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# EXPLORING NOTIONS OF RESILIENCE AND ADAPTABILITY IN THE CONTEXT OF PILOTING A MOBILE APP FOR RISK AWARENESS DURING COVID-19

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**Abstract:** This paper explores notions of resilience and adaptability in the context of the design, development and pilot of a mobile phone application, COVID-Aware, for enhancing risk awareness during the COVID-19 pandemic. Through an interdisciplinary team approach, we explore the utilization of an information and communications technology platform in supporting resilience and wellbeing at the individual and collective levels among community members. The study integrated data models, that were developed in Jamaica to predict the risk of COVID-19, with existing epidemiological models developed for COVID-19 in different parts of the world. Participants' perspectives on adapting to the use of the app on their mobile devices assisted with exploring ways to share visualisations of this data, and their views of adaptations to health protocols provided feedback for participatory development of the app. The use of the mobile application to support risk awareness, assessment and potential choices, and implications for resilience are discussed.

**Keywords:** ICTs, mobile app, COVID-19, risk, data modelling, community, health, adaptation, resilience.

## 1. INTRODUCTION

This study investigates the potential for information and communication technologies to support information sharing to facilitate risk awareness and mitigation of the impact of COVID-19. There have been a number of initiatives globally to develop technological applications to mitigate the spread and impact of COVID-19. Mobile applications have focused on aspects such as contact tracing, digital proximity, travel and border processing, health and safety protocols, vaccination status, and symptom checking. Applications have also been developed to support the transition to virtual modes or enhance activities such as online learning, telemedicine activities, and delivery services. While some technologies developed for the COVID-19 context had a positive impact, others have not been widely adopted and some have generated discussions regarding efficacy and ethical issues of privacy and consent (Alanzi, 2021; Dearden & Klein, 2021; Luciano, 2020). In

addition, considerations related to information technology for development implementations should include reflections on aspects of sustainability, resilience and scalability (Baduza & Khene, 2019). These discussions are important as well in the context of rapid responses to crisis situations such as the pandemic. Furthermore, the direct translation of such technologies into different contexts can be problematic and potentially exacerbate vulnerabilities and inequalities (Qureshi, 2021). This paper explores social and cultural aspects involved in the adoption of risk-mitigating technologies through the development of a pilot application and its assessment by a sample of respondents who participated in the pilot. The app depicts the potential spread of COVID-19 in a community based on the level of observation of health and safety measures such as social distancing.

In the context of the pandemic and related impacts, the importance of resilience-building has been highlighted (Zinser & Thinyane, 2021). With calls for additional research, Heeks and Ospina (2019) explore the existing and potential contributions of ICT4D research to community resilience and e-resilience, highlighting the synergies and role of ICTs in supporting resilience in communities. The research project explores the development of crisis-response technologies that may enhance individual and community resilience, particularly taking into account local practices, social constructs and values. Resilience looks at ways of managing during the pandemic, with the supporting resources and information to inform decisions around the implications for lives and livelihoods, and the societal perspectives on this balance. The role of infomediaries and information sources becomes increasingly critical in supporting resilience (Zinser & Thinyane, 2021).

This interdisciplinary project, which comprised team members from the fields of anthropology, computer science, design informatics, development studies, geography, ICTs for development, and social work, included the development of three distinct activities: one focused on the development of predictive data models, one concentrated on the design and development of an application, and a final one dedicated to qualitative analysis and testing.

A qualitative assessment of people's perceptions of current practices to mitigate the spread of COVID-19 in Jamaica, supported the exploration of ways to integrate data models that have been developed by Mona GeoInformatics Institute (MGI) to predict risk of COVID-19 spread in different areas in Jamaica (models that took the make-up of different communities into account) with existing epidemiological models developed for COVID-19 in different parts of the world, looking at ways to interpret this data and facilitate visualization in the most informative way possible. We developed a mobile phone application to share this information, and have piloted this application with participants from different communities.

As discussed below, while technological solutions can have an impact on mitigating the spread of the COVID-19, as with other technologies that aim to support social change (Pschetz, Dixon, Pothong, Bailey, Glean, Soares & Enright, 2020), they also need to take into account the needs and challenges of the contexts they are implemented in (Tolani, Owoseni & Twinomuruzi, 2020). The pilot of this application was conducted when Jamaica was at the early stages of COVID-19 spread, where dedicated technological solutions could potentially assist in mitigating the number of people affected by the virus. Such solutions, however, can face many challenges, ranging from varying levels of Internet access and data literacy. If carried out without due consideration of constraints, technological solutions may also exacerbate inequalities between characteristics such as demographic groups and geographic locations.

Through social analysis and practical technical experimentations that combine data modelling and prototype testing, we have investigated the potential of a digital tool to mitigate the spread of COVID-19.

The paper proceeds as follows: in the next section we explore related literature. The methodology is then discussed, followed by a presentation of findings, discussion and conclusion.

## 2. RELATED LITERATURE

The significant changes and disruptions that have arisen from the pandemic have resulted in the continued need for ongoing development of mechanisms to support and enhance resilience at the individual, community and societal levels. UNDP Jamaica (2021) has highlighted the importance of risk assessments in informing plans for growth and recovery to support increased resilience. Sakurai and Chughtai (2020) note that resilience entails working towards supporting the entire community or ecosystem, and understanding the diverse contexts, including under-resourced situations. It is further noted that resilience involves being able to handle the effects of disruptions while maintaining the ability to continue core practices and work towards planned goals.

Marais and Vannini (2021) emphasize the role of participatory approaches which consider the local context, socio-cultural perspectives and values. A key to resilience and sustainability also reflects co-design and the dynamics related to the role of the researchers. The importance of efforts to build risk awareness levels during the pandemic has been highlighted, which was seen as a key input in prevention and mitigation strategies (Chatterjee et al., 2020). Applications related to sharing information on risk modelling were being developed and tested (Chande et al., 2020), and ways of visualizing risks in accessible forms were being considered (Padillaa et al., 2021). Representations and interpretations of the visualizations, as well as the level of interactivity and types of device on which the information would be shared, were considered key (Goldberg, Bingaman, Perera & Ranney, 2021). Additionally, data, information and knowledge visualizations have an important role in facilitating knowledge transfer, supported by design considerations for ICTs to support communication (van Biljon & Osei-Bryson, 2020). Some applications have looked at supporting the health sector with information sharing on current policies and protocols (Helou, Waltmans–den Breejen, Severin, Hulscher & Verbon, 2022). Goldberg et al. (2021) further noted the potential impact of the use of health apps to mitigate risks, and the need for further research and development of risk assessment apps in diverse contexts, noting for example issues of technology access and user demographics.

A number of apps have been and continue to be developed to try to support a range of activities in mitigating the spread of COVID-19 (WSIS, 2020). The urgent situation also resulted in the need for rapid analyses of the interventions which can facilitate further development of initiatives (Rowe, Ngwenyama & Richet, 2020). There have been continued calls for the use of ICTs and expertise in epidemiology to support the management of crises and build resilience (Madon, 2005; Sakurai & Chughtai, 2020). The use of apps to support the building of resilience during the pandemic has also been explored (Golden et al., 2021; Nicolaidou, Aristeidis, Christodoulou, & Lambrinos, 2021).

Prosser, Judge, Bolderdijk, Blackwood & Kurz (2020) highlight the role of choice in decisions to observe COVID control and prevention guidelines such as wearing a mask, physical distancing, quarantine and isolation measures. They note that these choices have implications for individual and collective action, and the guidelines that are issued in relation to mitigation practices as COVID-19 measures are eased or further restricted. The role of individual and collective action continues to form part of the discussion on choices to be made for the economy and society in the short and long terms. Manyika (2020) reflects on the historical impact of choices made by societies, the shifting of responsibilities between institutions and individuals and the need for greater collective action and socially inclusive choices. There has been interest in the ways in which options and risks are assessed, and choices are made at the individual and collective levels during this pandemic.

James, Thompson, Chin-Bailey, Davis, Nevins & Walters (2021) noted that in a survey of taxi operators in Jamaica during the pandemic, risk perceptions varied based on the types and number of information sources, including the use of ICTs and social media. U-Report Jamaica, a UNICEF-supported youth platform and messaging tool, carried out a survey about people's perception of COVID-19 in Jamaica with 1,062 respondents, most between 20-30 years old. When asked about which issues they were most unsure or knew the least about COVID-19, most responded "risks and

complications” (22%) followed by “recognising symptoms” (17%), “preventing covid-19” (11%) and “what to do if I have symptoms” (11%). About a third of the youth respondents indicated that they did not feel they were at risk. The survey reinforced the relevance of supporting risk awareness.

### **3. RESEARCH METHODS**

Based on an initial assessment of the context, needs and available resources to work towards mitigation of the impact of COVID-19, through interactions with stakeholders, and a review of current developments, a number of ideas were considered by the research team (see Pschetz et al., 2022). The review entailed identifying existing known or reported initiatives, discussions with stakeholders involved in planned national or community initiatives, and the experiences of team members. Given the considerations related to the potential impact of the use of ICTs to support COVID-19 mitigation, the concept of providing information on the risk of spreading COVID-19 was selected. By combining a data model constructed by Mona GeoInformatics Institute, who were members of the research team, with models derived from the spread of COVID-19 elsewhere, the application would predict the risk of the spread of COVID-19 in different communities based on different potential situations. Individuals could then use the model to access advice that is specific to them and understand how their actions have an impact on their communities. Community leaders could also find opportunities to use the app as a tool and discussion point to visualize and illustrate potential risks.

To streamline the implementation of the defined concept, the team focused on three areas: 1) contextual analysis, 2) development of predictive data models, and 3) design and development of the application interface, as explained below. The research approach reflected considerations in design science for development (Osei-Bryson & Bailey, 2019; Pal, 2017).

#### **3.1 Contextual analysis**

With awareness of both the benefits and complexities of participatory design approaches in engaging and empowering users (Pschetz et al., 2020; Thinyane, Bhat, Goldkind, & Cannanure, 2020), and cognizant of the role of researchers and all participants in the research process (Jimenez, Abbott & Dasuki, 2022), the team explored the best approaches to facilitate interaction virtually with community members and representatives during the design phase due to COVID-19 guidelines. Working with communities, we defined a series of everyday scenarios that may impact social distancing or involve increased social interaction, ultimately increasing the risk of spread of COVID-19. These scenarios aimed to give a more naturalistic basis to define the number of people, proximity, and potential contact points between individuals, which would then be used to create parameters for designing the application. We defined fifteen scenarios that could take place under mild or medium lockdown restrictions, which were: shopping at an outdoor food market, queuing to withdraw money from a bank machine, attending church services, going to a traditional or faith-based healer, going to a community gathering, paying taxes at a tax office, using public transportation, visiting a barber shop or hairdressing activities, caring for the elderly, persons with disabilities and/or children in rural and urban areas, attending dance hall sessions, participating in group sporting activities, attending funerals, going to public wi-fi hotspots to access school material or other data, and joining lines to collect benefits through the Government’s COVID-19 grant assistance programme. We further delineated parameters for people to tailor each of these scenarios. For example, shopping at an outdoor food market could be refined by defining the average number of people present at a given time of day, the average time people spent there, how likely they were to observe social distancing advice, etc.

In addition, we conducted a literature review of ethnographic studies related to cultural and gendered understandings of illness and the body, Jamaican folk medicine, and the anthropology of the state. Frames of analyses from this literature review were set against media analysis of newspapers and responses to the COVID-19 pandemic in Jamaica. This background qualitative information shaped

the development of risk scenarios for the application, and helped us to formulate questions for feedback interviews.

### 3.2 Development of predictive models

The data infrastructure that supported the application resulted from the combination of four different sources:

a) *Determinations of population vulnerability*: based on existing predictive models of risk developed by the MGI. These models took into account the composition of communities in Jamaica through data on population density, age, and occurrence of health issues, such as diabetes and hypertension, to identify groups most at risk;

b) *Infection data*, including the probability of transmission through different levels of contact and the rates of progression through disease states. At the time, the probability of transmission was estimated based on data from China (Verity et al., 2020), and other transitions that had been estimated from world data<sup>1</sup>, and Scotland data (Banks et al., 2020). This allowed us to give the probability of transmission, given contact between an infectious individual and a susceptible individual, and to specify the probability of movement from a disease state at a single time step (notionally, one time step is a day), where these probabilities varied by age group. We used a compartmental model, a common approach in basic epidemiological modelling in which there are various disease-state compartments that individuals move between with specified rates. In our compartmental mode, there were seven states: Susceptible, Exposed, Asymptomatic, Infected, Hospitalised, Recovered, and Dead, as inspired by (Carcione et al., 2020), and similar to the model used by Banks et al. (2020). Susceptible people are uninfected and can catch the disease. Exposed people have caught the disease but are not yet infectious. Asymptomatic and Infected people are able to infect others, and can either progress to a more serious state of illness, i.e. Hospitalised or Dead, or can recover.

c) *Simulation configuration*, which was derived experimentally, based on network-based epidemiological models for COVID-19, according to which the spread of infection doubled over approximately two days. The simulation was run for each combination of app inputs provided; this was saved on datasets as cookies on users' mobile phones.

d) *Input from users*: "community" chosen from a list of communities, "behaviour" chosen from a list of behaviours, e.g. food shopping, which were drawn from a series of scenarios as defined above, "num\_visits": which included "behavior\_name": list of possible values of number of visits per week, and "num\_people".

### 3.3 COVID-Aware interface and visualisation

The mobile phone interface aimed to use the data above to communicate varying levels of risks of spreading/contracting the virus in different communities according to the predefined scenarios. It was designed to be interactive, allowing people to change the parameters of the epidemiological models (input from users above) and visualize how these changes can affect transmission rates. It was expected to be used by anyone, while considering the central role of community leaders who could provide support and advice. This way, the visualisation and parameter inputs would need to be clear and accessible. The application also assumed that phones accessing the application would be connected to the Internet but that this connection could be slow.

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<sup>1</sup> <https://www.worldometers.info/coronavirus/coronavirus-incubation-period/>

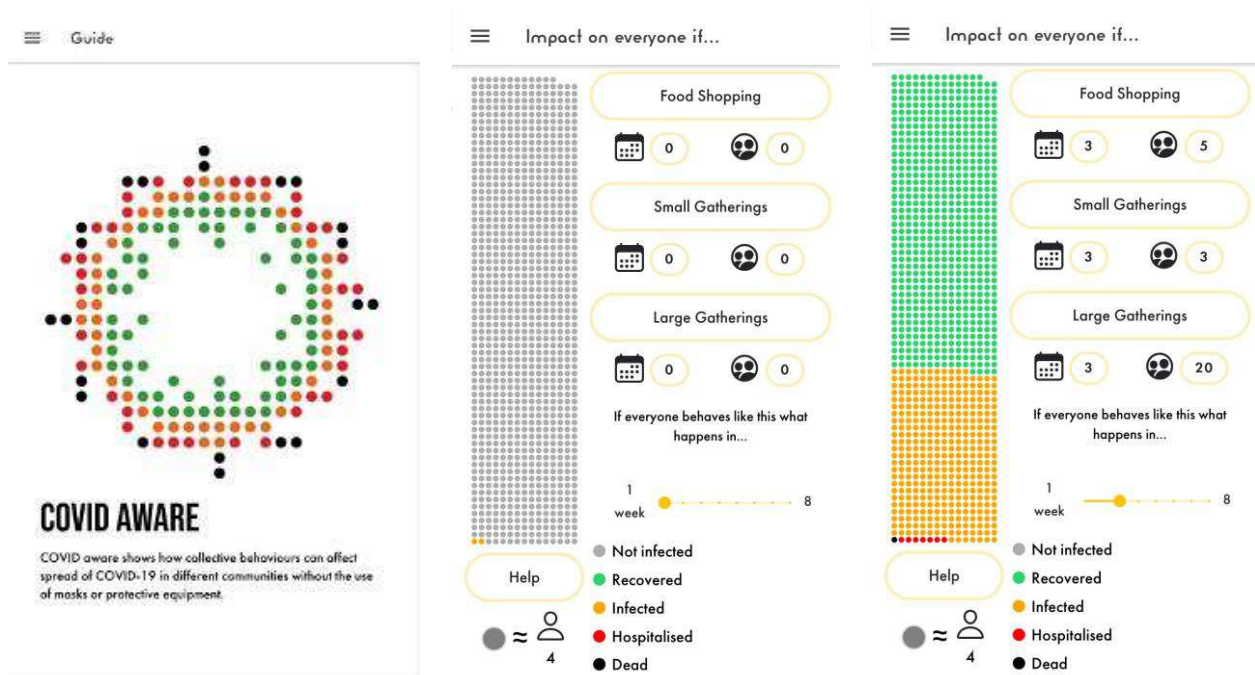


Aspects of digital adaptation were seen in relation to the design of the app, and adjustments that needed to be made during the design phase to accommodate data processing times, minimizing the number of datasets and streamlining the scenarios for visualizations.

Our first step to reduce the number of generated datasets was to generalise the sizes of different communities to small (up to 1,000 residents), medium (from 1,000 to 4,000 residents) and large (over 4000). In this way, when people selected their communities after opening the application, they would be informed about which population size the model was based upon, e.g. “You have selected Community A with a population of 3,878. The model will use the medium sized population dataset.” The system would then take into account the age structure of each community to modify the number of predicted hospitalisations and deaths.

The second step was to reduce the number of scenarios that could be selected in the application. The need to minimise the number of datasets led us to look for ways to cover most scenarios through parameters that could be combined to define a situation as close as possible to real-life. The scenarios were then simplified to accommodate three main input options: food shopping, small gatherings (up to 15 people) and large gatherings (up to 100 people). Within each of these options, people would set how many times each week they thought others would do these activities, and, for each activity, how many people they thought would come within six metric feet of each other. With the restriction to three general scenarios we were able to produce all data for the application to be tested by four communities (generating 2,788 datasets in total, 697 for each community).

Figure 1 depicts screenshots of the COVID-Aware application.



**Figure 1. Screenshots of COVID-Aware Mobile Application**

Wakunuma, Jiya and Aliyu (2021) highlight the socio-ethical implications in relation to the use of technologies for health initiatives, including during the pandemic. In the design and implementation phases of the study, there were a number of ethical considerations. These included the utilization and storage of the data models and qualitative interviews, and the process of interacting with participants given the health and safety protocols and physical distancing measures. The implications of the design of the interface and messages to be conveyed were also considered, as



well as the interview questions, particularly during this time of the pandemic. The interviews were conducted by phone, with initial connections made via phone or WhatsApp. Phone/data credit was provided to participants to assist with accessing the Internet for use of the app. Conducted by phone, interviews explored participants' interpretation of the application and their impressions of the design and functionality, likelihood of sharing app or information with their communities and networks, as well as also social and cultural factors influencing COVID-related behaviours and understandings of risk, such as sources of information, choice options, support networks, household structure, levels of risk perception, preventive practices, and levels of trust. Characteristics of participants are outlined in Table 1 below.

|                        |  |
|------------------------|--|
| Number of Participants | 28 (4 communities; 7 persons each)                                 |
| Gender                 | Female: 16<br>Male: 12   |
| Age Groups             | 19 – 29: 6<br>30 – 39: 6<br>40 – 49: 7<br>50 – 59: 6<br>60 – 69: 3 |

**Table 1. Characteristics of COVID-Aware Pilot Participants**

Interviews were recorded, then transcribed from the recordings, and the research team analysed the transcripts through content analysis exploring reflections on the app's design, content and participants' perspectives of the overall potential of the COVID-Aware app for risk assessment and mitigation towards wellbeing during the pandemic. For this paper, notions of resilience and adaptation reflected in the project were assessed.

#### 4. FINDINGS

In this section we highlight some of the participants' perspectives in relation to the app, the perception of risks during the time of the pandemic, and connect these to the notions of resilience and adaptability.

Reflecting on the information shared in the app, and their existing and new knowledge, participants shared their experiences with adapting to the evolving health and safety protocols, containment measures and restrictions:

*“Yes, it's very difficult.... [it] is going to take a heck of a time to adapt that social distance”.*  
(Participant R2)

*“It is very difficult for you consistently not to embrace, not to shake your hand because most of the time, you who is disciplined. You have to keep putting out your hand, pulling your hand and giving them the elbow or whatsoever. Most of the time you see a friend or what, you put your hand out, you stretch your hand out. We grow up that way”.* (Participant S1).

In some cases, adaptations included adjusting to the move to virtual social interactions. These were also discussed in relation to the research process, which included virtual interactions, and the existing protocols and recommendations, such as gathering limits, depicted in the app.

*“Automatically the human beings [are] social creatures, and because of norms and cultures it's hard to resist....It won't be so easy to stop [gathering] and even the virtual sense of reality now, virtual existence of things now. In reality, some persons don't feel that.”*  
(Participant W2).

Participants shared perspectives on the potential of the app to support education and knowledge sharing towards increasing risk awareness. This would have implications for building resilience and adapting as the context and available information evolved.

*“App useful in educating people what socialising could do in terms of transmissions in community, Good for visualising spread of COVID”.* (Participant A1).

A participant further shared that given the current context, the app could provide useful support:

*“I'm saying in my situation; it will be good for us (the app)”* (Participant D1).

The need for mobility to facilitate necessary activities was highlighted in terms of navigating the adaptations needed. ICTs were seen as a possible means to support carrying out these activities.

*“I would say why? - Let me use myself in that question. I would actually go to the supermarket, supermarket canteens, the cashiers, other employees, other buyers, other customers and all of that so you might -- We have to eat, we have to get something, we have to have food in the house. We have to have - in the sense of we cannot always stay in. Yes, some persons have to also work”.* (Participant C1).

Some of the respondents noted their thoughts on the ongoing risk, and assessment of the risk. The adaptability of the app to reflect scenarios or the selection of scenarios for inclusion was a consideration in the design and participant assessment of the app. One respondent indicated

*“Some people still don't maintain the distance. None of them don't maintain the distance. I don't think the distance has anything to do with it. If you are at a distance, if you have to catch it, you will catch it the same way. If you wear the mask and you still have to catch it, you will catch it the same way. It's just a risk we've got to take.”* (Participant W1).

Having explored the app, participants indicated some areas where they thought the risk awareness assessment would be useful. This would reflect ideas related to adaptability and building resilience in mitigating the effects of the pandemic.

*“Because I don't want to go close to anyone that have the virus and I don't know, because the virus doesn't show on everyone so you don't catch the virus so you have to keep your social distance.”* (Participant T1)

*“Why choose to go to a large gathering? They [are] basically social events, so a lot of them [are] funerals and sometimes they have parties. The restriction is being lifted now, so persons are feeling now more free, so they want to go out and try to feel some sense of normalcy”* (Participant R2).

*“You're saying what you'd want to see-- It would have been nice to have a symptom link or symptom page, so you go on and it says if you have these symptoms, you contact your local authorities”* (Participant C2).

In response to questions related to perceptions of the app, participants shared views of the existing features and the implications for awareness of risks and responses to the risks. The participants' responses reflected continued adaptations to the COVID-19 context, and ways in which the information shared via the mobile app could contribute to enhancing resilience during the pandemic.

*“App useful to learn how one could be infected/infect others when attending gatherings. [My friends] they really think it is a good thing because at least they can use something for a measure of it. Use something as a measurement. Now, what if we are all there? It make them even be more aware. Even my friends when I spoke to about it and they said it's automatic.”* (Participant T1).

*“The app now is useful because every time you think about you remember you're supposed to wear a mask, keep social distance or something like that”.* (Participant A2).

*“It’s a good app and I would say it will help me so I could know that “All right then, if there is 50 persons.” If I come on 50 persons on a daily basis within six feet, I can get affected with the virus and it maybe takes-- Well as far as what the app is showing me, it’s a possibility where you may not live because you have shows that you have deaths, you have recoveries, you have hospitalized. I would say you got-- It will give me and my family a chance to know what can take place or what do take place or what can happen”.* (Participant I1).

*“In the case of-- For instance, COVID-19 itself, again, when I use the app, I think it can help others to really understand the importance of following the guidelines of social distancing and wearing a mask and so forth because for instance, if you are not following the guidelines, you are going to ruin a lot of people exposing yourself to other persons who might be infected with the disease”.* (Participant C2).

*“App very interesting, and it’s informative. I’m glad I really- because I knew COVID-19 was a very deadly virus but I didn’t stop to think about how it could spread and how fast in a period of time. The app was very, very informative and it is an eye-opener”.* (Participant S2).

## 5. DISCUSSION AND CONCLUSION

This paper explores aspects involved in the adoption of risk-mitigating technologies through the development of a mobile application, COVID-Aware, to support information sharing and visualization of health and safety protocols, and the implications for individuals and communities based on the decisions made during the pandemic. Participants’ perspectives on adapting to the use of the app on their mobile devices assisted with exploring ways to share visualisations of this data, and their overall views of adaptations to the health protocols provided feedback for participatory development of the app. Ethical considerations during the research included the work with the data for the app, the approaches to interpretation, presentation and visualization of the data, and the field work conducted virtually with participants using mobile platforms. Throughout the study, concepts of technology adaptations and resilience (both digital and human), and the connections between them in relation to the development of the COVID-Aware mobile app were explored. At a time where there is continued focus on individual and collective responsibilities for managing the pandemic and balancing lives and livelihoods, with some persons expressing the need for additional guidance on safety measures to be adopted in a given context, approaches to visualizing and sharing information can be helpful in mitigating risks. The data modelling and visualization within a community context is also useful for research and practice.

Reflections on the process of design, development and participatory assessment of the COVID-Aware app also illustrate some of the “bounce forward” resilience pre-conditions discussed by Russpatrick, Sæbø, Monteiro, Nicholson and Sanner (2021). The existence of locally developed data models based on community information facilitated the development of the predictive models combined with the epidemiological models for other countries. It is recognized that the ability to respond to the shocks requiring rapid adaptation and innovation also facilitates learning and resilience for future crises or pandemics (Russpatrick et al., 2021).

The continued calls for increasing the messaging and communication around risks, particularly given the length of the pandemic, highlights the considerations around effective use of technologies to support risk awareness as we work towards increased resilience. The resilience of the technology and the users is also a key factor in exploring means of depicting the risks which may provide useful perspectives in the context of the debates on balancing lives and livelihoods within the recommended health protocols.

As indicated by Sakurai and Chughtai (2020, p.591) “Digital technology should be used in a productive and ethical way to develop long-term resilience in society”. This COVID-Aware app, through a multidisciplinary team approach, sought to utilize technology to facilitate risk awareness and measures to mitigate the spread of COVID-19, thereby increasing individual and collective resilience in a development context.

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