# A digital platform to support Citizen-Government interactions from Volunteered Geographic Information and Crowdsourcing in Mexico City

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**Abstract.** This paper presents two case studies of volunteered geographic information processes in two different neighborhoods in Mexico City. Both cases deal with citizen empowerment and actions directed for the improvement of their local surroundings. They are constructed in a bottom-up fashion: from the citizens towards the local authorities. A digital platform was developed to support user-generated data collection for both cases; the second being an evolution of the first that incorporates several enhancements. The collection of enough citizen data is useful to focus efforts to negotiate with the authorities in detected regions and matters that need attention. Citizen-generated maps are useful communication tools to convey messages to the authorities, as the identification of these locations and situations provide a better picture of what, from the citizens' perspective, is significantly deviated from the government's point of view. The platform incorporates a way to validate official data, a voting strategy as a first approach to assess the credibility of citizen-contributed observations and crowdsourced information on parcel records.

**Keywords:** Volunteered Geographic Information · Crowdsourcing · Citizen Science · Citizen Empowerment · Geospatial Web Platform · Web Mapping

## 1    Introduction

Geographic data collection has experienced a paradigm shift in the sense that users not only consume, but also generate new data. It has been progressively easier for people to participate in mapping processes, thus effectively becoming a *citizen mapper*. Recent tendencies show that it is not necessary for people to be certified in the field of cartography to actually be able to contribute to local cartographic records and collaborate in the collection and updating of geographic data.

Traditionally, governmental agencies have been in charge of this task, following strict protocols and adhering to quality assurance standards in order to provide the best data available for different purposes: population, cadastral, vehicle registrars, businesses, censuses, natural resources, etc. It has become increasingly common for citizens to collect geographic data that does not necessarily conform to these governmental standards. Apart from collecting, with help of all the mapping technologies

available on the web [1], it is also common for users to disclose part of this data, in what constitutes one of the pillars of neogeography: "sharing location information with friends and visitors, help shape context, and conveying understanding through knowledge of place" [2].

Volunteered geographic information (VGI) is, as defined by Goodchild, "the widespread engagement of large numbers of private citizens, often with little in the way of formal qualifications, in the creation of geographic information" [3]. It is often heard in contexts related to collective mapping activities or crowdsourcing, which involves "generating a map using informal social networks and web 2.0 technology" [4].

Crowdsourcing and VGI are two common terms. Crowdsourcing can be found in many different topics, not just geographical information, and "implies a coordinated bottom-up grassroots effort to contribute information" [5]. For some, VGI represents an "unprecedented shift in the content, characteristics, and modes of geographic information creation, sharing, dissemination and use" [6]. Others, like Harvey [7], propose that not all crowdsourced data is volunteer data and suggest making a distinction when data is collected with an "opt-in" or an "opt-out" agreement. Nonetheless, both rely on many users contributing data and are strong advocates of the "wisdom of the crowds" and collective intelligence: the idea of whether a product created collectively is better than the best individual product [8, 9].

It is also becoming more common for citizens to be able to compare what the official figures tell with what they observe and experience in their everyday life, without necessarily challenging the existence of official records. These types of citizen participation and public input have found a good niche in the report of social incidents and have given individuals direct access to establish a dialogue with the authorities. Data from different sources can be analyzed to propose different scenarios and possible courses of action that could improve citizens' quality of life without waiting for the government to provide official data, thus fostering the existence of different mechanisms that can be used to study societal issues.

Citizen-government interactions can be broadly separated as *bottom-up* or *top-down*. The former can be understood as "actions conceptualised, incepted, developed and led by members of the local community" [10]. Indeed, the appropriation of space by citizens has gained much momentum and has also proven to be an effective means for them to negotiate with the government for the procurement of benefits.

Conversely, top-down social processes focus on providing the structure of said processes for the building blocks of society. Namely, the government lays the infrastructure so the development in question can take place. In other words, it can be understood that bottom-up processes give rise to the existence of institutions because they are needed by the common practice of citizens. In the opposite case, institutions are determined by laws written by political leaders [11]. Johnson and Sieber [12] call the former 'citizen-to-government' (C2G) and the latter 'government-to-citizen' (G2C) processes.

With these types of action, the net effect from the societal point of view is citizen empowerment. The possibility for collaboration opens up and the citizenry has the opportunity to get involved in the betterment of its community.

VGI and crowdsourced information have the advantage of having low costs of entry, which in turn can represent a problem, as mentioned above, of users with little to no

technical knowledge collecting data. This raises issues related to the quality, accuracy, and credibility of VGI [9, 13, 14]. In contrast, other advantages include how fast data can be made available, especially distributing it over the web, and how citizens, while becoming empowered, can challenge and exert some pressure on the government so that certain information gets collected or is made available to them.

In this paper, two C2G processes are presented in which the citizenry engages in data collection of information not necessarily available from official sources. One goal is to promote actions from the citizens towards local authorities to try and implement actions that can help improve their neighborhood. For this, a digital platform was constructed that serves specific purposes for each case, although the second is derived from the first and incorporates several enhancements.

The rest of this paper is organized as follows: the next section gives a short review of other platforms. Each case study is presented along with their main findings and lessons learned. Preliminary results are discussed and lastly, conclusions are laid out together with some ideas for future work.

## 2 Other Platforms for Participatory Mapping

Citizen observation and reporting platforms have existed for quite some time now. They have a wide range of interests and applications –for both spatial and non-spatial data– but all seem to conform to the idea that many users can share knowledge and, by doing so, it becomes easier to achieve a proposed goal.

iNaturalist allows users to record observations about the natural world and make them available on the internet or through mobile apps [15]. By creating a community of people that shares common interests, and amassing a very large number of observations on different topics, their goal is to be able to provide a living record of life on Earth that can be used to monitor biodiversity. OpenTreeMap is a "collaborative platform for crowdsourced tree inventory, ecosystem service calculations, urban forestry analysis, and community management", also providing users with mobile apps [16]. GeoKey is a platform for participatory mapping that allows the creation of customized projects [17]. With a web-based backend interface, it allows users to collect, share and discuss data reports. GeoKey projects can be configured to use mobile devices to collect data with the EpiCollect+ mobile app [18]. Ushahidi was originally built to crowdsource crisis mapping [19]. Since its beginnings in 2008, it has come a long way to establishing a reputation as a good platform for "human rights activism, crisis response and civilian empowerment" [20]. It is available on the web, offers mobile apps and can be configured to receive data from various different sources. GeoCitizen is a platform for community-based spatial planning that involves governments and citizens [21]. ArgooMap is a tool designed to support structured discussions with spatial reference objects and has been used in different planning exercises [22]. It was re-implemented from a former Java-based incarnation (ArguMap) using Web 2.0 services and Google Maps API. Mapchat is also an open source platform that allows the integration of maps with real-time (and asynchronous) online discussions among several users [23].

In the case of Mexico, the city of Monterrey has a map that captures citizens' reports on diverse incidents in the public space [24]. The platform receives, validates, canalizes, keeps track and publishes citizen's reports, but no further information is provided on how this is actually done. In a sense, data curators and platform seem to act as a liaison between citizen's complaints and governmental attention.

This sample of apps and platforms can aid in exercises of participatory citizen mapping. Most of them are available as open source software and while it is possible to contribute and implement new functionality, it is also a cumbersome process to localize all the frontends to cater for users in different languages (Ushahidi is the exception that already provides some translations). Not all users are bilingual and this is a key factor in terms of how well or fast the platform is adopted. Most of these platforms focus on point data but GeoKey allows other geometries, although one still needs to develop a front end to interact with the data via its web API.

## 3    Citizen to Government (C2G) or Bottom-Up Cases

While all of the platforms presented in the previous section allow users to contribute data, some of them open the door to citizen-government interactions. In the context of this research, bottom-up processes are those that are created from the citizenry, which stem from the needs of the neighborhood and are aimed towards an interaction with local authorities. One goal is to provide information to help in the negotiation of that which is of interest to the citizens and that governments can help ameliorate.

Two bottom-up cases are presented in this section for which a digital platform was developed. The first is an example of the collaboration with citizens of a central neighborhood in Mexico City that were looking for ways to collect spatial data from their surroundings to help them justify actions and support negotiations with local authorities for neighborhood enhancements. This is what they called their 'citizen agenda'. It was decided to try and implement basic functionality in order to be able to capture citizens' perceptions as opposed to using a full blown platform and try to tweak and adapt it for a particular use. A complete suite of participatory mapping would have been too complicated for citizens to manage because this exercise started with the simple requirement of an online map and eventually needed the inclusion of more complex functionality and interactivity. However, the lack of personnel placed citizens in charge of the overall management the platform, so it had to be kept as simple as possible, yet functional and powerful. The second case is a derivative of the first in which neighbors from a different municipality were eager to partake in participatory data collection. The existing platform was adapted to include enhancements suitable for these neighbors' specific requirements.

The societal trend of citizen empowerment motivates the presentation of these two cases. Even though these are based in Mexico City, they are representative of what can happen in other cities. Many neighborhoods have to deal with issues related to business licenses, security, land use, city services, appropriate mobility, real estate and waste management. It is not just the location of the neighborhood that matters, but rather the

general behavior of the local activities that can be found someplace else. The recognition that citizens can and want to make a difference in local processes is very well expressed in these examples.

## 3.1    The Roma Neighborhood

This first case is an exercise carried out in the Roma neighborhood in central Mexico City, from mid-2014 to mid-2015. The Roma is a central neighborhood covering an area of about 3.7 km$^2$ (1.4 mi$^2$) with an approximate population of 45,000 inhabitants and 322 city blocks.

The Roma project is an essential one, because even though a digital platform was specifically tailored for this case, it set the basis for a more general model. The motivation for this project is that citizens in this neighborhood had already perceived many problems in their territory, but did not have the tools to properly show their locations and importance to others. They were aware that having such information would be valuable to articulate proposals and find solutions. There had been previous efforts to create paper maps pinpointing these locations and situations, but with little success. The idea of collecting citizen perceptions, making them publicly available, analyzing and using them to support proposals and solutions were the driving forces behind the project.

This was a direct collaboration with a civil group. Geared and spearheaded by the citizens' interests and needs, support was provided to help them understand why spatial conscience was useful to map and how it could be done. A digital platform was built to help collect data, visualize and make it available for the creation of a citizen agenda that would then be taken to the local authorities for negotiation. The goal was for the citizen group to take a 'snapshot' of their neighborhood and evaluate its current conditions. With that as a starting point, they would be able to use the special value of spatial data to identify *what* could be done, and *where*. The idea was for them to be able to analyze the current state of the neighborhood to detect issues and opportunities.

For this, an agreement on what was to be observed was needed. The list of variables to collect in the field was defined together with the citizen group in an iterative process of workshops and meetings that concluded with six main categories (businesses, services, real estate, security, mobility and waste) for a total of 42 variables (see Fig 2). Some variables required teams of citizens to go out in the field at different times to capture the dynamics of their environment during day and night.

The citizen group was in charge of promoting the utilization and adoption of the platform in the neighborhood. When the project started, a strong social base already existed and this was a key factor in the adoption of the platform and successful completion of data collection, as it made it easier to communicate the purpose and the usefulness of the goal to the rest of the participants.

During data collection, users had access to an online map in which they could report their observations. Names, addresses, and a picture were able to be attached to a location on the map. Neighbors and volunteers were both in charge of data collection and responsible for data quality. Some of them acted as users and managers at the same

time. Teams worked in the field using sheets of paper and, during a second stage, information was entered into the platform. Paper backups were useful to keep a record of the work carried out and also in clarifying information in case there were discrepancies with what was entered online.

The neighbors' organization wanted to avoid fake data as much as possible. Mattioli raises the issue that interventions put forward by citizens are often times not appropriately treated by the authorities due to their nature by giving examples of urban agriculture and urban abandonment maps in which users are not able to directly enter data, but rather get in touch with data curators to provide updates [25]. A conclusion is that complete control on data collection can help improve its accuracy, but can also discourage spontaneous participation. Taking this into account, a user authentication process was implemented so that any visitor could navigate, explore and see collected data on the platform, but only authenticated users could add new information. Knowing which user entered which records was deemed a reasonable way to discourage adding false information.

Database points are displayed on the map using a clustering strategy for each category that dynamically changes when zooming in or out. This serves as a visual aid for identifying areas where certain kinds of observations accumulate and is a much more efficient way to display data in terms of the platform's performance. Otherwise, users would experience lags when zooming in or out, or while panning.

The platform also includes some analysis capabilities. Users can create heat maps on the fly with information stored on the live database, overlap two of them and, as a very basic exploratory data analysis tool, compare if there is a spatial relationship between two variables (Fig. 1).
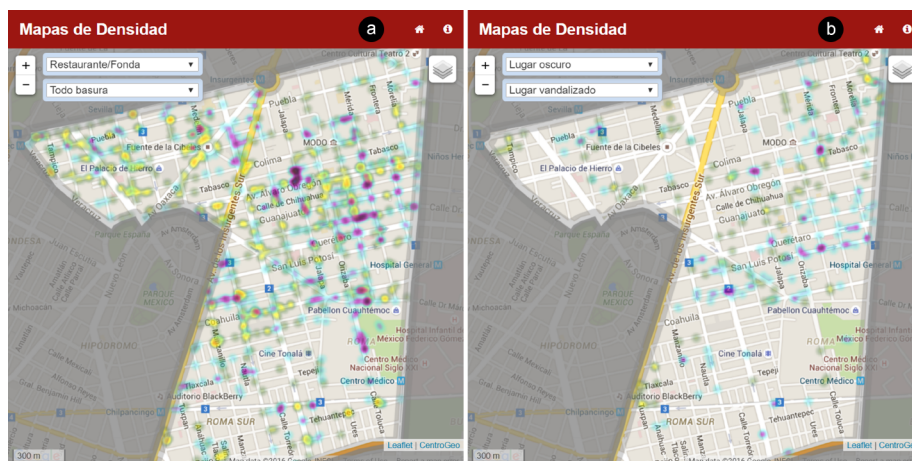


**Fig. 1.** Heat map intersections for the Roma exercise for a) restaurants and waste locations and b) dark places and vandalized places. Selected variables are shaded with warm/cool color ramps.

This was important as it enabled citizens to identify, at a very basic level, if their perceptions were showing some sort of spatial autocorrelation that could help them focus their efforts on specific regions and variables. The purpose was for this to become

an essential tool for citizens to consult and review when analyzing the spatial behavior of the variables they were interested in, so it could provide them with initial evidence to support the construction of their citizen agenda.

The digital platform was developed using open-source software and freely available tools such as PostgreSQL, Leaflet JS, PHP, Bootstrap and jQuery. In terms of the user interface, the platform was built as a web app, functional in all operating systems and browsers, on both desktop and mobile environments.

Once the data collection phase was completed, it was time for citizens to analyze all this information. They formed commissions for each of the different categories under study, with the task of finding ways to portray the spatial findings they had obtained, so they could fit their proposals for action with the local authorities with evidence of the neighborhood's perception. Spatial data is an essential part of the citizen's agenda that is being built to negotiate with the authorities. Once their proposals are ready, they will also be publicly available on the project's website for others to consult.

**Lessons from the Roma project.** Several things were learned from this study. First, even though only authenticated users were able to add data to the platform, a mechanism to correct information or delete data points was not implemented. As mentioned above, teams of citizens observers and volunteers collected data and were managed by another neighbor. If a mistake was detected, users could inform their fellow managers who in turn could contact the database administrator to make specific changes. There were, however, very few mistakes that needed correction. The two-step process used for data collection and entering was likely helpful in this matter, as records were tacitly double-checked before being added to the database. Second, the existence of a strong social base that pushes forward the adoption of the cause, and at the same time fosters the neighbors' interest, is essential. It would be very difficult to make a project like this work without such group. People in charge of the citizen side of the project were very upbeat about talking to other neighbors, recruiting them, inviting passersby and promoting the exercise. Additionally, this project was surrounded by public presentations, town-hall meetings, media communications and other types of diffusion mechanisms, which are paramount to reach different citizen groups that can and should get involved in participatory processes.

Another lesson is the need to provide users with access to the platform through different gadgets and operating systems. Most users accessed from desktop systems and a certain reluctance to adopt mobile devices was observed. This may have been due to the lack of smartphone and tablet native apps and of users not being eager to access web apps.

## 3.2 The Lindavista Neighborhood

The experience with the Roma neighborhood triggered the beginning of new collaborations with other sectors of society. In response to media coverage of the Roma study, neighbors from a different municipality called out their interest in having something similar.

The Lindavista neighborhood is located north of Mexico City, covering an area of about 2.1 km² (0.8 mi²) with an approximate population of 15,000 inhabitants and 122 city blocks. It was perceived that for the Roma case there were too many variables to be collected. Citizens' perceptions of a wide variety of topics have a broad range of variability, dependent on factors such as age, gender or personal interests. Fortunately, for this case, neighbors knew better what they wanted to map and it was much easier to come up with a limited set of variables to collect. Four categories with fewer subcategories were available.

While Roma neighbors were interested in gathering a lot of data to be able to construct an agenda, Lindavista citizens were already using paper maps to collect data on the field, had a clearer idea of what issues they wanted to tackle and a better understanding of the type of process in which they could participate. In a sense, Roma neighbors needed a more elaborate explanation on how to study their space and how maps could help them convey their message, as opposed to Lindavista neighbors who were more advanced in their spatial process and were already collecting information on paper maps.

The variables used in both bottom-up cases are shown in Figure 2. In the center are those that are common to both studies, to the left those that are only for Roma and to the right two that are used only for Lindavista. Nodes on this diagram are symbolized with patterns representing different variables' categories.
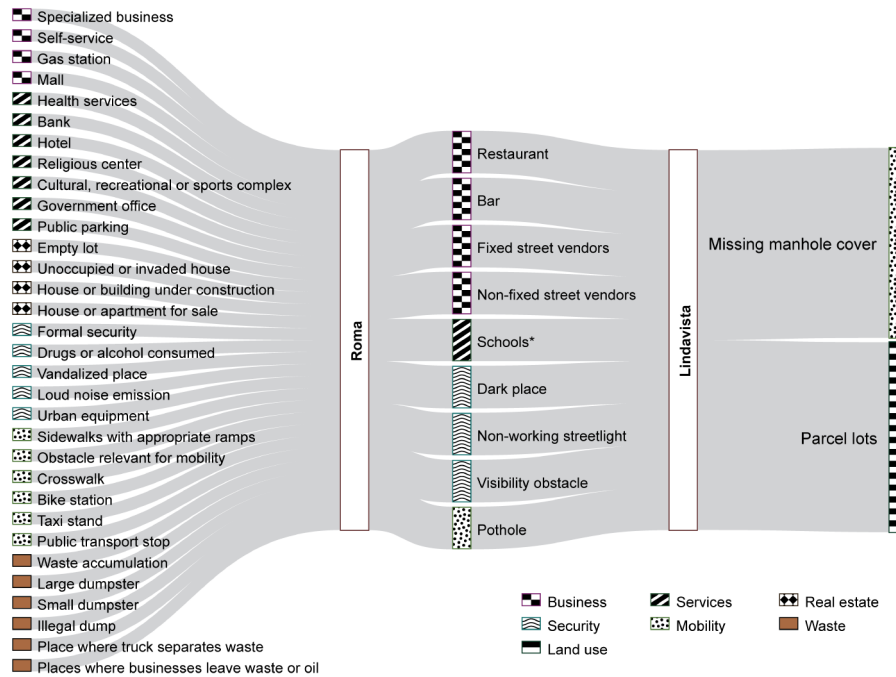


**Fig. 2.** Categories and corresponding subcategories used in the Roma and Lindavista projects.

Lindavista first considers four categories (businesses, schools, security and mobility) for a total of 14 variables (about one-third of those in the previous exercise) that can be collected in a more consistent way by different observers. This improves the data collection process from the Roma case as, from the citizens' perspective, it allows them to better discern whether a particular situation they observe fits in a given subcategory or not. For Roma, schools were one subcategory of the *Services* category, while for Lindavista the *Schools* category had different subcategories: elementary, middle, high school, university and combined (marked with an * in the diagram). An additional category for land use was considered for Lindavista to collect cadastral data on parcel lots.

This second case is relevant because it gave the opportunity to gain more experience in working with the citizenry and allowed enhancements to the platform. It posed the need to deal with data collection for cadastral data and gave another opportunity to stress the need to use more objective variables. The following features that had not been considered before are incorporated into the platform: the inclusion of official sources of data for citizens to validate; the ability of users to (dis)agree with an observation by voting; the possibility for users to collect cadastral data difficult to obtain from the authorities.

**Data Validation.** The national government publishes a nationwide survey of economic units. It is useful to locate and identify establishments that fit into the first two categories (businesses and schools) of the Lindavista study. This database is available from the National Institute of Statistics and Geography [26]. In the case of the Roma, this database was not used because citizens wanted to thoroughly collect what was in their neighborhood. They argued that the inclusion of this information would not be very useful since it was most likely outdated, and the dynamics of the neighborhood would not be accurately reflected. For the Lindavista exercise, on the other hand, this was perceived differently and citizens were glad they could be given a lot of records to begin with, so they did not have to start from scratch. Elements from the database of economic units matching the *Business* and *Schools* categories were added to the interactive map, and their associated information was available for display on click.

Again, visitors can navigate and explore data on the web app. Authenticated users have additional functionality when clicking markers. If the official category matches one of the desired ones, the user can validate it. If data is incorrect, the user can edit the information and update the data point. If the marker is not relevant for the categories under scrutiny (for instance, a karate school), the user can delete the observation. Figure 3a shows an example of the validation, edition or deletion of data points.

**User voting.** The credibility and accuracy of volunteered geographic information are topics that have been widely recognized and are open for debate. In Fonte et al. [27], some guidelines for assessing data quality and volunteer credibility are proposed. Here, a first attempt to measure the reliability of citizen contributions is introduced with a voting strategy. The idea is to capture users' perceptions to quantify how many people (dis)agree with existing reports and obtain an empirical degree of trustworthiness of the observations and, indirectly, of contributors. With this approach, quality assessment is

carried out by citizens themselves. Only authenticated users have access to this functionality, otherwise one runs the risk of letting a single user vote many times in favor or against a particular observation.

Once a user casts a vote, it is not possible to up- or down-vote again for the same data point, but users can change their opinion. Again, this is to prevent users from voting several times on a single observation and try to better capture the general feeling of a larger group of users. Figure 3b shows an example of the voting strategy implemented for this exercise.
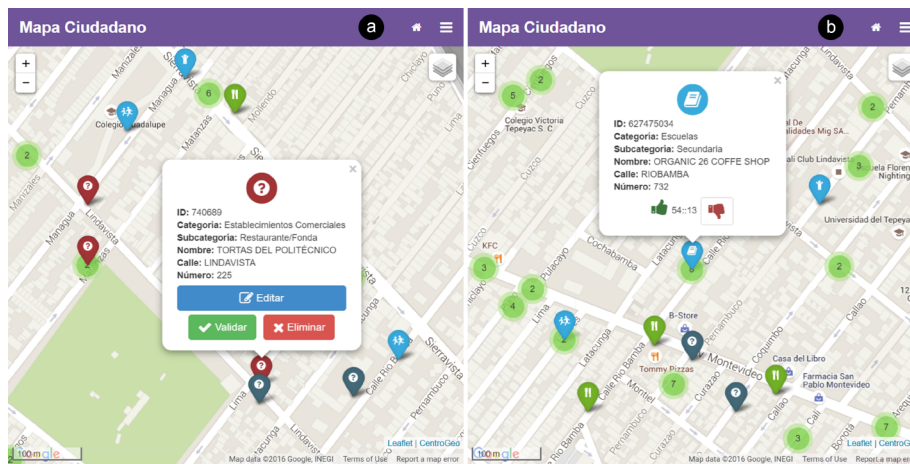


**Fig. 3.** Enhancements for the Lindavista case study: a) validation, edition or deletion of data points; b) the voting strategy.

**Parcel lot information.** Citizens in this neighborhood are also interested in obtaining information with respect to how aligned the land use in this urban area is with respect to the current land use policy for the city. Particularly, there are strong concerns regarding the maximum allowed levels of construction in each parcel lot. In accordance with local law, it is possible to access public records that contain relevant information for this matter, but it is a cumbersome process that can take a long time to achieve and obtained data may not be readily available in open formats.

The parcels' geometry was obtained, overlaid on top of the base map and each polygon was initialized with a *null* value for the number of levels of construction. Users can click on polygons and obtain information while authenticated users can edit the number of levels.

Parcel lots are colored in accordance with the map legend and clicking on a polygon displays a popup window (also shaded with the color corresponding to the number of levels) with the lot id, cadastral account, and current levels. The color schemes help the user get a better idea of the information and the map is a fast and an eye-catching way to get a quick overview of the spatial distribution of levels of construction. Once completed, this information will be very useful in order to compare citizens' observations

with official maps. With respect to government data, "it is crucial to distinguish between government transparency and open data" [28]. This remark is framed in the Open Government Working Group's eight principles of government data, which clearly define what characterizes open data [29]. It is often the case that data obtained through the Transparency Office in Mexico is precisely that: transparent but not necessarily open. Unfortunately, initial approaches with local authorities to obtain an official land use map have not to be very successful. However, the citizens' drive to obtain and make this information publicly available will likely serve as an example for the authorities to push towards open data. Figure 4 shows an example of the spatial distribution of parcel lots with different levels of construction in the study area.
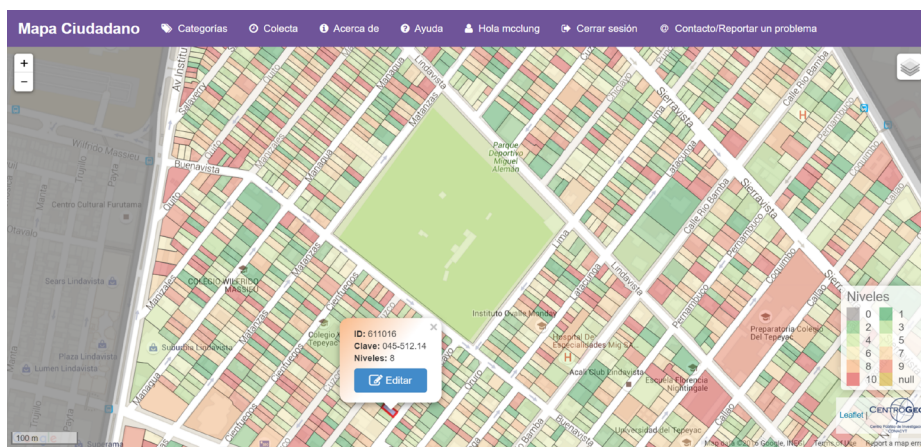


**Fig. 4.** Parcel lot data collection interface for Lindavista.

**Lessons from the Lindavista project.** In this second case, citizens' demands are more specific than in the previous one, because they want to promptly negotiate with the local authorities in specific matters. In a sense, they already have an 'agenda' and are looking into ways of supporting it with the spatial dimension from around the neighborhood. In contrast, the Roma was using collected information to build their agenda. The quality and accuracy of collected information are very important topics in VGI. With the approach presented here, users' opinions will be useful in clarifying the veracity and usefulness of reports for identification of issues, opportunities, and proposals. The inclusion of official sources of information is an important step as it provides the platform with a start, rather than building its database from scratch. This was well received by citizens, as it is useful for them and accelerates field data collection.

The spatial distribution of levels of constructions will be helpful to identify the type and characteristics of buildings that might be violating the law, as perceived by citizens. It will also serve to identify the type of land use that corresponds to those parcel lots and will help citizens provide clear examples to the authorities about what concerns them.

The number and type of variables used in this case are more concise than in the Roma. Being less subjective helps users better place their observations and provide more useful and meaningful data.

# 4    Preliminary results

The Roma project aimed at developing a platform to help citizens put points on a map and allowed them to voice their opinions and support the construction of a citizen agenda. This agenda is intended to help steer negotiations with their local authorities to improve their neighborhood. Around 200 volunteers collected little over 6 thousand data points on 41 variables inside the perimeter of the locality in about two months. Once this was completed, the citizens' organization decided to pause data collection to be able to concentrate on analyzing all the information they had collected and find out the current state of the neighborhood. Clusters of observations were useful to identify areas on the map that need attention. With the use of the dynamic generation of heat maps from these observations, citizens can display cross-correlation layers of the observed variables, useful in refining regions where different variables intersect. This supports the identification of locations, stimulates possible courses of action for the citizen agenda and helps in the generation of agreements between citizens, as they can prioritize places that need attention.

It is worth noting that citizens' analyses are not focused on individual reports for different variables, but rather in the collection of observations and perceptions of different users. It is this sense that the knowledge of the masses, the "wisdom of the crowds" and collective intelligence play an important role in the collaborative process.

The implementation of this platform was a successful endeavor in terms of citizen groups adopting it. As mentioned above, the existence of a strong social base that promotes it was essential. It would have been very difficult to bring together all the volunteers that donated their time, effort and knowledge to these projects.

Nonetheless, there were some concerns raised during data collection, as some of the variables were considered troublesome and is best to try and collect objective variables. That being said, the observations reported on the map represent users' perceptions of what happens in their neighborhood. There is always a tendency to judge what goes on in the territory. An example of this is that neighbors in the Roma strongly believed that waste accumulation was directly related with the existence of restaurants. A quick look at the heat map that compares waste accumulation and restaurants reveals that even though there are some places where they intersect, it is not the norm. The spatial intersection of variables available within the platform can help neighbors debunk certain beliefs of what goes on in the territory.

The Lindavista case is an ongoing one at the time of writing. As discussed above, the inclusion of other sources of information proved to be useful for citizens to speed up data collection. The strategy to let users vote and obtain an empirical degree of trust for users and contributions is useful, but it is in the long run when its true value will be seen, once many users have voted on several observations.

With the exception GeoKey, the reviewed platforms work with point data and none allow the possibility to collect data on parcel lots. Once data collection on levels of construction is completed, it is expected that it will either soothe citizens because there are not many deviations from the land use law, it will make evident the local government has done something wrong, or it will be a compromise where some regions are within the law and some are not. Regardless of the outcome of this comparison, this is a process that will definitely set the ground to empower citizens in this neighborhood.

The fact that the platform was not available as a native app for mobile devices may have had an impact on its appropriation by users, as the preferred method of access was on desktop systems. Initial data shows that roughly 10% of the users accessed the platform from smartphones, only 6% used tablets and 84% were on desktop systems.

## 5　　Conclusions

The platform supporting the exercises presented here not only provides the possibility to store complaints about issues, but rather boosts and supports the strong collaboration that can exist between citizens and authorities in a C2G process. It represents a way in which the population, by expressing perceptions, can be and feel more involved in what is happening around it. It also aids in the construction of citizen agendas that contain proposals that can be supported by local governments. This effectively constitutes a way in which individuals are empowered. They no longer are at the expense of the government's good will to act: they become involved. As citizens participated in different stages of the study, from the problem definition through data collection and analysis, this project fits Haklay's proposed typology of an extreme citizen science exercise [30].

These two bottom-up cases have been a substantial endeavor in terms of collaborating with the community that gave opportunities to reflect on several aspects regarding VGI and public participation together with how science and technology can relate to citizen issues and communication. They deal with how it is possible for citizens to collect geospatial information that can serve several purposes. First, it helps in the generation of data that may not be on the government's agenda; or that may in fact be, but for which no formal collection strategies have been implemented. Second, it can pose a challenge to current government structures in terms of the collection and availability of data that should be accessible through them in an open and transparent way. Third, it shows that citizen groups can be empowered by the added value that spatial data can provide them. Specifically, it can help them negotiate citizen agendas for the development of public policies with the government and their local authorities, which are routed for the improvement of the citizens' quality of life.

On the other hand, if local governments decide to follow up on those issues raised by citizens, a fruitful dialogue can be initiated between both parts in which authorities can inform back to the citizenry on the advancements on those issues that need attention. This is what Johnson and Sieber call 'citizen-to-government-to-citizen' (C2G2C) processes [12]. Authorities can also benefit from these practices by recognizing that many eyes on specific situations can be better than just their own. A long-term goal is

to have a generic platform that can be adapted and applied to heterogeneous cases that would allow its utilization in top-down social processes as well.

Further research is needed in order to understand the low percentage of access from mobile devices even though the platform is functional on these systems. Field data collection can and should take advantage of mobile devices. To reach a greater audience, it is useful to provide native mobile apps and complement them with websites. Perhaps it would be advantageous to be able to report on social networks and platforms that users are already familiar and acquainted with. Other platforms reviewed for this work already provide mobile apps and work very well, but are also specifically tailored for each particular case. A notable exception seems to be GeoKey, although a downfall seems to be its mobile counterpart, which has been adapted from a previous study and is now under development, but looks like a promising alternative.

During the final review of this paper, FixMyStreet [31] came across. It is an online service with mobile apps that allows users to report local problems in their neighborhoods. One of its most important features is that it communicates users' observations with the city council and the department in charge of overseeing specific types of reports so they can be taken care of. It is possible to deploy a local instance based on it (like several cities in different countries already have). Being a full blown participatory platform, it works best with a dedicated team of administrators, designers, developers, and data curators to keep track of reports and their evolution. It is an effort that aligns nicely with the spirit of this research and will certainly be interesting to try to merge the proposed platform with what FixMyStreet can do. One disadvantage is that it focuses on point data that somehow needs to be communicated to the authorities. This workflow implies that direct contact with the authorities has already been established since citizen reports are directed to the proper department for attention. For this research, however, such interaction with the government has not yet been established and is one of the goals. Additionally, as mentioned before, citizens are currently more interested in detecting regions that need attention, rather than taking care of specific reports.

It is also worth noting that the way the platform has been developed responds to specific requirements and demands. The social process that drives the needs of technological developments is far more important, even though there may be technological shortcomings that prevent the obtainment of better data. The proposed platform pretends to provide a way to help tackle issues and needs of social groups. This guides the platform development that is mounted on current technological trends but does not respond to an application of software developers' amusements.

Future work includes improving the data model to let users delete or edit their own reports, manage the reported number of levels of construction more efficiently, include visualizations for historical data of votes, optimize the reading of cadastral geometry into the map, and look into the strengths and weaknesses of other platforms to have better functionality.

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