

Understanding the use of bicycle sharing systems with statistics

April 4 2022



Bicycle sharing systems are a clean and healthy alternative to public transport in large cities. In a new study, TUS researchers explore their usage patterns to make sure all stations have enough bicycles available for users at all times. Credit: James Wheeler at Openverse

Bicycle sharing systems (BSSs) are a popular transport system in many

of the world's big cities. Not only do BSSs provide a convenient and eco-friendly mode of travel, they also help reduce traffic congestion. Moreover, bicycles can be rented at one port and returned at a different port. Despite these advantages, however, BSSs cannot rely solely on its users to maintain the availability of bicycles at all ports at all times. This is because many bicycle trips only go in one direction, causing excess bicycles at some ports and a lack of bicycles in others.

This problem is generally solved by rebalancing, which involves strategically dispatching special trucks to relocate excess bicycles to other ports, where they are needed. Efficient rebalancing, however, is an [optimization problem](#) of its own, and Professor Tohru Ikeguchi and his colleagues from Tokyo University of Science, Japan, have devoted much work to finding optimal rebalancing strategies. In a study from 2021, they proposed a method for optimally rebalancing tours in a relatively short time. However, the researchers only checked the performance of their algorithm using randomly generated ports as benchmarks, which may not reflect the conditions of BSS ports in the real world.

Addressing this issue, Prof. Ikeguchi has recently led another study, together with Ph.D. student Ms. Honami Tsushima, to find more realistic benchmarks. In their paper published in *Nonlinear Theory and Its Applications, IEICE*, the researchers sought to create these benchmarks by statistically analyzing the actual usage history of rented and returned bicycles in real BSSs. "Bike sharing systems could become the preferred [public transport](#) system globally in the future. It is, therefore, an important issue to address in our societies," Prof. Ikeguchi explains.

The researchers used publicly available data from four real BSSs located in four major cities in USA: Boston, Washington DC, New York City, and Chicago. Save for Boston, these cities have over 560 ports each, for a total number of bicycles in the thousands.

First, a preliminary analysis revealed that an excess and lack of bicycles occurred across all four BSSs during all months of the year, verifying the need for active rebalancing. Next, the team sought to understand the temporal patterns of rented and returned bicycles, for which they treated the logged rent and return events as "point processes."

The researchers independently analyzed both point processes using three approaches, namely raster plots, coefficient of variation, and local variation. Raster plots helped them find periodic usage patterns, while coefficient of variation and local variation allowed them to measure the global and local variabilities, respectively, of the random intervals between consecutive bicycle rent or return events.

The analyses of raster plots yielded useful insights about how the four BSSs were used in their respective cities. Most bicycles were used during daytime and fewer overnight, producing a periodic pattern. Interestingly, from the analyses of the local variation, the team found that usage patterns were similar between weekdays and weekends, contradicting the results of previous studies. Finally, the results indicated that the statistical characteristics of the temporal patterns of rented and returned bikes followed a Poisson process—a widely studied random distribution—only in New York City. This was an important find, given the original objective of the research team. "We can now create realistic benchmark instances whose temporal patterns of rented and returned bicycles follow the Poisson process. This, in turn, can help improve the bicycle rebalancing model we proposed in our earlier work," explains Prof. Ikeguchi.

Overall, this study paves the way to a deeper understanding of how people use BSSs. Moreover, through further detailed analyses, it should be possible to gain insight into more complex aspects of human life, as Prof. Ikeguchi remarks that they "believe that the analysis of BSS data will lead not only to efficient bike sharing but also to a better

understanding of the social dynamics of human movement."

In any case, making BSSs a more efficient and attractive option will, hopefully, make a larger percentage of people choose the bicycle as their preferred means of transportation.

More information: Honami Tsushima et al, Statistical analysis of usage history of bicycle sharing systems, *Nonlinear Theory and Its Applications, IEICE* (2022). [DOI: 10.1587/nolta.13.355](https://doi.org/10.1587/nolta.13.355)

Provided by Tokyo University of Science

Citation: Understanding the use of bicycle sharing systems with statistics (2022, April 4)
retrieved 23 June 2024 from <https://phys.org/news/2022-04-bicycle-statistics.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.