

Original Research Article

How Location-Based Social Network (LBSN) Data Contribute to Contemporary Urban Development

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Abstract: In recent years, social media has created a large amount of new data due to the development of Internet technologies. Scholars in related fields focus a lot on the location-based social network (LBSN) and data generated from LBSN to provide new ideas for urban development. This research analyses LBSN data advantages, including the advanced data source, diversity of LBSN platforms, and LBSN data contents. Challenges of using social media data like deviation in data samples, privacy issues and technical barrier are also covered. Last but not least, this essay will discuss the applications of LBSN data in urban design.

Keywords: Social Media; LBSN Data; Data Analysis; Patterns of Human Activity; Urban Development

1. Introduction

Nowadays, as social media development brings an explosion of data, the proper use of the data can turn it into valuable resources. It is no exception in the field of urban design. According to the definition from QDT, location-based social networks (LBSN) are networks that can locate users and let users show their location and other content from their mobile phone by using GPS (Sherman, 2010)^[1]. There are a great number of users on different social networks, such as Facebook, YouTube and WhatsApp (**Figure 1**). They generate a large number of social media data, including comments and photos uploaded to social networks such as Weibo, Facebook, Instagram and Twitter. The social media data usually contains location information, which can help in urban

design. They create a complement for regular data and can be used for urban design to understand human activities in urban space. Accordingly, LBSN data can be regarded as resources for decision-making and management in urban design (Martí, Serrano-Estrada *et al.*, 2019)^[2]. The social media data acquired from LBSN provide a way to evaluate the dynamics of different cities (Lin and Geertman, 2019). This essay will discuss the advantages and disadvantages of LBSN when applied in urban design. Also, the specific applications of LBSN in this field will be involved, such as human activity patterns research, urban land use, Urban management and design, transportation research and urban sustainability^[3].

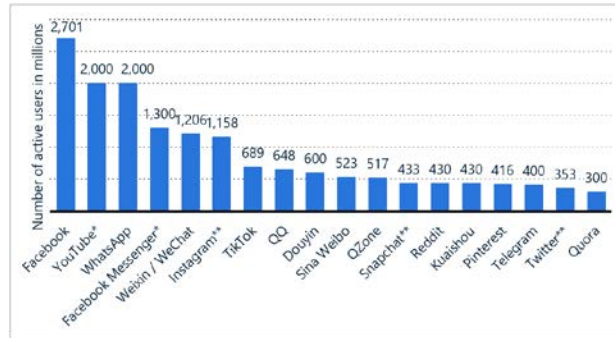


Figure 1. Global social networks ranked by number of users 2020

(Sources: We Are Social; Various sources (Company data); Hootsuite; DataReportal; ID 272014)

2. Advantages of LBSN data

2.1 Advanced data source

The LBSN data generated by social media users represent a technological advance. Data from LBSN are created through the Internet, which is the basis of advanced technology nowadays. Unlike traditional data collections, which tend to depend on large-scale surveys and long-term observation, LBSN data can be easier to be collected. Limitations such as the demand for accurate time and accurate location marking in traditional data collection approaches have declined by using LBSN data^[4]. Also, as the number of social networkers increases, the quantity and quality of LBSN data will keep increasing (Wang, He *et al.* 2018).

2.2 Diversity of LBSN platforms

A large number of social network sites results in the diversity of LBSN platforms. Quite several studies have used data from Twitter, Facebook and Instagram, which are all the world's well-known LBSN platforms, covering different topics related to different fields^[5]. Furthermore, other LBSN platforms, such as Baidu Maps and Google Maps, can be regarded as complementary data sources. Besides, some other LBSN platforms have the same functions as the world-famous LBSN and are more often used in a particular district. For example, Sina Weibo from China has similar functions to Twitter, while its target groups are mainly in China. Therefore, there are different LBSN data sources from different platforms.

2.3 Diversity contents of LBSN data

The contents of social network data are diverse, creating different kinds of data and providing a multi-perspective method for different research areas. For

example, Sina Weibo from China is a social media site based upon users' relationship. Users are able to enter it through various devices such as computer and mobile phone and attain instant information sharing, communication and interaction in multiple media forms such as text, pictures and videos (Sina weibo (social networking site) Baidu Baike, 2021)^[6]. Data from this platform tends to appear as individual living status sharing in the form of text, pictures and videos mentioned above. Also, Twitter, another famous social network site, is a mobile application and platform, allowing the users to capture their life memory in any environment with the function of image editing. Users add description and location information to the pictures and videos to share with other users. Data from this platform appear as pictures, videos and locations.

3. Challenges of using LBSN data

3.1 Deviation in data samples

There is a deviation in data samples, usually caused by ages and regions. Social media is frequently used by young people instead of the old, which leads to the deviation in different age groups. Also, there are differences in Internet access and social media use in different areas. Therefore, there are spatial deviations between different sample groups. To be specific, most of the data are concentrated in cities, while the data in rural areas is scarce.

3.2 Privacy issues

Social media data contains information about the users' personal location, text, and even photos, which usually cause privacy issues. Any analysis of individual social media data needs cautious attention to aggregating

the unidentified user's geographic information. Current policies on data privacy protection should also be considered, such as information technology security in the EU's general data protection regulations and China's information security regulations.

3.3 Technical barrier

High-tech skills in different fields are required in LBSN data research, creating technical barriers between some scholars. High-tech skills like analytical skill, analytical insight and supporting technology are necessary for the research. First, analytical ability refers to advanced skill, such as complicated analysis based on different data structures. Second, analytical insight refers to professional knowledge, such as formulating problems and figuring analysis. Third, supporting technology refers to the skill to develop some software tools and manage the database. It is impractical for every scholar to master all these skills. Also, making scholars with varying backgrounds work as a group to complete an interdisciplinary project will cost many academic resources.

4. Applications based on LBSN data in urban design

4.1 Monitoring human activity patterns

LBSN data are mostly based on people's activity patterns in real life. Users can show their location, event and some discussions of the site they visit, which means LBSN data record social interactions among people. Therefore, it is very convenient to use LBSN data to study people's activity and behaviour patterns. On the other hand, a large number of users on the form based on LBSN would generate a large amount of data. For example, according to the report of Weibo in 2020, average daily active users (DAUS) were 224 million in September 2020, a net addition of approximately 8 million users on year-over-year basis (Weibo Corporation, 2020). Also, this data source has a trend of expansion^[7]. The information in LBSN data can explore the intangible aspects of city life related to specific locations. Some social events in the city are not apparent. At the same time, LBSN data can provide a virtual trail connected to a specific place to analyse users' experience and perception of the city more comprehensively. Therefore, it is more and more meaningful to study human

activity with this sort of data.

For example, in the study of Muhammad *et al.*, Guangzhou City is taken as the study area. They applied Kernel Density Estimation (KDE) to observe people's check-in density and used the Geographically and Weighted Regression (GWR) method to study the relationship between a specific area and the number of people on weekdays or weekends^[8]. Finally, the Standard Deviational Ellipse (SDE) method was applied to analysing and dealing with the activity changes of different areas in Guangzhou within a day. The results of this research also confirm that LBSN data can be used to explore activity patterns associated with people's check-in data (Muhammad, Zhao *et al.* 2019).

4.2 In-depth study of urban land use

The usages of land in the city are often used for more purposes than those on the city planning diagram. That is because the same piece of land in the city can have different functions at different times^[9]. For example, some districts where residential and commercial areas are mixed, are more like commercial areas in the daytime, while in the evening, they mainly play the role of living areas. Through LBSN data, the dynamic changes of urban land use can be tracked, so that the use of urban land can be further optimised.

For example, in the study of Wei Tu *et al.*, they used a 'data-activity-function' methodology to process social media data. The calculated urban functions by the LBSN data are compared with the official Shenzhen Land Zoning Map (2010-2020), finding that 58% of urban units were the same as planned. Transportation function and curricular functions differ more significantly from actual urban functions. The main reasons are as follows: firstly, some urban units have changed with people's activities changing; secondly, Shenzhen is a rapidly developing city, and the use of some land has changed rapidly. For example, some old factories in Shenzhen city have turned into residences or parks because of urban development. Such research provides a deeper understanding of land use for urban management (Tu, Cao *et al.* 2017). In another study, Su evaluated the diversity of urban functions at the community level based on hotspot analysis by LBSN data (Su, Li *et al.* 2018). This analysis provides another way to depict the internal spatial structure and land use of the city. It can also provide a reference

for future planning to use the land properly^[10].

4.3 Urban management and design

LBSN is a new approach that can make a better combination between the data of human activities and the information of urban functions, which can facilitate urban management and design. Cities are usually designed to serve human activities, such as working, living, learning and entertainment. Today's urban design has become more dynamic; however, social media networks like Twitter and Flickr record information about people's interactions with their surroundings, especially the information about people's behaviour in geospatial environments. Besides, Flickr photos with geotags are highly appropriate for studying urban areas because they reveal people's interest in some locations. Through analysing LBSN data, we can obtain a large amount of information about the continually changing environment and citizens themselves. Combined with traditional data, using LBSN data can allow us to conduct better management of the city. Meanwhile, it can be used for urban construction and design in the future^[11].

For example, in the study of Mora *et al.* in 2018, they analysed social media data on sports in Alicante City to infer which areas of the city were popular for sports and found that more and more people liked to play sports in outdoor spaces in the city. Then they can design better sports infrastructure based on time, location and people's needs, such as reducing vehicle space and crossroads in running areas and displaying signs at certain times in popular areas to turn roadway into running ways (Mora, Perez-Delhoyo *et al.* 2018). In this manner, the urban space can interact with the citizens and achieve flexible urban management and urban design.

4.4 Transportation research

Social media data is also playing an essential role in transportation. Since the LBSN is an emerging industry with huge investment, researchers in many fields have begun to do in-depth research. In terms of transportation, some scholars have also proposed the use of social media data. For example, in the study of Rashidi *et al.*, they investigated the application of social media data to evaluate transportation systems, traffic conditions, and travel demand modelling (Rashidi, Abbasi *et al.*, 2017). For another example, in the study from Steiger *et al.*,

they used the LBSN data to evaluate public transportation traffic flow^[12]. They verified it with the real data of OpenStreetMap (Steiger, Ellersiek *et al.* 2014). These two studies all show that as LBSN develops, more and more applications of LBSN data will be made in the field of traffic engineering, and the effects they bring are becoming evident and significant^[13].

4.5 Sustainability research

Sustainability is a popular topic at present, and urban sustainability is necessary for urban development. Therefore, it is of great significance to use the data of LBSN to develop urban sustainability. So far, researches on urban sustainability through social media networks are limited. However, some researchers have begun to pay attention to the potential of LBSN for sustainable development^[14]. For example, in the study of Ilieva and McPhearson, they mentioned that the data of LBSN could be used to analyse urban green space and improve the accessibility of urban green space, which is environmental sustainability. They also studied the effects of LBSN on public health, social equity and economic development under the general premise of urban sustainability (Ilieva and McPhearson, 2018). Therefore, although there are some technical challenges in analysing LBSN data, it is a remarkable emerging technology. More and more sustainability scholars begin to take advantage of LBSN data (such as real-time, large scale) and imply it in urban sustainability. Simultaneously, more and more scholars begin to pay attention to this technology's potential in sustainable urban development.

5. Conclusion

Although the use of LBSN data still faces some challenges, its advantages are undeniable. This data can be applied to human activity patterns monitoring, urban land-use study, urban management and design, transportation research, and sustainability research in terms of urban development. All applications above have been proved effective and of great significance to the construction and development of future cities. This study still has some limitations. It hardly covers the specific details of analysing LBSN data and may not have strong practical meanings in implementation. In future studies, it is necessary to consider how to address the challenges faced by applying LBSN data, such as devia-

tion in data samples, privacy issues and the technical barrier. Besides, the discussion on the application of LBSN in urban development can be more concrete. Specific platforms, groups or cities can be the object of research to study the practical applications of LBSN data.

In the future, with the development of science and technology, social media will be used by more people, so the amount of LBSN data will become larger and larger. Appropriate use of LBSN data will undoubtedly have a more significant impact on urban development and construction. Furthermore, combining the LBSN data with surveys data, official data and some sensors data can make the research more accurate and convincing. At the same time, this also means that more scholars are needed to study the application of LBSN data in urban development. In all, making fair use of LBSN data can bring more effects to urban development.

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