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Analysis of urban mobility in 18th-century Rome: a research approach through GIS platform

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Abstract

The Geographic Information System (GIS) has been commonly used to analyse and elaborate the big data of urban mobility in modern cities. At the same time a range of studies has been utilizing it to examine various kinds of movements in old times, especially those on a large territorial scale. This article aims to highlight the use of GIS in the study of urban mobility of Rome during the 18th century, drawing on textual evidence and archives. The results of this work will offer new hypotheses around the most trafficked zones and the main routes of movement traveled in the Italian capital during this period.

Keywords: URBAN MOBILITY; MOVEMENT DATA; MOVEMENT ANALYTICS; ROAD NETWORK; HISTORICAL PATHS; 18TH CENTURY; MODERN HISTORY; GEOGRAPHICAL INFORMATION SYSTEMS.

Introduction

In the last few years, many different studies have addressed the use of Geographic Information Systems (GIS) to carry out analyses on the mass movement data. Undoubtedly, geo-informatics is the most recent source for the management of mobility and transport planning. However, the data set available to people who study these modern dynamics is different from that used by those who study the same phenomena in older times. It is essential to recall that the use of GIS and analyses of Least Coast Paths (LCP) is not lacking in the studies of the mobility of the past (van Lanen *et al.* 2015; Fonte *et al.* 2017). Especially, the LCP approach that utilizes the digital models of the territories and combines them with other factors (rivers, enemy borders, etc.), is often applied. Nevertheless, the review of the available bibliography, demonstrates that this type of methodology has been used widely for larger-scale research (regional or national). On the other hand, those who studied smaller contexts, such as cities, did not base their approach on information that precisely describing paths (Branting 2007), as in the present case.

The main concern of this research is to study the use of urban space through the reconstruction of people's movement and transportation of Rome during the 18th century. Therefore, it is necessary to list the sources from which data on urban mobility have been extracted. The crucial texts are booklets which were published to describe ceremonial events. These booklets provide information about the itinerary of imperial and religious processions in Rome. In addition, there are sources written by the criminal and civil justice (about 600 documents). The study of this sort of evidence gives endless information on the toponomy of streets and people's movements as the incidents have been registered in detail. For example, during

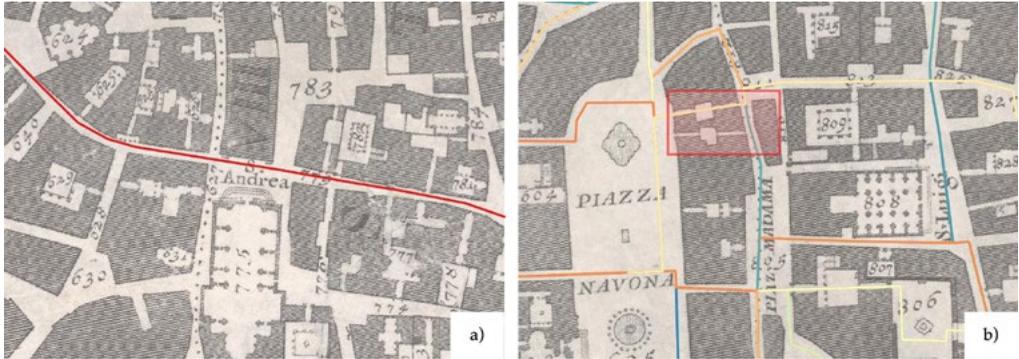


Figure 1: a) A section of the *strada della Valle* as depicted in Nolli's map; b) Example of a path that involves passing through a courtyard of a building in *piazza Navona* (base map: *Nuova Topografia di Roma*).

criminal investigations, the testimony of people demonstrates where a certain incident happened, where people came from, where they lived, etc. The case presented in this article focuses precisely on these data sources. Not only do they tell stories about the old times and a different urban layout of the city, but also provide precise descriptions about a certain path and the movements from start to end of it.

Therefore, considering these data, one of the goals of this study was to highlight the available information as much as possible using a GIS-based methodology. For this reason, each path has been recreated following step by step the description given by the sources. The outcome of this mapping made it possible to register all the ceremonial movements and daily transports and to evaluate its impact on the city and people's lives.

Last but not least, it should be emphasized that this research is entirely based on the use of an open-source solution through the use of QGIS. This choice is also in line with the release of an open-data test dataset to offer the possibility to replicate the methodology presented in this paper¹ and assumes a simple approach to the study of urban mobility that can then be reproduced or implemented by other researchers.

Materials and Methods

The cartography

First of all, an effective way to reproduce the urban grid of 18th century Rome was sought. Regarding this, in the field of studies investigating the past, one of the most effective responses to the challenge of reproducing the old appearance of places has been to exploit historical cartography. This constitutes a powerful means, especially when combined with the use of GIS (Bogdani 2021; D'Erasmus 2019; Rumsey and Williams 2001).

For this reason, the *Nuova Topografia di Roma* made by the surveyor G.B. Nolli in the middle of the 1700s was used in this project (Bevilacqua 2013). This map (downloaded from Rumsey

¹<https://codeberg.org/lad/roma-nel-settecento> (accessed 29/07/2021).

2021) was georeferenced through the plugin of QGIS 'Freehand Raster Georeferencer' (Guilhem 2016) and used as a basic map for drawing the itineraries on it. The map has an almost perfect correspondence with the modern urban grid, since the historical center of Rome has undergone few changes in the last 250 years. Moreover, this map provides precise information about the alleys, secondary entrances in palaces, etc. that no longer exist. In order to recognize all these places, the index available within 'The Nolli Map' project of the University of Oregon GIS Laboratory was also consulted (Tice and Steiner 2021). All these topographical elements construct a scenery of daily movements of Roman citizens, whereby, the paths have been mapped. This has allowed to work in absolute respect of the descriptions of the city given by the sources.

The other type of base cartography used is satellite imagery (Bing Satellite in this case). However, their use was limited to few cases where Nolli's map could not provide complete coverage for the entire itinerary (Figure 4).

The data structure

The mobility data differed by route type and by source. For the processional paths there is a precise sequence of stages. However, even in cases like these where a path is well described, there is the possibility of making assumptions about some roads that may or may not have been taken between stages (when they are not mentioned in the sources). An example could be the procession of the [S.mo Crocifisso](#) in 1700. The sequence of the stages indicated on the path by the booklets is: *S. Marcello al Corso, strada del Gesù, piazza dei Cesarini, strada della Valle, piazza Pasquino, ponte S. Angelo, Borgo Nuovo and S. Pietro*. Furthermore, with the analysis of the tales of the chronicler of that time, is possible to highlight further details: a huge machine was brought to the procession that needed more than sixty men to support it. The chronicler also mentions that when the brothers passed through the *strada della Valle* (Figure 1a), there were great difficulties in transporting the device, and to make it pass had to turn it to one side (Ago 2021). This procession was not the only one to use with such devices. Consequently, during the vectorization of these events, only the wide streets were selected when discussing their use.

Regarding the paths of individuals, a great part of their paths was documented by the texts. These reported a starting point, intermediate points, and an end point. Where there was a lack of information regarding the roads taken to get from point A to point B, alleys and side entrances in the courtyards of the buildings were favored (Figure 1b). The nature of this choice is dictated by the movements of all these men and women. In fact, they were released from having to follow an 'obligatory' path unlike the cases of processions. In addition, they most likely preferred to take shorter routes to get to the point of arrival.

The preference for alleys was not the only arbitrary choice made during the research. In fact, it happened that sometimes the sources spoke of places not mentioned in Nolli's index, and obviously no longer extant. In these cases, always trying to remain faithful to the sources, an arbitrary decision was taken about the position of these places. One example is that of Giuseppe Alessandri, a coachman who denounced an assault in 1749. From his complaint we know that the man left from *piazza Tomassi* for *piazza S. Carlo*. On the way he stopped at the *osteria del Turchetto* in *via Frattina* and was robbed there. Nolli's map does not indicate the location of the aforementioned inn; we chose to place it between *via Frattina* and *piazza di*

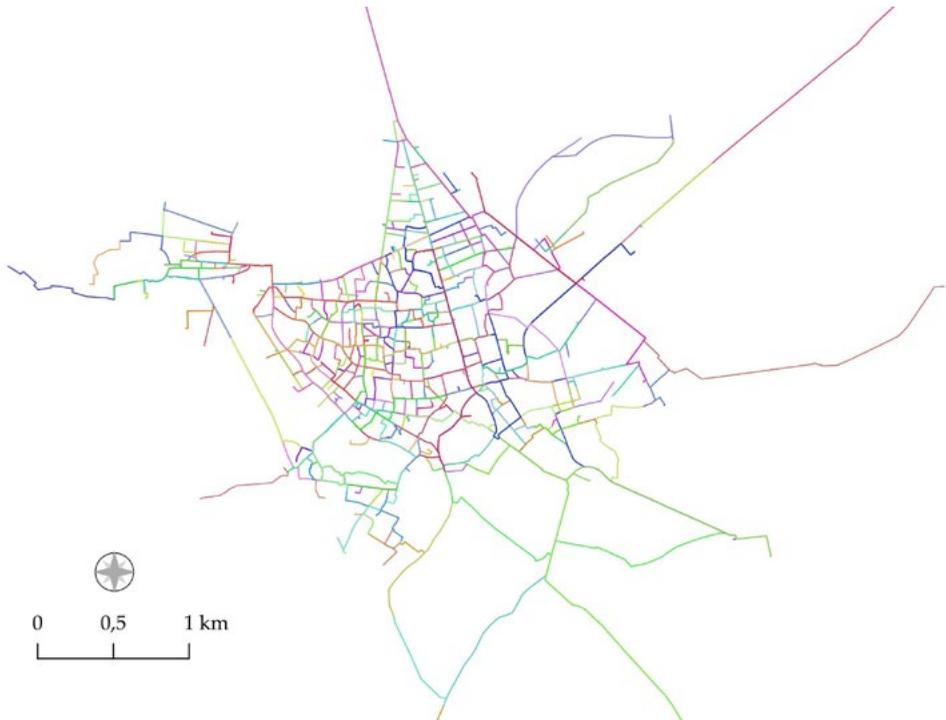


Figure 2: Result of the vectorization of all analysed paths by GIS platform.

Spagna. Similarly, for the washerwomen's paths the sources often spoke of the point of arrival as fountains located near *Borgo S. Spirito*. In that case it was decided to use the western bank of the Tiber river in front of the remains of the *ponte Trionfale* as the arrival point. These are only a few examples of arbitrary choices, but they serve to make clear how decisive our intervention has sometimes been.

Based on the foregoing, the paths were divided into those of ceremonial and of private citizens. In terms of numbers, the available data mapped around 30 paths used during the ceremonial events and 478 paths undertaken by the individual citizens (Figure 2). Moreover, there are 1,221 stages make up these itineraries (Figure 2). All these data are gathered in two vector layers, one for each type of the paths. Each layer contains two types of vectors: lines, reproducing the paths, and points, reproducing the stages. Regarding the vector of lines, the vectorization procedure was to keep always active the functions 'snap' and 'tracing' to hook the vertices of the various lines and guarantee the overlap between them. Through this method, we have been able to reproduce the 'heaviness' of the paths virtually, which means when a certain trace of a street is undertaken by more than one person. Following this, it is possible to select a trace of the street and pin a number as a record to show the crossing of the individuals by that point (Figure 3).

Last but not least, each of these vectors has been associated with the following data: name and surname of those travelling the path or the name of the procession, year, job, type

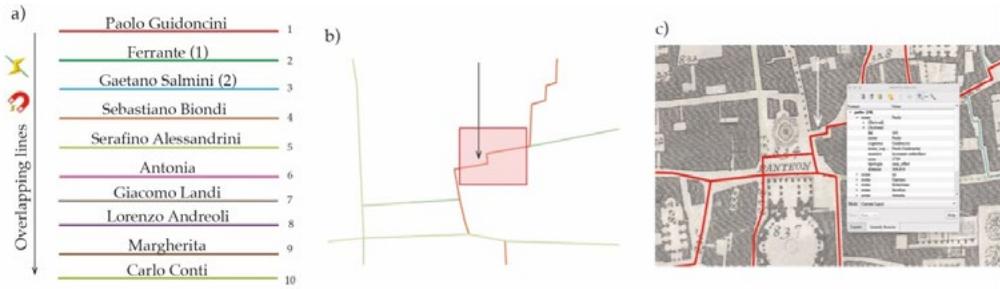


Figure 3: a) List of ten paths of private citizens passing through a street adjacent to *piazza della Rotonda*; b) vectorization result; c) list of returned records (base map: *Nuova Topografia di Roma*).

(ceremonial; home-work; home-business), and a calculation field indicating the distance travelled in meters (Table 1).

fid	name_surname	job	year	typology	distance
1	Agnese	unidentified	1739	home-work	2,336.432
2	Agostino Vigna	scarpinello	1739	home-work	2,892.471
3	Agostino Vigna	scarpinello	1739	home-business	2,892.471
4	Alessio Preti	sbirro	1739	home-work	835.591
5	Anastasio Ricci	muratore	1748	home-business	162.539
6	Anonymus (1) ¹	beccamorto	1739	home-work	1,077.47
7	Anonymus (2)	maniscalco	1739	home-work	290.135
8	Antonia	fruttarola	1739	home-business	2,806.896
9	Carlo Tognacci	ortolano	1739	home-work	1,147.85
10	Ester	bottonara	1739	home-work	881.372

¹ Sometimes more than one path of the same typology is associated with a person. The numbers are an expedient to count the different paths.

Table 1: Extract of the first ten records of the table of attributes of private citizens' paths.

Data analysis

Once the vectorization of the paths was completed, the data is analysed. The information was queried in a way as to divide the paths based on type and year. This way, it is possible to have a diachronic vision of the quantity of the itineraries mapped by year and type. Consequently, heatmaps were created to highlight the busiest zones of the city.

In order to use the Kernel analysis, the line vectors were transformed into points using a SagaGIS algorithm *lines to points*, through QGIS interface, which allows to insert a parameter indicating every how many meters a point must be inserted. To avoid leaving even the shortest path, a distance of 10 meters between two points has been set. As the lines had been overlaid in the vectorization process, the result was a layer that reproduced a concentration of points equal to the number of overlapping lines. In this way we reproduced the frequency of use of a certain road (Figure 4). This process was repeated for each type of path and each examined

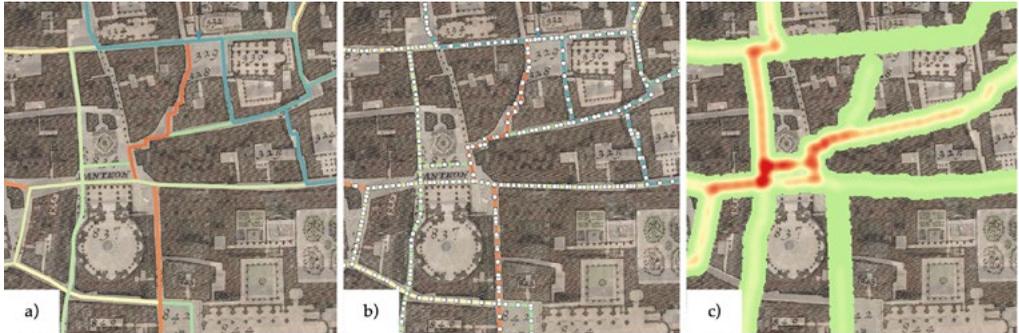


Figure 4: a) Vectorized paths around *piazza della Rotonda*; b) transformation of lines into points set 10 m apart; c) Kernel analysis (Base map: *Nuova Topografia di Roma*).

year. Finally, the Kernel analysis was applied which led to the creation of seven heatmaps which will be discussed in the following paragraphs.

Results

The ceremonial paths

After three centuries of the building projects by both popes and noble families and elite members of the society, Rome attained a significant urban space in the 18th century. These building projects mainly developed the busy quarters and districts of the city which were all in or around *Trastevere*. The increase in the population of Rome during the third decade of the 16th century onwards affected the whole street grid of the city and extended the inhabited areas towards the north close to the *porta del Popolo*, and towards the east, close to *via del Corso* until *Trastevere*. Furthermore, *via del Corso* assumed its current shape in the mid 17th century. The noticeable architecture of the palace of *Quirinale*, the residence of the popes, had a massive impact on the development of other palaces of nobles and pontiffs. They began to rebuild and renovate their palaces on *via del Corso* and adjacent areas (Guidoni and Marino 1979; Bevilacqua and Madonna 2003). The outcome of this slow transformation is visible in the maps of Nolli that indicates the centrality of the artery, crossing through the entire town from the *porta del Popolo*, close to *Campidoglio*, and the regularity of the street grid that defines the most recent quarters of the city (Bevilacqua 1998).

The results highlighted through the GIS platform between what this grid seems to suggest about the set of ceremonial processions along the streets are striking (Figure 5). As mentioned before, the booklets which had registered the itinerary of imperial processions, make the mapping of these movements possible and helped to compare them with the existing mobility. In addition, these booklets recall the problematic issues in choosing the right itinerary that could have met the needs of people and eased their movements on the streets during such events. Thus, they refer to the feeble nature of these statements, which tried to promote propaganda only.

The ceremonial paths of the pontiffs which were held right after the election of every new pope remained untouched according to traditions. The bishop of Rome had to receive the possession from his diocese, located in *S. Giovanni Laterano*. Therefore, he had to follow the *via*



Figure 5: Heatmap of ceremonial paths (14) of the 18th century (base maps: *Nuova Topografia di Roma* and Bing Satellite).

Papale path that from the apostolic palace in the Vatican, crossed the Tiber with the bridge of *S. Angelo* to reach *Campidoglio* and then *S. Giovanni* (Visceglia 2002). The first stretch of the street that crossed through the most densely built-up neighborhoods, was never enlarged or rebuilt as it required a series of expropriations that not even a Renaissance or Baroque pope could have afforded. On the other hand, the abandonment of that street was quite impossible, given the symbolic value of buildings that were built there. Despite all these attempts, during the processions which were held for the ambassadors of other emperors to meet with the Roman court or allies who entered the city during the holy years, they barely passed through all those stunning streets with the magnificent palaces which were built to attract them. Although foreigners who did not know the city might be tempted to take a route that allowed them not to move blindly but to see their destination from afar, the presence and guidance of locals allowed them to adopt even more tortuous routes. In this way they had the advantage of passing through significant places, such as their national church or the residence of the ambassador of their sovereign.

The examination of the heatmap of the ceremonial paths also showed that the same thing happened for the processions of Catholic monarchs (or their representatives) visiting Rome. Ambassadors who entered the city through the *porta del Popolo* rarely passed through *via del Corso* for reaching Vatican on the east or *Quirinale* on the west. Sometimes they avoided certain roads because of hostile relations with their enemies (avoid passing by their buildings). The architects of that time were convinced that the straight and wide streets were more practical

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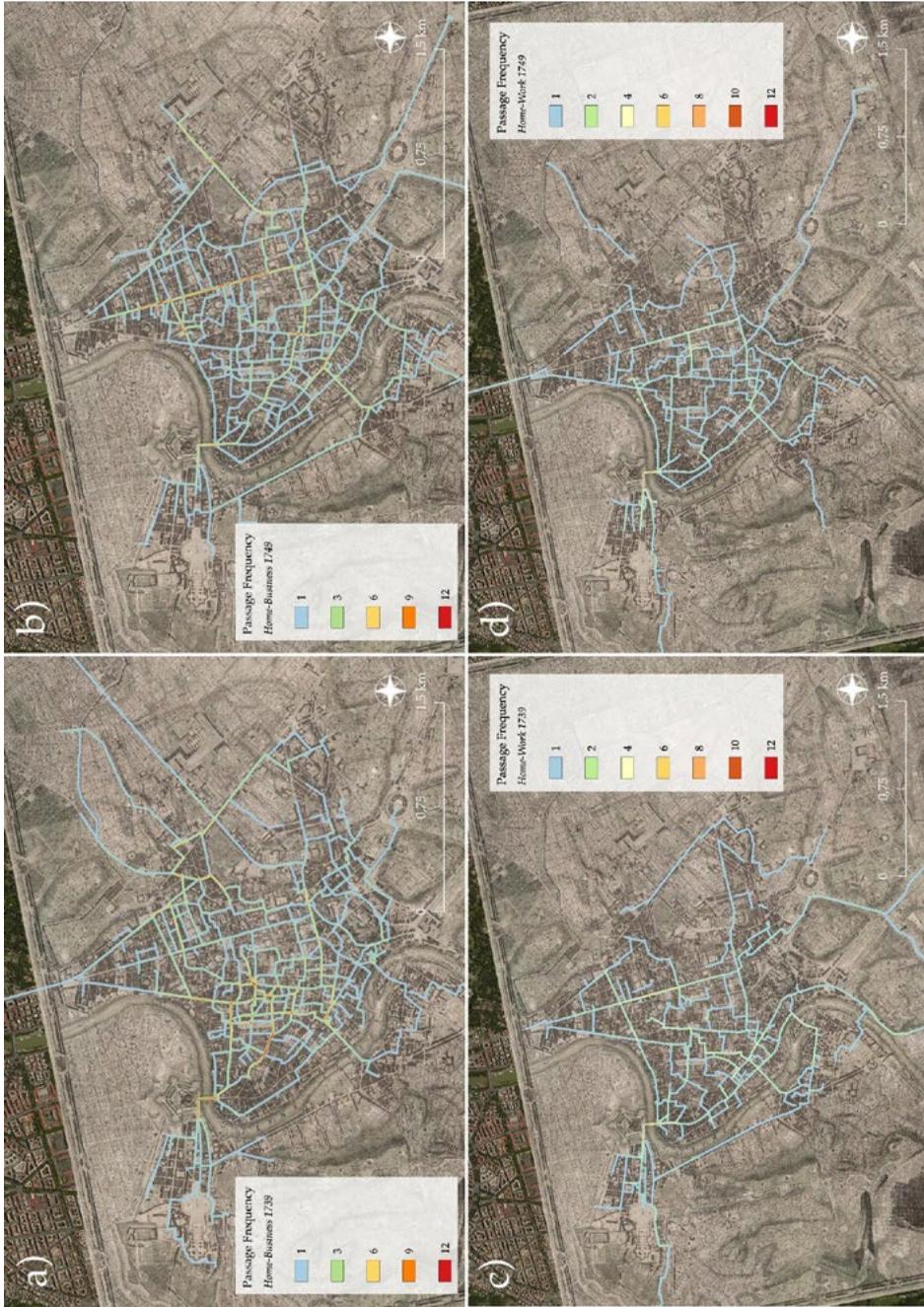


Figure 6: a) Heatmap of home-business paths in 1739; b) heatmap of home-business paths in 1749; c) heatmap of home-business paths in 1739; d) heatmap of home-business paths in 1749 (base maps: Nuova Topografia di Roma and Bing Satellite).

as they could allow people and carriages to pass through comfortably. However, the symbolic value of the buildings mentioned in the itinerary rewarded everything else and the processions of Rome continued to be held on that path.

The paths of private citizens

The analysis of the urban mobility of private citizens revealed that most of them did not go that far from their houses, and their work location is usually not distant from their homes. However, the landlords' shops were in the same place as their houses were. For the workers this was not the case: the numbers of apprentices living together with their masters were quite rare. The explanation is to be found in the high mobility that characterized both the home and the workplace. In fact, most of young workers could not afford a proper house, so they mostly shared with others; in some cases, they shared the whole room. Under these circumstances, finding accommodation was not that difficult and they could even find a place, close to their work. Following this, staying in one place was quite common and consistent with the economy of pre-industrial cities, where the demand for goods and services was limited and heavily relied on a small number of people (Brewer 1982; Ago 1998). Furthermore, sales were mainly on credit, thus, wages were paid partially, waiting for the final sale. There was no restriction or law regarding daily trips and transport outside of one's residency. However, it was not always appropriate to do so for fear of losing the contacts that had been established over time (Canepari 2017; Ago 2021).

In addition, the analysis of these paths also brought to light several unexpected data, such as activities outside the work sphere (e.g. going to a party, a tavern, or managing a street show). In these cases, it happened more often that people exercised their right to reside in the city, to fully enjoy what it offered without being confined in a circumscribed space.

Conclusion

Besides mapping the movements of individuals and the distances of paths and directions, processing the data with GIS allows evaluating the repletion of certain movements the frequent use of certain streets. Moreover, it helps to find out which roads were busier, which were the main directions of these movements (figs. 5, 6).

It is noteworthy that all the heatmaps, linked with any sort of movement, demonstrate the revealing direction of north-south compared to east-west which was taken during the ceremonial events (Figure 5). In other words, the city of daily affairs did not coincide with that of formal occasions which were highlighted by a few significant points of attraction such as Vatican, *Campidoglio*, and *Quirinale*. Moreover, all the economic activities and transactions were concentrated in central districts, from *piazza Navona* to *via del Corso* in the east-west direction and from *Campo Marzio* to *ponte Sisto* in the north-south direction. Also, this path had built a sort of border between the central area and the peripheral areas, while its wide, straight roads which crossed the entire city, were more frequent than *via del Corso*. Between 1739 and 1749 (Figure 6), the trafficked area of the city began to assume the brand-new zones as it was drawing the passengers' attention (Ago 2021).

In theory, paths that allow visual and long-distance control of the road are the friendliest. Moreover, they are those that regardless of other characteristics of the roads or the existence of particular poles of attraction, facilitate travel and even induce them (Hillier *et al.* 1993). To conclude, the results of this research suggest that this thesis is only partially correct: the local people who were familiar with the streets of Rome continued to use the same challenging roads for years and the new built-up part of *via del Corso* became gradually more popular over the years.

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