MASTER THESIS

Unravelling the CoronaMelder

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Our fellow citizens were no more to blame than others; they forgot to be modest, that was all, and thought that everything was still possible for them. They went on doing business, arranged for journeys, and formed views. How should they have given a thought too anything like the plague, which rules out any future, cancels journeys, silences the exchange of views. They fancied themselves free, but no one will ever be free so long as there are plagues.

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The announcement that there were three hundred and two deaths in the third week of the plague did not speak to the imagination. On the one hand, they may not all have been victims to the plague, on the other hand, no one in town knew how many people normally died each week. The city had two hundred thousand inhabitants. No one could say whether that death rate was normal or abnormal. This is, in fact, the kind of statistics that nobody ever troubles much about, notwithstanding that its interest is obvious. The public lacked, in short, the standards of comparison

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And, indeed, listening to the cheerful cries coming from the city, Rieux realized that this cheerfulness was still in danger. For he knew what the happy crowd did not know, and what the books read: the plague bacillus never dies and never disappears permanently; he can slumber in the furniture and linens for decades at a time, he waits patiently, in rooms, cellars, suitcases, handkerchiefs and papers, and perhaps a day will come when, to the harm and learning of mankind, the plague awakens its rats to let them die in a happy city.

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Albert Camus, The Plague, 1947

SUMMARY

In December 2019, the COVID-19 virus emerged in Wuhan, China – and on the 11th of March that same year, the WHO declared a pandemic. This pandemic has impacted our lives in profound ways, and all around the world people are looking for ways to battle this crisis. In doing so, many countries have turned to technological support tools, such as contact tracing applications. Contact tracing applications are meant to support the manual source and contact tracing and notify you if you have been close to a COVID-19 patient. A lot of attention has been paid to the ethical implications of the employment of tracing applications, while the process of how these applications have been developed is underexposed. However, these unique projects can offer us many insights in the interaction between governments, technology, and the public. Therefore, the aim of this thesis is to shed some light on the development process of these applications. This is done through a case-study of the Dutch COVID-19 tracing application: the CoronaMelder.

Throughout the thesis, I refer to contact tracing applications as 'public policy technologies', as they are a technology that, in a way, embody public policy and are initiated by the government. With the increasing digitalisation of almost all aspects of our lives, we can expect – and already see – an increase in governmental technologies. However, the development process of such technologies has not been studied in-depth and there even appears to be a knowledge gap on how to evaluate the development of such technologies. There is knowledge on how to assess new and emerging technologies from the perspective of philosophy of technology, and there is knowledge on how to make 'good policy'. But there the 'public policy technologies' fall into a void, as they are not fully situated in either research area, but in both a little. Therefore, the CoronaMelder offers a great opportunity to explore how we can overcome this gap. The research question that I aim to answer in this thesis reads: **What can society learn from the development of the CoronaMelder when approached from a RRI/co-production perspective?** This research question is answered through a mixed methods approach, including literature studies, document analysis and expert interviews.

My conclusion is two-fold, and somewhat contradicting. On an instrumental level, the application is developed with great care for the privacy of the end-user, in a short amount of time and under enormous pressure. However, when looking at the application from a broader point of view, we see that there is room for improvement. Additionally, the development of such applications raises questions about normalizing a culture of surveillance and solutionism. A way to overcome these issues in future situations, is a more inclusive process of deliberation throughout the whole development process.

I. Abbreviations

BLE	Bluetooth Low Energy
GGD	Municipal Health Authority [*Gemeentelijke Gezondheids Dienst*]
NPG	New public governance
R&D	Research and design
RRI/RI	Responsible (research) and innovation
SCT	Source and contact tracing

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IV. Acknowledgements

Writing this thesis was not always easy, and I have many to thank for their support. First of all, I would like to thank my extensive team of supervisors, Michael, Guus, Ben, Andreas and Pieter-Jan, for their constructive feedback and support. Also, I am grateful for my friends & parents, Jerphaas, Mariëlle, Dirk, Jaap, Laura and Niels for providing assistance and feedback when (sometimes desperately) needed. Of course I also want to thank my grandmother, whom provided me with a tranquil surrounding to be able to write my thesis, made me many dinners and stayed up all evening in excitement when I had a deadline to complete. And Tom, for bearing with me all this time. Finally, I want to thank all my fellow-philosophers from the PSTS program, and the two friends I've made in PA, it was a great pleasure!

CONTENT

CHAPTER I – INTRODUCTION

Currently, the world is on stand-still: people all over the world are confined to their homes, not allowed to go outside for anything but essentials, schools and universities are closed, human contact is restricted to 1.5 meters distance. 'Social distancing', 'self-isolation' and 'home-quarantine' are common jargon. In the words of Mister Cumbia, who made a cautionary song on request of the Mexican government: "*The whole world is scared / with a disease / it is called the coronavirus / and it is a worldwide emergency"*[1]. Coronavirus, also referred to as COVID-19, or in more technical terms SARS-CoV-2, is *"the most severe pandemic in living memory"* (Weible et al. 2020: 2). A pandemic is the prevalence of an infectious disease on a large scale (WHO 2020b) – spread to whole countries, or such as presently the case, the whole world. It usually signifies an epidemic that is beyond control (French & Monahan 2020: 2). COVID-19 spreads rapidly around the world and has unprecedented impacts. Milder symptoms include fever, aches, dry coughing, and shortness of breath. However, it poses life-threatening conditions for the elderly and people with pre-existing conditions (Weible et al. 2020: 2)[2]. Thus far, COVID-19 patients seeking medical care have strained existing healthcare systems. In many locations the outbreak of COVID-19 has overwhelmed hospitals and healthcare professionals (Weible et al. 2020: 2). Moreover, as described by Weible and colleagues: "*the effects go far beyond those felt by healthcare systems and stretch across virtually every sector of society – from food systems to education – and have crippled the economy*" (ibid).

However, it is not the first pandemic, neither will it be the last. As humans spread across the world, infectious diseases have been a constant companion – think for example of the Black Death (1347-1351) which killed around 200 million people, or the Smallpox in 1520 which caused 56 million deaths (LePan, March 2020). In the 20th century, three influenza pandemics occurred. The most severe was the Spanish Flu (1918-1919), responsible for the loss of 20 to 50 million lives, followed by the Asian Flu in 1957-1958 and the Hong Kong Flu (1968), which were both estimated to have caused 1 – 4 million deaths each (WHO 2020a). In 2009-2010, the first pandemic of the 21st century occurred – generally referred to as swine flu (H1N1). It should be noted that several epidemics have also occurred in this century: SARS (2002-2003), MERS (2012 - now) and Ebola (2014-2016). When facing an influenza pandemic "*government officials must be prepared to face the first wave without an effective vaccine and with a limited amount of antiviral medications (…) the implementation of nonpharmaceutical interventions during this time period is perhaps the most crucial element in limiting the effects and dissemination of a deadly virus"* (French & Raymond 2009: 823).

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[1] Todo el mundo está espantado / Con una enfermedad / Se llama el coronavirus / Y es una alarma mundial.
[2] see also the information box COVID-19.

At the time of writing, we find ourselves in this first wave of COVID-19, where the international community is working extremely hard to develop a vaccine but did not yet succeed (Rourke, May[3] 2020). Therefore, countries are turning to other, temporary responses to contain the virus to a manageable amount. Some countries decided upon a full lock-down, other countries take less intrusive measurements. However different strategies these countries deploy, a common response seems to focus on digital support - such as robotic creatures telling citizens to keep their distance (Wyatt, May 2020), police forces wearing helmets that measure your temperature (Reuters, April 2020), or dashboards that reveal numbers about affected people and death toll, about their age, gender and health situation, which are published and analysed on a daily basis – see **Figure 1** (Rocha, March 2020). The contemporary ability to almost follow the development of the virus in 'real time' (Thomas 2014), apparently must concern us all. Maybe this numerical focus gives us a sense of control, of manufacturability, of power over nature, while also allowing an 'objective' ground to base governmental decisions upon. This focus on digital support has another implication as it allows the technological positivism to enter a relatively 'untouched' field: the development of smartphone applications to contain a healthcare emergency. *Relatively* 'untouched', because it is not totally new, as phone applications have been used in healthcare emergencies before. Examples thereof can be found looking at the Ebola outbreak (Erikson 2018); malaria outbreaks in Kenya (Wesolowski et al. 2012); and infectious disease outbreaks after earthquakes in China (Yang et al. 2009). However, the scale and intrusiveness shown by the current applications has not been met before.

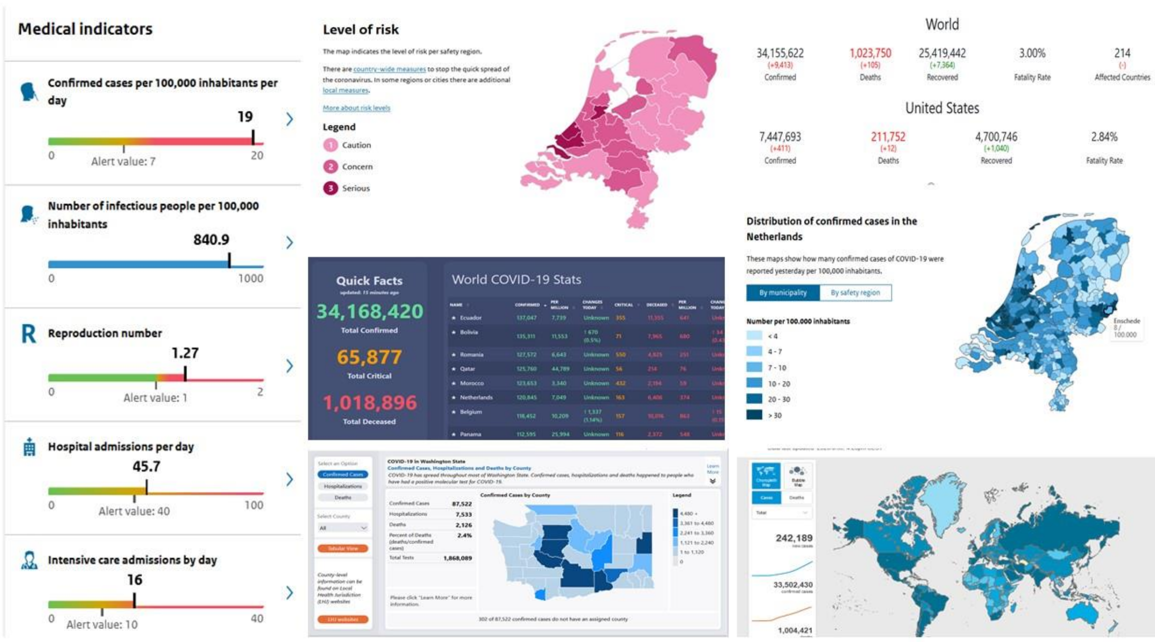

Figure 1. Combination of several COVID-dashboards, by author.

[3] As the COVID-19 virus is an extremely topical subject, I have included the months of articles concerning statements about the 'current' situation – as this is under constant change.

This focus on technological solutions is a very interesting development that gathers a lot of attention from the media as well as the academic world. Many focus on the ethical considerations and choice fallacies behind the COVID-19 applications, such as the apparent need to give up your privacy for your health – see for example publications by Rob Kitchin, Yuval Noah Harari, Bruno Latour and Luciano Floridi (all 2020). However, what seems to be missing is an understanding of how we got to this point, and what we can learn from earlier and contemporary attempts of battling viruses with smart phone applications. Therefore, the aim of this thesis is to shed some light on the development process of these applications. This is done through a case-study of the Dutch COVID-19 tracing application: the CoronaMelder.

COVID-19 (novel coronavirus)

The novel coronavirus first emerged in December 2019 in Wuhan, China and on March 11th the WHO declared it a pandemic. COVID-19 is a respiratory infection which can be transmitted through droplets. Droplet transmission occurs when a person is in close contact (within one meter) with someone who has respiratory symptoms (e.g. coughing or sneezing) and is therefore at risk of having their mouth/nose/eyes exposed to potentially infective respiratory droplets. Transmission can also occur through fomites in the immediate environment of the infected person. COVID-19 symptoms are similar to symptoms of a common cold at first. However, the disease can cause severe pneumonia, which can be fatal. Currently, no vaccine is available – and therefore other measurements such as social distancing, wearing facial masks, and extra hygiene measurements are taken. For more information see: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/.

THE CORONAMELDER

The CoronaMelder is a contact tracing application, developed by the Dutch government, which can be downloaded by the public. The application notifies its users when they have been close to a COVID-19 infected person for over 15 minutes. The CoronaMelder is not only a technology, but also a policy instrument, a tool used by the government to support the manual source and contact tracing. Therefore, the broader governmental context in which the CoronaMelder functions, is of great importance. When making public policy, it is fairly common to engage different parties in the process through co-production. However, while technologies are being used to engage in co-production process for public policy, there is no scheme on how to use co-production for the development process of 'public policy technologies' such as the CoronaMelder. The absence of such is remarkable as e-governments are emerging and ever more public services are being offered through digital tools. I deem this absence as a – both interesting and alarming – gap in the literature, which I aim to fill by combining the concept of co-production with the principles of Responsible Research and Innovation, an approach to develop new technologies in a responsible manner. This aim is captured in the research question: **What can society learn from the development of the CoronaMelder when approached from a RRI/co-production perspective?** [4] The research question is then divided into three sub-questions:

1. *What is the CoronaMelder and how does it relate to similar projects?*
2. *What is RRI, what is co-production and why is it of importance for the development of the CoronaMelder?*
3. *To what extent did the development of the CoronaMelder comply with RRI/co-production?*

In **Chapter II – Methodology**, the used methodology is addressed and the rationale behind the research is elaborated upon. In **Chapter III – Contact Tracing Applications**, the first sub question is addressed. To do so, first, attention is paid to the previous, similar applications. Second, the attention shifts to the current situation. Third, some concluding remarks are given. In **Chapter IV – Theory**, the second sub question is addressed. The complexity of the CoronaMelder is elaborated upon, followed by a specification of the theoretical framework. In **Chapter V – Results**, the third sub question is answered by an analysis of the gathered data. In **Chapter VI – Conclusion**, the research question is answered. Finally, in **Chapter VII – Discussion**, several discussion points are being highlighted and recommendations for future research are given.

[4] Society in this question refers to many different groups, such as governmental institutions, scholars, the public, NGO's, etc.

CHAPTER II - METHODOLOGY

In this chapter the research plan is introduced. It consists out of two parts: an introduction in which many fundamental issues are addressed, and a research design, in which the more practical side of the case-study is elaborated upon.

INTRODUCTION OF RESEARCH PLAN

The effects of COVID-19 are causing heavy disruption of existing infrastructures and systems. Measures to contain the virus are social distancing, wearing face masks, and washing your hands. Manual Source and Contact Tracing (SCT) and testing are seen as essential practices to get out of this situation. However, manual SCT takes time, and time is exactly what is scarce during a pandemic. Therefore, governments are trying to minimize the time spend on SCT by employing technological support tools, such as applications. These government employed applications are situated in two different areas: on the one hand the public domain, on the other hand the technological domain. However, the focus on a technological solution does raise some questions: why does the government regard an application as such an important crux to battling a virus? And for which purpose and which users, based on which expectations and underlying values?

As noted, the unique traits of the CoronaMelder – it being an online 'public policy technology', the success depending on the publics adaptation rate and other offline processes such as COVID-19 testing facilities – make it an outstanding case-study for the research on the usage of technology by governments.

LIMITATIONS

In December of 2019, the trajectory of writing a master thesis began – and I decided to focus on a case-study about smart fire sensors in Midden Brabant (a region in the Netherlands). However, after several months, COVID-19 reached Europe, and Brabant appeared to be a focal area. The new UT policies in relation to gathering data, the fact that I was working with many people involved in safety professions, and the inability to travel to the location made it an unworkable case. Therefore, I had to change my topic half-way in, and decided to tackle the bull by its horns. By changing my topic into the COVID-19 applications, I gave myself a coping mechanism. However, as everyone has experienced, working from (a student) home during a pandemic requires great effort. Additionally, there were other limitations: all data gathering, including interviews, had to be done online, and the people that are key actors in my research, are also the people that are extremely busy right now. Thus, while COVID-19 offered me the possibility to work on a cutting-edge case, it also imposed its limitations.

RESEARCH QUESTIONS

In this paragraph, the research questions will be introduced. The main aim of this thesis is to see how practice and theory can complement each other in order to learn how to best approach the development of 'public policy technologies'. This is captured in the following research question:

What can society learn from the development of the CoronaMelder when approached from a RRI/co-production perspective?

'Society' in the research question is understood as academics, governmental institutions, the public – and all that are in one way or another affected by the CoronaMelder. This question is then divided into three sub questions, which are answered in **chapter III**, **IV** and **V**, respectively:

I. What is the CoronaMelder and how does it relate to similar projects?

II. What is RRI, what is co-production and why is it of importance for the development of the CoronaMelder?

III. To what extent did the development of the CoronaMelder comply with RRI/co-production?

As noted, COVID-19 has really shaken the earth – and raised many global questions about our current system and way of living. The COVID-19 applications are just a piece of this huge challenge we are facing; however, they are not an independent part of the puzzle. They fit in a longer tradition of governmental and civil digitalization and raise questions about inclusion and representation in this digitalization. Therefore, the thesis is both scientifically – as a way of contributing to the contemporary discussion – and socially – as a way of raising awareness of these processes – relevant.

RESEARCH DESIGN

In the following paragraphs, the blueprint for this research is set out, which guided the process of collecting, analysing and interpreting the done observations. The criteria for interpreting governmental data and analysing findings are addressed and elaborated upon.

The engagement of tracing applications to help contain the spread of COVID-19 is a global trend. However, there are many, subtle differences between the different tracing applications employed, and one can imagine that the processes that led to the engagement of them are also different per country. Therefore, the case study of the Dutch situation should be regarded as a **single, descriptive case** – "*used to describe an intervention or phenomenon and the real-life context in which it occurred*" (Bryman 2008: 548).

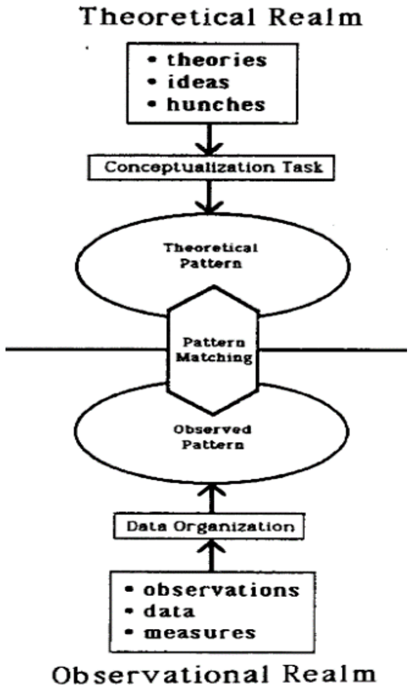

Figure 2. Pattern matching (Trochim 1989: 356).

Following the method of pattern matching, as set out by Trochim (1989), first research is done in the theoretical realm, where based on theories, ideas and hunches a conceptualisation of the 'public policy technology' is made (see both Chapter III – Contact Tracing Applications and Chapter IV – Theory). A combination of existing theories is developed into a theoretical framework, to hold the development of the CoronaMelder against – to be able to identify pressure points (i.e., theoretical patterns are developed). Then, the analysed data is being compared to this conceptualisation and patterns are matched. The main sources of data are governmental documents on the development of the CoronaMelder. When using governmental sources, there are four criteria against which we should hold them, following Bryman (2008: 550): namely authenticity, having meaning (being clear and comprehensible to the researcher), credibility (potential biases) and representativeness. As the used documents are retrieved directly from the official Dutch government website, a high level of authenticity is secured. All documents are published in Dutch, and as the researcher is a native Dutch speaker with a sufficient level of general knowledge, the documents should be understandable. The credibility might offer the most interesting criterion, as it can expose certain biases: what is not named, what is not discussed? Finally, representativeness - how representative these documents are for the case – is in this case a criterion on which the study is build: the goal is to understand the governments perspective.

Following Yin (2009: 40), there are three criteria for judging the quality of research designs for descriptive studies: construct validity, external validity, and reliability. **Construct validity** concerns identifying the correct operational measures for the concepts being studied and can be achieved by using multiple sources of evidence, establishing a chain of evidence, and/or having key informants review draft case study reports (idem: 41). For this research, I am using both governmental documents and interviews, clearly stating my chain of evidence and I ask key informants to either confirm or deny made inferences. **External validity** is defining the domain to which a study's findings can be generalized and is achieved by using theory in single-case studies (ibid). I will use the theory of pattern-matching to analyse the gathered data (see **Figure 2**), which includes a clear set-out theoretical framework which is then compared to the gathered data. This is a quite specific case-study and therefore not immediately generalizable to other cases. However, done observations can offer insights in existing theory and practice. Both theory and practice inform each other in this case. **Reliability** is demonstrating that the operations of a study – such as the data collection procedures – can be repeated, with the same results (ibid). This is achieved by the case-study protocol, which can be found under **Appendix I**.

LITERATURE OVERVIEW

Throughout, I refer to the CoronaMelder as a 'public policy technology'. This is a reference to the fact that the CoronaMelder is both a new and emerging technology, as well as a policy tool initiated by the government. This puts the application at the exciting cross-section between the societal and the technical realm, while at the same time it exceeds arbitrary boundaries between different fields of research. It situates this thesis in a specific niche – namely that of the relation between government, governance and technology. Much has been written on the usage of ICTs for governmental purposes, also referred to as e-governance. There is also a developing body of literature on how to enable a process of co-production by using digital infrastructures. However, there is little to no literature to be found on how to engage with a technology that the government develops in order to support policy purposes. A way of complementing this deficit is to integrate co-production with the principles of Responsible Research and Innovation. This way, it should be able to both capture the complexity of these 'public policy technologies' as well as being able to evaluate them.

To be able to analyse this cutting edge technology from all the interesting sides it holds, the used literature in this thesis contains texts from (but is not limited to) the fields of public administration, philosophy of technology, and science and technology studies. By combining different perspectives and theories, especially from the bodies of literature on (i) developing public policy and (ii) innovating responsibly, a framework to be able to evaluate the actual development process of the CoronaMelder is constructed. In doing so, a beginning is made to (a) expose the existing literature gap, and (b) start to connect these different fields of study.

CHAPTER III – CONTACT TRACING APPLICATIONS

As noted in **Chapter I - Introduction**, the CoronaMelder fits in a trend of similar tracing applications in healthcare emergencies. However, the contemporary apps differ per country in the degree of voluntariness, privacy sensitiveness, and technological underpinnings. In this chapter, the first sub question - *What is the CoronaMelder and how does it relate to similar projects?* - is addressed. In order to do so, first, previous cases in which phones were used during healthcare emergencies are highlighted. Second, the current technological options are set out, followed by their drawbacks and benefits. Third, some concluding remarks are given.

TRACING APPS IN HEALTHCARE EMERGENCIES

Although the usage and development of tracing applications appears to be a new, it is not. The usage of phone applications in times of healthcare emergencies has occurred previously. From these experiences, lessons can and should be learned. In the following paragraphs, different examples of the usage of such applications are elaborated upon, and the main lessons from these experiences are set out. To give some insight in (a) the chronological development of applications to contain the spreading of viruses, and (b) the specific aspects that should be paid attention to.

EARTHQUAKE, CHINA

The first discussed case is situated in China, after the Sichuan earthquake in 2008. This earthquake is known as one of the largest earthquakes in human history in terms of socio-economic losses (Daniell 2013). A surveillance system was needed in the most disaster-hit area, to reduce the risk of an epidemic – as the emergence of infectious diseases is common in populations displaced by natural disasters. However, after such a natural disaster, these systems are often damaged. Therefore, the China Centre for Disease Control and Prevention (CDC), set up a mobile phone emergency reporting system (Yang et al. 2009: 619). It should be noted that in 2008, the number of people owning a smartphone, was still low (the first iPhone came out in 2007). Therefore, the reporting system used in Sichuan should be seen as a surveillance application pre-smart phone times, which offers us some knowledge about the general underpinnings of the usage of phones during healthcare emergencies.

The Sichuan reporting system consisted out of five steps: (i) the selection of mobile phones and the network supplier, (ii) the development of a reporting system to run on mobile phones, (iii) the identification of places where the mobile phones would be needed, (iv) the distribution of the mobile phones and providing on-site training, and (v) the appliance quality control measures (Yang et al. 2009: 619). The system was especially meant as a disease spreading surveillance system, and not as a contact tracing system. Trained health officials would fill in a questionnaire on a patient via SMS on the mobile phones (about his/her syndromes), and this data would be gathered by a central authority. Then it would be processed and this way the development of the disease could be analysed (Yang et al. 2009: 621). This way, focal areas could be identified, and measurements imposed. In their conclusion, Yang and colleagues address some learned lessons. First, they note that instead of supplying the health professionals with actual phones, it might be more effective to use an application they could download on their own phones. Now, the supplied phones were also used for other activities than just the surveillance (i.e. calling), which emptied the provided phone credit and thus limited the ability to send texts (Yang et al. 2009: 621). Additionally, the authors state that "*whenever possible, mobile phones with global positioning system (GPS) capacity should be used. The reporting system can be programmed to attach coordinate data to each text message automatically (…) to track the disease in a spatial resolution higher than the township level"* (Yang et al. 2009: 621). Thus, overall, this set-up was quite labour intensive and could have benefited from the ability to download an application and/or a focus on GPS data.

MALARIA, KENYA

The second identified takes place in Kenya, 2008-2009, and concerns a Harvard study about the relation between human migration and the spread of Malaria parasites (Wesolowski et al. 2012: 268). At first sight, this study might seem very different from the contemporary tracing applications, and it is[5]. However, it did serve as the foundation for the next case, the Ebola pandemic of 2014-2016 in West-Africa, and is therefore elaborated upon.

The study on the spreading of Malaria was done using Call Detail Record (CDR) data. CDR data is gathered via telecommunication towers, which exchange pings with cell phones. These pings are time-coded signals, that send, receive, and register each time a cell phone passes a telecommunications tower, which makes it possible to track a cell phones movement and travel (Erikson 2018a: 9). This data is owned by telecommunication companies; therefore, they need to share it with researchers (Erikson 2018a: 13). The researchers could than estimate the route that an entity followed, and this way construct the migration patterns of these entities (see **figure 3** for a visualization).

The Harvard researchers analysed CDR data from 14,816,521 cell phone users in Kenya who travelled from home to work in 2008 and 2009 (Erikson 2018b: 328). This data – estimated location and prevalence (rather than specific people and incidence) - informed the mobility study (Erikson 2018a: 8). Thus, what was measured were human migration patterns, not specific individuals. It was discovered that these human migration patterns did contribute to the spread of malaria – which was not a new understanding, but now was confirmed 'common sense' (Erikson 2018b: 328).

[5] Note by the Dutch government did propose to change its current telecom law, in order to be able to retrieve CDR data, to better predict COVID-19 focal area's.

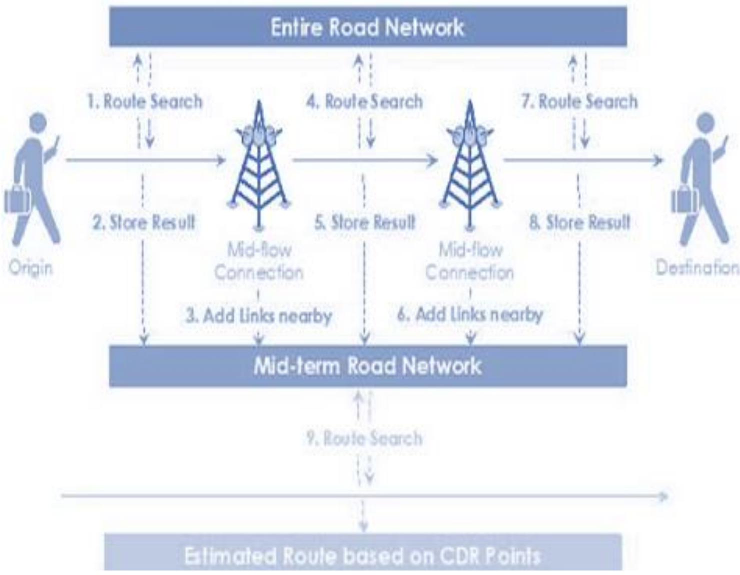

Figure 3. Visualization CDR data gathering (Shibasaki 2017: 14).

EBOLA, SIERRA LEONE

During the Ebola pandemic, between 2014 and 2016, big data was used as an anticipatory technology (Erikson 2018a: 4). In Sierra Leona, cell phones were expected to serve "*as beacons of contagion, signalling the mobility patterns of people with the disease*" (Erikson 2018b: 315). Build on the previous discussed study, CDR was used to identify the spreading of Ebola in Sierra Leone, in order to be able to anticipate on the spreading. However, the Ebola-containment using cell phones did not work in Sierra Leone. The researchers that developed this application did so from their own, Western, perspective: they saw phones as 'beacons of individual identity' (Erikson 2018b: 326). However, in Sierra Leone phones are not synonymous with individual people – the possession of a cell phone is often temporary or even fleeting, they are "*loaned, traded and passed around among family and friends, like clothes, books and bicycles*" (Erikson 2018b: 326). Next to that, it appeared that it was common to have more than one phone, as (i) calling outside a network is more expensive than having separate sim cards, (ii) power is a scare good, so it is common to have an extra phone, (iii) citizens carry different phones for the different roles they fulfil and (iv) network coverage outside big cities is spotty in Sierra Leone (Erikson 2018b: 326 – 329). Additionally, the core traits of Ebola and Malaria are fundamentally different.

In hindsight, the Malaria model was not applicable to the Ebola outbreak, due to two reasons. For a starter, the focus on human migration patterns to be able to predict Ebola outbreaks was not compatible with how Ebola spread. Additionally, the inhabitants of Sierra Leone have a different relation with their phones than the researchers assumed. The combination of these two deviations from the expectations of the researchers, ensured that the research failed to predict the spread of Ebola.

RECAPITULATING

Now that the usage of phones during healthcare emergencies has been addressed, several findings should be highlighted. First, none of these cases function on GPS or Bluetooth. Instead, they work with CDR and/or text messages, while both GPS and Bluetooth were already available. It could be that CDR and text messages were preferred because GPS and Bluetooth technologies were not optimized or widely accessible. Additionally, it is important to be aware of the fact that it is not possible to copy one working system and place it in another context – due to deviations in how diseases spread and local customs. Finally, the main take away from these early developments surrounding the use of mobile phones in healthcare emergencies, would be to be considerate about the people that have to use the technology and the ways in which the targeted disease spreads. This in order to make sure that there is an understanding of the socio-technical context in which the technology is operating, and to minimize the possibilities of the user using the technology differently than originally intended.

CORONAVIRUS? THERE'S AN APP FOR THAT.

Now that some precedents of tracing applications in healthcare emergencies have been highlighted, the attention is shifted towards the contemporary COVID-19 tracing applications. In this section, first the rationale behind the applications is being addressed. Second, the different technical possibilities are elaborated upon. Third, the general benefits and drawbacks are discussed.

R0 AND THE APP

An important measurement in the current pandemic containment discussion, is R0 - also known as "*the messy metric that may soon shape our lives*" (Fisher 2020). R0 is the basic reproduction number - the typical number of infections caused by an individual in the absence of widespread immunity. R0 can differ from place to place and from day to day; pushed up or down by local conditions and human behaviour (Fisher 2020). R0 is calculated from innate features of a disease, such as how easily it transfers between persons, along with elements of human behaviour that shape how often sick and susceptible people encounter others (Fisher 2020). R0 is constantly changing: "*the term can also be used to describe a snapshot in time: an estimate of how the virus is reproducing on the ground in a given time and place*" (Fisher 2020). Once R0 is less than 1, the epidemic declines in speed (Ferretti et al. 2020: 2). The practice of 'sustained epidemic suppression' means to reduce R0 to less than 1 by changing "*non immunological conditions of the population that affect transmission, such as social contact patterns*" (Ferretti et al. 2020: 2).

Governments try to lower the R0 metric, to 'flatten the curve' (Bay et al. 2020: 1). By doing so, the hospitals should be able to cope with the number of patients and not be overwhelmed. Contact tracing is an important tool for reducing the spread of infectious diseases: "*it's goal is to reduce a disease's* *effective reproductive number (R0) by identifying people who have been exposed to the virus through an infected person and contacting them to provide early detection, tailored guidance, and timely treatment*" (Bay et al. 2020: 1). Contact tracing is most effective when testing is rapid and widely available (Soltani et al. 2020). However, there are two main issues with manual SCT. First, an infected person can only report contacts they are acquainted with and remember having met – i.e. not a stranger next to them in store. Second, there is a significant delay between a case confirmation and a notification of its contacts (Bay et al. 2020: 1; Ferretti et al. 2020: 6). The traditional, manual SCT methods include a significant delay, and therefore are not fast enough to contain the spread of COVID-19 (Ferretti et al. 2020: 5). According to scholars, policy makers and experts, this delay can be avoided by using a mobile phone application (Ferretti et al. 2020: 5 – 6).

Thus, the main aim of the applications discussed in this thesis surrounds the ability to notify people early on that they are possibly infected - which takes away the delay between isolation and the possibility of infecting others. However, for these applications to be successful, as many people as possible must download and use the application, as it is quadratically increasingly effective, according to Edo Plantinga, community manager of the CoronaMelder (Plantinga, personal communication, September 23, 2020). This entails that for every doubling in the users, the chance that the application registers a contact, quadruples. Thus, if 10 % of the people have installed the application, the chance that both of them have the application is (10% * 10%=) 1%, if 20 % of the people have the application this becomes (20% * 20%=) 4% (Plantinga, personal communication, September 23, 2020). Thus, the contemporary applications differ from their predecessors in that those were mainly concerned with a macro-level of virus spreading, while the current applications focus on a micro-level.

Source and Contact Tracing (SCT)

SCT is carried out by the GGD. If a person takes a COVID-19 test and tests positive, the GGD does a SCT research to prevent further spreading of the virus. A GGD employee calls the infected person and together they try to investigate (i) where the person was infected (the source), (ii) with whom the person had contact with since then, and (iii) whom of those they could have infected. Then the GGD will contact the possible infected individuals and discuss their next steps. For more information, see: https://lci.rivm.nl/COVID-19-bco.

SPECIFICATIONS

Now that we have seen why an application is believed to help contain the spreading of COVID-19, the attention is shifted towards the technical aspects of the contemporary applications. Different kinds of applications are currently being proposed, developed, and used. There are symptom-tracker apps[6], informative apps[7], and contact tracing apps. The last ones are the most prevailing[8] and invasive, and therefore the focus of this thesis.

As noted, proposals to contain the virus using smartphones largely focus on facilitating the process of SCT. This entails a mobile application, which can trace contacts and notify instantaneous upon case confirmation (Ferretti et al. 2020: 5). By using an instantaneous contact tracing application, it is expected that transmission can be reduced enough to achieve R<1 and sustained epidemic suppression, thereby stopping the virus from spreading further (Ferretti et al. 2020: 7). According to some, these applications could even play a critical role in avoiding or leaving lockdown (Ferretti et al. 2020: 7). In the paragraph on **the technical specifications of the CoronaMelder**, the specific workings of the CoronaMelder and how those are expected to influence a lower R0 are set out.

In the previous paragraphs, it has been explained why these contact tracing applications are expected to be effective. However, this conceptualization is still quite broad - there are many ways one could go about developing such applications. As noted, different methods raise different issues, and to be able to fully engage in the debate it is of importance to recognise these differences.

Tracing applications can rely on wireless signals such as geolocation (GPS) data, Bluetooth, QR-Codes, WLAN or FM (Nguyen, Luo & Watkins 2013: 65). Currently, the three main discussed methods are based on either one or a combination of the following: QR-Codes, GPS signals and/or Bluetooth connections[9]. An example of how to use QR-codes is that people scan those when entering a public place, such as a restaurant or governmental building. In doing so, your visit gets a timestamp and is registered in a 'digital diary'. If and when an infected individual reports themselves to the authorities, their code is sent to all the users of the application, which then checks if there is an infection risk for the user (Tokmetzis & Meaker 2020). The privacy strength of the QR-code system depends on how the developers decide to build the system (central versus decentral, encrypted versus non encrypted, inclusion/exclusion of personal data such as phone numbers) (Tokmetzis & Meaker 2020). Besides, the system only lets you know that you have been in the same building around the same time as an infected individual, but not how close or for how long (Tokmetzis & Meaker 2020). Thereby, it asks the

[6] Symptom-tracker applications let the user track their symptoms, and then notify you when your symptoms are grave enough for you to get a test.
[7] These provide information surrounding COVID-19 to the users of these applications.
[8] See: https://docs.google.com/spreadsheets/d/1ATalASO8KtZMx__zJREoOvFh0nmB-sAqJ1-CjVRSCOw/edit#gid=0. This is a list by MIT on the different COVID-19 applications.
[9] See above and (Tokmetzis & Meaker 2020).

user to engage in a series of actions, which is expected to decrease the usage of the application (Plantinga, personal communication, September 23, 2020).

The second and third addressed methods are Bluetooth and GPS. Contact tracing applications that operate on Bluetooth follow the same protocols as contact tracing applications that operate on GPS. Therefore, I will address them together. Figure 4 shows a schematic overview of how proximity measuring through Bluetooth is done: during the day, contacts in proximity of subject A are traced with Bluetooth. When waking up with a fever, subject A requests a COVID-19 test. When A tests positive for COVID-19, a notification is sent to the individuals who have been in close spatial proximity (<1.5 meters) for a longer period of time (>15 minutes). The application advises isolation for the case (A) and quarantine for A's close contacts (Ferretti et al. 2020: 1). A GPS application would involve the same logic, but the contacts of A would be known through actual geographic location paths and times. However, using GPS data does entail gathering heaps of sensitive data – which can scare potential users into not using the application.

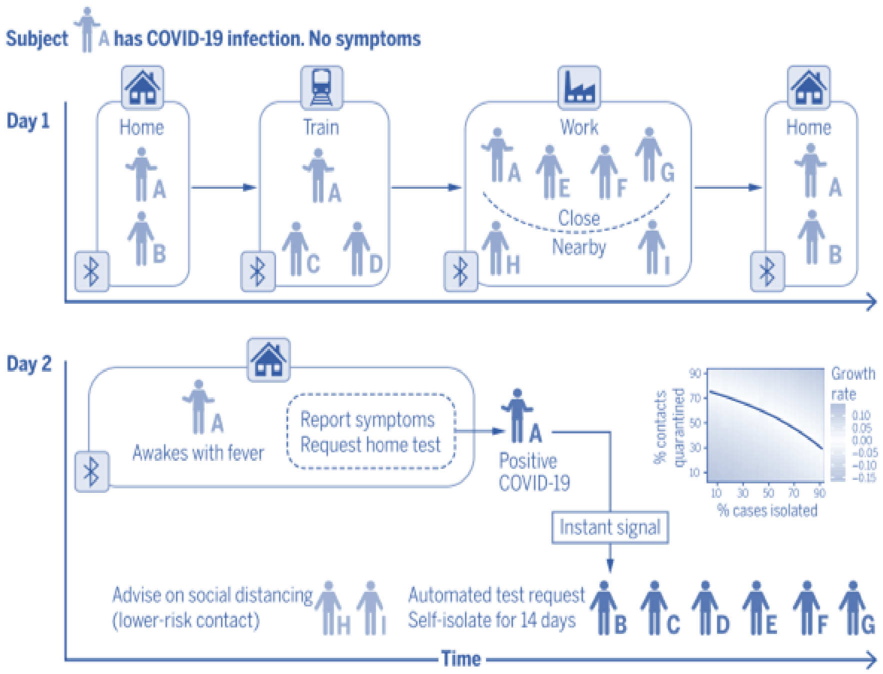

Figure 4. A schematic overview of Bluetooth based virus tracing (Ferretti et al. 2020: 1).

Next to the used technology for proximity measurements (QR-codes/GPS/Bluetooth), a decision must be made on the data protocol. This entails the way that the data is stored, which can either be centralized or decentralized. In centralized models, a single entity – such as a health organization, a government, or a company – is given special responsibility for handling and distributing user information. This is the only entity with access to that information (Cyphers & Gebhart 2020). In decentralized models the system does not depend on a central authority with special access. A decentralized application may share data with a server, but that data is made available for everyone to see (Cyphers & Gebhart 2020). Generally, a decentralized approach is designed with a better outlook for security and privacy - however it is never airtight (Soltani et al. 2020).

Then there is the third fundamental aspect, which concerns the voluntariness of the application. Applications can be mandatory, for example when the government forces you to download an application, or voluntary, where you are kindly asked to download it. Applications can also be something in between - i.e. mandatory if you want to use public transport, voluntary if you want to stay out of the public sphere. Thus, in short, there are a lot of different ways that these applications can be developed and structured. This is visualized in the decision tree in Figure 5.

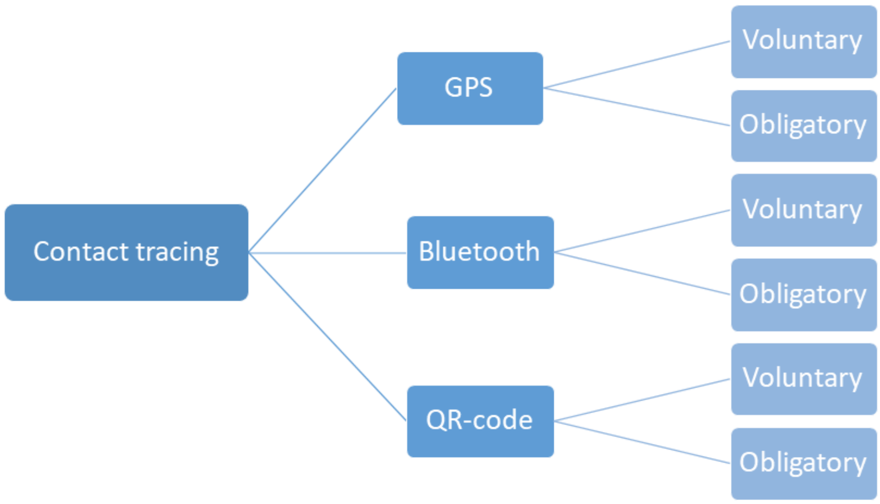

Figure 5. The possible tracing applications in a decision-tree.

BENEFITS & DRAWBACKS

In the paragraphs above, the technical specifications of contact tracing applications have been discussed. In the following paragraphs, the benefits and drawbacks of the different possibilities are set out.

As shown, the three main used methods for the contact tracing applications concern either the usage of QR-codes, Bluetooth or GPS-tracking, or a combination of those. All raise privacy and security issues, although the preferred method currently seems to be the tracing through Bluetooth – as this would not entail exact knowledge of locations of individuals (Klein & Felten 2020). However, scholars worry that these tracing applications will serve as vehicles for abuse and disinformation, while providing a false sense of security to justify reopening local and national economies before it is safe to do so (Soltani et al. 2020). In the following paragraphs, these concerns are displayed in more detail.

According to Soltani and colleagues (2020), tracing applications are likely to be simultaneously over- and under-inclusive. They raise issues concerning **false positives** (reports of exposure when they are non-existent), as the systems do not take into account precautions such as facemasks: "(…) *fleeting interactions such as crossing paths in the grocery store, will be substantially more common and substantially less likely to cause transmission (…) if the apps flag these lower-risk encounters as well, they will cast a wide net when reporting exposure*" (ibid). This might entail that an app-user gets a warning to quarantine three times a day – and this is expected to lead to disregarded warnings (ibid). **False negatives** (instances where the app fails to flag an individual at risk), are also a present threat, not in the least because not everyone carries a smartphone – or will install the application. Next to that, users who have the application and are infected might not report this – out of fear, because they did not get tested, or because they are asymptomatic (ibid). Then there is of course the danger of malicious use i.e. false reports, trolling, the ability to shut down an entire city by falsely reporting infections in every neighbourhood (ibid). It is also feared that these voluntary applications might change into mandatory applications if a citizen wants to engage in the public sphere (the partly voluntary, partly obligatory option) (ibid).

The aforementioned issues will exist for mandatory and voluntary apps, QR-codes, Bluetooth and GPS based, centralized and decentralized. Additional issues pop up when considering the specifications of the different possibilities. One can imagine that **mandatory** applications raise the same issues, to a more extreme – as more people are forced to use the application, including people who do not support the usage of the application. The incentive to cheat will become excessive (Anderson 2020) – as in order to be able to participate in society one has to have a proof of being COVID-19-free (which might be quite difficult, even if you use the application the correct way, as shown in above).

When looking at the more technical specifications of the contact tracing applications, there seem to be several preferred proximity-measurements: using **QR-codes**, **GPS** data or **Bluetooth** connections. The usage of **GPS** raises many privacy issues: it is fairly easy to trace who you are, you might visit places you do not want others to know about, and such. At the same time, it appears that GPS data is not that accurate – as it is quite difficult to access the proximity between two phones. The usage of **QR-codes** is really depending on how it is handled, and therefore it does not make sense to make claims on this method as a broad concept. However, we can state that it is less accurate than GPS or Bluetooth when looking at the proximity measurement element.

Bluetooth seems to be the more privacy friendly option (Greenberg 2020a; Ferretti et al. 2020; Cyphers & Gebhart 2020) – as it allows for a system that does not identify its users, nor the locations of these users and can be operated decentralized. However, even if the keys that the application uploads to a server cannot identify someone, they could be linked with the IP addresses of the phones that upload them. This would let whoever runs the server (a government or healthcare agency) identify the phones of people who report as positive, and thus their location and identities (Greenberg 2020a). At the same time, there are serious concerns about the accurateness of Bluetooth, as "*Bluetooth leaks* *through walls, while viruses don't*" (Greenberg 2020a). There is also a fear that contact tracing apps running on Bluetooth will eventually ask for location data anyways, as it is extremely useful for governments to know where hotspots arise in order to locate resources (Greenberg 2020a).

As shown in Figure 2, there are several choices to be made, also concerning the data storage of the applications. The **centralized** models rest on the assumption that a 'trusted' authority will not misuse the sensitive data it has access to. Carefully constructed **decentralized** models are much less likely to harm civil liberties, as in a **decentralized** proximity tracing system, the role of a central authority is minimized (Cyphers & Gebhart 2020). Of course, there are still privacy risks in decentralized systems. However, in a well-designed proposal, those risks can be greatly reduced (Cyphers & Gebhart 2020).

TECHNICAL SPECIFICATIONS CORONAMELDER

Now that the different kinds of possibilities have been explained, and the benefits and drawbacks have been laid out, the attention is shifted to the technicalities of the Dutch CoronaMelder.

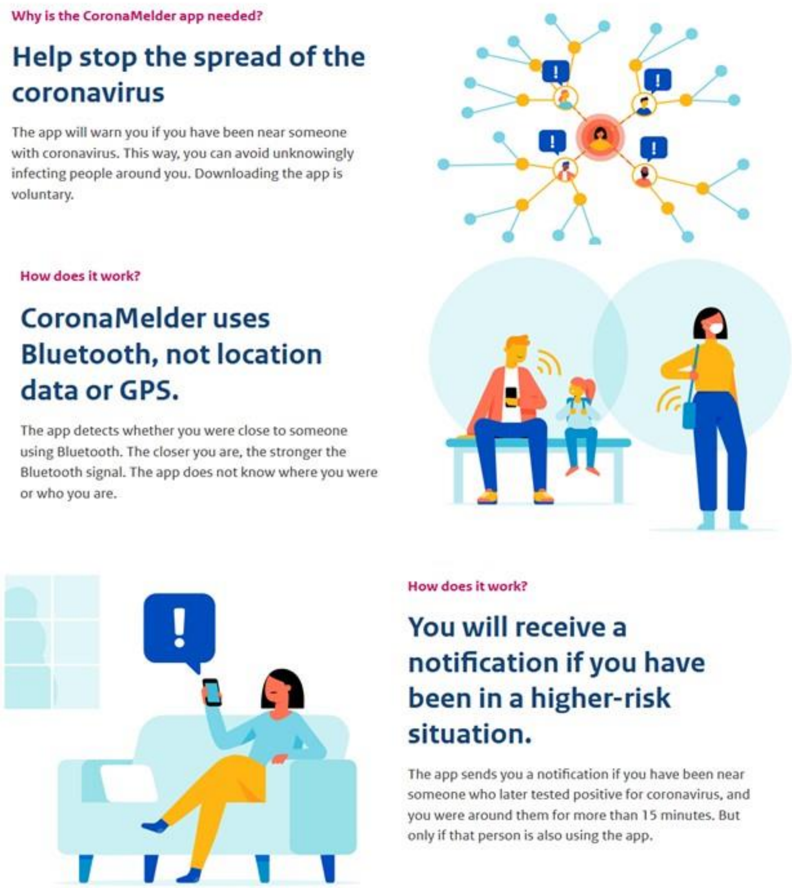

Figure 6. Screenshots of the CoronaMelder website, by Author.

The CoronaMelder is a proximity contact tracing application, meant to support the SCT of the GGD. The rationale behind this is mainly based on the temporal aspect of SCT. Thus, by using an application, it is expected that people who are possibly infected by COVID-19 can be notified on a shorter notice, thereby decreasing the time in which they could infect other people. In **Figure 6** some screenshots of the CoronaMelder website are shown – to exhibit the basic workings of the application.

Thus, imagine you want to install the CoronaMelder. You go to the app-store of your smartphone, search for CoronaMelder and download the application. Then you open up the application and some information on the workings of the application is given (for an exact overview, see **Appendix II – CoronaMelder**) – in which it is made clear that the application (a) does not know who you are, (b) works with Bluetooth Low Energy (not GPS), and (c) is fully voluntary. It also highlights that you can get a notification with suitable instructions when you have been close (within 1.5 meters) to someone for over 15 minutes. When looking at the earlier discussed specifications, the CoronaMelder runs **decentralized**, uses **Bluetooth Low Energy**, and is **voluntary** by law**.**

When going more into the specifics, we see that the CoronaMelder operates on the Exposure Notification API of Google and Apple. API is an abbreviation for 'Application Programming Interface', which entails that it offers other systems an entrance to the system offering the API – and through this entrance different systems can communicate and exchange data (Schoemaker 2019). The Exposure Notification API works using a **decentralized** identifier system, which uses randomly generated temporary keys that are created on a user's device. Public health agencies can request the usage of the API, and if this request is granted, are then allowed to define what constitutes as potential exposure (time and distance) and other factors according to their own insights. The API cannot be used if an application seeks to use GPS (Etherington 2020). This entails that, in a way, the skeleton of the CoronaMelder is made available by Google and Apple. This API works with Bluetooth Low Energy (BLE), which is a form of Bluetooth that does not use much battery energy. The data is stored decentralized, thus on the user's phone, unavailable for any central authority. From the beginning, it was clear that the Dutch application had to be voluntary – preferably by law. The developers designed the application following the privacy-by-design principle, which ensures a minimization of data gathering. All in all, the developers followed the DP3T principle: Decentralized Privacy-Preserving Proximity Tracing. This system for engaging in proximity tracing was developed by an international consortium of technologists, legal experts, engineers and epidemiologists ''*who are interested in ensuring that proximity tracing technology does not result in governments obtaining surveillance capabilities which will endanger civil society"* (Troncoso et al. 2020 : 2). The goal of the DP3T system is to offer a technological foundation for SCT which minimises privacy and security risks for individuals and communities and guarantees the highest level of data protection (ibid). Thus, concerning the CoronaMelder applications technicalities, all was ensured to make the application extremely privacy safe. However, it still shows a little crack: the dependency of the government on big tech companies.

CONCLUSION

In this chapter, sub question one – ***What is the CoronaMelder and how does it relate to similar projects?*** – was addressed. First, previous similar cases were addressed. It became clear that the used technologies, SMS and CDR, were not ideally fit for purpose. Additionally, different diseases ask for different approaches. It did not prove fruitful to use the same protocol for understanding the spreading of Malaria as well as the spreading of Ebola. Finally, we should be careful about the diverse socio-technical systems and not assume that one solution works for different contexts. This also entails paying specific attention to the end-user, and preferably engaging them in the development process, in order for it not to fail.

When relating these earlier cases to the CoronaMelder, another thing became apparent. Namely, that the focus of surveillance of diseases went from a macro perspective, such as human migration patterns, to a micro perspective, such as the contemporary proximity contact tracing applications. Additionally, the used technologies to enable this surveillance changed from SMS to CDR to Bluetooth/GPS/QR-codes. This shift from macro to micro surveillance could be explained by the fact that the projects based on macro surveillance did not deliver the hoped outcomes – especially the Sierra Leone case exhibits that a focus on human migration does not reveal new insights on the spreading of diseases, but just confirms common sense. The shift in used technologies most likely has to do with the development of the smartphone and availability of 4G – as the previous cases already state that they would advice future projects to focus on GPS systems or applications. Also, when using Bluetooth and/or decentralized saved QR-codes, the privacy of the end-user is better protected – which also relates to the shift of focus of the surveillance.

In this chapter, the second sub question - *What is co-production, what is RRI and why is it of importance for the development process of the CoronaMelder?* – is addressed. In order to formulate an answer, first, the complexity of the CoronaMelder is addressed. Second, theoretical approaches to the different aspects are addressed. Third, gathered insights are discussed, followed by concluding remarks.

A COMPLEX RELATION

Figure 7. Context placement of the CoronaMelder, by author.

The CoronaMelder and similar applications are different from most applications, as next to the relationship between an app-developer and an app-user, there is also the relationship between a government and its public at play (see figure 7). The application is initiated by the government and must function in the public domain. However, these perspectives can be conflicting - as governments need sufficient epidemiological information to manage the pandemic, whereas citizens, while wanting safety, are concerned about privacy, discrimination, and personal-data protection (Vinuesa et al. 2020: 3). One can also imagine for example that the value of privacy weighs differently for an app-maker, who might prefer to collect heaps of data for better marketing, than for a government, which is obliged to ensure its citizens a certain amount of privacy. At the same time, the application is made by the government, for the public, which is a broader group than solely citizens, as it includes people that cross boundaries and/or have no permanent place of residence. This entails that both sides are representing different roles in a complex process and that they need to find a way to arrange those. Thus, value trade-offs must be recognised and made by both sides. To make things even more complicated, the public, including both users and non-users of the application, has an inherent duality: they are both the subject and object of surveillance; as they are both engaging in the surveillance as being surveyed.

The different roles that both sides of this process represent, and the tensions that this might entail, should not hinder the involvement of different parties in the development of the application (Vinuesa et al. 2020: 3). This involvement is mainly important for two reasons. First, in previous, similar situations we have seen that the expectations of the application developers did not comply with how the end-user used the application. A problem that many designers are familiar with. By including these users in the making of such an application, it is hoped that such 'appropriation' can be kept to a minimum (Bar et al. 2016). The second argument is related to an underlying assumption of the application, namely the necessity of a high user rate for the application to be as effective as possible. According to the European Commission, an important prerequisite for the acceptance and up-take of tracing applications by individuals is trust (2020: 2). In their view, this trust can be gained by giving people the certainty that compliance with fundamental rights is ensured, that the apps will be used only for the specifically defined purposes, that they will not be used for mass surveillance, and that individuals will remain in control of their data (European Commission 2020: 2). Thus, in order to achieve a high adaptation rate, the public must trust both the application as well as the development process that led to the application. These two arguments are not limited to a pure technical consideration of the application, neither to a purely social examination – they cross the boundaries between the different roles and relations of and between the different sides.

As noted, the CoronaMelder is a technical undertaking, initiated and made by the government, which has to be embedded in the public realm. Therefore, the application is a unique undertaking that needs to be approached from different angles, in order to get a thorough understanding of the development process and possible pressure points. On the one hand there is the technological approach, which focuses on the development of the application and the interaction of the developers and the users of such a technology. On the other hand, there is the governmental context in which the technology is situated. Both perspectives offer their own insights in how to handle such a project, and especially how to engage with the user/the public when making such a 'public policy technology' (see figure 8).

To recapitulate: the CoronaMelder is a unique technology, because (a) it is a government initiated project, (b) which success depends on the adaptation of the public, which is both object and subject of surveillance, (c) the application exists online but is dependent on offline processes – such as testing facilities, and (d) all this while being multi-dimensional: influencing and being influenced by the technological and societal realms in which it has to function. In the following paragraphs, first the CoronaMelder is approached from the starting point of the governmental realm. Afterwards, the same is done from the perspective of the technological realm. Finally, some concluding remarks are given.

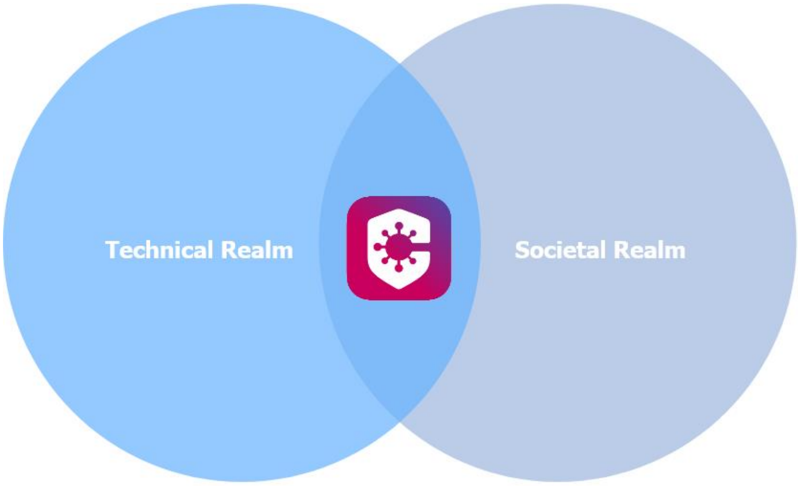

Figure 8. Venn diagram of different domains in which the CoronaMelder operates.

SOCIETY → TECHNOLOGY

As noted, we are dealing with a 'public policy technology', which entails that the CoronaMelder in a way is a public policy tool. Therefore, it is of importance to understand how public policies are made – and how those insights can be used to evaluate the design process of the CoronaMelder.

In the beginning of the late 19th century, the field of Public Administration was dominated by the *rule of law*, with a focus on administering set rules and guidelines (Osborne 2007: 378). There was a central role for bureaucracy in policy making and implementation, and a commitment to incremental budgeting. A hegemony of the professional ruled (ibid). Hierarchy was the key governance mechanism, with a focus on vertical management to ensure accountability for the use of public money (Osborne 2007: 378). But this traditional, hierarchical form of PA could not cope with certain problems, also referred to as 'wicked problems' (Head & Alford 2013: 719). Rittel and Weber state that wicked problems are situations in which no clear formulation of the problem exists (1973: 162). Wicked problems are generally seen as associated with social pluralism (multiple interests and values of stakeholders), institutional complexity (the context of interorganizational cooperation and multilevel governance), and scientific uncertainty (fragmentation and gaps in reliable knowledge) (Head & Alford 2015: 716). Head and Alford add: "*in general, the more complex and diverse the situation, the more wicked the problem*" (2015: 718).

Thus, around the early 1980s throughout the start of the 21st century, a new paradigm in PA emerged, also referred to as New Public Management (NPM). It was designed in part to address some of the above-mentioned shortcomings of traditional PA (Head & Alford 2013: 719). As the bureaucratic approach failed, the public servants turned to a field that was thriving: the market. Key elements of NPM are the focus on private-sector management, entrepreneurial leadership within public service organizations, performance management and output and cost management (Osborne 2007: 379). NPM emphasised the economy, efficiency and measurability (Osborne 2007: 382). Again, it could not handle the wicked and unruly problems, and again, another paradigm emerged, one in which we are currently situated (Head & Alford 2013: 719).

This is the era of New Public Governance (NPG) which acknowledges the increasingly fragmented and uncertain nature of public management in the 21st century (Osborne 2007: 382). NPG builds on the assumption that we live in a plural state, where "*multiple independent actors contribute to the delivery of public services and a pluralist state, where multiple processes inform the policy making system"* (Osborne 2007: 384). NPG aims to address wicked problems by collaborating, engaging in broader ways of thinking, and includes new models of leadership that better appreciate the distributed nature of information, interests and power (Head & Alford 2013: 722). The key process in NPG is 'co-production', a process wherein stakeholders are involved, and which recognizes the different collaborative arrangements as viable governance options at different levels (Sorrentino et al. 2018: 280). Or, as Osborne, Radnor and Strokosch define it "*the voluntary or involuntary involvement of public service users in any of the design, management, delivery and/or evaluation of public services*" (2015: 640).

Co-production functions as an umbrella term for several different approaches and forms, but Sorrentino and colleagues defined a common denominator: "*the relationships that allow co-production to happen and the new forms of knowledge, values, and social relations that emerge out of co-productive processes*" (2018: 286). As technology is omnipresent in our contemporary society, it also plays a role in the methods and tools of the NPG and co-production processes. Several scholars have touched upon the development of co-production in relation with technological advancement (Sorentino et al. 2016; Crosby et al. 2017; Osborne, Radnor & Stokosch 2015; Dunleavy et al. 2005; Lember 2017). According to Sorentino and colleagues, for example, the invention of ICTs enabled the increase of interaction and inclusion of several stakeholders in a more intense way (2016: 288). Osborne et al. note that emerging new technologies have offered service users new routes to gain bottom-up control over public services from the status quo (2015: 641). Dunleavy, Margetts, Bastow and Tinkler (2005) go even further, and refer to NPG as Digital Era Governance (DEG). They highlight the "*central role that IT and information system changes now play in a wide-ranging series of* *alterations to how public services are organized as business processes and delivered to citizens or customers"* (2005: 468).

However, the most extensive and critical view on NPG in relation to technology is given by Veiko Lember in his article 'the increasing role of digital technologies in co-production' from 2017. In this paper, Lember (2017) acknowledges that digital technologies can empower individuals and substantially increase opportunities for collective co-production as well as enable more personalized and demand-driven public services. Lember identifies three ways in which technology affects the traditional co-production processes: indirect (through coordinating co-production by allowing for more efficient information flows and providing supportive functions), transform (by adding a digital layer, e.g. hackathons, apps) or substitute (the automation of certain process e.g. by sensors) (2017: 3-7). However, contrary to his colleagues, Lember also gives a critical account of the usage of digital technologies in co-production processes. He highlights that conflicting interests and diverging values among stakeholders, the inability of algorithms to mirror the complexity of societies, the uneven spread of technological capabilities and such make digital co-production a fundamentally ambiguous, open ended and contested process (2017: 2).

Co-production is thus a process intrinsic to NPG, which includes the citizen in the development of new policies and designing services. Many scholars have touched upon the concept of co-production and the involvement of technology in these processes. However, they regard technology as a tool to better the co-production process, but do not refer to the process of co-production regarding governmental technologies, i.e. 'public policy technologies' such as the CoronaMelder. However, with the ubiquitous presence of digital technologies and the increasing role of ICTs in governance – one would expect some insights in how to establish these 'democratic' technologies. Therefore, this appears to be a gap in the contemporary PA literature. Thus, in the next paragraphs, the attention is shifted to a way of responsibly innovating technology, as one would want in a democracy. The aim is to find a fitting framework in which a 'public policy technology' can be evaluated.

TECHNOLOGY → SOCIETY

As noted above, the attention is shifted from the public realm, to the technological realm, to see how to operationalise the concept of a 'public policy technology' from both a societal and a technical perspective. This way a framework against which the development of the CoronaMelder can be held, in order to identify possible pressure points, and learn from those, is developed.

Amongst philosophers of science and technology, a famous quote sounds: "*you were so busy wondering if you could, that you did not stop and wonder if you should*". This refers to the practice of innovating for the sake of innovation, a trend that has been going on for a long time, where, once a project passed the ethical committee and was unleashed in society – no one cared anymore.

Innovation processes were the main aim of collective efforts in applied science, technology, and engineering (Van den Hoven 2016: 2). However, throughout history we have seen that not all innovation is necessarily 'good' innovation[10], and that a 'good' innovation can also have unintended negative consequences. Thus, to tackle this narrow view of innovation and to add a moral layer, around 2006 Responsible Research and Innovation (RRI) made its entrance – an approach which states that innovation processes, systems and investments should be focused on addressing societal challenges and urgent global problems (Van den Hoven 2016: 2).

In the article 'Prospects for technology assessment in a framework of responsible research and innovation', Rene Von Schomberg, a guest professor at the technical university of Darmstadt and affiliated with the European Commission on topics of RRI for over 20 years, refers to RRI as: "*a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society)*" (2011: 9). Thus, what is important about RRI is that it is (a) interactive, (b) includes different stakeholders[11], and (c) has normative anchor points, and through this evaluates the development of technology 'for good' in society. These normative anchor points Von Schomberg refers to, are connected to the convictions of the European Union. Early on in the RRI process there is room for societal intervention, which can help to avoid that technologies fail to embed in society and/or that their impacts are better governed and exploited at an early stage (Von Schomberg 2011: 11). In doing so, deliberative forms of decision making on the problem definitions themselves can be created, and then be placed in a wider perspective (Von Schomberg 2011: 7). This is akin to the earlier discussed process of co-production.

In Schombergs view, two interrelated dimensions can be identified in RRI: the product dimension and the process dimension. The **product dimension** assesses products in terms of overarching and specific normative anchor points: is it (ethically) acceptable? Sustainable? Socially desirable? This can be researched using technology assessment and foresight analysis, the application of the precautionary principle and the usage of demonstration projects. The second dimension is referred to as the **process dimension**, which reflects a deliberative democracy: "*a multidisciplinary approach with the involvement of stakeholders and other interested parties should lead to an inclusive*

[10] A great example originates from my favourite book 'De Gevleugelde', written by Arthur Japin. In this book, Japin describes the live of Alberto Santos-Dumon – who co-invented the airplane. Santos-Dumon believed that aviation would lead to an era of worldwide peace and prosperity, and therefore he was heart-broken when his invention was used in the war. In my humble opinion, this story is a brilliant example of the many ways in which a technology can be used differently then intended.

[11] Please note that an immediate normative deficiency of stakeholder deliberation is that the involved actors do not necessarily include the interests of non-included actors (Von Schomberg 2011: 7).

innovation process whereby technical innovators become responsive to societal needs and societal actors become co-responsible for the innovation process by a constructive input in terms of defining societal desirable products" (Von Schomberg 2011: 10-13). This entails the inclusion of a code of conduct, market accountability, ethics as a design factor (such as privacy by design; by which technology is designed with a view to taking privacy into account as a design principle of the technology itself), deliberative mechanisms for allowing feedback with policy makers and an ongoing public debate (ibid). When one wants to engage in RRI, there is a very useful toolbox, developed by a consortium of 26 European organizations, to be found online (https://rri-tools.eu/).

Von Schombergs description of RRI is anchored in the policy processes and values of the European Union. However, in different areas and/or cultural contexts, other values might be more pertinent, and these might conflict with Schombergs RRI approach. In the article 'developing a framework for responsible innovation', Jack Stilgoe, Richard Owen and Phil McNaghten develop a broader framework for RRI (2013), which they define as "*taking care of the future through collective stewardship and innovation in the present*" (Stilgoe et al. 2013: 1570). They state that the governance of emerging technologies is a major challenge for contemporary democracies – and the development of new technologies also is in need of new forms of governance, which takes place in new places such as markets, networks and partnerships as well as conventional policy and politics (Stilgoe et al. 2013: 1568-1569). In the view of Stilgoe and colleagues, we might see responsible innovation "*as a location for making sense of the move from the governance of risk to the governance of innovation*" (idem: 1570). They contest that instead of 'ends' such as sustainability, the key of RRI should be to improve the means of governance processes, in order to make them more democratic and more legitimate, to be attentive to the distinctive social and ethical stakes that are associated with particular scientific and technological developments (idem: 1577). Thus, in their view, the innovation process should be more democratic, which they refer to as 'vital' for the good governance of innovation processes (ibid). They propose four dimensions of RI, in order to provide a framework for raising, discussing and responding to questions: anticipation, reflexivity, inclusion and responsiveness (ibid). The dimensions do not represent clear cut divisions, but interrelated processes. **Anticipation** concerns the possible implications of new technologies, and involves the systematic thinking aimed at increasing resilience, while revealing new opportunities for innovation and the shaping of agendas for socially robust risk research (ibid). Methods of doing this include upstream public engagement and CTA (idem: 1571). **Reflexivity** demands openness and leadership, in order for the parties in charge to be held responsible. Methods include a code of conduct, the adaptation of standards and ethical TA. **Inclusion** is about the inclusion of stakeholders as well as the wider-public. Methods include consensus conferences, focus groups, inclusion of lay members on advisory boards and forums. **Responsiveness** entails the capacity to change shape or direction in response to stakeholder and public values and changing circumstances

– one way of doing so includes value-sensitive design (idem: 1572). Another aspect Stilgoe et al. highlight is that making technologies more responsive also "*requires attention to meta governance – the values, norms and principles that shape or underpin policy action*" (idem: 1573).

The conceptualisation of Stilgoe et al. aims to replace the normative anchor points in Von Schombergs approach by a deliberative process about these normative points. As normativity is subject to change, I agree with this remark of Stilgoe et al. However, the framework they offer is very broad and leaves much room for interpretation. Jeroen van den Hoven, founder and former chair of the program of the Dutch Research Council on Responsible Innovation, offers some more guidance. In his view, RRI can be understood in two senses: substantive and procedural (Van den Hoven 2016: 2). As a **substantive notion**, similar to Von Schombergs product dimension, it refers to results and outcomes of innovation processes in the form of products, systems, or services (ibid). As a **procedural notion**, similar to Von Schombergs process dimension, it refers to a process of innovation that meets certain procedural norms like accountability, inclusiveness, due care and transparency to stakeholders and society (ibid). Van den Hoven acknowledges that there are different ways to approach innovation and research, but they only count as responsible if:

> *1. risks, potential harms, wellbeing, values, needs, rights, and interests of relevant parties affected by the innovation are adequately taken into consideration at a very early stage,*
> *2. issues of governance, regulation, inspection, monitoring and reporting about innovations are adequately dealt with,*
> *3. relevant knowledge and information is shared and communicated between affected parties in a timely way,*
> *4. legitimate deliberative institutional arrangements, decision making instruments, communicative infrastructure are provided to relevant parties and individuals,*
> *5. options, possibilities, alternatives, scenario's, choices are conspicuously represented and presented to relevant agents and actors.*

These demands entail that RRI typically becomes (i) a multidisciplinary effort (ii) situated at the early stage of the development of new technology, representing a (iii) design orientation , it is also (iv) an on-going process that (v) is open, inclusive and involves all affected parties and stakeholders and is (vi) reflective (Van den Hoven 2016: 3). The four identified dimensions by Stilgoe et al. can also be found in the statements: anticipation in the first, reflexivity in the fourth, inclusion in all five, and responsiveness in the last two. Additionally, in these five demands, both dimensions (product/substantive and process/procedural) are combined, normative statements are not fixed, and deliberation and communication are key factors. Thus, these five fundaments for RRI offer a great template to hold a new innovation – such as the CoronaMelder – against.

CONCLUSION

In this chapter, the second sub question (*What is co-production, what is RRI and why is it of importance for the development process of the CoronaMelder?)* was discussed. It was shown that when developing a 'public policy technology' there are several aspects that should be considered. As the CoronaMelder is a governmental project, it is of importance to approach this undertaking as a public policy. In doing so, it becomes clear that – when dealing with wicked problems such as a pandemic – co-production is a key process in contemporary policy making. Co-production is a method which involves public service users in any of the design, management, delivery and evaluation of these public services. Turning to the technological aspect of this 'public policy technology', the approach from an RRI perspective was taken, as RRI evolves around the responsible innovation of technologies, which is a fundamental starting point when developing a technology as a democratic government. In Table 1, an overview of the RRI Fundaments is given, as these (i) offer important demands that an innovation needs to fulfil to be 'responsible', (ii) address both the procedural and substantive notion, (iii) do not define normative anchor points, but (iv) create space for deliberation about normative statements. Throughout the whole process, co-production is expected to take place. This entails the engagement of different parties, throughout the whole development process.

Table 1. RRI fundaments & co-production.

RRI Fundaments	COPRODUCTION
1. Risks, potential harms, wellbeing, values, needs, rights and interests of relevant parties affected by the innovation are adequately taken into consideration at a very early stage,	
2. issues of governance, regulation, inspection, monitoring and reporting about innovations are adequately dealt with,	
3. relevant knowledge and information is shared and communicated between affected parties in a timely way,	
4. legitimate deliberative institutional arrangements, decision making instruments, communicative infrastructure are provided to relevant parties and individuals,	
5. options, possibilities, alternatives, scenario's, choices are conspicuously represented and presented to relevant agents and actors.	

CHAPTER V - RESULTS

The third sub question is: *How did the development process of the CoronaMelder include RRI/co-production?* In order to answer this question, a document analysis on the development of the CoronaMelder has been done, and the made inferences were cross-checked with three key-actors[12]: Sjaak de Gouw (CEO of the GGD and GHOR Hollands Midden, involved in several committees working on the R&D of the CoronaMelder), Edo Plantinga (community manager of the CoronaMelder) and Rinie van Est (professor of Technology Assessment and Governance, theme coordinator at the Rathenau institute and involved in the ethical committee of the CoronaMelder).

The documents have been retrieved from the website of the Dutch government – where all the official documentation concerning the CoronaMelder has been gathered at: https://www.rijksoverheid.nl/onderwerpen/coronavirus-app/documenten. At 30-09-2020, when the data gathering was stopped, there were exactly 100 documents placed under this heading – published over a time span of six months. These documents include letters from the minister of Health, Welfare and Sport to his colleagues, technical reports on the application (such as penetration reports and DPIA's), advises from several taskforces, plain information on the app, feedback from the Dutch Data Protection Authority, and so on. Please note that the governments planning was to have the application up and running on the 1st of September[13] however, due to many different small and bigger setbacks, the application was only launched nationally on the 10th of October.

From earlier experiences and the theoretical framework we have learned that it is important to include the end-user in the development process of making a technology, especially if a technology comes from a governmental source. This increases the trust in the application, and (hopefully) limits the appropriation of the technology**.** The document analysis was done following an open-coding protocol, in order to (i) see if and how the Dutch government engaged in co-production/RRI processes, and (ii) be able to code any other interesting business. This led to 40 different codes, out of which 32 refer to the application and it's specifications, and 3 to the involvement of different actors. The other 5 codes include 'appathon', 'covid-testing', 'dashboard', 'national safety & security' and 'other remarks'.

The documents were coded through Atlas.TI, version 8.4.24.0[14]. For further explanations of the framework, see **Appendix I**. In the following paragraphs, the main findings are presented in a chronological order, by month. When multiple versions of documents were published, the latest version is presented. Throughout the text I have referred to the sources as (document *number)*, a table with full information on the sources can be found at the end of this chapter.

[12] These interviews can be requested at ellemijke@gmail.com.
[13] De Jonge in his letter 'Voortgang CoronaMelder' of 17th of August to the Chamber of Representatives.
[14] The Atlas.TI project can be send at request, contact: ellemijke@gmail.com.

I do wish to address that many documents do not have page numbers and often it is not clear who the author of a document is – I have tried to be as precise as possible. Next to this, there are several official sources for gathering more information about the CoronaMelder, if wanted: a website about the application (https://coronamelder.nl/en/), a website on which one can find the source code (https://github.com/minvws) and a website that is meant for public engagement (https://minvws.github.io/nl-covid19-notification-app-community-website/)[15]. Through this website, once found, one can join a walk-in session*,* which is an hour in which "*you can ask questions or just have a nice cup of coffee with other community members and developer*". However, when I joined this hour on Friday the 18th of September 2020, I was the only one present for the full hour.

In the paragraphs below, the findings are addressed following a chronological monthly order, starting in April and ending in September. Throughout, findings are connected through the five RRI fundaments and/or the co-production process. In the concluding section a schematic overview is given.

APRIL

On the 7th of April, the first document which mentions any sort of technological support, is published. In this document minister Hugo de Jonge states a great one-liner about how to handle the COVID-19 virus: "*testen, traceren & thuis rapporteren*", which has been translated in English documents a bit less catchy as "search, test & protect"[16] (document 1: 5). According to De Jonge, the search and test aspect of this slogan can be supported by the usage of applications. At this stage in time, the government is considering two different applications: one which can trace the contacts of infected people, and one that lets infected people report their sickness progress from home (document 1: 6). The first application is supposed to support and enlarge the contact tracing as done by the Dutch public health authorities (from this point on referred to as GGD). The second application can be considered as some sort of sickness diary, in which infected people report their state of being to a doctor in their region (document 1: 5). Both applications are meant to take pressure away from the GGD (document 1: 5). The tracing application is the application that the government decided to develop first. Therefore, this is also the focus of this thesis.

Thus, why did the government decide on employing this application? When asked at a press conference on the 17th of April, Dutch prime minister Mark Rutte, gives a two-folded answer. On the one hand, Rutte beliefs that the GGD cannot do proper contact tracing anymore due to the high infection rate, on the other hand, experts advised him to look into technological support to battle

[15] However, this one can only be found when going to the website of the national government, searching for the topic of Coronavirus-apps, going to the questions and answers subheading and scrolling until you have found the heading on how to give your opinion on the CoronaMelder.
[16] Why they did not translate it into 'test, trace and report (from home)' is beyond me, but 'search, test & protect' is the official English translation as found in the documents.

COVID-19 (document 3). Thus, in the first weeks of April 2020, the start signs had been given to develop an application to support the manual SCT of the GGD, as fitting in the search, test & protect approach of the Dutch government.

COVID-19 was spreading, and so was the belief that we needed technological support in the form of a contact tracing application. Governmental officials were under a lot of pressure to act and contain the virus, and they decided to invite commercial parties to help bring this application to life (document 4). This was done through an appathon[17] on the 18th and 19th of April. The government set out an open call for admissions of contact tracing applications, and received 700 responses, out of which 660 included a proposal. After a thorough review, 63 proposals were judged as sufficient, and those were then reviewed by 67 experts on the field of epidemiology, healthcare, privacy, information security and ICT. Afterwards, seven proposals were deemed acceptable and invited to join the appathon. During the appathon, everyone who was interested could follow the presentations, ask questions and/or give suggestions. On Saturday the 18th, 5000 interested parties joined in (on average), and on Sunday the 19th this decreased to 2800. The public send over 1300 e-mails with questions/suggestions, and a survey on the contact tracing application gained 24000 votes (document 9: 1). Afterwards, advisory consultants from KPMG and lawyers from the state attorney, Pels Rijcken, were asked to assess these applications, on technical and on privacy aspects.

This 'appathon' is a great example of attempted co-production/platform government, in which the government provides a platform for other, maybe more knowledgeable parties, to come together, while at the same time giving the opportunity to interested, self-selected citizens to engage with the design process. The government enabled a gathering of application designers, governmental officials, experts, consultants, lawyers and citizens in order to see if a contact tracing application would be feasible, and if so, how and by which demands. However, the appathon was not the grand success Hugo de Jonge hoped for: there were many pitfalls concerning privacy and unclear demands from the side of the GGD – whom this application was supposed to support. Therefore, when looking at the result, we cannot consider this appathon as a success story. However, process-wise, it did expose knowledge gaps and aspects that needed more attention. It should therefore be seen as a learning point. According to Van Est, this beginning phase of the development of the CoronaMelder exposed a 'technological dream' - the belief that a technology could fix this problem (Van Est, personal communication, September 25, 2020).

What is interesting to note is that all these proposals work with Bluetooth. According to Pels Rijcken, this technology entails some inherent risks: the risk that people outside 1.5 meters also get registered (behind a wall, window or Plexiglas) or being close to a phone but not a person (document

[17] Similar process as a hackathon: a gathering where programmers collaboratively code in an extreme manner over a short period of time (see: https://www.techopedia.com/definition/23193/hackathon).

5). If and why Bluetooth is the preferred technological framework for the application to operate on, is not discussed in the governmental documents.

After this appathon, Hugo de Jonge had a rude awakening, in that this was not the quick-fix he hoped for. In his letter to the House of Representatives on the 21st of April, De Jonge exhibits a more thorough understanding of what this technological solution entails. He highlights the need for a list of requirements from the GGD (for whom the application should offer relief), notes that a pandemic does not stop at the border, that not technology but human behavior in society will help end this pandemic and that we should acknowledge there is a cohesion between the introduction of digital support of contact tracing and test capacity (document 6: 35-37). This change in attitude is also recognized by Van Est, who describes the beginning of the R&D of the CoronaMelder as a false start in which it was approached as a technological fix (Van Est, personal communication, September 25, 2020). When scientists, experts and NGO's such as Bits of Freedom voiced their concerns about this, and the applications that sprung from the appathon were deemed insufficient by several expert analysis, a second path was pursued. The government decided to take full charge of the CoronaMelder.

SOCIETAL CONCERNS

Immediately after these first acknowledgements of interest in technological support by the government, voices of concern were raised by different societal actors. On the 8th of April, the manifest 'Safe Against Corona' was published and signed by many different parties including Bits of Freedom, Waag, Consumentenbond, Amnesty International Nederland, Code for NL, tech-journalists, writers, academics and experts. This manifest included 10 principles that the application should meet, ranging from a temporality principle to technical specifications such as a decentralized data-storage (see: https://www.veiligtegencorona.nl/). A few days later, on the 13th of April, more than sixty scientists signed a letter to the Chamber of Representatives, also voicing a considerable amount of concerns about such applications, warning for techno-solutionism, a false sense of security and privacy breaches (see: https://bit.ly/3oeyQFO).

MAY - JUNE

Following this new path, in May 2020, several taskforces were put together in order to understand the needs and demands from different perspectives (document 12; document 25). The different involved parties are exhibited in table 2, where next to the English and Dutch names, the chairs and the goals of the different committees are formulated. In Appendix III the exact names of the members of the different committees can be found.

Table 2. Overview different taskforces and committees involved in making the CoronaMelder.

Name	Chair	Goal
Taskforce Digital Support *Taskforce Digitale Ondersteuning Bestrijding COVID-19*	Dr. Sjaak de Gouw	Should consider the possibilities for digital support in fighting the virus from scientific and practical point of view.
Program Realization Digital Support *Programma Realisatie Digitale Ondersteuning*	Drs. Sylvia Bronmans	To research if there are any digital support means which can be introduced and can deliver a contribution to battling the virus.
Guidance Committee *Begeleidingscommisse*	Prof. Dr. Carl Moons	Advice the minister, based on propositions from the taskforces. Checks if the propositions fit the set-conditions.
Taskforce Behavioural Science *Taskforce gedragswetenschap*	Prof. Dr. Rik Crutzen	Sheds light on the digital support from a perspective of behavioural science, the aim is to broaden the public support for the digital support, to limit negative unintended consequences and to increase desirable behaviour.
Ethical Committee *Etische commissie*	Prof. Dr. Ir. Peter-Paul Verbeek	To see if the proposed solutions are ethically acceptable.
Design Team *Bouwteam*	Edo Plantinga	Develop the application in line with set-conditions.

What is interesting about these committees[18], is that they have only been brought to life after the market sphere failed to address the complex issues sufficiently. It exhibits a realisation of the undertaking of this project, and by having the Ministry of Health, Sport and Welfare taking full responsibility for the development of the application, also an acknowledgement of the application as a public policy tool. Another striking element of these taskforces is that the 'goals' of these different committees are formulated as if they need to assess whether or not any digital support could help in battling the virus. However, De Jonge already stated in his letter on the 7th of April (document 1), what kind of digital support he had in mind.

On the 24st of May, in a press conference, Rutte, when asked if we could battle the virus without an application, answered: *"I think that is very difficult, from my perspective, the applications really very important (…) because the GGD cannot manage all the contact tracing"* (document 13). The underlying assumptions of the application, by being able to identify contacts who have been closer than 1.5 meters to you for over 15 minutes, are supposed to make manual SCT faster and completer (document 16). The argument of it being faster, if adopted by a high percentage, is acceptable. However, the completer aspect might be overrated – when is the last time you were within 1.5 meters with someone, for over 15 minutes? This might have been on the train or on a ferry, however, on these places, there are extra regulations in place, such as Plexiglas screens or the obligatory wearing of mouth masks. Thus, the completer aspect is focused on the contacts that, with manual SCT, would maybe not be recollected as those contacts are strangers to you. However, the '1.5 meter distance society' is in place to eliminate those occurrences. Therefore, the completer aspect might be a fallacy – but only time will tell.

In a document called 'digital support combatting COVID-19' (document 25), the different taskforces are introduced in more detail and the hard demands are presented: information security, privacy, national safety and security, fundamental rights, accessibility and voluntary usage (document 25). The application also had to be open source (i.e. the source code has to be open for review on GitHub[19]), decentralized and has to follow the privacy-by-design principle (i.e. technology designed with a privacy as a design principle of the technology itself), this is referred to as DP3T (decentralised privacy-preserving proximity tracing) (document 34). These are all ways of gaining citizen trust, tools to ensure the usage of the application. According to Plantinga, it was also the only right way of making the application – as other democratic countries such as Norway and the United Kingdom developed applications which stored data on a central database, and both had to cancel the continuation of the

[18] It should be noted that these taskforces do not get paid, but they do get a reimbursement – an inside source told me. Source is known by the author.
[19] A website on which developers can share their source code, to get feedback, solutions and suggestions from other developers to improve their code.

applications due to privacy concerns (Plantinga, personal communication, September 23, 2020; O'Neill et al. 2020).

In June, only a document concerning the accessibility of the application was published and the application was made accessible for special needs and low literacy users (document 33).

JULY

In the beginning of July, the name of the contact tracing application was made public: CoronaMelder – which translates into CoronaNotifier, a very straight forward name. At this time, one of the committees[20] also published their first advice, and noted that *"in a general sense, the application has to contribute to the limitation of further spreading of the virus, the decreasing of R0, and decrease the amount of hospital admissions. (…) an interplay of these goals is being reached by diverse factors. To concretely contribute to these goals, the general aims of the application have to be made operational into measurable goals and results"* (document 35: 2). This is an interesting reference, as it talks about a feedback mechanism and about measurable goals and results. However, how do you measure the effect of such an application, especially when it is designed to gather as little data as possible? In the paragraph on September, we return to this point. The taskforce also notes that at this point, it is unclear why people would download such an application – what benefit do citizens gain by contributing to faster contact tracing (document 35: 3)? Also, the committee highlights that the only right perspective is to offer users who got a message, to get tested right away – even if they do not have any symptoms (document 35: 4). In their third advice, the committee again highlights the importance of international alignment on cross-border usage of notification-apps (document 38: 1). These remarks show that the socio-technical system in which an application is used, is of great importance.

On the 14th of July, the ethical analysis of the CoronaMelder was published (document 46). This document stated ten core values that should be leading in the design, implementation and usage of the application, namely: voluntariness, effectiveness, privacy, justice, inclusivity, procedural justice, responsibility, prevention of improper use, safeguarding of civil liberties, necessity and proportionality (document 46: 2). Building on these, the committee published several recommendations:

- There needs to be adequate legislation for the application, which ensures a goal description and a goal limitation, especially concerning governmental institutions, but also for private parties.

[20] It is not fully clear to me which committee is the author of these advises, as they are signed by the *begeleidingscommissie Digitale Ondersteuning Bestrijding Covid-19* which appears to be a combination of the *begeleidingscommissie* and the *taskforce digitale ondersteuning bestrijding Covid-19*

- The usage of the application is supposed to be fully voluntary, but the government is allowed to conduct a moral appeal to citizens to use the application in the view of collective responsibility to fight the virus (document 46: 2).
- It should be researched if the application is accessible for everyone and if the risks and burdens of the application do not cluster disproportionate amongst some population groups (ibid). This can be achieved through "*inclusive participation, fair and transparent knowledge acquisition and an open source design process on the basis of shared norms and values*" (document 46: 15).
- The government should monitor the social impact of the application carefully, in alliance with the principles stated in this document.
- To prevent the application from heralding a culture change of people becoming less hesitant concerning surveillance, the application should be implemented and positioned as a tool for digital solidarity (ibid).
- The application should only become available when the tests and DPIA come back positive, and when not only the application itself, but also the surrounding infrastructure is ready, under which the information provision, complaint possibilities and supportive and preconditional laws and regulations (ibid).

The ethical committee also notes that that there is some discussion surrounding the effectiveness of the CoronaMelder. According to the committee, there are two factors that play into the effectiveness of the application. First, the effectiveness depends on the test strategy, the test capacity and the quality of the testing and the package of measures (such as testing, application, social distancing). If testing is unavailable and/or unreliable, this will impact the trust in and effectiveness off the application. Second, the effectiveness depends on the percentage of the population that installs the application. At the beginning of the discussion the government communicated that the success of the exit strategies depended on the contact tracing application. It was also indicated that 60% of the citizens had to download the application and use it. The usage of the applications in other countries however shows that the actual usage lays way lower – around 25% (Vinuesa et al. 2020: 2; O'Neill, Ryan-Mosley & Johnson 2020). At this moment, the application is no longer presented as the solution, but as a digital technology that should support the GGD with the contact tracing. Due to this, the application is seen as useful with a lower adaptation threshold. However, still: the more people download and use the application, the higher the value of the support for the GGD (document 46: 7). The committee also highlights that during and after the appathon, it was noted in several ways that the development and application of such an application should happen in a democratic manner.

The ethical committee also touches upon the social awareness/inclusion and asks the question: are the perspectives of all relevant stakeholders being heard and acknowledged in the design process? Then they identify the different stakeholders that have been included so far: DPA, the state attorney, diverse experts (scientists, RIVM, GGD), diverse users of the application (including special needs groups), an ethical expert panel and stakeholder workshop (including different sorts of citizens from different work areas) and a technical expert who takes seat in the design team (document 46: 15). However, the committee wonders if there is sufficient time to acknowledge the critical notes from these stakeholders, and if the input from the diverse consultations is fed back to the development process (document 46: 15). Their advice is to allow for enough time for these critical remarks from the societal debate and the ethical test to address them in the application (through updates), in the embedding of the application (through rules and regulations) and especially in the communication surrounding the application and in fair information to the users (document 46: 15).

The ethical committee further notes that there needs to be attention for social innovation, not just technical innovation. The goal should not be to have a perfectly functioning application, but to offer a responsible contribution to society, help to stop the spreading of the virus and give citizens an instrument to take their responsibility voluntary for their own health and that of others (document 46: 16). In the first phase of the development of the application (March-April 2020), the focus was too much on the technical aspects of the application. There was attention for privacy and safety, but insufficient attention for the broader social, juridical and democratic context (document 46: 16).

AUGUST

In August, a document called 'eight misconceptions about the CoronaMelder unraveled' was published by the Dutch government. In this document, some myths were debunked (the government does not know where you are, who you meet, your phone battery is not heavily impacted, etc.). What is striking is the myth about the need for 60% usage of the application for it to be effective. The government answers that research shows that the virus could be stopped if 60% of the population downloaded the application <u>and</u> it would be the only resource used, or in Plantinga's words: "*60% is necessary if we would all start to go to the bar again"* (Plantinga, personal communication, September 23, 2020). According to the authors of this pamphlet, even if few people use the application, it could help slow down the spreading of the virus, because we also have other regulations, such as broad manual contact tracing by the GGD, 1.5 meters distance and frequently washing hands. Every successful warning that prevents someone from spreading the virus, possibly saves someone's live. Therefore: the more people that use the application, the better (document 60).

On the 17th of August, Hugo de Jonge sent a letter to the Chamber of Representatives titled: 'progress CoronaMelder'. I will highlight some striking points. First, De Jonge notes that (only) 70 to 75 % of the contacts in 1.5 meter get found and signaled – due to how Bluetooth Low Energy works, these are similar numbers in all countries that use such an application (document 66: 5-6). In consultation with the other countries that use such an application, and Google and Apple, they are trying to better this (ibid). De Jonge also speaks about a mass media public campaign, in order to invite as many people as possible to use the CoronaMelder (when nationally introduced). This campaign will exist out of: tv-commercials, radio commercials, outside commercials, print and online commercials (with banners and influencers). The campaign will highlight that people should download and use the application because "*everyone knows someone for whom they would want to download the application*" (document 66: 6). This campaign, influencing the people to use the application, might be in conflict with the voluntary principle of the application. It appears to be a nudging campaign. However, no documents from this committee have been published so far, and the media campaign has not been started yet. Therefore, I can and will only make some general remarks about this in the conclusion.

On the 19th of August, a second opinion by privacy management partners DPIA on the CoronaMelder was published, which is only the second document (after the ethical consideration) which touches upon risks outside of the technicalities (document 69: 5-6). They identify two risks: an extra burden for people who cannot work from home - as they are amongst more people and will get a notification more often than others, which can have negative impacts such as ignoring exposure signals due to habituation. Additionally, they lose labor intensiveness due to undergoing of extra COVID-19 tests and self-isolation until the test results are in. The second risk is the irreversibility of technological developments: even if the intention is to use the application only temporarily and that the application will be deactivated as soon as possible, long term effects are not to be ignored. In the past we have seen that temporarily privacy invasive measures get a permanent character: but even when the government deactivates the app, it is not unthinkable that a new purpose if found for the contact tracing functionality. The unintended effects of a contact tracing application on the society are still difficult or even impossible to oversee (document 69: 5-6).

In a management summary without specified author, a report on the effects of the implementation of the CoronaMelder for the GGD's was published. Conclusions on the impact of the CoronaMelder on the manual SCT were that (a) the needed actions for sending a notification leads to little extra work for the GGD employees, (b) some GGD's experience that due to the workings of the CoronaMelder the control on the manual SCT gets a bit lost, and (c) some have the unjust expectation that the CoronaMelder can give information to identify focal area's (this is not possible). The authors of the summary conclude that in general, they are critically positive about the CoronaMelder as a support system to the manual SCT. However, the insecurity about and late announcements surrounding the possibility of asymptomatic[21] testing, do not contribute to the support of the

[21] Asymptomatic testing leads to a strong increase of the number of requested tests and this way has an impact on the capacity of the test locations and labs. Next to this, asymptomatic testing is not in line with the current guidelines. Concluding it should be noted that the current systems are not designed for planning appointments

CoronaMelder (document 74). These conclusions are of enormous importance, as the application is meant to support the GGD in the contact tracing process. However, they do not seem to have gained much attention.

On the 25th of August, the 'program of demands[22]' was published, and from earlier documents I retrieved that this document was made by the *begeleidingscommissie digitale ondersteuning bestrijding COVID-19*. However, there is no author on the document so I cannot be sure. The document opens with stating that the demands are specified to the Dutch situation, and follow the advice of the European Union surrounding Contact Information apps (document 73: 3). The rest of the document contains many technical demands. What is most striking about this document is that it is the first document that goes beyond stating that citizens need to trust the application in order to use it**.** The authors of this document actually attempted to include the citizen perspective, and they reasoned from the dual role of the user (document 73: 4): from an infected user (use to application to take responsibility in relation to others), and the not infected user (want to be sure they did not have contact with an infected user/help solve the crisis/help ease the restriction/stop the spreading of COVID-19).

SEPTEMBER

In September the evaluation protocol of the CoronaMelder was published (document 78). This protocol is aimed at evaluating the effectiveness of the CoronaMelder, once introduced. The committee identifies six evaluation area's that should be used to judge if the CoronaMelder should be kept in use:

1. the adaptation percentage – number of downloads (back-end data)
2. the usage of the application - the amount of requested tests after notification (GGD codes)
3. direct effects - such as if the *handelingsperspectieven* etc. are being followed (asked by GGD during test-requests and manual SCT)
4. the indirect intended consequences - is R0 decreasing (RIVM models)
5. unintended consequences - is the application leading to a false sense of security (survey's)
6. and traits of users that cohere with adaptation, usage and effects - why do people use the applicationor not (survey's)

As the observative reader might have noticed, this evaluation protocol of the CoronaMelder is dependent on a lot of external data. This has to do with the privacy-by-design principle of the application – which ensures a minimalization of data-gathering. Due to this, for example, the GGD

in the future – which is needed when people are tested asymptomatic. For these reasons, there is a lack of support for asymptomatic as action perspective in the CoronaMelder (document 74).

[22] The date on the document was not adjusted, but it was published on 25-8-2020.

cannot identify focal COVID-19 areas. Thus, for the evaluation of the effectiveness of the CoronaMelder, except from the first two points, data has to be gathered secondary. Another striking aspect is that this document is the first document which highlights the possibility of appropriation, a process through which the users of the application go beyond adaptation and make a technology their own (Bar et al. 2016).

Table 3. Document sources for data analysis.

	Date	Author	Title
1	7-4-2020	Hugo de Jonge	Kamerbrief COVID-19 Update stand van zaken
3	17-4-2020	Mark Rutte	Persconferentie
4	19-4-2020	KPMG	Securitytest potentiële Corona-apps
5	19-4-2020	Pels Rijcken	Openbare samenvatting privacyanalyses bron- en contactonderzoeksapps
6	21-4-2020	Hugo de Jonge	Kamerbrief COVID-19 Update stand van zaken
9	n.d.	n.a.	Bijlage gelopen proces ten aanzien van tracking en tracing apps
12	6-5-2020	Hugo de Jonge	Kamerbrief COVID-19 Update stand van zaken
13	21-4-2020	Mark Rutte, Jaap van Dissel	Persconferentie
16	6-5-2020	Mark Rutte, Hugo de Jonge	Persconferentie
25	n.d.	n.a.	Digitale ondersteuning bestrijding COVID-19
33	24-6-2020	n.a.	Toegankelijkheidsverklaring corona-app
35	?-6-2020.	Begeleidingscommissie Digitale Ondersteuning Bestrijding COVID-19,	Advies 1: Programma van Eisen voor digitale oplossing ter aanvulling op bron- en contactonderzoek GGD
46	14-7-2020.	Verbeek, P.P.C.C., Brey, P., Est, R. van, Gemert, L. van, Heldeweg, M., Moerkel, L.	Ethische analyse van de COVID-19 notificatie-app ter aanvulling op bron en contactonderzoek GGD
60	12-8-2020	Rijksoverheid	8 misvattingen over Corona ontrafeld
66	17-8-2020	Hugo de Jonge	Voortgang CoronaMelder
69	16-8-2020	Jeroen Terstegge	Second Opinion DPIA CoronaMelder App
73	25-8-2020	n.a.	Programma van Eisen voor een digitale oplossing ter aanvulling op bron- en contactonderzoek van de GGD
74	n.d.	n.a.	Managementsamenvatting
78	n.d.	Ebbers, W., Hooft, L., Laan, N. van der.	Evaluatieprotocol Effectiviteit CoronaMelder

OVERVIEW

Above, the most remarkable documents have been discussed following a chronological, monthly, order. In these paragraphs, these insights are held against the five fundamental principles of RRI and the concept of co-production.

FUNDAMENT 1. Risks, potential harms, wellbeing, values, needs, rights and interests of relevant parties affected by the innovation are adequately taken into consideration at a very early stage.
Partly met.

In the case of the CoronaMelder, this RRI fundament is a fairly interesting one, as the start of the development of the application had a different approach than the further development process. At the beginning of April, the government announced their interest in a technological support to battle COVID-19. Immediately, societal actors such as NGO's, experts and scientists, voiced their concerns. Still, the government decided to host an 'appathon', in order to discover what kind of technological support was viable and which private company could bring this to life. However, after the appathon, it became clear that (i) the privacy standard of a governmental policy tool was not met by these commercial actors, and (ii) the demands of the GGD were not clear enough yet. Especially the second point exhibits that the government might have been to eager to develop this application quickly. After this, another approach was taken, which involved the inclusion of many different perspectives through taskforces, a clear program of demands and set requirements concerning privacy. Additionally, when looking at the technical specifications of the CoronaMelder, we see that the developers did all they could to ensure a responsible technology, by making use of the privacy-by-design principle, the DP3T foundation, ensuring a minimization of data gathering, working with BLE and ensuring the availability of the application for low-literacy publics. These are all technical ways of taking into consideration the risks, potential harms, wellbeing, values, needs, rights and interests of relevant parties.

Still, there is room for improvement concerning this fundament. Mainly because of two curious developments: (a) the limited inclusion of the GGD in the decision for a particular application, and (b) the (non) inclusion of the end-user throughout the process. The first development is remarkable because from the beginning, this technological aid was framed as a support tool for the GGD. However, the GGD would have preferred to see the second application – the home reporting application – developed first, because it would offer them more effective support (De Gouw, personal communication, November 18, 2020). The second development concerns the (non) inclusion of the end-user throughout the development process. During the development process of the application, all different kind of user-tests have been done, ranging from field tests on military bases to see how the

BLE works to user test for people with limited literacy skills. However, these tests only have taken place on an instrumental level – to see if people can use the application and how they engage with it. The public has not been engaged at the same level as the taskforces have been, and therefore both the institute for which this application is supposed to offer relief and the intended end-user, have not been engaged in this process soon enough, neither intense enough.

FUNDAMENT 2. Issues of governance, regulation, inspection, monitoring and reporting about innovations are adequately dealt with.
Mostly met.

The second fundament is especially interesting as the innovation discussed is a 'public policy technology'. This entails that all the issues of governance, regulation, inspection, monitoring and reporting have to be handled with due care, and that these are publicly available.

However, the political and juridical context in which the development of the application is situated, did cause the national embedding of the application several months of delay (Plantinga, personal communication, September 23, 2020).

FUNDAMENT 3. Relevant knowledge and information is shared and communicated between affected parties in a timely way.
Partly met.
FUNDAMENT 4. Legitimate deliberative institutional arrangements, decision making instruments, communicative infrastructure are provided to relevant parties and individuals.
Partly met.

Fundament 3 and 4 are discussed together, as they adhere to the same processes of transparency, communication and public debate. At first sight, these fundaments seem to have been met: the source code was publicly available on GitHub, communication with the developers was possible through Slack and digital coffee hours, and some involvement of the public was facilitated. More than 100 documents concerning the development of the CoronaMelder were published on the website of the government. However, as stated by Van Est, this 'openness' follows a narrow definition of transparency (Van Est, personal communication, September 25, 2020). How many people can actually read the source code, let alone contribute? When going through all the documents, both Van Est and me had to put a lot of time and effort in figuring out what tests had been done with the CoronaMelder, as well as figuring out which taskforces published which document. At the same time, there were no documents published from the Taskforce Behavioural Science, so their role in the process stays unclear. Also, there were three different websites that the government used to communicate information about the application – there was not one clear overview. Additionally, on Friday the 18th of September 2020, I joined the online coffee hour – to ask some questions to the developers of the application – but for the full hour, no one besides me was present. Communication with the developers through Slack and GitHub, which is available for 'everyone', require an account and a certain skillset – which immediately eliminates publics with lower digital literacy. Also, these communication possibilities only concern the technical specificities (instrumental level); whereas the bigger concerns the public might have about the application, the public debate, was not facilitated through this. All these examples exhibit a very transparent process at the surface, however, when diving in deeper, the development process was not that transparent.

Publishing a source code is a narrow definition of transparency, and when broadening this into procedural transparency, we can conclude that there is much room for improvement. The government should be communicating clearly about the effectiveness of the application[23] about their uncertainty about the impacts of the application and their choice to develop this one, 'for the GGD', while the GGD acknowledged that they would be helped better by another sort of application[24]. This last point also exhibits the importance of co-production when defining a problem – asking the GGD what they would need, and listening, before deciding that you need an application to combat COVID-19, might give whole new insights.

After the first mentions of the possible employment of contact tracing applications, voices of concern were raised by the public through a letter signed by more than sixty scientists and the 'manifesto safe against Corona'. According to Van Est, such processes can be referred to as public engagement, and that is exactly what is needed when new technologies are developed (Van Est, personal communication, September 25, 2020). After this 'uprise' of the public, we can spot a change in the attitude of de Jonge – which is translated into the set of demands and conditions that were drafted shortly after.

[23] The application notifies between 70 and 75% of the users accurately, this entails that they (i) have been within 1.5 meter distance from a COVID-infected person, (ii) for longer than 15 minutes, and (iii) get a notified about this. This entails that almost a quarter of the notifications entail false positives/negatives.
[24] Which is currently being developed (De Gouw, personal communication, November 18, 2020).

FUNDAMENT 5. Options, possibilities, alternatives, scenario's, choices are conspicuously represented and presented to relevant agents and actors.
Not met.

In the case of the CoronaMelder, this fundament exhibits an inherent duality in the development process. In April, the government stated that they wanted to look into technological support in order to battle COVID-19, and to support the work of the GGD. Hugo de Jonge noted that they were looking into two different application possibilities: a contact tracing application and/or a home reporting application. During the appathon, the invite set out was for all different kinds of technological support tools, however, the proposals that were invited to join all concerned contact tracing applications. This also had to do with the fact that it seemed that there were already home reporting application infrastructures available. From the appathon on, the decision was made to focus on a contact tracing application and in order to support the development of this application taskforces were formed. The goals of these taskforces were formulated as if they were supposed to "*consider the possibilities for digital support*'' and ''*research if there are any digital support means which can be introduced and can deliver a contribution*''. However, (i) the decision upon which application would be developed was already taken, and (ii) except for the ethical committee (which is even more striking, as their goal was "*to see if the proposed solutions are ethically acceptable"*), no committee seems to have asked the question if this application was indeed necessary, what would be alternatives, and if technological support was necessary.

Co-production
Partly met.

Throughout the whole development process, some form of co-production has been present. The inclusion of the taskforces, which from many different perspectives shed their lights on the CoronaMelder, is the most striking example of this. However, the co-production process could have been more productive if the different involved stakeholders would have already been included in the problem definition – thus before the decision to make a contact tracing application took place. The COVID-19 crisis is a wicked problem, and a problem definition should have included the different affected parties. Both the GGD and the public should have been included more intensively – as they are the ones for which this application is developed. However, the GGD was represented only by few in the taskforces, and the public was only involved on an instrumental level – to see how they engaged with the application.

All in all, especially with the inclusion of many different taskforces, co-production has been an extensive part of the development of the CoronaMelder. However, when looking at the involvement of the end-user, there is room for improvement. Additionally, the role of the GGD throughout the process was not clear, however they were framed as the 'main stakeholder'.

FUNDAMENTAL ISSUES

In the paragraphs above, it was shown that the development process of the CoronaMelder leaves room for improvement, when analysed from an RRI/co-production perspective. This is problematic, as it is a 'public policy technology', and needs to function in the public domain. The two main problematic developments concern (i) the (non) inclusion of both the GGD and the public, and (ii) the communication and transparency of the development to the public. Next to these findings, discovered when the development process was held against the developed framework, there are also several issues to be defined from a more fundamental point of view – about the bigger processes and trends which this application touches upon. The CoronaMelder and similar applications do not exist in isolation – they are embedded in techno-social systems which include many different infrastructures, both offline and online. The CoronaMelder, for example, can only function if the means are available to test possibly infected persons for COVID-19, and if the test results can be communicated to these persons as well as through the application. The application is in need of specific software, working Bluetooth or GPS technology, enough battery, and network coverage. A striking example of how the development of the application has not taken the bigger picture into account, is the fact that the CoronaMelder can't communicate with 'foreign' applications, such as the German Corona-Warn-App. Developing and 'implementing' such applications does not solve any problem if the contexts in which it is placed are not taken into account. This necessity to acknowledge the bigger systems in which a technology is embedded, already became clearer throughout the development process – such as the need to think beyond national borders, the dependency on test availability and the implications of wearing face masks. There are two other meta-processes that need to be addressed: the normalizing a culture of surveillance and the possibility of the CoronaMelder being a technological fix.

NORMALIZING A CULTURE OF SURVEILLANCE

"In an era in which everyone is to be considered potentially suspect, we are invited to become spies – for our own good"

~ David Lyon 2018: 49

The development of contact tracing applications to battle the spreading of COVID-19 fits in what David Lyon, professor at the department of sociology and director of the surveillance studies centre at Queen's University in Canada, refers to as 'surveillance culture' (2018). In the book 'The Culture of Surveillance: Watching as a Way of Life', Lyon describes how in the contemporary Western society "*people actively participate in and attempt to regulate their own surveillance and the surveillance of others*" (2018: 6). This 'culture of surveillance' entails a widespread compliance with surveillance, without questioning, often lead by convenience and custom (Lyon 2018: 40). Lyon states that todays emerging surveillance culture is unprecedented (2018: 6) – and that a key feature of this surveillance culture is that people actively participate in and attempt to regulate their own surveillance and the surveillance of others, a phenomenon he refers to as 'a participatory approach to surveillance' (ibid; idem: 50). A defining feature of surveillance culture is the state of technology, as the use of interactive and smart technologies shifts the focus from fixed to fluid surveillance, from hardware to software (2018: 95).

In Lyons view, we mistakenly view surveillance as something that is done to us; while in reality it is experienced and initiated by ordinary people (2018: 29). He identifies several common features of surveillance, in which increasingly social relationships are digitally mediated and where subjects are involved not merely as the targets/bearers of surveillance, but more and more as knowledgeable and active participants (2018: 39-41). A common feature entails the widespread compliance with surveillance without questioning. According to Lyon, this has to do with three mechanisms, namely fear, familiarity and fun. The fear mechanism entails the way in which politicians use the publics fear of violence and terrorism to obtain support for the introduction of new security measures (2018: 40). The familiarity aspect shows how surveillance mechanisms have been normalized in our culture: we endure invasive security checks at the airport, are used to ubiquitous cameras in public and private spaces, we have a loyalty card for the supermarket, and even track our health with Fitbits. This normalization and domestication of surveillance enables a certain amount of compliance with it. The third aspect defined by Lyon is 'fun', which surveillance mechanisms such as social media provide us (ibid). Together these mechanisms make it easier for society to accept quite intrusive surveillance technologies, such as the CoronaMelder. Additionally, Lyon identifies 'surveillance imaginaries' – shared understandings about certain aspects of visibility in daily life (2018: 41). These include some very striking and recognizable imaginaries, such as "*the belief that to organize and oversee anything, data are needed, and using data is more efficient than previous methods, or, at worst, a necessary evil*" (ibid). The COVID-19 crisis makes this belief highly visible, for example in the extreme focus on data on the representation of those on dashboards. Another imaginary Lyon identifies is that "*security is a key driver and justification of extra surveillance*" (ibid) – again, the contemporary situation proves how striking this imaginary is; the qualification of this healthcare crisis as an issue of 'national safety and security' also enables new surveillance technologies to enter society. The third imaginary is that it is possible to trade privacy for benefits. Again, a prevailing misconception related to our surveillance culture, and also one that occurred often during this crisis.

The inherent duality of the COVID-19 contact tracing application users, being object and subject of surveillance, is an ambiguity also described by Lyon as peer-to-peer monitoring. Peer-to-peer monitoring is understood as the use of surveillance tools by individuals, rather than by agents of institutions, to keep track of one another. According to Lyon, people know that they are being watched and modify their moves in ways that fit their imaginaries (idem: 60). Thus, the government asks its people to engage in peer-to-peer surveillance, which is the use of surveillance tools by individuals, to keep track of another, while the government itself does not engage in this surveillance (Lyon 2018: 49).

A fundamental distinction between the surveillance of Lyon's book and the surveillance of the CoronaMelder has to be made – when using the CoronaMelder, a user is not aware of the other users of the application, and the application also does not allow interaction between users. This way, it is fundamentally different from other digital surveillance tools, such as social media platforms. The literal aspect of being the watcher and being watched is abandoned. However, that this aspect is not literally present, does not mean that it is not present at all – it is, just not visible. One could argue that this is even more tricky, as it makes the surveillance more obscure.

SOLUTIONISM

"These days, it seems, just carrying your phone around might be an act of good citizenship"

~ Evgeny Morozov, 2013: 5.

In his book 'To Save Everything Click Here', Evgeny Morozov, a tech-journalist and researcher, addresses the ideology of 'solutionism' (2013). An ideology based on the belief that complex problems can be neatly defined and solved by technological solutions, also referred to as technological fixes (Morozov 2013: 5). In Morozov's view, this 'quest' is likely to have unexpected consequences that could eventually cause more damage than the problems they seek to address (ibid). 'Solutionism' defines extremely complex, fluid and contentious problems – such as wicked problems - in ways that technology can 'fix'. However, exactly these problems can not be defined in the singular and all-encompassing ways that solutionists propose; the trouble therefore is not their proposed solution, but the very definition of the problem (idem: 6). Where Plantinga, involved in the development of the application, claims that the CoronaMelder is not a technological fix (Plantinga, personal communication, September 23, 2020) – Van Est would disagree with this statement. According to him, the CoronaMelder can be regarded as a technological fix, especially when considering the start of the development process, when De Jonge still thought that such a complex and sensitive technology could be developed within a month. Van Est does acknowledge that this attitude changed after the public raised its voice, and that this can be seen in the involvement of many different actors and user-tests that have been done. However, all these reflections stayed on an instrumental level – still, not enough attention was being payed to the broader social embedding of the application (Van Est, personal communication, September 25, 2020).

Morozov does not provide his readers with a clear way to 'overcome' solutionism. However, he does touch upon two elements that could help us to understand when we fall for technological fixes: deliberation and a revival of moral and political philosophy. Morozov states that that we need to develop a better way of evaluating, comparing, and discriminating across technological fixes (Morozov 2013: 324). He argues for a 'new' system, in which agreements about what a device should do are regarded as temporary and contingent and always liable to revision through debate and deliberation. In Morozov's words: "*Under this system, the goal of design is not just to build an artifact to fulfil some genuine social need 'out there' but also to make us reflect on how that need has emerged, how it has become a project worth pursuing, and how, all things considered, it may actually not be worth pursuing at all. Designers shouldn't fore these answers to users, but they should make it easier for users to ask questions that may or may not lead to such answers*" (idem: 329). This debate/process of deliberation should also be informed by moral and political philosophy, and, "*If, after extensive deliberation, we cannot find a rationale, then perhaps we shouldn't be pursuing that activity in the first place*" (Morozov 2013: 334).

CONCLUSION

In this chapter, the third sub question (*To what extent did the development of the CoronaMelder comply with RRI/co-production?*) was addressed through an analysation of governmental documents about the CoronaMelder and complemented by interviews with key-actors. It became clear that the development process of the CoronaMelder on an instrumental level was done superb. However, when zooming out and considering the bigger picture, there are many hooks and eyes attached to this project, which should be addressed before implementing such a technology.

CHAPTER VI - CONCLUSION

When I wrote the introduction of this thesis, the Netherlands was experiencing the first lockdown period, and I am writing this conclusion during the second lockdown. Societies all over the world are learning how to cope with such a crisis, and so are many individuals. The way the crisis is handled raises many questions on different areas and with this thesis the aim is to start answering a tiny segment of those questions. In doing so, the ambition is to also shed light on grander on-going processes.

The topic of this thesis is the development process of contact tracing applications, and specifically the development process of the Dutch CoronaMelder. The research question was: *What can society learn from the development of the CoronaMelder when approached from a RRI/co-production perspective?* In order to be able to answer this question, three sub questions were drafted, which I am going to answer successively while building an answer to the research question.

In **Chapter III – Contact Tracing Applications** the sub question - *What is the CoronaMelder and how does it relate to similar projects?* – was addressed. To start answering the question, previous, similar projects were addressed. Through this, two things about the usage of phones in health-care emergencies became apparent. First, the surveillance of the spreading of the diseases went from a focus on macro perspectives, such as human migration patterns, to micro perspectives, such as proximity tracing applications. Second, the used technologies to enable this surveillance changed from SMS to CDR to Bluetooth/GPS/QR-codes. The shift from macro to micro surveillance could be explained by the fact that the projects based on macro surveillance did not deliver the hoped outcomes – especially the Sierra Leone case exhibits that a focus on human migration does not reveal new insights on the spreading of diseases, but just confirms common sense. The shift in used technologies most likely has to do with the development of the smartphone and availability of 4G – as the previous cases already state that they would advice future projects to focus on GPS systems or applications. Additionally, when using Bluetooth and/or decentralized saved QR-codes, the privacy of the end-user is better protected – which also relates to the shift of focus of the surveillance.

After the previous, similar usage of technologies was discussed, the contemporary contact tracing applications were elaborated upon. The main purpose of the contemporary applications appeared to be support for manual SCT, in order to make it quicker and more inclusive. It was shown that there are many different methods to engage in proximity tracing, and that there are several decisions that have to be made when such applications are developed. An application can for example function on Bluetooth, GPS or QR-codes, or a mixture of those; it can be voluntary or obligatory and data storage can be central or decentral. And these are just the most apparent choices that the application developers have to make – there are also choices about the design process, such as whom to include. Thus, the development process of the application entails many choices. The Dutch CoronaMelder is a voluntary application, which uses the Google/Apple API, runs on Bluetooth Low Energy and stores data decentralized. The developers followed the DP3T principle and used privacy-by-design as a fundament. The development of the application exhibits a high regard for the privacy of the end-user. It is interesting that due to the application being so secure, the application loses a lot of functioning for the GGD – which would have gained more insights if some data was gathered, for example about the postal code of the (possibly) infected users.

Now that we have seen that the focus from these applications has shifted from a macro level to a micro level, and the ways in which contact tracing applications can be designed, we turn to the second sub question: *What is RRI, what is co-production and why is it of importance for the development of the CoronaMelder?* In **Chapter IV – Theory** the complexity of a project such as the CoronaMelder was set out. It was argued that applications such as the CoronaMelder should be handled with due care, as they are a 'public policy technology'. This entails that these applications transcend the relationship between app-user and app-maker, as also the relationship between a government and its public is at play. Additionally, the public of these apps possesses an inherent duality – as they are both subject and object of the surveillance. These different relations and interactions make the CoronaMelder a difficult project. Summarizing, the CoronaMelder is a unique technology, because (i) it is a government initiated project, (b) which success depends on the adaptation of the public, which is both object and subject of surveillance, (c) the application exists online but is dependent on offline processes – such as testing facilities, and (d) all this while being multi-dimensional: influencing and being influenced by the technical and societal realms in which it has to function.

The discussed complexities make the CoronaMelder both a difficult and exciting 'public policy technology' to evaluate. As the CoronaMelder is a governmental project, it is of importance to approach this undertaking as a public policy. In doing so, it becomes clear that – when dealing with wicked problems such as a pandemic – co-production is a key process in contemporary policy making. Co-production is a method which involves public service users in any of the design, management, delivery and evaluation of these public services. Turning to the technological aspect of this 'public policy technology', an RRI approach was taken, as RRI evolves around the responsible innovation of technologies, which is a fundamental starting point when developing a technology as a democratic government. As it appeared that neither a solely technical approach, nor a solely societal approach could offer a framework to hold the development process of the CoronaMelder against, the decision was made to combine both by taking the five fundaments of Van den Hoven – in which both procedural and substantive notions are brought together, and normative aspects are not defined but left to deliberative processes - and adding co-production as an overarching dimension.

This brings us to the next question, answered in **Chapter V - Results**: *To what extent did the development of the CoronaMelder comply with RRI/co-production?* In this chapter the actual development process of the CoronaMelder was hold against the discussed framework. The development process was researched through a document analysis of publicly available documents, as well as interviews with key-actors. It was shown that the development of the CoronaMelder does exhibit room for improvement. The main identified issues concern (i) inclusion, (ii) transparency, and (iii) alternatives. Inclusion entails both the early inclusion of stakeholders, such as the GGD and the end-users, as the inclusion throughout the development process – both were not met sufficiently. The transparency issue concerns the argument that the transparency offered was a false transparency – as publishing the source code only offers transparency to a select group of people. The alternatives issue revolves around the fact that even though the GGD acknowledged that they would benefit more from other applications, the government did pursue the contact tracing applications and did not present nor consider other technological support for the GGD. Co-production only took place on an instrumental level – such as through user tests. The combination of these issues is problematic, as it exhibits an instrumental attitude from the government towards the technology, while the implementation of the technology does have many (unintended) consequences that should also be considered. A technology does not exist in isolation.

With the CoronaMelder, there were two fundamental issues at play that were not discussed in the documents of the government: the normalization of a culture of surveillance and the possibility of the CoronaMelder being a technological fix. The normalization of a culture of surveillance is extra dangerous in this case, as it happens on an extremely subtle level – almost unnoticeable. When actually considering that the government is asking its public to engage with peer-to-peer surveillance for the 'public safety' – this really would have been unthinkable before COVID-19. Of course, we are situated in a crisis and some sacrifices have to be made, but there should be more acknowledgement of what this normalization of surveillance actually entails and how it influences our society. Additionally, the CoronaMelder can be regarded as a 'technological fix', and when looking at the beginning of the development process, it definitely was presented as such. Later, the frame surrounding the CoronaMelder changed into it being a technological support of the GGD, but *the damage was already done.* In the sense that the definition of the problem (the GGD needs help with the SCT) was made with a technological solution already in mind. This is exactly what is meant with technological fix.

It should be noted that the CoronaMelder has been developed under bizarre conditions and enormous time pressure. When taking this into account, one can only have respect for the way in which the developers of the CoronaMelder did ensure to make an application with a high regard for privacy and established a minimalization of data-gathering.

When going back to the main research question - *What can society learn from the development of the CoronaMelder when approached from a RRI/co-production perspective?* – it can be stated that a lot can be learned from the development of the CoronaMelder, both theoretically and practically. As noted, a clear framework on how governments should engage with the development of 'public policy technologies', is missing. It is of great importance that this will be developed, as the digital world becomes a bigger part of our society every day. From a practical point of view, the development processes show that there was little inclusion of the actual end-users of the application – the GGD and the public. The GGD was involved, but minimally, and after the decision was taken to make a technological support tool. The public was involved via user tests throughout, but only on an instrumental level, to see if the application functioned.

It should be noted that the government's attitude towards the CoronaMelder did change after the public raised its concerns. The government installed taskforces, developed the application open source with an extreme high regard for privacy, and engaged in user tests throughout. Thus, steps in the right direction were already made, however, some fundamental aspects were still missing.

ADVICE

After months of investigating the development of the CoronaMelder, some final remarks and a word of advice will be given. First, theoretical insights are addressed, followed by some practical advice.

We can expect an increase in technologies that qualify as 'public policy technologies'. However, as shown, there appears to be a gap in the public administration literature about how to address governmental technologies, which can be complimented with literature from philosophy of technology surrounding RRI. In this thesis, the concept of 'public policy technology' was used to refer to the CoronaMelder, in order to make the inherent dichotomy clear. However, the concept is in need of a more thorough conceptualization, as well as a clear operationalization. This would be an interesting task for research situated at the intersection of the social and the technical.

For the development of future, similar applications, I have a three-folded advice: deliberate, deliberate, deliberate. First, deliberate about the problem definition to overcome the possibility of a technological fix. Second, deliberate to understand the consequences of the implementation of a technology and to start a public debate about these - to figure out what normative statements should be fundamental for the technology. And third, deliberate once the technology is implemented, in order to constantly re-evaluate the existence and necessity of such applications. Of course, deliberate, deliberate, deliberate might seem like a hard task, but it is a necessary one if we really want to co-produce responsible 'public policy technologies'. Or, to quote van Est who quoted Gandhi: "*everything you do for me, but not with me, you do against me*".

DISCUSSION

This research concerned the development of the CoronaMelder and similar applications from a perspective of co-production and RRI. In these paragraphs I will address some points for discussion.

First, the conceptualization and operationalization of 'public policy technology' could have been more detailed, in order to really introduce a new concept. However, the aim of this thesis was not to introduce a new concept, but to research the development process of the CoronaMelder. In order to do so, a term that included both involved perspectives was used. More research into a concept such as 'public policy technology' would be interesting.

Second, the theoretical framework used was still quite broad. This was due to the fact that both co-production and RRI are concepts that can be operationalized in many different ways – and because there are so many ways to engage with these concepts, if you chose to present it in a certain way, many other methods are excluded. This is a trade-off that the author has to make, and I chose to keep the framework quite broad. A consequence is that the data analysis leaves room for interpretation. However, by engaging key-actors and by checking made inferences, this aspect of interpretation was kept to a minimum.

Third, it would have been interesting to compare the development of the CoronaMelder to the development of similar applications in other countries. Now, an ideal type situation was set out in the theoretical framework – but the feasibility of this, especially during emergencies, is questionable.

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APPENDIX I – CASE STUDY PROTOCOL

This research has been conducted as part of a master's thesis in the PSTS-PA programme at the University of Twente in the Netherlands. The case was chosen as due to COVID-19, an earlier case study about smart fire sensors was cancelled, and the researcher decided to turn her faith and change a burden into a research topic. The case-study was confined to the Netherlands, mainly for practical reasons (language, access of key players, document availability).

At the time of writing the thesis, we are still in the middle of the pandemic. As it is a new sort of phenomena for this generation, the case is scientifically relevant as it might offer new insights on the contemporary situation. The study is socially relevant as it might address some pressure points for developing 'societal technologies.

Field procedures

Two sources of data have been used: the official state documents from the first published document on the 7th of April, until the 30th of September, published on https://www.rijksoverheid.nl/onderwerpen/coronavirus-app/documenten and interviews with key-actors.

'Daily' assistance was given by two supervisors on a monthly basis (one from PA, one from PSTS) and one external supervisor who was greatly experienced in doing research in social sciences and held many valuable contacts. When the researcher struggled, other assistance was offered by peers or acquaintances, gathered through the supervisors.

Schedule

Below, you find the schedule as planned. Of course, this research was conducted with severe limitations and a lack in resources such as a place to study or face-to-face meetings. Next to that, doing research is an iterative process and therefore not as clear cut as it might seem.

Month	Task	Chapter
April	Orientation by doing literature research.	Introduction
May	Doing in-depth literature research.	Previous cases.
June	Researching context of case-study.	Current cases.

July	Methodology, Theory.	Methodology.
August	Methodology, Theory, Data analysis.	Methodology 2, Theory, Data analysis
September	Finalize.	Draft 1, Final version, Graduation.

Semi-structured interview list

As the interview have been conducted with several key actors, the questions did differ per participant. However, a semi-structured interview method was chosen as this offers the needed guidance during the interviews.

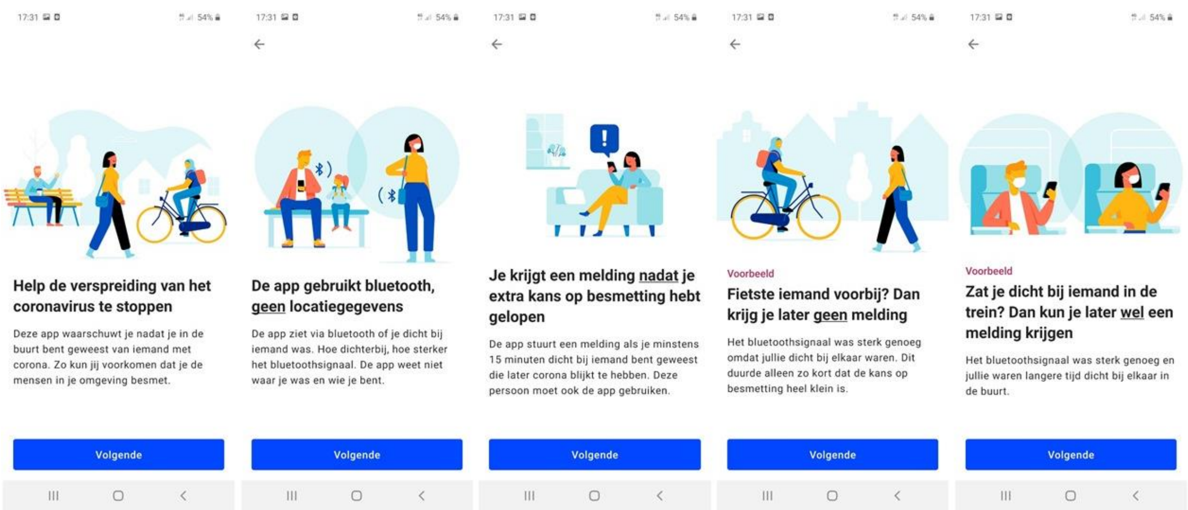
Final report

The final report is written with an educated audience in mind, however the researcher also wanted it to be accessible for others who are interested in the topic. Therefore, a writing style was chased, which should be readable by most. The final thesis has a linear-analytic structure; thus, the sequence of subtopics starts with the issue or problem being studied and a review of the relevant prior knowledge. The subs topics then proceed to cover the methods used, the findings from the data collected and analysed, and the conclusions and implications from the findings.

All the analysed documents and interviews can be retrieved by sending the author an e-mail (ellemijke@gmail.com). A list of the used literature is situated under the Bibliography.

APPENDIX II – CORONAMELDER

1. The CM makes an individual code for every phone. This code is not traceable to a person and changes multiple times every hour.
2. If your phone is near another phone which downloaded the CM, the phones share their codes through Bluetooth Low Energy
3. Do you test positive? This means that you have COVID-19. A GGD-employee will reach out to you. During the conversation, this employee will ask if you use the CM. If so, you are being asked to open the application.
4. In the CM a GGD-key will be ready for you. You give this to the GGD-employee.
5. The GGD-employee enters the GGD-key, and a button named 'upload codes' will appear on your screen.
6. You can now click this button on your app.
7. On the screen, another button appears in which you can confirm that you agree to upload all exchanged codes from the pasted 14 days.
8. App-users who have been near to you for longer than 15 minutes, receive a notification. In this notification, a recommendation is given. CM does not know who you are, who the other people are and where you have been.



APPENDIX III – KEY ACTORS

	TF digital support	TF behavioural science	Guidance committee	Design team	Ethical committee
Sjaak de Gouw	x		x		
Mart Stein	x				
Marc Bonten	x				
Martin Bootsma	x				
Nicole Dukers-Muijrers	x				
Lisette van Gemert-Pijnen	x	x	x		x
Mariska Petrignani	x				
Stijn Raven	x				
Jim van Steenbergen	x				
Lex van Velsen	x				
Freke Zuure	x				
Albert Jan van Hoek	x				
Susan van den Hof	x				
Margreet ter Wierik	x				
Albert Wong	x				
Rik Crutzen		x			
Catherine Bolman		x			
Wolfgang Ebbers		x			
Sander Hermsen		x			
Nynke van der Laan		x			
Peter-Paul Verbeek		x			x
Carl Moons			x		
Peter Boncz			x		
Danny Mekic			x		
Hester de Vries			x		
Maartje Schermer			x		
Jan Kluytmans			x		
Bert Jacobs			x		
Anne-Miek Vroom			x		
Elisabeth van der Steenhoven			x		
Bert Wijnen			x		
Patricia Heijdenrijk			x		
Janneke van de Wijgert			x		
Erik Buskens			x		
Jochen Cals			x		
dirk-willem van Gulik				x	
Edo Plantinga				x	
Hugo Visser				x	
Ivo Jansch				x	

Jelle Prins				x	
Philip Brey					x
Rinie van Est					x
Michiel Heldeweg					x
Lokke Moerel					x