IET Smart Cities

Review Article

IET Journals
The Institution of Engineering and Technology

Mobile crowdsensing approaches to address the COVID-19 pandemic in Spain

eISSN 2631-7680
Received on 1st May 2020
Revised 16th May 2020
Accepted on 28th May 2020
doi: 10.1049/iet-smc.2020.0037
www.ietdl.org

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Abstract: Mobile crowdsensing (MCS) is a technique where people with computing and sensing devices such as smartphones collectively share data that are of potential interest to the rest of society. MCS includes two different trends (i) mobile sensing, which shares raw data generated from the sensors that are embedded in mobile devices, and (ii) social sensing, which uses the information shared by people in online social networks (OSNs). In this study, the authors present the timeline evolution of the COVID-19 pandemic in Spain, and summarise the MCS research efforts that are being undertaken by the Spanish community to address COVID-19 outbreak. Indeed, the COVID-19 pandemic is putting today's society at risk; lockdown and social distancing measures proposed by governments are dramatically affecting economies. In this regard, MCS tools can become a powerful solution to provide smart quarantine strategies in periods of a steep decrease of infections, or new outbreaks.

1 Introduction

The World Health Organization (WHO) first warned on 12 January 2020 about that a new Coronavirus outbreak was the cause of respiratory diseases in a group of people in the city of Wuhan, Hubei Province, China. According to the WHO, the evidence was highly suggestive that the outbreak was associated with exposures in one seafood market in Wuhan. The market was closed on 1 January 2020. At this stage, there was no infection among healthcare workers, and no clear evidence of human-to-human transmission [https://www.who.int/csr/don/12-january-2020-novel-coronavirus-china/en/. As of 21 April 2020, the COVID-19 pandemic has caused 2,314,621 detected cases globally, and has claimed more than 157,847 lives worldwide [1]. For the time being, Spain is the second most affected country in the world, with up to 204,178 total cases of infection, and a total of 21,282 deaths, only behind the United States [2]. The experience of all affected countries shows that the COVID-19 can even exceed the capacities of all health systems, including those with the most resources [3, 4]. In the absence of specific vaccines or medications, state interventions have focused on contact tracing, quarantine, and social distancing. The intensity, duration, and urgency required of these responses will depend on both the way the initial pandemic wave develops, and the subsequent transmission dynamics of SARS-CoV-2 [5].

The majority of affected countries have adopted social distancing measures in the first pandemic phase, which have been worsened by the increasing trend in the number of people infected and died. Some countries, such as China, are gradually lifting these measures after achieving adequate transmission control, but, still, it is estimated that prolonged or intermittent periods of social distancing may be required to avoid the possibility of re-infection. The socioeconomic effects of these measures are incalculable. International organisations such as the International Labour Organization (ILO) of the United Nations (UN) [6], and UNICEF [https://www.unicef.org/ethiopia/reports/socio-economic-impacts-covid-19] have warned about the risks to peace and social cohesion, in particular for fragile environments.

Under this dramatic scenario, smart city technologies are a good alternative to ensure the success of quarantine periods, and to provide smart approaches that do not cripple the economy. Of particular interest to us are mobile crowdsensing (MCS) approaches. MCS is a recent research trend based on data collection from a large number of sensing devices [7]. In comparison with traditional physical or hard sensors, MCS is inexpensive, since there is no need for network deployment, and its spatio-temporal coverage is outstanding. Two different approaches of MCS have been distinguished; they are (i) mobile sensing, which leverages raw data generated from the hardware sensors that are embedded in mobile devices (e.g. accelerometer, GPS, network connectivity, camera, or microphone, among others); and (ii) social sensing (or social networking), which leverages user-contributed data from OSN. The latter considers participants as 'social sensors', i.e. agents that provide information about their environment through social-media services after the interaction with other agents. Doran *et al.* [8] highlighted that social sensor might serve as a complementary or alternative source to physical sensors. Although physical sensors can identify what has happened, social sensors can provide an explanation of why or how specific events may happen. Moreover, social sensors can be deemed to be an alternative source in case of physical sensors' malfunctioning, or when a sensor network cannot be afforded.

In this paper, we present the timeline evolution of the COVID-19 pandemic in Spain, and the MCS research projects and technologies that are being developed in Spain to address the effects of containment measures imposed to deal with the COVID-19 outbreak, and to enable epidemiological surveillance. As stated in [5], intermittent social distancing is likely to be required until 2022, unless critical care capacity is increased substantially, or treatment or vaccine becomes available. Moreover, epidemiological surveillance should be maintained in the coming years to anticipate the possibility of resurgence.

The remaining of the paper is structured as follows. Section 2 shows the situation in Spain of the COVID-19 outbreak, and the main measures adopted by the Spanish Government. Then, the main MCS projects and technologies are briefly described before providing a discussion of the impact of these projects. The main findings are then discussed. Finally, we present the main conclusions of this work.

2 Status quo in Spain

2.1 Timeline evolution of the COVID-19 pandemic in Spain

This section briefly summarises the timeline evolution of the COVID-19 in Spain. The first confirmed cases in the country were tagged as 'imported cases', belonging to tourists from areas where a large number of COVID-19 cases have already been detected, such as Italy. The first case was officially identified on 31 January 2020, in La Gomera (Canary Islands). Nine days later, another case

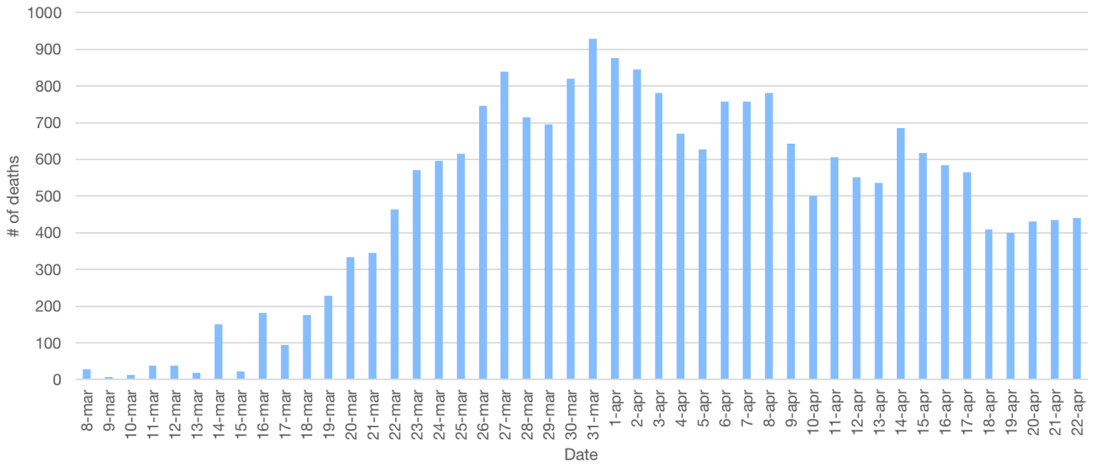

Fig. 1 *Death toll in Spain (source: Spanish Ministry of Health)*

was identified in Palma de Mallorca (Balearic Islands). She/he was also a tourist who was infected in France. On 24 February, after an outbreak of COVID-19 in Italy, a doctor and his wife from Lombardy (Italy) tested positive. They were on holiday at the H10 Costa Adeje Palace hotel, which was put on lockdown with more than 1000 guests and workers there [https://www.theguardian.com/world/2020/feb/25/tenerife-coronavirus-guests-hotel-quarantined]. On 25 February, four new cases were notified, all of them related to Italy. They include people in Barcelona, Madrid, and Villarreal (Valencia). Moreover, several soccer players from the Valencia F.C. also tested positive after returning from a UEFA Champions League match against Italian soccer team Atalanta. About one-third of Bergamo's population is known to have attended to this match.

The first death in Spain was registered in Valencia on 13 February 2020. He was a 69-year-old man who had been in Nepal and was diagnosed post-mortem. By 13 March, several cases have been registered in all 50 provinces of the country. On 14 March, a state of alarm and lockdown was imposed throughout the national territory governed by law RD 463/2020. This law defined a new delegated competent authority chaired by the Minister of Health, and composed of the Minister of the Home Office, the Minister of Transport, Mobility and Urban Agenda, and the Minister of Defence. The limitations imposed included: (i) limitation to the freedom of movement of persons; (ii) temporary requirements and mandatory personal benefits; (iii) containment measures in the field of education and training; (iv) containment measures in the field of commercial activity, cultural facilities, recreational establishments and activities, hotel and restaurant activities, and other additional ones; (v) containment measures in relation to places of worship and civil and religious ceremonies; (vi) measures to strengthen the National Health System throughout the country; (vii) measures to ensure the supply of goods and services necessary for the protection of public health; (viii) measures in the field of transportation; (ix) measures to ensure food supply; (x) measures to ensure customs transit; (xi) guarantee of supply of electrical energy, petroleum products, and natural gas; (xii) critical operators of essential services; (12) public and private-owned media. These measures were extended on 28 March. All activities were halted unless they provided an essential service. The involved workers passed into a recoverable paid leave, or worked remotely, or had their contracts suspended.

Fig. 1 shows the number of deaths in Spain as officially reported by the Spanish health department on 22 April. It looks like the coronavirus infections have peaked in Spain, and also in the rest of the rich world [https://www.economist.com/graphic-detail/2020/04/17/coronavirus-infections-have-peaked-in-much-of-the-rich-world]. In the particular case of Spain, the peak of deaths took place on 31 March, with a death toll of up to 929 people in the same day. Nowadays, the death toll is 22,157 as of 22 April, with the total number of cases reaching up to 213,024. The number of deaths per million is of 4556, and the number of active cases (i.e. the number of people infected) is of 100,757.

2.2 Research innovations and funding

On January, the EU (European Union) initially mobilised EUR 10 million for research into the new outbreak of Coronavirus, which has so far funded 18 new research projects for a total amount of EUR 48.5 million [https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/covid-19]. These projects include mechanisms to improve epidemiology, and public health, including preparedness and response to outbreaks, the design of rapid point-of-care diagnostic tests, the development of new treatments by accelerating those currently in the pipeline, and secondly, screening and identifying molecules that could work against the virus, using advanced modelling and computing techniques, and finally, the development of new vaccines.

The Spanish Government has also mobilised a total budget of up to EUR 24 million through the *Instituto de Salud Carlos III* (ISCIII) [https://eng.isciii.es/eng.isciii.es/Paginas/Inicio.html]. The scope of these proposals included (a) SARS-CoV-2 rapid virological diagnostic techniques, industrially scalable and applicable to healthcare; (b) clinical-biological-molecular characterisation of the COVID-19 disease, stages, prognostic stratification and complications; (c) development of innovative therapies, new antiviral, antiseptic and disinfectant molecules against SARS-CoV-2; (d) characterisation of the SARS-CoV-2 virus, knowledge of the genetic and antigenic variations of SARS-CoV-2, as well as the immune response to SARS-CoV-2 virus and virus–host interaction; (e) vaccine development, effectiveness and applicability; (f) epidemiological surveillance of SARS-CoV-2 and molecular epidemiology; (g) socioeconomic impact of the COVID-19 disease; and, (h) artificial intelligence and mass analysis of integrated data aimed at the epidemiological control of the COVID-19 disease.

Some private organisations in Spain have also mobilised some resources for research in this area. Particularly, we would like to highlight 'La Caixa' foundation through the CaixaImpulse COVID-19 Call for projects that address the COVID-19 emergency [https://caixaimpulse.com/]. Moreover, the Association of Spanish Universities (CRUE), Banco Santander and CSIC (*Consejo Superior de Investigaciones Científicas* – Spanish National Research Council) has launched the *FONDO SUPERA COVID-19* with up to EUR 8.5 million. The call defines three priority funding lines: applied research to the COVID-19, social impact and profitability projects, and strengthening the ICT capacity of the Spanish Universities.

3 MCS projects and technologies

In this scenario, information technologies are called upon to help authorities to deal efficiently with the containment measures of the pandemic. These measures include (but are not limited to) enforcing lockdown, maintaining social distancing, and ensuring basic supplies of food and medicine, just to name a few. In what follows, we briefly summarise the main efforts that are being developed in Spain within the area of MCS, with a particular

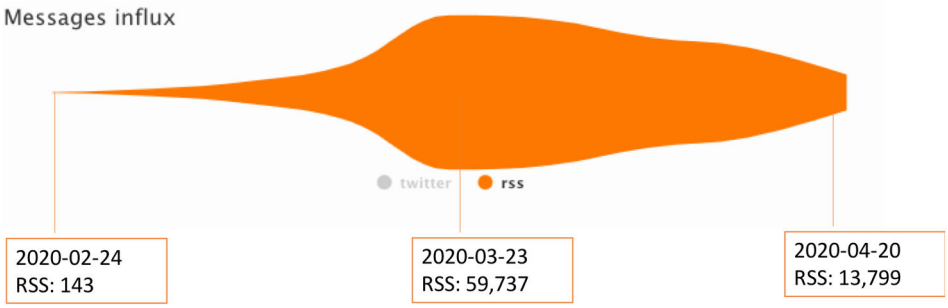

Fig. 2 *Number of RSS messages published in Spanish media since 2020/02/24 until 2020/04/20*

Fig. 3 *Geographic scope of coronavirus news in Spanish news*

emphasis on those that have been supported or applied to the research calls previously summarised in Section 2.2.

3.1 Enforcing lockdown

One of the most critical measures taken by governments worldwide is the declaration of quarantine status. This involves confining the population to their homes to prevent the transmission of the virus. This is a drastic and draconian measure that involves the police and even the army reporting people who do not strictly respect confinement. However, the resources to maintain public order in this regard are limited, considering that the entire population must be controlled throughout the entire territory. In this sense, social sensors can be a powerful tool to ensure confinement compliance based on people's complaints on social networks. Social media tools have become a global phenomenon of communication, where users post content in the form of text, images, video, audio, or a combination of them, to express their opinions, report facts that are happening at that time or show situations of interest. A current line of research related to these tools consists of crowdsensing, i.e. the analysis and interpretation of the enormous amount of information that is daily posted in these tools. This new paradigm aims to achieve several results, such as identifying events or situations of interest in cities, detecting possible emergencies due to natural disasters, or even knowing the popularity of companies and organisations.

One of these proposals is COVIDSensing.com, which aims at developing an early warning system based on citizens' complaints in social networks for the management of epidemiological control measures of the COVID-19 outbreak. Specifically, the knowledge expected to be generated from the analysis of this information obtained from social networks includes (but is not limited to) the following points:

- Early identification of non-compliance with the measures decreed in law RD 463/2020 and its subsequent extensions, such as (i) limitation of the freedom of movement of persons, (ii) opening to the public of unauthorised premises, establishments, areas of worship, etc., and (iii) agglomerations, among others. Social networks are an increasingly common way of reporting such events, and their identification can be used by authorities for resource planning. In addition, they are usually accompanied by photographs and videos that can serve as accusatory evidence of a crime.
- Identification of groups and communities that are vulnerable or especially sensitive to the pandemic. It is common to find in social networks the reports made by groups vulnerable to this disease due to their high exposure (e.g. health and police), their high risk (e.g. elderly and citizens with previous pathologies), or their lack of awareness (e.g. oblivious people).
- Identification of shortages and supply of basic resources. Social networks have become a loudspeaker to denounce the lack of basic resources for the control of the pandemic. Likewise, there are many citizens' movements that promote the development and supply of basic resources such as masks, respirators and health tools through 3D printers, the aid to disadvantaged groups, etc. The identification of these groups through social networks can facilitate their coordination in a centralised manner, thus helping to plan more effectively the generation and distribution of resources. In short, valuable partnerships are established to guarantee the supply of extremely necessary products for the country in a situation of 'war economy'.
- Prediction of areas of potential contagion for reasons of large influx, presence of diagnosed cases, lack of socio-health measures, etc. In this sense, the early prediction of this type of situation would allow competent authorities to regulate or restrict access to identified hot spots.
- Creation and provision of a real-time report of observations and suspicions of COVID-19 by the population.
- Facilitate access to social network data on the epidemic for the scientific community to support artificial intelligence, simulation and epidemiology.

It is noteworthy to highlight that the information is obtained and managed anonymously to meet the requirements of the General Data Protection Regulation rules (EU) 2016/679 (GDPR). Fig. 2 shows the number of Rich Site Summary (RSS) messages published by Spanish media as of 20 April. At the end of February, the number of messages in the Spanish media about Coronavirus could be considered high (i.e. 143 RSS feeds). However, the impact of the Coronavirus in Spain has monopolised the Spanish media, reaching a point where more than 59,737 news items were published in the official media on the same day. At present, we can also see a decrease in the number of news items about COVID-19, although the numbers are still very high (13,799 news items on 20 April).

Fig. 3 shows the geographical scope of the news related to COVID-19 in the Spanish media. It should be noted that most of them refer to Spain as a country, and this is reflected by the largest point on the map. The second-largest point is in Madrid, which is actually the most affected city in Spain. In addition, there are orange points throughout the country, reflecting the fact that all cities were affected by the COVID-19 outbreak.

Although not strictly related to the application of lockdowns and quarantine periods for epidemiological control, another interesting tool based on social media analytics is covid19-civiclytics [https://covid19-civiclytics.citibeats.com/]. This tool was developed by the Bank of Inter-American Development (IDB), and shows the perceptions and concerns expressed by Latin

Fig. 4 *COVID19-civiclytics: conversation ratio by topic based on Twitter, for the last seven days*

Americans and Caribbean people on the Internet regarding the COVID-19 pandemic. The data and information allow for better listening and understanding of different categories of issues in order to preserve the civic needs of dignity, trust, security and visibility. Knowing these data allows innovative solutions to be implemented by citizens, governments, and the private sector (see Fig. 4).

3.2 Social distancing

Social distancing is defined as a set of non-medical measures taken to reduce or even prevent the spread of a contagious disease. This is achieved by keeping a physical distance between people, and also by limiting the number of times people contact each other closely [9]. These measures are critical but economically painful for all the countries that are suffering the COVID-19 pandemic. However, social distancing can be achieved in several ways, and this is based on the decision-making procedure of politics [10]. Smart city technologies can also help in this regard. Several MCS projects are being proposed to achieve social distancing without the need for a strict lockdown.

Smartphone-based contact-tracing applications are shown as a promising technology to finish or reduce the lockdown and quarantine measures. The technology of these mobile apps is based on the results of several years of research efforts on Mobile Computing, and particularly on Opportunistic Networking (OppNet) and MCS. In Europe, each country is developing or adapting its own contact tracing application. Although initially there was some joint effort in developing common tools and applications (such as the European's PEPP-PT), it finally seems that the joint proposal of Google and Apple to develop and integrate one such application into their mobile operating systems could be a definitive solution for contact tracing, having only privacy issues as its potential Achilles' heel. As for Spain, and for the time being, there are no plans for developing these kinds of applications.

I-MOVE-COVID-19 aims to obtain epidemiological, clinical and virological information about COVID-19, and patients infected with SARS-CoV-2, through the provision of a flexible surveillance platform (adaptable to the epidemiological situation), research studies, hypothesis-testing, and evaluation of public health interventions (e.g. vaccination, antivirals etc.) in order to contribute to the knowledge base, guide patient management, and inform the public health response. This will be achieved through adaptation and expansion of the existing, long-running, Europe-wide influenza surveillance network (I-MOVE) to include COVID-19. The network includes primary care networks, hospitals, and national laboratory reference centres in ten countries.

I-MOVE-COVID-19 priority activities and research projects will be selected based on ECDC/WHO input and the proposal's detailed list. These will be conducted by mobilising an existing large European multidisciplinary network, combining the expertise and resources of groups working in surveillance (epidemiological, clinical, virological), respiratory disease research, and evaluation of vaccines/treatments. Through protocol sharing, and by pooling European results, questions will be answered, which could not be efficiently answered by countries acting alone. I-MOVE-COVID-19 will share study results rapidly and widely with national and international partners, and with the wider scientific community, to contribute to the clinical management of patients, and to the public health preparedness and responsiveness to COVID-19.

Moreover, the Spanish National Research Council (CSIC) is developing a data science project that uses mobile phone data to study the effectiveness of containment on the dispersion of COVID-19. It uses AI techniques to assess whether the containment measures that have been taken to stop the dissemination of the COVID-19 are being effective. This is important to improve the social distancing strategies taken in future outbreaks. To carry out the research, a multidisciplinary team with experts in computing, demography, physics and movement studies is analysing massive, anonymous, high-resolution data being obtained from telephone operators and map servers. These data explain how mobility and social contacts have changed since confinement began.

With all the information gathered, the project simulates different scenarios or strategies for social distancing and decision support. The results are key both to decide whether to activate tighter confinement rules, and to plan a safe and effective end to the confinement. The characterisation of mobility is being coordinated from IFISC based on the contribution of different data platforms: information, for example from online social networks, and mobility patterns captured by mobile phone traces. In the latter case, the data are collected by the operators and companies participating in the project, providing the research team with aggregated travel flows between areas.

Finally, another important aspect is the change in people's behaviour due to the perception of risk. The Centro de Estudios Avanzados de Blanes (CEAB) and the Instituto de Economía, Geografía y Demografía (IEGD) are developing surveys and mobile applications to quantify these changes, trying to estimate the population's adherence to personal protection measures, and what the changes are in the quantity and quality of the contacts they have. This information is crucial for understanding the process of contagion. Finally, all these data are part of the computational models being developed by IFISC and IFCA to study the different scenarios for ending the crisis. Confinement has been generalised and relatively sudden, but if new outbreaks are to be avoided, it becomes necessary to have simulators capable of evaluating

scenarios with different rates of resuming normal activities, both by sector and by geographical area.

3.3 Monitoring pandemic evolution

Some mobile applications have been developed for monitoring the COVID-19 pandemic evolution in Spain. They are described below.

{https://play.google.com/store/apps/details?id=org.madrid.CoronaMadrid}{CoronaMadrid} allows users to detect, inform themselves and contact the authorities at any stage of the conception of the COVID-19 disease. This application has the mission of helping citizens to be able to detect if they are being affected by the disease and obtain the best recommendations depending on their condition. In the event of a serious condition, the authorities will be aware of the situation and will be able to communicate directly with the affected person.

{https://play.google.com/store/apps/details?id=com.erictelm2m.colabora&hl=es}{Covid1-19.eus} is a collaborative application to manage the COVID-19 pandemic in the Basque region. The application allows a self-diagnosis of the COVID-19 infection. If it is positive, the user will consider it as a possible infection (according to WHO terminology) and will warn the whole circle of people so that they will be considered at risk. Together with this information, the system will register this data, so that a trace of contagion can be followed with this circle functionality. Along with this information, the postal code is requested, and in case of community infection, outbreaks of infection could also be detected.

{https://play.google.com/store/apps/details?id=cat.gencat.mobi.StopCovid19Cat&hl=es}{STOP COVID19 CAT} is a mobile health application with a double purpose. Firstly, to respond to the information needs of citizens in relation to COVID-19, through a questionnaire that tells them if they have the possibility of having COVID. Secondly, it aims to collect data from the population in order to create statistics.

{https://play.google.com/store/apps/details?id=es.navarra.coronatestnavarra&hl=es}{CoronaTest Navarra} is developed by the Government of Navarra and its main aim is to reduce the volume of calls to the health emergency number, to deal with doubts about the infectious disease COVID-19 (of the Coronavirus family of infections), to calm down the population, as well as to allow an initial triage of possible cases and a subsequent follow-up.

Finally, {https://play.google.com/store/apps/details?id=es.gob.asistenciacovid19&hl=es}{Asistencia COVID-19} is the official application of the Spanish Government in cooperation with the adhered Autonomous Communities. It enables self-assess the possible symptoms of the infectious disease COVID-19 and informs people about the recommendations to be followed. Its mission is to help citizens self-assess the probability of suffering the infectious disease COVID-19, to reduce the volume of calls to the health emergency number, informing the population, allowing an initial triage of possible cases and a subsequent follow-up by the Health Authorities.

4 Discussion

Social lockdown and distancing measures are the only tools available to fight the COVID-19 outbreak. Unfortunately, scientists predict a duration of the pandemic longer than what economies can hold out. We already see de-escalation measures in many countries, such as China, Germany, Portugal, Sweden, Denmark and Spain, the effects of which are unpredictable. Engineering tools can help to ensure that such de-escalation measures do not result in a regrowth of COVID19. In particular, the technologies that can contribute most, beyond biotechnological ones, are the tools for big data analytics of social data, and, in particular, those that model people dynamics. MCS tools are actually within this umbrella as they enable people to share real-time information either from their sensing devices such as smartphones, or their opinions on social networks.

Here, we have reported some MCS research efforts that are being developed in Spain to enforce lockdown, and to maintain social distancing. The former scenario is led by COVIDSensing.com in Spain, and COVID19-civiclytics in Latin America. Both tools rely on people's opinions to identify social issues. The main focus of COVIDSensing.com is the epidemiological control and management of the pandemic, to ensure, through people's complaints in social networks, greater control over the measures. The main focus of COVID19-civiclytics is the social impact of the COVID outbreak on certain social aspects throughout Latin America. Indeed, online social networking is a place where people express their opinions freely, and this particular pandemic is being broadcast live from millions of different points of view. Undoubtedly, if governments want to make decisions based on people's needs, tools like these are absolutely necessary.

Regarding social distancing, we have shown some interesting projects that are using information from large telecommunications companies to detect the geopositioning of users, mobility patterns, and to avoid contacts between potentially affected people. In particular, evaluating how smartphone contact tracing technology and people's mobility can impact the control and spreading of infectious diseases is a key issue for planning future measures for controlling the disease. For example, for evaluating contact tracing technologies, it is necessary to consider contacts individually and on a temporal basis. The combination of Network Science with stochastic and deterministic mathematical Epidemic Models is a useful tool for considering the effects of contact tracing and quarantine measures. First studies based on these models have shown that in order to be effective against the COVID-19 disease, contact tracing technology must be precise, contacts have to be traced fast, and a huge percentage of the population must use the proposed smartphone contact-tracing application.

Last but not least, it is worth highlighting the thin line that separates these type of applications with some of today's personal data protection legislation, especially in Europe. The General Data Protection Regulation (EU) 2016/679 (GDPR) is an EU regulation on data protection and privacy. The GDPR's main objective is to provide control to individuals over their personal information, and to make international business easier by unifying regulations within the EU [11]. To take steps to contain and mitigate the disease, governments and public and private organisations around the world are taking measures that may involve the processing of different types of personal data. Andrea Jelinek, Chair of the European Data Protection Board (EDPB), said: 'Data protection rules (such as GDPR) do not hinder measures taken in the fight against the coronavirus pandemic. However, we would like to underline that, even in these exceptional times, the data controller must ensure the protection of the personal data of the data subjects. Therefore, a number of considerations should be taken into account to guarantee the lawful processing of personal data [https://edpb.europa.eu/news/news/2020/statement-edpb-chair-processing-personal-data-context-covid-19-outbreak_en].' Indeed, the GDPR provides the legal basis to allow employers and competent public health authorities to process personal data in the context of epidemics, without the need to obtain the consent of the data subject.

Undoubtedly, MCS applications may be affected by this legislation. Therefore, private entities and research bodies have to handle the information anonymously, offering aggregated data that can identify collective problems, rather than personal complaints that can infringe the rights of individuals.

5 Conclusion

We are witnessing one of the major crises of our recent history. The COVID-19 outbreak is causing a great number of deaths (193,145 death toll worldwide as of 24 April). Social lockdown and distancing measures are slowly mitigating the spread of the virus. These measures are the only tool available until the long-awaited vaccine can be distributed to the entire population, and this is not expected to happen until about mid-2021. However, these measures are drastically damaging the economy, putting at risk the welfare state of rich societies, and with very bad forecasts for developing societies. Fortunately, technological tools such as MCS offer

innovative solutions to create ‘smart’ quarantine periods, ensuring social distancing without lockdowns. In this study, we have briefly introduced some new developments within the MCS framework that are being undertaken to achieve this smart quarantine concept in Spain. These tools require people's contributions through their posting in social networks, or by sharing information from mobile devices such as GPS location. This could be a trade-off between the rights of individuals to have control over their personal data, and the general benefit of the society.

6 Acknowledgments

This work was partially supported by the Fundación Séneca del Centro de Coordinación de la Investigación de la Región de Murcia under Project 20813/PI/18, and by the Spanish Ministry of Science, Innovation and Universities under grants RTI2018-096384-B-I00 and RTC-2017-6389-5.

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