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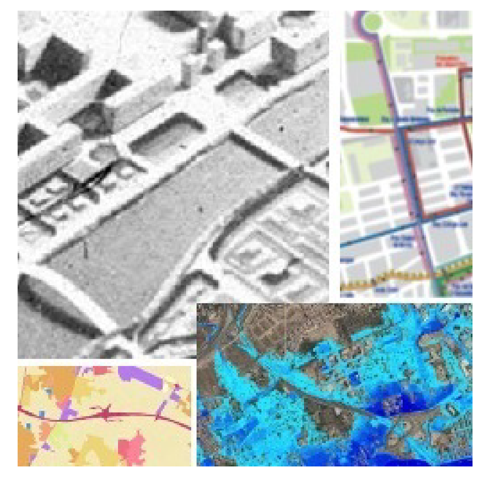

Understanding the determinants of built environments on Free Floating Bike-Sharing in the CBD: A case study of Shenzhen

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Introduction

With the development of Internet Technology and Global Positioning System, bike-sharing has come into people's lives. It has evolved into its fourth generation since the emergence of Free Floating Bike-Sharing (FFBS) in 2016.
Central Business District (CBD) is the core area of urban planning and management [1]. The CBD area has a high density of population and therefore a high demand for short distance travel. Bike-sharing is highly suitable and the demand for it is large in the CBD.

Study area and Data

This study focuses on a case study of the CBD in Shenzhen. The CBD is located in Futian district. It has a area of 413 ha and the construction area is about 7.5 million square meters. There are 9 metro stations and 1 high-speed railway station in the CBD. Both long distance and short distance transportation are very convenient.
FFBS data is provided by Ofo, a former FFBS operator in China. The date of the trip records was September 27th, 2017. The information provided includes the time of unlocking and locking, the starting and ending longitude and latitude, along with the distance of the trips. Trips with a distance less than 100m or more than 5km are eliminated according to previous studies[2,3].

Fig 1. Satellite picture of the study area

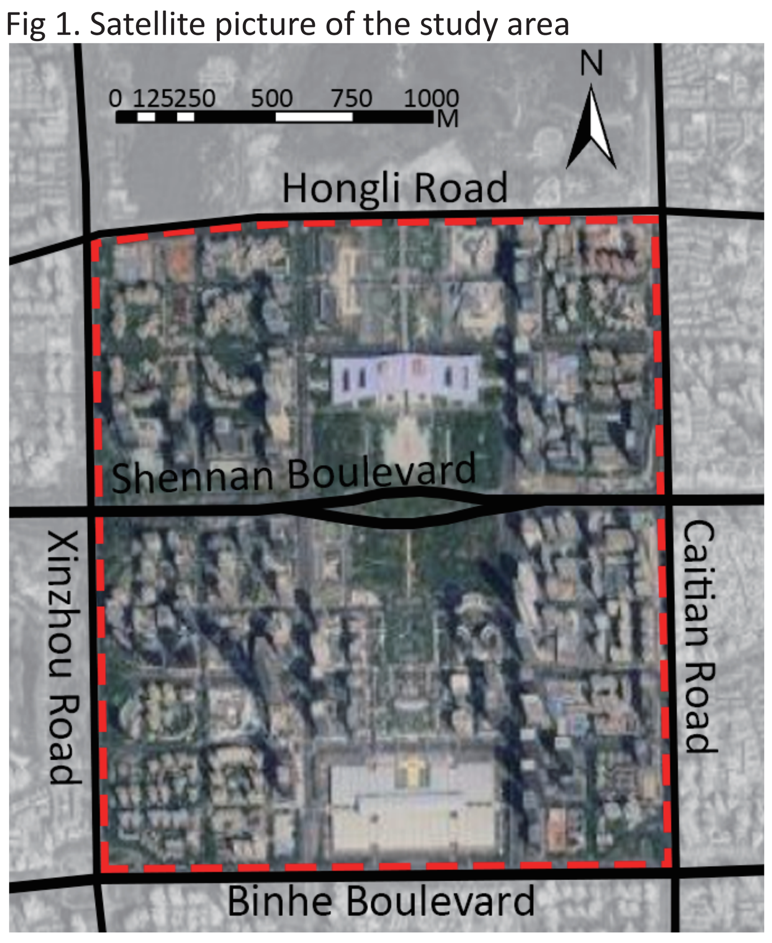


Fig 3. Location of Futian district and the CBD area

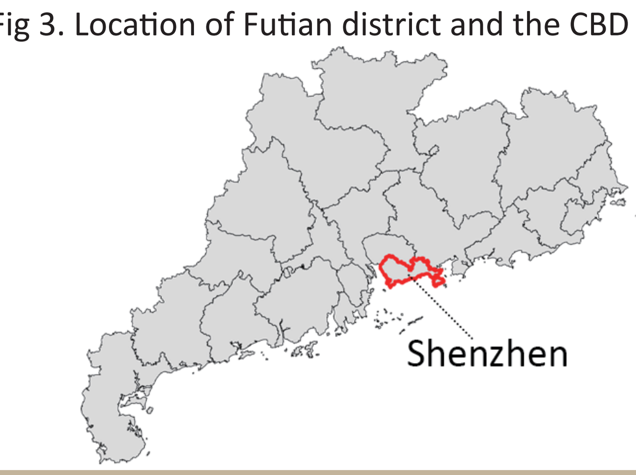
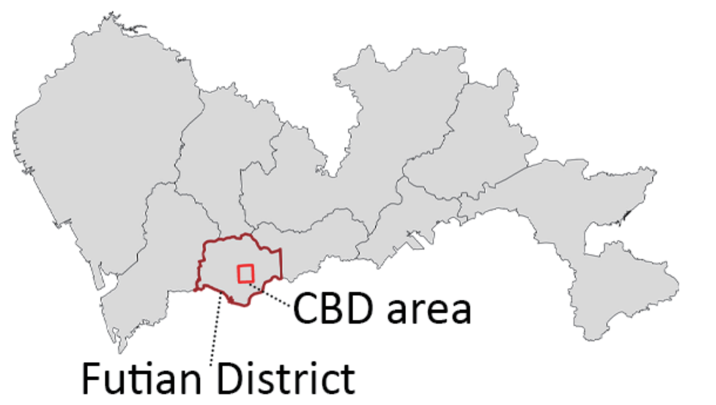


Fig 3. Location of Futian district and the CBD area



Methodology

FFBS Data preparation
Trip records are collected from ofo, a former FFBS in China. The information includes the time, distance and origins and destinations of FFBS trips.

FFBS Data cleaning
Trip records with a distance of less than 100 meters or more than 5 kilometers are deemed to be atypical. These records were eliminated.

Hot spot analysis
Hot spot analysis shows that the CBD of Shenzhen is a hot spot for FFBS usage, which is consistent with the expectation.

Built environment factors selection
Built environment factors are categorized into 3 types, building features, POI and transport accessbility. Then the factors are selected according to previous researches.

VIF test
VIF test is used to testify the multicolinearity problem between independent variables. The variables that failed the test are deleted.

Moran's Index
Moran's Index is able to determine the spatial autocorrelation of variables. A larger Moran's index indicates higher degree of autocorrelation.

Global regression
Global regression is able to provide a general understanding of the relationship between FFBS usage in the CBD and the built environment.

GWR
The GWR model can explain the spatial variance of the influence exerted by the independent variables.

Results

The spatial distribution of the origins and destinations of FFBS trips can be seen in Figure 4. The FFBS trips are concentrated on the western parts of Shenzhen, which is the more develped area. Figure 5 shows the hot spots and cold spots of FFBS usage in Shenzhen. The CBD of Shenzhen is considered hot spot area for FFBS usage. The research units of the CBD of Shenzhen are shown in Figure 6. There are 105 research units in total, the average area of them is 3.74 ha.

Fig 4. Spatial distribution of FFBS origins and destinations

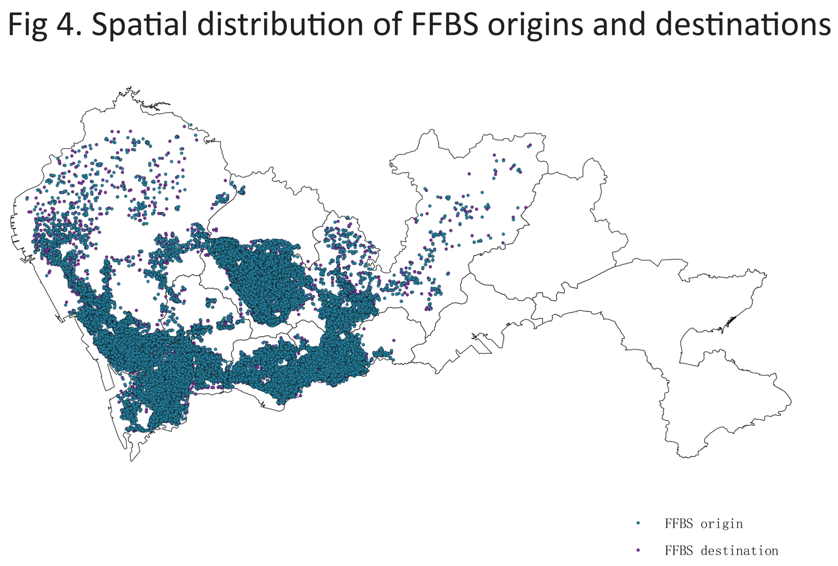


Fig 5. Hot spots and cold spots of combined FFBS usage

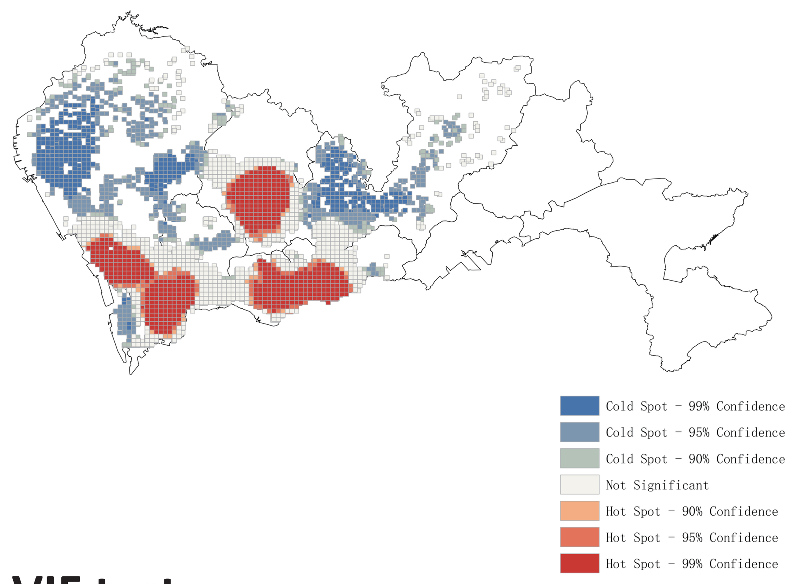


Fig 6. The research units of the CBD

VIF test

Before running the regression model, Variance Inflation Factor (VIF) test needs to be carried out in order to examine the multicollinearity issue among all the explanatory variables. Catering POIs has a VIF value greater than 5, thus it is removed.

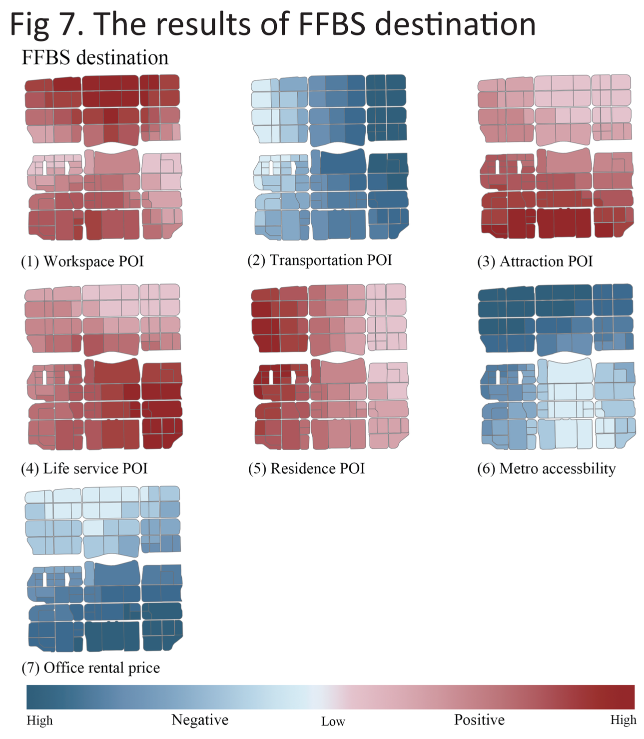
Moran's Index

The p-values of three dependent variables are all significant, which indicates that these variables are spatially autocorrelated. Moran's index of Combined FFBS usage (0.4247); FFBS origin (0.3647); FFBS destination (0.4893). Compared to other 2 types of FFBS usage, the result of FFBS destination has a higher value, which indicates higher degree of spatial autocorrelation.

Global regression

The results show that combined FFBS usage and FFBS destination have similar significant factors, which can be explained by the greater abundance of FFBS destination records (2160) compared to FFBS origin (1251). Among 3 types of built environment factors, building features seem to have the least impact on the usage of FFBS in the CBD. Density of POIs, however, is tightly related to FFBS usage. Among transport accessbility variables, metro accessibility is related to FFBS usage in a unprecedented way, other variables are not significant variables.

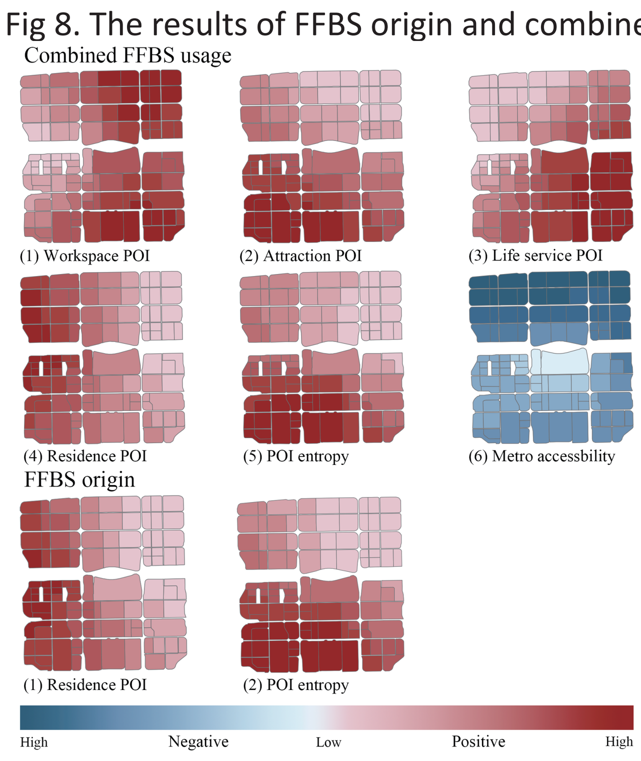
Fig 7. The results of FFBS destination



GWR

A surprising result is that metro accessibility is negatively related to the FFBS usage in the CBD, which is contrary to the findings of previous studies [4,5]. The characteristics of the CBD has to deal with this finding. First, higher density of metro stations shortens the distance people have to travel in order to get to the metro stations. Second, the underpasses in the CBD are well-developed. Using underpasses can avoid heat and people can also engage in more activities underground.

Fig 8. The results of FFBS origin and combined FFBS usage



Conclusion

The findings of this study can be concluded as follows: (1) POI density is mostly positively related to the usage of FFBS. Commuting, entertainment and daily routines are three main purposes of FFBS trips. (2) POI entropy is positively related to the usage of FFBS, which indicates that mixed use urban areas might stimulate the usage of FFBS. (3)The result concerning metro accessibility differ from previous findings. Metro accessibility is negatively related to the FFBS usage in the CBD of Shenzhen, which is caused by the unique built environment characteristics such as well-developed underpasses and the high density of metro stations.

References

1. Yu, W., Ai, T., & Shao, S. (2015). The analysis and delimitation of Central Business District using network kernel density estimation. Journal of Transport Geography, 45, 32–47. https://doi.org/10.1016/j.jtrangeo.2015.04.008
2. Chen, E., & Ye, Z. (2021). Identifying the nonlinear relationship between free-floating bike sharing usage and built environment. Journal of Cleaner Production, 280, 124281. https://doi.org/10.1016/j.jclepro.2020.124281
3. Li, A., Zhao, P., Huang, Y., Gao, K., & Axhausen, K. W. (2020). An empirical analysis of dockless bike-sharing utilization and its explanatory factors: Case study from Shanghai, China. Journal of Transport Geography, 88, 102828. https://doi.org/10.1016/j.jtrangeo.2020.102828
4. Cai, Y., Ong, G. P., & Meng, Q. (2023). Understanding bike-sharing as a commute mode in Singapore: An agent-based simulation approach. Transportation Research Part D: Transport and Environment, 122, 103859. https://doi.org/10.1016/j.trd.2023.103859
5. Xu, Y., Chen, D., Zhang, X., Tu, W., Chen, Y., Shen, Y., & Ratti, C. (2019). Unravel the landscape and pulses of cycling activities from a dockless bike-sharing system. Computers, Environment and Urban Systems, 75, 184–203. https://doi.org/10.1016/j.compenvurbsys.2019.02.002
6.Guo, Y., & He, S. Y. (2021). The role of objective and perceived built environments in affecting dockless bike-sharing as a feeder mode choice of metro commuting. Transportation Research Part A: Policy and Practice, 149, 377–396. https://doi.org/10.1016/j.tra.2021.04.008