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The systemic dimension of success (or failure?) in the use of data and AI during the COVID-19 pandemic. A cross-country comparison on contact tracing apps

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Abstract

During the COVID-19 pandemic, public attention turned to contact tracing apps as a possible solution to the spread of the virus. Many countries have moved in this direction, adopting contact tracing apps, while respecting personal data protection and, for EU countries, adhering to a number of fundamental principles: voluntariness, interoperability, regulatory coverage, purpose specification, minimisation, transparency, protection, security, and timeliness. In spite of timely public policy efforts, tracking apps have not been a success in many countries, and today, when their use could be of great importance, it seems appropriate to open a reflection on the success and unsuccessfulness of a public policy that has resolutely supported the use of digital technologies for public utility purposes.

This working paper proposes a comparative analysis of nine OECD countries: Australia, France, Germany, Ireland, Italy, New Zealand, Russia, South Korea, Spain. It outlines the specific factors in each country's public policy that made the use of tracking apps possible, in terms of policy design with respect to: objectives, instruments, public procurement selection criteria, resources and the context in which the policy was implemented. The working paper concludes with three lessons learned from the comparative analysis: the privacy paradox, the choice of a public interest technology, and the systemic interweaving that the implementation of a public policy must take into account to enhance the effectiveness of a public interest action.

Keywords: STI policy, data, covid-19, privacy, app, information, users, contact tracing, developers; Australia, Korea, France, Germany, Ireland, Italy, New Zealand, Russia, Spain

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1. Introduction and context

During the COVID-19 pandemic, public attention turned to contact tracing apps as a possible solution in collecting and using information to contain the spread of infections (WHO 2020). The interest aroused by the success in some countries - Singapore (OPSI 2020) and South Korea, in particular (Shendruk 2020) - has promptly fueled the expectation in other countries that an effective solution essentially required an appropriate technology, a population willing to be tracked and a public policy that activated tracing as an integrated program in the contagion containment plan. That things were more complicated than expected was observed by various authors as early as the summer of 2020. Among them, Sander van der Leeuw (van der Leeuw 2020) opens to the general theme of information in addressing measures to contain the pandemic; a contribution proposed by Maria Savona (Savona 2020) highlights, on the one hand, the criticality inherent in the very idea of a technological solution for the collection of infectious tracking information without a social context aligned to the solution, and, on the other hand, the need to open a critical discussion on the main technological players involved in the development and use of tracking apps, Apple and Google.

The analysis of the problems related to the adoption of contact tracing apps offers a framework of considerable interest on the innovation policy to combat COVID-19 and the related critical issues, even more so today, in which countries with the higher vaccination rate are starting to contain the spread of the infection, with tracking apps that will be able to identify and contain specific outbreaks.

The opportunity to resort to the use of tracing systems to stop the spread of secondary infections has fully entered the scientific as well as the media debate, leading many countries to commit themselves to their adoption. According to Bending Spoons, which developed the Immuni app adopted by Italy (Immuni 2021), there have been numerous questions raised by citizens with regard to privacy, an issue that was immediately grasped within the European Union, by the European Data Protection Board (EDPB 2020), which promptly highlighted the need to field "modern techniques" for the fight against COVID- 19 "in the interest of humanity", warning, at the same time, on the necessary respect, even in emergency contexts, of all human rights, not least those related to the sphere of individual privacy, expressly protected by the same Charter of Fundamental Rights of the European Union (articles 7, 8 and 52) (European Union 2016). It was, moreover, on this basis and in consideration of the other specific European disciplines on the protection of personal data, that the fundamental principles to which the Member States should have complied with were first identified and then better specified: voluntariness, interoperability, regulatory coverage, clarification of the purposes, minimization, transparency, protection, security, temporariness.

In this paper we build on these premises and, in addition to what has already been discussed in other works (see, in particular, Savona 2020), we focus on the relevant dimensions in enhancing the success of a public policy that supports the use of contagion tracking apps. The case study on this STI policy concerns a significant innovation, not so much for the specific technical solutions proposed by developers in the various countries, but for the objective of their use - accelerated in a period of a few months - and for large-scale adoption for public utility purposes.

The essay offers a comparative analysis on innovation policies supporting the adoption of contact tracing apps in nine OECD countries: Australia, France, Germany, Ireland, Italy, New Zealand, Russia, South Korea, Spain. To contextualize the dynamics of adoption of tracking apps (download and use) and to enhance the potential that these technologies will have in the next phases of containment of the pandemic, it is appropriate to consider the changed scenario of the spread of infections, made possible, initially, by the practices of containment of social interactions that limited mobility and economic and social activities, and by the administration of vaccines.

The structure of the paper is as follows. Section 2 presents the sources of information and data used in the comparative analysis. Section 3 describes the main features of the contact tracking apps that characterize the nine countries. Section 4 outlines a longitudinal cross-country perspective on the changes occurred during the pandemic. Section 5 concludes with three main lessons learned from the comparative analysis and with possible developments in the analysis.

2. Information and Data Sources

The comparative analysis refers to France, Germany, Italy, and Spain, among the countries in Europe most affected by the virus, to the Republic of Ireland, which has created one of the best tracking programs in Europe. Australia, South Korea, New Zealand, and Russia have been identified as a reference to non-European countries which have used different systems and methods for tracking, with far from unanimous opinions. The countries considered in this comparative analysis allow us to have a first reference framework of the determinants and specific social and institutional features that have characterized the European and non-European context in the use of a contact tracing technology to contain the spread of the pandemic contagion. COVID-19. Cross-country comparison of the implementation of the contact tracing apps refers to countries with different economic and demographic characteristics that may have affected the capacity and speed of response to the emergency healthcare: the size of the countries, the resident population, the growth rates of GDP, and the deficit of the individual countries may have been a source of limiting or facilitating the effectiveness and speed of fighting the pandemic.

With respect to contact tracing apps we focus on their technological features and the following aspects: when and who developed it, on behalf of whom, where (place and company/startup/ research center), if and how much public funding it has received; when the app came into operation, data on its use, public information and advertising campaigns on its use, institutional statements.

For each country, beyond specific sources of information, we integrate two main data sources: Norton Rose Fulbright (2021) and the public database *Covid Tracing Tracker*, created by O'Neill, Ryan-Mosley, and Johnson (2020), available on the MIT Technology Review website.

Norton Rose Fulbright (2021) allows us to consider some of the countries analyzed in our work - Australia, France, Germany, Russia - regarding three areas: how the government of each country has acted to monitor and control the spread of the virus through the use of tracking technology; the main problems related to the use of this technology; a detailed description of the main contagion tracking apps. With reference to Australia and Germany, we integrated the information - on the characteristics of the technological platforms used and on the policy decisions - drawing on De Michele (De Michele 2020). Other sources were also scrutinized for a broader picture of South Korea, New Zealand, the Republic of Ireland, and Spain.

As for the *Covid Tracing Tracker*, the main motivation that prompted the US media company to undertake the project of public collection of information on contact tracing lies in the vast proliferation of apps available globally as a result of the pandemic and its relative difficulty. of finding comprehensive official information about their applications. To build the database, O'Neill, Ryan-Mosley, and Johnson (2020) used government sources, news outlets, and interviews directly with application developers to understand the technologies and policies involved[1]. Although it provides useful information for international comparisons, the database

[1] For each country, in addition to the name of the tracking app used, the following information is shown: who are the developers, the number of users, the penetration and the target of penetration of the app in terms of percentage of users on the total population , the type of technology used, whether or not citizens have the right to choose about the use of the applications, if there are limitations on how the data is used, if the data will be destroyed after a certain period of time, if the app collects only the information it needs to operate efficiently or if it collects additional

Covid Tracing Tracker does not cover information on South Korea, Russia, and Spain.

Detailed information by country is available in Annex 1.

3. Contact tracking apps used in nine countries

How contact tracing apps work

Contact tracing apps differ primarily in information management. The centralized" type apps (PEPP-PT type) in which the data are consolidated in a system and removed from the peripheral devices, is contrasted by the technological infrastructure developed and made available jointly by Apple and Google (A/G platform) in which repositories and data retention are managed by the same smartphones, according to a solution considered "decentralized" (DP-3T and A/G solution), in which all or almost all of the data remains on personal devices[2].

Concerning the tracking technologies and information management, we found that Australia, France, South Korea, and New Zealand have adopted apps that use different data transmission technologies (Bluetooth, Google/Apple, QR codes), but all with centralized information management; Germany, Ireland, Italy and Spain have instead chosen technologies with Bluetooth data transmission and Google/Apple protocol with decentralized data management; no information was found on the technology of the app adopted in Russia.

Who are the developers? Identikit of a competence network

Overall, the development of tracking apps has put in place a network of skills that embraces software developers (both the giants of the caliber of SAP and small companies such as Webtek), telecommunications companies (such as Orange, in France, and Deutsche Telekom, in Germany), academic researchers working in many fields, university spin-offs and civic hackers. In the world of software developers, new skills are pooled around young developers, with high international mobility, as in the case of Bending Spoons (developer of Immuni, in Italy). In the field of academic research, consortia have been created for the development of strategic research alliances with private companies. In some cases, the app has been designed for non-profit purposes (Australia and Italy), while in the other cases it is a public contract, even if the terms of the contracts are not easily available.

Comparative analysis of the implementation of policies for the use of infection tracking apps

In addition to the technologies that characterize the tracking apps used by the nine countries, the comparison proposed in this work covers four main dimensions of the policy implementation of the tracking apps.

(a) Selection of the app, resources, management, and regulation about the information collected

Implementing the Tracking App Policy is primarily concerned with how the app is selected. The Italian government has launched an open call. Governments in France, Germany, and Ireland have the company or coalition of companies in charge of development. The public resources invested for their use and maintenance are clearly identifiable only for Germany. For the other countries, we have not been able to trace the information.

Using the categories proposed by O'Neill, Ryan-Mosley, and Johnson (2020), the policies associated with the use of apps have been classified according to five main characteristics of management and regulation of the information. With the exception of South Korea and Russia, the comparative results highlight that: all the apps require a user's explicit permission and a person can choose not to use it without negative effects; policies are in place to ensure that tracking does

information to what is stated, if the user's true identity is anonymized or not, if a decentralized or centralized architecture is adopted and, finally, whether the application has been launched or not.

[2] Refer to the Savona working paper (2020) for a summary of these technologies and the implications for privacy.

not survive specific use to combat COVID-19; technology and policies ensure that data is deleted when it is no longer needed for public health purposes; user identification is masked or anonymized; policies exist to ensure that only necessary information is collected; sharing data with external entities is prohibited; government and technology are transparent about what data is acquired, from where, how it is used and who has access to it.

(b) Integration of the information collected

Regarding the integration between the information collected with the tracking app and the health system, we did not find information relating to France, Germany, Ireland, and Spain. We have found that in Australia and Italy there is an integration with the local health system, while in New Zealand, Russia and South Korea, the central government manages the information directly, also in concert with the health authorities. The levels of integration, where present, are considered poorly or poorly integrated.

(c) Communication and information campaign

Regarding the characteristics of the information campaigns implemented in the nine countries, we currently have found information only about Italy. The campaign had the following objectives: to promote the use of Immuni and contribute to the increase of downloads; inform people about the functioning of Immuni, about its usefulness, safety, reliability; promote a sense of personal responsibility and belonging to the national community. Promoted on TV, press, radio, and social media, the campaign lasted four months, divided into three phases: the launch in June, a maintenance phase in July / August and early September, and the third recall at the start of autumn. The coordination of the campaign, both for creativity and planning, was handled by Publicis Groupe (a French multinational also based in Italy), which made teams and resources available completely free of charge, coordinating a real alliance among the media involving Rai, Mediaset, Sky, Apple, Google, Facebook, Mondadori, ItaliaOnline, Il Messaggero, RCS, Gedi Group, public figures, startups, companies. The continuity of the information campaign failed precisely in the acceleration phase of the infections, in autumn 2020, in a context in which the opposition parties of the Government declared themselves opposed to "Immuni" or simply claimed they would not download it, while the parliamentarians of the ruling coalition (and Forza Italia) were instead generally in favor, and some of them showed that they had downloaded and activated it on their smartphone, inviting everyone to do so.

(d) The citizens' response

The response of citizens of different countries to the use of tracking apps can be summarized by the data available in the database by O'Neill, Ryan-Mosley, and Johnson (2020): the percentage of use concerns about 26.6% of the population in Australia, 26.3% in Ireland, 21.7% in Germany, around 16.2% in Italy and just 3.3% in France. For South Korea, New Zealand, Russia, and Spain, data is not available.

4. A longitudinal perspective: December 2019 - June 2021

The WHO announcement of the spread of the COVID-19 pandemic was accompanied by strategic indications on the containment of infections: hygiene rules, social distancing (then implemented through lockdown measures of entire cities, regions, countries), tests of diagnostics, therapies aimed at contrasting acute manifestations, development of medical technologies for assisted breathing have appeared in many of the countries affected by the pandemic at different times as the intensity of the phenomenon increased. Vaccine research was the field of action on which many specific resources were concentrated in countries that had research capacities and production centers of the pharmaceutical industries. The international scientific community has achieved unthinkable results under normal conditions. Suffice it to say that in tackling the race

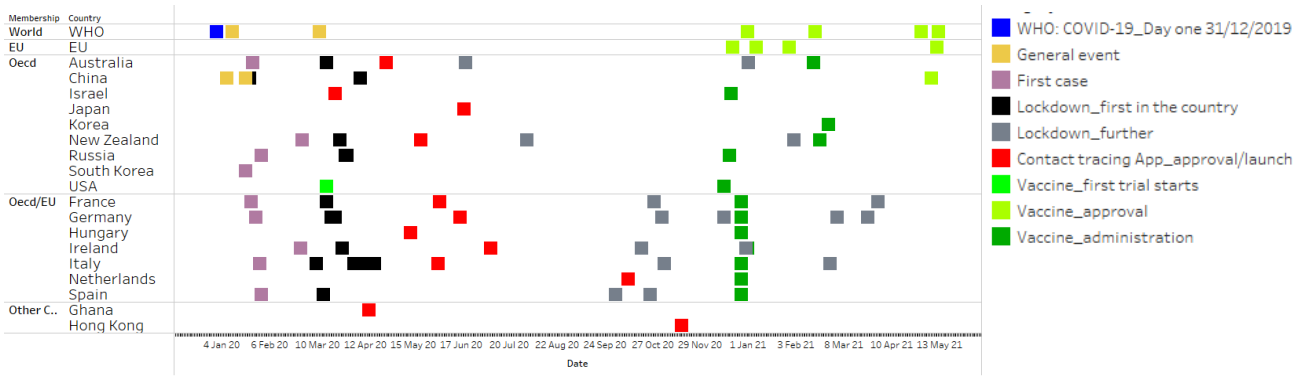
against the pandemic, an open-access collection of documents relating to the COVID-19 virus and online interrogation tools for digital documents in text format was created from scratch (Lu Wang et al. 2020).[3] The American medical library launched in March 2020 the largest open-access initiative ever, involving researchers from all countries. Significant publishers of scientific journals have signed an agreement to share their publications in text format, Google provided the query platform and developed the text query algorithms. In two months, the scientific community had access to the information already available with *ad hoc* interrogation tools: an unprecedented collaborative effort that supported the intensification of the activity of scientists in academic research laboratories and pharmaceutical industries and which had great results in the development of vaccines. Just think of the very short time interval between the WHO announcement of the start of the COVID-19 epidemic and the start of the Moderna trial, just four months later: a record so extraordinary that it can be compared to the moon landing (Sky TG24 2020).

Figure 1 shows, for various countries, the series of events that took place from December 31, 2019 to June 9, 2021. The information collected makes it possible to outline - for the countries in question - a longitudinal perspective on the information taken into consideration. The narrative unfolds along four themes: general information on the pandemic and the first case declared in each of the countries, the lockdowns, the adoption of tracking apps, the launch of the first trial of a vaccine against COVID-19, and the initiation of administrations.

Five phases are evident: the announcement of the pandemic and the reporting of case zero (or case 1) in each country are followed by the first series of lockdown decisions. Within a few months, all countries launch the use of tracking apps, which, as we have seen, have had a moderate or low level of use, and in the third phase the countries all proceed with subsequent lockdowns, aimed at containing infections in regions or areas that make it possible to limit the outbreaks.

A year after the WHO announcement on the new Coronavirus, there are a series of vaccine approvals. In the European countries, such as France, Germany, Italy, Spain, The Netherlands, and Hungary, 27 December 2020 was chosen as the symbolic date of the first vaccine administrations. The United States, Russia, and Israel preceded Europe of a few days: 15, 19 and 20 December respectively. In February 2021, several countries, such as Australia, Japan, New Zealand, South Korea, and Hong Kong, began their vaccination process

Figure 1 - Activation of the use of contact tracing apps, lockdowns, launch of vaccine trials, general events



Source: Authors' elaboration on various sources[4]

[3] The OECD-WPTIP conference on "Open data and AI analytics in times of COVID-19: the CORD-19 initiative" (30 November 2020) documented the potential of a change of mindset with respect to open access, particularly in the contributions to the conference by Jerry Sheehan (Deputy Director at the National Library of Medicine - National Institutes of Health), Kathryn Funk (Program Manager for PubMed Central at the US National Library of Medicine) and Sebastian Kohlmeier (Sr. Manager of Program Management and Business Operations at the Allen Institute for AI (AI2)).

[4] On line browsing at https://www.tiki-toki.com/timeline/entry/1639555/COVID-19/. Data Source in Annex 2.

5. Lessons learned and further developments of the analysis

The aim of contact tracing apps was outlined by the World Health Organisation (WHO 2020) as a means to contain contagions. Despite the use of apps in many countries, there seems to be no evidence to date that they have had an effect. Even countries such as Iceland, which as of 6 October 2020 registered about 40% of citizens (however insufficient) with the application downloaded, or Switzerland with its SwissCovid, where more than 1.6 million people use it on a population of 8.5 million on the same date. In both countries, tracking showed no performance that could be used as a model for the other countries.

That the effectiveness of tracking is inversely proportional to the number of infections seems to be a relevant issue. Now that vaccines are reaching the threshold of herd immunity in many Western countries, apps could become useful for tracking the spread of variants of COVID-19, a condition that calls for attention on the importance of public investments in the use of this technology. This explains the relevance of addressing a comparative analysis of which conditions would make more effective a STI policy supporting the adoption of contact tracing apps.

The comparative analysis proposed in the paper suggests that some conditions seem to explain the success/failure of those policies. In these concluding remarks, we propose three main lessons learned concerning: the privacy paradox, the choice of a technology of public interest, and the systemic intertwining of which the implementation of a public policy must take into account to enhance the effectiveness of an action of public interest.

Lesson 1 - The paradox of privacy and the social dimension of technology

The main similarities between countries are not so much the technical features of the applications - often also connected to Apple and Google as seen in Germany, Italy, and Spain - rather than in the reception that the population has reserved for such a policy strategy. Distant or culturally unrelated countries have encountered similar difficulties on the part of citizens in accepting the use of tracking apps, with political interventions that have negatively influenced public opinion often even before the apps became downloadable.

As for the European and non-European countries that we have examined, all countries have based the tracking software following a mandatory rule: the right to the maintenance of privacy, which in Europe is regulated by the General Data Protection Regulation, and specifically for COVID-19 data (EDPB 2020). As obvious as it may seem, it is actually a very strong signal of how there is a shared sensitivity in keeping individual movements anonymous. Yet the use of social networks, which often have active the location of the mobile phone, or of digital payment means to make purchases, which track those activities in precise ways, spatially and temporally, is widely widespread today, with no concern on the privacy issue by the majority of individuals. So why care so much about privacy of a contact tracing app when our data bounce every day on clouds around the world? The explanation seems to us to reside in the different point of view that people take in the social media and the market sphere (closely connected), to which as users/consumers they seem to rely on without hesitation, and the sphere of the state intervention, to which the citizens seem to regard with distrust: it appears as "a privacy paradox". Big companies have modeled social media and consumers' confidence, without transparency in their actions. Democratic governments, as in Europe, have regulated in a transparent way the privacy issue, but have failed to create consensus on collection and use of individual data. Companies use information to outline the profile of the social/consumer user aiming at increasing the profits deriving from advertising for commercial purposes. The governments could use the information to control citizens, knowing what they do and where, even in relation to domains that do not concern a pandemic, but other spheres of private life. Although such control can be approved when criminals are being controlled, the only idea that everyone could end up under that control

widens distrust of tools that offer individual data to the state[5].

An interesting exception to citizens' hesitations over the use of tracking apps seems to be the Czech Republic, which has employed "Smart Quarantine", designed by geo-locating credit card movements to create "memory maps" with places where an individual has spent their time in the past five days, and what contact they have had. Similar thing for Israel that with its "Shield" tracks and combines the different positions to then report any quarantines.

The overall issue is addressed in terms of "democratic compromises and digital surveillance" (OECD, 2021), but it would be useful to analyze the privacy paradox in a slightly different declination. If we were only rational beings, we would take every measure available to preserve ourselves, including using an app that tells us if we have come into contact with positive people; what makes us so unwilling to download a contact tracking app necessary to contain the spread of the pandemic? We are talking about an app that is born, serves, and is linked to a context of strong negative feelings: fear, anger, sadness, anxiety. In the short term, it offers – with respect to those basic functionalities - no individual benefit. It is therefore not surprising that the different contact tracking apps have turned out to be a little-used tool and viewed with distrust.

A public policy that invests in tools such as the tracking app to contain contagions should therefore accompany public action by creating the conditions to dialogue, inform and build with citizens a sense of collective interest on objectives that require, in order to be achieved, a particular commitment to individual behavior. Achieving this result requires adequate tools that impact not only generically on communication, but also on the participation of citizens in undertaking individual decisions for a collective interest, participation that must be nurtured in normal times, to be effective even in emergency conditions, a result also demonstrated by the field experiment conducted by Pancotto's research group on citizens participation in seismic emergency contexts and different social propensities to participate (Pancotto and Righi 2021).

An alternative way to incentive individual use of a contact tracing up is to limit users' freedom of daily life, such as access to shops and malls. Such incentives leverage on the consumer sphere. This might have a short term impact but it does not address the necessary shift from individual behaviour towards a collective goal: an investment that social institutions (not necessarily the state) should foster for the many goals to be achieved, as the UN SDGs, entering in the agenda of most countries for the post pandemic recovery.

The privacy paradox is then not only a matter of regulation; it highlights that the social dimension of technology is just as important as the strictly technical dimension.

Lesson 2 - How do you choose a technology of public interest?

If the social dimension we discussed above is central in implementing a public policy, so too is the technical dimension concerning the competence network it relies on. The substantial differences in the tracking apps adopted by the countries examined concern the information transmission technology (Bluetooth, QR codes, Google/Apple, GPS) and the information collection technology (decentralized or centralized). Countries have adopted different approaches

[5] This sensitivity is by no means new. One of the most striking events that caused discussion in this sense was the massacre in San Bernardino, California on December 2, 2015, when two people, husband and wife, entered the Inland Regional Center, a social center for the disabled, opening the fire killing 14 people plus dozens of injured. That event shook the West, not only because of the Islamic matrix, in the United States strongly after 9/11, but also because Apple refused to create and deliver to the US Department of Justice the software to decrypt the passwords of the mobile phones, with the goal of finding in those mobile phones more information on the two criminals. That software would not only have allowed to unlock that particular iPhone, but theoretically all of them, making the US government essentially free to use the data of about 50% of Americans, plus other users of the Apple brand around the world (Canu 2020), about 1.5 billion potential devices (Migliorino 2020).

in the selection of the apps, both with respect to the technology to be adopted and the network of competence to rely on. Australia was the only one of the analyzed countries to use an app developed by academic researchers from several internationally renowned institutes, including the University of Queensland, Auckland, the Massachusetts Institute of Technology, and the Delft University of Technology. The rest of the countries have relied on private companies. France and Germany have selected the national reference company for the development of the app, respectively, TousAntiCovid was developed with the French telephone operator Orange Sa and the French public search system of INRIA, the German Corona-Warn-App was developed by SAP and Deutsche Telekom. The Italian government has instead launched a selection open to many alternatives, including an app created by Bending Spoons, a mobile phone app development company. The Irish government has relied on Near Form in collaboration with Apple and Google. Similarly, the Russian government said it used the collaboration of Apple and Google to develop the app. In South Korea, New Zealand, and Spain, input from their respective governments was essential; while in South Korea, the tracking app *Corona 100m* was developed by the Ministry of the Interior and Security, in New Zealand the Ministry of Health intervened, in Spain the Ministry of Economic Affairs and Digital Transformation.

A public policy that uses data collection and analysis technologies for public purposes, as in the case of the data necessary for tracing infections, makes specific choices that orient public procurement towards technological solutions that are based on the enhancement of skills that exist in the country or that attract skills that exist in other countries. In the current political and economic context, in which the technological sovereignty of a country returns as a central element of public policies, also in Europe (Edler et al. 2020; Darnis 2020; European Commission 2020; VDE 2021), the question of the choice of technology for a public need requires a reflection on the choices of creation or consolidation of internal competences in countries, an issue that goes beyond the contingency of this pandemic. For example, has Italy the skills of France or Australia, and could it have activated them quickly?

The choice of a technology of public interest, therefore, requires a reflection on what skills a country has and on the decisions about which public policies favor the support and development of those skills or the creation of new skills.

Lesson 3 - How important are interconnections for the success / effectiveness of policy implementation?

A public policy that uses data collection and analysis to address an issue of collective concern, to be effective in its impact, must outline the relevant direct, and possibly indirect, interconnections.

A first area, which might seem essentially technological, concerns precisely the compatibility with the mobile devices necessary for data collection. In various countries, many potential users could not use the contact tracking app due to software incompatibilities, such as in Portugal, where almost 10% of the population does not have a compatible device with the reference app (Adnkronos 2020). A technological development is not the best one if it does not take into account the users' characteristics, such as the structure of the population in terms of income and propensity to consume digital products.

Another interconnection concerns an infrastructural aspect: the intertwining between a technology - destined to tackle a health problem - and the health system, with which the tracking app must enter into dialogue for effective transmission and recording of the data you activate. We have not been able to find adequate documentation to develop a reflection on this issue, which we intend to deepen with direct interviews with public organizations of the health system in different contexts. In Italy, health is a constitutional right, guaranteed by the national health system with organizational autonomy on a regional scale. This decentralization impacts in different ways the

adoption of an app that is designed regardless of those specificities, including the absorption / processing / integration of the collected data for health surveillance. Such an area of reflection deserves special attention if the tracking app is to be used in the exit from the pandemic.

Another issue that impacts on the effectiveness of adopting a technology concerns the information campaign: an issue on which we have not been able to find adequate evidence. In Italy, the advertising campaign, made possible by the voluntary effort of a large group of private actors (both from the media sector and software development) had a modest temporal coverage, leaving the field when the difficulties of downloading the app and its functioning would have required a specific commitment of information. The theme of public communication, therefore, returns as an issue that cannot be separated from the implementation of a policy, intertwining success / effectiveness not so much with the technology that has been chosen, but with its adoption, which must be supported with specific social actions beyond media.

Last but not least is the issue of resources allocated to the implementation of the policy. The fact that we were only able to find information for Germany may indicate the difficulty of accessing that information, which should also be in the public domain. The number of resources invested monthly by Germany for the maintenance and development of its tracking app, around 3 million euros per month (Brady 2020), should make it clear that the digital world has a material dimension (of specific goods and services) that often is overlooked by decision-makers: public policies that rely on the use and analysis of data do require to invest additional resources once the software application has been developed.

Further research developments

The comparative analysis between the countries considered has highlighted the different institutional and organizational contexts as well as the specific STI policies that have promoted the use of contact tracing apps. Broadening the set of countries on which to carry out a comparative analysis would be interesting, not only to validate and collect more evidence, but to test the analytical framework proposed in the comparative analysis explored in this paper. A systemic perspective on the implementation process of a policy needs to address the complexity of its multilevel interaction (Geyer & Rihani, 2012; Gray, 2015; Hjern & Porter, 1981; Tenbensel, 2015). This requires a look from the inside – adopting an ethnographic method (Agar, 1996, 2006) - being a participant observer (Bobbio et al., 2017; Vino, 2018), elaborating a massive over determination pattern of information, highlighting rich points to outline a new framework in which the comparative analysis can be interpreted and the policy recommendations become more effective.

In such a development it is essential to carry out interviews with experts and managers of the institutions and organizations involved in the development of contagion tracking apps. To deepen the technical and operational nature of the tracking apps and their uses and to fill the lack of press sources or scientific literature, it is considered appropriate to resort to direct and targeted interviews with the representatives of various companies and institutions mentioned in this preliminary work by research, also regarding the choices of the advertising campaign relating to tracking apps. In the case of Italy, among the possible alternatives to the Immuni app, particular interest deserves the analysis of the developments undertaken by the developers of Air - Digital Arianna, of the University of Urbino, which would offer a case to analyze if and in what direction its development is proceeding in terms of collaborations and what the next objectives will be, as well as the application on the tracing of infections.

With reference to the health system, the interviews would allow to outline the reasons and implications of the choices made in the different countries and to understand the functioning of the entire process of adopting the tracking app for an effective containment of infections. In Italy, in particular, an analytical gap remains to be filled regarding the technological and organizational

infrastructures of the regional health systems. In the new phase of contagion containment that will be implemented thanks to the spread of vaccines, health infrastructures could derive important operational advantages if they were able to effectively integrate the information detected through the tracking apps. A comparative analysis of the potential organizational change that the regional health systems are planning and that is characterizing the health systems in the countries examined may therefore be of great interest.

References

Adnkronos. 2020. «App anti-Covid in Europa, quanti le scaricano? I numeri». Adnkronos. 10 giugno 2020. https://www.adnkronos.com/app-anti-covid-in-europa-quanti-le-scaricano-i-numeri_7kBre5OkeRO7COLfuWmyVF.

Agar, M. (2006). An Ethnography By Any Other Name ... Forum Qualitative Sozialforschung / Forum: Qualitative Social Research, Vol 7, No 4 (2006): Qualitative Research in Ibero America. https://doi.org/10.17169/fqs-7.4.177

Agar, M. (1996). The professional stranger: An informal introduction to ethnography (2nd ed). Academic Press.

AIFA. 2021a. «Vaccini COVID-19 | Vaccini a mRNA». 2021. https://aifa.gov.it/vaccini-mrna.

———. 2021b. «Vaccini COVID-19 | Vaccini a vettore virale». 2021. https://aifa.gov.it/vaccini-vettore-virale.

Bobbio, L., Pomatto, G., & Ravazzi, S. (2017). Le politiche pubbliche: Problemi, soluzioni, incertezze, conflitti. Mondadori Università.

Brady, Kate. 2020. «Day one of using Germany′s coronavirus tracing app | Germany| News and in-depth reporting from Berlin and beyond | DW | 16.06.2020». DW.COM. 16 giugno 2020. https://www.dw.com/en/day-one-of-using-germanys-coronavirus-tracing-app/a-53828730.

Canu Eugenio. 2020. «Perché Apple non vuole sbloccare gli iPhone dei terroristi?» il Foglio. 15 gennaio 2020. https://www.ilfoglio.it/tecnologia/2020/01/15/news/perche-apple-non-vuole-sbloccare-gli-iphone-dei-terroristi-296549/.

Clarizia, Paolo, e Eleonora Schneider. 2020. «Luci e ombre sulla procedura di selezione di "Immuni", l'app del governo di tracciamento del contagio da Covid-19». IRPA (blog). 19 aprile 2020. https://www.irpa.eu/luci-e-ombre-sulla-procedura-di-selezione-di-immuni-lapp-del-governo-di-tracciamento-del-contagio-da-covid-19/.

Corona Virus Outbreak. 2021. «Covid Community Alert». 30 marzo 2021. https://coronavirus-outbreak-control.github.io/web/.

Covid Community Alert. 2020. «Home Page. Coronavirus Outbreak Control». 2020. https://coronavirus-outbreak-control.github.io/web/.

Covid19 Vaccine Traker. 2021. «Trials & Approved Vaccines by Country – COVID19 Vaccine Tracker». Https://Covid19.Trackvaccines.Org. 7 giugno 2021. https://covid19.trackvaccines.org/trials-vaccines-by-country/.

Darnis, Jean Pierre. 2020. «A COVID-19 Moment for Technological Sovereignty in Europe?» Text. IAI Istituto Affari Internazionali. 27 aprile 2020. https://www.iai.it/en/pubblicazioni/covid-19-moment-technological-sovereignty-europe.

De Michele, Stefania. 2020. «Il confronto: tutte le app europee (e non) per tracciare i contatti [The comparison: all the European (and non-European) apps to track contacts]». Online newspaper. Euronews; it.euronews.com. 29 maggio 2020. https://it.euronews.com/2020/05/29/covid-19-fatevi-tracciare-e-per-il-vostro-bene-ecco-le-app-nel-mondo.

Edler, Jakob, Knut Blind, Rainer Frietsch, Simone Kimpeler, Henning Kroll, Christian Lerch, Thomas Reiss, et al. 2020. «Technology Sovereignty: from demand to concept». Perspectives-Policy Brief.

EDPB. 2020. «Guidelines 03/2020 on the processing of data concerning health for the purpose of scientific research in the context of the COVID-19 outbreak». Institutional. European Data Protection Board; edpb.europa.eu/edpb_en. 21 aprile 2020. https://edpb.europa.eu/sites/default/files/files/file1/edpb_guidelines_202003_healthdatascientificresearchcovid19_en.pdf.

European Commission. 2020. «Europe: The Keys To Sovereignty». Text. European Commission. 11 settembre 2020. https://ec.europa.eu/commission/commissioners/2019-2024/breton/announcements/europe -keys- sovereignty_en.

Geyer, R., & Rihani, S. (2012). Complexity and Public Policy. Routledge.

Gray, B. (2015). A case study of complexity and health policy: Planning for a pandemic. In R. Geyer & P. Cairney (Eds.), Handbook on Complexity and Public Policy (pp. 384–398). Edward Elgar Publishing.

Hjern, B., & Porter, D. O. (1981). Implementation Structures: A New Unit of Administrative Analysis. Organization Studies, 2(3), 211–227. https://doi.org/10.1177/017084068100200301

Holder, Josh. 2021. «Tracking Coronavirus Vaccinations Around the World». The New York Times, 26 aprile 2021, par. World. https://www.nytimes.com/interactive/2021/world/covid-vaccinations-tracker.html.
Immuni. 2021. «Numeri di immuni [Official Numbers of the Immuni App]». https://www.immuni.italia.it/. 15 marzo 2021. https://www.immuni.italia.it/dashboard.html.
Leeuw, Sander van der. 2020. «COVID-19 and the Role of Information Processing». Global Sustainability 3: e27. https://doi.org/10.1017/sus.2020.22.
Lu Wang, Lucy, Kyle Lo, Yoganand Chandrasekhar, Russell Reas, Jiangjiang Yang, Darrin Eide, Kathryn Funk, et al. 2020. «CORD-19: The Covid-19 Open Research Dataset». ArXiv, aprile. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7251955/.
Migliorino Giuseppe, Giuseppe. 2020. «Apple supera il miliardo di utenti iPhone nel mondo». iPhone Italia. 27 agosto 2020. https://www.iphoneitalia.com/747882/un-miliardo-utenti-iphone-mondo.
NTR. 2021. «Norton Rose Fulbright Is a Global Law Firm». Https://Www.Nortonrosefulbright.Com/En-It. 2021. https://www.nortonrosefulbright.com/en-it/about/our-firm.
O'Neill, Patrick Howell, Tate Ryan-Mosley, e Bobbie Johnson. 2020. «A Flood of Coronavirus Apps Are Tracking Us. Now It's Time to Keep Track of Them» Official corporate website. MIT Technology Review; Www.Technologyreview.Com. 7 maggio 2020. https://www.technologyreview.com/ 2020/05/07/ 1000961/launching-mittr-covid-tracing-tracker/.
OECD. (2020). The Covid-19 crisis: A catalyst for government transformation? Policy brief of the Open and Innovative Government Division (OIG) of the Public Governance Directorate of the OECD. OECD. Retrieved 5 July 2021, from https://www.oecd.org/coronavirus/policy-responses/the-covid-19-crisis-a-catalyst-for-government-transformation-1d0c0788/
OECD. (2021). Enhancing access to research data during crises: Lessons learned from the COVID-19 pandemic. DRAFT summary note of a GSF-RDA workshop. https://one.oecd.org/document/ DSTI/STP/GSF(2021)13/en/pdf
OECD. (2021). Enhancing access to research data during crises: Lessons learned from the COVID-19 pandemic. DRAFT summary note of a GSF-RDA workshop. https://one.oecd.org/document/DSTI/ STP/GSF(2021)13/en/pdf
OPSI, Observatory of Public Sector Innovation. 2020. «Singapore Is Using "contact Trackers" to Work out Who Coronavirus Patients Have Come into Contact With». OECD-EU. Observatory of Public Sector Innovation (blog). 20 marzo 2020. https://oecd-opsi.org/covid-response/singapore-is-using-contact-trackers-to-work-out-who-coronavirus-patients-have-come-into-contact-with/.
Oxford Martin Programme on Global Development. 2021. «Our World in Data». Our World in Data. 12 giugno 2021. https://ourworldindata.org.
Pancotto, Francesca, e Simone Righi. 2021. «Reflectivity relates differently to pro sociality in naive and strategic subjects». Nature Scientific Reports.
Savona, Maria. 2020. «The Saga of the Covid-19 Contact Tracing Apps: Lessons for Data Governance». SPRU Working Paper Series, n. 10 (luglio): 15. http://dx.doi.org/10.2139/ssrn.3645073.
Shendruk, Amanda. 2020. «South Koreans Are Using Smartphone Apps to Avoid the Novel Coronavirus». Quartz. 29 febbraio 2020. https://qz.com/1810651/south-koreans-are-using-smartphone-apps-to-avoid-coronavirus/.
Sky TG24. 2020. «Edizione speciale da Courmayeru di "I Numeri della Pandemia"». 5 dicembre 2020. https://www.facebook.com/watch/?v=309190290259195.
STOPcovid19. 2021. «Scarica STOPcovid19 sul tuo smartphone e ferma il virus [Download STOPcovid19 on your smartphone and stop the virus]». STOPcovid19. 19 aprile 2021. https://www.stopcovid19.it/it/.
Tenbensel, T. (2015). Complexity and health policy. In R. Geyer & P. Cairney (Eds.), Handbook on complexity and public policy (pp. 369–383). Edward Elgar Publishing.
Tiki-Toki. 2011. «About us - Tiki-Toki Timeline Maker». 2011. https://www.tiki-toki.com/about-us/.
Unione Europea. 2016. «Carta dei diritti fondamentali dell'Unione Europea (2016/C 202/02)». Gazzetta ufficiale dell'Unione europea C 202/389.
Università degli Studi di Urbino. 2021. «diAry – Digital Arianna – App per il contenimento di COVID-19 [diAry - Digital Arianna - App for Containment of COVID-19]». University. Covid19app. 30 marzo 2021. https://covid19app.uniurb.it/.
VDE, Association for Electrical, Electronic & Information Technologies. 2021. «New position paper on technological sovereignty for Germany and Europe». 12 marzo 2021. https://www.vde.com/en/ press/press-releases/vde-calls-for-microelectronics-masterplan.
Vino, A. (2018). L'attuazione delle politiche pubbliche: Dalla decisione politica all'efficacia sociale (1a edizione). Carocci editore.
WHO. 2020. «Contact Tracing in the Context of COVID-19». maggio 2020. https://www.who.int/ publications-detail-redirect/contact-tracing-in-the-context-of-covid-19.

Annex 1 - Tracking apps in Australia, France, Germany, Ireland, Italy, New Zealand, Russia, South Korea, Spain

Australia: Covidsafe

Source: De Michele 2020; Fiore 2020; Melissari 2020; Norton Rose Fulbright 2021; Wikipedia 2021

Who are the developers

COVIDSafe, adopted on 1 December 2020, works thanks to the "Trace together" software used by Singapore, and is connected to a government server and operated by Amazon. It is based on the Safe Blues method of estimating and controlling infections against COVID-19 which was developed by academic researchers from various institutes, including the University of Queensland, Auckland, the Massachusetts Institute of Technology and the Delft University of Technology (Safe Blues 2020).

How it works

The app is based on Bluetooth technology. COVIDSafe periodically issues a unique identifier (ID) that can be picked up by the smartphones that use the application, and that are nearby. If one of the app users later discovers that they are coronavirus positive, they can give consent to health authorities to use this information in a centralized online registry. COVIDSafe periodically connects to the registry and compares the list of IDs reported with those it has collected, passing by other smartphones that use the application. In case it finds a match, it sends a notification to alert the user who can then contact the healthcare staff. The ID for each user of the application is provided at the time of registration, again through the app. To be able to register, you must enter your name and surname, age and postcode of the area in which you reside. The app then asks for a mobile number to have a unique reference to the user, and to prevent individuals from creating multiple IDs, complicating system management. You will then receive an SMS with a PIN to be entered in the app to confirm your identity. The application only collects anonymous IDs issued by nearby smartphones, with the time in which it collected the data. The ID and the time are two sufficient data to reconstruct a possible contact with a person who later tested positive. COVIDSafe therefore does not collect geographic information and does not use GPS, offering, according to its developers, some more guarantees for privacy.

Data and privacy

The Australian government has confirmed that it will be responsible for managing the online registry, where IDs of positive results flow together. The collected data will be deleted after 21 days from the first entry. However, the health authorities of the individual states (Australia has a federal structure) will have access to the information, while this will not be made available to law enforcement or other federal agencies. The police will not have access even with a warrant and the courts will not be able to force the government to provide information on individual users.

France: StopCovid and TousAntiCovid

Source: Norton Rose Fulbright 2021; Horton Ollia 2020

Who are the developers

The app was designed by a government-led task force, in collaboration with the leading telephone operator Orange Sa, the software company Dassault systemes Se, and Inria, the French research institute for digital science and technology, was publicly launched on 8 April 2020, tested until May and then definitively operational from early June (Norton Rose Fulbright 2020). France has chosen to have its app designed by companies and national bodies.

How it works

France has chosen to have its app designed by companies and national bodies. Unlike what happened in Italy, France, similarly to the United Kingdom, has decided not to use the Apple-Google platform in the name of the country's digital sovereignty. The French independence in choosing the application in the centralized PEPP-PT model with data on a server was highlighted, compared to other 22 European countries that have chosen the decentralized DP-3T model, with the data remaining on the phones.

The StopCovid tracking app does not use geolocation and also relies on Bluetooth to notify when a phone is in the vicinity of others who have the application and alert in relation to any proximity to those who tested positive (without revealing their identity). Bluetooth then tracks contacts, not where they happened. TousAntiCovid is an enriched and interactive version of the first StopCovid application. The functionalities remain almost completely unchanged, even if the name change brings with it some aesthetic tweaks and the introduction of new features such as direct access to updated official data about the pandemic, links to institutional sites and resources and the list of measures to be respected to deal with the emergency. TousAntiCovid is an application that allows everyone to be an actor in the fight against the epidemic, and as already mentioned it has features similar to the Italian app and more generally to those of European countries, paying particular attention to privacy at the expense of efficiency at times. There is greater transparency with automatic and regular publication of key data, access to DépistageCovid, the updated map of screening locations that includes practical information such as estimated waiting times.

Data and privacy

The application is based on voluntary use and allows the traceability of contacts, thanks to the use of Bluetooth technology, without resorting to the geolocation of people. The collected data will be deleted after 14 days from the first entry. The Secretary of State for Digital, Cédric O, tried to reassure the population, recalling that geolocation (the focal point of much of the controversy on data protection related to the Immuni app) will not be used by

the French application StopCovid, which the code computer (source code) of the app will be completely public. In the exceptional context of crisis management, the members of the college Commission nationale de l 'informatique et des libertés CNIL intervened on April 24, 2020 claiming that the system complies with the general data protection regulations (GDPR) if certain conditions are met. CNIL noted that a number of guarantees are provided by the government plan, notably the use of pseudonyms. However, the CNIL requested vigilance and stressed that the application can only be implemented if its usefulness is sufficiently demonstrated and if it is integrated into a global health strategy. Insisting on the necessary safety of the device, he made technical recommendations.

Germany: Corona-Warn-App

Source: Norton Rose Fulbright 2021; De Michele 2020

Who are the developers

On 16 June 2020 the German federal government launched an official "Corona-Warn-App" app developed by SAP and Telekom for account of the German federal government.

How it works

Its functioning is similar to that of the others and is based on Bluetooth Low Energy technology, a technology for greater energy saving, which stores data on phones without transferring them to a central server. Germany has sacrificed the so-called "digital sovereignty" invoked by France and the United Kingdom and supports the technology proposed by Apple and Google for the coronavirus infection tracking app. Corona-Warn-App is based on contact tracking to protect of privacy (PEPP-IT). They are entirely open source, licensed by Apache 2.0. Corona-Warn is under development on the basis of the Exposure Notification Framework (ENF) provided by Apple and Google, which uses Bluetooth Low Energy technology (BLE). The app collects anonymous data from nearby cell phones using BLE. As soon as two users approach a distance of about two meters and remain at this distance for fifteen minutes or more, their apps exchange data via BLE. If a user tests positive for COVID-19, the user can enter the test result in his Corona-Warn app. The app then anonymously informs allcontactsstored. The data is stored locally on each device by preventing access and control over the data by the authorities or third parties.

For the maintenance and development of its tracking app, Germany has invested around 3 million euros per month (Brady 2020).

Data and privacy

There are no major privacy concerns as Corona-Warn-App was designed with a focus on privacy from the very beginning. German data protection authorities generally support the Corona-Warn app and have only expressed small concerns, but less about the Corona-Warn app itself and rather about how it can be used: there are some concerns regarding intent from Apple and Google. The collected data will be automatically deleted after 14 days from the first entry. The voluntary aspect of the Crown-Warn-App could be undermined through social or economic pressures that could be specifically applied by employers. It has been proposed that a special accompanying law (which has not been passed, only drafts from the opposition parties) is required to address these issues. The Federal Commissioner for Data Protection and Freedom of Information (Bundesbeauftragter für den Datenschutz und die Informationsfreiheit) has announced that the use of telephone registration is not an optimal solution because the complete anonymity of the user will no longer be guaranteed.

Ireland: Covid Tracker Ireland

Source: Government of Ireland sd; Kelion Leo 2020

Who are the developers

We were unable to trace an official source regarding the government's decision to set up a tracking app, but we know that its launch took place in conjunction with the most European applications (Leo Kelion 2020). Developed by the company Neaform software, Covid Ireland Tracker application uses the API *"ExposureNotification"* developed by Apple and Google, which has been available in the latest iOS (iOS 13.5) and Android (6.0) update. NearForm, the software company that created COVID Tracker in collaboration with the Irish health authorities, to find out how they avoided the problems found in other contact-tracing apps. NearForm was initially working on a centralized app to collect data to share with authorities, but it moved on to a more private and decentralized model after Google and Apple released new contact-tracing technologies for developers.

How it works

The company has employed a team to investigate the use of Bluetooth technology within the app. Like many other contact-tracing apps, COVID Tracker uses phones' Bluetooth to send signals and search for nearby devices that have the app installed. These signals allow you to create a contact log - if one of the users tests positive for the coronavirus, the Health Services Executive can download his log and notify all users with whom they have come into contact through the app itself. The use of Bluetooth has caused some problems, especially with regard to iPhones, which do not allow apps running in the background to send Bluetooth signals. The HSE then contacted Apple directly, and in a short time, both Apple and Google announced a new API specifically for contact-tracing apps - basically, a standardized app model for developers to use. This new API has completely revolutionized the plans of the company. NearForm's app was based on a centralized model, which collects user data externally so that it can be analyzed by authorities. But Apple and Google were clear: in order to use their API, the authorities would have to employ a decentralized model, where all data remains within the single mobile device.

This would have preserved the privacy of individual users, according to the two companies. The limitations of Bluetooth and the privacy issue made the HSE's decision to switch models very easy. Being able to share part of the technical burden with Apple and Google was certainly a positive aspect.

Data and privacy

The HSE highlighted how COVID Tracker is based on the decentralized model implemented by Apple and Google, such that the contact data will be stored and archived only on the user's terminal and not within a government server. "The decentralized model" declared the Institute: "allows to align the application to the privacy and public health principles outlined by the European Commission, the OECD, the WHO and the European center for disease prevention and control".

Italy: Immuni

Source: ANSA 2021; Barlassina 2020; Allievi 2020; Angius and Coluccini 2020c; 2020b; 2020a; Bandirali 2020; Barlassina 2020; Berti, Longo, and Zanetti 2021; Camera dei Deputati 2021; Clarizia and Schneider 2020, De Michele 2020; Dipartimento per le Politiche Europee 2020; Erman 2020; Feroni 2021; HDblog.it 2020; Il Messaggero 2020; Il Post 2020; Immuni 2021; Jakala 2021; Janssen 2021; Marioni 2020; Melissari 2020; Menietti 2020; Ministero della Salute 2020; Ministero per l'innovazione tecnologica e la transizione digitale 2021; NTR 2021; Nuova Società 2020; O'Neill, Ryan-Mosley, and Johnson 2020; Pezzali 2020; Rai 2020; Rociola 2020; Ruffino 2020; Salerno 2020; SoftMining 2021; Zunino 2020

From the idea of a tracing app to the contract and related public funding

The idea of developing a contact tracing application takes shape on 23 March 2020, when the Minister of Economic Development, the Minister of Health and the Minister for Technological Innovation and Digitization launched a *fast call for contribution*, closed on March 26, 2020, aimed at private individuals, companies and organizations, aimed at identifying the best digital and technological solutions available for the "active" monitoring of the risk of contagion from COVID -19.

On March 31, 2020, the Minister for Technological Innovation and Digitization appointed the "*Data-driven working group for the COVID-19 emergency*" with the aim of carrying out analysis and study of the impacts of the epidemiological phenomenon in progress, as well as to proceed quickly with the evaluation of the proposals formulated by the participants in the *fast call*, in order to select the most effective and suitable proposal to be implemented quickly at national level.

Following the results of the assessments carried out by the Working Group and communicated to the Minister for Technological Innovation and Digitization, Paola Pisano, and from what was declared by the Research Institute on Public Administration (IRPA) in 2020, the solution of "Immuni", was considered the most effective and efficient in combating the virus both for compliance with the European model outlined by the Pan-European Privacy-Preserving Proximity Tracing Consortium (PEPP-PT Consortium) created by a group of 130 scientists and 32 companies and research institutes of 8 countries, including the ISI Foundation of Turin, on which France and Germany are converging, as well as for the guarantees it offers in respect of *privacy*.

For this Bending Spoons SpA has been selected, among the more than 300 solutions proposed, by the task force of 74 experts chosen in collaboration with the Ministry of Health to evaluate and propose technological solutions based on data analysis and address the health emergency.

The proceedings continued, with ordinance no. 10/2020 of April 16, 2020 of the former extraordinary Commissioner for the implementation and coordination of the containment and contrast measures of the epidemiological emergency COVID-19, upon the signing of the open, free, perpetual and irrevocable license agreement of the source code and all application components. It also committed, again free of charge, to complete the software developments necessary for the activation of the national contact tracing service.

Who are the developers

In Italy, the digital tracking system is being considered to contain and combat the epidemiological emergency COVID-19 in the first half of 2020 because it can "help identify potentially infected individuals before symptoms emerge and, if conducted quickly enough, can prevent subsequent transmission from secondary cases." This is what we read on the ordinance of April 16, 2020 with which the former extraordinary Commissioner for the emergency Domenico Arcuri signed the contract with Bending Spoons. Bending Spoons, the creator company is Italian. Founded in 2013 by five partners, four Italians and one Danish, all under 30, it is number one in Europe for the development of iPhone apps and among the top ten in the world for downloads. Initially the headquarters was in Copenhagen, but in 2014 it was moved to Milan.

How it works

In general, a tracking app can be downloaded and used by any individual on their smartphone. The app creates a contact log in which there are three pieces of information: what device I have been in contact with, how far away, for how long.

These three characteristics are usually typical of all tracking models since they contain the key factors to be able to identify where and when the potential contact occurred and to break the chain of transmission. If the individual is positive following a test, the medical operator authorized by the positive citizen, through the anonymous identification of the same, sends an input / alert message to inform all those users identified anonymously who have come into contact with him. On this aspect, doubts have often been raised regarding the confidentiality of such data and its management. However, their administration never seems to have presented critical issues given the encryption of the subjects, the automatic deletion of data every 14 days (complete reset as of 31 December 2020). In Italy, on the other hand, it was found that in some cases the application did not communicate with an alert the contact with a positive

subject, therefore not making it known until the application was opened again, which often occurs sporadically, thus causing the proliferation of the virus to continue. Although this has happened to some individuals, most cases have not encountered this problem.
Starting from February 25, 2021, with a provision of the Guarantor for the protection of personal data (change of reporting procedure), a new, more accurate and effective procedure for tracking data has been established.
With the authorization of the Ministry of Health, the app allows a positive person to "self-report" i.e. to independently activate the alert procedure sent to close contacts. Up to that moment, in fact, a great critical issue of the local health systems had been the inability to proceed in this sense by having adequate structures and personnel to manage the reports. With the introduction of the new functionality, it will be possible to interact directly with the COVID-19 alert system (the definition can be found in the FAQ of the Immuni app) by entering, in the specific section of the Immuni app, the unique national code (Cun) attributed to the health card to its report of a successful COVID-19 diagnostic test, together with the last 8 digits of the health card.

Data and privacy

The Alert System, after verifying the data provided, enables the loading of temporary keys (so-called Tek) generated by the smartphone of the positive user, necessary to alert his close contacts.
Once the Teks have been successfully loaded, the COVID-19 alert system will invalidate the Cun code, in order to prevent further reports so as to avoid subsequent improper use (this is to avoid that the system can be polluted with false data and keep at the same time total privacy)
The application consists of two parts.
Contact tracking via Bluetooth: Bluetooth allows you to detect the proximity of two smartphones within one meter; the user will then be able to know if he has come into contact with a COVID-19 positive person. It will also be possible to retrace all the encounters of a positive person to track and isolate the potential infected: the app keeps a register with the anonymous identification codes of all the other smartphones in the vicinity of which you have been close;
Clinical diary: contains all the most relevant personal information of the individual user (sex, age, previous illnesses, drugs taken, etc.). The user must take care to update the clinical diary daily with any symptoms and details on the state of health (the data of the clinical diary remain stored in their device so it is not possible to establish what portion of the population is able to provide correctly to update their data on the clinical diary).
The framework of the Immune System therefore has three fundamental components to date:

- the app installed on smartphones,
- the national server located at the Ministry for Technological Innovation and Digital Transition,
- the platform located across the Atlantic which, as we shall see, intervenes during the two delicate phases in which the procedure is carried out: the "ante alert" and the "post alert" of contagion risk.

Public information and advertising campaigns on its use

The campaign aims to:

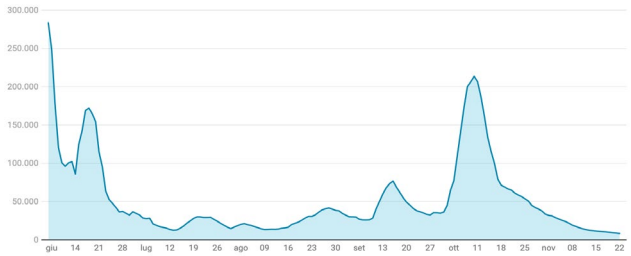
- promote the use of Immuni and contribute to the increase of downloads;
- inform people about the functioning of Immuni, about its usefulness, safety, reliability;
- promote a sense of personal responsibility and belonging to the national community.

At the beginning of May 2020, when the alternative of the application was known, the Minister for Technological Innovation and Digitization Paola Pisano also announced a strong promotion with an advertising campaign on TV, press, radio and social networks.
The campaign lasted 4 months, divided into three phases: the launch in June, a maintenance phase in July / August and early September, and the third recall phase at the start of autumn.
The coordination of the campaign, both for creativity and for planning, was handled by Publicis Groupe, which made team and resources available completely free of charge, coordinating a real alliance between the media involving Rai, Mediaset, Sky, Apple, Google, Facebook, Mondadori, ItaliaOnline, Il Messaggero, RCS, Gedi Group, public figures, startups, companies.
According to a Rai 3 report conducted by Enrico Lucci aired on October 27, 2020, most of the politicians of the parties at that time in the opposition considered themselves opposed to "Immuni" or simply claimed they would not have downloaded it, especially parliamentarians of the League and Brothers of Italy. The parliamentarians of the ruling coalition (MoVimento 5 stelle, Democratic Party, Liberi e Uguali, Italia Viva) and Forza Italia were, on the other hand, generally in favor. Some of them have shown that they have downloaded and activated it on their smartphone inviting everyone to do so.

Usage data

In total there were 9.9 million downloads for Immuni, including 7.3 for Android and 2.6 for iOS. However, the trend of downloads over time has been very irregular, as can be seen from the graph: until June 22, daily downloads have never been less than 80,000, and then dropped significantly and remained below 50,000 for the whole summer. In the first ten days of October, on the other hand, there was a rapid increase in downloads (over 200 thousand per day), before returning to drop and arrive - on November 22 - below 10 thousand. These numbers are definitely below the minimum necessary in order to reach a satisfactory level of contact tracing coverage on the national population.

Figure 5 - Immuni download trend, June-November 2020 (seven-day moving average)



Source: Processing on YouTrend and Immuni data (created via Datawrapper).

Why has the Immuni app been implemented and not other apps?

In order to better understand why the application created by Bending Spoons SpA was chosen, it was deemed appropriate to carry out a comparison between the winning Immuni application and the other alternatives on the market during the year 2020. In particular, among the different alternatives, four apps were identified for the analysis - Covid Community Alert, DiAry - Digital Arianna, Sm-COVID-19 and StopCovid19 - and an identikit was built for each. As it can be seen in the appendix, in analogy to what was done for the Immuni app, three aspects have been the focus about the four alternative apps: the characteristics of the developers, the operating modes, the processing of data and the privacy. Covid Community Alert, DiAry - Digital Arianna, Sm-COVID-19 and StopCovid19 have been selected by us, since the related official sources (websites) allowed a detailed comparison and analysis. To this end, please refer to the appendix. Regarding the question that we asked ourselves at the beginning of the paragraph, according to the Institute of Research on Public Administration (IRPA) and, as already explained at the beginning of paragraph 3, Immuni has been implemented because according to the "Working group given -driven for the COVID-19 emergency ", appointed on 31 March by the Minister for Technological Innovation and Digitization, the application complies with the provisions of the PEPP-PT Consortium and guarantees respect for privacy. That said, there are still elements of ambiguity regarding the procedure used. In fact, according to IRPA, Immuni does not seem to comply with all the criteria identified in the fast call. Furthermore, in the decree of the Extraordinary Commissioner for the COVID-19 emergency, no detail is indicated on the effectiveness of the chosen technological solution. According to government estimates, in fact, the tracking and contact app must be systematically used by at least 60%. Furthermore, there is no indication on compliance with the mapping minimization principle, or on the transfer of data, processed and, apparently, stored on a single ministerial server. Despite the critical issues identified above, it should be considered that there is no perfect app. In fact, the cost-benefit analysis regarding Italy found preferences towards a decentralized rather than centralized app architecture, a Bluetooth technology instead of GPS and without the support of big tech companies.

Italy: the other main tracking apps

Italia_Sm-COVID-19: the first Italian contact tracing app

Source: SM-Covid-19 App 2021; SM-Covid-19 2021c; 2021b; 2021a; 2020; STOPcovid19 2021

Who are the developers

The team is made up of a consortium of epidemiologists, engineers, data scientists, developers, lawyers, professors and researchers from numerous companies and institutions including, in addition to SoftMining, there are: Nexus TLC, MinervaS (TruckY), PushApp, TTPoint University of Salerno, Digital Magics, Apple Academy. The Sm-COVID-19 app was developed without profit or for the acquisition of sensitive data (SM-Covid-19 2021b).

Mode of operation

SM-COVID-19 bases its operation on the ReCoVer protocol, a centralized protocol defined to achieve the following objectives: to

- be used on a voluntary basis;
- allow contact tracing;
- guarantee the anonymity of the participants;
- allow the reconstruction of the chains of contagion;
- allow the calculation of a risk estimate, for each node connected to the network;
- send notifications to devices connected to the network without knowing their identity;
- allow the acquisition, on a voluntary basis, of location information without binding it to sensitive data;
- prohibit the connection between devices for the exchange of keys or other information;
- allow third-party apps to interact with the ReCoVer network;
- allow the use of customized Beacon Layouts;
- allow entities with the role of authority to be able to query coherent anonymized data (SM-Covid-19 2021a).

In order to help health professionals in managing the pandemic crisis, the app transmits a specific code to the health authorities. More precisely, thanks to the use of Bluetooth Low Energy (BLE) wireless technology (SM-Covid-19 2020) an anonymous beacon is emitted. This anonymously contains the individual user's 128-bit ID code. The generated IDs undergo a remote Claim procedure aimed at ensuring that the IDs have not already been used in the past. The remote Claim service guarantees two properties:

- **Atomicity**: if two simultaneous calls to the Claim function contain the same universally unique identifier (UUID), one of the two is canceled;
- **Non-repeatability**: a UUID is accepted by the Claim phase and is authorized if and only if it has not been previously accepted (SM-Covid-19 2021a).

If the ID is declared unique it is authorized to be transmitted and the app receives a temporary authentication token. The first will allow access to the other services on the network during the lifetime of the random ID. Each device keeps track locally of all the unique identifiers it has managed to register. In the event that the Claim procedure fails, the device is forced to generate a new temporary ID in order to use the network services. The beacon can be intercepted by applications that are nearby, with subsequent estimation of the distance between the emitter and the receiver. For devices without BLE, but compatible only with standard Bluetooth technology, BT broadcast packets are emitted, according to pre-established time intervals, which can be intercepted by all devices using the Sm-COVID-19 application. Also, it is important to note that the app does not need GPS data in order to function properly. The user must have the ability to disable the tracking functionality. In fact, Sm-COVID-19 provides the functions "outdoors" and "at home". The app can be authorized to automatically start tracking when it is detected that the user is outside a safe zone.

Data and privacy

The Firebase-Firestore framework (SM-Covid-19 App 2021;

Firebase 2021) is used for data collection. The company SoftMining Srl also underlines that the data are anonymized at the time of their acquisition and processed by automated systems (machine learning, clustering and / or scientific applications) to extract recurring patterns and information related to their clustering (SM-Covid-19 2020). Regarding the possible GPS localization, the company affirms that only in case of explicit authorization by the user will the data relating to its geolocation be used. More precisely, these data can be used for the creation of Heatmaps and risk models and contagion trends. However, location data will only be recorded in the event that other users in the immediate vicinity are detected (SM-Covid-19 2020).

Italy_Covid Community Alert

Source: Corona Virus Outbreak 2021; Covid Community Alert 2020

Who are the developers

The official homepage reports that the Covid Community Alert application has been developed by experts from all over the world. In fact, the Coronavirus Outbreak Control team is made up of 35 experts from six different countries (Corona Virus Outbreak 2021). It is also reported that some members of the team have worked in the past with internationally renowned partners, such as Airbnb, Google and Microsoft. The project leaders are: Luca Mastrostefano, Antonio Romano, Domenico Lupinetti, Carlo Martini (Covid Community Alert 2020). The team was formed on February 15, 2020 (Corona Virus Outbreak 2021). Three days later the collaboration with the National Research Council (CNR) and with the research team in Brazil began. On 8 and 16 April 2020 there was, respectively, the demo with the Brazilian Ministry of Health and the start of integration with IT services in Brazil. In Italy, the app is awaiting technical approval.

How it works

The application is compatible with both iOS and Android and is absolutely compliant with European directives. According to the homepage, the app allows anonymous monitoring by 38% more than traditional Bluetooth solutions (Corona Virus Outbreak 2021). The app is based on a worldwide open source standard and allows monitoring anonymously. The website emphasizes the international dimension of the application, since users' movements and travel abroad imply the need to have a worldwide protocol available that can adapt to all different scenarios. Each open source component - as well as the rules and messages established by virologists to identify people at risk - can be modified and adapted to the different regulations of different countries.

It is important to distinguish between:

– iPhone and Android user applications (CovidApp)
– medical applications for iPhone and Android (CoviDoc).

The keywords underlying Covid Community Alert are:

– **coverage**: ability to anonymously monitor 91.2% to 98.5% of all interactions between mobile phones (iPhone and Android), compared to 71.7% for traditional technologies;
– **interoperability**: distribution of open-source SDKs (software development kits) that implement the anonymity protocol;
– **roaming**: support for interoperability between nations that implement the open-source protocol. Experts are given the opportunity to establish rules and notifications to be sent to patients;
– **reaction speed**: automatic contact of users. The notification can be sent directly from the laboratories where the swab is analyzed. The platform is also able to identify patients who have no symptoms (Corona Virus Outbreak 2021).

Data and privacy

IDs are anonymous and cannot be used to obtain personal data. Also, no login is required. There is no collection of sensitive data; the user's IP, in turn, is not saved. The application uses a technology that does not require GPS geolocation. All the product code needed for the service to function is open source and available online for review.

Italy_StopCovid19

Source: Barlassina 2020; STOPcovid19 2021

Who are the developers

The project that led to the creation of the StopCovid19 app was created by Webtek completely free of charge (STOPcovid19 2021). According to Forbes, Webtek is a company founded in 2008 by Emanuele Piasini and his team of 30 people (Barlassina 2020). Before the pandemic, they were involved in communication and development of small software.

How it works

StopCovid19 keeps track of the movements of users and their contacts and is available for iOS and Android. The application uses the GPS signal to locate the device on which it is installed and to store data relating to movements. If necessary, the competent authorities may have access to the data, which will be automatically deleted after 30 days and cannot be used for commercial or other purposes (STOPcovid19 2021). The health authorities are able to get in touch with the affected user and know whether or not the user in question has been exposed to the infection. In case of need, the user can be promptly notified.

Data and privacy

The information collected by the application is accessible only to the competent authorities. No user can view the data, not even their own. It is possible to delete your user profile and all data recorded by the application, which will be permanently deleted (STOPcovid19 2021).

Italy_DiAry - Digital Arianna

Source: diAry - Digital Arianna 2021; University of Urbino 2021a

Who are the developers

DiAry - Digital Arianna, whose name is a mix between the English word diary and the myth of the Minotaur, is developed without purpose of profit from the University of Urbino and DIGIT srl, a university spinoff, innovative srl and benefit company, with the voluntary contribution of civic hackers, developers and researchers (University of Urbino 2021a).

How it works

The application automatically detects the user's position and movements and stores it on their local memory (i.e. on the personal device). The user is granted the possibility of labeling all the places where he stops for at least 5 minutes, keeping memory of it (University of Urbino 2021a). Furthermore, the application is able to calculate the time spent in each place or on the move, recognizing whether the trips are on foot, by bicycle or by motor vehicle. The application allows the anonymous and voluntary transfer of daily statistics to a central database, thus contributing to the construction of an open data set. The user can also share the traces collected on his device and cross them with data of public utility (University of Urbino 2021a). The application calculates the following statistics every day: number of hours of application activation, percentage of time spent at home, total travel time, maximum distance from home, number of spontaneous annotations. The main system used is GPS, which, based on signals received from satellites, makes positioning errors of the order of 5 meters outdoors, but is less accurate inside buildings or in very narrow streets.

It is possible to find the source code, freely available under the MIT license, on GitHub.

The source of the mobile application diAry (Digital Arianna "diAry" [2020] 2020) is developed in Flutter, for Android and iOS. The data transfer back-end source (Digital Arianna "diAry" [2020] 2020) is developed in C # for .NET Core 3.1 (diAry - Digital Arianna 2021).

DiAry - Digital Arianna rewards responsible behavior, allowing you to collect at the end of the day a number of WOM, acronym for Worth One Minute, voucher for the recognition of social value (University of Urbino 2021a) proportional to the time of use of the app and time spent at home. WOMs can, in fact, be used as vouchers. Merchants and service providers can attribute value by granting discounts and concessions (University of Urbino 2021b). The aim is to contribute to social cohesion, attributing a value to the compliance with containment measures and offering a simple mechanism to link this act of responsibility to the economy of the territories involved.

Data and privacy

The application is completely open source. The specification and algorithms are public. The data are stored exclusively on the personal device of the user, who can freely decide to consult them, export them and possibly cross them with information of public utility. All collected statistics will be made available as open data. The WOM platform, used to recognize the social value of individual behaviors, is also an open source technology. No registration or account creation is required, as the data is stored on the user's personal device. There is no way to upload tracks to the network. The application only allows you to extract them in csv format to leave the user full freedom of use outside the app. The statistics collected daily do not allow to trace the person to whom they refer or his movements (University of Urbino 2021a).

New Zealand: NZ COVID Tracer

Source: New Zealand Government 2021

Who are the developers

NZ COVID Tracer is an app from the Ministry of Health. NZ COVID Tracer was developed for the Ministry of Health by New Zealand company Rush Digital and is based in part on the Amazon Web Services (AWS) platform.

How it works

The strategy adopted by New Zealand does not aim at coexistence with the virus, but at its elimination. It is a method that allows to reduce to zero the incidence of a disease in a certain geographical area. The "zero covid " road was adopted by the New Zealand government after an initial attempt to keep the curve under control through stringent strategies aimed at trying to control the number of infections. After a 5-week lockdown, the NZ went from a level 4 to a level 1 alert, declaring the pandemic over after 103 days without any positive cases.

The NZ COVID Tracer app used by New Zealand is a kind of digital diary to help people track their movements. It can be used to:

- scan QR codes to create a private digital diary of the places visited;
- use Bluetooth tracking to keep an anonymous record of the people you have been close to;
- record their contact details so that contact tracers can get in touch if necessary;
- save your National Health Index (NHI) number to expedite the process if you need a test;
- find the nearest test center and access other useful information.

The Bluetooth trace allows you to receive an alert if you have been near another app user who tested positive for COVID-19. It is safe, private and anonymous. Creating a private digital diary of the places you visit makes it easier to remember where you've been if needed. This way by scanning QR codes with the NZ COVID Tracer app you can receive a location alert if the same place is visited, at roughly the same time, by someone who later tests positive for COVID-19. The app will therefore only be used in the event that a person contracts the virus, so as to be able to easily reconstruct and report their movements. In addition, a solid system of isolation of positive cases was implemented in the country, which were transferred to hotels transformed into quarantine facilities.

Data and Privacy

An All-of-Government Cloud Services Agreement with AWS has been in effect since 2017. AWS services and

infrastructure have been reviewed as part of the procurement process and are regularly tested against third-party warranty frameworks. Any information recorded by NZ COVID Tracer that you choose to share for contact tracing is encrypted before being sent to the Ministry via the AWS cloud services platform. The information you have chosen to share will be stored securely on the Ministry's servers on the Amazon web service hosted in Australia, and later deleted. The Ministry maintains control of the decryption keys. NZ COVID Tracer has also been evaluated by independent security experts to ensure your data is handled securely. NZ COVID Tracer has been approved by the Privacy Commissioner because it is designed to protect the privacy of all who use it. NZ COVID Tracer has also undergone independent safety testing. Any personal information and contact details you choose to register through NZ COVID Tracer are provided to the Ministry of Health so that contact tracers can contact you quickly if you are identified as a close contact of someone who has COVID-19. It is entirely your choice which information to provide - all information is optional, it will never be used for enforcement purposes. It will also not be shared with another government agency unless that agency is directly involved in the COVID-19 response and information sharing is required for public health purposes during the pandemic.

Russia: Gosuslugi

Source: ICT Moscow 2020; Norton Rose Fulbright 2021

Who are the developers

Russia has developed a smartphone app that alerts users to possible coronavirus exposure. The country's ministry of digital development, communications and media announced the app, tentatively titled "Stopcoronavirus", in mid-November 2020. The ministry said it had partnered with Moscow City Hall, as well as Apple and Google to develop the contact tracking app. The tech giants last spring collaborated on the development of exposure notifications now available in many countries including the European Union. The Ministry of Digital Development of the Russian Federation then launched at the end of November the real application "Gosuslugi. Covid Tracker" (on the App Store, Google Play) to keep track of contacts with coronavirus patients throughout Russia. Gosuslugi is a platform active since 2009 in Russia that we can consider as the site of the Russian public administration.

How it works

The contact tracing system is based on Bluetooth technology similar to that of public health authorities in other countries and its download is a voluntary decision. This application replaces a previous tracking model that is the one of tracking only the infected with a strict control of quarantines such as random "inspections" in which users were asked to show with a selfie that they are isolated at home. On this system there have been various criticisms about alleged high fines that arbitrarily arrived even to those who were not isolated. Now users diagnosed with COVID-19 must report it independently and anonymously via the app. In turn, users with whom this person has been close in the last 14 days will receive a notification with the date of the possible contact. To avoid false notifications (for example, a user who jokingly registers as sick), a person diagnosed with the coronavirus will have to enter a special code in the app, which will send notifications to people who have been in contact with them. These codes will be made available when a Russian resident tests positive for COVID-19. Once a user logs into the notification system, it generates a random ID for their iOS or Android device, which is then exchanged with surrounding phones via Bluetooth (in other words, the phone broadcasts the ID, while collecting the IDs of the devices around it). During the day, the device will download and check for random IDs linked to positive COVID-19 cases against its own list. In case there is a match, a notification is sent saying that you have been in contact with a COVID-19 patient and offers advice on how to proceed "

Data and privacy

The contact tracing app, which is based on developed technologies by Apple and Google, it's designed to track nearby mobile devices and alert you if they're within 10 meters of someone diagnosed with COVID-19. Russian authorities have also promised not to use the app to collect personal information. Your phone scans your surroundings within a maximum range of 10 meters. All interactions are recorded anonymously on the device. The shorter the distance and the longer the interaction, the higher the risk estimate of infection by the app. The information is anonymous, the patient's identity is not disclosed. The data remains on the device and is automatically deleted after 14 days. Apple and Google know ttolined as the technology does not use GPS, which means it does not track users' locations. The app is completely anonymous, without any connection to "Gosuslugi", otherwise the same companies would have allowed it to be used.

South Korea: Corona 100m-Corona maps

Source: Lightning 2020; Zunino 2020; Shendruk 2020; Ribeiro 2020

Who are the developers

We have not been able to find a reliable source with a precise date for the development and adoption of the Corona 100m-Corona maps app in Korea. The Corona 100m app was developed by the Ministry of Interior and Security, with the collaboration of Bae Won-Seok, one of the creators of Corona 100m (Shendruk 2020). Lee Jun-young is the developer of Corona Map (Ribeiro 2020).

How it works

Corona 100m crosses the user's geolocation data with public government databases, allows users, among other things, to see the date on which a patient has had the confirmation of positivity, as well as his nationality, the gender, age and its movements, and of course, as the name of the app implies, the distance from potential places at risk. When someone enters a radius of 100 meters from

where a person registered as suffering from Coronavirus has passed, they receive a push notification. Coronamap allows you to track the movements of people registered as carriers of the virus. Users are informed of places visited by infected people, again in the area of one hundred meters. And always through this tool it is possible to notify the health authorities and thus trace the infected and exposed people. At that point, for those who do not yet have a diagnosis, quarantine, antigenic swabs and therapy are automatically disposed. The prerequisite for the operation of this system is the geolocation with Gps through the smartphone.

Data and privacy

The "Corona100m" government application crosses the user's geolocation data with those provided by the government, and was launched on 11 February 2020. Quarantined people are assigned to a government official who checks them twice a day. day by phone. However, they can, voluntarily, download the app and be tracked through it, as an alternative to checking via telephone. However, government officials are advised to use the app's results with discretion, considering that GPS data is not always reliable and accurate. The data that flow to the authorities allow not only to support the government's activities to combat the spread of the coronavirus, but also to constantly inform the population of these activities carried out by the authorities, and of the spread of the infection. Obviously, keeping the spread of the infection under control exactly means monitoring people. This is an approach that could be highly invasive of privacy. But it is a specific choice of the Korean authorities who consider it the only way to prevent the spread of the virus, without at the same time canceling the activities of an entire nation. There is no tracking of the entire population, but only of the subjects in quarantine (voluntary or forced) who decide to use the app. The use of the app is entirely voluntary (unlike in China), and is based on the consent of the individual, who may also not download or use it. The app also serves to keep in touch with healthcare professionals, as an alternative to the phone. The infected are interviewed, to verify their movements, and then the data are cross-referenced with those of government or private databases (surveillance cameras, credit card transactions, etc.), to collect information on their movements and to recreate the their paths (*contact tracing*). Then only the data about the places where a contact of the infected person with other people was possible (if the patient was without a mask) is disclosed to the public. In some cases, the name of a specific shop is also indicated (which leads to its closure). The authorities specify that they disclose only some of the data of the infected subjects. The dissemination of such data, however "anonymized", has created serious problems for some Koreans, who have been recognized by crossing the information, or simply because someone mistakenly believed to recognize them, thus defaming completely innocent people. Many people have complained on social media about such situations and the discriminatory consequences, asking to be left alone. Authorities said they intend to further limit the information disclosed. Despite the problems that have emerged, there seems to be a strong demand for more information (even a petition has been launched to get more information on the movements of the infected).

Spain: Covid Radar

Source: Government of Spain 2021

Who are the developers

The contact tracing technology was developed with the help of Apple and Google as well and is very similar to the Immuni app in Italy, it was developed by Ministry of Economic Affairs and Digital Transformation.

How it works

The application uses the terminal's Bluetooth connection, through which mobile phones emit and observe anonymous identifiers of other phones that change periodically. When two terminals have been close for 15 minutes or more, two meters or less apart, they both retain the anonymous identifier issued by the other. If a user is diagnosed positive for COVID-19 after undergoing a PCR test (a PCR test is the best way to ascertain a covid-19 infection. Through this test the results of a rapid test can be confirmed or it can be determined healing by decreeing the end of the quarantine period), they can decide whether to give their consent so that an anonymous notification can be sent through the health system. In this way, the mobile phones that had been in contact with the patient would receive a warning about the risk of possible infection and instructions on how to proceed would be provided. By not requesting data of any kind, it is impossible to identify or locate any user in any way. One contact tracking element is Exposure Notification - the use of digital privacy preservation technology to tell someone that they may have been exposed to the virus. The implementation of this function on devices has raised the usual wave of suspicion among users and citizens, raising doubts about the actual respect of privacy. Both companies argue, however, that these are simply functions designed so that each country's administrations don't have to build systems from scratch.

Data and privacy

Covid Radar tracks who you have been in contact with over the past 14 days via mobile devices. In this way, the developers assure, it is possible to determine whether the user has been exposed in full anonymity. The application follows the most guaranteed technical standards with user privacy in compliance with all the recommendations made by the European Commission in this regard. In this way, no user can be identified or located because there is no recorded data and because the whole process takes place on their phone without going to any server. Both the use of the app and the communication of any contagion will always be voluntary.

Bibliographic references of the Annex on contact tracing apps

Allievi, Gianluca. 2020. «Bending Spoons, la società che ha ideato l'app "Immuni"». Agi. 2020. https://www.agi.it/innovazione/news/2020-04-17/coronavirus-app-immuni-bending-spoons-8364207/.

Angius, Raffaele, e Riccardo Coluccini. 2020a. «Abbiamo analizzato tutte le app che si possono già usare per il contact tracing del coronavirus [We analysed all the apps that can already be used for contact tracing of coronavirus]». Wired (blog). 24 marzo 2020. https://www.wired.it/internet/web/2020/03/24/coronavirus-app-contact-tracing/.

———. 2020b. «Coronavirus, le 2 app in pole position per fare tracking in Italia - Wired [Coronavirus, the 2 apps in pole position to do tracking in Italy - Wired]». Wired. 10 aprile 2020. https://www.wired.it/internet/web/2020/04/10/coronavirus-app-tracking-task-force/?refresh_ce=.

———. 2020c. «Coronavirus, tutte le app per fare contact tracing in Italia - Wired [Coronavirus, all the apps to do contact tracing in Italy - Wired]». Online newspaper. wired.it. 22 aprile 2020. https://www.wired.it/internet/web/2020/03/24/coronavirus-app-contact-tracing/.

ANSA. 2021. «Garante Privacy, sì a nuove funzionalità per l'app Immuni - Software e App». Agenzia ANSA. 11 marzo 2021. https://www.ansa.it/sito/notizie/tecnologia/software_app/2021/03/11/garante-privacy-si-a-nuove-funzionalita-per-la-app-immuni_c6381c38-9d3b-422a-bfbc-cf8e841437eb.html.

Bandirali, Federico. 2020. «Coronavirus, Immuni ha un'app rivale: Sm-Covid-19 [Coronavirus, Immuni has a rival app: Sm-Covid-19]». TimGate. 21 aprile 2020. https://timgate.it:443/news/tecnologia/coronavirus-app-rivale-immuni-sm-covid-19.vum.

Barlassina, Marco. 2020. «App di tracciamento: Stop Covid-19, l'applicazione italiana per fermare il coronavirus [Tracking App: Stop Covid-19, the Italian app to stop the coronavirus]». Forbes Italia (blog). 27 marzo 2020. https://forbes.it/2020/03/27/coronavirus-app-di-tracciamento-stop-covid-19/.

Berti, Riccardo, Alessandro Longo, e Simone Zanetti. 2021. «Immuni, cos'è e come funziona l'app italiana coronavirus [Immune, what is it and how does the Italian coronavirus app work]». agendadigitale.eu. 17 aprile 2021. https://www.agendadigitale.eu/cultura-digitale/immuni-come-funziona-lapp-italiana-contro-il-coronavirus/.

Camera dei Deputati. 2021. «Misure fiscali e finanziarie per l'emergenza covid-19 [Fiscal and financial measures for emergency covid-19]». Camera.it. 11 marzo 2021. https://www.camera.it/temiap/documentazione/temi/pdf/1210883.pdf?_1611832237853.

Clarizia e Schneider. 2021. «Luci e ombre sulla procedura di selezione di "Immuni", l'app del governo di tracciamento del contagio da Covid-19 - IRPA [Lights and shadows on the selection process for "Immuni," the government's Covid-19 infection tracking app - IRPA]». Official non-profit organisation website. IRPA; www.irpa.eu. 28 aprile 2021. https://www.irpa.eu/luci-e-ombre-sulla-procedura-di-selezione-di-immuni-lapp-del-governo-di-tracciamento-del-contagio-da-covid-19/.

Clarizia, Paolo, e Eleonora Schneider. 2020. «Luci e ombre sulla procedura di selezione di "Immuni", l'app del governo di tracciamento del contagio da Covid-19». IRPA (blog). 19 aprile 2020. https://www.irpa.eu/luci-e-ombre-sulla-procedura-di-selezione-di-immuni-lapp-del-governo-di-tracciamento-del-contagio-da-covid-19/.

Corona Virus Outbreak. 2021. «Covid Community Alert». 30 marzo 2021. https://coronavirus-outbreak-control.github.io/web/.

Covid Community Alert. 2020. «Home Page. Coronavirus Outbreak Control». 2020. https://coronavirus-outbreak-control.github.io/web/.

De Michele, Stefania. 2020. «Il confronto: tutte le app europee (e non) per tracciare i contatti [The comparison: all the European (and non-European) apps to track contacts]». Online newspaper. Euronews; it.euronews.com. 29 maggio 2020. https://it.euronews.com/2020/05/29/covid-19-fatevi-tracciare-e-per-il-vostro-bene-ecco-le-app-nel-mondo.

diAry - Digital Arianna. 2021. «Codice sorgente». diAry - Digital Arianna (blog). 19 aprile 2021. https://covid19app.uniurb.it/codice-sorgente/.

Digital Arianna "diAry". (2020) 2020. digit-srl/diAry-backend. C#. DIGIT srl. https://github.com/digit-srl/diAry-backend.

Dipartimento per le Politiche Europee. 2020. «COVID-19: le app di tracciamento dei Paesi europei verso un sistema comune [COVID-19: European countries' tracking apps towards a common system]». Institutional. 20 ottobre 2020. http://www.politicheeuropee.gov.it/it/comunicazione/notizie/app-interoperabili-ue/.

Erman, MIchael. 2020. «Covid. Vaccino Pfizer/BioNtech: dati definitivi sperimentazione Fase 3 indicano efficacia al 95% - Quotidiano Sanità [Covid. Pfizer/BioNtech vaccine: final Phase 3 trial data indicate 95% efficacy - Quotidiano Sanità]». Quotidiano Sanità e Daily Health Industry. 18 novembre 2020. http://www.quotidianosanita.it/scienza-e-farmaci/articolo.php?articolo_id=90073.

Feroni, Cerrina. 2021. «Provvedimento di autorizzazione al trattamento dei dati personali effettuato attraverso il Sistema di allerta Covid 19- App Immuni a seguito dell'aggiornamento della valutazione di impatto effettuata dal Ministero della salute su cui l'Autorità si era espressa con provvedimento del 1° giugno 2020 - 25 febbraio 2021 [9555987]». Institutional. garanteprivacy.it. 25 febbraio 2021. https://www.garanteprivacy.it:443/home/docweb/-/docweb-display/docweb/9555987.

Fiore, Paolo. 2020. «Il flop mondiale delle app di tracciamento per il coronavirus [The worldwide flop of coronavirus tracking apps]». Online newspaper. Agi; www.agi.it. 16 luglio 2020. https://www.agi.it/salute/news/2020-07-16/immuni-flop-app-tracciamento-9172190/.

Firebase. 2021. «Privacy e sicurezza in Firebase». Firebase. 2021. https://firebase.google.com/support/privacy?hl=it.

Government of Ireland. s.d. «Covid tracker App Ireland». Covid tracker App. Consultato 1 giugno 2021.

https://covidtracker.ie/.
Government of Spain. 2021. «App RadarCOVID». Radar Covid. 2021. https://radarcovid.gob.es/.
HDblog.it. 2020. «Coronavirus: come funziona Immuni l'app per il tracciamento dei contatti in Italia». HDblog.it. 18 aprile 2020. https://www.hdblog.it/mobile/articoli/n519704/immuni-app-tracciamento-contatti-italia/.
Horton Ollia. 2020. «France's StopCovid App: What Is It, How It Works and Why Privacy Groups Are Concerned». RFI. 27 maggio 2020. https://www.rfi.fr/en/science-and-technology/20200527-france-coronavirus-stop-covid-mobile-phone-app-technology-controversy-law-vote-privacy-concerns-surveillance-human-rights.
ICT Moscow. 2020. «Russian Government Launches Covid Contact-Tracing App». 25 novembre 2020. https://ict.moscow/en/news/the-ministry-of-digital-development-released-the-application-gosuslugi-covid-tracker-to-track-contacts-with-coronavirus-patients-all-around-russia/.
Il Messaggero. 2020. «Coronavirus, arriva la app "rivale" di Immuni: è già stata scaricata migliaia di volte [Coronavirus, Immuni's "rival" app arrives: it's already been downloaded thousands of times]». Il Messaggero. 21 aprile 2020. https://www.ilmessaggero.it/italia/coronavirus_app_contagio_sm_covid_19-5183844.html.
Il Post. 2020. «I piani per il contact tracing in Italia [Plans for contact tracing in Italy]». Online newspaper. Il Post; www.ilpost.it. 25 marzo 2020. http://www.ilpost.it/2020/03/25/coronavirus-app-contact-tracing-italia/.
Immuni. 2021. «Numeri di immuni [Official Numbers of the Immuni App]». https://www.immuni.italia.it/. 15 marzo 2021. https://www.immuni.italia.it/dashboard.html.
Jakala. 2021. «Location analytics - Jakala». Official corporate website. Jakala; www.jakala.com. 28 aprile 2021. https://www.jakala.com/en/solution/location-analytics/.
Janssen. 2021. «About Janssen | Janssen EMEA». Https://Www.Janssen.Com/. 11 giugno 2021. https://www.janssen.com/emea/our-company/about-janssen.
Kelion Leo. 2020. «Coronavirus: Ireland Set to Launch Contact-Trace App». BBC News, 22 giugno 2020, par. Technology. https://www.bbc.com/news/technology-53137816.
Marioni, Elisa. 2020. «Come funziona l'app per tracciare i contagiati testata dall'Umbria [How the app to track infected people tested by Umbria works]». Agi. 22 marzo 2020. https://www.agi.it/cronaca/news/2020-03-22/covid-19-umbria-app-tracciamento-7763334/.
Melissari, Laura. 2020. «Immuni e le altre app di contact tracing in Europa e nel mondo [Immuni and other contact tracing apps in Europe and around the world]». Online newspaper. Internazionale; www.internazionale.it. 25 giugno 2020. https://www.internazionale.it/notizie/laura-melissari/2020/06/25/app-immuni-contact-tracing-confronto-europa.
Menietti, Emanuele. 2020. «A che punto è il contact tracing in Italia [At what point is contact tracing in Italy]». Il Post. 16 aprile 2020. http://www.ilpost.it/2020/04/16/contact-tracing-coronavirus-italia-applicazioni-bending-spoons-centro-medico-santagostino/.
Ministero della Salute. 2020. «Contact tracing: Arcuri firma ordinanza per app italiana». https://www.salute.gov.it/. 2020. https://www.salute.gov.it/portale/nuovocoronavirus/dettaglioNotizieNuovoCoronavirus.jsp?id=4513.
Ministro per l'innovazione tecnologica e la transizione digitale. 2021. «Telemedicina e sistemi di monitoraggio, una call per tecnologie per il contrasto al Covid-19 [Telemedicine and monitoring systems, a call for technologies to combat Covid-19]». Ministro per l'innovazione tecnologica e la transizione digitale. 26 marzo 2021. https://innovazione.gov.it/notizie/articoli/telemedicina-e-sistemi-di-monitoraggio-una-call-per-tecnologie-per-il-contrasto-a/.
New Zealand government. 2021. «NZ COVID Tracer app». Institutional. Ministry of Health NZ | www.health.govt.nz. 22 aprile 2021. https://www.health.govt.nz/our-work/diseases-and-conditions/covid-19-novel-coronavirus/covid-19-resources-and-tools/nz-covid-tracer-app.
Norton Rose Fulbright. 2020. «Contact Tracing Apps in France». Https://Www.Nortonrosefulbright.Com. 2 dicembre 2020. https://www.nortonrosefulbright.com/-/media/files/nrf/nrfweb/contact-tracing/france-contact-tracing.pdf?revision=73eb9585-be68-4fde-82fd-d5362607b907&la=en-in.
———. 2021. «Contact Tracing Apps: A New World for Data Privacy». Https://Www.Nortonrosefulbright.Com/Ru-Ru/Knowledge/Publications. 1 febbraio 2021. https://www.nortonrosefulbright.com/ru-ru/knowledge/publications/d7a9a296/contact-tracing-apps-a-new-world-for-data-privacy.
NTR. 2021. «Norton Rose Fulbright Is a Global Law Firm». Https://Www.Nortonrosefulbright.Com/En-It. 2021. https://www.nortonrosefulbright.com/en-it/about/our-firm.
Nuova Società. 2020. «Sm-Covid-19, l'app "rivale" di Immuni: tutti la stanno già scaricando [Sm-Covid-19, Immuni's "rival" app: everyone is already downloading it]». Nuova Società (blog). 21 aprile 2020. https://nuovasocieta.it/sm-covid-19-lapp-rivale-di-immuni-tutti-la-stanno-gia-scaricando/.
O'Neill, Patrick Howell, Tate Ryan-Mosley, e Bobbie Johnson. 2020. «A Flood of Coronavirus Apps Are Tracking Us. Now It's Time to Keep Track of Them.» Official corporate website. MIT Technology Review; Www.Technologyreview.Com. 7 maggio 2020. https://www.technologyreview.com/2020/05/07/1000961/launching-mittr-covid-tracing-tracker/.
Pezzali, Roberto. 2020. «L'app di tracciamento Immuni diventa l'ennesimo ed inutile caso politico. [Immuni tracking app becomes yet another useless political case.]». Online newspaper. DDAY; www.dday.it. 6 maggio 2020.

https://www.dday.it/redazione/35269/lapp-di-tracciamento-immuni-diventa-lennesimo-e-inutile-caso-politico.
Rai. 2020. «I politici e la app Immuni - Cartabianca - 27/10/2020 - YouTube». 2020. https://www.youtube.com/watch?v=ElgW5uMT-Xs&ab_channel=Rai.
Ribeiro, Ana. 2020. «Mobile App to Track the Coronavirus Outbreak». 26 marzo 2020. https://patient-innovation.com/post/3181.
Rociola, Arcangelo. 2020. «Immuni, fonti ministero: è stata una scelta del governo, ma l'app da sola non basterà [Immune, ministry sources: it was a government choice, but the app alone will not be enough]». Online newspaper. Agi; www.agi.it. 6 maggio 2020. https://www.agi.it/politica/news/2020-05-06/immuni-app-anti-contagio-scelta-8529501/.
Ruffino, Lorenzo. 2020. «Tutti i dati su Immuni». YouTrend. 24 novembre 2020. https://www.youtrend.it/2020/11/24/tutti-i-dati-su-immuni/.
Saetta, Bruno. 2020. «Coronavirus: l'uso della tecnologia, il modello coreano e la tutela dei dati personali». Valigia Blu (blog). 2020. https://www.valigiablu.it/coronavirus-dati-tecnologia/.
Safe Blues. 2020. «Home Page». Safeblues.Org. 2020. https://safeblues.org.
Salerno, domenico. 2020. «Reti di telecomunicazioni e Covid-19. Così le infrastrutture italiane hanno retto all'onda d'urto del lockdown - I-Com, Istituto per la Competitività». https://www.i-com.it/. 20 novembre 2020. https://www.i-com.it/2020/11/20/reti-covid-infrastrutture/.
Shendruk, Amanda. 2020. «South Koreans Are Using Smartphone Apps to Avoid the Novel Coronavirus». Quartz. 29 febbraio 2020. https://qz.com/1810651/south-koreans-are-using-smartphone-apps-to-avoid-coronavirus/.
SM-Covid-19. 2020. «Informazioni – SM-Covid-19 App [About - SM-Covid-19 App]». Official corporate website. SM-COVID-19; smcovid19.org (blog). 2020. https://smcovid19.org/info/.
———. 2021a. «Protocollo RecoVer – SM-Covid-19 App [RecoVer Protocol - SM-Covid-19 App]». 5 aprile 2021. https://smcovid19.org/recover/.
———. 2021b. «Team – SM-Covid-19 App». Official corporate website. SM-COVID-19 - Team; smcovid19.org (blog). 11 maggio 2021. https://smcovid19.org/team/.
———. 2021c. «L'Indice dei Contatti – SM-Covid-19 App [The Index of Contacts - SM-Covid-19 App]». Official corporate website. SM-Covid-19; smcovid19.org. 4 giugno 2021. https://smcovid19.org/lindice-dei-contatti/?fbclid=IwAR3LS68kVr_CYF8qRNuJf01VCAuIh_bnD6wYxgApZwCtX-NJI5wGR9MrL-0.
SM-Covid-19 App. 2021. «SM-Covid-19 App – Tracing app against Covid-19». 26 marzo 2021. https://smcovid19.org/.
SoftMining. 2021. «SoftMining – Unleash the Power of AI in Drug Discovery». Https://Www.Softmining.It. 30 marzo 2021. https://www.softmining.it/.
STOPcovid19. 2021. «Scarica STOPcovid19 sul tuo smartphone e ferma il virus [Download STOPcovid19 on your smartphone and stop the virus]». STOPcovid19. 19 aprile 2021. https://www.stopcovid19.it/it/.
Università degli Studi di Urbino. 2021a. «diAry – Digital Arianna – App per il contenimento di COVID-19 [diAry - Digital Arianna - App for Containment of COVID-19]». University. Covid19app. 30 marzo 2021. https://covid19app.uniurb.it/.
———. 2021b. «FAQ – Risposte alle domande su diAry [FAQ - Answers to questions about diAry]». University. Covid19app. 19 aprile 2021. https://covid19app.uniurb.it/faq/.
Wikipedia. 2021. «COVID-19 Apps». In Wikipedia. https://en.wikipedia.org/w/index.php?title=COVID-19_apps&oldid=1015949009.
Zunino, Giorgia. 2020. «Coronavirus, app e sistemi per tracciare i positivi: come funzionano (nel mondo, in Italia) [Coronavirus, apps and systems to track positives: how they work (in the world, in Italy)]». Agenda Digitale. 23 aprile 2020. https://www.agendadigitale.eu/sicurezza/privacy/coronavirus-i-sistemi-per-tracciare-i-positivi-come-funzionano/.

References to the categories of events shown in Figure 1

online consultation of the timeline: https://www.tiki-toki.com/timeline/entry/1639555/COVID-19/

Contact tracing App

https://coronamelder.nl/en/

https://covidtracker.gov.ie/

https://govextra.gov.il/ministry-of-health/hamagen-app/download-en/

https://techcrunch.com/2020/06/02/france-releases-contact-tracing-app-stopcovid-on-android/?guccounter=1&guce_referrer=aHR0cHM6Ly93d3cuZ29vZ2xlLmNvbS8&guce_referrer_sig=AQAAAEUtbItb9WtW_GnRcbvGP50fOF3L_p_ld8J3aj9w-Cgjr4YRy2_zJdUo-gcA4hUEJLC5q1AKhWhv8jlD-V6KymtiVHG-FoL-vDAJZmDID0ymphyM_-RGiprp5I6WTq2hefNnc0xMq8DlxhtWiPG9hWtMyLkvK2es87-wYEVHrTkU

https://virusradar.hu/

https://www.dw.com/en/germany-launches-best-coronavirus-tracing-app/a-53825213

https://www.health.govt.nz/our-work/diseases-and-conditions/covid-19-novel-coronavirus/covid-19-resources-and-tools/nz-covid-tracer-app

https://www.immuni.italia.it/

https://www.info.gov.hk/gia/general/202011/11/P2020111100367.htm

https://www.iuj.ac.jp/oss/cocoa/

https://www.moc.gov.gh/launch-gh-covid-19-tracker-app

https://www.theguardian.com/australia-news/2020/apr/26/australias-coronavirus-tracing-app-set-to-launch-today-despite-lingering-privacy-concerns

First case

https://en.wikipedia.org/wiki/COVID-19_pandemic_in_France

https://en.wikipedia.org/wiki/COVID-19_pandemic_in_Germany

https://en.wikipedia.org/wiki/COVID-19_pandemic_in_South_Korea

https://en.wikipedia.org/wiki/COVID-19_pandemic_in_Spain

https://shorthand.radionz.co.nz/coronavirus-timeline/

https://www.corriere.it/cronache/20_gennaio_30/coronavirus-italia-corona-9d6dc436-4343-11ea-bdc8-faf1f56f19b7.shtml

https://www.garda.com/crisis24/news-alerts/310266/russia-first-cases-of-novel-coronavirus-confirmed-january-31

https://www.health.gov.au/ministers/the-hon-greg-hunt-mp/media/first-confirmed-case-of-novel-coronavirus-in-australia

https://www.irishtimes.com/news/health/coronavirus-belfast-patient-passed-through-dublin-airport-before-travelling-to-northern-ireland-1.4187155

First lockdown

https://apnews.com/article/pandemics-wuhan-china-coronavirus-pandemic-e6147ec0ff88affb99c811149424239d

https://en.wikipedia.org/wiki/COVID-19_lockdown_in_Italy#Initial_lockdowns

https://en.wikipedia.org/wiki/COVID-19_pandemic_in_Australia

https://en.wikipedia.org/wiki/COVID-19_pandemic_in_France

https://en.wikipedia.org/wiki/COVID-19_pandemic_in_Germany

https://en.wikipedia.org/wiki/COVID-19_pandemic_in_New_Zealand

https://en.wikipedia.org/wiki/Timeline_of_the_COVID-19_pandemic_in_Russia

https://it.wikipedia.org/wiki/Pandemia_di_COVID-19_in_Italia#Prima_ondata

https://lab24.ilsole24ore.com/storia-coronavirus/

https://www.bbc.com/news/world-asia-china-51217455

https://www.dublinlive.ie/news/dublin-news/coronavirus-latest-ireland-full-lockdown-17998356

https://www.euractiv.com/section/coronavirus/news/spain-lifts-lockdown-after-98-days-to-enter-a-new-normality/

https://www.garda.com/fr/crisis24/alertes-de-securite/324591/germany-first-town-under-lockdown-in-bavaria-march-19-update-11

General

https://pubmed.ncbi.nlm.nih.gov/32191675/#:~:text=The%20World%20Health%20Organization%20(WHO

https://www.cdc.gov/media/releases/2020/p0130-coronavirus-spread.html

https://www.who.int/csr/don/12-january-2020-novel-coronavirus-china/en/

https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200121-sitrep-1-2019-ncov.pdf

Lockdown further

https://en.wikipedia.org/wiki/COVID-19_pandemic_in_Australia

https://en.wikipedia.org/wiki/COVID-19_pandemic_in_France

https://en.wikipedia.org/wiki/COVID-19_pandemic_in_France#:~:text=From%20August%202020%2C%20there%20was

https://en.wikipedia.org/wiki/COVID-19_pandemic_in_Germany

https://en.wikipedia.org/wiki/COVID-19_pandemic_in_New_Zealand

https://lab24.ilsole24ore.com/storia-coronavirus/

https://www.bbc.com/news/world-europe-54364015

https://www.bbc.com/news/world-europe-54682222

https://www.gov.ie/en/press-release/066ce-ireland-placed-on-full-level-5-restrictions-of-the-plan-for-living-with-covid-19/

https://www.irishtimes.com/news/ireland/irish-news/covid-19-state-moves-to-level-5-for-six-weeks-with-hopes-of-meaningful-christmas-celebrations-1.4384986
https://www.mcguinnessinstitute.org/projects/pandemicnz/covid-19-timeline/
https://www.theguardian.com/world/2020/oct/28/germany-set-to-impose-new-coronavirus-rules-amid-record-rise-in-cases
https://www.theguardian.com/world/live/2021/mar/22/coronavirus-live-news-global-covid-updates-germany-lockdown-chile-record-daily-cases?page=with:block-6058c4098f080d1c287d8e1c#block-6058c4098f080d1c287d8e1c

Vaccine

https://www.ema.europa.eu/en/news/ema-recommends-covid-19-vaccine-astrazeneca-authorisation-eu
https://www.ema.europa.eu/en/news/ema-recommends-covid-19-vaccine-janssen-authorisation-eu
https://www.ema.europa.eu/en/news/ema-recommends-covid-19-vaccine-moderna-authorisation-eu
https://www.ema.europa.eu/en/news/ema-recommends-first-covid-19-vaccine-authorisation-eu
https://www.who.int/news-room/q-a-detail/coronavirus-disease-(covid-19)-vaccines

Vaccine_first trial starts

https://investors.modernatx.com/news-releases/news-release-details/moderna-announces-first-participants-dosed-phase-23-study-0/

WHO-COVID-19_Day one

https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200121-sitrep-1-2019-ncov.pdf