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CROWDSOURCING E-PARTICIPATION PLATFORMS: ANALYZING NOISE COMPLAINTS REGISTERED IN LISBON

Sara Carolina Gouveia Rodrigues Ascensão Jardim

Dissertation

presented as partial requirement for obtaining the master's degree Program in Information Management

NOVA Information Management School
Instituto Superior de Estatística e Gestão de Informação
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CROWDSOURCING E-PARTICIPATION PLATFORMS: ANALYZING NOISE COMPLAINTS REGISTERED IN LISBON

By

Sara Carolina Gouveia Rodrigues Ascensão Jardim

Master Thesis presented as partial requirement for obtaining the master's degree in Information Management, with a specialization in Knowledge Management and Business Intelligence

Co-Supervisors: Miguel de Castro Neto and Fátima Trindade Neves

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STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration. I further declare that I have fully acknowledge the Rules of Conduct and Code of Honor from the NOVA Information Management School.

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ABSTRACT

Smart governance is one of the domains that constitute the smart city concept. In Western European countries, this concept is associated with e-participation, which is conceptualized as the use of Information and Communication Technologies (ICT) to mediate and transform the relations between citizens and governments toward increasing citizens' participation. This study concentrates on crowdsourcing incident management platforms. It uses data about incidents submitted on the Na Minha Rua Lx platform and focuses on understanding socio-demographic patterns related to urban noise complaints reported in Lisbon. Furthermore, relevant factors were analyzed using other data sources, such as the Portuguese Census of 2021 and the Lisbon Open Data Portal datasets. Following a Design Science Research Methodology approach, a dashboard was built to achieve the research objectives. The results provide tangible insights for policy-making, revealing that the factors that most impact urban noise complaints in Lisbon are work and anthropic activities, the number of households per residential building, gender, and age. In contrast, population density, education level, and marital status are factors that have a lower impact on urban noise complaints in Lisbon.

KEYWORDS

Smart governance; E-participation; Incident management platforms; Na Minha Rua Lx; Crowdsourcing; Noise complaints.

Sustainable Development Goals (SGD): Goal 11

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LIST OF ABBREVIATIONS AND ACRONYMS

ICT Information and Communication Technology

DSRM Design Science Research Methodology

This study was submitted to a top journal

1. INTRODUCTION

Cities have become more populated over the past years. According to the United Nations Department of Economic and Social Affairs (UNDESA), by 2050, 68,4% of the global population will live in urban areas (UNDESA, 2018). To keep up with this increase in the number of inhabitants, the concept of a smarter and more sustainable city has been developed over the last decades (Cocchia,2014). This concept can be subdivided into six domains, and one of them is smart governance (Caragliu, Del Bo, & Nijkamp, 2011), which can be defined as the city's networked infrastructure enabling political efficiency in social and cultural development (Albino et al., 2015). According to Bosch et al. (2017), smart governance contributes to a city with an efficient administration and a well-developed local democracy, thereby engaging citizens proactively in an innovative way.

Smart cities can play a role in reconciling public administration and citizens (Lebrument et al.,2021). Since citizens seem to prefer electronic public services over non-digital public services (Pleger et al., 2020), e-participation must be introduced to enable citizen participation in the community. It is an approach in which the citizen contributes to the community by producing and providing data or using Information and Communication Technologies (ICT) to mediate and transform the relations between citizens and governments toward increasing citizens' participation (van Dijk, 2010). One example is participation platforms that allow citizens to submit their ideas, vote for their preferred ones, and discuss them with each other (Simonofski et al., 2021).

Many countries have adopted this approach and created incident management platforms where citizens can report an issue and follow the process from when it is submitted until it is solved. Many cities and municipalities have implemented this type of initiative. In Lisbon, the initiative that follows the same purpose is *Na Minha Rua Lx*[1].

In this platform, citizens can submit complaints that fit 12 complaint types and are subdivided into multiple categories for each complaint. This study focuses on noise complaints, specifically on some categories inside the complaint type public safety and noise. Since noise exposure is a problem that is becoming increasingly more common worldwide due to rapid urbanization, it is important to perform a more in-depth analysis of the subject.

Thus, this study follows a Design Science Research Methodology (DSRM), aiming to answer the following research question: What are the main causes of urban noise complaints registered in the incident e-participation platform in Lisbon, and how can they be explained? With the DSRM approach, we intend to build a dynamic dashboard as an artifact that enables users to draw insights and patterns about noise complaints in Lisbon municipality submitted on the platform Na Minha Rua Lx combined with other data sources containing socio-demographic data and to provide tangible insights for policy-makers. Three research objectives were drawn to address this topic and are presented in Table 1.

Objectives	Description
O1	Build an interactive dashboard using data collected from *Na Minha Rua Lx* platform.
O2	Analyze information and detect patterns in noise complaints.

[1] *Na Minha Rua Lx* website: https://naminharualx.cm-lisboa.pt/

O3	Draw insights by comparing socio-demographic data (Portuguese Census 2021 data and several datasets available in the Lisbon Open Data Portal "*Lisboa Aberta*") with *Na Minha Rua Lx* data related to noise complaints.

Table 1 - Research objectives

The remainder of this study proceeds as follows. In section 2, we conducted a thorough literature review regarding smart governance, crowdsourcing civic e-participation, and noise complaints. Section 3 presents the methodology followed and describes the data collected. In section 4, the results of our study are presented and analyzed. Finally, in section 5, conclusions are stated, and some limitations of the study and suggestions for future works are mentioned.

2. LITERATURE REVIEW

2.1 SMART GOVERNANCE AND CROWDSOURCING E-PARTICIPATION

Smart governance has been considered a smart city domain (Caragliu, Del Bo, & Nijkamp, 2011). Ruhlandt (2018) defined smart governance as the processual interplay among a diverse set of stakeholders, equipped with different roles and responsibilities, organized in various external and internal structures and organizations, driven and facilitated by technology and data, involving certain types of legislation, policies and exchange arrangements, for the purpose of achieving either substantive outputs for cities or procedural changes (or even both).

A crucial type of stakeholder involved in this concept is citizens. Citizens' involvement in smart city project design is decisive since the project may fail without proper citizen participation. Participation platforms can constitute a valuable method when considering the requirements for citizens to submit ideas and for public servants to process them (Simonofski et al., 2021). According to Zandbergen & Uitermark (2020), citizens can participate by providing data that can be collected through sensors or by submitting it online; the latter is related to e-government.

E-participation can be defined as a branch of e-government that focus especially on citizen engagement for deliberation and decision orientation (Welch, 2012). A type of technology used to enhance citizen engagement is participation platforms, and they have become the most popular government-led participation form in smart cities (Berntzen & Johannessen, 2016).

According to De Castro Neto et al. (2020), to attain urban intelligence, which establishes resource usage efficiency, the challenge of city data—considered the fuel of urban intelligence, must be overcome. As previously mentioned, governments have been relying their decisions on resident-reported data now more than ever and using data-driven methods to reinforce the city's public management (Bouzguenda et al., 2019), which is one of the parameters that measure the degree of sustainability of a smart city (Kraus & Syrjä, 2015). Allen et al. (2020) also revealed that feedback and monitoring from citizens through a smart city platform improves the percentage of resolved problems.

The term e-complaint, derived from the electronic complaint, is considered a type of e-government that enables citizens to communicate a complaint to the government (Monicha et al., 2018). To enable citizens to collaborate with their governments to sustain their environments, web-based platforms that crowdsource civic participation for urban governance have been created as public service improvement systems that promote transparency and accountability (Pak et al., 2017; Neves et al., 2020). These platforms can also be mentioned as incident management platforms. Using them, citizens can report incidents and defects to their governments, who commit to promptly answering requests. After reporting an occurrence, the incidents are aggregated on a publicly accessible map that reveals the disposition of the environment. Since these maps are accessible to the public, citizens can monitor and consider the performance of their governments when responding to incidents (Pak et al., 2017). Nevertheless, the major advantage of implementing crowdsourcing for urban governance is the ability to address and solve issues that are typically large-scale, complex, and difficult to handle in a top-down manner (Surowiecki, 2005).

Over the years, countless web-based platforms that promote civic participation have been developed to support many forms of urban planning, design, and governance tasks (Pak et al., 2017). As previously

mentioned, many cities worldwide have implemented this type of platform. Na Minha Rua Lx is an example of this type of platform.

To conclude, in practical terms, crowdsourcing civic participation platforms, such as Na Minha Rua Lx, provide valuable and powerful datasets and, consequently, helps local governments improve their knowledge of the citizens and act based on the information revealed from this data toward satisfying public needs (Pedro & Santos, 2020). Since urban data analytics and smart city technologies hold greater potential for improving the city's efficiency and citizens' quality of life (Bettencourt, 2014; Wu, 2020), when making decisions in smart cities, governments have progressively relied more on resident-reported data and used data-driven methods to support the management and planning of the city (Bouzguenda et al., 2019). Therefore, analyzing data collected through web-based platforms that engage citizens' civic participation, such as 'Na Minha Rua Lx', is crucial to acknowledge public space complaints, understand social-demographic patterns, and, consequently, helping governments' decision-making.

2.2 NOISE COMPLAINTS

A problem becoming more common globally due to rapid urbanization is exposure to noise (Tong & Kang, 2021b). According to Weinhold (2013), noise pollution seems to be one of the significant causes of personal dissatisfaction, mainly in urban areas. The same author argues that once the noise is controlled, the negative impact on happiness associated with urban life is fully eliminated. Noise complaints are at the top of the list of environmental-related complaints and have received research attention (Kang, 2006). Noise pollution can be originated from multiple sources, and road traffic is the dominant noise source in urban areas. However, the noises perceived as more disturbing originated from industrial facilities, constructions, and social activities such as parties, fairs, open-air markets, and residential noise (Zambon et al., 2020).

Many publications have been made about the factors that can explain urban noise complaints. In table 2, nine relevant factors are summarized and explained according to the literature.

Factors	Explanation	Authors
Age	According to a study that analyzes the relationships between noise complaints and socio-economic factors at the city/region scale in England, the higher the percentage of underage and young people, the more the city or region tends to have noise complaints.	(Tong & Kang, 2021a)
Sex	A study in England concluded that cities or regions with a higher percentage of male residents tend to have a higher noise complaint rate.	(Tong & Kang, 2021a)
Marital status	Following a study in England, cities with a larger proportion of single residents tend to receive more noise complaints when compared to married couples.	(Tong & Kang, 2021a)
Education level	Noise complaints have a negative relationship with the percentage of residents that are in professional-level occupations. For example, a study in England revealed that areas	(Tong et al., 2021; Tong

	with a higher number of residents without qualifications have a higher noise complaint rate.	& Kang, 2021a)
Barking dogs	A study about noise complaints in England revealed that noise from barking dogs is normally heard during the day, and over two-thirds of cases come from outside. It is a dominant source of noise for detached houses.	(Utley & Buller, 1988)
Work/anthropic activities	In a study that analyzed noise annoyance complaints in Milan, work and anthropic-related activities were the most frequent sources of complaints. The author also estimates that spreading leisure activities, malls, exhibition centers, and venues will likely determine a further increase in complaints. Another study about the relationship between urban development patterns and noise complaints in England revealed that service-dominated cities register more noise complaints when compared to cities dominated by primary and secondary industries. Also, cities or regions where residents are separated from workplaces tend to lower noise complaint rates and vice versa.	(Tong & Kang, 2021c; Zambon et al., 2020)
High-density areas	In a study of New York City, noise complaints were not uniformly distributed across the city. Instead, noise complaints were clustered around the highest-density areas. Therefore, the more enclosed and denser blocks are (urban morphology), the higher the noise complaint rates. For example, another study in England revealed that areas with more residents living in flats tend to have a higher noise complaint rate. Larger, uneven, clustered cities or regions tend to have more noise complaints. On the other hand, cities with more dispersed and fragmented patterns and ragged boundaries tend to have fewer noise complaints.	(Tong & Kang, 2021a, 2021b, 2021c)

Table 2 - Factors that explain urban noise complaints

3. METHODOLOGY

In this study, the methodology followed was a Design Science Research Methodology (DSRM) (Hevner & Chatterjee, 2010). According to Vaishnavi & Kuechler (2004), this methodology follows a process composed of six activity stages, which were all covered, namely: Activity 1 – the problem and the motive were identified, and this phase corresponds to the Introduction section; Activities 2 and 3 - the objectives and goals of the study were also defined in the introduction section, and it required knowledge of the problem's state, current solutions, and efficacy which are addressed in sections 2 and 3; Activities 4 and 5 – a dashboard was developed as a solving-problem artifact to study the phenomenon and to effectively drawn insights using metrics and analysis techniques; lastly, in Activity 6 – the study was published.

Several datasets were used in this study. Firstly, Nova Cidade- Urban Analytics Lab provided the dataset containing the complaints registered in the platform Na Minha Rua Lx in 2018 and 2019. This dataset structure comprises the category, geolocation, registration date, and status. To better understand the causes of these complaints, other datasets from the open data portal *Lisboa Aberta*[2] concerning work and anthropic activities were used. Additionally, preliminary data from the Portuguese Census of 2021[3] were used to perform a socio-demographic analysis. The data was stored in a data warehouse, aggregated, and analyzed at the parish level.

[2] 'Lisboa Aberta' website: https://lisboaaberta.cm-lisboa.pt/index.php/pt/dados/conjuntos-de-dados

[3] Portuguese Census of 2021 preliminary data: https://www.ine.pt/scripts/db_censos_2021.html

4. RESULTS AND DISCUSSION

4.1 INCIDENT ANALYSIS

4.1.1 General Analysis

The total number of noise-related complaints for both years in this analysis is 8 350 complaints, and most were about 'illegal works - Buildings, public roads, and noise', representing 52,97% of the complaints, followed by 'inspection of commercial establishments - schedule and noise', representing 31,64% of the complaints. The remaining two types were not representative since complaints about 'neighborhood and street noise' represented 9,35% and 'inspection of animals - no documents, excess, unsanitary, and noise' only represented 6,04% of total complaints. Fig. 1 illustrates these values.

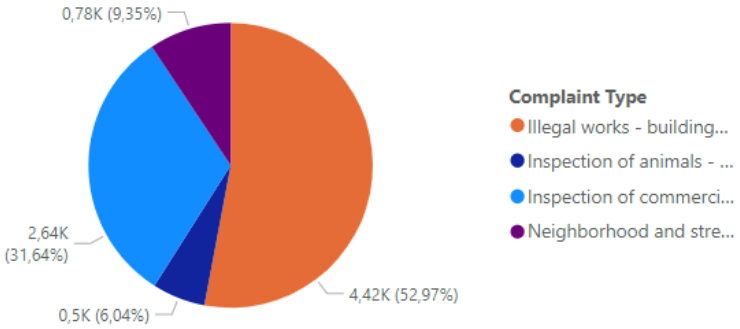

Figure 1 - Noise complaints in 2018 and 2019, per complaint type

The parishes that registered higher number of complaints were Arroios, Misericórdia, Santa Maria Maior, Avenidas Novas, and Santo António, and it can be stated that most complaints are overall located in parishes that are in the city center, as depicted in Figure 2.

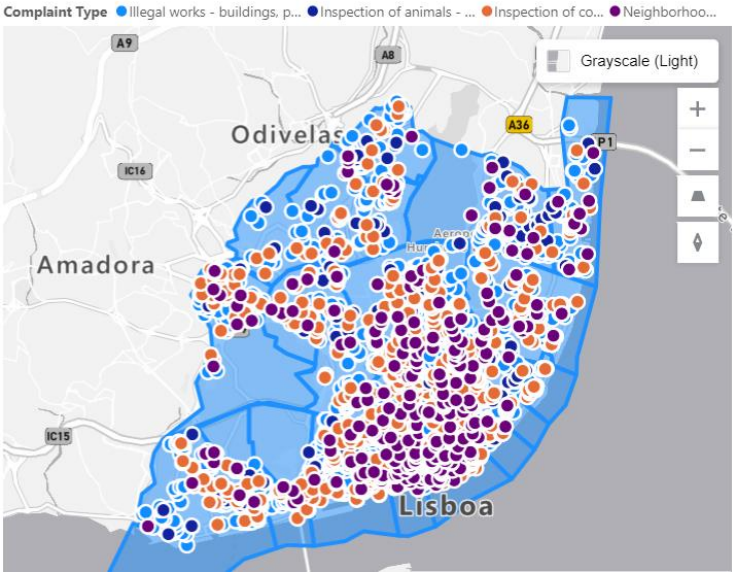

Figure 2 - Noise complaints geographical location, per complaint type

The complaint type of 'illegal works - Buildings, public roads, and noise', the most frequent complaint type reported, is mostly registered in Arroios, Santo António, and Santa Maria Maior. This type of complaint is most registered in parishes located in the city center.

The second most registered complaint type is the 'inspection of commercial establishments - schedule and noise', and the top 3 parishes that registered most of these complaints are Misericórdia, Arroios, and Santa Maria Maior. This complaint type is also most registered in parishes in the city center.

The complaint type 'neighborhood and street noise' is mostly registered in Santa Maria Maior, Arroios, and Misericórdia. This type of complaint is also most registered in parishes located in the city center.

Lastly, the complaint type 'inspection of animals - no documents, excess, unsanitary, and noise' is mostly registered in Penha de França, Olivais, and São Domingos de Benfica. Unlike the other complaint types, this one is mostly registered in parishes that are not as near the city center.

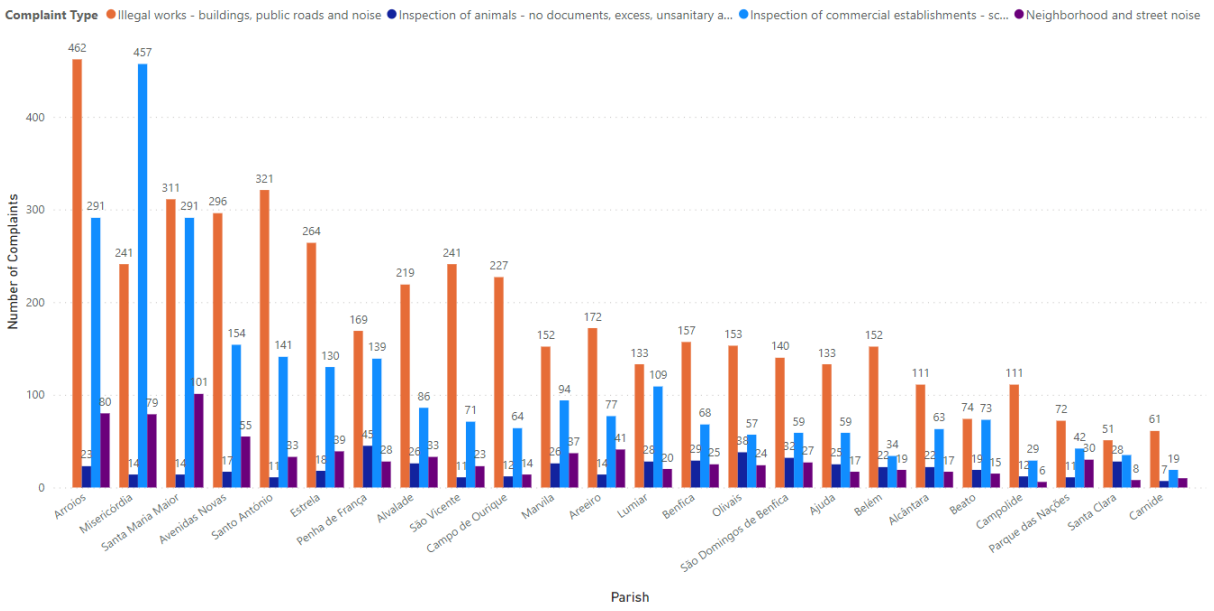

Figure 3 - Number of complaints per parish and complaint type

4.1.2 Seasonality

Regarding the seasonality of the complaints, according to Figure 4, most complaints are generally registered in July, September, and October. However, complaints about 'inspection of animals - no documents, excess, unsanitary, and noise' are also mostly registered in August.

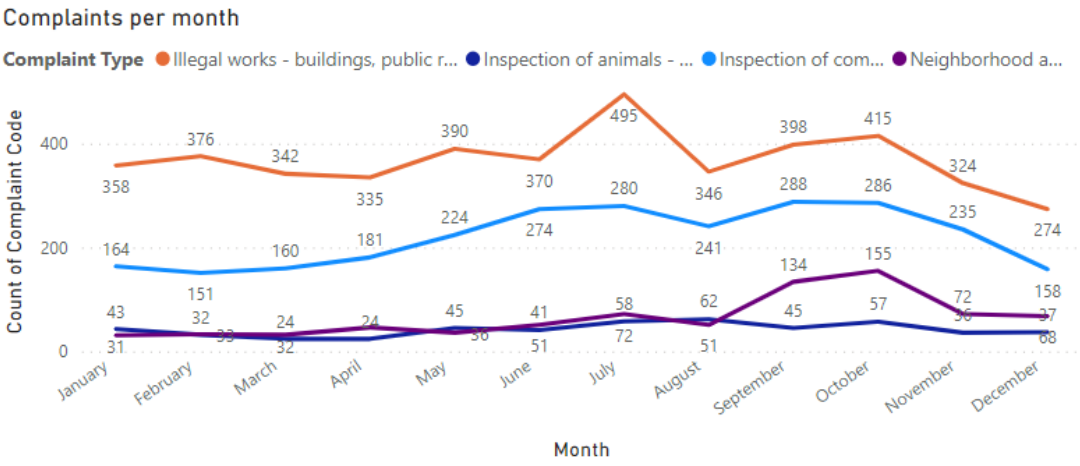

Figure 4 - Noise complaints seasonality within a year, per month, and complaint type

When analyzing the seasonality within a day, it can be stated that most complaints are registered on a weekday and in the afternoon (see Figure 5).

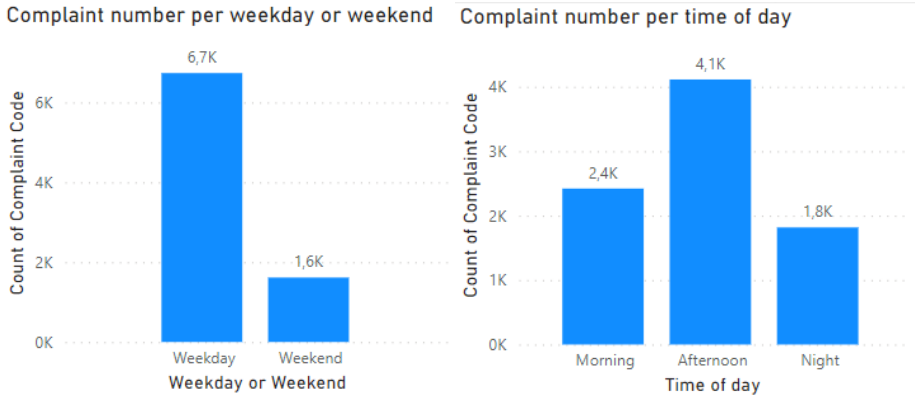

Figure 5 - Noise complaints seasonality within a day, distinguished by weekday and weekend and per time of day

4.2 Work and Anthropic Activities: Location Analysis

According to section 2.2, one of the factors that may influence noise complaints is work and anthropic-related activities. To better understand the impact of noise complaint registration, an analysis comparing the location of different places related to work and anthropic activities, such as shopping centers, fairs, sports facilities, and markets, and the location of the complaints registered was performed.

Starting with fairs, when analyzing their location, it can be considered to impact noise complaints about 'inspection of commercial establishments - schedule and noise'. Parishes with a higher number of fairs also have a higher number of the mentioned noise complaint type, such as Misericórdia, Santa Maria Maior, and Santo António. Also, the same complaints tend to group around areas with more fairs.

In terms of shopping centers' location, it seems that there is a tendency to group complaints of the type 'inspection of commercial establishments - schedule and noise' around areas with more shopping centers, as seen on the maps presented in Figure 6. For example, when filtering Avenidas Novas, the parish with the higher number of shopping centers, a tendency to group complaints of the type' inspection of commercial establishments - schedule and noise' around the location of the shopping centers was detected. Another tendency about shopping centers' location is that complaints of 'neighborhood and street noise' tend to gather around those areas.

When analyzing the location of sports facilities, there was no tendency related to any complaint type detected. For example, sports facilities tend to be located in parishes that are further away from the city center, a tendency that is not recognized in the analysis of most complaint types that have been grouped near the city center.

Finally, when analyzing the location of markets in Lisbon's municipality and focusing on Alvalade, which is the parish with most of that location type, it can be argued that noise complaints about the 'inspection of commercial establishments - schedule and noise' tend to group around areas with more markets.

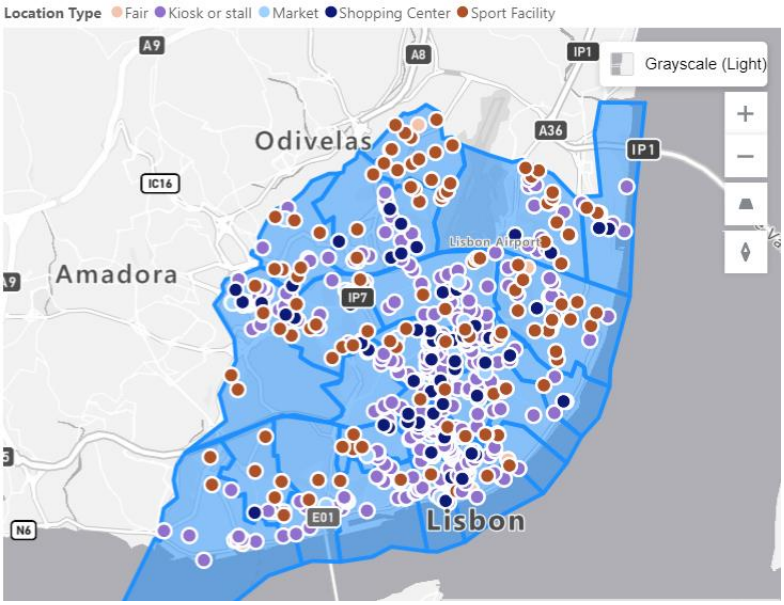

Figure 6 - Anthropic activities related locations

4.3 Socio-Demographic Analysis

4.3.1 Number of Households per Building

It was revealed that most complaints in parishes with more buildings with one household are about 'illegal works - Buildings, public roads, and noise', as the example of Belém. Also, when analyzing the complaint type' inspection of animals - no documents, excess, unsanitary, and noise', the parishes with more residential buildings with only one household per building also tend to register a higher percentage of this complaint type when compared to the remaining parishes. For example, in Olivais, the percentage of the mentioned complaint type is more than twice the overall tendency, representing

13,9% of the complaints registered in this parish, while the average of all parishes registered is only 6,04%.

When analyzing the parishes with more buildings with 2 to 4 households, the most frequent complaint type registered tends to be 'inspection of commercial establishments - schedule and noise'. However, when analyzing the percentage of noise complaints about 'neighborhood and street noise', the parishes with more residential buildings with 2 to 4 households tend to register a higher percentage of noise complaints of this type compared to the remaining parishes. For example, Santa Maria Maior registered 14,09% of complaints about 'neighborhood and street noise', while the average of all parishes registered only 9,35%.

The parishes with more buildings holding 5 to 9 households follow the same tendency as those with only one household, meaning that the most frequent noise complaint type registered was 'illegal works - Buildings, public roads, and noise'.

The parishes with more buildings holding more than ten households also frequently register noise complaints about 'illegal works - Buildings, public roads, and noise'. However, when analyzing the complaint type inspection of 'animals - no documents, excess, unsanitary, and noise', the parishes that have more residential buildings with more than ten households also tend to register a higher percentage of this complaint type when compared to the remaining parishes, similarly to what was detected in parishes that have more buildings with only one household. For example, in São Domingos de Benfica, the percentage of the mentioned complaint type is more than twice as much as the overall tendency, representing 12,4% of the complaints registered in this parish, while the average of all parishes registered only 6,04%.

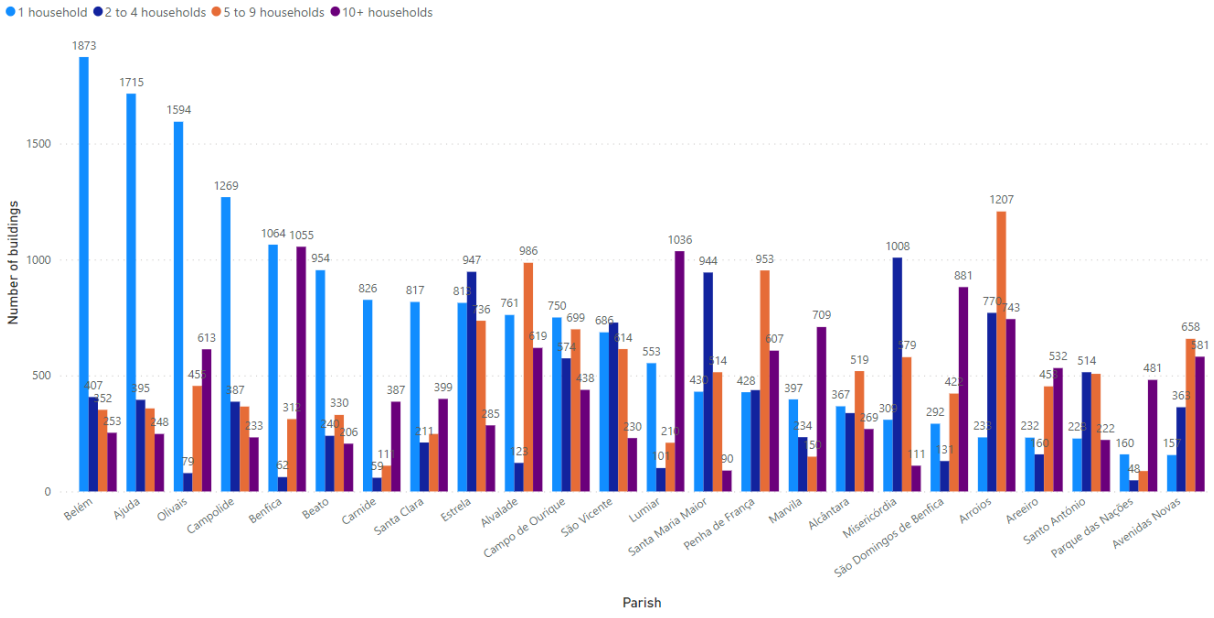

Figure 7 - Number of buildings per parish according to the number of households per building

4.3.2 Sex

According to the analysis, there are more women than men living in Lisbon municipality, and, except for Santa Maria Maior, most parishes have more women than men. When analyzing the complaints registered in each parish and regarding the gender distribution, the parishes with the highest percentage of male citizens, Santa Maria Maior, Arroios, and Misericórdia, tend to register more complaints of the type' neighborhood and street noise'.

4.3.3 Age

Parishes with more citizens between the age of 25 to 64 follow the overall tendency, meaning that the main types of noise complaints are 'illegal works - Buildings, public roads, and noise', followed by 'inspection of commercial establishments schedule and noise'. The same happens in parishes with more citizens older than 65 years old.

However, when analyzing the number of complaints per complaint type according to the percentage of citizens in each age group (see Figure B.1 of appendix B), it was revealed that parishes that have a higher percentage of citizens with ages between 25 and 64 years old tend to register more complaints of the following types: 'illegal works - Buildings, public roads, and noise', 'inspection of commercial establishments - schedule and noise' and 'neighborhood and street noise'.

Furthermore, it was also revealed that parishes with a higher percentage of citizens older than 65 years old tend to register more complaints about the type 'inspection of animals - no documents, excess, unsanitary, and noise' (see Figure B.2 of appendix B).

4.3.4 Education Level

When analyzing citizens' education level per parish and focusing on Lumiar—the parish with more citizens with higher education levels- it was revealed that noise complaints follow the overall tendency. However, this parish registered a lower percentage of complaints about 'neighborhood and street noise' compared to the overall tendency. The opposite was detected in Marvila—the parish with more citizens with lower education levels, having a higher percentage of 'neighborhood and street noise'.

Nevertheless, when analyzing the number of complaints per complaint type according to the percentage of citizens in each education level, only a slight tendency was detected in the number of complaints of the type 'neighborhood and street noise'. In addition, the percentage of citizens that belongs to the education level "none" (parishes with a higher percentage of people with no education level) have a slight tendency to register more complaints about the type of 'neighborhood and street noise' (see Figure B.3 of appendix B). For the remaining complaint types, no impact was detected.

4.3.5 Marital Status

When analyzing the number of complaints per complaint type having the percentage of citizens in each marital status, only a slight tendency was detected in the number of complaints of the type 'inspection

of animals - no documents, excess, unsanitary and noise' according to the percentage of widows and widowers: parishes with a higher percentage of widows and widowers also have a slight tendency to register more complaints about the type of 'inspection of animals - no documents, excess, unsanitary, and noise' (see Figure B.4 of appendix B). For the remaining complaint types, no impact was detected.

5. CONCLUSIONS AND FUTURE WORKS

This study's objectives aimed to identify and analyze the noise complaints in Lisbon. It brings theoretical insights concerning the type of variables used in this topic. It also contributes to practice by delivering an artifact that aims to support decision-making and contribute to smarter city governance. Indeed, this study revealed that the main causes of urban noise complaints in Lisbon are related to work and anthropic activities' locations, the number of households per building, gender, and age. On the contrary, population density, education level, and marital status are factors that have a lower impact.

The incident analysis revealed several insights: the city center is the place with the higher number of noise complaints; the category 'illegal works - Buildings, public roads, and noise' has the highest number of noise complaints (52,97%), while the category 'inspection of animals - no documents, excess, unsanitary and noise' has the lowest number of complaints (6,04%), and it is mostly registered in parishes further away from the city center. Focusing on seasonality, July, September, and October were the months with the higher number of noise complaints registered, having 'inspection of animals - no documents, excess, unsanitary and noise' most registered in August, which might be explained by the fact that usually, people go on vacations that month, leaving animals at home alone more time than usual. Most complaints were also registered on weekdays and in the afternoon.

The geographic analysis of work and anthropic activities' location revealed that parishes with a higher number of fairs also tend to have more complaints about 'inspection of commercial establishments - schedule and noise'. Also, noise complaints of the types 'inspection of commercial establishments - schedule and noise' and 'neighborhood and street noise' tend to group around areas with more shopping centers. In addition, areas with more markets tend to have more complaints about 'inspection of commercial establishments - schedule and noise'. Lastly, sports facilities' location did not impact noise complaints since most are located further away from the city center, as most complaints are registered in the city center.

From the socio-demographic analysis, several insights were drawn considering the number of households per residential building. Firstly, parishes with more buildings with only one household register more complaints about 'illegal works - Buildings, public roads, and noise'. These parishes also tend to register a higher percentage of noise complaints about 'inspection of animals - no documents, excess, unsanitary, and noise' when compared to the remaining parishes. Secondly, the parishes with more buildings with two to four households tend to register a higher percentage of noise complaints about 'neighborhood and street noise' when compared to the remaining parishes. Thirdly, parishes with more than five households per building follow the same tendency as those with only one household. Therefore, the number of households per residential building is a factor that impacts noise complaints.

Also, the socio-demographic analysis revealed that parishes with the highest percentage of male citizens tend to register a higher percentage of noise complaints of the type of 'neighborhood and street noise'. Hence, gender is a factor that impacts noise complaints in Lisbon.

When comparing the age of the citizens in each parish, it was revealed that parishes with a higher percentage of citizens between 25 and 64 years old tend to register more of the three noise complaint types studied. Additionally, parishes with a higher percentage of citizens older than 65 years old tend

to register more complaints of the type 'inspection of animals - no documents, excess, unsanitary, and noise'. Therefore, age can be considered a factor that impacts Lisbon's noise complaints.

Marital status has a lower impact on noise complaints in Lisbon since only a slight tendency was found when analyzing this factor. The same was registered for education level.

This study has some limitations. The first one relies on the preliminary data of the Portuguese Census of 2021 used to perform the socio-demographic analysis, which is not the final result. A second one relates to the noise complaints dataset's period, which only has data for 2018 and 2019, limiting a time series analysis. A third one concerns that some noise complaints might be addressed differently than the complaint registration in the Na Minha Rua Lx platform. For example, citizens might prefer to contact authorities directly via phone when faced with a higher noise annoyance, such as 'neighborhood and street noise', to ensure that the problem is solved as fast as possible, making it more difficult to analyze this type of complaint.

For future work, it would be important to analyze other complaint types registered in the Na Minha Rua Lx and to understand which factors intertwine with noise complaints for better understanding and mitigation. Another suggestion is to perform a comparative analysis of noise complaints with data from other crowdsourcing platforms from the same country or other cities worldwide to support evidence from the literature and extend with new conclusions.

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APPENDIX A. DASHBOARD OF NOISE COMPLAINTS REGISTERED IN LISBON

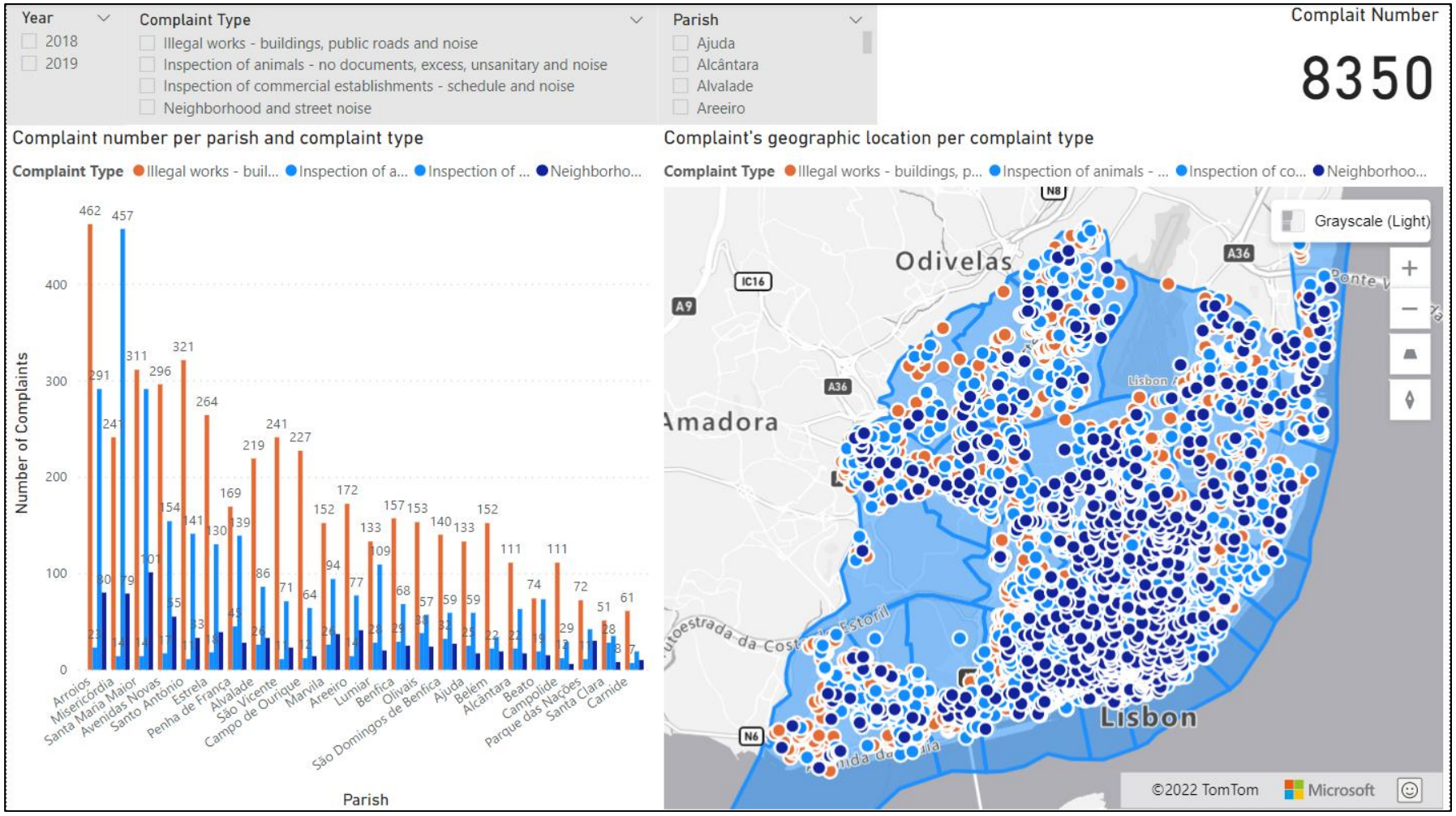

Figure A.1- Dashboard screen example

APPENDIX B. ANALYSIS OF THE NUMBER OF COMPLAINTS PER COMPLAINT TYPE HAVING THE PERCENTAGE ACCORDING TO AGE, CITIZENS IN EACH EDUCATION LEVEL AND MARITAL STATUS

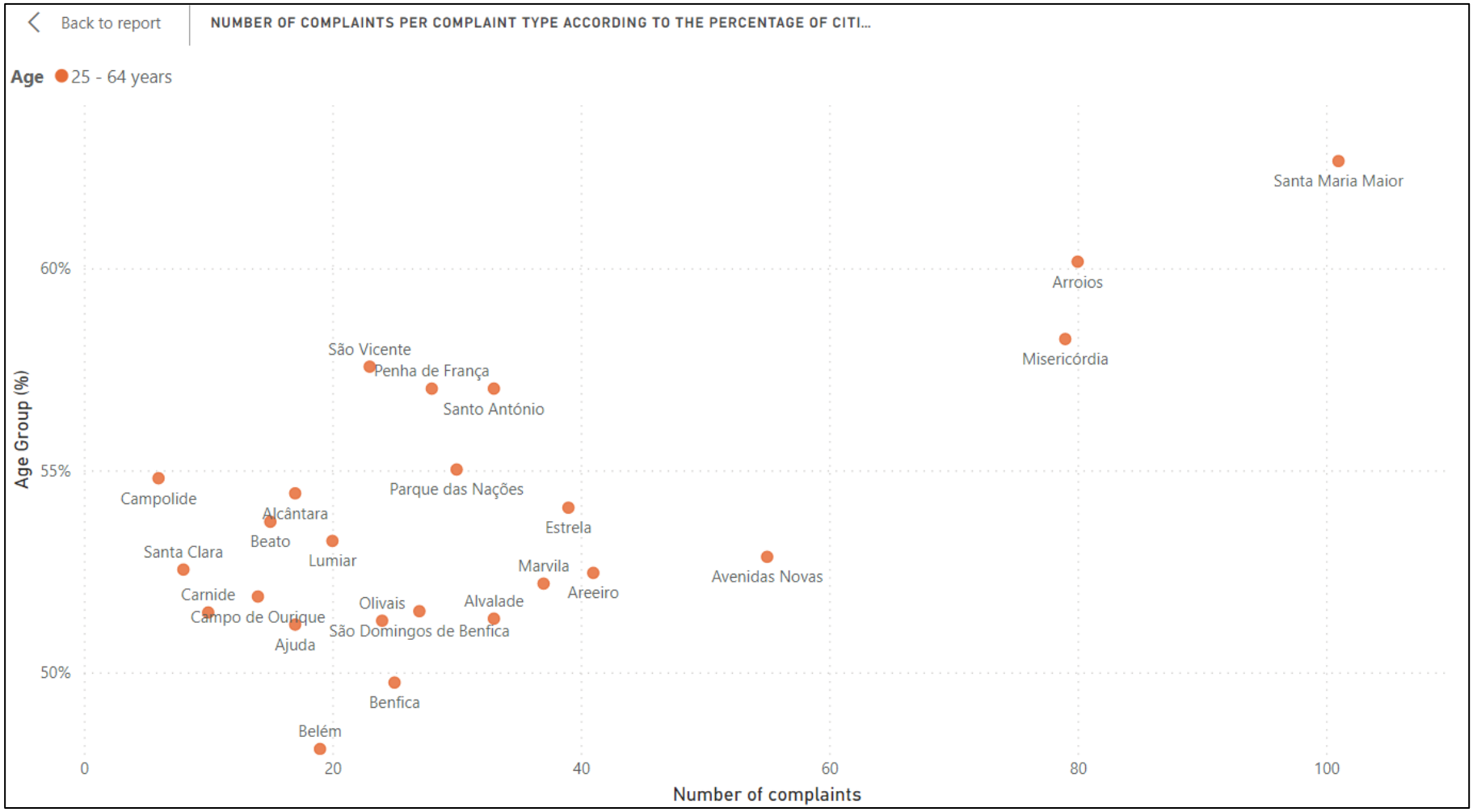

Figure B.1 - Number of complaints about 'neighborhood and street noise' according to the percentage of citizens with ages between 25 and 64 years old, per parish

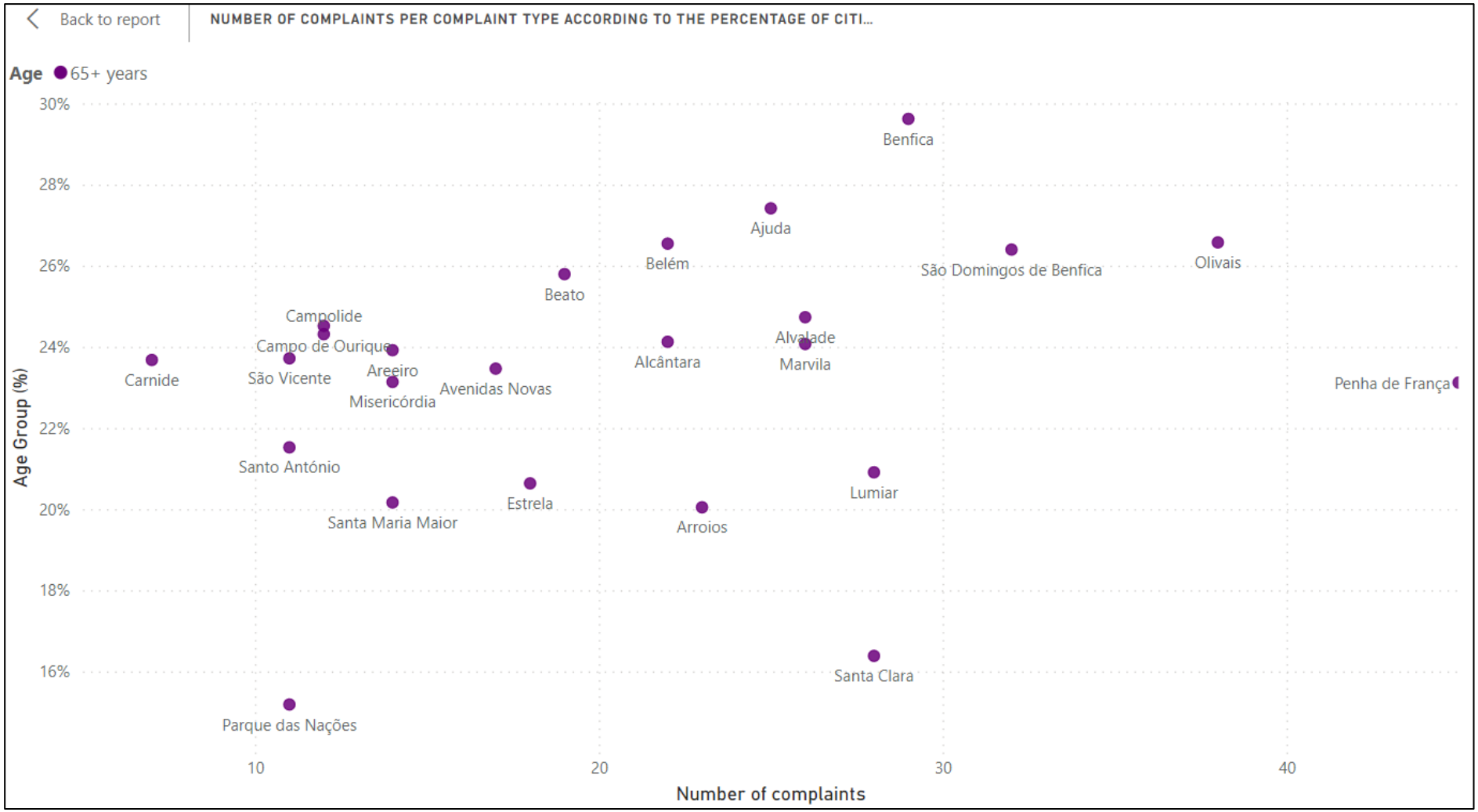

Figure B.2 - Number of complaints about the 'inspection of animals - no documents, excess, unsanitary and noise' according to the percentage of citizens older than 65 years old, per parish

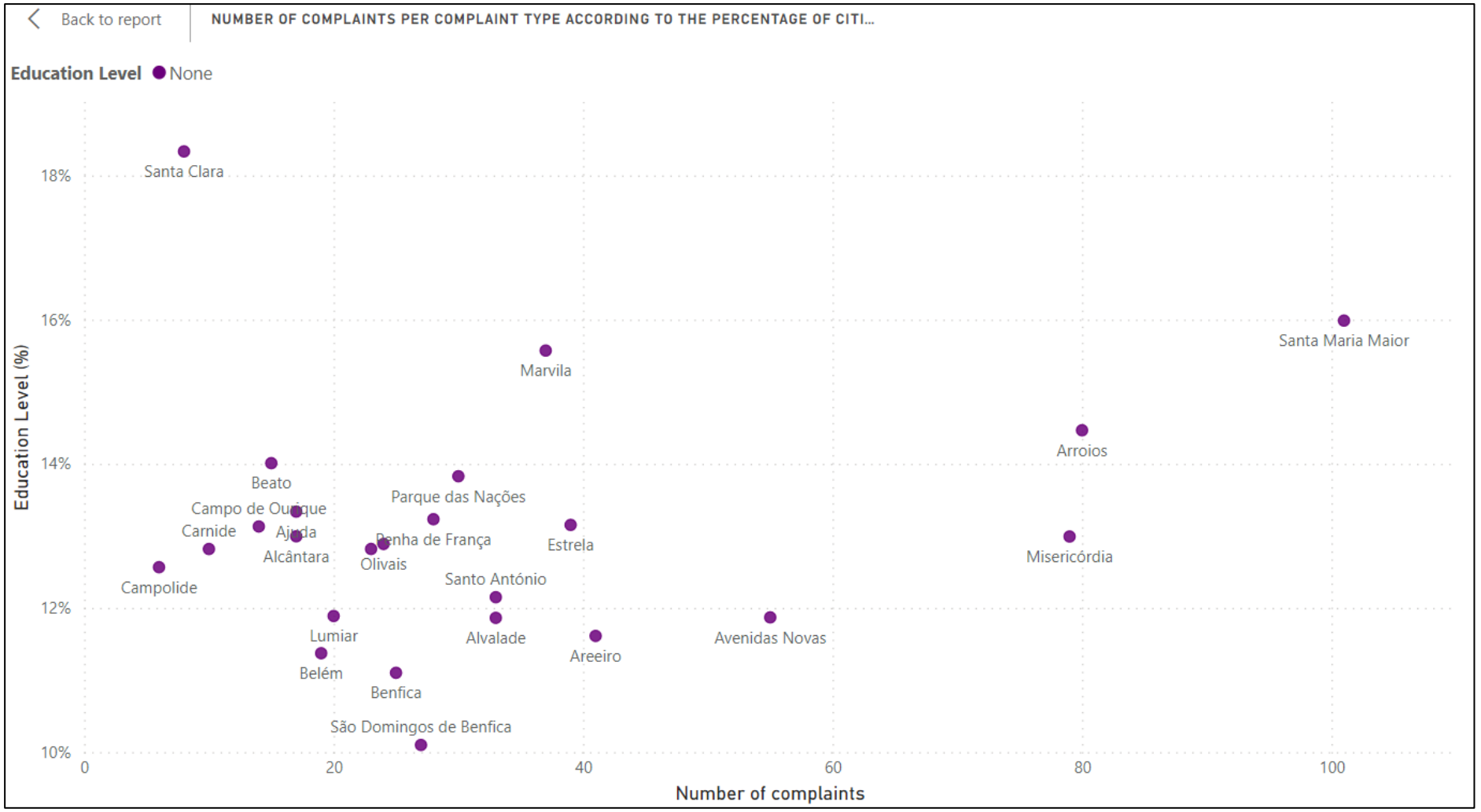

Figure B.3 - Number of complaints about 'neighborhood and street noise' according to the percentage of citizens that has no education level per parish

Figure B.4 - Number of complaints about the 'inspection of animals - no documents, excess, unsanitary and noise' according to the percentage of widows and widowers per parish