An analysis of potential spaces for implementing geofences in a dynamic bike-sharing system

TIMO HECHEMER[1], JUKKA KRISP[2] AND ANDREAS KELER[3]

[1]Institute of Geography • University of Augsburg • Alter Postweg 118 • 86159 Augsburg

Tel.: +49 151 521 - 50280 • Email: timo.hechemer@student-uni.augsburg.de

[2]Applied Geoinformatics, Institute of Geography • University of Augsburg • Alter Postweg 118 • 86159 Augsburg

Tel.: +49 821 598 - 2756 • Email: jukka.krisp@geo.uni-augsburg.de

[3]Chair of Traffic Engineering and Control • Technical University of Munich • Arcisstraße 21 • 80333 Munich

Tel.: +49 (89) 289 - 22468 • Email: andreas.keler@tum.de

Keywords: Geofence, GIS, Bike-Sharing, Mobility, Digitalisation

Summary: This paper focuses on the analysis of bike-sharing data in Munich from 2016 - 2019 and discusses its spatial distribution in its central area for further implementation of dockless bikesharing. New developments in transport alternatives can change user behavior and increase the competition between different types of mobility. Since 2017 bike-sharing started to decrease with the launch of electric scooters which don't rely on docks at all. On the one hand it means for Munich's central area that public space will now contain more dangerous obstacles if both - electric scooters and bikes - are highly distributed spatially. On the other hand bike-sharing seems to be in need of an increase in its user flexibility by offering a greater variety of storing the bike which can be achieved by Location Based Services which are already used by electric scooters. Following these thoughts, an implementation of geofences is discussed in order to reduce the spatial distribution over Munich's public space and thus reducing the bikes potential of becoming a dangerous obstacle for other road users.

Introduction

The bike has always been an important way of getting from one point to another in our modern society and it is hard to imagine a world without it. The reason for traveling doesn't matter – it is used in time of leisure, to get to work or for a short ride to the next shopping district. Thus, the bike is often times used at first choice because it offers independence and can be held at low cost which lie mostly in repairing and changing wheels. As a positive side effect bike users benefit from a lot of healthy aspects – for example getting fresh air and movement that is gentle on the joints which is great for the elderly users. In addition to that, bike users don't rely on parking slots to be able to get anywhere in the city.

So the question arises if existing bike-sharing with docking-stations can still be improved to offer more flexibility. The most direct case would be to not be reliant on a dock at all to store the bike in. This is also the research thematic of this paper which is centered around the spatial independence of bike-sharing with dockless models. Space and time depend on eachother and so moving through space takes time – especially in modern cities that are full of obstacles that can be avoided.

The aim of this paper is to provide useful information about Munich's bike-sharing data that can be used to implement dockless bike-sharing in its central area.

The key questions being answered are...
[1] What is geofencing and how can it be implemented in useful ways?
[2] What does Munich's bike-sharing data tell about its spatial distribution?
[3] How can Munich's central area benefit from a dockless bike-sharing system?

Methods

In this paper the Origin-Destination (OD) data of bike-sharing in Munich from the years 2016 to 2019 is analyzed using ArcGis. The OD contains information about the Starting and Ending position of the ride as well as the rental station. The data that was available through a CSV was imported into ArcGis. The OD will be analyzed using a *Point Clustering Method* that was mentioned earlier and an implementation of geofences for a dockless bike-sharing in Munich's central area will be discussed based on these results.

Results

The results of this Paper contain visualisations of the OD Data by using tools of ArcGis. In Figure 1 Thiessen-Polygons for each Station in Munich's central area were created which have a bar chart for the total number of points of bike-sharing usage in each year (2016 - 2019). It is clearly visible that the need for bike-sharing suffered a great decrease in the year 2017 which only slowly started to recover afterwards. This decrease might have a direct link to the launch of electric scooters in Munich in the year 2017.
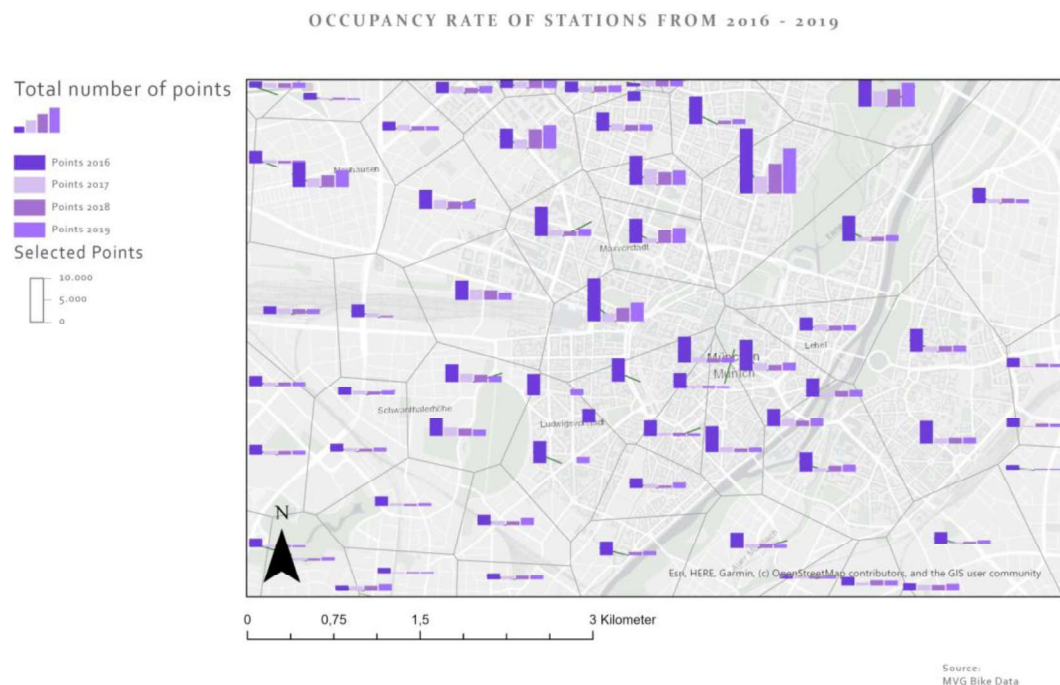

Fig. 1 Occupancy rate of stations between 2016 and 2019

Conclusion

The bike-sharing data of Munich's central area has shown that bike usage is highly distributed over space. This might make it difficult for bike-sharing to reach its full potential of flexibility as stated by Chen et al. (2019: 334). There has been no further development of actual geofences for Munich's central area because it is lacking space for parking bikes in general. Most space is been taken by buildings, streets or public places. The later might seem to offer lots of space but is actually used by people to relax and meet each other which means bikes might become an obstacle in that area. So the increase for bike-sharing that is visible in figure 1 might make geofences through *Location Based Services* interesting for further developement.

References

Chen Z., van Lierop D., Ettema D. (2019): Dockless bike-sharing systems: what are the implications? In: Transportation Reviews 40(3), 333 - 353.

DOI: 10.1080/01441647.2019.1710306

He B., Zhang Y., Chen Y., Gu Z. (2018): A Simple Line Clustering Method for Spatial Analysis with Origin-Destination Data and Its Application to Bike-Sharing Movement Data. In: International Journal of Geo-Information 7 (203), 1 - 16.

Krinkin K., Yudenok K. (2013): Geo-coding in Smart Environment: Integration Principles of Smart-M3 and Geo2Tag. In: Balandin S., Andreev S., Koucheryavi Y. (Eds.): Internet of Things, Smart Spaces, and Next Generation Networking. Berlin, Heidelberg: Springer Verlag, 107 - 116.

Namiot D. (2013): GeoFence Services. In: International Journal of Open Information Technologies 1(9).

Namiot D., Sneps-Sneppe M. (2013): Geofence and Network Proximity. In: Balandin S., Andreev S., Koucheryavi Y. (Eds.): Internet of Things, Smart Spaces, and Next Generation Networking. Berlin, Heidelberg: Springer Verlag, 117 - 127.

Rahate S. W., Shaikh M. Z. (2016): Geo-fencing Infracstructure: Location Based Service. In: International Research Journal of Engeneering and Technology 3(11), $1095 - 1098$.

Raviv T., Tzur M., Forma I. A. (2013): Static repositioning in a bike-sharing system: models and solution approaches. In: EURO J Transp Logist 2, 187 - 229.

DOI 10.1007/s13676-012-0017-   6.

Reiss S., Bogenberger K. (2016): Validation of a Relocation Strategy for Munich's Bike Sharing System. In: Transportation Research Procedia 19, $341 - 349$.

Sheppard J. K., McGann A., Lanzone M., Swaisgood R. R. (2015): An autonomous GPS geofence alert system to curtail avian fatalities at wind farms. In: Animal Biotelemetry 3(43).