Mobile Application for Healthcare: The Case of COVID-19 in Mobile Apps

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Abstract

The COVID-19 era has forced us to reduce our face-to-face interactions. For this reason, Information and Communication Technologies (ICTs) have substituted this direct relationship among people. One tool able to support health authorities by monitoring and mitigating the ongoing COVID-19 is Mobile Applications (mApps). They have also facilitated follow-up among patients and practitioners and provided direct guidance to citizens, so they can play their part in the control of the disease. The main purpose of this paper is to understand and analyse the features and functionalities of the COVID-19 mApps currently available in the widely used smartphone applications stores, such as Play Store and iTunes. The first results obtained at this stage of the research have permitted us to give a preliminary taxonomy of the mApps, specifically concerning COVID health management in Italy. The research found 71 mApps operating in the principal stores, focusing on the underlining features and aspects useful for making users more responsible and enabling self-management regarding their own health. MApps in the COVID period could represent organisational support for maintaining a useful relationship among patients and health operators concerning health care assistance. To do this, it is necessary to determine optimal capabilities and evaluate the utility and clinical benefit of these tools. Doing this, we have been able to recognise and obtain the first data and information through this research.

1. Introduction

The World Health Organization (WHO, 2011; Livingston and Bucher, 2020; Wu and McGoogan, 2020) has declared COVID-19 a pandemic outbreak. The Coronavirus pandemic has shown the importance of Information and Communication Technologies (ICTs) in a context in which "*moving information*" is much better than "*moving people*". In the pandemic context, where it's impossible to communicate with people face to face, ICTs have become the only tool able to substitute direct and personal relationships.

The COVID context has imposed, especially on the elderly, the need to develop ICT-related skills. At the same time, organisations face the need for using various mechanisms that facilitate and support interaction between individuals through ICT tools.

ICTs have demonstrated that they are a powerful tool that can aid the fields of healthcare by promoting patient empowerment and disease management. In this way, the mobile application can transmit information among health organisations, experts, families and people worldwide. Mobile Applications (mApps) can support health authorities—at the national and EU level (eHealth Network, 2020)—by monitoring and mitigating the ongoing COVID-19 pandemic, facilitating follow-up among patients and practitioners and providing direct guidance to citizens so that they can play their part in the control of the disease. With these premises, the spread of mobile applications represents a way health knowledge can be shared, improving the interactions between health operators and patients, and most likely the general efficient of processes. MHealth has great potential to address disruptive issues in healthcare, given the ubiquity of mobile devices around the world and the unique aspects of mobile technology, including its high reach, cost-effectiveness and relative ease tool use (Steinhubl *et al*., 2015). In addition, mHealth can link and interact patients with operating interfaces directly inside the App, frequently without the involvement of healthcare operators.

This possibility could generate new awareness regarding health and will indirectly impact on the costs related to the health system. So, mHealth represents a rapidly developing field which has the potential to play a critical role in the re-organisation of healthcare systems. This study focuses on the implementation and use of mobile devices to carry out or support health care activities remotely during the pandemic era. In fact, the COVID-19 situation has pushed for the development of new mApps able to support patients and communities in this complex period. Therefore, the main purpose of this work is to review and analyse the features and functionalities of the apps specifically dedicated to COVID-19 that are currently available in widely used smartphone application stores, like Play Store and iTunes.

The research questions are:

RQ1 What are the principal characteristics of mApps used for COVID-19?

RQ2 Are mApps functional in regard to the objective?

RQ3 Are users' ratings proportionally linked to the functional content of mApps?

The study starts with a systematic examination of mApps for smartphones in the most popular mobile app stores in Google Play (for Androids) and the iTunes store (for macOS). The analysis of available mApps was conducted from February to April 2020, by selecting a 7 apps from the Play Store and 64 from iTunes. The present work is structured as follows: section 1 is the introduction, followed by the theoretical background in section 2, methodology and

data selection in section 3, Results and Discussion in sections 4, and, finally, conclusions and organisational Implications in section 5.

2. Theoretical background

Several scholars claim that the application of Knowledge Management (KM) practices in the healthcare sector is a growing research area. Healthcare organisations are an institutional and social model that represent a complex organisational environment. Traditional KM practices in health care organisations did not seem consistent with their institutional goals; in fact, the adoption, transfer and sharing of new knowledge in healthcare organisations requires different methods and techniques. KM is a process, according to scholars, and the existing literature offers a large number of KM processes (Gao *et al*., 2018). The operational definition of KM focuses on three processes: knowledge creation, knowledge sharing (KS) and knowledge utilisation (Shujahat *et al*., 2019). Many scholars have pointed out that KS is a key pillar for effective KM (Alavi and Leidner, 2001; Donnelly, 2019). KS refers to the "*process of sharing relevant information, ideas, suggestions and skills with others*" (Bartol and Srivastava, 2002: 65), as well as the "*process in which individuals exchange their knowledge (explicit and implicit) and create new knowledge*" (Van den Hooff and De Ridder, 2004: 118). A significant number of previous studies have explored KS through the meso-level lens, emphasising the role of ICT systems in KS (Mirzaee and Ghaffari, 2018). However, attention was dedicated to what practitioners mean by KS and, more specifically, how they exchange knowledge in practice (Minbaeva, 2013; Panahi *et al*., 2016; Donnelly, 2019). Hence, users use information and communication technologies (ICTs) to share tacit and explicit knowledge among organisation members and external parties (Panahi *et al*., 2016; Bouncken and Aslam, 2019). Since the IT tools make KS easy (Ghosh and Scott, 2005), according to Salisbury and Bloodgood (2001), IT has two main capabilities with respect to knowledge, namely, to encode knowledge and create networks. Therefore, IT facilitates interaction among people and ultimately improves the KS. Furthermore, IT makes knowledge clearer and more explicit, as modern technologies make it easier to encode knowledge by making it available (Salisbury and Bloodgood, 2001). The ability of IT to encode knowledge and make it more explicit is significant (Salisbury and Bloodgood, 2001). There are several types of IT tools used in KS, like the intranet, chat, email, blog, etc. (Omana *et al*., 2010). Depending on the types of knowledge, IT is designed for KS practices. Within the use of IT in healthcare, Mobile Health (mHealth) is highlighted and defined by Istepanian *et al*. (2007) as the use of "*emerging mobile communications systems and network technologies for healthcare*". A more comprehensive definition is implemented by the World Health Organization (WHO, 2011: 6) which defines mHealth as "*medical and public health practices supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants and other wireless devices"*. The adoption of these technologies in healthcare has allowed the transition from Electronic Health (e-Health) systems of traditional "*telemedicine*" platforms to wireless communication and wireless and mobile configurations (Istepanian *et al*., 2007). Basically, using mobile devices connected through the network and wireless communication technology in healthcare improves health safety and results (Yu *et al*., 2006), overcoming geographical, temporal and even organisational barriers with low costs and convenient practices (Silva *et al*., 2015).

In this new evolving context, a particular role is played by apps (on mobile devices), as a new technological system capable of transmitting, creating and sharing knowledge and improving

an open innovation model (Chesbrough, 2003). MApps is an interactive tool among patients and doctors, capable of facilitating the monitoring and highlighting of alarms by developing combinations of know-how among the nodes of healthcare networks.

The use of mobile applications (mApps) in healthcare provides three clarifications.

First of all, each user/patient can use mobile applications (mApps) in healthcare that are downloadable through the main operating systems existing on smartphones and mobile phones (Apple iOS, Android and others). However, this can only happen if these four main characteristics are attainable (Davis *et al*., 2016): (1) population penetration or adoption, (2) the availability and form of apps, (3) the availability and form of wireless broadband Internet access; and (4) individual ownership of the device. The first feature is an internet connection (e.g., coverage, service continuity, reduced connectivity delays). The second feature of smartphone technology is the availability of apps that can be installed on the device. The third feature is the ability to quickly access the Internet or the World Wide Web via mobile broadband. The last feature of the technology is that cell phones are usually in people's possession; they are associated with individuals, not residences (which require a permanent physical location).

Secondly, ICT and medical experts can combine their knowledge to produce innovative and user-friendly mApps. Patients as users—on the other hand—can learn new information on how to prevent and treat their disease, even if the mApp is not connected with healthcare professionals (Kogut and Zander, 1992). According to the Institute for Healthcare Informatics (IIHF, 2013), consumer-related mHealth apps focus on general wellbeing, diagnosis, finding a healthcare provider, filling prescriptions and compliance. Dennison *et al*. (2013) conducted a qualitative study on young adults to explore their experiences and positions regarding apps related to health behaviour change, including their perception of various characteristics and their willingness to use the apps. They identified several valuable features that have major influences on the usability of the app, such as: accuracy, legitimacy, security, required effort and immediate effects. Interestingly, context sensing capabilities and social media features were deemed unnecessary. However, they also noted that some of their study participants weren't motivated enough to regularly and accurately use apps to make healthy lifestyle changes. This phenomenon is particularly relevant in immersive online virtual worlds that offer new territories that can often be customised by users and where rules and fees become more labile (Taylor, 2002).

Third, the dissemination and ease of downloading of mApps represent a way in which healthcare professionals and patients/users can better share health knowledge (KS) and can provide adequate tools to support this (Atinaf and Garfield, 2015). On the one hand, the motivations to carry out KS through Apps in healthcare would be attributable to the self-efficacy and personal development of the operators and users/patients who use them (Zhang *et al*., 2017; Choi *et al*., 2020).

On the other hand, the sharing of knowledge implemented through mHealth leads to greater interaction among healthcare professionals and patients and greater efficiency (Eze *et al*., 2016). In fact, there is a reduction and improvement in terms of patient data collection by healthcare professionals, allowing for easier storage of this information in a shared way.

For this reason, the first phase of the study aimed to understand the main theories in this research area. This step is necessary due to the exploratory nature of the study. In particular, the keywords were entered through the consultation of databases. A search string was created

to identify all scientific documents in English, published in double-blind journals and belonging to the Business, Management and Accounting areas. After this selection, a focus on a systematic review of the phenomenon was carried out by VOS viewer as a software tool for constructing and visualising bibliometric networks. Figure 2.1 shows the relationship between the keywords that the authors used for their scientific contributions. Each circle represents a keyword. The size of a circle reflects the number of publications of the corresponding word. The distance between two circles approximately indicates the strength of the link. In general, the closer two circles are located to each other, the stronger the link is among keywords. The colours represent clusters of keywords with strong links. Lines are used to indicate the links between keywords.

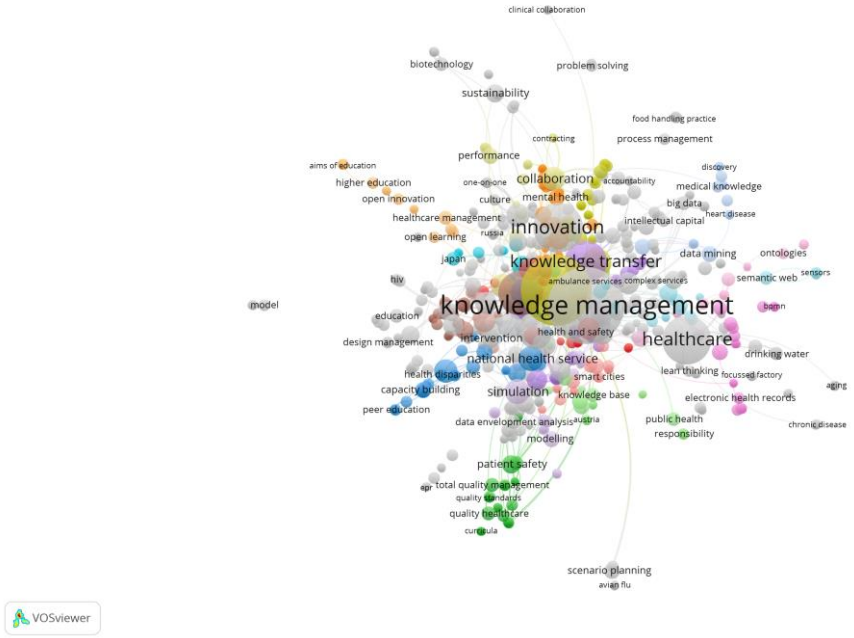

Figure 2.1. Relationship between keywords – VOS viewer Software.

From Figure 2.1, it is clear that this new phenomenon of mApps in healthcare has created a solid framework in the KM field of study. The selection of the sub-area keywords highlights how the mApps phenomenon, studied under the KM perspective, is linked to: Knowledge Management, Knowledge Transfer, Innovation, Open Learning, Health Care Management, Higher education and Culture.

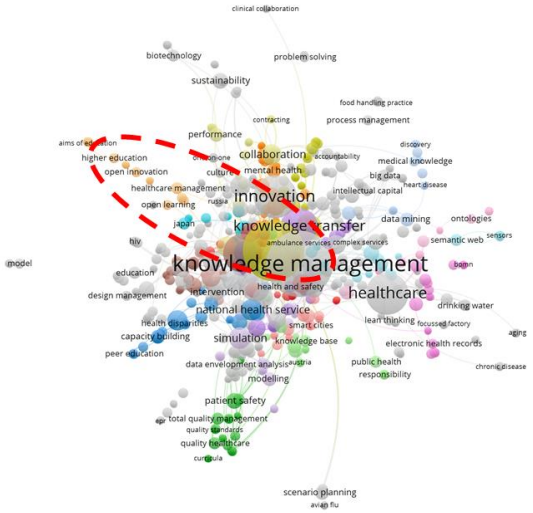

Figure 2.2. Sub-area keywords – Our Elaboration with VOS viewer Software.

Therefore, it is possible to identify, within the graph, one research area that links the topics covered in this study (Figure 2.2).

3. Methodology and data selection

This work presents the results of the exploratory and descriptive study to understand and define the frame of the general dynamics of the phenomenon [7; 24;17] This study is based on a two-step method:

The first step—Theoretical Background—explores the literature and underlines the characteristics of the mApps as a new mechanism of sharing knowledge in Healthcare. In this step, on the desk, analysis scientific documents were identified and filtered by using keywords, language and abstract.

For this reason, a review of the literature was conducted in April 2020 by the author. The systematic review was completed in accordance with the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) guidelines (PRISMA, 2009). However, this protocol was modified by incorporating the article screening process as each article was identified, rather than as a single solitary stage later on its process. The search strategy used a series of specific keywords. A primary keyword (1 - Knowledge Management) was used in direct combination with a second (2 - Knowledge Sharing) and third keyword (3 - IT), and 4 - mobile Application (mApp).

Four inclusion criteria were established to exist as a specification for relevance once any sources were identified. The four criteria were:

1) The years considered must be between 2014 and 2020;
2) Must be peer-reviewed literature;
3) English language;
4) Open access.

Relevant bibliographic databases were used for this purpose, including the Scopus databases. Furthermore, referring to PRISMA protocol, additional records were identified through other sources. These sources included the use of article reference lists identified through the primary search stage by using Google Scholar. Once the duplicates had been removed, the remaining publications were then filtered using the inclusion criteria.

Number of articles from the first search	498
Number of articles removed due to article duplication/application of eligibility criteria	30
Number of eligible articles from the first search	458
Number of those eligible after reading the abstract	135
Number of those eligible after reading the full paper	36
Number of articles identified by other means	2
Total number of eligible articles	38

Table 3.1. PRISMA protocol.

Source: Our elaboration.

Subsequently, 38 publications met the conditions and were included in this review, allowing us to frame the phenomenon theoretically in according to the research questions.

The second step—Empirical Observation— - firstly explores the different mApps officially identified as COVID-19 tools and presents the most popular operating platform (Play Store and iTunes). Then, we classified mApps according to their Type, Technical functionality, Description, Download and Users comment. In this way, it was possible to comprehend the aspects of knowledge and the possibility of sharing and diffusion (see Table I.1 in Appendix).

In this phase, we had to consider both payment and free mApps found in the Play Store and iTunes app store (Figure 3.1). Until April 28, 2020, Android and macOS users could choose among 71 mApps. Our search focused on COVID-19 management, prevention, contact tracing mApps, using search terms such as: "*COVID-19* and *Coronavirus*". In the following scheme, the research-mApp-process is presented.

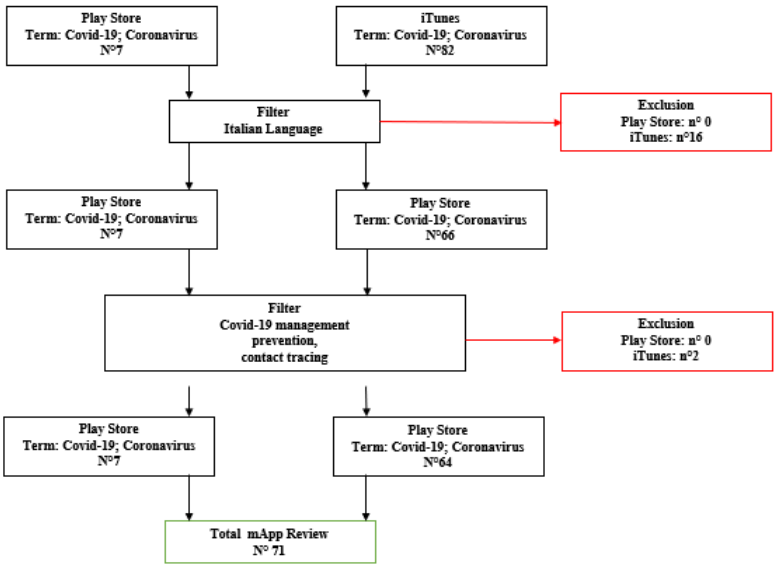

Figure 3.1. Examination scheme of mApps; Source: our elaboration on Moher *et al*. (2009).

Then the mApps were evaluated through a review based on product description, technical functionality and the screenshots provided with the reviews by current users. All data were collected in an Excel sheet, with the name, functionality and features of each mApp.

4. Results and discussion

Since the beginning of the COVID-19 pandemic, numerous mApps have been developed, some by public authorities like World Health Organization (WHO, newsletter March 2020), Italian Ministry of Health, Ministry of Social Affairs, Ministry of Communication; Governments and Departments. They have worked on the development of applications able to provide medically approved information and advice to users based on their symptoms.

Figure 4.1. Section Actor Relevant.

Source: our elaboration

On April 10, 2020, Google and Apple jointly announced an initiative related to the use of the Bluetooth protocol to support contact tracing mApps (Newsroom-Apple, 2020).

The protocol supports the use of Bluetooth LE (Low Energy) for the detection of nearby mobile phones and the data exchange mechanism. In this way, mApp users can receive an alert of possible Coronavirus transmission, by showing people with a positive diagnosis that they have recently been in contact with. The apps included in the present study are those pertaining to COVID-19 and are available in Google Play and the iTunes Stores. Our research started with keywords like "*COVID-19 and Coronavirus*", detecting 71 mApps (Google play store and iTunes store); once identified, manual inspection was done on the apps by using the filters: management and prevention contact tracing. As a result, 7 mApps in the Google Play Store and 64 in the iTunes Store were found.

The research led to mApps, according to the previous criteria, n° 71 mApps overall. The differences between the Google Store and Apple Store are remarkable for different reasons, and the research on the Play Store showed only 7 mApps unlike the initial 82 in iTunes, all this to ensure the credibility of health and safety information related to mApps. Apple has chosen to manage applications related to the COVID-19 pandemic with a very critical review by reviewing the publishing policies aimed at developers for apps. Google, to avoid problems, blocked mApps in March and subsequently publishes only 7 of them.

The overall characteristics of the mApps selected are presented in the tables in the Appendix; the analysis was developed by the authors directly through their phone. In fact, mApps are designed to interact directly with users with the acquisition of personal information to manage their own health, with or without the presence of a health worker. In this research, 71 mApps were able to support patients with a pro-active approach by improving their participation and self-management capacity with self-monitoring programs (see Table 4.1).

In this research, the 71 mApps identified are mostly related to the detection and contact warnings, self-diagnosis or the transfer of information and knowledge and symptom control.

		Play Store (Android)	**iTunes Store (macOS)**
Type	Symptom checking and contact tracing	1	2
	Contact tracing and self-diagnosis	3	22
	Contact Tracing and warning	1	15
	Knowledge transfer	1	2
	Contact Tracing, warning and self-diagnosis	1	1
	Contact Tracing and information	0	18
	Guidelines	0	1
	Contact tracing and prevention	0	2
	Job security	0	1

Table 4.1. Section Type.

Source: our elaboration.

The main purposes of this work are to give answers regarding the three Research Questions proposed (RQ1-RQ2-RQ3). At this point of the analysis, the contribution presents the survey produced during this COVID period with the full list of existing mApps and their principal characteristics, as reported in tables (see the tables in Appendix). Every mApp has its own specific goals and technical characteristics, such as the minimum number of clicks, taps or other user gestures to activate themselves by responding in a fast and rapid way to the interactions requested.

One of the principal characteristics of mApps investigated is their simple design, able to ensure good content, high value and acceptance among users. A lot of mApps are responsive when running long operations such as database access and network access (users' comment). Another feature regards mApps' personalisation through the creation of individual content and roles based on the context or their specific usage. In fact, users want the mApp to fit their needs and perform the way they want it to. This specific attribute not only covers custom-made content but also controls data that is stored, shared or used for different actions. The mApps have sensors that respond to device movement, numerous gestures, a global positioning system, cameras and multiple networking protocols. About 30% of the selected mApps show localised information and the possibility to provide their position. Information is a crucial feature that renders mobility impressive, convenient and valuable by providing a good user experience. So, their reachability permits us to use them anywhere, at any time (100% mapping). The m-Apps can send and receive and record Bluetooth signals even in the background mode (even when the phone is locked) and can estimate, with sufficient accuracy, the proximity among mobile phones via Bluetooth signals. They make their presence known continuously by using a temporary anonymous ID that permits established contact with other App users in proximity. The App records and stores IDs observed from other mobile phones in epidemiologically relevant proximity on the device, and then the App communicates this information to a Public Health Authority. Another important feature is security; around 20% of the comments found by users ask for a secure mobile app. They believe that these problems should be rectified because they think that mobile apps are vulnerable. In fact, with the interactive knowledge-transfer platform, vital parameters can be acquired and monitored and subsequently sent to health organisations. In this way, users can record significant information about the virus; it is important and practical to record routine activities and medical care received and keep track of the progress of the disease. As a result, it is possible to indicate accelerated or delayed growth of the virus. Users can also use the diary and recording features. Likewise, keeping the mApp on your person is important to evaluate and detect eventual diagnosis discomforts.

Furthermore, the healthcare workforce can be more efficient and virtually close to patients, supported by real-time communication with them (e.g., via the exchange of app users' data). In addition, the possibility to share experiences with others can be of great assistance in addressing certain issues about manage and social relationship. Social support can reduce levels of stress as well as improve our overall health and quality of life. Secure and easy-to-use mHealth apps have the potential to increase adherence and engagement with the health system as a whole. The last characteristic is usability; it relates to the ease with which users can complete their tasks in a specified context of use (comments by the users).

The task structure and interaction style should be optimal to minimise usability flaws. The purpose of the development of the mApp for COVID-19 is to limit the infection, manage the monitoring and self-management of the virus, etc. In this study, we considered whether mApps were functional in regard to the objective. 70% of mApps has the function to reliably determine the epidemiologically targeted, so the information on App should be able to estimate, with sufficient accuracy, the proximity to the "contagion risk map". 30% of mApps has the function of acquiring and monitoring vital parameters and subsequently sending them to health organisations.

		Play Store (Android)	**iTunes Store (macOS)**
Technical Functionality	Proximity technology	5	56
	Interactive knowledge-transfer platform	1	1
	Acquisition and monitoring of vital parameters	1	6
	Invention management in the Region	0	1

Table 4.2. Technical Functionality.

Source: our elaboration.

5. Conclusions and organisational implications

The results of this study show that mApps have great ability to engage users (patients) in the healthcare process, which is mainly due to the accessibility of apps and the diffusion of the mobile phone (Kumar, 2013). MHealth apps can be used as a powerful tool for health prevention and self-management. In fact, the characteristics and technical functionality of mApps—ubiquitous, portable and capable of advanced computational capacity—permit us to explore new opportunities to change patients' health behaviour (Cafazzo *et al*., 2012; Ben-Zeev *et al*., 2013). The diffusion of mobile applications in the health sector is a particular event that, in a short period of time, has completely modified not only the relationship between medical professional and patients but also habits and patients' lifestyles, so it is very difficult to imagine living without it (Kaplan, 2012). This digital technology in the COVID era, if deployed correctly, could substantively contribute to containing and reversing the spread of the virus. Knowledge sharing and the community created among patients, medical doctors and public authorities through mobile technology can play a prominent role in improving our quality of life (social support and personal interactions) and modifying contact tracing and symptom checking. In this COVID-time, 71 mApps were specifically developed (on different platforms and in various stores) to support self-management, contact tracing, symptom checking differently for quality, content and functionality.

More research is needed to determine their optimal capabilities and evaluate their utility, which can be done by determining the clinical benefit. MHealth can offer a wide range of smart

modalities that allows patients to interact directly with health professionals and systems to obtain help in real-time and feedback along the continuum of care from prevention to diagnosis, and treatment and monitoring. Specifically, the apps offer a particular value for health treatment in situations where continuous interaction is important. App developers get deeper insights on critical determinants that govern the adoption of mApps. It is initially important to consider antecedents like perceived usefulness, ease to use, enjoyment and cues to action when designing the user interface and application features to establish a solid foundation for a health app. The developed research allowed us to underline the ease and practical use of the mApps in supporting Health Systems. However, the sensitivity of the subject requires greater attention to their practical use. Hundreds of mobile applications are available to users/patients, and they are rapidly changing on a daily basis. Our results indicate, however, that the quality and content of these applications vary greatly, suggesting that while some users consider that certain applications are of high quality, many others are sub-optimal and in need of improvement. Technical malfunctions may be one of the primary reasons for negative reviews (comments users). Despite these limitations, users find the applications to be tremendously beneficial.

Some limitations appear in this research paper. Firstly, applications are created and fail daily, and their dynamic nature gives this work contingent value. In the future, the situation could change. Secondly, for their analysis, the authors used the available information presented in the full descriptions of each application regarding functions and capabilities. It is possible that applications had features that were not listed in the description or, alternatively, advertised features that were not present or functional in the actual product. The analysis used comments and ratings on technical functionality; users who provide reviews may differ systematically from users who do not so. In addition, the language could be an obstacle to the diffusion of the mApp and understanding the phenomenon at the international level. In any case, the results can provide information on the features that are currently available on the mobile applications. Similarly, findings can provide valuable guidance to clinicians, patients and public health authorities by considering the use of mobile applications. On these premises, it is essential to ensure that patients use well-functioning applications that fulfil their unique needs for health self-management.

Another important problem regards users' privacy and security while using mApps.

As a result, the existence of a privacy policy is an important baseline standard to know why, where, and how personal details will be collected, used, shared and protected (Sunyaev, 2015). Health-related apps, in particular, are dedicated for tracking, recording and managing users' Personal Health Information (PHI) of users. PHI is extremely sensitive and needs to be highly protected through robust security and confidentiality mechanisms, such as encryption and authentication methods. Alternatively, without appropriate safeguards, the use of mApps could have a significantly negative effect on privacy and individual rights. This paper aims to help strengthen the link between ICT and healthcare. The use of mApps in healthcare can represent a new way for patients to approach the healthcare world. Therefore, this research has highlighted some interesting elements that can contribute to the efficient use of technology in the healthcare sector. These document aims to contribute both theoretically and practically onto the issue of the use of new technologies in the health sector. The results of this study provide implications for future research on the role and impact of innovation in healthcare. In fact, it was possible to test new tools that can be used in organisations to lead to a framework of high practical relevance. The originality of this study offers several innovative profiles. In

fact, in fact improving patients' relationships with health technology is a process that involves multiple considerations in the field of knowledge management.

Keywords

healthcare; knowledge management; knowledge sharing; ICT; mobile Application (mApp); COVID-19

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Appendix I

Table I.1. Play Store mApps.

Source: Play Store (Android)

	App name	Type	Technical Functionality	Description	Actor Relevant	Territorial area of reference	Download	N° Comments by users
1	**AllertaLOM**	Symptom checking and contact tracing	Proximity technology To reliably determine the epidemiologically targeted. The information on the app should be able to estimate, with sufficient accuracy, the proximity of the " contagion risk map".	App (in conjunction with the Regional Crisis Unit) should be able to record symptoms day by day through self-diagnosis	Public Authority (protezione civile Lombardia Region)	Local Territory (Lombardia Region)	500,000+ 3.1*	3,104
2	**Sicilia Si Cura**	Contact tracing and self-diagnosis	Proximity technology To reliably determine the epidemiologically targeted.	The App should be able to record symptoms day by day through self-diagnosis	Public Authority Sicilia Region	Local Territory	1,000+. 3.5*	30

	App name	Type	Technical Functionality	Description	Actor Relevant	Territorial area of reference	Download	N° Comments by users
3	**LaziodrCOVID**	Contact tracing and self-diagnosis	Proximity technology To reliably determine the epidemiologically targeted.	Control of the level of risk. Consultation of statistics. Sending a contagion report.	Team Project	Local Territory	50,000+. 3.2*	557
4	**WHOinfo**	Contact Tracing and warning	Proximity technology Information on the state of the virus and better health for everyone everywhere	Control of the level of risk.	Public Health Authority	Total Territory	50,000+ 3.8*	162

5	**SM_COVID 19**	Contact tracing and self-diagnosis	Proximity technology The App should be able to send and receive and record Bluetooth signals even in the background mode (even when the phone is locked). The App should be able to estimate, with sufficient accuracy, the proximity between mobile phones via Bluetooth signals. The App should make their presence known continuously by using a temporary anonymous ID that permits establishing contact with other app users in proximity. The App should record and store IDs observed from other mobile phones in epidemiologically relevant proximity on the device. App should be able to indicate the Public health Authority.	Control of the level of risk. Consultation of statistics. Sending a contagion report. The code (QR codes) created ensures that other individuals cannot use it to pollute the data collected on the server.	Team Project	Local Territory	10,000+. 4.0*	280

	App name	Type	Technical Functionality	Description	Actor Relevant	Territorial area of reference	Download	N° Comments by users
6	**OpenWho knowledge for Health Emergencies**	Knowledge transfer	Interactive knowledge-transfer platform	Offering online courses to improve the response to health emergencies	Public Health Authority and Team Project	Total Territory	500.000. 4.2*	2173
7	**COVID-19**	Contact Tracing, warning and self-diagnosis	Acquisition and monitoring of vital parameters. Subsequently sent to the reference health organisations	Control of the symptom level (Application for those in self-isolation)	Team Project	Total Territory	10,000+. 2.8*	119

Table I.2. iTunes Store mApps.

Source: Play Store (Android)

	App name	Type	Technical Functionality	Description	Actor Relevant	Territorial area of reference	Download	N° Comments by users
1	**COVID-19!**	Contact Tracing and warning	Proximity technology. Information on the state of the virus and better health for	App provides expert information about the infection, how to identify it and	Team project	Total territory	54	16

	App name	Type	Technical Functionality	Description	Actor Relevant	Territorial area of reference	Download	N° Comments by users
			everyone everywhere	how to defend yourself			4.1*	
2	**Healthlynked COVID-19 Tracker**	Contact Tracing and Self-diagnosis	Proximity technology To reliably determine the epidemiologically targeted.	The App should be able to record symptoms day by day through self-diagnosis	Public Authority	Total territory	1097 4.4*	37
3	**COVID-19 Gov Pk**	Knowledge transfer	Proximity technology. Information on the state of the virus and better health for everyone everywhere and Interactive knowledge	The app provides expert information about the infection and offers online courses to improve the response to health emergencies	Public Authority (National Information Tecnology board)	Local Territory (Pakistan)	5 1.0*	0
4	**Stop Codi19 CAT**	Contact Tracing and Self-diagnosis	Proximity technology in order to reliably determine the	The app provides expert information about the infection, how	Public Authority (Generalitat de Catalunya)	Local Territory (Catalunya)	21 2.5*	5

	App name	Type	Technical Functionality	Description	Actor Relevant	Territorial area of reference	Download	N° Comments by users
			epidemiologically targeted.	to identify it and how to defend yourself.				
5	**TreCOVID19**	Contact Tracing and Self-diagnosis	Invention management in the region	The app indicates the measures for the containment of the virus and the numbers to contact in case of need.	Public Authority (Heath Company)	Local Territory (Trentino)	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	
6	**COVID19Regione Sardegna**	Contact Tracing and Self-diagnosis	Proximity technology To reliably determine the epidemiologically targeted.	App for self-declaration of arrivals and departures in Sardinia and authorisation for transport	Public Authority (Sardinia Region)	Local Territory (Sardinia)	2 4,5*	0
7	**Coronavirus-COVID19**	Contact Tracing and warning	Proximity technology. Information on the	The app provides expert information about	Public Authority (Heath Company)	Total Territory	The app did not receive a sufficient number of ratings	

	App name	Type	Technical Functionality	Description	Actor Relevant	Territorial area of reference	Download	N° Comments by users
			state of the virus and better health for everyone everywhere	the infection, how to identify it and how to defend yourself.			or reviews, and an average is not visible.	
8	**Coronavirus- SUS**	Contact tracing and self-diagnosis	Proximity technology. To reliably determine the epidemiologically targeted.	Control of the level of risk. Consultation of statistics. Sending a contagion report	Public Authority (Government of Brazil)	Local Territory (Brazil)	16 3.0*	4
9	**patientMpower for COVID-19**	Contact tracing and self-diagnosis	Proximity technology To reliably determine the epidemiologically targeted.	The app will allow you to monitor symptoms and health information in self-isolation.	Tem Project	Local Territory (Ireland)	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	
10	**Coronavirus COVID Trancker**	Contact Tracing and warning	Proximity technology. Information on the state of the virus and better health for	The app fights COVID-19 by tracking global evolution and staying up to date	Team project	Total Territory	The app did not receive a sufficient number of ratings or reviews, and an average is not visible	

	App name	Type	Technical Functionality	Description	Actor Relevant	Territorial area of reference	Download	N° Comments by users	
			everyone everywhere	with the latest official information on protection measures and treatments.					
11	**TraceCOVID**	Contact Tracing and Self-diagnosis	Proximity technology. Information on the state of the device	The app helps the Government with contact tracing for the benefit of the whole community.	Public Authority Department of health Abu Dhabi	Local Territory (Abu Dhabil)	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.		
12	**Relief Central COVID-19**	Gudelines	Proximity technology to give guidelines in the management of the epidemic	The app helps the health community stay up-to-date with this rapidly changing infection	Team project	Total territory	22 4.3*	0	
13	**Disinfection Checklist**	Contact tracing and prevention	Proximity technology to give guidelines for disinfection	The app is a great tool for ensuring proper disinfection of commercial and residential facilities	Team project	Total territory	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.		

	App name	Type	Technical Functionality	Description	Actor Relevant	Territorial area of reference	Download	N° Comments by users
14	**COVID-19 News**	Contact Tracing and Self-diagnosis	Proximity technology. Information on the state of the device	all the news related to the pandemic	Team project	Local Territory	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	
15	**COVID -19 AR**	Contact tracing and prevention	Proximity technology To reliably determine the epidemiologically targeted.	The app will provide health information for prevention	Public Authority (Government Argentina)	Local Territory (Argentina)	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	
16	**Castor COVID-19**	Contact tracing and self-diagnosis	Proximity technology To reliably determine the epidemiologically targeted.	The app will allow you to monitor symptoms, which can be monitored by trained healthcare professionals through real-time dashboards	Public Authority (Healthy Ageing)	Total territory	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	
17	**Cova Punjab**				Public Authority		3	0

	App name	Type	Technical Functionality	Description	Actor Relevant	Territorial area of reference	Download	N° Comments by users	
		Contact Tracing and information	Proximity technology To reliably determine the epidemiologically targeted.	The app provides citizens with preventive care information and other government advisories.	(Government Punjab)	Local Territory (India)	5*		
18	**Covive: your COVID-19 app**	Symptom checking and contact tracing	Proximity technology To reliably determine the epidemiologically targeted.	The app guides you in evaluating the probability of contracting COVID-19 and helps you monitor your symptoms	Team project	Total territory	6 5*	0	
19	**SOS Coronavirus**	Contact Tracing and information	Proximity technology To reliably determine the epidemiologically targeted.	The app raises awareness of the damage from COVID-19 and manages suspected cases.	Public Authority (Ministry of Health and Social Affairs)	Total territory	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.		
20	**COVID-19 UAE**	Contact Tracing and Self-diagnosis	Proximity technology To reliably determine the	The app provides you with real-time Coronavirus cases information	Public Authority (Ministry of Health UAE)	Total territory	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.		

	App name	Type	Technical Functionality	Description	Actor Relevant	Territorial area of reference	Download	N° Comments by users
			epidemiologically targeted.					
21	**COVID -19 Armenia**	Contact Tracing and warning	Proximity technology Information on the state of the virus and better health for everyone everywhere	The app will help you stay up to date with the latest official news about COVID-19	Public Authority (Government Armenia)	Local Territory	the app did not receive a sufficient number of ratings or reviews, and an average is not visible.	—
22	**COVID-19 learning Platform**	Knowledge transfer	Interactive knowledge-transfer platform	Learning platform is an online web and mobile based large-scale training solution developed by combining empower's digital, products and services, including learning platform, impact measurement tools and e-learning content	Team project	Total territory	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	— —

	App name	Type	Technical Functionality	Description	Actor Relevant	Territorial area of reference	Download	N° Comments by users
23	**COVID-19 Cuernavaca**	Contact Tracing and information	Proximity technology To reliably determine the epidemiologically targeted.	The app provides citizens with preventive care information	Team project	Local Territory	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	
24	**CDC**	Contact Tracing and information	Proximity technology To reliably determine the epidemiologically targeted.	The app ensures that you're getting the most up to date health information	Team project	Local Territory	4 2*	1
25	**MyAus COVID-19**	Contact Tracing and information	Proximity technology To reliably determine the epidemiologically targeted.	A resource for information about COVID-19 and how it impacts you	Team project	Local Territory (Australia)	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	
26	**Coronavirus Australia**	Contact Tracing and information	Proximity technology To reliably determine the epidemiologically targeted.	The app provides citizens with preventive care information	Team project	Local Territory (Australia)	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	
27					Team project			

	App name	Type	Technical Functionality	Description	Actor Relevant	Territorial area of reference	Download	N° Comments by users
	BMC Combat COVID	Contact Tracing and Self-diagnosis	Proximity technology Information on the state of the virus and better health for everyone everywhere	**The app marks you transition from self quarantine, this will help us track your health progress and contain the spread of this virus**		Local Territory (Mumbai)	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	
28	**Patientsphere for COVID 19**	Contact Tracing, warning and self-diagnosis	Acquisition and monitoring of vital parameters.	The app tracks symptoms and helps you communicate with your doctor and help them to diagnose the disease accurately.	Team project	Total territory	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	
29	**HowweFeel**	Contact Tracing and information	Proximity technology To reliably determine the epidemiologically targeted.	The app is the global community to fight the COVID-19	Team project	Total territory	2 5*	0
30	**Bolivia Segura**				Team project		1	0

	App name	Type	Technical Functionality	Description	Actor Relevant	Territorial area of reference	Download	N° Comments by users
		Contact Tracing and information	Proximity technology To reliably determine the epidemiologically targeted.	The app gives official information about the COVID-19		Local Territory (Bolivia)	5*	
31	**CoronaFacts**	Contact Tracing and information	"Proximity technology Information on the state of the virus and better health for everyone everywhere"	Created by a physician, the app provides a trusted source of information on the spread of COVID-19 globally	Team project	Total territory	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	
32	**Nuahealth Video Consultation**	Contact Tracing and information	Proximity technology To reliably determine the epidemiologically targeted	The app is a Video Consultation service with a physician	Team project	Total territory	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	
33	**Sentinel Monitor**	Symptom checking and contact tracing	Acquisition and monitoring of vital parameters. Subsequently sent to the reference health organisations	Control of the symptom level	Team project	Total territory	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	

	App name	Type	Technical Functionality	Description	Actor Relevant	Territorial area of reference	Download	N° Comments by users
34	**Tarassud**	Contact Tracing and information	Proximity technology To reliably determine the epidemiologically targeted	The app gets updates about the virus in the country	Public Authority (Ministry of health Oman)	Local Territory (Oman)	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	
35	**StopCOVID**	Contact Tracing and information	Proximity technology To reliably determine the epidemiologically targeted	The app supports the prevention and spread of COVID-19 through contact tracing.	Public Authority (Ministry of health and Social Affairs)	Local Territory (Georgia)	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	
36	**COVID-19 Tam**	Contact Tracing and information	Proximity technology To reliably determine the epidemiologically targeted.	The app gives official information about COVID-19.	Team project	Total territory	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	
37	**CoronApp-Colombia**	Contact Tracing and warning	"Proximity technology. Information on the state of the virus and better health for everyone everywhere"	Control of the level of risk.	Public Authority (national health Institute)	Local Territory (Colombia)	3 4.3*	2
38	**COVIDom Patient**				Public Authority			

	App name	Type	Technical Functionality	Description	Actor Relevant	Territorial area of reference	Download	N° Comments by users	
		Contact Tracing and warning	Acquisition and monitoring of vital parameters	The app is only useful for patients who need to use hospital services		Local Territory (Paris)	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.		
39	**Assistencia COVID-19**	Contact tracing and self-diagnosis	Proximity technology. To reliably determine the epidemiologically targeted.	The App should be able to record symptoms day by day through self-diagnosis	Team project	Local Territory (Guatemala)	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.		
40	**Apollo COVID19**	Contact Tracing and warning	Acquisition and monitoring of vital parameters	The app enables contactless screening for COVID at the medical frontlines	Team project		"The app did not receive a sufficient number of ratings or reviews, and an average is not visible. "		
41	**GVA Coronavirus**	Contact Tracing and warning	Acquisition and monitoring of vital parameters	The App should be able to record symptoms	team project	Local Territory (Valencia)	1 5*	0	
42	**NHS24:COVID-19**	Contact Tracing and warning	Acquisition and monitoring of vital parameters	The app assesses symptoms	Team project	Total territory	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.		
43	**Corona care**				Team project	Total territory			

	App name	Type	Technical Functionality	Description	Actor Relevant	Territorial area of reference	Download	N° Comments by users
		Contact Tracing and warning	Proximity technology. To reliably determine the epidemiologically targeted.	The app helps healthcare providers in their research of the symptoms of infection			The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	
44	**Canada COVID-19**	Contact tracing and self-diagnosis	Proximity technology. To reliably determine the epidemiologically targeted.	Control of the level of risk.	Public Authority (Canada)	Local Territory (Canada)	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	
45	**Assistencia COVID-19**	Contact tracing and self-diagnosis	Proximity technology. To reliably determine the epidemiologically targeted.	The App should be able to record symptoms day by day through self-diagnosis	Public Authority (Espana)	Local Territory (Espana)	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	
46	**Coronavirus UY**	Contact tracing and self-diagnosis	"Proximity technology. To reliably determine the epidemiologically targeted."	The App should be able to record symptoms day by day through self-diagnosis	team project	Total territory	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	
47	**bewellxcel**				team project	Total territory		

	App name	Type	Technical Functionality	Description	Actor Relevant	Territorial area of reference	Download	N° Comments by users
		Contact Tracing and warning	Proximity technology. Information on the state of the virus and better health for everyone everywhere	The app helps you be more informed about the developing pandemic.			The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	—
48	**Cachoeirinha ContraCoronavirus**	Contact Tracing and warning	Proximity technology. Information on the state of the virus and better health for everyone everywhere	The app helps you be more informed about the developing pandemic	team project	Total Territory	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	—
49	**GH COVID-19 tracker**	Contact Tracing and warning	Proximity technology. To reliably determine the epidemiologically targeted.	The app helps healthcare providers in their research of the symptoms of infection	Public Authority (Ministry of Communication)	Total territory	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	—
50	**Public Access Control System**		Proximity technology.	This app is used for public access	team project	Total territory	The app did not receive a sufficient number of ratings	—

	App name	Type	Technical Functionality	Description	Actor Relevant	Territorial area of reference	Download	N° Comments by users
		Contact Tracing and warning	Information on the state of the virus and better health for everyone	control in the Community. any suspicious person can be blacklisted in communities and public areas to ensure safety for everybody			or reviews, and an average is not visible.	
51	**Musc COVID-19 Vital Link**	Contact tracing and self-diagnosis	Proximity technology. To reliably determine the epidemiologically targeted.	The App should be able to record symptoms day by day through self-diagnosis	Public Authority (Sud Carolina)	Local Territory	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	—
52	**BC COVID 19 SUPPORT**	Contact Tracing and information	Proximity technology To reliably determine the epidemiologically targeted.	The app gives official information about COVID-19	Public Authority (COLUMBIA)	Local Territory	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	—
53	**OBVIO-19**	Contact tracing and self-diagnosis	Proximity technology. To reliably determine the epidemiologically targeted	The App should be able to record symptoms day by day through self-diagnosis	Team project	Total territory	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	—

	App name	Type	Technical Functionality	Description	Actor Relevant	Territorial area of reference	Download	N° Comments by users
54	**Tali Symptom tracker**	Contact tracing and self-diagnosis	Proximity technology. To reliably determine the epidemiologically targeted	The App should be able to record symptoms day by day through self-diagnosis	team project	Total territory	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	
55	**cov_cl**	Contact Tracing and warning	Proximity technology. To reliably determine the epidemiologically targeted.	Control of the level of risk. Consultation of statistics.	team project	Total territory	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	
56	**PreMedicus ER**	Contact tracing and self-diagnosis	"Proximity technology. To reliably determine the epidemiologically targeted"	The App should be able to record symptoms day by day through self-diagnosis	team project	Total territory	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	
57	**JamCOVID19**	Contact tracing and self-diagnosis	Proximity technology. To reliably determine the epidemiologically targeted.	Control of the level of risk. Consultation of statistics. Sending a contagion report.	Public Authority (Jamaica)	Local Territory	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	
58	**AarogyaSetu**				Team project		3	0

	App name	Type	Technical Functionality	Description	Actor Relevant	Territorial area of reference	Download	N° Comments by users
		Contact Tracing and information	Proximity technology To reliably determine the epidemiologically targeted	The app is aimed at augmenting the initiatives of the Government of India for the prevention COVID-19		Local Territory (India)	5*	
59	**Spectrum-Clinicaldecisions**	Contact tracing and self-diagnosis	Proximity technology. To reliably determine the epidemiologically targeted.	The app is a customisable clinical decisions tool for infectious diseases.	team project	Total territory	2 5*	0
60	**Kencor COVID 19**	Contact Tracing and information	Proximity technology To reliably determine the epidemiologically targeted	The app is a Video Consultation service with a physician.	team project	Total territory	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	
61					team project	Total territory		

	App name	Type	Technical Functionality	Description	Actor Relevant	Territorial area of reference	Download	N° Comments by users
	Managing your stress& anxiety	Contact Tracing and information	Proximity technology To reliably determine the epidemiologically targeted	The app provides information and evidence-based coping strategies to help you manage stress and anxiety during COVID-19.			The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	
62	**COVID-19 Virginia Resources**	Contact Tracing and information	Proximity technology To reliably determine the epidemiologically targeted	The app supports the prevention and spread of COVID-19 through contact tracing.	Public Authority (Department of Social Services)	Local Territory (Virginia)	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	—
63	**patientMpower for COVID-19 USA**	Contact tracing and self-diagnosis	Proximity technology. To reliably determine the epidemiologically targeted.	Control of the level of risk. Consultation of statistics. Sending a contagion report.	team project	Total territory	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	—
64	**CNESST-COVID19**	job security	Proximity technology	Support the enterprise	team project	Total territory	The app did not receive a sufficient number of ratings or reviews, and an average is not visible.	—

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