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An Analysis of the Service Coverage and Regulation of E-Scooter Sharing in Rome (Italy)

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Abstract

In recent years, electric scooters (e-scooters) have become a major successful expression of micro and shared mobility and have widely spread across the world. Because of this ample success, numerous e-scooter sharing companies have started their business in an increasing number of cities. A typical company puts a fleet of vehicles at disposal of its users, allowing to rent them by a smartphone application and paying a per-minute fee. Each company identifies a service area, namely a portion of the territory of the city where shared e-scooters may be rented, ridden and parked. The service area is commonly provided under the form of a geofence, namely a virtual limit that can be set through Global Positioning System (GPS) technology and is drawn on the map provided by the smartphone application of the company. In this work, we study the e-scooter sharing systems that have been created by a number of private companies in Rome, the capital city of Italy. Specifically, we focus on identifying and analyzing the service coverage guaranteed by the companies through their service areas and the overlap of areas managed by different sharing companies. We also provide an overview of the e-scooter sharing regulation of Rome, identifying some first recommendations that could lead to a more effective deployment of e-scooter sharing services.

Keywords: Micromobility; Shared Mobility; E-Scooters; Urban Transport; Geofences; Service Coverage.

1. Introduction

Over the last years, electric scooters (e-scooters) have become a major successful expression of micro and shared mobility and have widely spread across cities all around the world. As highlighted in studies like (Laa and Leth,

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2020; Sanders et al., 2020), in some countries they have started to consistently replace walking and biking of individuals and have also induced a remarkable mode-shift from private car trips. The wide success that e-scooters have experienced can be traced back to major advantages that they offer, like low buying price and maintenance cost and the ease with which they can be driven and parked. Furthermore, they have been welcomed as a way to decrease pollution and traffic, representing a valid sustainable alternative to fossil fuel-based private cars. For a wider introduction to features and benefits of e-scooter mobility and, more in general, to shared mobility, we address the reader to Gössling (2020); Shaheen et al. (2020); Boglietti et al. (2021); O'Hern and Estgfaeller (2020).

Thanks to the big success of e-scooters, an increasing number of sharing companies has appeared in many cities around the world. However, the easiness of parking and riding that characterizes such sharing services has soon started to represent a source of issues: users have shown a clear tendency to ride against rules of the road and to cause *wild parking*, namely parking without respecting road rules and abandoning vehicles in risky positions that may pose threats to pedestrians on sidewalks and to other vehicles on the streets. Due to this, local governments have started to impose bans and fines to sharing companies (see e.g., CNN (2019)). To tackle these parking issues, Carrese et al. (2021a, 2021b) have recently proposed to introduce the figure of the *beautificators*, agents that are hired by a sharing company expressly for contrasting wild parking and guaranteeing urban decorum. The critical task of a beautificator is to reposition e-scooters over short distances (even just a few meters), so as to fix inappropriate and disordered parking. This kind of repositioning should not be confounded with traditional relocation made over long distances in vehicle-sharing systems for rebalancing fleets in the service area (e.g., Boyaci et al. (2017)).

Each sharing company distributes its fleet inside a service area, namely a portion of the territory of the city in which users may rent, ride and park the e-scooters. The service area is typically provided under the form of a coloured virtual polygon, highlighted in the city map provided in the smartphone application of the company. The sides of this polygon correspond to a geofence, namely a virtual limit that can be set through Global Positioning System (GPS) and outside which the e-scooters cease to function. The polygons defined by distinct companies are typically different in shape and size, reflecting the specific business objectives and strategic and operative decisions taken by the respective companies.

The study and analysis of the service areas in major cities around the world allow to evaluate how e-scooter sharing services are deployed in a city and gives the opportunity of gaining valuable insights about spatial management of the service. To the best of our knowledge, just a limited number of studies has attempted to operate this and, among them, we recall in particular the works by Moran (2021), Moran et al. (2020), Straub and Gajda (2021), which have respectively focused on the cities of San Francisco, Vienna and a selection of Polish cities.

In this work, we study the e-sharing scooter sharing systems that have been created by a number of private companies in Rome, the capital city of Italy. Specifically, we focus on identifying and analyzing the service coverage guaranteed by the companies through their service areas, especially considering their distribution over the territory. Specifically, our main original contributions are:

- we provide a visualization of the service areas of the six companies that operate in Rome, deriving the maps of their intersection and union, and discuss their features, highlighting their surface and analyzing how they distribute over the territory of Rome;
- we review major regulations that affect e-scooter sharing services, both at national Italian level and at the level of the municipality of Rome, highlighting the crucial fact that e-scooter sharing is under experimentation in Italy and how this reflects on the regulation;
- we provide a number of preliminary recommendations for completing the regulation, based on the insights gained through the analysis of the service areas of Rome and on the review of Italian and Rome's regulations.

The remainder of this paper is organized as follows: in Section 2, we depict and analyzes the service areas of the e-scooter sharing companies; in Section 3 we provide an overview of relevant regulations at national and local Rome's level. Finally, we discuss conclusions and directions of future research in Section 4.

2. Service Area Analysis

A major objective of the study that we propose in this work is to identify and visualize the service areas of the six e-scooter sharing companies that operate in Rome. We remark that, to the best of our knowledge, such service

areas are not made publicly available by the operators and there is no official website that makes them openly available through a geospatial vector data format that can be processed by a Geographic Information System (GIS) software. Because of this lack of open and easily processable official data, in order to conduct our analysis, we manually drew the service areas by means of the open source GIS software QGIS (2021). Specifically, the area of each e-scooter sharing company was drawn as a layer in a QGIS project, following the borders of the area as reported in the official smartphone application of the company. Each area corresponds to a QGIS polygon whose sides are defined on a street-by-street basis. By defining layers, we had the possibility of exploiting useful QGIS functions supporting the computation of areas and the intersection and union of territories covered by distinct layers. This has led to new valuable insights about the geospatial distribution of the service areas in Rome and constituted a valuable basis for new analysis and recommendations for future regulations and policies.

Specifically, we considered the six companies: 1) BIRD (2021), 2) DOTT (2021), 3) HELBIZ (2021), 4) LIME (2021), 5) LINK (2021), 6) WIND (2021) and we drew the QGIS polygons of their service areas as shown in the respective smartphone applications on May 2nd, 2021. The polygons are based on the areas that were reported as available for renting, riding and parking the e-scooters at the considered date.

We remark that drawing by hand the service areas in QGIS may naturally generate (small) inaccuracies and some (limited) discrepancies between the maps. This results particularly true in the case of the company LINK that seems to adopt an hexagonal raster grid as basis for defining its service area, in which long straight lines cannot be drawn. This results in contrast to the other five companies that instead adopt standard geospatial polygons.

We stress that it would be very easy to solve this hand drawing issues if the companies openly shared their data in geospatial format on their website. At the same time, as highlighted in discussions that we had with (e-scooter) sharing mobility professionals, we recognize that the companies may tend to avoid to clearly share their data since this reduces the visibility of variations in the size and features of the service area and in the shared vehicles distribution which could be negatively perceived by the users (e.g., an area that was previously covered by the service is cut off for difficulties related to the deployment of vehicles).

The first observation about service areas that we can make concerns the relation between the extension of the overall territory of Rome and the extension of its internal area in which e-scooter sharing services are available. This is depicted in Figure 1, in which we show in azure the territory of Rome and, inside it, highlighted with black diagonal lines, the area of the city that is covered with service by at least one e-scooter sharing company. The area covered with service is approximately equal to 134 km^2, which represents about 10% of the total area of Rome. This percentage may look small, but it is important to note that the overall territory of Rome is extremely large, for Italian municipality standards. It indeed stretches for more than 40 km between its extreme points, including very different districts that vary from highly dense and populated areas, located closer to the centre, to rural and more peripheral areas with very low population density. So, while this datum is useful to get an idea of how the service area relates to Rome taken as a whole, the attention should be more focused on the area that is included inside the so-called *"Grande Raccordo Anulare"* (*GRA* - roughly translatable as "Great Ring Road"), a ring-shaped highway with a radius of about 20 km that not only hosts the largest part of the population of Rome, but also contains the vast majority of the historical, business and governmental districts of the city. If we focus on the portion of Rome inside GRA, which covers about 390 km^2, the percentage of area covered with e-scooter sharing services rises to the significantly higher percentage of about 34%.

Taking into account the previous considerations about GRA, in what follows, we restrict our maps depicting the e-scooter service areas, so as to focus and center on Rome's territory inside the GRA. The six companies operate with similar and comparable tariffs, requesting a user to pay a fixed fee to unlock an e-scooter and start the rent and then a per-minute renting fee until the rent is ended. The service areas of the companies are depicted in the six subfigures (a)-(f) of Figure 3. The first observation that can be made is that all the six companies cover the downtown of Rome, including the oldest districts of the city where are concentrated all the most important tourist attractions, shopping streets and governmental institutions. Furthermore, this area also includes the main restricted traffic area of Rome, in which, from Monday to Saturday, the access is only allowed to residents and owners of selected categories of business activities. We highlighted the intersection of the six service areas in Figure 2b, where the green area represents the territory of Rome where a user has full choice and may rent an e-scooter from any company. This intersection covers an area of about 33 km^2, which constitutes a very small 2.5% of the total surface of Rome, whereas it represents the 8.5% if we consider the more relevant area inside the GRA.

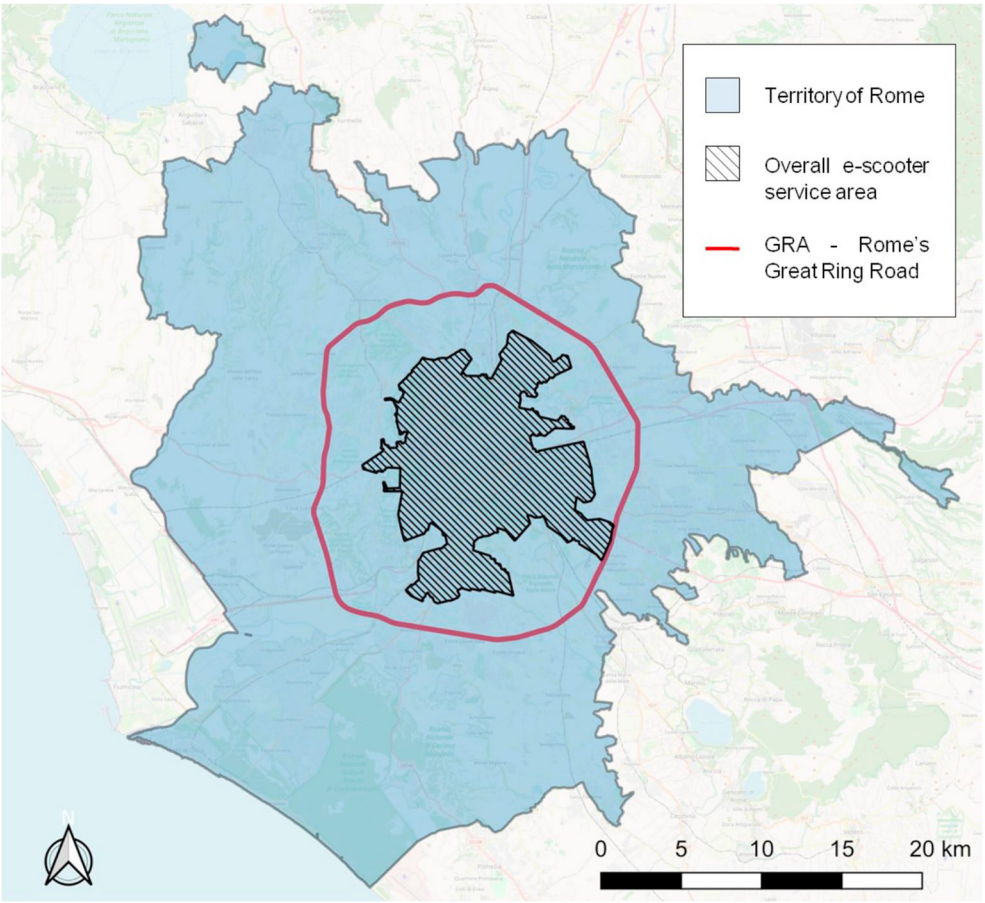
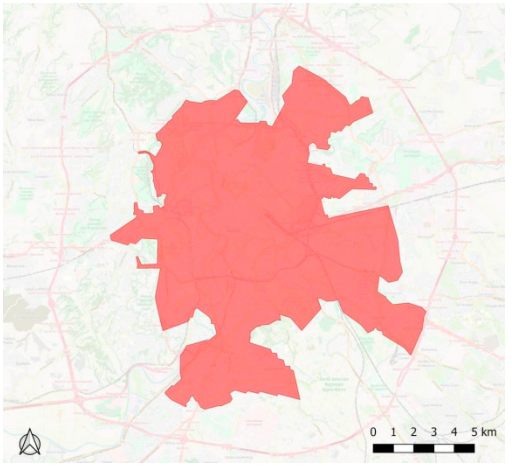


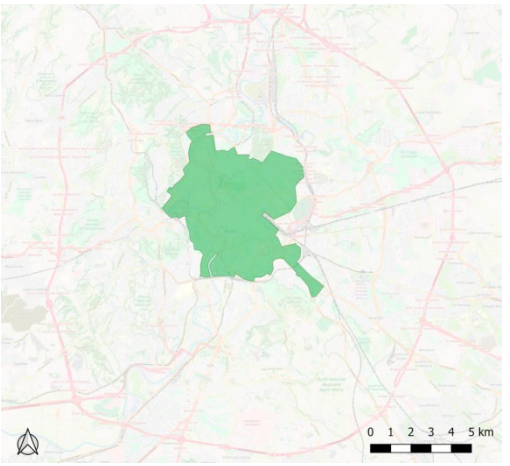
Fig. 1: Territory of the Italian city of Rome with highlighted the area covered with service by at least one e-scooter sharing company.

Another perspective about the service coverage may be obtained considering the union of the areas of the six companies, which provides the area where at least one company operates. This area is depicted in Figure 2a and spreads over 134 km^2, which represents about 10.5% of the total surface of Rome and reaches the remarkable value of 34% of the area internal to GRA. It is interesting to note that, in comparison to the intersection, the union extends especially to the eastern and southern quadrants of the area inside the GRA, which, most notably, include some of the districts with highest population density and the monumental district of EUR, characterized by a high concentration of activities of the tertiary sector of the economy.

We can then proceed to provide more insights about the specific features of the service areas. In Table 1, for each area, we report its overall surface (T*otal Service Area*) and its distinctive surface (*Distinctive Service Area*), namely the area where the company is the only one offering sharing services. Jointly looking at the data of the table and at the maps, we can make the following major observations: a) BIRD offers the smallest service area, which is limited to the historical center and almost totally coincides with the intersection area, defining a very small distinctive area; b) the four companies DOTT, HELBIZ, LIME and WIND offer service area of comparable size ranging from about 60 to 77 km^2; however, while DOTT, HELBIZ and LIME present very small distinctive areas (less than 3 km^2), WIND provides a much larger distinctive area that constitutes more than 25% of its overall service area, remarkably offering services in densely populated districts of the Eastern quadrant; c) LINK stands out of the six companies by offering the largest overall area (more than 100 km^2) and a large distinctive area (more than 20% of its area), especially offering sharing in the southern quadrant of the city.



(a) Union of the six service areas



(b) Intersection of the six service areas

Fig. 2: Visualization of the areas covered by at least one operator (left) and by all operators (right).

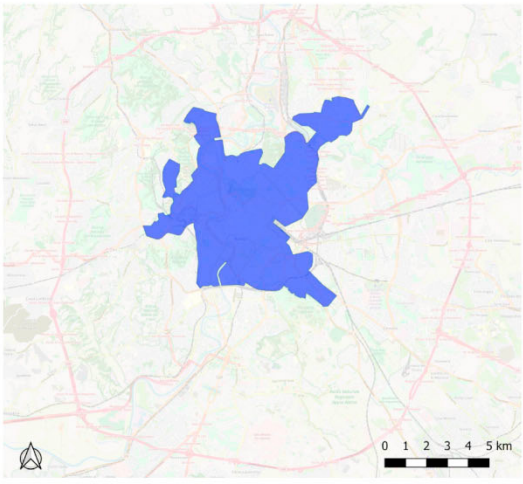
Company	Total Service Area (km^2)	Distinctive Service Area (km^2)	% Distinctive Area
BIRD	46.42	0.09	0.19
DOTT	77.29	2.36	3.05
HELBIZ	74.17	2.63	3.54
LIME	60.90	0.11	0.18
LINK	107.02	22.82	21.32
WIND	67.92	17.64	25.97

Table 1: Surface of the e-scooter service areas.

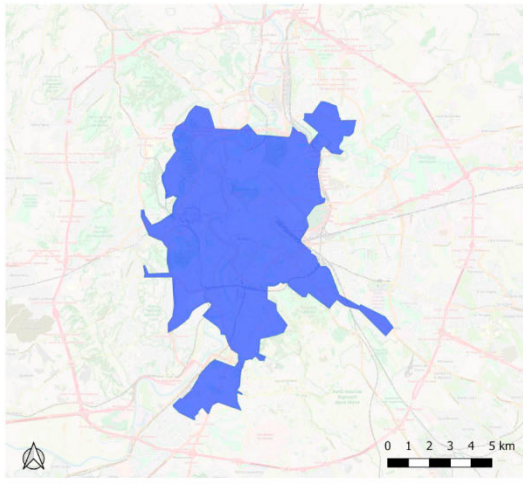
3. Overview of Regulation

When dealing with regulation of e-scooter sharing services in Italy, a first crucial remark that must be made is that such services are considered under experimentation: the 2019 national law (L. 30.12.2018, 2018) authorized Italian municipalities to start to experiment the introduction of e-scooter sharing services, delegating each single municipality to develop its own specific local regulation, while respecting general constraints fixed by the government. These general constraints are specified by the national ministerial decree (D.M. 04.06.2019, 2019), which provides more details about how the e-scooter sharing experimentation should be conducted, confirming that authorizing e-scooter sharing is an option and not an obligation for a municipality. Furthermore, notable parts of this decree specify that: 1) a municipality, before starting the experimentation on its territory, should identify and map the streets where e-scooters may circulate; 2) e-scooters must satisfy a number of technical constraints (e.g., power of at most 0.5kW and limited maximum speed of 20km/h), 3) e-scooters, in contrast to other types of micromobility devices like monowheels and hoverboards are allowed to circulate in pedestrian zones, shared bycycle-pedestrian lanes, reserved bicycle lanes and 30 km/h zones, under the condition to be equipped with speed limiters that allow to maintain speed under 6 and 20 km/h. Another major reference is represented by the law L. 27.12.19 (2019), which identifies the e-scooters meeting the technical requirements specified by the decree (D.M. 04.06.2019, 2019) as *"velocipedes",* thus including them in a large family of lightweight wheeled vehicles propelled by the rider and of which bicycles are the most remarkable example. This law fixed the essential legal basis for comparing e-scooters to (electric) bicycles.

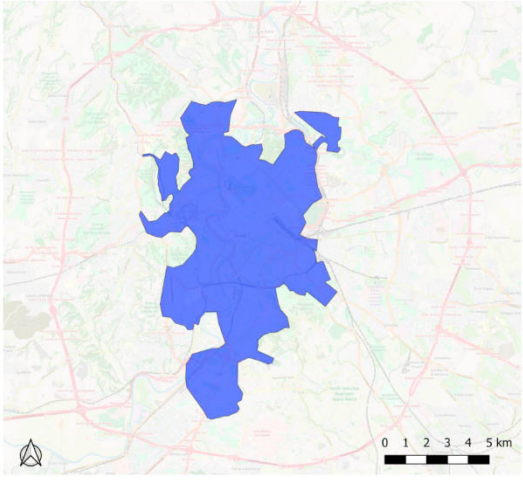
Concerning the specific regulation introduced by the municipality of Rome, the fundamental reference is represented by the Resolution (Roma Capitale, 2020) that introduced a number of rules, officially classified as guidelines, for introducing free-floating e-scooter sharing in the city. The Resolution first reasserts that the municipality authorizes just an experimentation, fixed for a duration of two years, and opens an invitation to tenders of companies interested in obtaining a license to operate.



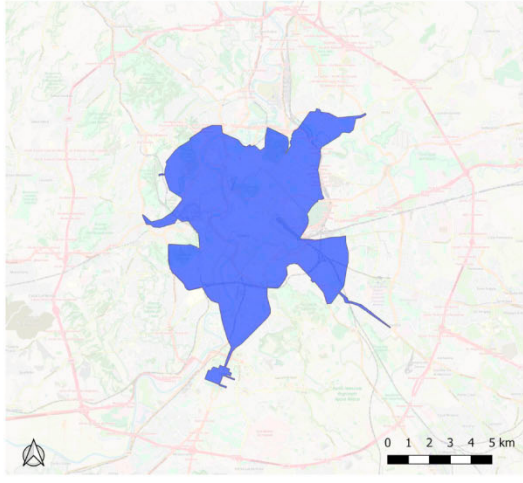
(a) BIRD's service area



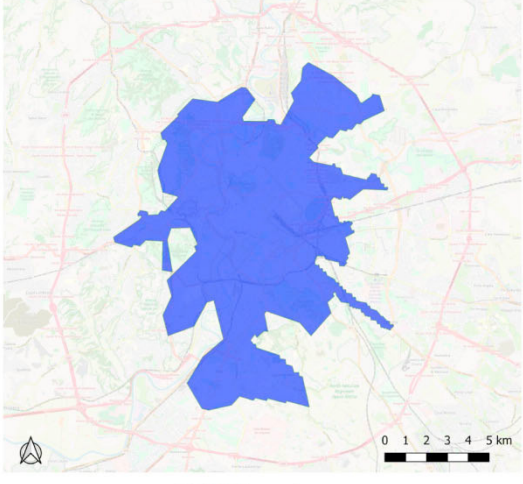
(b) DOTT's service area



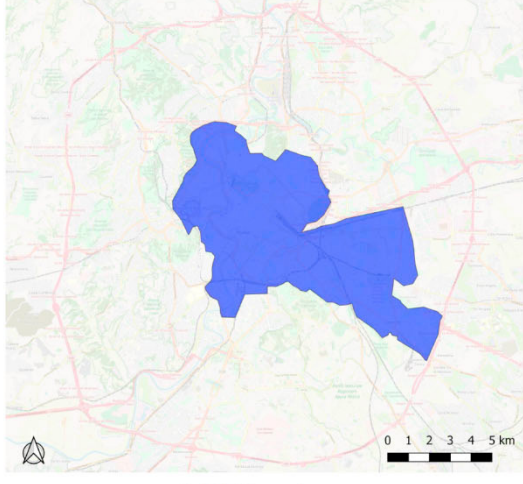
(c) HELBIZ's service area



(d) LIME's service area



(e) LINK's service area



(f) WIND's service area

Fig. 3: Visualization of the service areas of the considered six e-scooter sharing companies

Besides confirming that e-scooters are compared to bicycles, it states that free access to the restricted traffic zones is granted. Moreover, it fixes that e-scooters may be parked in lots reserved to motorbikes and in lots positioned on sidewalks specifically designed for not conflicting with pedestrians. More remarkable restrictions that are imposed are represented by putting an upper bound on the total number of e-scooters that are globally allowed to circulate in Rome (no more than 16.000 in total) and imposing that each license granted to a sharing company imposes to deploy at least 750 and at most 1000 e-scooters. The municipality reserves the right to identify the zones and streets where the circulation and parking is allowed. However, to the best of our knowledge, this constraint has remained quite vague and no map clearly identifying those zones and streets has been made openly available on the open-data website of the municipality. We can note that, just very recently, in April 2021, the municipality of Rome has identified a small number of areas reserved to parking e-scooters in the core of downtown and has announced to soon ban the circulation in a few critical streets inside the restricted traffic zone. Some more specific constraints that have been imposed by the Resolution (Roma Capitale, 2020) is that each licensed sharing company must continuously guarantee that at least the 90% of its e-scooter fleet is correctly operative and assure that any problem related to the status of its vehicles (e.g., wild parking) must be resolved within six hours from a warning provided by the local police authorities. Furthermore, a company must guarantee that group of e-scooters closely parked must not exceed 5 units, for pursuing urban decorum. Failure to comply with these conditions may lead to temporary bans and fines, as recently happened for 15 days at the end of 2020 for two companies because of incorrect parking made by users. We remark that the regulation introduced by the municipality of Rome, as also indicated by the fact that is introduced under the name of guidelines, may suggest and highlight their temporariness and the fact that they are part of an experiment whose results will have to be analyzed at the end of the two years. We believe that the vagueness and what could be considered incompleteness of a number of aspects of e-scooter sharing have been intentionally introduced. We expect that those gaps will be filled in the future, as the experimentation brings on, on the basis of the results that will be obtained. An example is provided by the recent explicit introduction of reserved parking zones and by the ban of e-scooter circulation in a few very selected historical streets, due to incidents that occurred and to the impact of wild parking on urban decorum and interference with pedestrian and motor vehicles.

4. Conclusions and Future Work

The study and analysis that we have conducted in the previous sections allow us to derive some first recommendations concerning the definition and management of e-scooter sharing service areas in Rome on both the business and the municipality sides. In what follows, we first derive recommendations that could be applied to all municipalities in Italy and then proceed to identify recommendations that refers more specifically to the city of Rome. First of all, not only for Rome but for every Italian municipality, we think that it would be very important to fill the gap about the availability of openly available geospatial data: all companies should submit their data, permitting to clearly and univocally visualize the geofences and extent of their areas in a shared website, possibly maintained by the municipality. This would allow users to gain a clear global view of where and by which company they may benefit from shared mobility services in the city. We recognize that an incompleteness of open data is also present on the municipality side: to the best of our knowledge, in the open data website of the municipality of Rome, like in the websites of other major Italian municipalities, there are no geospatial data sets that identify a) the areas where e-scooter sharing services may be deployed, b) the no-parking zones and c) the zones where the circulation is prohibited. We believe that making these maps openly available would be very useful not only to potential and active sharing companies for better designing and managing their service areas, but also to the increasing number of people possessing their own e-scooter. We think that a clear geospatial visualization of the no-circulation and no-parking zones would be also valuable to the e-scooter users, whose (bad) riding and parking habits seem to be often affected by a lack of easily accessible information about the local rules of the road that they must respect. Another important recommendation that we suggest is that the maps and geospatial data made available by both the companies and the municipality should be updated and published monthly, highlighting the changes that have occurred with respect to the previous month. Creating historical data sets would be valuable to track the overall evolution of both the sharing services and the circulation and parking constraints of the municipality. Focusing on the specific case of Rome and considering service coverage, our spatial analysis has highlighted that all the companies concentrate on providing sharing services especially in the central historical districts of Rome. This is not surprising since it is expectable that a company intends to focus on those central zones where circulation conditions and renting opportunities are more favourable and profitable. However, at the same time, we think that it would be very important to guarantee larger service zones and a fairer access to sharing services, better covering also peripheral districts of Rome inside and outside the GRA road ring. Since this enlargement of the service areas is

likely to be costly and cumbersome for the companies, it would be important to identify incentives that could make it more attractive (e.g., removing fleet size caps, allowing to increase the fleet size more easily, or granting tax benefits). We intend to study such aspects in our further studies. Moreover, as future work, we plan to extend our analysis to the no-parking zones defined by each company and to the explicit definition of reserved parking spots in central areas that some companies adopt, also proposing improvements of their coverage by means of optimization methods as done in (Carrese et al., 2021). Furthermore, we intend to report and analyze the evolution that the service areas has experienced over a reference time period, using historical data that we collected.

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