



Cognitive surveillance in public spaces for epidemiological control in Ecuador

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Abstract

The COVID-19 pandemic has underscored the limitations of public health infrastructure and leadership in epidemiological containment and prevention in Ecuadorian cities. Given this problem, this study emphasizes the necessity of generating localized data to inform public decision-making, leveraging socio-technological innovations to support spatial planning processes. This article presents the design and implementation of a model aimed at risk prevention of epidemiological contagion in public spaces and social congregation areas. The model enables real-time identification of behavioral patterns associated with contagion risks, facilitates the urban spaces redesign to promote health, and supports care networks to address socio-spatial needs arising from pandemic scenarios. The research integrates theoretical and empirical advancements in epidemiological surveillance, utilizing collective intelligence mediated by disruptive technologies. We employ a mixed methods approach that combines quantitative and qualitative analyses, integrating primary data from citizen surveys and public space surveillance reports provided by the Municipality of Chone. The findings led to the development of a collaborative and anonymous surveillance software prototype featuring three core functionalities: (a) participatory surveillance by public space users, (b) assisted surveillance mechanisms, and (c) care network integration. The study advocates for governmental adoption of this cognitive model by integrating a “COVID-19 Community” function into the existing Cognitive Urban Planning web platform. This addition would enable operational training and the systematic recording of epidemiological incidents, supporting urban resilience and public health management in intermediate cities.

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Introduction

This article is part of the research project entitled “Cognitive model of community surveillance for COVID-19 epidemiological infection risks” within the call made by Giz. This call was made to finance applied research projects that contribute to responding to the pandemic caused by COVID-19 and the construction of healthy cities from the perspective of climate change, sustainable urban development and public health. The lines of action of this study are healthy and cognitive cities, the generation of local information for decision-making against COVID-19, and community epidemiological surveillance models for the control of COVID-19.

The call stated that a healthy city is a place where the development of habitat and sustainable housing must be considered integrally, promoting collective participation, mainly in search of teamwork with the different actors of society, whose intervention strengthens the exchange of knowledge and experience in relevant and essential issues that are a priority in the territory. This city is conceived as one where the risks that threaten urban health can be prevented through citizen action. Included among these risks are those that promote epidemiological infection.

This study seeks to promote citizen participation and awareness about epidemiological risks by applying a cognitive model of community surveillance of infection risks in the context of the COVID-19 pandemic. Based on this objective, the research tries to answer the following question: How can communitarian surveillance help prevent infection risks in the context of the COVID-19 pandemic? Additionally, it tries to respond to: What are the population criteria for communitarian surveillance to improve the COVID-19 pandemic? What is the procedure for applying communitarian surveillance on the territory? Moreover, How could the *Tecnologías de la Información y Comunicación* (TICs) support the communitarian surveillance process?

In this sense, developing strategies and mechanisms for community control of risks against public health, which support decision-making supported by a collaborative and inclusive planning system, with the support of systems with geographic information approaches and artificial intelligence techniques in

real-time, is presented as a viable option. It allows the application of a community surveillance model to control and prevent epidemiological risks. In this model, citizens can contribute to the identification of risk points through incident reporting processes, as well as the provision of real-time perceptions to determine a geo consensus of the population and the analysis of structured data patterns (taken from the platform, official databases), as well as unstructured ones (declared social networks).

Similarly, this cognitive prototype aspires to generate local information for public decision-making to face COVID-19. It addresses methodological innovations to ensure prosperity for cities based on access to knowledge and support for the decision-making process for land planning. In this context, the need to design a community surveillance model to control and prevent epidemiological risks was considered. With this model, citizens using the Cognitive Urban Planning (PUC) system¹ (Recalde et al., 2020) can contribute to identifying risk points through incident reporting processes and providing real-time perceptions that allow for determining a geo-consensus of the population.

On the other hand, countries with deficient public health systems and weak planning and leadership processes to take prevention and control measures in the territories have suffered the onslaught of high waves of resurgence of COVID-19. They have little chance of controlling the virus's transmissibility in public spaces and places of social gathering, where the risks are still present through new imported variants, which threaten higher rates of contagion.

Such conditions force all the society actors to find strategies to converge towards innovative ways of risk prevention to avoid the spread of new and more potent virus strains. In this way, the research processes allow us to implement the PUC conceptual framework. The PUC is a model that articulates the potential of collective intelligence, geographic information systems and cognitive systems as tools to face the city's urbanization problem, developing a new governance system to support timely and efficient decision-making based on participatory work software products in real-time (Jiménez-Pacheco et al., 2019).

In this scenario, we wonder if the urban community of Chone Canton (Ecuador) is interested in exploring a collaborative surveillance model to counteract the risks

¹ The Cognitive Urban Planning (PUC) system was born from an inter-university research project that won the INEDITA national call of the National Secretariat of Higher Education of Ecuador in 2018. It is based on a web application that promotes collaborative citizen urban planning within the framework of cognitive cities, in order to support the decision-making of local governments and face the challenges proposed by the United Nations in the New Urban Agenda.

of epidemiological infection by COVID-19. A model of community surveillance of infection risks is considered to improve the decision-making process of municipalities for the control and prevention of epidemiological risks in urban areas. Consequently, the study proposes the design of a cognitive model of community surveillance for to prevent of risks of infection by COVID-19 with application in the intermediate city of Chone, which can be replicated in urban areas of the cantons of Ecuador in cases of epidemiological outbreaks. This model made it possible to build the desired software prototype and apply it within the framework of this research project.

Social Surveillance Approach in Public Spaces in the Context of COVID-19

The expansion of COVID-19 has affected all communities to a greater or lesser degree. All countries have implemented social and public health measures to stop its spread, which include limitations on national and international travel, stay-at-home orders, and closure of public activities and facilities, among other measures. Thus, in the context of stopping some restrictions that public health authorities consider on some of these measures, solid surveillance must be established to control the spread of COVID-19 and guide the continuous application of control measures (Ibrahim, 2020).

Prevention of contagion

The goal of COVID-19 surveillance is to limit the spread of the disease, enable public health authorities to manage the risks of COVID-19, and allow social and economic activities to resume as long as possible. States, in coordination with World Health Organization (WHO) recommendations, should also undertake surveillance action to monitor long-term trends in COVID-19 transmission and virus changes.

Countries such as New Zealand, Cuba and Australia, which have successfully overcome the processes of resilience to the ravages of COVID-19, showed good performance based on the capacity of the political leadership to face and contain the effects of the pandemic in their countries (Beldarraín Chaple & Gillies-Lekakis, 2020). However, this meant taking drastic measures of social distancing, closing borders and isolating cities, provinces, and states; carrying out large diagnostic campaigns (tests) in the population at risk; as well as the existence of public and accessible health systems, which were able to respond to the care needs of the affected population. Vietnam, China and Singapore also obtained flattering results for containing COVID-19

deaths per million inhabitants (0.5, 3 and 5 respectively). In addition, its surveillance strategies have been its best allies in the fight against the virus (Worldometer, 2021).

Ibrahim (2020) provides an overview of surveillance strategies that states should consider as part of the integral national surveillance of COVID-19. This research emphasizes the need to adapt and strengthen existing national systems where appropriate and to expand surveillance capabilities as needed. Their study is based on the WHO guidance document on global surveillance of human infection by COVID-19 (World Health Organization [WHO], 2020). This document establishes that the national surveillance strategies of the member countries must provide sufficient capacity to inform the WHO about the global surveillance of COVID-19.

Ibrahim (2020) provides a comprehensive classification of surveillance types, from routine to active and passive. In addition, it expresses the importance of helplines, surveys, and participatory surveillance through electronic or digital surveillance. Given the difficulty of containment, the author proposes the need for new surveillance trends for undetected COVID-19 cases to combat new transmission chains.

For the Ministry of Public Health of Ecuador (MSP by its initials in Spanish), epidemiological surveillance is a fundamental process for public health and improvement in the response of health services. It constitutes the second essential function of public health since it is a tool that allows for the collection, consolidation, analysis, and dissemination of strategic information for decision-making on various events of epidemiological and public health interest. Thus, epidemiological surveillance provides the basic materials for designing and applying intervention measures, offering a scope to deepen and update prevention and control actions (Subsecretaría Nacional de Vigilancia Epidemiológica, 2020). In this regard, the MSP has developed the Integrated Epidemiological Surveillance System in two areas:

- Indicator-based surveillance: consists of the systematic collection of information, analysis and interpretation of structured data from surveillance systems.
- Event-based surveillance: consists of capturing, filtering and verifying information on events that may have an impact on public health, coming from different official and unofficial sources.

The institutional role in public spaces

Evidence in early 2021 showed that pre-COVID-19 rules on physical distancing were based on outdated science. Since the distribution of viral particles depends on many factors, including airflow, in this way,

it is suggested that SARS-CoV-2 can travel more than 2 meters through actions such as coughing and screaming. Therefore, the rules on distancing must reflect the multiple factors that affect this risk, such as ventilation, occupancy and exposure time, both in open and closed places, without neglecting that the transmissibility of the virus in outdoor spaces and places of congregation is closely linked to the quality of ventilation, the length of stay, the use of a mask, physical distancing and the type of activity that is carried out (Jones et al., 2020).

This situation has allowed many Latin American states to decide to implement drastic control over the use and occupation of public space, generating a scenario of excessive surveillance, although insufficient in the fight against the pandemic in the territories. In Latin America, the limited quality of public spaces in lower-income neighborhoods is aggravated by the lack of security, as criminal groups have taken functional control of these spaces. In Ecuador, Chile, Bolivia and Peru, the pandemic has led authorities to reassert control of the streets to enforce quarantine and restrict movement, making these spaces safer for health personnel or essential services but unusable for the general public (Honey-Rosés et al., 2020). This condition creates a powerful precedent, and public opinion is divided on how much police state we are willing to accept in exchange for safer cities based on institutionalized surveillance, aggravating the levels of segregation and fragmentation of the Latin American city.

A mixed system of institutional and citizen responsibility has been chosen in other geographies. Such is the case in Vietnam, where a neighborhood watch plan has been implemented. In this country, which a single party governs, political conditions have aligned the military and institutional services with the efforts of organized groups in society. In the state reports, the surveillance culture is revealed as a key factor that helps explain the neighbors' disposition as informants of non-compliance with health regulations. It is thought that this approach could hardly work in more open societies, but the importance of adequate health policies supported by citizen surveillance systems in countries with limited hospital resources is affirmed (Ebbighausen, 2020; Fleming, 2020). This reality is replicated in countries like Cuba or Thailand, where, in the absence of last-generation technology, the dense network of neighborhood committees, police and neighborhood guards go to the residences of those infected to monitor their evolution and warn of possible suspected cases (Arana, 2020).

Keys to community surveillance to prevent epidemiological contagion in public spaces

Ibrahim (2020) makes several recommendations regarding improving epidemiological surveillance that allows a safe return to urban life, considering long-term trends and changes in the virus. Among various adoption measures, it suggests that more training is needed for official and voluntary surveillance. This should result in the implementation of technological practices through active surveillance, with innovative methods for data collection and collaborative tasks that add value to the control of the pandemic. It is cautioned, however, that the design of surveillance systems must be appropriate for each country.

The World Health Organization guide (WHO, 2020) highlights the importance of community individuals and their role in COVID-19 surveillance. When people cannot access care tests in a primary health network, community-based surveillance can help identify clusters of infected people and monitor and report health events to local authorities. Thus, participation in tracking infections and cluster identification are other vital ways individuals and communities contribute to COVID-19 surveillance.

In this sense, the WHO incorporates participatory surveillance of diseases so that citizens can self-report the signs or symptoms of the disease without the need to resort to a laboratory or to an evaluation by a health care provider. Disease participatory surveillance is based on voluntary reporting and is often facilitated through specific smartphone applications. Data collected from participatory surveillance may also provide clues of changes in health-seeking behavior. Consequently, health organizations worldwide agree that it is essential to ensure that prevention strategies for COVID-19 are implemented in urban areas where the risks of infection are not adequately monitored for prevention purposes and study of epidemiological transmission patterns.

So, while we may be at the beginning of a new era for digital and electronic surveillance, are we prepared to handle the current challenges of COVID-19 and, at the same time, to make real the potential of the new technology of the future? Under the geospatial technology approach, Sameer (2020) recounts the development of various smartphone applications during the COVID-19 pandemic, some of which use location for proximity, and others that do not use location services of the mobile device to preserve privacy.

Attention should be paid to the fine line where institutional epidemiological surveillance systems sit, where violations of users' civil liberties are likely to be experienced (Fleming, 2020). Fleming's study (2020) reveals the risk of social segregation and fragmentation

in structuring new urban spaces based on intelligent surveillance. Critics of these technologies cite data filtration, false positives, privacy violations, harassment towards disease carriers, and, ultimately, misuse of data by authorities. Here, the challenge arises of configuring a predominantly community surveillance model that provides certainty of health care but also facilitates processes of solidarity and mutual support; that is, software for collective work and practical purposes of service among community citizens.

Social participation in affected areas

For community participation in the face of COVID-19, Navarro Machado et al. (2020) show a descriptive study in the Municipality of Cumanayagua, Cuba, in which 627 people participated in the Active Population Screening Process (APSP-COVID). Active screening is the action that seeks to diagnose individual health status in population groups to establish existing risk factors and discover hidden morbidity early. It is a tool that facilitates the detection of relevant diseases in the epidemiological profile. In this framework, the statistics generated by the APSP-COVID were centralized in the Statistics Department Direction of the municipality, from where the information was officially disseminated.

Pola García et al. (2020) show that addressing community participation and communication during a pandemic is not easy. Therefore, each territory must develop its approach based on the strengths, capacities, health assets and weaknesses of its context and reality, assuming the need for collaborative spaces to manage the common problem of the socio-health crisis. This will allow the identification of needs in various dimensions: information transmission, monitoring of needs, emotional support, care, coverage of basic needs, identification of vulnerable people and groups, identification of resources and assets for health and well-being, prevention, and others.

Following this idea, the Ministry of Health, Government of Spain (2020) points out that community networks are collaborative structures to manage property or common problems around the socio-sanitary crisis caused by COVID-19 in a given territory. These networks can comprise citizens, administrations, professionals, or technical personnel, possibly contributing sectoral potentialities that are complementary to reaching the entire population efficiently and forcefully. In this sense, for the construction of our cognitive model, the structure of actors from the Spanish network has been reconciled within a community network with local relevance due to its role and function (Table 1).

Table 1 Functions by role of actors at the local level

Role	Function
Community leader	Assuming your responsibility as a protagonist of the community well-being of those you represent. Identifying vulnerable people and groups, as well as barriers to access to information or approved measures. Paying attention to digital and language gaps. Tracking needs in a changing context. Transmitting information (health protection and promotion measures, local epidemiological situation, resources or assets in the community, get off false news, protect against stigma, etc.). Coordinating coverage of basic needs. Coordinating care (for children, elderly, sick, people with functional diversity, caregivers, both family and paid, etc.). Seeking measures to prevent infection, detect cases and contacts, care, quarantine support, and provide treatment.
Citizenship	Knowing and detecting needs and resources. Being trusted interlocutors. Participating according to the ability to mobilize own resources. Looking for associations to mobilize own resources, professionals, volunteers, communication channels. Identifying and accessing the most vulnerable population.
Professionals and technicians	Maintaining direct relationship with citizens. Facilitating the implementation of various measures. Acting as transmitters of trust between institutions, citizens and vice versa. Ensuring continuity and closeness to the population. Providing emotional accompaniment.
Administration (counterpart of the project)	Developing measures in the face of new contexts of need. Guaranteeing measures to protect citizens and volunteers. Providing information on preventive measures. Coordinating services. Mobilizing or redistributing resources. Identifying resources, assets for health and well-being (support groups, associations, volunteers, neighborhood networks, collaborating establishments, socio-health services, etc.).

Methodology

The methodological design is part of the applied research processes through a pluralism that holistically addresses the research object. The work perspective establishes, in the first place, the look at the theoretical and empirical advances in the processes of epidemiological surveillance in the public space from collective intelligence. From here, it is based on the mixed quantitative and qualitative analysis of the information collection that includes primary and secondary sources of information: territorial planning instruments, citizen surveys and control reports of the public space of the Gobierno Autónomo Descentralizado Municipal de Chone (GADM-Chone, 2015). The deepest qualitative phase involves the participation of the relevant actors of the community in the urban space of Chone through action-participatory research techniques (Stolterman & Wiberg, 2010), carried out in the territory and channeled through physical and virtual means (Figure 1).

Characterization of Territorial Management for COVID-19

The canton of Chone (Ecuador) is part of the province of Manabí and is located to the northwest of the Ecuadorian territory in the coastal region. It has a population of 126,491 settled in an area of 3,570 km². The urban parishes Chone and Santa Rita show a population increase of around 9.12 percent, measured in 2010. In general, most of the population is concentrated in areas where essential services, education, and health infrastructure are available, preferably in proximity and good accessibility. Therefore, the population concentration in the Chone canton is in the south-central sector of the Chone central parish.

According to the Municipal GADM-Chone (2015), the coverage of public health services is concentrated mainly in the Chone cantonal capital, where the cantonal hospital is located and where the residents of other parishes of the canton go. However, for those who live in the parishes of Convento and Chibunga, accessibility

to the hospital is almost zero since the distance is around three hours by car. For this reason, sometimes, they prefer to go to the province of Santo Domingo. There are several health facility projects planned and others under construction.

Currently, in the context of municipal regulation and control of events in the public space in the period of the COVID-19 pandemic, the GADM-Chone, through its control instances, reports operations for the following factors in frequency order:

- Control of drinkers and consumers in public spaces.
- Control of capacity in public establishments (crowds).
- Control of biosecurity standards (use of a mask, physical distancing, use of alcohol or disinfectant gel).
- Misuse of public spaces (informal vendors, sales and free movement at times and places not allowed).
- Citizen Security (thefts, fights).

Data Collection of the Urban Population of Chone

Socio-spatial information was collected in the urban parishes of Chone through a semi-structured survey. This survey made it possible to diagnose the cognitive context of epidemiological surveillance through the identification of the community's perceptions and the definition of key actors for experimentation with the prototype. The aim is to determine the characteristics of the surveillance model for a technological tool that contributes to preventing infection risks of the pandemic in the public space.

Target population: citizens over 16 years old from the urban parishes of Chone (Chone and Santa Rita). The total number of voters established in those two urban parishes who attended the electoral process of February 2021 elections were taken as a reference to obtain the sample (Table 2).

Table 2 Sample of the study population by parish

Urban Parish	Voting population	Percentage	Sample (# surveys)
Chone	54,896	78	299
Santa Rita	15,860	22	84
Total	70,756	100	383

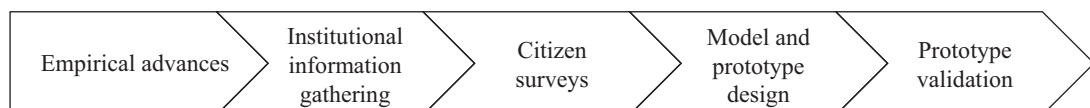


Figure 1 General research process

To obtain the sample, the following mathematical expression was applied:

$$\text{Sample size} = \frac{\frac{z^2 \times p \times (1-p)}{e^2}}{1 + \left(\frac{z^2 \times p \times (1-p)}{e^2 N} \right)}$$

Where:

N = Population size (70,756 inhabitants)

e = Error range (5%)

z = Confidence level ($z = 1,96$)

Thus, with a margin of error of 5 percent, the total sample is 383 surveys. Table 2 shows the equivalent percentage of the study population adjusted with the corresponding sample by parish.

Collection and processing methods: The applied methodology was face-to-face in the study parishes, and it was developed through interviews with the community. The survey involved collecting data using the Pencil And Paper Interviews (PAPI) method and processing it through the Google Forms platform. The data were exported to Excel sheets for graphing. From the processed data, an intentional sample of community leaders and representatives who participated in the validation of the prototype was identified.

The collection of information in the field took place continuously from Sunday 7 to Wednesday 10 of February, 2021. This was during the time of compulsory attendance to vote in the first round of presidential elections in Ecuador. Participation was voluntary, without offering any type of incentive to the surveyed citizens. The processing of the data was carried out by using descriptive statistics techniques.

Prototype Validation Process

The methodological design is completed with the validation phase of the software prototype in the territory through collaborative workshops with citizens who expressed their willingness to collaborate as community vigilantes in the survey phase. The workshops were held in May 2021. Once a focus group made the required adjustments for volunteer security guards in the workshops, the prototype was implemented as a mobile application interconnected with the PUC system (<https://puc.ec/>).

Results

The surveyed population was mainly between 16 and 38 years old, with 48 percent of men and 50 percent of women participating. The three main occupations declared were dealer, housewife, and student. The family group of the respondents was concentrated between 3 and 5 members. These families reside mainly in the urban neighborhoods of San Cayetano and Santa Rita in the Chone canton.

The most relevant perception results indicated that a percentage of 43 percent of the population of Chone consider that the COE is not efficient in controlling the epidemiological infection, in contrast to 57 percent who think that it is efficient. In this sense, 90 percent of the population sample believes it is necessary to implement new community surveillance mechanisms. Regarding the perception of public places and places of social encounter with the greatest probability of epidemiological infection, the surveyed population indicated that the places of mass supply, public transport, squares or parks, streets and urban services are the spaces with the greatest risk.

Regarding the wishes of the population, 86 percent would agree with anonymously alerting the control authorities about potential risks of epidemiological infection in public spaces; 81 percent with anonymously alerting another citizen of this situation. It is identified that 42 percent show interest in participating as a volunteer in the prevention of infection risks in public spaces; and another 48 percent express interest in participating through a mobile application in the control of infection risks in their neighborhoods. In addition, 92 percent of the urban population reports having at least one smart mobile phone device.

It is important to point out that the survey was used to identify an intentional population sample of eight watchers and community leaders, who were strategic collaborators in the validation of the model and experimentation with the software prototype.

Community Surveillance Model for Public Spaces on Epidemiological Contagion Alert

Epidemiological surveillance includes the systematic and continuous collection, analysis, interpretation and dissemination of data related to a health event to take regulatory and preventive actions. Surveillance is a fundamental part of public health practice. Real-time analyses of epidemiological data are urgently needed to raise awareness of the problem and to carry out rapid

interventions. Identifying the risks of transmission in the public space, as well as new suspected cases, will be essential for the effectiveness of public health interventions and for preventing the pandemic spread (Ibrahim, 2020). Therefore, surveillance of COVID-19 in the public space implies developing an alert system to prevent the spread of the disease, identify and monitor patterns of risk behaviors and apply targeted prevention and control measures. Likewise, the pandemic has strongly impacted social ties, with material and subjective consequences produced by urgent socio-spatial needs. In this sense, activating networks of caring for the other is required to counteract the symptoms that reproduce social inequality from the incentive of cooperative and mutual solidarity practices in the urban environment (Gallo-Acosta, 2020).

Model design

The epidemiological surveillance model is based on the systems that reinforce the cognitive human factor (Thagard, 2016); it studies the information obtained from the GADM-Chone on the municipal control of activities by COVID-19, as well as the survey results to the citizens. The technical sheet of the cognitive model (Table 3) is established from the perception of citizen desire about the spaces of most significant risk, the preferred channels for reporting risk alerts, and their willingness to report risk threats anonymously to the authorities and other citizens in the environment.

Roles assigned to the citizen

- Public space User. – Ordinary citizen who is carrying out activities in places characterized as public and social gathering spaces (streets, squares, parks, public transport, public facilities, leisure services, etc.).

- Community watcher. – Citizen interested in monitoring a sector or neighborhood, through a flexible tour of the public space, generating alerts for public institutions, as well as validating the registry of care services related to social needs due to the pandemic. In addition, the community guard must validate and register the care services of his monitoring sector (Figure 2).
- Care server. – Individuals or groups that provide health care services, social care, and distribution of food and supplies related with health and alike, to cover social needs in the pandemic situation.
- Care seeker. – People who face a social need in their homes due to the pandemic crisis.

Functions of the cognitive model

- Participatory surveillance. – Control of epidemiological risk in the use and occupation of public spaces and places of social gathering through anonymous alerts reported en masse on nearby devices of other users about improper health behavior, using a text channel (Figure 2).
- Assisted surveillance. – Control of epidemiological risk in the use and occupation of public space and social gathering places through anonymous alerts reported promptly to instances of institutional control about a specific sanitary incompleteness, using text, voice and image channels (Figure 2).
- Activation of a care network. – Creation of a bank of care services through the validation and registration of services to meet the social needs arising from the pandemic crisis, to find solutions based on solidarity and non-monetary exchange and to develop a culture of mutual support (Figure 2).

Table 3 Data sheet of the cognitive model

Cognitive strategies	• To prevent risks of epidemiological infection in public spaces • To identify behavioral patterns of risk of epidemiological transmission in the public space for the design of healthy and resilient cities • To promote the development of networks for care and mutual support in the face of socio-spatial needs due to epidemiological events	
Territorial application	Urban parishes of the Chone canton (Chone, Main Canton, and Santa Rita)	
Principal actor	Citizen who carries out activities in public space	
Roles	Main	• Public space user • Community watcher
	Secondary	• Care server • Care seeker
Functions	• Participatory surveillance • Assisted surveillance • Activation of the care network	

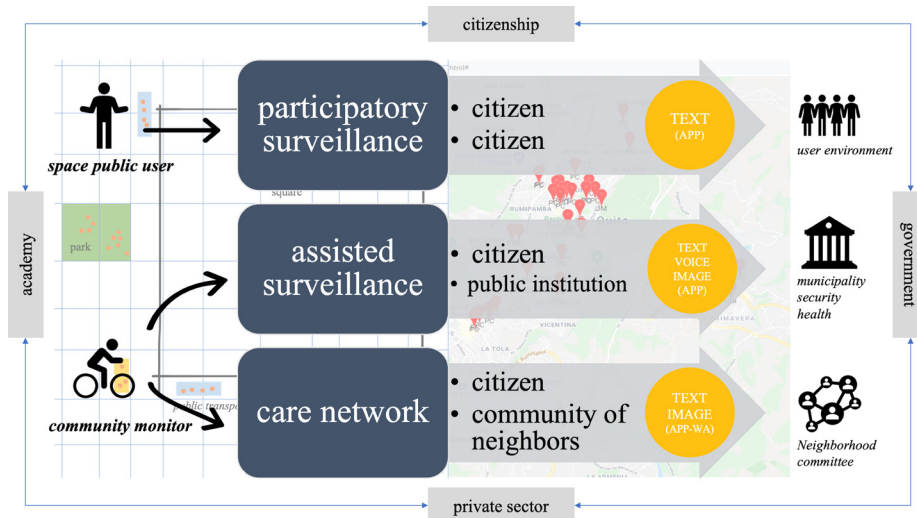


Figure 2 Diagram of the model of community surveillance in public spaces

Regarding the experimentation processes in the territory, it is recommended that the promoter of participation in these processes be the community watcher in the figure of the self-identified community leaders and representatives. The community watcher must access a group of people previously willing to

collaborate in the prevention of risks by COVID-19 and who are preferably located in the same sector or neighborhood of residence (Figure 3). Similarly, Table 4 summarizes the processes by each actor, which will be represented in the software prototype.

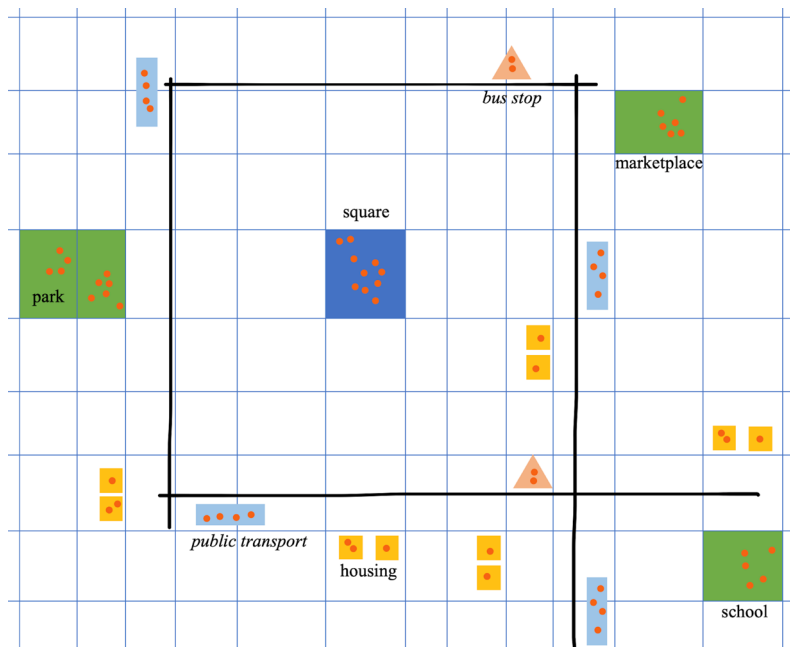


Figure 3 Typology of public sites where the community watcher works

Table 4 Cognitive actions carried out by each actor

Role	Function	Type of alerts	Transmitter	Receivers	Channel
Public space user	Participatory surveillance	- Physical distancing. - Improper use of mask. - Not wearing a mask.	Citizen user of the public space.	Users of the application who are within a radius of 50 meters.	Text (APP)
Community watcher	Assisted Surveillance	- Capacity of squares and parks, premises and public transport. - Biosafety standards in premises and events.	Community watcher	- UPC - ECU 911 - GAD Chone	Text Voice and image (APP)
	Activation of a care network	Validation and registration of care services associated with the pandemic crisis.	Community watcher	Users of the application within the surveillance perimeter.	Text (APP)

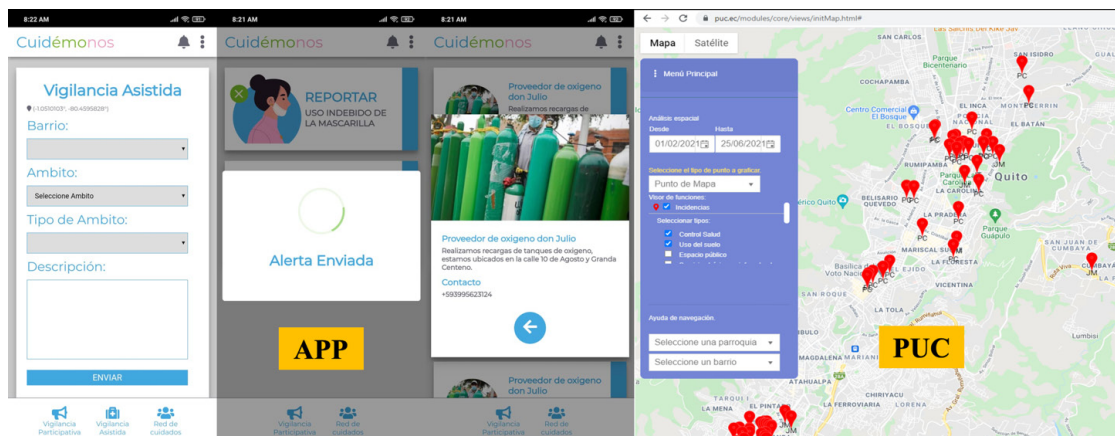
Validation and experimentation of cognitive model in Chone

A group of volunteer community watchers was established (Table 5) to operate the prototype within a strategic circuit that enables a flexible route in an assigned urban sector. It allowed linking various points of interest (market, plaza, bus station, school, etc.). Care centres, restaurants, etc.) within the framework of the epidemiological risks present in the territory and the

functions pre-established in the model. The residential influence of the watcher was used as a surveillance area. The experimentation of the prototype was based on the information provided by the COVID-19 control instances of the canton. The adjusted prototype was translated through the development of the mobile application entitled “Cuidémonos”, which is monitored by the PUC platform (Figure 4).

Table 5 Identified volunteer community watchers

Names and Last names	Parish	Neighborhood sector	Position in the neighborhood board
Miguel Alejandro Moreira Barreto	Santa Rita	Parque las Madres	Treasurer, inhabitant
Silva Vera	Boyacá	Boyacá	President
Santos Romero Edison Daniel	Chone	Naranjo 2	President
Fanny Caicedo	Chone	—	President
Galo Hidalgo	Chone	Cauca	President
Carlos Enrique Salaborria Navarrete	Chone	Calle 14 de Agosto	Member
Solorzano Cedeño Lito	Santa Rita	Los Sauces	President
José Cedeño	Chone	—	Member

**Figure 4** Interfaces Cuidémonos App and PUC web platform

Discussion

The results obtained and the validation in the territory show some insight into the significance of community surveillance, which could improve to reduce territory risk; in the next paragraphs, this research discusses the theoretical and empirical evidence that show the positive effects of combining community surveillance with the TICs. In this sense, Ibrahim (2020), and Worldometer (2021), agree when they mention that in the context of stopping some restrictions that public health authorities consider on some of these measures, it is essential that solid surveillance be established to control the spread of COVID-19 and guide the continuous application of control measures. This research confirms the ideas posed by the authors since, with the Chone populations, 90 percent of the population believes it is necessary to implement new community surveillance mechanisms; these mechanisms have to cover places of mass supply, public transport, squares or parks, streets, and urban services are the spaces with the most significant risk. Such also agrees Jones et al. (2020).

The World Health Organization guide (WHO, 2020) and Ibrahim (2020) highlight the importance of individuals in the community and the role they can play in COVID-19 surveillance and the implementation of technological practices through the application of active surveillance, with the use of innovative methods for data collection and collaborative tasks that add value in the control of the pandemic; moreover, Sameer (2020) recounts the development of various applications for smartphones in the COVID-19 pandemic, some of which use location for proximity and others that do not use location services of the mobile device in order to preserve privacy. Based on these experiences and the territory diagnosis, the epidemiological surveillance model is based on the systems that reinforce the cognitive human factor; the technical sheet of the cognitive was established from the perception of citizen desire about the spaces of most significant risk; the preferred channels for reporting risk alerts; and their willingness to report risk threats anonymously both to the authorities and to other citizens in the environment (see section 5.1. Model Design).

Navarro Machado et al. (2020) conducted a descriptive study in the Municipality of Cumanayagua, Cuba, where 627 people participated in the Active Population Screening Process (APSP-COVID). In section 5.4, Validation and experimentation of cognitive model in

Chone, the proposed model was appropriately adjusted to the cantonal reality of an intermediate city with the capacity to replicate at the national level. In this context, the challenges of preventing epidemiological infection in the public space are met through the designed prototype to contribute to the public health system and alleviate the institutional burden of epidemiological risk prevention. In turn, the experimentation phase confirmed the initiative of social participation in adherence to the desire for collaboration and mutual help.

Conclusion

Within the framework of the Cognitive Urban Planning software application, the incorporation of this model is recommended as a function called “COVID-19 Community”, from the conceptual category of participation in the co-creation of the city. The work software tools must allow the autonomous development of the two main roles through the execution of the three assigned functions: “participatory surveillance”, “assisted surveillance” and “care network”. The participation of the role of “public space user” must be open without any registration, while the participation of “community watcher” will imply to get out in a timely manner.

It is planned to develop future experiments under the patronage of the government and the academy, with the purpose of training the application and capturing incidences of infection in the public space. This will contribute to the construction of healthy cities, tending to improve the epidemiological control with reports in real time over the territory and monitored from the Cognitive Urban Planning platform.

The opportunities of this cognitive surveillance prototype are encouraging due to its practical and intuitive processes. In the future, municipalities of intermediate cities must be responsible for rebuilding the social fabric in neighborhoods since trust and collaboration between neighbors are the raw material for the application’s usability. Finally, urban planning must recognize the importance of technology incorporating collaborative practices to develop participation processes supported by cognitive intelligence and geographic information systems.

Conflict of Interest

The authors declare that there is no conflict of interest.

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