CERIS: Civil Engineering Research and Innovation for Sustainability

Dynamic virtual bicycle-sharing system stations location framework – a GIS-MCDM approach

Summary

Bike-Sharing Systems (BSS) are important for achieving urban transportation sustainability goals. A comprehensive literature review was conducted on two BSS typologies, Station-based (SBSS) and Dock-less (DBSS), respectively, to understand their functionality and identify their main problems and improvement opportunities. For the case of SBSS, one of the critical problems was the unbalance of bicycle inventory, when empty or full stations prevent normal usage and induce dissatisfaction in users. On the other hand, in DBSS, parking disarray harms the city environment.
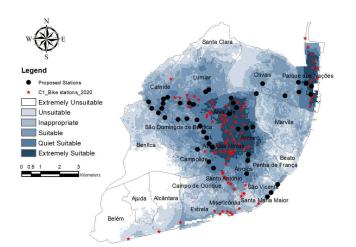
To minimize the two mentioned problems, a combination of both systems, named "Mixed eBike Sharing System" (MeBSS), is proposed in this study under the concept of "dynamic virtual station" (DVS). Unbalanced stations in SBSS and incorrect bicycle parking in DBSS require improving the system's operation. For instance, increase the number of stations and parking locations, better location of those facilities, and incorporate the analysis of historical transaction data patterns of station or parking location.

Multi-criteria decision-making (MCDM) techniques and geographical information systems (GIS) analysis were used in the case study of Lisbon's BSS, Gira, to propose and rank locations for DVSs, and to improve it through the adaptation to a MeBSS. A total of 45 suggested locations in Lisbon were proposed based on Gira transaction data and other criteria identified in the literature as relevant and ranked with the TOPSIS technique.

The study concludes that a hybrid approach like the proposed MeBSS would improve the system's functionality. The combined MCDM-GIS methodology can provide valuable locations for its expansion. A set of general guidelines is included to assist the design of SBSS expansion or adaptation to MeBSSs.

Keywords

Bike-Sharing System (BSS), Geographic Information System (GIS), MCDMAHP, site selection, Dynamic Virtual Station (DVS).

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