban mobility through the provision of shared bicycle services.

2. Methodology

The methodology of this paper consists in an extensive literature review to understand the historical and theoretical context related to urban mobility, industrial growth, and the use of bicycles as a means of transportation.

Furthermore, the literature review explores shared bicycle services, active mobility, urban public policies, and the influence of the Internet of Services (IoS) on urban mobility using São Paulo city, Brazil, as a reference.

3. Urban Mobility and Bikesharing Service

Urban mobility is defined as the movement of people and goods, encompassing both collective and individual transportation, whether motorized or not [7]. It is a fundamental factor for promoting economic and social development. Through urban mobility, individuals carve out their social space, pursue income sources, improve their educational levels, and have opportunities for leisure. For it to be considered sustainable, the movement of people and products must occur rationally, with minimal environmental impact. By promoting the connection of people to city opportunities such as schools, work, entertainment, health, among others, urban mobility demonstrates its role in favoring socioeconomic development when utilizing an inclusive road system that preserves environmental quality [8].

The excessive use of motor vehicles, besides being highly detrimental to health due to sedentary behavior and high CO₂ emission rates, also hinders commercial development. Commercial areas become mere transit zones. The use of bicycles as a mode of transportation allows for greater interaction between cities and cyclists.

The bike-sharing system service called “tembici Itaú” began in 2012 in Rio de Janeiro and later expanded to São Paulo, providing 300 stations and 3,000 bicycles in collaboration with the São Paulo City Hall Government. The platform on which Bike Itaú, Figure 1, operates allows users to pick up a bicycle at one station and return it to another in a different area. The development of this service to its current level was made possible through the advancement of media technologies, including smartphones, tablets, and other devices that rely fundamentally on location-based services such as GPS (Global Positioning System), GIS

(Geographic Information System), and web mapping services, connecting users, platforms, companies, among others [9].

The importance of the internet in services for urban mobility can be observed in four fundamental aspects [9]:

a) **Health:** If the population adopts bicycle use as a means of transportation, there would be a decrease in the number of people with circulatory and cardiovascular diseases, as well as a reduction in the number of people with diabetes. These health benefits could reduce São Paulo's SUS (Unified Health System) spending by R\$ 34 million.

b) **Individual Economy - Income:** Workers with shorter commuting times tend to show higher productivity. For public transportation users, bicycle use could represent a 17% reduction in transportation expenses, while for São Paulo residents using private motorized transportation, it could mean an average monthly savings of up to R\$ 450.00.

c) **Impact on the Municipality's Economy:** Increased productivity and consequent GDP growth with reduced commuting time.

d) **Environmental Impact:** Considering the potential for cycling and the fact that bicycles emit zero CO₂, the impact of reducing pollutants by replacing cars with bicycles is significant.



Figure 1. Tembici (Bike-Itau) station in São Paulo. Source: CC BY-NC-ND 3.0

The use of shared bicycles, often employed in users' first and last miles, encourages the use of public transportat by promoting intermodality between bus terminals, metro or train stations. In addition, there is apps that display available service stations, cycle lane routes, or bike paths that allow cyclists to travel more safely. The bicycle-sharing service provides customers with a vehicle (bicycle) in a virtual environment where customers can also pay for the rental service using debit or credit cards. "The bicycle rental platform consists of a solution with hardware embedded in a mobile device. The hardware is responsible for supporting the bicycle and providing security using an electromagnetic lock" [10].

In more peripheral neighborhoods, short-distance delivery services are carried out by bicycles. The Aliança Bike [11] identified that 2,349 daily deliveries are made by bicycles and tricycles in the Bom Retiro neighborhood - São Paulo, with part of these operations performed by shared bicycles.

4. Final Remarks and Outlook

It is of utmost importance to observe the impact on the economy, health, mobility, and the environment provided by the use of shared bicycles. The inclusion of different transportation modes, besides promoting equity, fosters social development.

Neighborhoods farther from the center of São Paulo often lack infrastructure that allows their residents access to social development facilities (health, education, work, and lei-

sure), forcing them into commuting. Unfortunately, these individuals may not have the financial means to pay for a bus, or the neighborhood may not be served by subway and train networks. The use of public shared bicycles can provide opportunities for these people.

The level of importance of the Internet of Services (IoS) in the development of urban mobility is noteworthy, as it makes it more inclusive, provides opportunities to people, meets the requirements of the UN Sustainable Development Goals (SDGs), promotes job opportunities, and is favorable to public health and the environment. This makes it sustainable in the most comprehensive sense of the word, benefiting the environment, preserving the planet, maintaining health, and enhancing quality of life.

Finally, the use of bicycles as a means of transportation promotes more interaction between the user and the city, benefiting local commerce and generating new demands for services and business opportunities.

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References

1. IBGE – Instituto Brasileiro de Geografia e Estatística. <https://www.ibge.gov.br/>. Acesso em 23 de outubro de 2023
2. CET. Companhia de Engenharia de Tráfego. São Paulo. Mobilidade no Sistema Viário Principal Volumes e Velocidades 2019 – disponível em <http://www.cetesp.com.br/sobre-a-cet/relatorios-corporativos.aspx> - acesso em: 12 de jan. 2023.
3. Objetivos de Desenvolvimento Sustentável – Agenda 2030 – Disponível em: <https://odsbrasil.gov.br/objetivo/objetivo?n=11> – acesso em 12 jan. 2023
4. POJANI, D.; STEAD, D. Policy design for sustainable urban transport in the global south. *Policy Design and Practice*, v. 1, n. 2, p. 90–102, 3 abr. 2018.
5. ACIOLI, I. S. D. et al. O papel da bicicleta durante e após a pandemia do novo Coronavírus. p. 8, 2020.
6. Plano de Mobilidade de São Paulo. Josias Lech, , 2015. Disponível em: <https://www.prefeitura.sp.gov.br/cidade/secretarias/upload/chamadas/planmobsp_v072__1455546429.pdf>
7. PERO, V.; STEFANELLI, V. A QUESTÃO DA MOBILIDADE URBANA NAS METRÓPOLES BRASILEIRAS. *Revista de Economia Contemporânea*, v. 19, n. 3, p. 366–402, dez. 2015.
8. GOMIDE, A. Á., E GALINDO, E. P. A mobilidade urbana: uma agenda inconclusa ou o retorno daquilo que não foi. *Estudos Avançados*, 27(79), 27-39, 2013.
9. SCHNEIDER, Luciana N.; COSTA, Helen F.; CIPULLO, Guilherme M. Estratégias Itaú Unibanco para o BIG Push da Mobilidade urbana. Disponível em: [Caso118-EstrategiaItaúUnibancoMobilidadeUrbana.pdf](#) (cepal.org). Acesso em 27 jan. 2023.
10. CARVALHO, J. G. A. et al. Vá de Bike: Plataforma IoT para Aluguel de Bicletas. *Anais do XLI Simpósio Brasileiro de Telecomunicações e Processamento de Sinais. Anais... Em: XLI SIMPÓSIO BRASILEIRO DE TELECOMUNICAÇÕES E PROCESSAMENTO DE SINAIS. Sociedade Brasileira de Telecomunicações, 2023. Disponível em: <<https://biblioteca.sbrt.org.br/articles/4449>>. Acesso em: 13 dez. 2023*
11. Aliança Bike (2018) Logistics Cycle: deliveries of bicycle and tricycle in Bom Retiro. Report. Disponível em: http://www.aliancabike.org.br/assets/_docs/20_04_2018_16_44_ciclogistica_bom_retiro