



The three levels of the urban digital divide: Bridging issues of coverage, usage and its outcomes in VGI platforms

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ABSTRACT

This article aims to provide a more detailed conception of the production of urban digital divides by VGI platforms in the context of the platform economy, through the articulation of the first (access and coverage), second (usage and skills) and third (outcomes) level of the digital divide. Our conceptual approach departs from a discussion of the geographical consequences of the different levels of the digital divide, focusing on their application to the study of VGI platforms, especially those working under the logic of the platform economy. We draw on a multi-level case study of the geographies of TripAdvisor and the geographies of restaurants or similar establishments in Lisbon, which comprised data analysis and interviews with restaurant owners, to argue that VGI platforms are producing urban digital divides that can only be fully detected through the triangulation of the different levels of the digital divide. They are not only producing different levels of territorial coverage in cities, but also different levels of usage intensity which have caused negative and positive outcomes for the firms associated. All these levels are spatially distributed, and such distribution is even more pronounced at a finer scale. We conclude that VGI platforms are producing a myriad of new forms of spatial divides that need more attention, given that the digital divide is present within the mechanisms designed by digital platforms. The vast and complex effects of such data engineering is best captured when all three levels of the digital divide are taken into account.

1. Introduction

The topic of the digital divide has been in discussion since the emergence of information and communication technologies (ICT) and the internet, but there is now renewed attention to this issue due to the appearance of volunteered geographic information (VGI) platforms (Graham, 2002; Hilbert et al., 2010; Graham, 2011). While for a long time the production of information was made exclusively by experts with appropriate skills working in institutional or private entities to produce information in private data bases, there is now a myriad of possibilities for users to create geographical information through the digital platforms (Goodchild, 2007; Ash et al., 2016). Although the

emergence of VGI platforms has enriched territories with several types of information and its usefulness has been recognized (Zook et al., 2011; Cinnamon & Schuurman, 2013; Ferreira & Vale, 2020; Encalada-Abarca et al., 2017), some authors stress that the uncontrollable and unbalanced use of VGI generates digitally unequal territories (Crutcher & Zook, 2009; Elwood et al., 2012; Sui et al., 2012). There is an acknowledgement in literature that VGI generates digitally fragmented places in which there is a peripherization not only of places but also of people (Graham et al., 2014). Some authors have focused on the concept of the digital divide, analysing the mechanisms that promote these inequalities (Crutcher & Zook, 2009; Elwood et al., 2012; Ash et al., 2016).

Initially, the topic of the digital divide revolved mainly around the

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issue of access to the internet and ICT, which is now considered to be the first level of the digital divide (Van Dijk, 2006; Ragnedda, 2017; Van Deursen & Van Dijk, 2019). The number of studies on this topic has steadily increased, which can be explained by the constant technological developments which generate new issues of access and coverage (Gilbert, 2010; Chen et al., 2014; Niehaves & Plattfaut, 2014). Nevertheless, there has been an emergent necessity to analyse the digital divide beyond the issue of access especially in developed countries where the problem has been minimized.

It has been argued that the digital divide is not only about who has and who does not have access because, despite widespread access to the internet in developed countries, the divide still persists in other forms. Considering that first level analysis has not been enough to understand the digital divide as a whole, some authors have attempted to understand the new levels of digital divide. Two further levels of digital divide have been identified (Van Deursen & Van Dijk, 2014; Ragnedda, 2017; Scheerder et al., 2017; van Deursen & Mossberger, 2018; Lutz, 2019). On one hand, it has been noted that even with equal levels of access, people have not the same skills and knowledge to use digital resources in the same way, leading to the different usage levels, which has been understood as the second level of the digital divide (Van Dijk, 2006). On the other hand, there is increasing awareness that differences in access or usage of digital resources have inherent outcomes and consequences in the real world. Those consequences have been considered the third level of the digital divide (Selwyn, 2004; Fuchs, 2009; Scheerder et al., 2017).

Thus far, most geographic research has been focused on the first level, by exploring the territorial coverage of several digital platforms, although there is growing literature on the geographies of digital usage and its offline consequences. More importantly, literature on the three levels of the digital divide emphasises the relationality between these different levels. Therefore, geographic research that considers the triangulation of the three levels of the digital divide is crucial to provide comprehensive explanations of the depth of digital inequalities. These unexplored concerns are assuming more importance due the increasingly complexity of the technologies, which are able to generate new forms of digital divides, particularly in urban areas in which inequalities can be invisible when studied in a broader scale or when only first-level coverage issues are considered (Warf, 2018).

Such a perspective is particularly important to understand the effects of proliferation of VGI platforms, which cannot be dissociated from the emergence of a new economic logic built upon a data revolution (Kitchin, 2014; Kitchin & Dodge, 2014). New services have been created through these digital platforms in order to develop new products, promote innovation, or generate value, often through cocreation processes (Pralhad & Ramaswamy, 2004a; 2004b; Truong et al., 2012; Beer, 2013; Ramaswamy & Gouillart, 2010; Ramaswamy & Ozcan 2014). This has presented a new opportunity for firms to grow by integrating themselves into digital platforms and exploring the potentialities of the services that these can offer. This new economic context has been defined as a platform economy or platform capitalism (Kenney & Zysman, 2016; Langley & Leyshon, 2017; Srnicek, 2017). Nevertheless, the growing integration of firms on VGI platforms has also presented challenges that require further examination. Firstly, the duality between those who are in or out of platforms can create important inequalities in terms of online visibility, which might arise from ICT access constraints due to different geographical coverage. Moreover, the fact that VGI platforms allow open interaction between the firms and several actors generates different levels of interaction that stem from the firm's different levels of usage. Furthermore, platforms with unequal coverage in which there are different levels of usage by firms generate a myriad of inequalities that deserve further research, given their significant positive and negative outcomes. It is only possible to get a whole picture of this process through the triangulation of three levels of the digital divide.

With this in mind, the objective of this article is to provide a more detailed conception of the production of urban digital divides by VGI

platforms in the context of the platform economy, through the articulation of the first, second and third level of the digital divide. To do this, we draw on a multi-level case study of the geographies of TripAdvisor and the geographies of restaurants or similar establishments (hereafter: restaurants) in Lisbon, in which we draw upon data collected from the TripAdvisor's platform and the restaurants in the city of Lisbon, and a series of interviews with restaurant owners. We argue that VGI platforms are producing urban digital divides that can only be fully detected through the triangulation of the different levels of the digital divide. They are not only producing different levels of territorial coverage in cities, but also different levels of usage intensity which have caused negative and positive outcomes for the firms associated. All these levels are uneven spatially distributed, and such uneven distribution is even more pronounced at a finer scale.

This article is further divided into four sections. First, we discuss the three levels of the digital divide, focusing on their application to the study of VGI, especially under the context of the platform economy. Secondly, we present the methodology of our case study of the geographies of TripAdvisor and the geographies of restaurants in Lisbon, including the criteria for case selection and the methods of data collection and analysis. Thirdly, we analyse the different levels of the digital divide in the restaurants in Lisbon, showing that platforms are producing uneven geographies with different levels of coverage and usage intensity, which in turn generate differentiated outcomes for the firms. We conclude the paper by reflecting more widely on the spatial consequences of the digital divide that stem from VGI platforms.

2. The levels of digital divide

The concept of digital divide is not recent and the discussions around its definitions have been well documented in several works (Servon, 2002; van Dijk, 2005; Vehovar et al., 2006; Stevenson, 2009). Recently, a new approach to the digital divide that tries to attend to its complexity and current challenges through the consideration of the different levels of the divide – coverage and access, usage, and real-world consequences – has been proposed.

Although the digital divide stems from social, economic, and political factors, geography has always been considered an important variable (Warf, 2018). The analysis of the digital divide from a geographical perspective has led to the creation of several concepts that try to explain the spatial distribution of such divide. For instance, we have recently witnessed a myriad of geographic studies on user-generated data and the spatial inequalities it produces (Graham, 2011; Graham & Zook, 2013; Shelton et al., 2014; Yang et al., 2016). Such studies have already explored all three levels of the digital divide. However, they are still predominantly focused on the first level of digital divide, which is to say the levels of coverage or the access to the technologies (Van Deursen & Van Dijk, 2019). Moreover, while there are works that approach the divide in usage and real-world consequences, the relationship between these levels is rarely considered and never properly discussed. In this section, we critically review the current geographical approaches to the different levels of digital divide, focusing on the emergent necessity of triangulating them to understand the spatial digital divide generated by VGI digital platforms as a whole.

The first level of the digital divide is defined by the issue of access to the internet and the various ICT. The digital divide was firstly associated with a socio-economic gap between those who have access to the computer and the internet, and those who do not. This is mostly a binary view of the concept of digital divide based on access and non-access to the internet, but also the most widespread notion (Graham, 2011; Eastin, et al., 2015). For instance, the Organization for Economic Cooperation and Development (OECD) defines the digital divide as a “gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard both to their opportunities to access ICTs and to their use of the Internet for a wide variety of activities.” (OECD, 2011, p. 5). The studies of the European

Commission's Eurobarometer and the National Telecommunications and Information Administration (USA) were also based on this first notion of the digital divide, showing the differences in internet access between different segments of the population (NTIA, 2000; 2002). This definition has also become consensual in several scientific spheres of the academia (e.g., technology and information systems, management, economics and business and social sciences) (Katz & Aspen, 1997; Hoffman & Novak, 1998; Pick & Sarkar, 2015). It was only in the last decade that it became *de rigueur* to note that the digital divide implies more than a gap in access between different groups and places (Graham, 2011). Nevertheless, the first level of digital divide should not be forgotten given the constant emergence of new trends and technological advances (Halford and Savage, 2010; Van Deursen & Van Dijk, 2019). The issue of access remains an important concern because without works about access to information, it is not possible to keep track of how these advances contribute to the maintenance or the deepening of the uneven coverage of geographical information. Moreover, geographic studies have generated important concepts to account for the spatial digital divide of digital platforms. Several studies have used the term "data shadows" to refer to the spatial differences in the amount of information in different platforms such as Wikipedia (Graham, 2014), Google Maps (Shelton et al., 2014), and Twitter (Zook et al., 2011). Although there is no concrete definition for "data shadows", the concept is based on the idea that territories are composed of different intensities of online information coverage. In this sense, the term "shadows" is used to describe the different shades - represented by different colours or gradations of colours - that an area can contain. Similarly, Wentrup et al. (2016a) and Wentrup et al. (2016b) use the term "digital oases" and "digital deserts" to describe the distribution of Internet access and Facebook usage in Sub-Saharan Africa, arguing that most countries in this continent are still digital deserts and that the areas with the highest internet are correlated with economically stronger areas. While the concept of data shadows directs our attention to the nuances in the amount of available information on a given space, the terms digital oasis and digital deserts highlight the intense gaps between the most and least affluent spaces. However, Graham and Zook (2013) show that, beyond the recognized importance of information densities, it is also necessary to take into account their cultural and political nature and underlying power relations. They use the term "uneven linguistic geographies" to highlight the issue of language as a shaper of online access which, in turn, influences the way that places are represented online.

Despite these explorations of the urban scale, most of the geographic terms that describe digital divides were thought for wider analysis. Some concepts such as data shadows can be applied to different scales of analysis. Yet, some finer scales might not display the heterogeneous results that the term suggests, creating the appearance of non-shadowed areas. On the other hand, concepts such as digital deserts or digital oases, mostly applied to larger areas, suggest the homogeneity of certain spaces that can be considered digital enclaves. We can think of these concepts at a finer scale, namely in cities in which we can find similar digital enclaves that can be thought of as deserts or oases. However, while the concept of digital deserts and oases often neglects internal differentiations, at the finer scale context, due to its reduced dimensions, we can think about actual digital urban voids that are defined by their complete absence of data, or digital urban islands that are defined by the non-shadowed homogeneity of their data.

The second level of the digital divide, which consists on the differences in usage of digital resources, stems from the need to extend the notion of digital divide beyond its access, making it a concept with a broader spectrum of perspectives (van Deursen & Mossberger, 2018; Lutz, 2019). It has been noted that first level studies were not considering the multidimensionality of what it means to be connected (Mossberger, et al., 2003; Warschauer, 2003), as even in spaces in which there is a good level of access and territorial coverage, the use that people make of digital technologies is not the same (Hargittai & Hinnant, 2008). Individuals from different classes and groups might have equal

access to the internet, but not everyone has the same skills and knowledge to use and apply them in the same way, and empirical studies have been showing the relevance of these differences (Van Dijk, 2006; Scheerder et al., 2017). More precisely, it has been noted that, due to differences in skills and knowledge, some individuals taking far more advantage of technologies than others (Hargittai & Hinnant, 2008; Zillien & Hargittai, 2009; Van Deursen & Helsper, 2015). The second level of the digital divide has had less expression in literature so far, with the exception of some sociological works (Hargittai, 2002; van Deursen & Mossberger, 2018; Lutz, 2019).

While there is much merit in such research, the spatial consequences of these inequalities deserve further examination. Several studies have showed that although the internet and technologies have enabled greater social engagement, economic opportunities and political participation, these benefits are not the same for all individuals (Hargittai & Hinnant, 2008; Boulianne, 2009; Van Deursen & Van Dijk, 2009; Zillien & Hargittai, 2009; Hargittai, 2010; Gui and Argentina, 2011; Van Deursen & Van Dijk, 2014). Such empirical studies have contradicted the deterministic view that having access to the internet already provides all of its benefits (Hargittai, 2002). Instead, it is increasingly noticeable that there are not only differences in terms of digital skills and resources between different social groups, but also significant individual differences in skill levels within social groups (Van Deursen & Mossberger, 2018), which has a relevant impact on the benefits that individuals can draw from the digital world (Witte & Mannon, 2010; Quan-Haase et al., 2014).

Geographers have provided good contributions to these debates. The concept of cyber-divides put forward by Graham (2011) echoes the emergent necessity to consider the digital divide beyond issues of access and coverage. He describes cyber-divides as the difficulty of articulation and interaction within cyberspace, claiming that overcoming physical or material barriers is not enough to overcome the digital divide, as there are other divisions in cyberspace itself. While this topic lacks further research, some studies have sought to address such cyber-divisions. Riddlesden and Singleton (2014) have demonstrated that social and spatial inequalities are present in the use of broadband internet, by showing that there are areas and social groups with higher internet speed than others. The study is carried out on a national scale and shows that urban areas have a faster internet connection than rural, less dense and more isolated areas, but there is not an in-depth analysis of these areas and their possible inner disparities. On the other hand, Millán et al. (2019) address the digital divide among entrepreneurs. Although their main differentiation is between those that use ICT and those who do not, they also note that not all entrepreneurs who are using ICTs draw immediate benefits from it, as entrepreneurs have different levels of skills and dedicate different amounts of time to this task.

The third level of the digital divide focuses on the real-world consequences that stem from the different levels of access and usage of digital resources (Selwyn, 2004; Fuchs, 2009; Scheerder et al., 2017). This focus is necessary because studies on the first and second levels of the digital divide have often not been able to frame and explain the social, cultural, economic, political and territorial outcomes produced by the digital divide (DiMaggio, et al., 2004; Van Dijk, 2005; Stern, et al., 2009). Given that the focus is on results at the economic, social, cultural or political level, these are understood as the real-world or offline consequences of technologies (Blank & Lutz, 2018; Van Deursen & Helsper, 2015; 2018). These outcomes do not refer to the actual divisions in the gains or losses of using the digital, but in the offline consequences of such gains and losses (Van Deursen & Helsper, 2015; Ragnedda, 2017). For instance, it does not refer to the reputation that a firm can acquire through TripAdvisor, but to the economic or urban consequences of that reputation, such as increasing work posts or improving urban footfall. Most of these studies show that individuals use the internet for their personal benefit, whether in health, in social relationships, or in business (Blank & Lutz, 2018; Van Deursen & Helsper, 2015; Millán et al., 2019; Scheerder, et al., 2017), but it has also been

noted that the negative outcomes of digital access and usage should not be overlooked (Blank & Lutz, 2018). For instance, Orben and Przybylski (2019) show some of these negative outcomes related to intangible aspects, such as well-being and the use of technology. On the other hand, the implications that technologies have had on the population have also been studied, and it has been shown that marginalised groups are those most vulnerable to surveillance, to fraudulent offers, or predatory sites (Madden et al., 2017; Lutz & Hoffmann, 2017; Marwick & Boyd, 2018). In geography, such studies have mostly shown the role that digital platforms have played in leveraging processes of urban and social transformation, namely gentrification, touristification or the social consequences of the gig economy (Wachsmuth & Weisler, 2018).

Although all three levels of the digital divide have been addressed, geographers are yet to approach the triangulation between them, despite some explorations (Stephens, 2013; Cinnamon, 2020; Shaw & Graham, 2017). Such triangulation is even more crucial if we think about VGI platforms, in the sense that the differences in coverage, usage and skills now contribute toward differentiated territories. Within the study of VGI, some authors have focused on the concept of the digital divide, analysing the mechanisms that promote these inequalities (Crutcher & Zook, 2009; Elwood et al., 2012; Ash et al., 2016). While there has been a wealthy debate on the social and spatial inequalities that VGI produces, there are few works on how economic activities are affected by the divides of platforms, both in terms of access and coverage, skills and usage and the real-world consequences. The economic challenges and opportunities promoted by VGI platforms require further investigation, as the uneven production of information also has positive and negative outcomes for firms.

Digital platforms establish ecosystems that connect firms with other economic actors (Truong et al., 2012; Beer, 2013; Ramaswamy & Gouillart, 2010; Ramaswamy & Ozcan, 2014). This has led to what has been called the platform economy (Pasquale, 2016; Srnicek, 2017; Langley & Leyshon, 2017), in which the cocreation paradigm dominates the economy (Gouillart & Quancard, 2016; Ramaswamy and Ozcan, 2014). In this context, digital platforms became a nexus for firms who increasingly seek business models with an open logic. Firms are no longer producing or innovating in isolation, they are seeking to exchange external services in order to cocreate value and innovation. In this context, firms look to new ways of creating and developing services and products in an open logic, integrated in ecosystems constituted by different elements. Digital platforms have played an important role for ecosystems because they are able to reach different firms and actors and promote and mediate links between them in order to establish service exchanges. Therefore, digital platforms are characterized by an assemblage of people, processes, interfaces and artefacts which allow the cocreation of value and innovation for firms (Brown, 2009; Martin, 2009; Ramaswamy and Ozcan, 2014). Users have gained an important role in the firms' decisions as their feedback has become more valued. Simultaneously, users are providing online information about firms, which has been recognized as a new form of online credibility for firms, which influences other users. Lastly, the firm ranking systems that the platforms provide are another example of a new form of valuation from the firms (Flint & Mentzer, 2006; Vargo et al., 2006; Vargo & Lusch, 2004; 2008; Sandström et al., 2008). In this sense, the platform economy is generating reputation economies and that reputation is a form of capital, constituting an added value for the firms (Arvidsson & Peitersen, 2013; Langley & Leyshon, 2017), which in turn comes to exert both direct and indirect feedback on innovation (Callon et al., 2002; Piller & Walcher 2006; Grabher et al., 2008).

Even when the firms are well-established and integrated into platforms with several partners, especially users, the production of VGI is always unpredictable as it depends on the access to and coverage in the platform, as well as the usage and skills of users, which are geographically uneven, resulting in positive and negative outcomes for firms. More importantly, the success of firms also depends on the access to information by firm managers, as well as their skills and usage of the

platform, which is likewise geographically uneven. Thus far, this latter aspect has been neglected by the literature. While there has been some exploration of how the analysis of reviews and other user-generated inputs of platforms can contribute to improve businesses, especially in tourism activities (Ferreira, 2019; Paiva & Sánchez-Fuarrós, 2020), these studies have ignored that the diverse consequences for firms that VGI platforms generate stem from the different levels of the digital divide. Some studies have approached specific levels of the digital divide, but there is no triangulation between different levels of the digital divide that allows us to achieve a more complete view about the inequalities generated by VGI platforms. For instance, Baginski et al. (2014) have shown that the user-generated evaluations of restaurants are concentrated only in certain areas of the city, thus highlighting the intra-urban digital divide. Meanwhile, the actual usage that firms make of such data, the outcomes they draw from it, and its geographic distribution are unexplored matters. We tackle this gap in the following sections, as we present a case study of the geographies of TripAdvisor and the geographies of restaurants in Lisbon to show that urban digital divides become more evident and profound through the study of the first, second and third level of the digital divide.

3. Methodology

The objective of this article is to provide a more detailed conception of the production of urban digital divides by VGI platforms in the context of the platform economy, through the articulation of the first, second and third level of the digital divide. To do so, we draw on a case study of the geographies of TripAdvisor and the geographies of restaurants in Lisbon which comprised the collection and spatial analysis of data from this platform as well as the conduction of interviews to restaurant firm owners. TripAdvisor is a digital platform that provides a wide range of user-generated information about restaurants, hotels, flights, tourism areas, and leisure activities. It is focused on connecting and serving the needs of both demand and supply in the sector of travel and leisure, meeting the needs of users and firms (Yoo et al., 2016). According to 2013 data, TripAdvisor is the platform with the most travel content (Baka, 2016; Yoo et al., 2016). Information on TripAdvisor has high visibility and is generally seen as reliable, credible and updated (Yoo & Gretzel, 2009; O'Connor, 2010; Dickinger, 2011). It has also been noted that this user-generated content has a strong influence on consumer choices and the image of places (Tussyadiah & Fesenmaier, 2009). Our study takes restaurants as the unit of analysis since it is one of the economic sectors that has the largest amount of information available in digital platforms (Graham & Zook, 2013). Moreover, the restaurants in TripAdvisor provide a strategic case for the study of the digital divide in terms of access and coverage and in terms of skills and usage because restaurants can be inserted in the platform by both firm owners and costumers. In both cases, several validation processes are initiated by TripAdvisor. Our study focuses on the city of Lisbon, which is delimited by its municipality, because restaurants are particularly central to Lisbon's urban economy (Cachinho, 2014). Although it has been noted that the creation of online content is higher in metropolises and capitals than in medium-sized cities or rural areas, our study also sheds light on the need for multi-level analysis of intra-urban divides (Haklay, 2010; Zielstra & Zipf, 2010). The combination of these levels also led us to approach different geographical scales, namely the scale of the city, the parish, the subsection, and the street-level. This multiscale approach contributes for a more complete understanding of the digital divide.

3.1. Data collection and pre-processing

In early 2019, we collected data on 3989 restaurants in Lisbon from the TripAdvisor platform. The data included the establishment's name, address, classification, and type of insertion (inserted by the owner/inserted by a customer). The database was subject to a validation procedure in order to guarantee that the data would have the necessary

conditions for the purposes of statistical and cartographic analysis. Firstly, we verified the postal code of every establishment. There were 795 establishments with absent or incomplete postal codes. We collected the missing postal codes of the restaurants by searching their address in Google Maps. Secondly, we identified the duplications of restaurants in the datasets. Since any user can insert establishments voluntarily, there is the possibility of having more than one insertion for a given establishment when the establishment's name is written in different ways by the users. To verify this issue, we identified the duplications of postal codes and door numbers to exclude duplicated establishments. We found 382 duplications that were deleted from the dataset. Thirdly, we deleted 155 restaurants from the dataset because these were not located within the limits of the municipality of Lisbon. Our dataset has a total of 3452 validated restaurants.

3.2. Data aggregation and data analysis

Individual data from TripAdvisor were aggregated based on distinct spatial scales, using GIS-based tools. Firstly, restaurants were spatially aggregated using the boundaries of city parishes, and the boundaries of census statistical subdivisions (i.e. subsections). For both cases, the value associated to a given parish or subsection corresponded to the total number of establishments located within the extent of the corresponding aggregating units. Some descriptive statistics were applied to data aggregated at the subsection level. Secondly, since we were aiming to analyse the spatial distribution of restaurants at a finer scale of analysis, we associated each establishment to the street level. To this end, all establishments were matched to the corresponding streets based on the postal code information retrieved from TripAdvisor. Then, the total number of restaurants associated to a given street consisted on the sum of the establishments with the corresponding postal code. Since the number of establishments may vary according to the length of the street segments, we further provided the number of establishments per 100 m, for each street in Lisbon.

3.3. Interviews

We conducted 27 semi-structured interviews to restaurant firm owners from Lisbon with the purpose of understanding the third level of the digital divide in greater detail. Out of the 27 restaurant firm owners, 14 registered their restaurant themselves in TripAdvisor and 13 have their restaurant registered by another user. These interviewed owners have their restaurants located in historical city centre of Lisbon (13), modern city and eastern waterfront (10), and other areas, namely peripheral areas (5). The interviews allowed us to understand the positive and negative outcomes of the online engagement with digital platforms on the businesses. In these interviews, we focused on three topics: (i) the level and intensity of engagement with digital platforms and types of interaction; (ii) the firm's business path and the impact of the emergence of digital platforms in their business plan; and (iii) the outcomes of the use of the digital platforms by the firm, namely if digital engagement has contributed to the success of the firm.

4. Findings

4.1. The first level of digital divide

Although there is a myriad of VGI studies focusing on access and coverage, the analysis of the first level of digital divide is still necessary because the technological development is constant and, for this reason, platforms are constantly changing the available data. However, the first level should not be studied alone. The complementarity of the different levels can be the key for a greater understanding about the digital divide, especially under the context of increasingly complex technologies that are more and more intertwined with everyday life. With this in mind, we start by presenting our findings on TripAdvisor's restaurants

coverage in the city of Lisbon.

Fig. 1 shows that platforms are indeed producing uneven geographies with different levels of coverage intensity. These different levels of coverage translate to a set of data shadows which reveal the spatial discrepancies in the relation between TripAdvisor's coverage and the total number of existing restaurants, also allowing us to identify the extremely under-represented areas (Graham, 2014; Shelton et al., 2014; Zook et al., 2011). In general, there is a gradual decrease of the intensity of the shadows from the city centre to the most peripheral areas. In line with Graham and Zook (2013), we argue that such discrepancies can be explained by the underlying geographies of power of the city.

In sum, higher levels of coverage are associated to areas of economic power, namely touristic, service or high-income residential areas whereas lower values are related to vulnerable or marginal areas in Lisbon. Echoing the arguments of Su et al. (2017), the socio-economic factors explain the uneven geographies of TripAdvisor's coverage of restaurants in Lisbon. However, the analysis at the city level hints at specific characteristics of the spaces and its users that must be examined in further detail at the scale of the parish. Restaurants not only cater to the demand of touristic or leisure areas, but also to the necessities of workers in several areas of Lisbon in which the presence of services and firms is stronger (Cachinho, 2014; Mendes, 2020; Encalada-Abarca, 2021).

As Graham (2002) and Warf (2018) have argued, local scale analysis can reveal the complexity of the issues of digital divide that remain invisible in cities. Despite this, there is fewer research made at the local scale. With this in mind, we turn to the street scale to further explore the invisible first level digital divides in Lisbon.

We selected four Lisbon parishes for a more detailed analysis of the spatial distribution of TripAdvisor's coverage of restaurants. Fig. 2 shows the density of restaurants in each parish and the number of TripAdvisor's establishments at the street level (given by units per 100 m). It is noteworthy that some places retain data shadows – which points out unseen local digital divides – while others become non-shadowed. While Santa Maria Maior has a high level of coverage, it is also the most heterogeneous area with better coverage in tourist-ridden downtown streets than in the residential neighbourhoods around downtown. On the other hand, Avenidas Novas, which is an area with a good level of coverage, displays a homogeneous intensity of coverage at the street level. The explanation for this difference might lie in the type of city-users, as the restaurants in Avenidas Novas tend to cater to professionals. Lumiar and Santa Clara are likewise non-shadowed, although TripAdvisor's coverage of restaurants in these parishes is low. Lumiar has a total of 168 restaurants and only 60 of them are inserted on TripAdvisor, whereas Santa Clara has 162 establishments and there are only 4 establishments listed in the platform. While this prevents us from identifying data shadows, it allows us to identify urban digital voids. We use this concept to refer to areas for which there is not digital data available, but there is activity (economic or otherwise). While any place might have digital urban voids because not all firms are integrated into platforms, it is difficult to identify them correctly in the data shadows of wider scales. Nevertheless, finding digital urban voids matters because they signal areas that are economically or socially excluded as result of digital invisibility. Much like digital desert concept (Wentrup et al., 2016a; Wentrup et al., 2016b; Robinson & Franklin, 2020), digital voids highlight the severe inequalities of the digital divide. However, while digital deserts refer to wider scales which contain their own data shadows, digital voids are a signal of social and economic life at a finer spatial scale that is not mirrored or mapped into the digital world.

Analysing the first level of the digital divide reveals the uneven geographies that platforms are producing through their different levels of spatial coverage, and coverage intensity, but it might still hide other inequalities that stem from these platforms. In the next section, we will explore the second level of the digital divide in the restaurants of Lisbon, showing that the differentiated usage of platforms by firms not only is spatially distributed but also has geographical consequences.

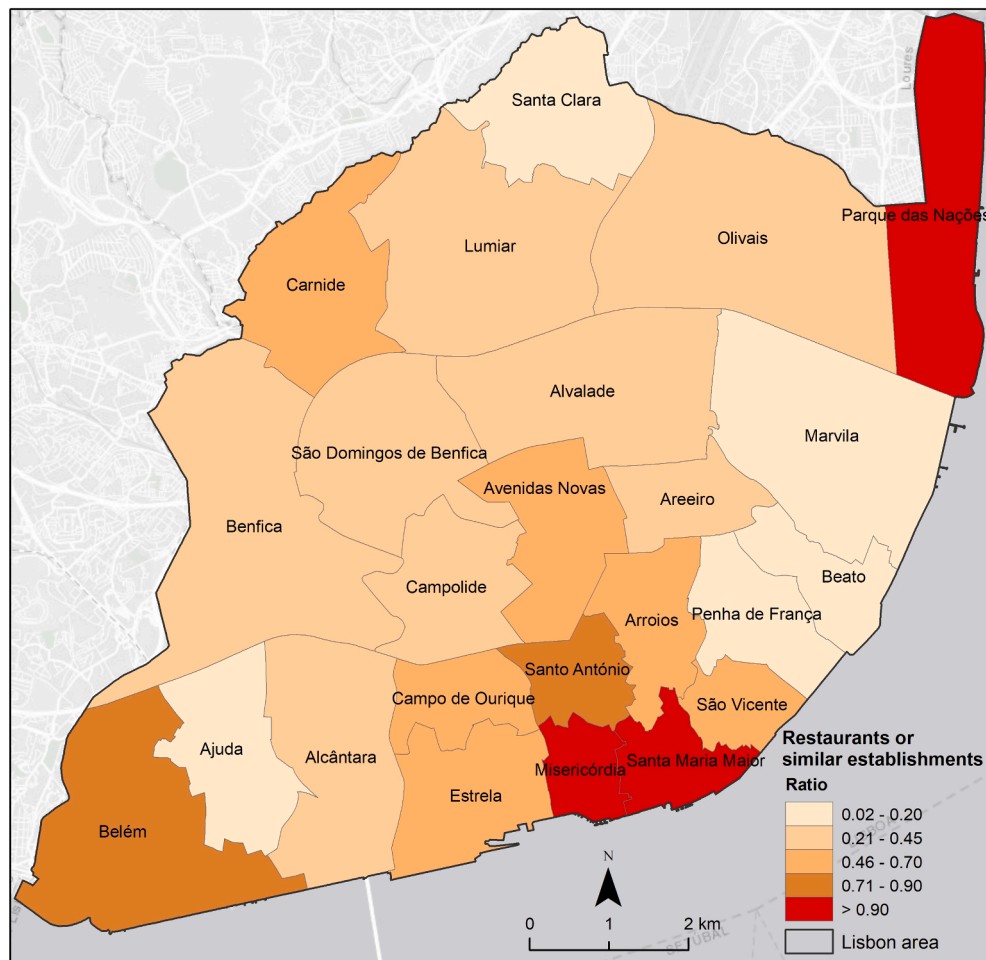


Fig. 1. Ratio of restaurants on Tripadvisor and the existing restaurants or similar establishments by parishes, in Lisbon.

4.2. The second level of digital divide

The production of VGI in digital platforms generate divides even in cases of good coverage, because the digital divide extends to the different types of usage of platforms, which lead us to the second level of the digital divide (van Deursen & Mossberger, 2018; Lutz, 2019). Even when firms are inserted in TripAdvisor, there are cyber-divisions (Gram, 2011) that stem from the different levels of engagement of firm owners. These cyber-divisions only can be analysed if we consider other levels of the digital divide focused on the usage. TripAdvisor's restaurants database has two distinct sources of information, which allows different forms of usage. The establishment can be added by the owner of restaurant to advertise the business, or they can be added by clients who wish to upload a review of the establishment's service. This leads to different possibilities. In the first case, the firm is able to promote its establishment to the users of the platform, receive feedback and communicate with customers. It can also establish several partnerships with different actors, such as reservation and delivery services. Therefore, the platform provides services that might expand the restaurants' business model and promote customer engagement. However, in the latter case, the establishment is in a vulnerable position as its online image depends solely on the shared experiences and ratings of the users. There is no engagement with the costumer and no opportunity to strategically manage situations that might harm the firm's image.

We selected two restaurants located in Santa Maria Maior, one of the parishes with the highest levels of coverage, to demonstrate the practical difference that claiming the firm can make. This difference is essentially based on whether a restaurant is claimed on the Tripadvisor or not

(Fig. 3). The first restaurant, which is classified with 4.5 stars and has a certificate of excellence, was claimed by the owner. Claiming the restaurant allows the firm to manage its image and connect with other services. The firm is able to organize its pictures, provide information about the restaurant and its services, and rank the best comments. It can also connect with Google Maps to display its location. This restaurant is also connected to The Fork, which allows users to book tables, and connected to Takeaway.com, which allows users to make online orders. In this sense, the platform generates an ecosystem that provides a new form of valuing the business through co-creation of experiences and services (Vargo & Lusch, 2004; 2008; Lusch & Vargo, 2014; Ramaswamy & Ozcan, 2014). On the other hand, the second selected restaurant, which was inserted by a user, does not have any partnership and available services excepting the basic information provided by TripAdvisor. The only actors that are active are the users and, in this particular case, this has led to a negative valuation generated by unmanaged processes and undirected flows between platform, firm and users.

These examples show that the different forms of usage – claimed by the owner or claimed by the user – influence the available tools to construct online ecosystems for firms, constituted by individual networkings (Ramaswamy & Ozcan, 2014). The agency of firms, including the intensity of interaction with all actors, the level of efforts to reach partnerships, the digital literacy of the managers, and their digital strategy, in tandem with the territorial, social, political and economic context, contributes to the differentiated usage, resulting in different performances of any specific networking, making it unique. As we will see, such cyber-divisions are spatially distributed, thus contributing to

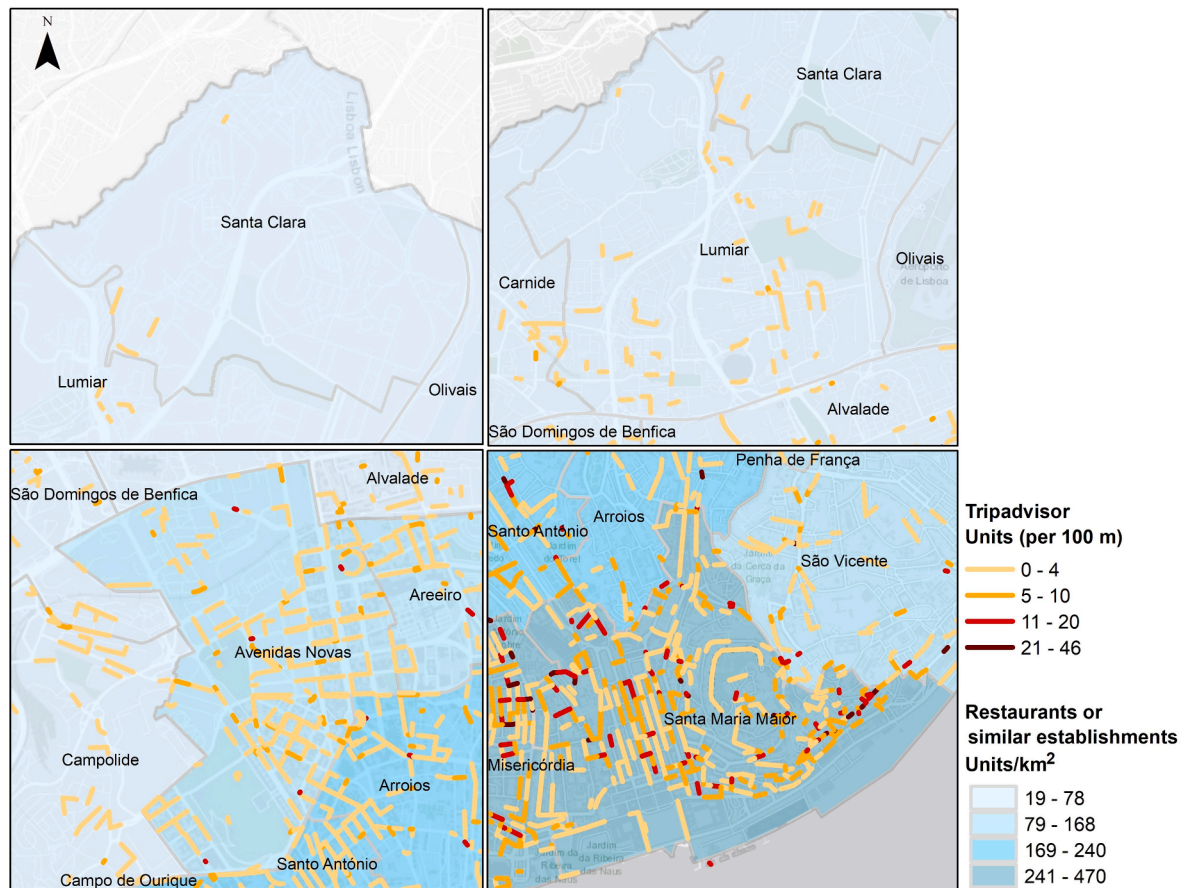


Fig. 2. Data shadows areas, data non-shadowed areas, and digital urban voids on TripAdvisor. Density of restaurants by parishes (per km²), and number of restaurants or similar establishments at the street level (per 100 m).

spatially differentiated performances in the local economy (Van Dijk, 2006; Baginski et al., 2014; Ferreira & Vale, 2021).

According to our database, out of the 3,452 Lisbon restaurants in TripAdvisor's database, 1,248 were claimed by firm owners and 2,204 were inserted by users and not claimed by firm owners. Fig. 4 shows that the establishments claimed by owners display a wider spatial distribution. Thus, it seems that the firms willing integration in the platform has no particular spatial concentration. On the other hand, establishments inserted by users are predominantly concentrated in the historical and the modern city centre of Lisbon. Nevertheless, the touristic historical centre and Western waterfront display a high rate of restaurants inserted by owners, which might mean that the owners of restaurants in touristic areas are more concerned with their online visibility. On the other hand, it is noteworthy that the establishments of the modern city centre of Lisbon have been predominantly inserted by owners. As we stated before, this is an important service and business area in the city where a large number of professionals spend their day.

4.3. The third level of digital divide

The third level of the digital divide entails the outcomes of the access to and use of technologies. The presence of restaurants in TripAdvisor can generate positive and negative outcomes for the businesses, according to the level and type of engagement of owners and other users. We explore one of these outcomes through the analysis of TripAdvisor data and our interview data, namely the restaurants reputation that stems from the interaction between users and platform. Fig. 5 shows that these TripAdvisor's classifications are spatially distributed. Although most of the subsections show an average of medium-high classifications, it is noticeable that several subsections show very low and very high

average classifications, mostly in the peripheral urban areas.

It is not the classification that is a third-level effect but the outcomes that this classification can generate for the restaurants located in certain areas. In this sense, the online reputation, generated by TripAdvisor's classifications, emerges as a concern. We highlight this topic because it emerged as a main concern in the interview data, in which we found that the division between claimed and non-claimed restaurants is echoed in the real-world outcomes of the platform's use.

On the one hand, non-claimed restaurants are more vulnerable because their reputation is solely dependent on user reviews. As an interviewee who has his restaurant located in the historical centre of Lisbon surrounded by several other restaurants inserted in TripAdvisor told us:

It is increasingly difficult to compete because the consumers are always with their phones choosing the best restaurant according to the classification. Unless people know the restaurant beforehand, they will not enter restaurants with a classification below 4. This situation is very complicated for us because we have a classification of 3 and people do not understand that most of our negative commentaries that contributed to lower the classification are false or unfair. We see people entering other restaurants next to us just because they have a good classification (November 2020).

The interviewed adds that their patrons are "more than 90% tourists", and for this reason, the firm faces a great challenge in overcoming this situation as there is a strong relation between their patrons and the use of TripAdvisor. However, he adds:

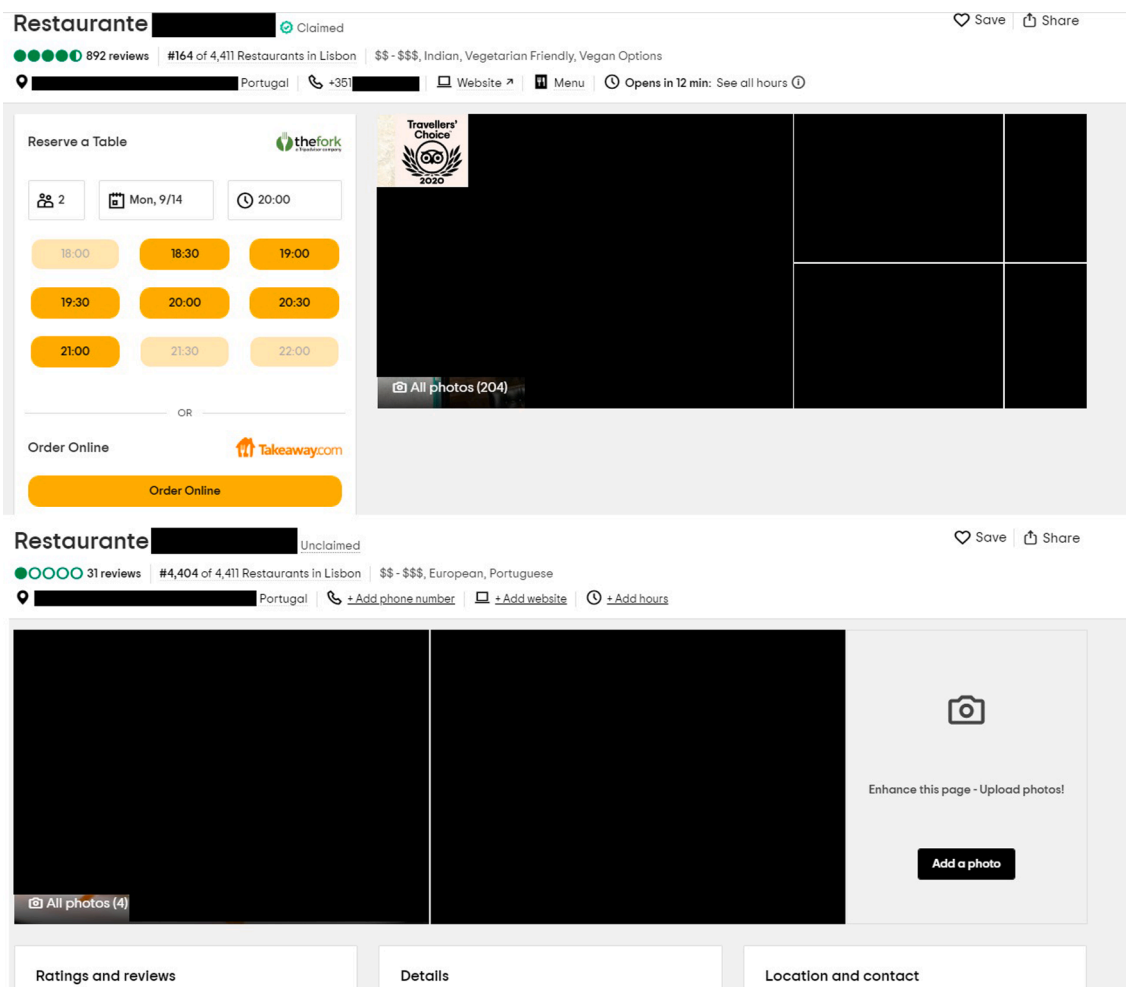


Fig. 3. Restaurant pages on TripAdvisor.

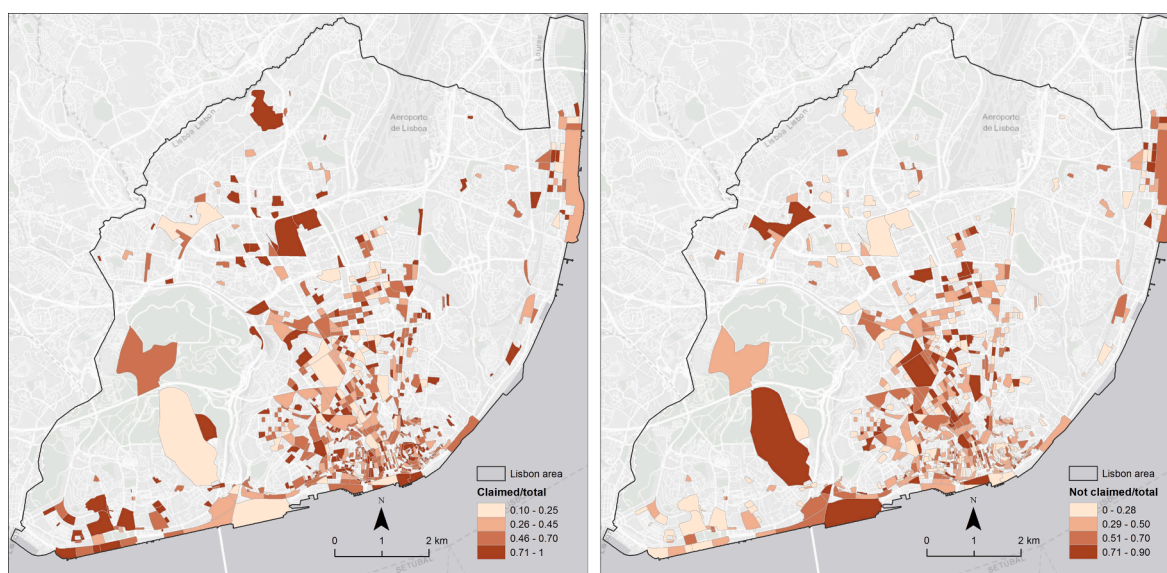


Fig. 4. Ratio of restaurants on TripAdvisor claimed by owners (left), and not claimed by owners (right).

This does not mean that Portuguese people do not use TripAdvisor, but there are restaurants with a great percentage of loyal consumers that can support our business survival (November 2020).

It is important to highlight that most of the owners and managers in our sample who have not claimed their restaurant say they would like to not be on TripAdvisor or any other digital platform, excepting Facebook

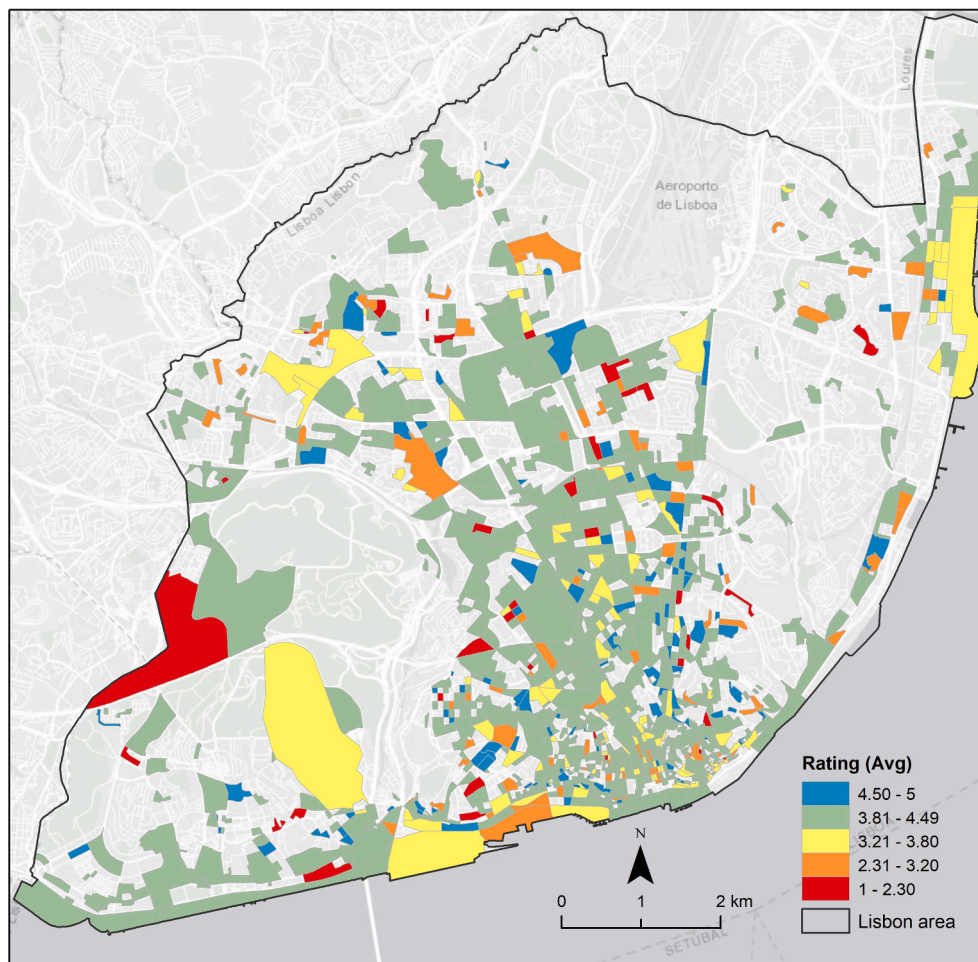


Fig. 5. Average rating of restaurants on TripAdvisor aggregated by subsections, in Lisbon.

or Instagram where they can control the content produced.

On the other hand, the business of restaurants that have higher classifications on TripAdvisor have benefited from their online reputation. We highlight the words of an interviewee whose restaurant is located in the historical city centre and very dependent on tourism:

Taking into account our touristic localization, I believe that, if TripAdvisor and other similar platforms would not exist, we could not exist either, because they can give us more visibility. Our classification is a way to stand out among others. This area has a lot of restaurants and other similar establishments which makes the competition harder. Since our rating increased from 4 to 4.5, we have seen an increase in demand (November 2020).

Online reputation can improve physical location in some of these cases through the digital platforms, especially in touristic areas with a high density of restaurants. For several restaurants, this was understood as a way to stand out from the competition. It is noteworthy that several interviewed owners – especially those with more skills and engagement in digital platforms – have seen this issue as an investment to improve the success of the business.

In this sense, we can argue that the reputation economies of platforms have produced positive and negative results for firms and the online classification has been preponderant. The third level of the digital divide reveals that cyber-divisions are mirrored in the territory, which means that they are also contributing toward geographical divides (Graham, 2011; Arvidsson & Peitersen, 2013; Langley & Leyshon, 2017). Such divides are a consequence of the complexity of the online interactions that span across the first, second and third level of the

digital divide. Furthermore, these geographical divides not only mean that the businesses of a certain place might become valued or devalued, but also that the general online visibility of certain urban areas can be positively or negatively affected. Although geographical divides cannot be explained solely through the digital divide, this nexus is becoming more evident.

5. Conclusion

This article sought to provide a more detailed conception of the production of urban digital divides by VGI platforms in the context of the platform economy, through the articulation of the first, second and third level of the digital divide. We drew on a case study of the geographies of TripAdvisor and the restaurant sector in Lisbon to show that VGI platforms are producing several forms of urban digital divides that can only be explained by the study of the different levels of the digital divide. They are not only producing different levels of territorial coverage in cities, but also different levels of usage intensity which have caused negative and positive outcomes on the reputation and patronage of the firms.

Although geography has approached these three levels of the digital divide in separate, this study shows the benefits of attempting to triangulate the three levels, especially in studying the impact of digital platforms in the urban economy. VGI platforms in which several firms are integrated are producing a myriad of new forms of spatial divides that need more attention, given that the digital divide is present within the mechanisms designed by digital platforms. These were designed in a way that produces digital divides by default and the vast and complex

outcomes of such data engineering is best captured when all three levels of the digital divide are taken into account. The combination of new economic logics with technological developments constantly generates new concerns about the digital divide as a field of research, given the increasing complexity of available interactions and tools provided by these platforms.

In exploring the three levels of the urban digital divide, our research hints at specific challenges in doing so. Addressing the three levels of the digital divide requires acknowledging the limitations of our methods. On one hand, it calls for working at different scales in order to unveil invisible or hidden inequalities. More thorough local scale analysis reveals that some places retain data shadows – which points out unseen local digital divides – while others become non-shadowed (Graham, 2002; Warf, 2018). In addition, we have seen that this allows us to identify urban digital voids which signal local areas that are economically or socially excluded because they are digitally invisible (Wentrup et al.'s, 2016a; Wentrup et al., 2016b). On the other hand, addressing the three levels of the digital divide requires mixing methods in a way that is possible to grasp the continuities between online and offline inequalities. This implies mixing digital methods such as spatial analysis and 'offline' methods such as interviews, focus groups or ethnography. This way, the relation between the digital divides and the underlying geographies of economic power of the city can be explored in greater depth (Graham and Zook, 2013; Su et al., 2017).

Triangulating the three levels of the digital divide opens up new avenues for research and allow further encounters between digital, urban and economic geography. First, we must bear in mind that it is dangerous to neglect the ways in which the different levels of the digital divide are articulated. Overlooking the articulation between these different levels will lead to partial accounts of the complex layers of the digital divide and its entanglement with the geographies of the economy. Given the fast changes in technologies and in their spatial effects, it is important to mind the constant feedbacks between the various levels of the digital divide, as well as the different scales of such feedbacks. If VGI platforms are here to stay, then such lines of research will play a significant role in achieving a more comprehensive understanding of its economic potential and limits. Secondly, it would be important to reflect about the firms that are excluded from VGI platforms. As the logic of platform economy becomes increasingly dominant, the success of offline firms is threatened. There is still little research about the outcomes of passive digital presence in the firms or places in digital urban voids, despite the fact that such passivity does not mean immunity to the effects of the platform economy. To tackle this issue, it is necessary to understand what offline vulnerabilities are undermining the firms' use of platforms, such as digital literacy. However, it must be taken into account that some firms are not willing to engage with platforms, for instance, for ethical reasons. Thus, research must also explore digital alternatives for economic spaces in the city.

Although the combined study of the three levels of the digital divide can offer more detailed understandings, some inequalities linked to the structuration and politicization of platforms cannot be fully explained by this approach. For instance, the nature of digital platforms can be conceived under an uneven design, compromising *a priori* the results of the study of the digital divide levels (Stephens, 2013). Issues of representation, right to information, and the power dynamics might likewise be obscured by a focus on coverage, usage and outcomes (Shaw & Graham, 2017; Cinnamon, 2020). Nevertheless, the combined study of the three levels of the digital divide, by unveiling the complex layers of this phenomenon, can provide new hints for further exploration of the structuration and politicization of platforms.

CRediT authorship contribution statement

Daniela Ferreira: Writing - original draft, Investigation, Conceptualization, Methodology, Validation, Formal analysis, Data curation, Writing - review & editing. **Mário Vale:** Writing - original draft,

Supervision, Formal analysis, Writing - review & editing. **Renato Miguel Carmo:** Writing - original draft, Supervision, Writing - review & editing. **Luis Encalada-Abarca:** Methodology, Validation, Formal analysis, Data curation. **Carla Marcolin:** Formal analysis.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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