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COVID-19 CONTACT TRACING AND TRACKING

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ABSTRACT

The recent outbreak of COVID-19 has taken the world by surprise, forcing lockdowns and straining public health care systems. COVID-19 is known to be a highly infectious virus, and infected individuals do not initially exhibit symptoms, while some remain asymptomatic. Thus, a non-negligible fraction of the population can, at any given time, be a hidden source of transmissions. In response, many governments have shown great interest in smartphone contact tracing apps that help automate the difficult task of tracing all recent contacts of newly identified infected individuals. However, tracing apps have generated much discussion around their key attributes, including system architecture, data management, privacy, security, proximity estimation, and attack vulnerability. The use of Covid-19 contact tracing applications is close to be unheard of in Nigeria. We are far behind in leveraging on mobile app technology to combat the continued spread of this deadly virus. This project proposes a mobile app solution that provides adequate information to the contacted victims and as well warns the non-contacted of the dangers of leaving home without their kits.

KEYWORDS: Covid-19, covid-19 contact tracing, contact tracing apps, coronavirus, mobile app, covid-19 alert.

INTRODUCTION

Contact tracing is a fundamental containment strategy in response to emerging outbreaks. Public health agencies aims to rapidly identify individual who may have been exposed to a person who is infected to recommend the most appropriate course of action (e.g., self-isolation, symptom recording, and testing). The incubation period of this virus can last up to 14 days, during which infected individuals can unsuspectingly contaminate others. Pre-symptomatic transmission along with other epidemiological, social, economic, and political challenges, coupled with chronic underfunding of public health systems, have undermined the reach of manual contact tracing during the COVID-19 pandemic. Contact tracing is the process of identifying, assessing, and managing people whom been exposed to a disease, to prevent onward transmission.

This process follows risk stratification concerning the infectiousness of the index patient, the duration and proximity of exposure, and the susceptibility of the contact. More important the screening includes evaluation for possible COVID-19 with a symptom's questionnaire (e.g Fever, dry cough tiredness, aches and pains, sore throat, diarrhea, conjunctivitis, headache loss of taste or smell, a rash on skin, or discoloration of fingers or toes, difficulty breathing or shortness of breath, chest pain or pressure) and chest radiography WHO (2020).

The current Manuel contact tracing and screening activities in Nigeria, supported by modern information technologies through use of mobile phone and text communication with possible Coronavirus contacts. The ability to rapidly collect and access high quality data presents a notable benefit of the proposed system. The proposed COVID-19 contact tracing in general aims to identify individuals who may have had contact with COVID-19 patient. Tracing people whom exposed to Covid-19 is an important step in winding down socially and economically crippling lockdowns. Manual tracing is resource-intensive and ineffective. A number of countries, including Singapore and Australia, have adopted smartphone apps for tracing Covid-19 cases.

Despite these advancements in technology that can improve COVID-19 Contact tracing, the Nigeria Centre for Disease Control has fallen short in adopting them. It is on this note that the study is undertaking to establish an effective and efficient way of contact tracing using mobile application system. The study aimed at incorporating USSD and Android technology in contact tracing and screening activities in order to target a larger population of Nigerians and improve Covid-19 contact tracing in Nigeria.

1.2 STATEMENT OF THE PROBLEMS

Ever since discovered in China in 2019, Covid-19 has become a global pandemic, wrecking livelihood of individuals and communities across the world. Every country and city has tasted from the rage of this deadly disease, with millions of lives claimed and tens more rendered helpless. The problems initiated and powered by this pandemic as highlighted below:

I. Structural negligence of healthcare infrastructure across all spectrums throughout the federation as a result of decades of underfunding by all tiers of government in Nigeria, inadequate testing equipment, inefficiencies in data collection and reporting COVID-19 patients and their contacts.
II. A lot of people are afraid of taking the available vaccines, thus making the containment of this deadly disease very hard
III. The deadly virus has threatened the mental and physical health of children and the grown-ups significantly
IV. It has resulted into death due to the lack of peer contact that has been placed upon the people of all ages by the government's Covid-19 containment procedure
V. The continued existence of Covid-19 is causing the risk of parental and mental illness, domestic violence and child maltreatment
VI. Quarantine-related mental health problems include depression, low mood, irritability, insomnia, anger and emotional exhaustion are among the significant problems that Covid-19 is causing.

1.3 AIM OF THE PROJECT

This project work aims to design and implement a mobile application for Covid-19 contacts tracing using a suitable programming language, framework, libraries and design paradigm that all work together to bring about a working system.

1.4 OBJECTIVES OF THE STUDY

The primary objective of this project work is to map, analyze design and implement various works, studies and components required on the design and implementation of COVID-19 contact tracing apps. In a detailed sense, the objectives listed below:

I. To study, examine and implement how the automated Coronavirus patient contact tracing using mobile application can be used to curtail the spread of COVID-19
II. To study the related works, models and researches on Covid-19 contact tracing and examine the limitations of the existing solutions
III. To reduce the spread of the deadly corona virus disease
IV. To improve the effectiveness of containing the deadly virus
V. To help the public to be informed of the covid-19 heat map locations
VI. To help Nigerians in reporting early signs of covid-19 symptoms

1.5 RESEARCH METHODOLOGY

The research uses a waterfall methodology in developing the mobile application. As the feasibility of the project have been checked, then choosing the process that would best fit to realize the project with time and requirements constraints is being carried out. Foremost, the existing solutions (such as the effects of lockdowns and curfews in combating the spread of Covid-19 in Nigeria) as examined. While the limitations of the existing solutions meant to overridden, their objectives of reducing the spread of the virus as envisioned to be included in this project, hence, prompting for a complete requirements analysis. Following the above steps is getting the non-functional requirements of the project. These will work hand-in-hand with the functional requirements, part of which is the user interface of the application, through which the users can access its functionalities. The design phase would be the next step and used in Android platforms

On the implementation side, this project brought to life using the most popular mobile app development programming language out there; Dart alongside the leading framework today; Flutter. Google Firebase acts as the central server for file storage as data and information will be stored and retrieved in form of JavaScript Object Notation (JSON). GetX is another important library in developing the Covid-19 contact tracing mobile app. It helps with routing and route management. As well, it makes arguments and state management easily compared to the traditional Flutter way.

1.6 SIGNIFICANCE OF THE STUDY

This project will demonstrate how to reduce the spread of Covid-19 disease by alerting people whenever they are closer to a person that has contacted the disease. The Covid-19 contact tracing mobile application can help Nigerians avert contacting the disease and combat it from spreading even more as it alerts them whenever there is a potential danger. Having compared the existing solutions, this research work will bring about a mobile application that overrides the weaknesses of the existing ones. It has academic advantage of helping me and other interested students in developing interest and perfecting their passion for software programming.

1.7 SCOPE OF THE STUDY

This research specifically focused on COVID-19 contact tracing methods currently in practice in Nigeria based on the guidelines developed by Ministry of Health and international guidelines laid down by World Health Organization. The study is limited target users included COVID-19 health workers, Coronavirus contacts. The deliverable of this research was a mobile-based system and a web application. This involved development of an Android application, which allows health workers to trace COVID-19 contacts, and a USSD application, which enabled the COVID-19 contacts to screen their symptoms and risk factors. The web dashboard allows display and presentation of the various analytics and reports as collected from the Android and USSD applications

2. LITERATURE REVIEW

Coronavirus disease 2019 (COVID-19) is caused by the SARS-CoV-2 virus, and spreads from person-to-person through droplet and contact transmission. To control the spread of COVID-19, interventions need to break the chains of human-to-human transmission, ensuring that the number of new cases generated by each confirmed case is maintained below 1 (effective reproduction number < 1). As part of a comprehensive strategy, case identification, isolation, testing and care, and contact tracing and quarantine, are critical activities to reduce transmission and control the epidemic (WHO report, March, 2020).

Contact tracing is the process of identifying, assessing, and managing people who have been exposed to a disease to prevent onward transmission. When systematically applied, contact tracing will break the chains of transmission of an infectious disease and is thus an essential public health tool for controlling infectious disease outbreaks. Contact tracing for COVID-19 requires identifying persons who may have been exposed to COVID-19 and following them up daily for 14 days from the last point of exposure. (Abeler, J., Bäcker, M., Buermeyer, U., & Zillessen, H. (2020).)

Critical elements of the implementation of contact tracing are community engagement and public support; careful planning and consideration of local contexts, communities, and cultures; a workforce of trained contact tracers and supervisors; logistics support to contact tracing teams; and a system to collate, compile, and analyse data in real-time. (Cheng, H. Y., Jian, S. W., Liu, D. P., Ng, T. C., Huang, W. T., & Lin, H. H. (2020).)

For contact tracing to be effective, countries must have adequate capacity to test suspect cases in a timely manner. Where this is not possible, testing and contact tracing strategies may instead focus on specific high-risk settings with vulnerable individuals, such as hospitals, or other closed settings. Because individuals may transmit COVID-19 while pre-symptomatic or asymptomatic, this guidance also emphasizes the importance of quarantining contacts to further reduce the potential for secondary transmission. (Robert Koch Institute, June 16 2020.)

2.3 EPIDEMIOLOGICAL SCENARIOS

Contact tracing preparedness, readiness and action will depend on the four main transmission scenarios:

1. **No cases:** a well-trained contact tracing workforce should be identified, trained and on standby ready to respond to first cases.
2. **Sporadic cases** or **clusters: exhaustive** contact tracing is essential for rapidly suppressing transmission.
3. **Clusters**: contact tracing is essential for suppressing transmission and reducing transmission within clusters.
4. **Community transmission:** contact tracing may be difficult when transmission is intense but should be carried out as much as possible, focusing on household contacts, health care workers, high-risk closed settings (dormitories, institutions, long term-care homes), and vulnerable contacts, as well as maintaining strong contact tracing capacity in areas with smaller clusters of cases.

When countries have passed the peak of transmission and case numbers are decreasing, and particularly when rigid public health and social measures are being adjusted, rapid identification of cases and contact tracing are critical to maintain low levels of transmission and rapidly identify and break new transmission chains.

2.4 STEPS IN UNDERTAKING CONTACT TRACING

The definitions of suspect, probable, and confirmed COVID-19 cases have been published here. Contact tracing is essential to be conducted for all confirmed cases and may be desirable for probable cases in the absence of comprehensive testing capacity.

1.) Defining contacts

A contact is defined as anyone with the following exposures to a COVID-19 case, from 2 days before to 14 days after the case's onset of illness:

I. Being within 1 metre of a COVID-19 case for >15 minutes;
II. Direct physical contact with a COVID-19 case.
III. Providing direct care for patients with COVID-19 disease without using proper personal protective equipment (PPE);
IV. Other definitions, as indicated by local risk assessments, as outlined in Table 1.

If confirmed cases are asymptomatic, contacts should be managed in the same way as for a symptomatic case with an exposure period from 2 days before the case was sampled, to 14 days after.

2.) Identifying contacts

To identify contacts, a detailed case investigation and interview with the COVID-19 patient or their caregivers are in need. Table 2.3.1 provides examples of ways the contact tracing teams can identify contacts in various settings. Public health officials will need to identify contacts depending on the local context and culturally appropriate measures.

3.) Informing contacts

The contact tracing team should develop a list of persons who had been in contact with the COVID-19 patient. Each contact should first be contacted by phone or in person to determine whether they meet the contact definition and thus require monitoring. Each individual confirmed as a contact should be provided with information on:

a. The process and rationale for contact tracing, and information on quarantine.
b. Where they will be quarantined and how they will be cared for.
c. What symptoms to look out for during the monitoring period. These include any symptoms, especially fever (measured or feeling feverish or having chills) or at least one of the following: sore throat, cough, runny nose or nasal congestion, shortness of breath or difficulty breathing, muscle pain, loss of smell or taste, or diarrhoea
d. What to do if they become unwell, including 1) whom to inform, 2) how to self-isolate and what precautions to take (respiratory and hand hygiene) and 3) what referral mechanisms are in place for testing and treatment.
e. Data protection, including how their personal information will be used, processed and stored.
f. Any other specific query or concern raised by the contact.

Information should ideally be provided over the phone or in person, although alternative approaches such as text messages and emails could be considered when direct contact cannot be made.

4.) Managing and monitoring contacts daily

a. Quarantine

Quarantine of persons is the restriction of activities of or the separation of persons who are not ill but who may have been exposed to an infectious agent or disease, with the objective of monitoring their symptoms and ensuring the early detection of cases. Quarantine is different from isolation, which is the separation of ill or infected persons from others to prevent the spread of infection or contamination.

b. Daily monitoring

Daily monitoring refers to the regular communication between the contact tracing team and the contacts they have been assigned to monitor for any sign of illness. The options for daily monitoring include:

I. Direct monitoring by the contact tracing team, monitoring potential signs and symptoms by phone or visiting them in person. Contact tracers should implement standard precautions and physical distancing.
II. Self-reporting, whereby contacts self-monitor and report any signs and symptoms to the contact tracing team. Self-reporting should be conducted daily, even if no signs or symptoms are present (so-called zero reporting).
III. Contact tracers collect information on signs and symptoms from each contact on a contact tracing form on a daily basis. Electronic data capture tools should be used wherever possible (see section on Information technology).
IV. If contacts cannot be reached, the contact tracing team should ask relatives and friends or explore other means to find them. If contacts relocate to known locations in the same

catchment area, the contact tracing team should visit them. If contacts move to another catchment area, the contact tracing team responsible for that catchment area should be informed and follow up.

V. If a contact develops symptoms, the individual should self-isolate, and follow the established referral pathway for testing and treatment in their area.

VI. The monitoring phase ends 14 days after the contact last came into contact with the COVID-19 patient, or if the contact develops COVID-19.

VII. In the event that contacts are in close proximity to each other, such as being in the same household, and one of them becomes a COVID-19 case, the follow-up period is reset to 14 days after the last exposure to the new case.

2.5 CONTACT TRACING APPS AS EHEALTH SOLUTIONS DURING THE COVID-19 PANDEMIC

A variety of ehealth solutions, which leverage information and communication technologies for the betterment of health and health care services, have been proposed in response to the pandemic. Early in the pandemic, digital contact tracing rapidly emerged as a promising tool to support manual tracers and enable a more selective approach to regional lockdowns. Contact tracing apps constitute an example of ehealth aimed at supporting standard nonpharmaceutical interventions. Generally, the intended use is to digitally collect information within their network of users to reduce pathogen transmission. A recent review of international technological innovations developed in response to the pandemic listed almost 100 tracing applications at different stages of development, most of which were smartphone-based.

These can be further categorized as position tracking applications, which aim to enforce the quarantine of infected individuals, and the more commonly deployed contact tracing applications, which continuously measure distances between users to rapidly notify the high-risk contacts of an individual with a confirmed SARS-CoV-2 infection. The latter type predominates internationally, as it is more compatible with civil liberties. Although the term “contact tracing app” is typically used in academic texts and the general press, the primary purpose of such tools is to rapidly identify and notify individuals who have had a high-risk exposure. Terminology matters as it may erode public trust in tools that are perceived to enable state surveillance of individual mobility (tracing, tracking). In this context, the contact tracing technology developed by Apple and Google refers to an “Exposure Notification System”. Similarly, the government of Canada encourages the public to use COVID Alert, an “exposure notification app,” which it describes as “an additional tool to protect yourself and your loved ones”.

Contact tracing apps can differ according to eight fundamental characteristics. First, their installation can be voluntary or compulsory. Second, the extent of informed consent varies between apps. Third, some apps use a decentralized data management strategy, while others enable linkages with governmental agencies. Fourth, their ability to detect contact between users can rely on technologies such as GPS, Bluetooth, or Quick Response codes. Fifth, the specific algorithms deployed in the back end of these apps will determine their output (e.g., the calculation of a risk of infection or the tracing of potential contacts). Sixth, they require varying levels of human oversight, if at all present.

Seventh, the degree of interaction with users regarding recommended actions (e.g., testing and isolation recommendations) and the extent of interaction with public health agencies can differ. Last, safety protocols for data privacy may also vary. Contact tracing apps thus refer to a heterogeneous cluster of ehealth tools that likely differ in effectiveness and uptake depending on their respective design characteristics.

2.6 COVID-19 CONTACT TRACING APP EFFECTIVENESS, BARRIERS TO ADOPTION, AND FACILITATORS

Given their fundamental mechanism, the effectiveness of contact tracing apps depends in part on the level of uptake and ongoing use by patients who have contacted the SARS-CoV-2 virus and other citizens. An influential modeling study published by a team of researchers at the University of Oxford originally suggested that a 60% adoption rate should be targeted for effective virus transmission reduction, although any level of uptake may help lower disease transmission. Even though numerous public consultations have suggested a general willingness to use contact tracing apps during the pandemic, the available data suggests low rates of continuous use in practice. For instance, app penetration rates as of March 2021 were as low as 3.6% in France, 6.1% in Japan, 14% in Canada, and 28.5% in the United Kingdom. On the other hand, other countries such as Iceland and Finland have seen higher rates of adoption, at 38.5% and 45.3%, respectively. The significant disparity in adoption rates worldwide highlights the fact that certain approaches could be better than others for successful implementation of this emerging technology.

As contact tracing apps encompass many underlying principles and disciplines, multiple aspects can facilitate or hinder their adoption. One of the main caveats in their implementation is concerns over data security and management. Societies are rightfully preoccupied with the challenges in reconciling civil liberties with public health imperatives in a pandemic context. Data privacy, breaches in confidentiality, and the fear of mass surveillance are among the main concerns raised in surveys on user perspectives. Moreover, as with other health informatics interventions, contact tracing apps may generate or exacerbate inequalities if they are not deployed carefully. There is a risk of discrimination, repression, and systematic exclusion, especially among communities of color and marginalized groups, which are disproportionately affected by COVID-19 due to structural economic, political, and social vulnerabilities.

3. SYSTEM ANALYSIS

This section of the project deliberates on the source of information about the current system and maintenance.

3.1 ANALYSIS OF THE EXISTING SYSTEM

Since the Covid-19 outbreak began, digital contact tracing usefulness as a containment measure has sparked political discussions globally. As one of the oldest public health disease methods, contact tracing works by public health experts identifying infected individuals, isolating them and then finding out with whom they came in contact. Digital contact tracing expands on this by harnessing mobile technologies such as GPS, Bluetooth or QR codes, to digitally track and notify users about their interactions with potentially infected individuals. This automated and digital approach thus offers governments a more cost-effective and easily scalable method than traditional contact tracing.

Given such advantages, several countries have or are in the process of developing Covid-19 digital contact tracing mobile applications. Asian countries with previous experience of SARS, in particular China and Singapore, quickly took on a pioneering role, capitalizing on their well-developed digital infrastructures to deploy contact tracing apps amongst other digital disease surveillance methods. Concurrently, researchers in Europe formed collaborations to work on contact-tracing solutions, with one of the first being the Pan-European Privacy-Preserving Proximity Tracing (PEPP-PT) consortium. Austria was then among the first countries in Europe to deploy a digital contact-tracing app. Their “Stop Corona-App”, launched by the Austrian Red Cross, was available for download from March 25, 2020. In Germany, the Robert Koch Institute launched its “Corona-Warn-App” on June 16, 2020. Switzerland's “SwissCovid-App”, jointly developed by the two Swiss federal institutes of technology (EPFL and ETH), then followed on June 25th. These German speaking countries use digital contact tracing as a tool solely to support mitigation and containment, contrasting to other countries (like Taiwan, Singapore and Poland) that use digital contact tracing apps to enforce quarantine measures

3.2 CHALLENGES OF THE EXISTING SYSTEMS

Contact tracing can be an important component of an epidemic response especially when the prevalence of infection is low. Such efforts are most effective where testing is rapid and widely available and when infections are relatively rare. But to date, no one has demonstrated that it’s possible to do so reliably despite numerous concurrent attempts. Apps that notify participants of disclosure could, on the margins and in the right conditions, help direct testing resources to those at higher risk. Anything else strikes us as implausible at best, and dangerous at worst.

The academic community rapidly responded to this surge in digital contact-tracing solutions. Critics argued that such apps bring to the fore several ethical and technical challenges. To begin, scholars questioned the approach’s accuracy. Experts highlighted the low data quality and Bluetooth technology inaccuracy for proximity tracing and that including citizen’s self-diagnosis along with official validated tests propagates false positives. Furthermore, although a significant percent of the population needs to participate for efficacy, in countries like

Singapore the adoption rate has been below 20%. The opt-in approach can thus undermine effectiveness through lack of critical mass; however making it mandatory would sacrifice autonomy. Furthermore, there are short and long-term surveillance and privacy concerns. Critics highlight that digital contact tracing operationalizes a large-scale surveillance system that could outlive the pandemic. Others draw attention to potential privacy breaches, the questionable reliability of anonymization, the national differences in data protection and privacy regulations, as well as the weaknesses of centralized report processing. Despite this myriad of concerns and challenges, proponents maintain that digital contact tracing, when combined with other measures, careful oversight, and abidance to data protection regulations and protocols through privacy preserving technological options, can reduce transmission rates and allow for a relaxation of measures

3.4 DESCRIPTION OF THE PROPOSED SYSTEM

The proposed system is a mobile application that does not only provide help and support for the infected victims but also warn the uninfected ones from being careless when they get close to the users that have reported symptoms of the deadly disease. The mobile app identifies contacts with positive symptoms and provides them adequate support in order to begin their treatment early, to reduce further infections, to plan COVID-19 control, to notify COVID-19 cases early and to adhere to COVID-19 control strategies.

The COVID-19 contact tracing and screening encompasses a range of activities from identification of index patients, symptoms screening, risk assessment and laboratory tests. Relevant results are then presented to parties for action to be taken. The Android application allows effective completion of these activities and data is saved in a secure database for furthers analysis. The web application module allows easier management of the application and also analyzing the data and displaying the results in charts, tables and graphical formats. In light of the application functional operation, the COVID-19 contact tracing and screening system whose key objectives are to improve surveillance and monitoring of COVID-19 patients and their contacts, complement the inadequate number of health workers involved in contact tracing and screening, reduce deficiencies in coordinating data collection and reporting is a reliable solution to the problem stated in the problem statement. The overall project adhered to a majority of the proposed objectives. The research was completed in ample time for testing and getting feedback from the application.

3.4.1 FEATURES OF THE PROPOSED SYSTEM

In order to ensure file security on cloud, the above hybrid cryptosystem is deployed on cloud. We assume cloud server as trusted but in order to prevent tampering/misuse of data by intruder or data leakage or other security concerns, the data is stored at server in the encrypted form. By classifying the scheme deployed on cloud in three phases:

I. Tracing
II. Notification
III. Support and monitoring

A. Tracing
Here, the app trace registered users who have reported Covid-19 symptoms to the app admin. Their locations are tracked at all time while ensuring that there is no breach of privacy rules.

B. Notification
Once a user recorded to have Covid-19 symptoms gets close to another user of the app, the user is notified and reminded to kit up and protect himself from contacting the virus.

C. Support and monitoring
Once contacts have been notified about potential exposure to the new coronavirus, the contact tracer will provide them with additional information on risks and next steps.

3.5 RESEARCH METHODOLOGY
The system methodology that was used in developing the COVID-19 contact tracing and screening system was Agile Methodology. Agile Development methodology allowed flexibility in integrating user requirements due to its incremental and iterative nature. Design, testing and implementation were done throughout the project cycle. The fundamental concepts to agile development are simple design principles, large number of releases in a short time frame, extensive use of refactoring, pair programming and testing during development (Boem & Turner, 2003). Agile development of the system followed five main phases, which include the Planning phase, Requirement analysis phase, Design phase, Building phase and the Testing phase. Figure 3.1 illustrates the Agile Methodology.

3.6 SYSTEM DESIGN
The main purpose of this study was to come up with an effective system for COVID-19 contact tracing and screening. Object oriented analysis and design were used in this research. This chapter is based on data analysis, system analysis and system design. The three are discussed in detail throughout the chapter with data analysis focusing on the data collected from the sample population. System design and architecture involved the design of the system architecture and outlining the various requirements needed for the implementation of the application. This involved the presentation of sequence diagrams, use case diagrams, entity relationship diagrams (ERD), design class diagrams and wireframes.

4. DESIGN, EVALUATION AND IMPLEMENTATION

4.1 INTRODUCTION
System design is a logical and creative process consisting of an integrated collection of tools and specifications of input, output etc. of the system. The purpose is usually to propose a specification which will enable the complete and accurate implementation of this new system. The result of such an analysis will give rise to proper documentation of events into a document or a set of documents which will enable the programmer or software engineer to start work

4.2 SYSTEM DESIGN AND IMPLEMENTATION

The program is designed to take care of the continued spread of coronavirus disease throughout the country. The design is made using some UI/UX design tool while bringing this into code was done using the leading mobile app development tools out there; Android Studio, Dart and Flutter. The program design is based on the input and output specification to facilitate easy coding, testing, debugging and it is in module.

Talking about the implementation, this is the actual process of bringing the proposed system to lift and place it in the organization. System implementation also includes creating a new system and getting it into working order. For this to be achieved it must be done in a procedure involving how to start and stop the system, entering of information and data must be documented. Although some users already have a good idea of the system while others need to be taught about it in order to be conversant with it. Here, the entire program is tested using different data and system platform. During this phase, the developer documents clearly the user trimly and instructions on the changes the new system will introduce in the area of information management and decision making.

The Proposed System after the design is implemented and test by the user which is derive from the parallel approach of system design which allow the user to make use of the old system and the Proposed System at the same time then make a choice of choosing the most suitable system to be used. During the system implementation the below mentioned characteristics are put into consideration which are;

i. Efficiency of the Program
ii. Integrity of the Program
iii. Readability of the Program
iv. Accuracy of the Program

If all the above mentioned characteristics are met, then the system is ready to be used by the user as accurate result will be produced in a short period of time to solve users need and reduce human effort. In the course of implementing this project the below mentioned software are required for effective work;

a) Android Studio
b) Flutter plugin
c) Dart libraries

Step To Take During Implementing the System:

i. Launch the Android Studio application
ii. Open the Cov-alert project
iii. Export the APK file
iv. Copy the APK file to Android device
v. Install the APK file
vi. Launch the mobile app

4.2.1 INPUT DESIGN SYSTEM

The system is designed to accept several input details efficiently through input from user clicks. The data captured through the user key strokes and clicks are received by specific modules on the system and relayed to the back-end of the system for processing.

4.3 RESULT

In the new design, the output specification of the software is the details of the transaction as ran through the smart contract.

4.4 SYSTEM DOCUMENTATION

Documentation is very important since it is a method of recording and communicating the activities of the system development and the outcomes of each stage in the entire process. Documentation of any system will minimize during the problem that may be encountered during modification or maintenance of the system. Documentation serves the following purpose:

i. Eliminates duplicates and reducing of effort in the system development process,
ii. It minimizes ambiguity in the procedures,
iii. It prevents loss of key information vital to proper implementation of the system,
iv. It provides adequate instruction for proper use of the system.

The complexity of the system documentation will normally depend on the extent of the system being developed. For instance, a system being developed for a temporary use would not require a detailed documentation as the system being developed for permanent use. Nevertheless, system documentation is divided into two parts system manual and user manual.

4.4.1 SYSTEM REQUIREMENTS

System requirements are all of the requirements at the system level that describe the functions which the system as a whole should fulfill to satisfy the stakeholder needs and requirements, and are expressed in an appropriate combination of textual statements, views, and non-functional requirements; the latter expressing the levels of safety, security, reliability, etc., that will be necessary.

4.4.3 OPERATIONAL INSTRUCTIONS

The three major aspects of implementation are:

a. Training personnel
b. Changeover procedures
c. Post-implementation review

4.4.3.1 TRAINING PERSONNEL

The staff / Users of the new system will be given adequate training, it involves prove decision on how well the system work, handbooks are needed for this purpose to provide detailed description on how the job is done. On rare occasions depending on the complexity of the system and the level of skill currently available courses should be organized periodically to update the staff/user knowledge.

Also, job aid is needed to assist staff /user to carryout instruction while performing the job. Effort should be made to work on the psychology of staff/user in order to disabuse any wrong motion or mindset they have about the new system.

4.4.3.2 CHANGEOVER PROCEDURES

This is the implementation process which the changes are made from the existing system to the newly designed one. There are three basic methods:

i. Pilot Change Over: This involves changing part of the system using parable or indirect change over procedure. This procedure is a trial system implementation in a subset of the overall operation as an office geographical area.
ii. Direct Change Over: This is termed immediate or crash change over using this method, the old system is discontinued and the new system is put into operation at once. For a large organization. This system is risky should there be a system failure. This approach is feasible only the timing problem becomes greater as the scale of operation increase with regard to the new system an individual can easily adapt. This system without much course to regret.
iii. Parallel Change Over: Is a changeover procedure where the old system is run in parallel with the new system and comparison made for a whole. One merit is that, there is room for proper evaluation of the new system as to ascertain errors in any of the process. This method has been formed to be operational effective despite the fact that procedure is not cost-effective.

4.5 SYSTEM EVALUATION AND MAINTENANCE

Maintenance of the system means keeping the system running without a problem that may cause the system to breakdown. The steps outlined below can help prevent the system from breaking down:

i. No usage of outside source floppy disk, flash drives or CD-ROM which may contain program that can rearrange files in the system
ii. No external bodies should be allowed to access the system
iii. Anti-virus package must be installed and updated annually
iv. The system should be out of reach to unauthorized users in the organization
v. Faulty material should be changed immediately.

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 SUMMARY

The proposed solution is a mobile-based contact tracing system with a Web dashboard. Agile methodology was used to design, develop and test the application. The design of the system involved coming with UML diagrams such as Use-case diagrams, sequence diagrams, context diagrams and entity relationship diagrams. User testing and evaluation statistics indicated that the system fulfilled its functionalities and usability requirements. Based on questionnaire responses, the system is generally considered easy to understand and use. Thus, the research objectives of the study can be said to have been achieved since the system met the needs of the users and received a good reception from target users.

5.2 CONCLUSION

The main goal of the dissertation was to develop a mobile-based system that can be used for COVID-19 contact tracing and prevent the rapid spread of the virus, and hence address the needs of COVID-19 officers in improving COVID-19 contact tracing. Contact tracing and approaches exist but these approaches are faced by significant challenges as discussed in this dissertation. The incidence of COVID-19 will not decline in the absence of effective and organized contact tracing. The mobile-based system comes in handy to positively impact COVID-19 control efforts specifically in COVID-19 contact tracing. Studied literature revealed that the current system used in Nigeria for contact tracing was paper based, although other countries have employed web-based systems, Android applications, USSD systems and geographical information systems.

The challenges of COVID-19 contact tracing were successfully investigated. It was noted that the current system is faced with challenges of low surveillance and monitoring of COVID-19 patients and their contacts, inadequate number of health workers to cover sparse geographical locations, and deficiencies in coordinating data collection and reporting. The assessment showed that the current system of contact tracing is paper-based along with MS-office applications for recording data. The researcher also further studied the related architectures, designs and models of contact tracing and the gaps identified to provide an optimal solution.

5.3 RECOMMENDATIONS

The recommendations, which can be made, are that the Nigeria Government should recognize and embrace novel technologies for COVID-19 contact tracing. The National COVID-19 program can also consider supporting the development of dedicated teams or units that facilitate novel methods for COVID-19 contact tracing and to complement the work of field health worker/ epidemiologists. More work needs also to be done on the web dashboard in terms of integration with existing systems, which the policy makers use. This will help avail information to the policy makers as soonest as possible.

In order to successfully integrate these novel methodologies of COVID-19 contact tracing, community involvement, on-going support at every level and capacity building will be required. This will enable in breaking the cycle of transmission by prioritizing COVID-19 contacts that should isolate themselves or undergo treatment.

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