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The challenge of privacy and security when using technology to track people in times of COVID-19 pandemic

Hermanus J Smidt[a], Osden Jokonya[b*]

University of the *Western Cape, Bellville, Cape Town 7535, South Africa*

Abstract

Since the start of the Coronavirus disease 2019 (COVID-19) governments and health authorities across the world have find it very difficult in controlling infections. Digital technologies such as artificial intelligence (AI), big data, cloud computing, blockchain and 5G have effectively improved the efficiency of efforts in epidemic monitoring, virus tracking, prevention, control and treatment. Surveillance to halt COVID-19 has raised privacy concerns, as many governments are willing to overlook privacy implications to save lives. The purpose of this paper is to conduct a focused Systematic Literature Review (SLR), to explore the potential benefits and implications of using digital technologies such as AI, big data and cloud to track COVID-19 amongst people in different societies. The aim is to highlight the risks of security and privacy to personal data when using technology to track COVID-19 in societies and identify ways to govern these risks. The paper uses the SLR approach to examine 40 articles published during 2020, ultimately down selecting to the most relevant 24 studies. In this SLR approach we adopted the following steps; formulated the problem, searched the literature, gathered information from studies, evaluated the quality of studies, analysed and integrated the outcomes of studies while concluding by interpreting the evidence and presenting the results. Papers were classified into different categories such as technology use, impact on society and governance. The study highlighted the challenge for government to balance the need of what is good for public health versus individual privacy and freedoms. The findings revealed that although the use of technology help governments and health agencies reduce the spread of the COVID-19 virus, government surveillance to halt has sparked privacy concerns. We suggest some requirements for government policy to be ethical and capable of commanding the trust of the public and present some research questions for future research.

* Corresponding author. Tel.: +0-000-000-0000 ; fax: +0-000-000-0000 .
E-mail address: ojokonya@uwc.ac.za

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1. Introduction

Across the globe governments and health authorities are seeking for solutions to deal with the Coronavirus disease 2019 (COVID-19). COVID-19 is an emerging viral infection, which started in Wuhan, China, in December 2019 and transmitted as a pandemic outbreak to other countries [1]. Humans' tendency to travel as a result of technological ability and economic feasibility by airplane has caused COVID-19 to spread with an unprecedented speed [2]. This has caused COVID-19 to become a major global public health challenge as it presented the fastest spread, with the widest scope and the greatest difficulty in controlling infections since the Second World War [3]. When compared to similar viruses, Coronavirus has spread much more quickly than Severe Acute Respiratory Syndrome (SARS) or Middle East Respiratory Syndrome (MERS) [4]. The table below shows a comparison of information on COVID-19 with similar recent coronavirus-related diseases.

Table 1: Comparing COVID-19 and similar recent coronavirus-related diseases SARS and MERS

Virus	Period	Average number of people to be infected by a contagious person (R0)	Country First Reported	Infections	Deaths
SARS	Active: 2002-2004	2-4 people	China	8,098	774
MERS	Active: 2012-present	<1 person	Saudi Arabia	2,521	866
COVID-19	Active: 2019-present	2-2.5people	China	1.45m	83.5 k

Adapted from Uras [5]

According to Uras [5] the latest statistics indicate COVID 19 has a fatality rate of about 2.2%, while the SARS virus killed about 10% and MERS had a fatality rate of around 35%. Peeri et al. [4] through an analysis of SARS, MERS and COVID-19, concluded that we did not learn from the two prior epidemics of coronavirus and were ill-prepared to deal with the challenges of COVID-19. They argue that future research should address the uses and implications of internet of things (IoT) technologies for mapping the spread of infection. The World Health Organization (WHO) is mobilizing the nations globally, around scientific and evidence backed measures to mitigate COVID-19. As part of global efforts to reinforce the fight against COVID-19, countries that have already experienced COVID-19 are using their capabilities to provide unconditional support to needy nations. The WHO has appointment an envoy to mobilize economic resources to assist Africa in ramping up their fight against COVID-19 [6].

In the battle against the outbreak China and South Korea have applied mobile technologies with some measure of success. The US, Singapore, Poland, Israel and South Korea are some of the other countries that are using Smartphone tracking and the British government is discussing the possibility of location data tracking [7]. In India, a team collated the entire surveillance data of affected people into live geo-maps, with each of the primary and secondary contacts traced, marked and identified on the map [8]. Digital technologies such as artificial intelligence (AI), big data, cloud computing, blockchain and 5G have effectively improved the efficiency of efforts in epidemic monitoring, virus tracking, prevention, control and treatment [3]. Technologies are helping governments and health agencies to combat the virus and save lives through surveillance.

The South African government is now supporting community and stakeholder mass screening and testing programmes across the country. The aim is to mitigate the current crisis and ease the measures of national lockdown [6]. Diphoko [9] propose that South Africa should seek the best mobile technology solutions to deal with the spread of Covid-19 and follow other countries, like China who could track millions of people daily. He motivates that the access to public information to create dashboards were used to monitor and control the virus. However, Xiaoxia [10] argues that government surveillance to halt COVID-19 has contributed to privacy concerns and highlights that sensitive data collected is not exclusive to public health organizations and governments, but also accessed by surveillance technology companies and mobile app developers. He emphasises that data privacy regulations are crucial to manage companies storing sensitive data from using it.

In this paper we use a Systematic Literature Review (SLR) to explore the potential benefits and implications of using digital technologies to track COVID-19 amongst people in different societies. The aim is to highlight risks of security and privacy to personal data when using technology to track COVID-19 in societies and identify ways to deal with these risks. Next, Section2 presents the method adopted, background and overview of the research question. Section 3 analyse and integrate the outcomes of the various studies. Finally, Section 4 interprets the evidence, presents the results and concludes with policy considerations and recommendations for further research.

2. Method adopted, background and overview of the research question

The Systematic Literature Review (SLR) approach adopted in this study is to answer the proposed research question: "What are the privacy and security factors that influence the tracking of people in terms of society, technology and resources in times of COVID-19?"

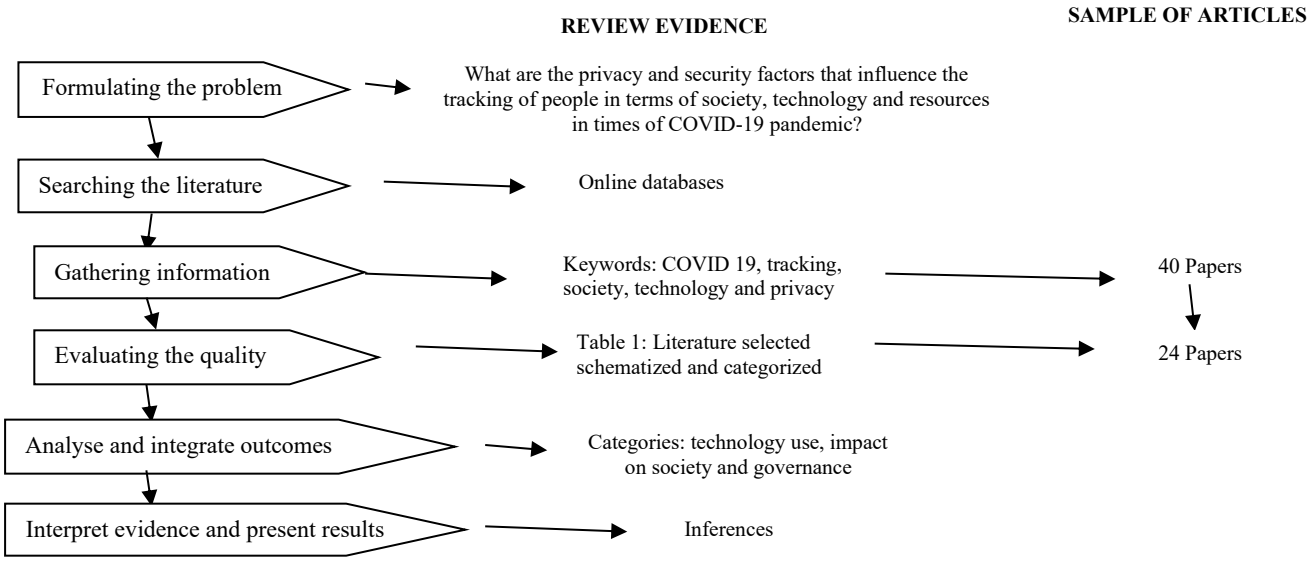

Figure 1: Adoption of the Systematic Literature Review (SLR) (Source: Adapted from Cooper [12])

A SLR is an essential feature of any academic project aimed at making a systematic collection and analysis of prior, relevant literature. It creates a firm foundation for advancing knowledge to identify, select and appraise all the significant studies previously published and identify knowledge gaps for further research [11]. The SLR will contribute by means of identifying, evaluating and interpreting all available research relevant to the main research question for this study. Figure 1 gives a schematic presentation of the steps for research synthesis when adopting a SLR approach according to Cooper [12] and includes the following: formulating the problem; searching the literature; gathering information from studies; evaluating the quality of studies; analyzing and integrating the outcomes of studies; interpreting the evidence and presenting the results.

2.1. Formulating the problem

With a broader aspiration of identifying best practices to maintain a high level of security and privacy to support community and stakeholder mass screening and testing programmes across the country, is to make a first approach to analyse and identify the factors that influence the tracking of people in terms of society, technology and resources in times of COVID-19. The aim is to mitigate the current crisis in order to ease measures of national lockdown and disaster in South Africa. This is a mandatory first step to understand the different actors, networks, institutions,

technology-organisation environments as to identify the technology, political and social factors involved in design, use and governance of such a tracking and tracing system.

2.2. Searching the literature

Due to the lack of precise key words defining the topic, academic and industrial journals were sorted by reviewing their titles, abstracts and manuscripts in the traditional and electronic library systems. Since technology adoption for tracking of COVID-19 affected people in society is a recent phenomenon that has emerged only recently, related publication channels are very scattered.

In our view the dominant method in identifying the most relevant papers today is to focus on online databases rather than reviewing library collections. This research targeted literature published related to the topic over the past few months on the following major online databases for: Google Scholar, Wiley Online Library, JSTOR and Science Direct (Elsevier). The problems that were addressed by the review were specified in the form of a clear, unambiguous and structured question before beginning the review work. A total of 40 papers were used in this research, however, a total of 27 papers were sampled and selected for more detailed analysis. The study selection criteria flowed directly from the review question. Papers older than 1 year were excluded as using technology to track COVID-19 affected people only came into existence recently.

2.3. Gathering information from studies

The search for studies was extensive and multiple sources were searched. The following criteria were applied in the search and selection of papers covered in the study: the keywords COVID 19, tracking, society, technology and privacy were used to search the titles and abstracts of the publications.

Other more specific search strategies were attempted in order to obtain systematic and exhaustive results. We also used guidelines on ‘technology adoption for tracking for COVID-19’ related to low-income countries to retrieve papers used by International Organizations such as WHO, UNESCO, etc. The purpose of this literature review is to analyse and determine the factors that influence technology adoption for tracking COVID-19 affected people in society. Such information has been processed to summarize the existing research and identify the conceptual content of the field that can contribute to theory building.

2.4. Evaluating the quality of studies

The next step involved evaluating the quality of studies and gathering information from studies to review and classify relevant studies to gain insight into factors affecting the adoption of technology for tracking of COVID-19 affected people in society. The literature sources are investigated in scientific databases and regular search engines which include peer and non-peer reviewed papers, industrial reports, policy papers and books. The keywords were not predetermined before the search, but they have gradually emerged during the extensive reading process that took place while drafting this study.

Accordingly, this research captures the trends in the adoption of technology for tracking of COVID-19 affected people in society literature by examining published academic articles and industrial reports. Considering the nature of technology adoption, it is quite a challenge to confine studies into specific categories in order to ensure that these papers are sufficiently investigated based on the year of publication, subject, objective or method. However, an exception was made for industry publications due to the limited output generated based on search criteria from the academia.

Finally, after the first two criteria were applied to filter the output, the remaining journal publications that were available in English were all considered. In Step 4, the selected studies from Step 2 were subjected to a more refined quality assessment by use of general critical appraisal guides and design-based quality checklists. These assessments were used for exploring heterogeneity and informing decisions regarding suitability.

Table 2: Literature selected schematized and categorized sort by the SLR approach

ARTICLES	Literature Categories			ARTICLES	Literature Categories		
	Technology use	Society	Governance		Technology use	Society	Governance
Brous, et al. [22]	**X**		**X**	Mchunu et al. [6]		**X**	**X**
Chan et al. [25]		**X**		Mian & Khan [19]	**X**	**X**	
Chang, et al. [15]	X			Park [13]	**X**	**X**	
Chaturvedi [7]	**X**			Qinyi et al. [18]		**X**	**X**
Cheifet [17]	**X**	**X**		Raskar et al. [27]	**X**		**X**
Cho et al. [26]		**X**	**X**	Sookman [29]	**X**		**X**
De Carli et al. [23]		**X**	**X**	Souza et al. [24]	**X**		
Diphoko [9]	**X**	**X**		Verburg [2]	**X**		**X**
Emameh, et al. [1]	**X**			Weidemann [14]	**X**		
Fitzpatrick et al. [16]				Whelton & Rhoads [3]	**X**	**X**	
Joosub [8]	**X**	**X**		Xiaoxia [10]		**X**	**X**
Kaye et al. [21]		X		Yakobi et al. [21]	**X**		

Each of the papers identified, provide certain elements and different points of view to address the goal for this work. At this point, literature selected was schematized and categorized, in order to find consistencies, common patterns that help to sort those papers by a systematic approach as shown in Table 1.

As a summary to this methodology section, my literature review on factors affecting technology adoption for tracking of COVID-19 affected people in society led us to identify 24 papers out of more than 40 papers which were relevant to the analysis. In the two following sections of this paper we will analyse and integrate the outcomes of studies, interpret the evidence and present the results to find consistencies and common patterns. This will help to determine the factors affecting the adoption of technology for tracking of COVID-19 affected people in society. Beyond the fact that all methodological approaches have their limitations, this literature review had followed the structured procedures that provide a systematic approach and thus ensure objectivity. The validity condition was attained by following the formal recommended steps for a literature review by Cooper [12], while reliability was addressed by having all the formal procedures conducted.

3. Analyzing and integrating the outcomes of studies

As a first step, papers were classified into different categories in terms of the approach to security and privacy when adopting technology track COVID-19 affected people in society. The three main categories identified was technology use, impact on society and governance.

The first group of papers identified technology factors that influenced technology adoption for tracking of COVID-19 affected people. Globally, governments and health authorities are working together to leverage digital technologies to find solutions to the COVID-19 pandemic. The main contribution of the authors within this line is that they highlighted the huge potential technologies such as IoT, artificial intelligence (AI), big data, cloud computing, blockchain and 5G have to assist in Infection Prevention and Control (IPC). Smartphone apps, data analytics and artificial intelligence companies are making their algorithms available while firms increased access to key video casting tools for educators and remote workers [3, 13, 14]. Park [13] further argues that these technologies make finding and treating people with an infectious disease far more efficient than ever before. Smartphone apps are used to keep a tab on people's movements and ascertain whether they had been in contact with an infected person [9].

Supporting this notion Chang et al. [15] proposes Big Data, IoT and Analytics for future development of research and complex tracking systems. Fitzpatrick et al. [16] explored the potential of Artificial intelligence (AI) to benefit

IPC in areas of epidemiology and laboratory infection diagnosis. He discovered that AI contributed to speed, consistency, and capability of handling infinitely large datasets. In a similar line Cheifet [17] highlights the rapid advancement of knowledge on COVID-19 was fuelled by the open and willingness of researchers to share raw sequencing data of the virus and their research findings. This encouraged other researchers to share data, build on the data and confirmed the importance of open access [17].

The second group of papers identified the impact on society of technology adoption that assist in tracking COVID-19 affected people. Qinyi et al. [18] explains that data about COVID-19 is essential for controlling the source of infection, cutting off the route of transmission, and protecting vulnerable populations. He argues that by sharing epidemiological data with medical institutions have effectively and comprehensively improved the prevention and control of the pandemic. On the other hand, Fitzpatrick et al. [16] argues that technologies alone will not improve IPC as we also require culture and behaviour changes within societies. Verburg [2] argues that mature and available modern technologies have reduced the need for travelling and in the light of the current COVID-19 developments alternative education away from traditional patterns should be explored. Universities need to consider utilising other modes such as live tele-teaching and video conference platforms. Such approaches will also serve to lay the foundation for teaching during future disasters and beyond [19]. Yakobi et al. [20] identify the challenges of using social media for Big Data Analytics when developing citizen relationships and e-participation through a conceptual model. Yakobi et al. [20] further argues that although this has the potential of a new solution to support decision-making, the main aim should be that it brings “Big Value”.

The third group of papers identified governance factors that influenced technology adoption for tracking of COVID-19 affected people in society. This analysis identified the factors that determine the intrusion of privacy of society and the access of personal sensitive data. This implies asking questions on to what extent should government restrict the usage and storage of sensitive data. In line with this Xiaoxia [10] suggests that data privacy regulations should restrict companies storing sensitive data from using it. He proposes the use of privacy-enhancing technology that assists companies to use data without revealing confidential information. Kaye et al. [21] believes governments are obligated to promote and protect access to information during the pandemic and argues the need for truthful information about the nature of the threat posed. Governments must protect the work of journalists while Internet access is critical for access to information. This could guard against the spread of false information about the pandemic that could lead to health concerns, panic and disorder. It is important that governments make people aware of the growing use of tools of surveillance technology to track the spread of the coronavirus [21]. Thus, how to restore data privacy after the coronavirus pandemic becomes a major challenge [10]. A case study done by Brous [22] show that ownership, monitoring the quality, having a controlled overview of standard and specific compliance requirements are important factors for maintaining data quality and compliance. Having these considerations could lead to building trust in data science products.

4. Interpreting the evidence and presenting the results

The protection of society against harm and health threats involves the collection of very basic and health-related data of individuals in today’s highly mobile phone usage society. This assists health authorities and governments to identify the next steps to plan and implement in order to protect society where every individual is a key player [23]. Monitoring health and location data of local populations is the key to an effective containment strategy and our personal data is currently being collected, used and shared in a variety of ways. Mobile location data with advanced tracking capabilities enforce quarantines while the identity of individuals can be captured by facial recognition technology linked with biometric databases. Open-source applications share genomic data to help researchers track and study the evolution of COVID-19 [10]. Souza et al. [24] argues that mining data from various big data sources find useful information and discover knowledge, which can be transformed into wisdom for appropriate actions that benefits health agencies in disease control and prevention. Joosub [8] further supports this use of big data analytics to assist governments to track the spread of the disease, as well as to monitor population movements.

On the other hand, Xiaoxia [10] warns that government-sanctioned surveillance programme, however well-intentioned, raises serious questions of how sensitive data are being used and how to mitigate the risk of privacy breaches. Although the current situation is serious and demands certain measures, Chaturvedi [7] agrees and states that there could be serious ramifications for countries compromising individual privacy. We found that although most

of the authors agree that technology help governments and health agencies reduce the spread of the virus, a few have argued that government surveillance to halt COVID-19 has sparked privacy concerns.

Central to public health law is the ethical question of how to balance what is revealed for the good of public health versus individual freedoms. Thus, we need to investigate the civil liberties and the risks that contact tracing can pose to civil liberties [25]. Cho et al. [26] investigates the privacy trade-offs people are willing to make in favour of public health and app-based contact tracing without completely compromising privacy. Raskar [27] agrees and further propose Mobile Apps that enables privacy protected participatory sharing of data by diagnosed carriers without allowing a third party, particularly a government, to access individual location trails. While many countries require that infected people share their location history with the health authorities, Reichert et al. [28] propose a system for privacy-preserving contact tracing that can deal with this conflict of interests. We agree with Cho et al. [26] that policymakers and developers need to give privacy considerations careful thought when designing new contact tracing technology applications.

4.1. Conclusion and Recommendations

This paper reports on a systematic literature review to explore the potential benefits and implications of using digital technologies such as AI, big data and cloud to track COVID-19 amongst people in different societies. The aim of the paper was to highlight the risks of security and privacy to personal data and ways to deal with it.

In analyzing and integrating the outcomes of studies, papers were divided into three categories, namely technology use, impact on society and governance. The technology use category highlighted the huge contribution technologies have made in disease control and prevention of the COVID-19 epidemic. The next category explored the impact of COVID-19 on vulnerable populations where it was argued that besides technology, society also require culture and behaviour changes to prevent, intervene and control the epidemic. Finally, the intrusion of privacy of society and the access of personal sensitive data was identified as major challenges in the governance category. The need for a balance of what personal data is revealed for the good of public health versus individual freedoms is highlighted. When evaluating technologies to adopt for tackling epidemics such as COVID-19, numerous privacy considerations must be considered.

Some of these considerations are the architecture protocols of the solution, the access and purpose of parties, is participation voluntarily or mandatory, is data encrypted, are users anonymous, what is revealed by infected users to individuals they come into contact with, whether the system can by exploited by external parties, and how reliable and secure the system is [29]. When interpreting the evidence of this SLR we found that although most of the authors agree that technology help governments and health agencies reduce the spread of the virus, a few have argued that government surveillance to halt COVID-19 has sparked privacy concerns. In South Africa, the national lockdown seeks to pursue a path which saves lives and protects livelihoods. This is based on intensifying public health response to reduce infections and to protect the poor and the vulnerable [6]. Thus, I agree with Sookman [29] that the following requirements should be included in government policy for the intervention to be ethical and capable of commanding the trust of the public.

- Appoint an inclusive and transparent advisory board that includes civil society to do oversight.
- The agreement and publication of ethical principles to guide the intervention.
- Guarantees of equity of access and treatment.
- The use of a transparent and auditable algorithm.
- The effective management of future major outbreaks by integrating evaluation and research.
- Careful oversight of and effective protections around the uses of data.
- The sharing of knowledge with other countries, especially low- and middle-income countries.

Ensuring minimum regulations are imposed plus policy and practice are guided by equal moral respect, fairness, and the importance of reducing suffering [29]. In informing and giving clarity to the above requirements the following research questions for further research are proposed. These are important questions that will most certainly resurface even if we are too preoccupied to think about them today once panic ebbs and calm has been restored in the post-coronavirus era [10].

- Who has access to it?
- How vulnerable is our data to leaks and hacks?

- How could it be exploited by private companies in the future?
- Is there a way to mitigate the risk of privacy breaches?

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