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Urban Consumption Patterns: OpenStreetMap Quality for Social Science Research

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Abstract: Citizen consumption refers to the goods and services which citizens utilise. This includes time spent on leisure and cultural activities as well as the consumption of necessary and luxury goods and services. The spatial dimension of consumption inequality can show the underlying urban spatial structure and processes of a city. Usually, the main barrier to effectively measuring consumption is the availability and accessibility of spatial data. While the main body of the literature utilises official, government data, such data is not always available, up-to-date or can be costly to acquire. In this paper, we discuss the potential of Volunteered Geographic Information (VGI) as a source of spatial data for determining consumption inequality. To this end, we compared OpenStreetMap (OSM) data, that can be used as proxies for consumption inequality, with official data in the area of Greater London. The results show that OSM is currently inadequate for studying the spatial dimension of consumption. It is our view that while VGI is appropriate for tasks such as routing and navigation, it also has the potential to add value to social science studies in the future.

1 INTRODUCTION

Cities are centres of consumption due to the size of population and density (Glaeser et al. 2001) but access to consumption spaces is not equal for all citizens (Mahadevia and Sarkar 2012). While the focus of the literature on urban inequality is usually on income inequality, consumption inequality deserves more attention. Briefly, consumption means what people consume including what they allocate time to such as leisure or cultural activities e.g. cinema and music, luxury goods such as jewellery and necessary goods such as food and medicine. On one hand, shopping baskets vary across income groups in terms of quality and quantity. On the other hand, from a geographic point of view, it is taken for granted that the prices of goods and services are usually not constant in different parts of cities due to their quality and consumers' ability and willingness to pay for them.

Although measuring consumption and leisure is complex due to the multidimensionality of consumption (Attanasio et al. 2012) such as allocated time for leisure (Aguiar and Hurst 2007), identifying where different goods and services are offered in the city is a common interest of many disciplines such as urban geography, urban economy, and sociology (Cai et al. 2010). There are different data sources for measuring consumption, such as Consumer Expenditure Surveys[4] by the US Bureau of Labor Statistics which provides data on expenditure, income, and demographic characteristics of consumers but this survey does not cover all components of urban utilities such as leisure. Even the Index of Multiple Deprivation[5] in the UK which covers income, employment, health deprivation and disability, education, skills and training, barriers to housing and services, crime and living environment does not include consumption and leisure data. Other efforts are usually limited to mapping energy consumption and water consumption regardless of the sociospatial setting of the city.

Measuring consumption and leisure inequality (Attanasio and Pistaferri 2016), and mapping patterns of consumption inequality of goods e.g. the geographical distribution of fast food outlets and supermarkets, pharmacies, and cultural centres of a city draw a different picture from income inequality (Attanasio and Pistaferri 2016). Many researchers believe Volunteered Geographic Information (VGI) can be an effective alternative to official data

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5 https://www.gov.uk/government/statistics/english-indices-of-deprivation-2015

(Goodchild 2007) or can enrich or complement official data (Antoniou 2011). Among VGI platforms, OpenStreetMap (OSM)[6] has been tested in various domains such as land use classification (Pfoser 2013), road network analysis (Zhang and Malczewski 2017), and disaster management (Zook et al. 2010). While many previous studies seem promising of the high potentials of OSM applications, there is little research on the extraction of locational insight from user-generated data (Shelton et al. 2015) to investigate spatial inequality, especially the spatial dimension of consumption inequality. This is not surprising since, OSM was not intended for this purpose, yet we seek to understand if it is suitable for this type of study.

The focus of the literature is on different metrics of accuracy related to OSM data, but mainly on the road network and landmarks (Fan et al. 2014; Graser et al. 2014). The aim of this paper is to examine the question as to whether OSM data can be used as an alternative to official data to measure or map spatial variation of consumption inequality in goods and urban amenities (Fraser et al. 2010; Dai and Wang 2011). The three main contributions of this paper are:

- Assessing completeness, accuracy, and usefulness of OSM data layers to study consumption inequality in London.
- Testing OSM data in mapping the spatial dimension of consumption inequality.
- Highlighting some of the limitations of using OSM data in urban studies.

2 BACKGROUND

Crawford describes how "the ethos of consumption has penetrated every sphere of our lives…[and] increasingly constructs the way we see the world" (Crawford 1992, p. 11). Moreover, as Crew and Lowe argue, "retailing and consumption create and recreate place-specific" (Crewe and Lowe 1995, p. 1878). Similarly, Functional Utility can help us to understand the preferences of individuals for different goods and services. Simply put, individuals buy the most important goods and services of their necessities based on their needs and ability to pay. (Currid-Halkett et al. 2019) classified consumption into three frameworks from an economic geography perspective, 1. commodification of cultures 2. high-end luxurious 3. amenities. In this research, we investigate the potential usage of OSM data to map the spatial dimension of these main categories of consumption in the city. The first one represents cultural centres such as cinemas and theatres. The second one can be viewed as *conspicuous goods (Veblen or luxury goods)*, and the last one as *necessary goods for life* (Currid-Halkett et al. 2019).

Table 1 shows which OSM tags may be used to study and map consumption inequality in the city. It also identifies why the selected tags are proxies of consumption inequality based on relevant references to the literature. For example, from a welfare point of view, consumption inequality of basic necessities, especially food is very important (Attanasio and Pistaferri 2016). Food, as one of the basic needs of human life, is a proxy for both nutrition and leisure (Mair et al. 2008), but fast-food is energy-dense, nutrient-poor and can cause obesity (Bowman et al. 2004). Fashion is a specific good that shows where local identity and global drivers are united (Crewe and Lowe 1996) and it is a cultural signifier (McRobbie 1994) and is classified as Veblen goods. Similarly, a beauty salon belongs to this class. Furthermore, the swimming pool layer in OSM has the potential to map the difference between rich and poor neighbourhoods (Stephens 1996).

VGI has attractive characteristics such as free use for users and researchers. During the last decade, a plethora of research has been done using this type of data (Longueville et al. 2010). The huge range of applications and potential of VGI opens new horizons for socioeconomic research and applications to overcome data limitations and availability (Sun and Du 2017). OSM, a prominent example of VGI, attracts much attention, especially where there is no validated or official data (Moomen et al. 2019). OSM is available under an Open Database License[7], and users can use, edit and share the maps without copyright permission. Recent growing usage of OSM in different domains of socioeconomic and health research includes the spatial availability of alcohol (Bright et al. 2018), social activity of the population (Putrenko 2017), and retail tobacco exposure (Rodriguez et al. 2013).

The literature on consumption (inequality) is usually based on official data and is concentrated on the consumption of energy (Pereira and Assis 2013; Souza et al. 2009) or water (Panagopoulos et al. 2012; Vandecasteele et al. 2014). Usually, an important driver in sociospatial studies is availability and access to valid spatial data. Official data are not always up-to-date and free to access for researchers. This prompts the question in this paper regarding the possibility of using OSM data to map consumption inequality in the city as an alternative to official data. To achieve this, we need to assess the veracity of OSM data for this purpose. Different

[6] https://www.openstreetmap.org

[7] https://opendatacommons.org/licenses/odbl/summary/

Table 1: List of selected OSM Tags and layers

Name	Proxy/Description	References
Fast food	Malnutrition/health	(Burns and Inglis 2007; Mair et al. 2008)
Beauty Salon	Veblen good	(Kwate et al. 2009)
Garden	Leisure/health	(Chen and Jim 2008; Loughran 2014),
Swimming pool	Leisure/health	(Stephens 1996; Salvati et al. 2016)
Cinema	Entertainment/culture	(Shiel and Fitzmaurice 2001)
Pharmacy	health	(Clark et al. 2012; Todd et al. 2014)
Library	Entertainment/culture	(Calcuttawala 2004; Park 2012),
Banks	Access to finance	(Liu et al. 2015)
Bakery	Food/ health/Nutrition	(Dai and Wang 2011)
Restaurant	Leisure/health/ Food	(Mehta and Chang 2008)

guidelines and measures have been suggested to assess data quality (Batini et al. 2009). Each method usually suggests different metrics for different aspects of data quality.

For spatial data, seven key metrics are as follows (Guptill and Morrison 1995; Shi et al. 2002; McArdle and Kitchin 2016).

1. Lineage: the history of data.
2. Positional Accuracy: absolute and relative position.
3. Attribute Accuracy: the accuracy of quantitative and qualitative data.
4. Completeness: to what extent spatial and attribute data are complete, including geographical coverage of spatial data (maps).
5. Logical Consistency: trustiness or dependability of data.
6. Semantic Accuracy: consistency and persistency of classes of objects.
7. Temporal Data: observation date, the validity of time and type of update.

Although all measures are important in OSM assessment (Fan et al. 2014; Ballatore and Zipf 2015), based on our theoretical framework and the aims of our research, we gave priority to the completeness of data because it is a significant metric to study the spatial dimension of inequality research. It is our position that without a minimum acceptable degree of completeness of data, it is not possible to measure any type of (spatial) inequality in the city. McArdle and Kitchin describe completeness as the degree to which spatial and attribute data are included or omitted from the database. It also describes how the sample is derived from the full population and presents the spatial boundaries of the data (McArdle and Kitchin 2016).

3 CASE STUDY & DATA

The case study is Greater London. London is a thoroughly studied global city that is an ideal and unique place to assess the usefulness and completeness of OSM urban data. Researchers agree that OSM data for London are extremely rich and so it is an ideal case study to assess the best-case completeness of OSM data for urban sociospatial research (Ballatore and Sabbata 2018). OSM Shape files were collected through two methods using the GeoFabrik[8] website and the QGIS plugin[9] tool, for the Greater London area in November 2019.

4 RESULTS & DISCUSSION

Table 2 shows the difference between the number of entities of each layer in the official data and OSM data that we selected to measure consumption inequality. All layers of OSM present a lower number of points compared to official data although official data is usually updated slowly and scarcely. Most official point layer data were downloaded from the London Datastore[10]. To assess the impact of utilising OSM data, typical spatial analysis approaches used to identify the spatial aspects of consumption were applied to the OSM and official data. Figure 1 presents, (a) the number of OSM data, (b) number of official data, (c) Getis Ordi Gi*(Getis and Ord 2010) of OSM, and (d) Getis Ordi Gi* of official data respectively for 1. cinema as a cultural centre, 2. jewellery shops as a provider of luxury good, and 3. pharmacy as a place to provide basic necessary goods in a 1000-meter hexagonal gird of the Greater London Area. Getis Ordi Gi* (Z Score) shows the hotspots and coldspots of selected layers on each map. Figure 1 shows how three selected layers including cinemas (cultural consumption), jewellery shops (Veblen goods), and pharmacies (necessary goods) are distributed in both OSM and official data.

In figure 1a, the blue points show the location of these layers from OSM and the red points are the

[8] . http://download.geofabrik.de/europe/great-britain/england/greater-london.html
[9] . https://plugins.qgis.org/plugins/QuickOSM/
[10]. https://data.london.gov.uk/dataset/statistical-gis-boundary-files-london

Table 2: Comparison between OSM and other (non) official data sources

OSM Tag	Download Source and Number of entities		Official Statistics	Date	Reference	Format
	geofabrik.de (tag=amenity)	QuickOSM (tag=class)				
Fast food	2398	2400	8662	June 2016	gov.uk	Georef/ CSV
Swimming pool	13	15	196	Oct 2008	london.gov.uk	Report
Cinema	69	69	116	May 2019	data.london.gov.uk	Georef/CSV
Library	169	169	342	Dec 2019	data.london.gov.uk	GeoPackage[11]
Pharmacy	816	815	1839	Sep 2019	ordnancesurvey.co.uk	Georef/txt
Theatre	92	80	118	Jan 2019	data.london.gov.uk	GeoPackage
Pub	2211	Na	4098	Jan 2019	data.london.gov.uk	GeoPackage
Museum and Public gallery	Na	86	163	Jan 2019	data.london.gov.uk	GeoPackage
Jewelry Design	Na	288	320	Nov 2018	data.london.gov.uk	GeoPackage
Music	Venue 4		Venues 797	March 2018	data.london.gov.uk	GeoPackage
	School 4		Rehearsal Studio 79	June 2019		
	Instrument 2		Recording Studio 71	June 2019		

location of cinemas defined by the official reference datasets, again there is a difference in this metric.

Both datasets show a concentration of data points in the city centre. It shows that editors and contributors in OSM are more focused on the centre of London where the population activities and consumption spaces are concentrated while other areas are ignored. In other words, there is an inconsistency between the geographical coverage of OSM and official data. This means that OSM data are not representative of the ground truth data. All Getis indexes (Z Score) also illustrate a sharp gap between OSM and the official dataset. For example, the maps in Figure 3c and 3d show that hotspots and coldspots of pharmacy have different patterns of data concentration and richness. These types of visualisation were selected because they can show the difference between point layers of official and OSM datasets for this social science study.

The analysis has shown the gaps in the OSM data and highlights the challenges of using OSM data for a study on consumption and inequality. Each dataset would yield different results. The gaps may relate to the semantic completeness of map features. Semantic information describes the function or meaning of a map feature such as its name or type. In many cases, the spatial information is available but the description of the spatial feature which is essential for sociospatial research is absent and leads to an inability to classify the feature type which impacts completeness and veracity (Iddianozie and McArdle 2019).

5 CONCLUSIONS

Data collection is costly and time consuming, and permission to use or license the data is a barrier in providing the necessary data for research. Emerging VGI in general and in particular the OSM platform are considered as tools to overcome the data barrier and limitation. OSM provides easy access to spatial data for citizens, policy designers, urban mangers, and researchers in some domains such as tracking and road mapping. However, at present the veracity of OSM data is insufficient for mapping underlying sociospatial patterns.

Other studies have corroborated the inadequacy of OSM in other research areas (Muzaffar et al. 2017). In addition, we have seen in this paper that OSM data and tags are not consistent across different downloading methods. This issue makes OSM less useable in urban socioeconomic research especially for researchers with less technical skills. This research raises these critical questions:

1. Why are some layers of OSM (especially layers which were assessed in this paper) not complete? How can the OSM mapping community be supported to address this type of completeness?

[11] .https://www.geopackage.org/

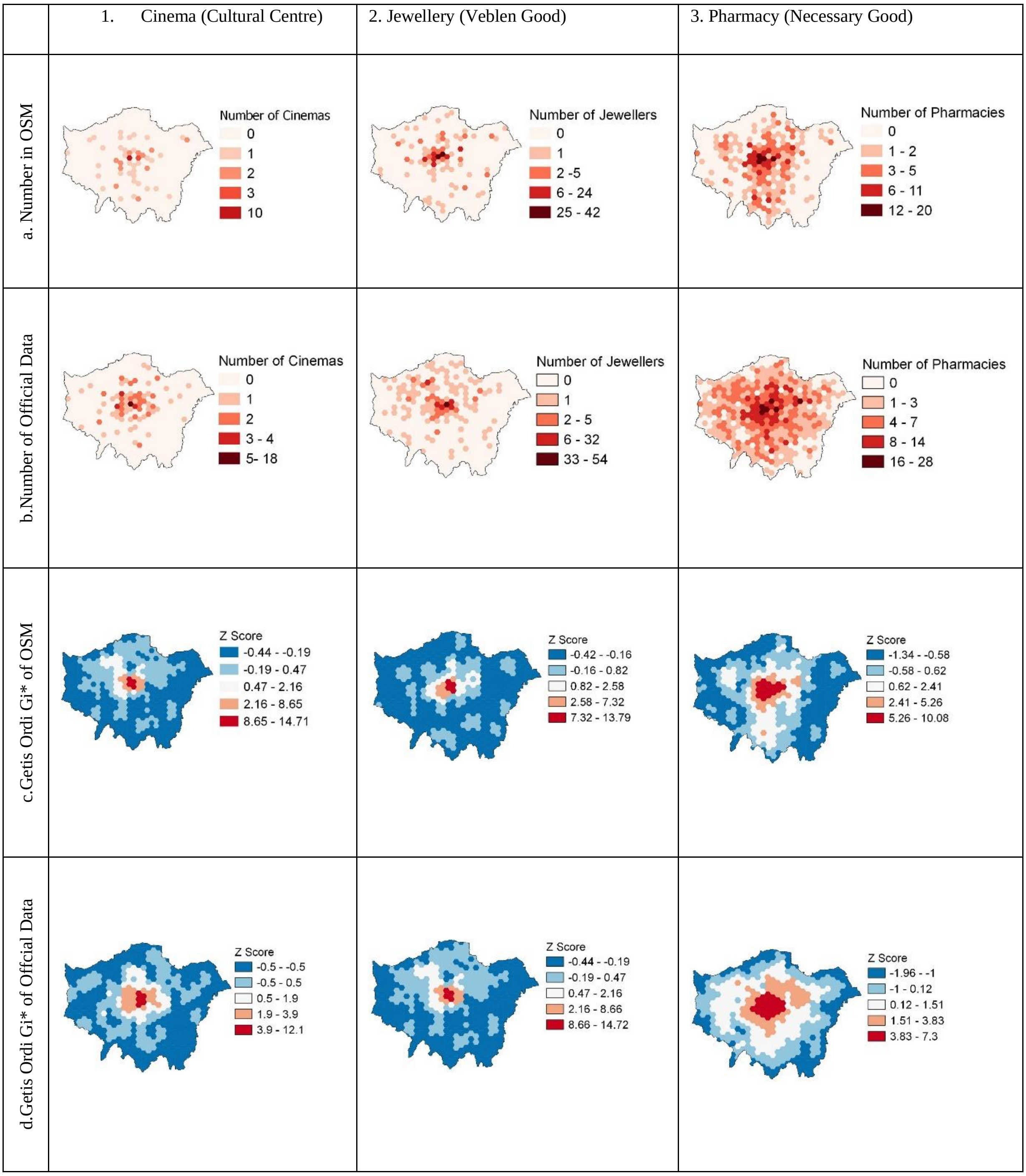

Figure 1. Spatial Coverages and Patterns of Cinema, Jewelry Shops, and Pharmacy in OSM and Official Dataset. (Figure a) Intensity of red color shows the number of points in each hexagon (Figure a and Figure b). Dark red color shows hotspots and dark blue is coldstops (Figure c and Figure d) or Getis Ordi Gi* based on Z Score.

2. Are there any relationships between the completeness of OSM data and the underlying socioeconomic process? Or in other words, can we use spatial patterns of richness/incompleteness of OSM data as a proxy for urban spatial inequality especially (spatial) digital divide in the city?

3. Will OSM find its position in the future for urban socioeconomic research comparing to authoritative data sources considering the past and current trends of enriching? Or How can we deal with this problem?

It is not our intention to be negative towards OSM. Afterall, it is not the remit of OSM to provide data for the type of projects discussed in this paper, instead we wish to highlight the potential of OSM as tool for use within the social sciences. We have highlighted some of the current shortcomings of OSM for this purpose. A partial solution might be technical, but there are other underlying cultural and socioeconomic factors in OSM production and consumption that have potential for multidisciplinary and interdisciplinary research (Ballatore and Sabbata 2020). We will explore these in future research.

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