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Developing an App for Improving Access to COVID-19 Information in Underserved Communities

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Abstract: The deployment of mobile health (mHealth) apps can transform healthcare in rural and remote communities worldwide. Rural communities in Zimbabwe have limited access to information that affects their health, economic and social being due to structural and social barriers related to the inaccessibility of traditional media. mhealth apps are a valuable tool to monitor disease outbreaks and provide preventative information to the public. Lack of access to COVID-19 information results in high fatalities and public panic, and it is critical to publish reliable and timely information. The study's objective was to demonstrate the utility of a mHealth app prototype developed to enhance access to COVID-19 information in rural and remote communities in Zimbabwe. The prototype provides COVID-19 information such as statistics, preventative measures, self-diagnostics, social distancing information, and general hygiene to rural communities with limited access to official information channels on the pandemic. A design science research methodology was used to design, build and evaluate the COVID-19 mHealth app and fulfil the study's objectives. Thirty potential users participated in the evaluation of the prototype. The evaluation results show that potential users perceived that the prototype was useful, engaging, easy to learn, well designed, and provided relevant information. A strong correlation was observed between the design, engagement, functionality, and learnability. More widespread usability and more representative tests should be conducted to ascertain the efficacy and usability of the app. The study contributes literature on usability studies in developing countries. As more mHealth apps are being developed and deployed, more usability tests will be required to ensure that they are fit for purpose. The paper provides a baseline for developing related health information apps. Policymakers, health practitioners, technologists, and scholars can further investigate the deployment of digital technologies to improve healthcare and control the transmission and spread of COVID-19.

Index Terms: Health Information, Healthcare, Design Science Research, mHealth, COVID-19

1. Introduction and Background

The outbreak of COVID-19 plunged the entire world into a crisis that annihilated health systems and affected other sectors, including education, business, and sports [1]. The world has become a global village, facilitating the increased movement of people and products; this mobility has heightened the spread of COVID-19 [2]. Many countries came up with measures to curtail the gathering of people to halt its transmission and ordered citizens to stay at home [3]. Fragile health systems in developing countries could not contain large-scale humanitarian tragedies and were overwhelmed by the number of dying and sick people [4]. The situation is worse for Zimbabwe, which has one of the world's highest doctor-patient ratios of 1:250 000, coupled with inadequate healthcare facilities [5]. Most rural communities in Zimbabwe have limited access to public media such as radio, television, and newspapers [6]. Ubiquitous technologies can be used in healthcare interventions for disease surveillance and detection and increase access to rapid testing [7].

The significant disruptions in traditional business operations, education, industry, and travel, among others, forced the world to migrate to digital platforms [3]. Thus, information and communication technologies (ICTs) have demonstrated their capacity to sustain most of the significant sections of the global economy and kept billions of people connected to each other during the pandemic. ICTs are critical in poverty reduction, reducing the cost of access to health education and creating new streams of income and diverse jobs [8]. The past decades have witnessed a tremendous fall in the cost of ICT devices, the introduction of diverse and more accessible ways to access the Internet, and the rise of social media resulting in increased access to the Internet.

The growth of mobile phone penetration has been phenomenal, from less than 1 billion people in 2000 to over 7 billion in 2015, translating to a staggering 700% global penetration rate [9]. The World Bank [10] reported that over 40 % of the world's population is connected to the Internet, with more than 70 % of the poorest households owning a mobile phone. Zimbabwe experienced a sharp increase in mobile phone penetration, which surpassed 100 % in 2016, with Internet penetration reaching 59.9 % [11].

The mobile phone is the most significant technological revolution of this century, positively impacting human life. Barutçu [12] asserts that today's smartphone has more computing capabilities than a primary phone. The lives of many people in low-income countries have been transformed by mobile phones, as they can now access digital services that affect their daily lives. Cheap Andriod phones have improved mobile phone ownership in developing countries. The decrease in mobile Internet costs has created new possibilities in harnessing its potential in enhancing access to health services in rural and remote communities. The World Bank [10] reports that most people in developing countries prioritised the acquisition of mobile phones over sanitary facilities. Thus access to a mobile phone is more critical as most households have no access to clean water and toilets but have multiple mobile phones [10]. Electronic or mobile health (mHealth) technologies have blossomed and deployed in developed countries to complement service delivery, management of diseases, and dissemination of health information to the public [13]. Access to healthcare is a challenge for most people in the developing world due to limited access to health facilities, lack of financial resources, high patient to doctor ratio, unavailability of reliable transport, and limited healthcare information.

The mobile phone presents significant opportunities for real-time healthcare access compared to other devices such as the fixed computer, in that information can be delivered to the owner at any time and place as people carry the phone wherever they go. The mobile phone's ubiquity and low cost can improve access to healthcare by eliminating barriers associated with distance, lack of facilities and saving many lives in remote and rural communities. Remote health access has been supported by voice and text through short message services in the past, but access through apps has increased [14]. The widespread use of mobile apps covering edutainment, social media, shopping, and healthcare has drastically affected our way of life, making smartphones the most sought-after device [15]. Mobile apps provide low-cost access to high-quality healthcare services without time and location constraints.

The uptake and use of contemporary technologies to support healthcare in low-income countries have not significantly developed compared to high-income countries. Persistent barriers such as inadequate infrastructure, financial resources, and lack of skills have denied low-income countries to fully benefit from some of the benefits offered by digital technologies. Developing countries face barriers in deploying mHealth apps such as infrastructure, lack of access to equipment and the technology gap [16]. Mobile phones promise access to reliable information in real-time across commerce, education, and healthcare. While the least developing countries have begun adopting mobile apps, developed countries have long since adopted complex technologies such as big data, the Internet of Things, wearables, among others, to enhance healthcare. Wearable devices collect biometric information such as heart rate and body temperature and aggregate physiological data to improve human health [17]. The use of video, geo-targeting and access to vast amounts of up-to-date information promises to transform healthcare.

Mobile wireless technologies have revolutionised healthcare across many nations through personalised management of individuals' health. mHealth refers to delivering public or medical health through handheld devices such as mobile phones, wearable devices, and other mobile wireless devices. mHealth has transformed healthcare by increasing access to healthcare information, improving healthcare provision, and assisting in curbing and monitoring the outbreak of diseases easily.

mHealth improves the efficiency of accessing health information, ultimately increasing knowledge of diseases and conditions that affect the public, improving physician and patient communication, and seamlessly coordinating operations for better healthcare outcomes [18]. Pankomera and van Greunen [19] note that mHealth has transformed the exchange of information between healthcare providers and patients, resulting in improved healthcare services, especially for developing countries with fewer resources and limited healthcare support. mHealth applications offer several advantages such as reduced costs incurred by patients and healthcare providers, shorter time to diagnosis, monitoring patients remotely from home, reduced healthcare costs when admitted, and lesser visits to the healthcare facility [20].

The developing world must develop apps to serve their local needs; otherwise, the health disparities will continue to increase between developed and developing countries. Increased access to mobile phones in developing countries should improve communication between the public and healthcare workers on COVID-19 guidelines. Technology-enabled initiatives to fight COVID-19 in Africa have been low, with South Africa, Kenya, Nigeria, and Rwanda leading through contact tracing apps, chatbots, robotics, 3D printing, and other ICT enabled initiatives [21]. This study contributes to the literature on improving access to health information in low-income countries through the development of the COVID-19 information app.

In developing countries like Zimbabwe, the healthcare system is manual and paper-based; mHealth adoption will spur healthcare institutions to adopt electronic-based systems for interoperability. Once healthcare workers and patients start using mHealth, this will automate some of the manual systems such as referrals and bring efficiency. The study is motivated by Maramba [22], who highlighted that despite an increase in app development, reporting on the usability of these apps has decreased. Knighton et al. [23] concluded that populations with low economic status correlated with low health literacy. The study aimed to develop and evaluate a mHealth mobile app that can enhance access to COVID-19 information in rural and remote communities. Adopting digital platforms during COVID-19 will widen the digital divide, and other inequalities experienced by rural communities; developing this app will bridge the divide and improve access to COVID-19 information. The findings can be helpful to mobile app developers and contribute to app development and usability literature.

2. Literature Review

The mobile phone is one technological innovation that could flatten the digital divide and enable many African people to connect to the transformative information superhighway. The digital revolution affects every sphere of human life, including improving access to healthcare. Barutçu [12] noted that mobile phones have considerably impacted medical health through innovative means for providing healthcare services, managing disease, and information dissemination. Senteio [24] posited that advancements in mobile phone technology led to the development of wearable devices, smartphones, and cellular networks, improving access to health information that helps manage chronic diseases. McKay et al. [14] assert that the increase in the development of mobile apps has allowed health information to be transmitted at a lower cost using multimedia-rich tools compared to the previous text and voice-based approaches.

Oluocha and de Keizer [25] noted an increase in the remote exchange of information between caregivers and patients in developing countries due to increased mobile phone ownership that supports video-conferencing through improved Internet access. Telemedicine allows rural and remote communities to access healthcare specialists for diagnostic and consultation, just like their urban counterparts. About 96 % of participants in a study conducted in the USA agreed that mobile phones would provide core healthcare support and routinely support clinical care [26]. Lack of ICT skills by health workers, high Internet tariffs, intermittent network signals, and telemedicine equipment cost hampers its full scare deployment in rural areas. Ogunkola et al. [27] noted that rural communities' lack of access to health information results in ill-informed decisions, resulting in deaths, which shows the great need for telemedicine in Africa. For rural and remote communities in Zimbabwe, characterised by a poor road network and an unreliable transport system, telemedicine promises to improve access to healthcare services and avert the need for patients to travel. mHealth has brought convenience to the patient and improved their relationship with the physician as they can do consultations, book appointments, and consult on other health issues [28].

The number of smartphone ownership continues to rise, fuelling the growth of the mobile app market. Over 6.378 billion smartphone users represent over 80% of the world's population [29]. Knighton et al. [23] concluded that there was a correlation between low socioeconomic status and low health literacy. Lack of health information prevents individuals from making informed healthcare decisions [30], and limited access to healthcare and information during the outbreak of the COVID-19 resulted in massive fatalities.

There is a rapid development of apps almost covering every domain, and Google Play has over 2.8 million apps and over 1.9 million apps in Apple App Store [31]. Levine et al. [32] reported a whopping 40 % of all apps targeted healthcare. There was a 50% increase from 3.668 billion app users in 2016 to 6.378 billion [31]. Industry experts report that mobile app downloads exceeded 218 billion in 2020, implying an average of 31 apps per person [33]. The mobile app industry will generate over $US77 billion when over 268 billion mobile apps are downloaded, making apps the most preferred computing device globally [34]. In the first half of 2020, health apps increased by 60%, as many people spent their time isolated in their homes due to COVID-19 and accessed medical care remotely [33]. As individuals spent their time isolated in their homes, they relied on fitness, health, and other medical apps.

Providing authentic sources of information is critical in containing the spread of COVID-19. Over 67 % of the Zimbabwean population is rural, with limited access to public media such as radio, television, and newspapers [6]. Most rural communities in Zimbabwe have limited access to official communication related to COVID-19. Like many African countries, mobile penetration in Zimbabwe increased significantly, reaching 102.7%, while internet penetration reached 50.8% [35]. High mobile phone penetration will enable more people to access education, entertainment, communication, and healthcare; thus, rural communities of Zimbabwe can fully utilise the mobile app in the absence of all other information dissemination platforms such as newspapers, radio, and television.

Mobile phone-based solutions are ideal as many people in Africa and the developing world do not have access to conventional computing devices [36]. The app's development presents an opportunity to avail healthcare information and reduce the digital divide. This is in line with strategies formulated to contain the spread of the coronavirus by using digital technologies [37]. Barutçu [12] notes that apps enable health practitioners to track diseases and disseminate health information with minimal effort. With their broad penetration in societies, smartphones and other forms of mobile technology have become a key component in communication throughout the world, serving as an effective tool to collect data and disseminate critical instructions and information during worldwide crises such as the current pandemic [2]. There are significant barriers to using health apps, such as lack of digital skills, small device screens, the cost of data, and the inability to understand the potential of apps in health care improvement.

Singh and Landman [38] described mHealth as the use of mobile and wireless devices to improve healthcare quality. Senteio [24] contended that mHealth improved health care by quickly monitoring and sharing information, which improves disease management. Mosa et al. [39] categorised the mHealth apps into those that provide information on disease diagnosis, chronic illness disease management, databases to search medical literature, access to hospital information systems, general information to the public, and training content for medical students.

Several apps emerged in developed countries to help citizens screen themselves for possible COVID-19 symptoms by asking self-assessment questions [40]. The COVID-19 vaccination and passport apps have been adopted across 30 countries, with the CovPass having 7.1 million downloads in six months, while the CoronaCheck had two million downloads [33]. Several countries such as China, Israel and Singapore instituted mandatory contact tracing and social distancing using apps [41]. One popular app, the CoyTracer, was deployed to protect Singapore's frontline workers and critical health personnel by determining safe quarantine paths [42]. In enforcing quarantine, geofencing apps have been developed and use the global positioning system to detect the phone's location, track the patient's movement, and notify officials of any violations [43].

In many developed countries, artificial intelligence-enabled wearable devices are used to detect and lower the spread of COVID-19. Smart health bands, smart boots and smart garments are used for contact tracing, location detection and temperature tracking for COVID-19 screening and social isolation [44]. Health experts argue that the deployment of mobile apps assisted the Chinese combat COVID-19. Zhou et al. [45] noted that mobile apps were used to suppress the spread of COVID-19 in China through contact tracing and dissemination of information that curtailed movement and promoted behavioural changes.

In improving healthcare provision, a South African local app called Vula Mobile is freely used to link on-call specialists with primary healthcare providers [46]. The iPhone has an inbuilt COVID-19 screening app available to all iPhone users; through a series of questions, the app can identify if the user has COVID-19 related symptoms and make recommendations [47]. Germany launched the Thryve, a smartwatch app for monitoring the spread of COVID-19 by gathering temperature, pulse, and other flu-like symptoms from volunteers wearing the smartwatch [48]. Another COVID-19 app MySejahtera is being developed in Malaysia for monitoring symptoms and providing hotline numbers [49]. Wallis et al. [50] suggested that developing countries could use mobile phones for coordinating communication and reporting COVID-19 related information. Most of the apps presented communicate behavioural change information to help monitor the spread of COVID-19.

In many developing countries, broadband access is limited, the cost of data is prohibitive, and lower digital skills may inhibit the adoption of mHealth apps. In 2019, Zimbabwe had the most expensive data costs at US$75.00 for 1GB of data [51]. The mobile phone infrastructure in Africa is expansive but not yet resilient and reliable, and in some countries, there is a lack of skilled developers and technical maintenance skills, which slows down the implementation of mHealth projects [52]. Scholars report that SMS-based interventions are prevalent because it is cheap and easy to send and receive text messages, and they also work on every phone [53,54].

mHealth implementation is without challenges; Poushter [53] reports that data privacy is a major concern as people share smartphones in developing countries leading to leaking private health information. mHealth apps access detailed medical records of identifiable patients, which raises confidentiality questions when data is breached, and a lot needs to be done to safeguard the patients. There is a need to design medical health information systems that are interoperable with mHealth apps to ensure seamless interchange of information for the benefit of the patients [54].

3. Methodology

This study adopted the Design Science Research (DSR) methodology, a socio-technologist paradigm associated with pragmatism as its philosophical orientation [55]. Pragmatists consider the real practical effects as the components of meaning and truth. The DSR methodology was chosen because it supports designing, building, and evaluating information systems. The study aimed to improve access to COVID-19 information by underserved communities through a mHealth app. Vaishnavi and Kuechler [56] described DSR as a problem-solving approach that creates new knowledge by building and evaluating artefacts that respond to current challenges faced by communities. Building artefacts and testing their utility is a knowledge accumulation process associated with DSR [57].

The primary output of a DSR is an artefact that is produced through creative problem-solving activities. DSR focuses on finding a solution to a real-life problem, and its core processes are artefact building and evaluation [55]. The DSR was chosen because it supports participatory and iterative development involving potential users, thus increasing its adoption. The DSR is appropriate for this study because it creates and evaluates artefacts to address existing organisational problems [58]. This paper focuses on developing a COVID-19 mHealth app prototype to enhance access to health information in rural and remote communities. After the development, the app prototype was evaluated to determine the perception of potential users regarding its usability and efficacy.

4. Design and Implementation

The design activity involves demonstrating the process of transforming the research objective into an artefact. The study's domain was evaluated, and steps taken to build the artefact are demonstrated from building to evaluating its usability. As the world battles with the COVID-19 pandemic, the public is more eager to access information related to available drugs, the spread of the infection, mortality rates, and hospitalisation statistics [59]. The rapid development of mobile apps that many governments supported in developed countries during the COVID-19 pandemic provided access to credible information promptly. The study analysed available COVID-19 apps. The majority of the available apps offered advanced features such as detecting and reporting symptoms associated with COVID-19 and using the phone's Bluetooth to track users who came within the phone's radius and could have transmitted or acquired the coronavirus. These apps do not provide local and national information and therefore cannot be used to their full potential by Zimbabweans. In response to limited information sources in most rural communities, the prototype provides access to information related to the COVID-19 pandemic and is written in simple language to enable most of the population to understand.

A three-stage DSR was utilised to implement the study's objective. The first stage of a DSR approach is problem awareness or problem identification. Gregor and Jones [60] point out that a systematic literature review of the current problem and new developments in the domain help ground the development of the proposed artefact. The problem awareness phase is also known as the relevance cycle, and it provides an overview of the domain research problem and links it with the environment. As stated earlier, rural and remote communities in most rural districts in Zimbabwe have limited access to information due to the unavailability of traditional media such as radio, television, and newspapers. Communities face challenges in accessing credible and up-to-date information related to COVID-19.

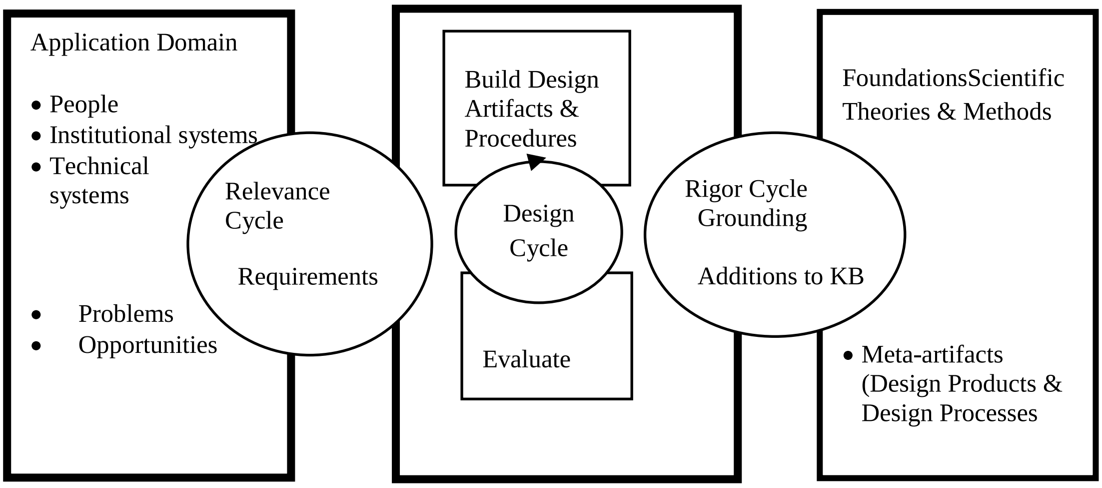

Fig.1. Three cycle Design Science Research [55]

During the building phase, the requirements are translated into a tentative design that should address the problems that have remained unsolved. The creation and evaluation of artefacts are central to any DSR approach [61]. To address information access challenges, the researcher developed a mobile phone app that enhances access to COVID-19 information. The researcher evaluated current solutions to ensure that the proposed solution will be most appropriate for the needs of the rural communities. The researcher developed the app in August 2020 by incorporating user feedback.

The app prototype provides information such as COVID-19 symptoms, a self-assessment tool, preventative measures, statistics on the number of people infected, recovered, and those who have died from COVID-19, and contact information for medical care as shown in fig 2. The app provides brief background information on COVID-19 and the guidelines that should be taken to prevent infection. The app allows the public to conduct self-assessment and self-diagnosis based on questions that check for the most common symptoms, such as severe cough, muscle pain, and fever. Adopting this app will help in decongesting the few available health centres. Mobile apps developed for rural communities must be easy to learn and use. This was achieved by using consistent and clear icons, buttons, and a simple navigation system. The background and foreground were contrasted to ensure that the text was easy to read. The app supplements information sources, and the community can voluntarily download the app to access COVID-19 information.

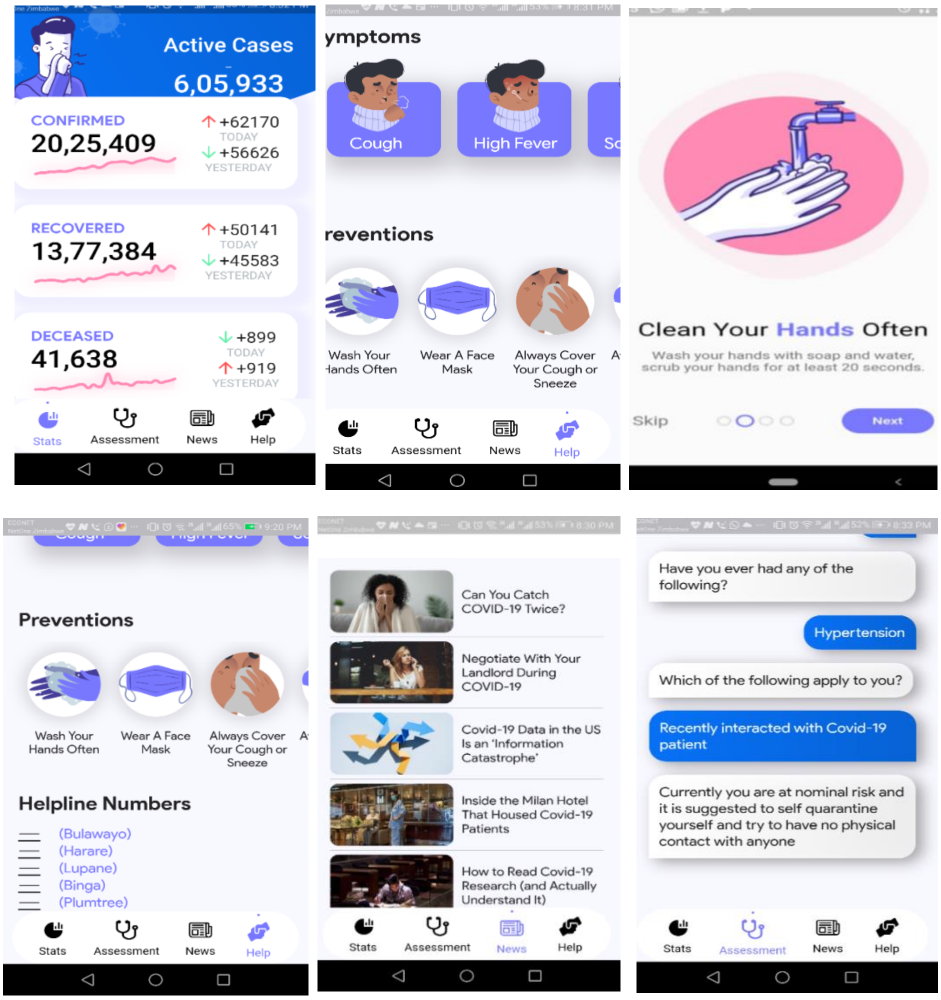

Fig. 2. Showing the different screens of the app

4.1 *Participants*

Thirty participants were recruited from the rural community to evaluate the prototype for two weeks in September 2020, 18 were female, and 12 were male, as shown in Table 1. The average age of the participants was 35 years, and all the participants had post-secondary education. Five participants were medical personnel working in rural clinics. All the participants owned an Android-based smartphone and frequently used various apps installed on their smartphones.

Table 1. Demographics of the participants

Demographic variables	Demographic variables values
Gender	Male (40 %), Female (60%)
Age	Mean 35; range 19-55 years
Qualification	High school (80%), Undergraduate (20%)
Experience in using mobile apps	Mean = 3.5 years, range 1-6
Occupation	6 Community Health officer; 10 Members of the public; 5 Students; 4 Teacher; 3 Nurse; 2 Pharmacist
Mobile platform	All Android

4.2 *Instrument*

After building the artefact, Gregor and Jones [60] assert that it should be evaluated to ensure that it meets the users' requirements in solving a particular problem. Some performance evaluation matrix is adopted to test the artefact [62]. The matrix could be the artefact's effectiveness, utility, and efficiency in solving the stated problem. The study used a usability matrix designed by Nielsen [63], covering design, functionality, engagement, satisfaction, and learnability to evaluate the prototype, as shown in Table 2. A 20-item questionnaire instrument was used for evaluation, with the first part covering the participant's demographic information and device ownership, and the rest used a Likert scale: 1 – "Strongly Disagree" to 5 – "Strongly Agree" to assess the level to which participants agreed with the usability item being measured.

Table 2. Five usability attributes [63]

Attribute	Properties
Learnability	The app is very simple to use
	Information provided by the app is easy to understand
Memorability	The organisation and flow of screens is clear
	The app is easy to remember
Engagement	The app made locating it easy to locate the information I required
	It was quick to respond to the questions and complete tasks
Satisfaction	The graphics and icons are well designed The app provides all the information that I expected
Functionality	The app performs as expected with few errors detected
	It was easy to find my way after the error

The usability attributes are briefly explained below:

- Learnability: Potential users should use the app with ease because the content is readable, easy to accomplish, and understand.
- Memorability: In between task breaks, users should remember the last task they performed and continue because of simple navigation and arrangement of screens.
- Engagement: Users feel satisfied and sustained while using the app
- Satisfaction: The app meets the user's expectations and desired functionality.
- Functionality: The app performs as expected with very few errors

4.3 Reliability

The instrument's reliability and internal consistency were measured using the correlation coefficients of the main constructs, as shown in Table 4. Cronbach's alpha estimates the extent to which multiple items measure the same factor. The minimum acceptable value for the instrument's reliability is 0.7 [64]. Every construct was positive and statistically significant in this study at $P<0.01$. The Cronbach's alpha coefficients were positive, ranging from 0.82 to 0.95, indicating the instrument's high reliability and internal consistency. The high values also indicate that the constructs are measuring some common factors.

Table 3. The study's construct values for the Cronbach's alpha

Attribute	Cronbach's alpha	Number of items
Learnability	0.82	4
Memorability	0.87	3
Engagement	0.88	4
Satisfaction	0.91	4
Functionality	0.95	5

5. Results

Participants were asked to evaluate the app after navigating through the different screens as guided by usability attributes in Table 2. The results reveal that most of the participants "strongly agreed" or "agreed" that the app provided the desired functionality (92 %). Similarly, Hussain et al. [65] found that over 80% of the participants found a smoking cessation app very functional. In rating the prototype's design, 90 % of the participants agreed that the app design was good. Three-quarters of the participants agreed that the prototype was easy to learn, and 80 % believed the app provided appropriate content regarding COVID-19. In a related study, Khalil et al. [68] observed that about 80% of the participants found an educational app very easy to learn. Regarding the app's memorability, 78 % of the participants agreed that the app was easy to remember, and its screens were clearly flowing.

Furthermore, most of the participants (85 %) agreed that the app was engaging. Table 4 shows a strong Pearson correlation of 0.78, $p< 0.001$, that was observed between design and engagement. The significant positive correlation means that the prototype was designed well and has features likely to engage users. Learnability and functionality have a significant positive correlation of 0.71, $p<0.001$, meaning that a very functional systems encourage users to learn. Another significant positive correlation of 0.67, $p<0.001$, was observed between engagement and memorability. Thus, the app is likely to engage users when the design and organisation of content flows and is easy to remember. Results show that the app's design features influence its functionality with a significant positive correlation of 0.73, $p<0.001$. The observed correlation between functionality and memorability was average (0.53, $p<0.001$), which means a marginal relationship between the two variables was observed. A significant correlation of 0.69, $p<0.001$, was observed between memorability and learnability.

Table 4. Pearson's correlation coefficients

Scale	Engagement	Design	Memorability	Functionality	Learnability
Engagement	-	0.78	0.67	0.56	0.46
Design	0.78	-	0.42	0.73	0.51
Memorability	0.67	0.42	-	0.53	0.69
Functionality	0.56	0.73	0.53	-	0.71
Learnability	0.46	0.51	0.69	0.71	-

6. Limitations

Lack of specialised laboratories limited the evaluation to a field test. The app's limitation is that it was developed for rural communities with no Wi-Fi access and may struggle to buy data and face network challenges due to intermittent power and load shedding. Smartphone ownership in rural areas may be lower than in urban areas. The results have low statistical power since a small sample was used for usability testing, which will affect the results' generalisability.

7. Conclusion

The study aimed to develop and evaluate a mobile app prototype for disseminating COVID-19 information in communities without access to traditional media. Fighting the COVID-19 pandemic requires the implementation of country-specific settings in line with the World Health Organisation recommendations. The theoretical contribution of a DSR study is the development of an artefact or its instantiation [55, 62, 57]. This study also contributes to the literature on app development in resource-constrained environments. The immediate contribution of the study is improved access to COVID-19 information by rural communities in Zimbabwe. The iterative development process can be adopted in developing and evaluating related mHealth apps. Usability and evaluation results provide a benchmark for developers engaged in similar work in future. The paper's objectives were realised by developing and evaluating a mHealth app that could improve access to COVID-19 information in rural and remote communities. The development of this prototype can help bridge this information access divide and save lives. Results show that the app provided a source of reliable information. Evaluation results show that potential users perceived that the prototype was engaging, easy to learn, designed well, functional and provided relevant information. The results show a strong correlation between design, engagement, functionality, and learnability. The study demonstrates the prototype's potential to be deployed in remote and rural communities to improve access to COVID-19 information.

The study recommends that policymakers and health practitioners advocate for zero-rating health-related information websites as data costs remain a deterrent when accessing healthcare information. In the future, mHealth apps should export and import data and seamlessly interconnect with healthcare systems. Blockchain technology should be adopted in healthcare infrastructure to link disparate healthcare data. The integration of the app with the national health information system to capture the user's health status can improve healthcare outcomes. The app was evaluated in one location by a small number of participants, which affects the generalisability of the results. The study provides an opportunity for policymakers, health practitioners, and technologists to investigate further the deployment of digital technologies to improve healthcare and control the transmission and spread of COVID-19. The app can be further developed to ensure that it is more usable and addresses the users' needs.

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