GOING THE EXTRA MILE: INVESTIGATING THE RELATIONSHIP BETWEEN BIKESHARE AND PUBLIC TRANSIT

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Abstract

Bikesharing has emerged as a popular response to the ever-growing need for sustainable, flexible transportation options in urban areas. With the ability to bridge the gaps in traditional transit networks, bikesharing offers a potential solution to the first-mile/last-mile problem, making it easier for commuters to connect to and from public transit. Despite its rapid adoption, little is known about how bikesharing trips interact with public transit usage on the aggregate. This research studies the complex interplay between bikesharing and public transit in three major U.S. cities: Chicago, New York City and Los Angeles. I use bikesharing trip data along with historical general transit feed specification data to investigate the extent to which bikesharing trips integrate with or substitute against public transit in these geographically and demographically distinct cities, as well as how various spatial, temporal and socioeconomic factors may influence these dynamics. Our findings reveal that modal integration is associated with higher availability of public transit, while modal substitution tends to be more common in dense urban cores. The interaction between bikesharing and public transit is also shaped by neighbourhood-level social factors. Younger commuters, particularly in college towns, and individuals from socioeconomically-disadvantaged neighbourhoods are more likely to integrate bikesharing with public transit. Built environment differences between the three cities also influence how bikesharing is used in relation to public transit. These findings support the need to consider built environment and socioeconomic factors when planning for effective integration between bikesharing and public transit systems and, ultimately, sustainable and equitable urban transportation systems.

Modal integration and modal substitution

Modal integration trips are trips used to connect to public transit (MI-FM), connect from public transit (MI-LM), or both (MI-FLM). Modal substitution (MS) trips are trips that replace public transit altogether.

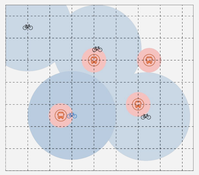


Figure 1. (left) *Bikeshare and transit buffer zones. Used for buffer analysis in classification.*

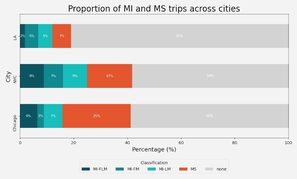


Figure 3. (above) *Modal share across cities.*

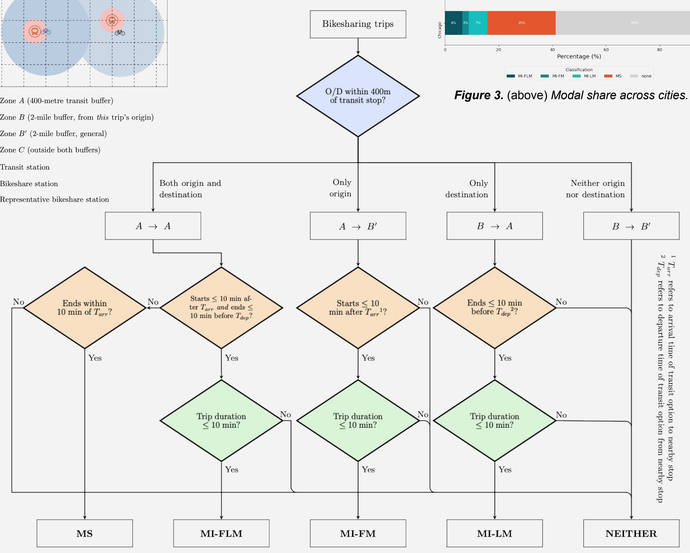


Figure 2. (above) *Three-step framework for classifying bikeshare trips. A three-step approach is used, which includes **buffer analysis**, **transit availability analysis**, and **trip duration analysis**. Trips are classified according to their origin, destination and time.*

Spatial distribution of bikeshare trips

Bikeshare usage is shaped by the geography of each city and its transit infrastructure. Several spatial patterns emerge when observing the relationship between bikeshare and transit:

- Trips that begin in census tracts near the central business district are more frequently used for modal integration trips to connect to or from public transit.
- Bikeshare usage clusters along transit corridors and areas with high transit accessibility.
- Areas with mixed-use development and higher job or population density see more transit-connected bikeshare trips due to proximity of services, employment and transit stops.

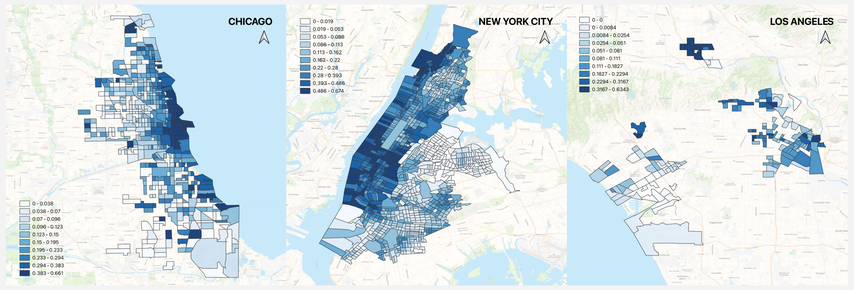


Figure 4. (above) *Proportion of modal integration trips by census tract of trip origin. A high concentration of modal integration trips occur around the central business districts in each of the three cities, such as the Loop in Chicago, Midtown and Downtown Manhattan in NYC, and Downtown LA. There also appears to be a higher MI proportion in college towns, which typically have increased public transit access. This includes the UIC, DePaul and UChicago in Chicago, Columbia and NYU in New York City, and USC and UCLA in Los Angeles.*

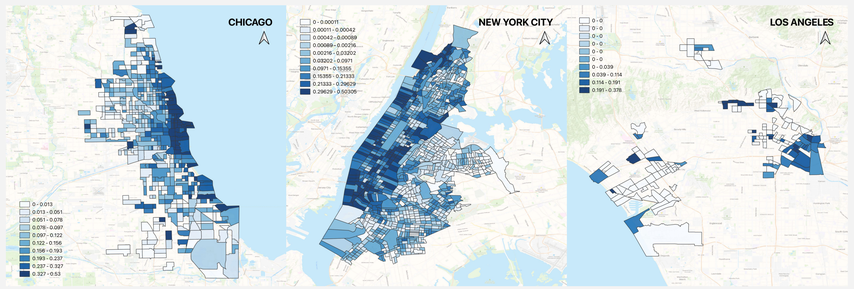
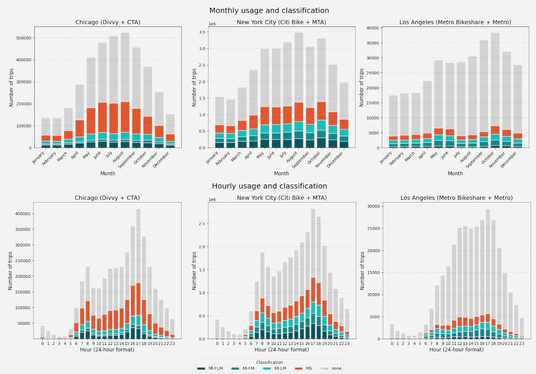


Figure 5. (above) *Proportion of modal substitution trips by census tract of trip origin. Many of the spatial patterns are similar to that of MI proportions.*

Along with the regression results, we observe that:

- Tracts with lower median household income tend to have a higher proportion of MI trips.
- More housing units and more jobs are both associated with greater MI trip proportions.
- Increased transit accessibility makes bikeshare a more attractive option.

Temporal distribution of bikeshare trips



- In Chicago and NYC, ridership (and MI and MS proportions) surge in the warmer spring and summer months and declines in the colder winter months.
- Bikeshare usage peaks during the morning (7–9 AM) and evening (5–7 PM) rush hours, aligning with the work day.
- During times of peak bikeshare usage, modal integration trip proportion is also higher.
- Commuting patterns drive usage.
- There is a less pronounced temporal trend in Los Angeles.

Built environment, socioeconomic and transit accessibility in bikeshare-transit integration

I applied regression analysis to identify key factors that influence bikeshare's role in multimodal transportation and assess how different urban contexts across different cities shape these interactions. The following table shows the results of a spatially-weighted ordinary least squares regression on the modal integration proportion at the census tract level across the three cities:

	Chicago	New York City	Los Angeles
(Intercept)	0.000	0.000	0.000
Urban design and built environment			
Number of streets	-0.152*	-0.047	-0.152
Intersection density	-0.142**	0.045	-0.152
Average traffic	0.200***	-0.041	0.045
Socioeconomic and demographic			
Median household income	-0.068	-0.187***	0.001
Households with children	-0.080	0.001	-0.097
Number of housing units	0.299***	0.047	0.239*
Number of jobs	0.045	0.098*	-0.182
Mobility and accessibility			
Number of transit stops	0.057	0.320***	0.150
Number of bikeshare docks	0.029	-0.049	0.240
Percentage walking commute	0.139**	0.072	-0.066
Statistical summary			
Number of observations	250	376	65
Coefficient of determination (R^2)	0.2188	0.1558	0.1483

[a] Significance codes: *=0.1, **=0.05, ***=0.01

I also used spatial weights and spatially-lagged explanatory variables to model the relationship between these factors and modal integration proportion. The results are similar to those above, and further suggest that modal integration in a given census tract is also influenced by various factors in the neighbouring tracts.

Conclusions

- Bikeshare is a valuable first- and last-mile solution; it is not just a standalone mode of transport but an important component of modern urban mobility systems.
- Built environment, socioeconomic and transit accessibility factors play a role in the bikeshare-transit relationship, but their impacts are highly city-dependent.
- Bikeshare is often used as an alternative to transit for work commutes, in areas where transit reliability, accessibility or affordability may be concerns.

Future work

- Examine the factors that result in low integration and substitution.
- Study the changes in bikeshare-transit dynamics over time, particularly how the pandemic and shift toward telework may have influenced modal choices.
- Augment the current analyses with qualitative findings, such as through surveys.

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