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The status of *wheelchair*-tagged OpenStreetMap point data in European capital cities

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ABSTRACT

For a person with walking disability, one of the important information is whether a street has a wheelchair-friendly infrastructure or not. Accessing this information quickly and accurately is crucial. Believing that it will be very convenient to get this information from a single platform, some volunteers enrich OpenStreetMap (OSM) data with a *wheelchair*=* tag that provides information whether a street, building, or any feature in OSM is suitable (or not) for wheelchair use. However, since the tagged data is insufficient in many urban areas, OSM data still requires contributions. This study examines points of interest in Ankara comparing with five capital cities of Europe in terms of the statistics of the *wheelchair* tag contributions. The result shows that Ankara has fewer POIs compared to other cities and volunteers should be attracted to increase the number of *wheelchair* tagged POIs.

1. INTRODUCTION

Learning which places are suitable for wheelchair use and which are not, requires challenging experiences. Volunteered geographic information (VGI) helps us to easily present this information from a single window. In short, a VGI is a platform that is fed by the geometric and semantic contributions of volunteers and presents them openly and freely (Goodchild 2007). OpenStreetMap (OSM) is one of the popular VGI projects. In OSM, while geographical features are contributed with several geometric elements (i.e. node, way and relation), semantic information is contributed as tags (*key = value*) (OSM 2021). It is possible for contributors to add a semantic tag freely on any subject to a geographic location (OSM Wiki: Map Features 2021). Specifically, there are also various tags for wheelchairs, but the most preferred one is *wheelchair = ** (Taginfo 2021). This tag presents whether a feature is wheelchair-friendly or not.

Mobesheri et al. (2017) explained the technical details and framework of the Wheelmap project where OSM infrastructure was used. The application shares with users whether or not geographical contents are accessible for wheelchairs. In addition, the study introduced how contributors can add the compatibility information of wheelchair to the features. Basiri (2017) proposed an approach that identifies wheelchair barriers with visibility graph analysis and calculates routes based on factors that are important for wheelchairs. The suggested routes offered a higher level of user satisfaction than Google Maps suggests. Kocaman and Özdemir (2020) proposed a conceptual (law and geography) and methodological (identifying the barriers) framework by using GIS in order to reduce the social inequality faced by people with physical disabilities. Moutinho et al. (2020) carried out NOVA-MAS project using the sensors and traffic lights as the sources. It enables that wheelchair users can get accessibility information from the urban environment and infrastructures. Götzelmann and Kreimeier (2020) presented a simulator in which virtual reality is integrated with urban plans. According to the approach, wheelchair users are able to interpret 3D city plans and learn about the accessibility. In addition, some other projects for wheelchair users and individuals with reduced mobility are carried out within the scope of cartography (Hoy and Rogala 2018; Tannert et al. 2019; Biagi et al. 2020; Zastudi et al. 2020).

In this study, since OSM is an important source for the previous projects, the *wheelchair = ** tag contributions in OSM were examined. Other tags contributed most to the *wheelchair* tagged points have also been evaluated to understand the contribution trends. The paper continues with the following section describing the study area and the evaluation schema. Then, the results are evaluated over the statistics of the analysed data for six cities. The study ends with some discussions and further studies.

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2. MATERIAL & METHOD

2.1. The study areas and data

In this study, we examined six capital cities in Europe (Figure 1). While Ankara, Sofia, and Warsaw represent the urban settlements from the developing countries, Berlin, London, and Paris are the developed countries.

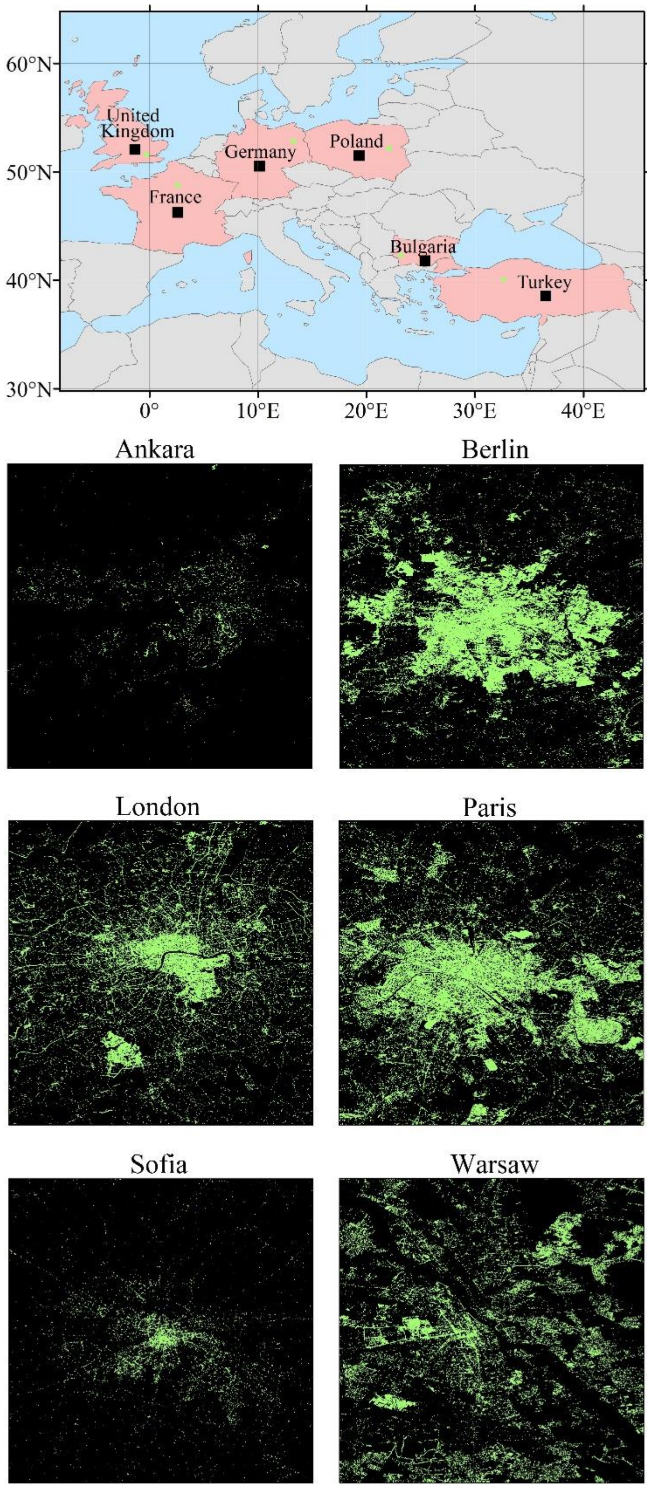

Figure 1. The density representations of POIs (Country boundaries are taken from [2])

[2]https://ec.europa.eu/eurostat/web/gisco/geodata/reference-data/administrative-units-statistical-units/countries

OSM point data in the cities was used for the evaluation. The data consists of non-linear and non-polygonal objects. This means that the points constituting lines (node) and polygons (vertices) are excluded from the dataset. The rest of the point data represents the points of interest (POIs) used in the study. The statistics of data given in Table 1 shows that there is no correlation between the urban characteristics (i.e. population, and total area of buildings) and the number of POIs.

Table 1. Urban and POI statistics of the study areas.

City	Population [1]	Total area of buildings in OSM (km^2)	Number of POIs
Ankara	4,725,000	43.1	11,594
Berlin	3,972,000	104.7	614,903
London	10,979,000	79.1	252,495
Paris	11,020,000	225.9	623,244
Sofia	934,000	20.1	20,345
Warsaw	1,935,000	65.2	244,015

[1] http://www.demographia.com

2.2. The evaluation approach

According to the original approach in Hacar (2020), the semantic information in OSM data is analysed in a direction from the most general framework to the target tag value. The most used keys in the OSM planet dataset and the most used tag values together with these keys are determined and preliminary information about the weights of the semantic data is obtained. Our proposed approach was adopted from the approach in Hacar (2020). The evaluation of the *wheelchair* tag contributions relies on the depicted schema below in Figure 2. The tag contributions are assessed from popular tags used in *wheelchair* tagged POIs to the *wheelchair* tag values. Hereafter, the tags contributed most to the *wheelchair* tagged points are called popular tags. While the schema enables the evaluation of *wheelchair* tagged points with and without popular tags, it also examines used *wheelchair* values such as *yes*, *no*, and *limited*.

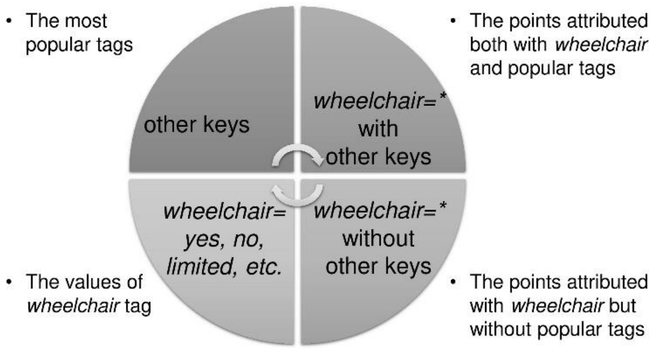

Figure 2. The schema of the evaluation.

3. RESULTS

Four popular tags in POIs contributed with *wheelchair* tag are *name*, *amenity*, *shop*, and *building*

(Taginfo 2021). The stacked bar (green+red) in Figure 3 represents the sum of *wheelchair* tags used with the POIs in the regarding city. While green color shows the number of used respective popular tag with *wheelchair* tag, red color is for the number of unused popular tags. For instance, while the number of *name* tags contributed to the *wheelchair* tagged POIs in Ankara is 65, the number of empty tags for *name* key is 2. This means that 67 points in Ankara have the *wheelchair* attribute. While 65 of them also have the name information, rests have no name.

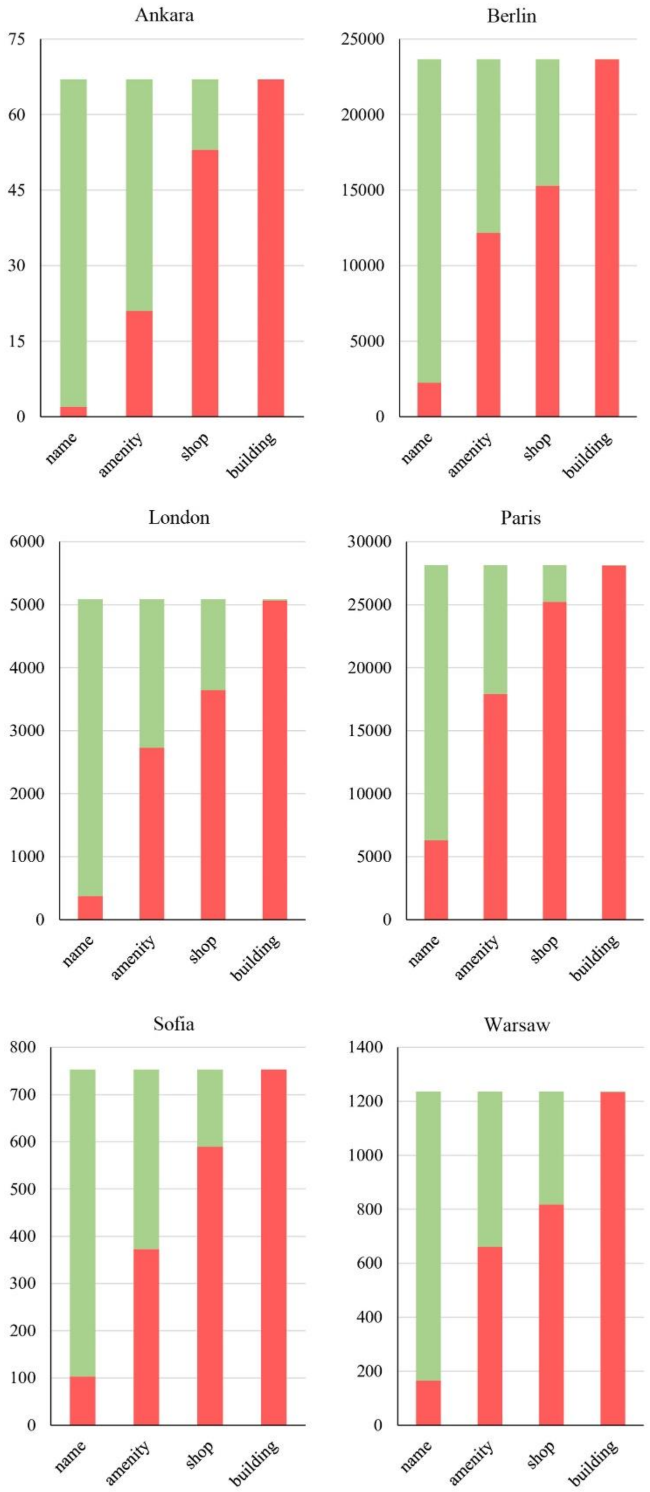

Figure 3. The distribution of popular tags in the *wheelchair* tagged POIs: existent (green) and non-existent (red).

Briefly, the *name* tag exists in 97%, 91%, 93%, 78%, 86%, and 87% of *wheelchair* tagged POIs of Ankara, Berlin, London, Paris, Sofia, and Warsaw, respectively. At least 36% of the wheelchair tagged POIs have the *amenity* tag. Also, while over 10% of the wheelchair tagged POIs have *shop* tag, less than 0.5% of them have the *building* tag. The distribution trends of popular keys in wheelchair tagged POIs of the cities are similar. However, as seen in Figure 3, there are dramatic differences in the numbers of used tags among the cities. While the capitals in developed countries have the maximum numbers, the others have the less numbers. Figure 3 also shows that all of the cities have the same contribution trend of popular tags. The trend from the most used tags to the least is occurred as the *name*, *amenity*, *shop*, and *building* tags, respectively.

Wheelchair tag was used on a small number of POIs in each city (Figure 4). Paris and Berlin, which has the largest numbers of POIs, are also the cities where the *wheelchair* tag is used the most (4.5% and 3.8%, respectively). Surprisingly, although Sofia has about 12 times less POIs than London, it is more complete (3.7%) than London (2.0%) in terms of the *wheelchair* tag rate in POIs. The capital cities where the tag is used the least are Ankara (0.6%) and Warsaw (0.5%), respectively. It can be said that the volunteers' interest in contributing information about wheelchair suitability were the less in Ankara and Warsaw.

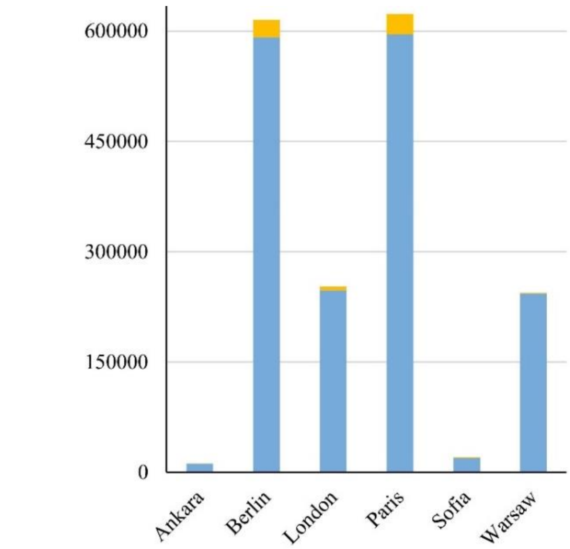

Figure 4. The distribution of the *wheelchair* tagged POIs in all POIs: existent (yellow) and non-existent (blue).

The suitability information of *wheelchai*r tag is represented by several tag values such as *yes*, *no*, *limited*, and so on. Figure 5 shows the percentage of the used values in each city. Warsaw (69%) and London (64%) are the cities that *yes* value is used the most for the *wheelchair* tag. In Berlin and Paris, *yes* value is approximately half of the *wheelchair* values. Moreover, while Paris, Sofia, Ankara, and Berlin have *no* tag value more than 30% of *wheelchair* tags, London (21%) and Warsaw (17%) has the less. Thus, it can be interpreted that the volunteers contributed in Warsaw and London preferred focusing the wheelchair-friendly entities the most. However, in Ankara, Berlin, Paris, and Sofia, they contributed the values homogeneously. In other words, the contributors focused not only the wheelchair-friendly entities, but also unsuitable or restrictedly available entities.

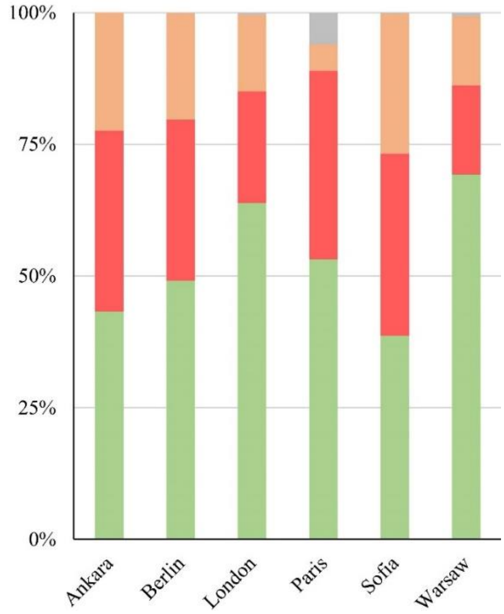

Figure 5. The distribution of the wheelchair tag values: *yes* (green), *no* (red), *limited* (orange), and the others (grey).

4. CONCLUSION

The contributors focused on not only the wheelchair-friendly entities, but also unsuitable or restrictedly available entities in Ankara, Berlin, Paris, and Sofia. However, it seems that the interest of volunteers is mostly in wheelchair-friendly entities in Warsaw and London.

Volunteers contributed the popular tags with the same trend in all cities. The trend from the most used tags to the least is occurred as the *name*, *amenity*, *shop*, and *building* tags, respectively.

Ankara has the least number of POIs comparing with other capitals. Also, the city ranks second from the last after Warsaw in terms of the number of *wheelchair* tagged POIs. Paris and Berlin, which has the largest numbers of POIs, are also the cities where the wheelchair tag is used the most. Considering the population and urbanization of the case cities, it is expected that Ankara would have much more POIs and also *wheelchair* tagged POIs than it has. It can be said that the volunteers' interest in contributing information about wheelchair suitability were the less in Ankara and Warsaw.

Future works about this topic will be focusing on a framework increasing the amount of *wheelchair* tagged POIs in OSM.

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