How Bike Sharing Could Become Mainstream

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Bike sharing could scale up enough to make a real impact on urban air pollution and plug public transport gaps.

Today's traffic-choked city streets are a major contributor to the **blight on public health** that is air pollution. Research suggests that auto emissions comprise an estimated 45 percent of urban air pollution in Europe, a figure that rises to as much as 80 percent in some Asian cities. In an attempt to encourage a cleaner commute, major cities from Shanghai to Chicago have recently introduced bike-sharing systems, whereby commuters can cheaply rent public bikes to travel between curbside docking stations.

Bike-sharing is not a new concept—in fact, it dates back to the 1950s—but it has resonated with contemporary eco-conscious urbanites. Still, at this early stage participation has been underwhelming in many cities. Some bike-sharing systems have reached financial self-sustainability—but the goal of revolutionising the commute by getting cars off the road remains far off. Meanwhile, most analysis of bike-sharing has focused on aspects of the

technology and equipment rather than how to design such a system to maximise ridership. Our recent working paper "**Bike-Share Systems: Accessibility and Availability**" investigates this neglected topic.

Snapshots of the system

Paris is home to one of the world's most successful bike-sharing programmes. The Vélib' system has the most bikes per capita (about 17,000) of any major city and facilitated nearly 173 million rides in the six years following its launch in July 2007. Vélib's mobile app gives users a real-time picture of bike availability across the system's more than 1,200 stations. Using this technology, we were able to take "snapshots" of activity in the ten central districts of Paris (arrondissements 1-10) at two-minute intervals during the peak summer months of 2013. All told, our research incorporated 22 million snapshots of 349 bike stations.

Accessibility vs. availability

Our data enabled us to place accessibility (the number of stations located in a given area) and availability (the number of usable bikes at each station) in direct juxtaposition. When a particular station ran out of bikes, we could measure how ridership was affected by simply observing whether, and by how much, usage increased at neighbouring stations. We found that the attraction of bike-sharing is highly local. If the next station was more than a few blocks away, people couldn't be bothered walking there and chose to get to their destination some way other than biking. Remember that we conducted the study during summer, when weather would be most favourable for walking.

The median system user was willing to walk only 150 meters (about two blocks) to the next station. Of course, some would walk more, but in general more and more demand diffused out of the system the farther apart stations were spaced beyond the 150-meter mark. The Vélib' system is extremely vulnerable to this effect, as it turns out—we saw that 95 percent of a given station's demand was lost when it ran out of bikes.

Lost opportunities

Assuming a finite pool of resources, bike-sharing system administrators must make spending decisions according to a trade-off between accessibility and availability. Clearly, this is not a zero-sum game; both of these matter but it's

important to know how to balance the two to attract the most riders. In this way, bike-sharing resembles other location-based services such as hotel chains and retail stores, which are designed with similar trade-offs in mind.

Our mathematical model, created from the Vélib' dataset, shows the tangible benefits of increasing either accessibility or availability. We posit that increasing the bike-availability of all stations by 10 percent would increase system-use by 11.73 percent, while reducing the distance between stations by 100 meters would boost ridership by 37.57 percent.

As stated above, Vélib' is upheld as a model for other bike-sharing programmes in major cities to follow. Even so, we found its accessibility/availability tradeoff is not all it could be. Without adding a single new bike or docking point to the system, Vélib' could recapture much of its diffused demand by splitting existing stations into two smaller ones placed close together, effectively knitting a tighter net to retain its customers. Higher station density would, in this scenario, necessarily reduce bike availability, but there would be net ridership gain as commuters would be more likely to walk to more than one station (because the stations would be within 150 meters of each other) before giving up.

In this way, our model demonstrates that Vélib' could increase ridership by as much as 29.41 percent, or 268,440 rides per month, before low availability would begin to compromise the system.

Public policy implications

The obvious takeaway from our research is that cities should not bow to political demands to maximise coverage at the expense of density. Sprinkling a low number of stations over a wide area is likely to lead to less participation, not more. It would be wiser to concentrate solely on blanketing the most traffic-congested urban areas with docking stations.

Bike-sharing should also be viewed as part of a public transport ecosystem. For example, our data shows that Vélib''s peak hours are approximately 9pm-2am, when the Metro is slow to inactive. Cities with a bustling CBD (central business district) surrounded by more sparsely populated areas can use bike-sharing as a relatively inexpensive "feeder" to fill in transport gaps. Many commuters would be only too happy to dispense with the cost and inconvenience of driving to and from work. All they need is a bike ready and waiting to carry them that last mile.

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