

Online QR Code Digital Contact and Quarantine Tracing Using Independent Software Vendor Oracle – Cloud Computing

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ABSTRACT

While the cure has not yet been discovered, one way to prevent the spread of the virus is Contact Tracking. A systematic Interaction Monitoring protocol must identify, assess, and manage people who are positive or exposed to the virus in order to break the chain of transmission and thus prevent continued transmission of the disease. The current system is a manual data collection approach, where people who need to enter banks, malls, and government offices have to line up, waiting their turn to write their required personal data in the logbook. Of a security guard. The researchers developed the system using Information Technology, various trends, QR codes, Cloud computing, Data Analytics, smartphones, and Big Data. The QR code system eliminates long queues when entering establishments. Using the assigned smartphone connected to the internet, the scanning officer only needs two (2) to five (5) seconds to scan the QR code of the person entering the office or building. The scanned QR code will provide the scanning officer with the necessary personal information and information related to the person's exposure or non-exposure to the virus. All retrieved information will be sent to the cloud so that the command center can access the report at any time for possible contact tracking analysis of the known positives on COVID-19. Anyone violating quarantine will be identified — using the method used in the Rapid Application Development model. The researcher anchored each module as a guide during system development using Oracle's front-end and back-end. The development tools used in scripting for forms and reports are native Oracle scripts, including Oracle plug-ins. The system has already tested its purpose and functionality for contact tracking and quarantine solutions. It is already available using Oracle infra and Oracle platforms suitable for bringing BIG DATA into implementation nationwide.

Key words : Big Data, Cloud Computing, Contact Tracing, Oracle Infrastructure

1. INTRODUCTION

In light of the pandemic [6] that the world is experiencing today, various types of prevention measures [8] have been implemented vis-à-vis the relentless efforts of health professionals to come up with a cure for this virus. [4]

While the cure has not yet been discovered, one of the strategies to prevent the spread of the virus is Contact Tracing [3]. In addition, a systematic Communication Monitoring protocol should identify [11], assess, and manage people who have tested positive or been exposed to the virus [17] to disrupt the transmission chain, thereby preventing continued transmission of the disease [9].

The current manual approach is redundant data collection. For example, people who had to enter banks, malls, and government offices had to line up, waiting their turn to write their required personal data in the logbook of security guards.

In this situation, people are very prone to virus contamination due to frequently used ball pens and logbooks during the manual registration process. As a result, the goal of preventing the spread of viruses has been defeated.

Another strategy implemented by department stores is to have their QR code at the mall entrance. The person who wants to enter the mall must scan the QR code for their smartphone to access the forms to fill in the required parameters for their whereabouts before entering the mall.

Many contact tracing applications exist [10] in the country, but the application is only to track possible contact with the infected virus. They could not get accurate data because they had not verified the person's name. However, they need text validation before they can proceed with getting the QR code. The previous system did not properly

verify the person's name. In other words, anyone can register without using their real name. [28] [29] [30] [31] [32] [33] [34] [35] [36] [38] [42] [43]

The researchers developed to contact and quarantine tracing software using a quick response (QR) code system that eliminates [7] long queues when entering establishments. It is a cloud-based domain application using Oracle infrastructure, Oracle platform, Oracle front-end, and a back-end that smartphones, laptops, tablets, and Personal computers can use as scanner gadgets connected to the internet to access cloud server [1].

For checkpoints, any smartphone connected to the internet, the scanning officer only needs two (2) to five (5) seconds to scan the QR code of the person entering the office or building and even crossing the borders.

The system requires comprehensive registration of all Cebu City residents to obtain a one-time QR code through an on-site designated area by accessing a domain for on-site registrations and requiring a valid ID or barangay clearance as a minimum requirement before registration. Furthermore, domain access for online registration requires two (2) layers of authentication. First, send a valid picture ID. Second, the selfie captured carries a valid ID for a strict validation of the data or person to register the system to ensure that the collected data is correct and accurate. After the verification process, the in charge of the command center will email the corresponding QR code.

Furthermore, this study is an innovative approach to obtaining personal information of the residents of Cebu City and neighboring provinces in a verified and accurate manner, as it is essential for communication and quarantine monitoring. Other innovative solutions do not consider the accuracy of the collected data as their primary concern. Their system can register using any name and address as long as the cellphone number receives a validation code as the primary requirement for issuing the QR code.

The residents must carry their QR codes, either printout or screenshots, on their smartphones every time they go out to markets and malls. After the registration process, the proper implementation needed at the barangay level security assigns a scanning officer to scan the person outside of their residents to determine that they are under home quarantine restrictions or allowed to go outside of their resident's belonging to PUI and PUM status.

The security of the malls and establishments acts as a scanning officer to scan the person's QR code that enters the mall or establishment. In addition, the police officers serve as a scanning officer to examine the vehicle passing at the checkpoints or borders for the checkpoints. During the scanning process, all the data captured in the QR code would send directly to the cloud for possible data reporting and possible virus carriers' data analysis.

All the contact tracers must position the command center for the possible contact tracing analysis by accessing the command center domain. Therefore, the command center is equipped with unbreakable user authentication to ensure that only an authorized person can access the command center.

The command center can update the record given by the Department of Health (DOH) for the alert of a possible infected person, quarantine restriction for persons under investigation (PUI)[25], or a person with COVID-19 infected and cured, and persons under monitoring (PUM). The health department can access the domain for updating the residents' records for any restrictions or healing patients if they have user rights to access the updated environment. If, just in case of losing the QR code for those on-site registrations, they can ask for a copy at the designated on-site registration office. Figure 1 shows the concept of the study.

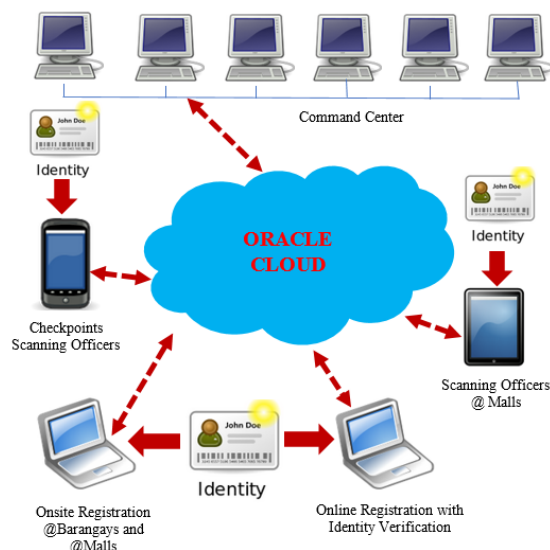


Figure 1. Concept of the study

2. OBJECTIVES

The main objectives of the study are to support the Cebu City government in managing the COVID-19 virus and other health emergencies affecting the community thru:

- a. Contact and Quarantine tracing using QR code technology to monitor the allowed persons outside their residence for a possible contact tracing.
- b. A gadget or smartphone that is capable of accessing a cloud server using the internet browser with internet connectivity that can access the application for scanning:
 - b.1. Checkpoints
 - b.2. Malls
 - b.3. Public Markets
 - b.4. Establishments
 - b.5. Barangay Outpost
 - b.6. Inter-City Border
- c. Cloud computing-based independent Software Vendor Oracle and Oracle infrastructure that caters entire Cebu province as one database.
- d. A fully managed technology solution with a secure approach without infringing on individuals' privacy.
- e. Application software that is suitable for the DOH action plan for the COVID-19 reduction mechanism.

3. METHODOLOGY

The researchers decided to use the Rapid Application Development (RAD) model as the basis of the methodology for developing an effective and accurate solution for contact and quarantine tracing in the independent software vendor oracle (ISVO) environment [14]. To help search for infected in the city to reduce the rapid spread of the virus. In the city of Cebu in particular and in the province of Cebu in general. Figure 2 shows the RAD model.

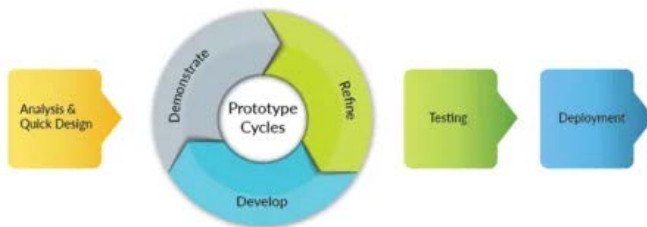


Figure 2. Rapid Application Development Model

3.1. Project Planning Phase

There are many factors that the researchers have considered before starting the development of the solution:

1. The possible bloating of data is captured day by day by the end-users.
2. The infrastructure that supports wide-area networks easily.
3. The front end and back end of the system are used.
4. The platform and the application of the system are used.

The researchers decided that cloud computing is the best solution to implement. In figure 3, shown below, the concept of cloud computing is identified as all the requirements to proceed with the development of the system. Oracle Platform, Oracle Infrastructure, and Oracle Application were used so that the system made became Safety, Accurate, Fast, and Easy solution based on the characteristics of the Oracle Enterprise Solution provider.

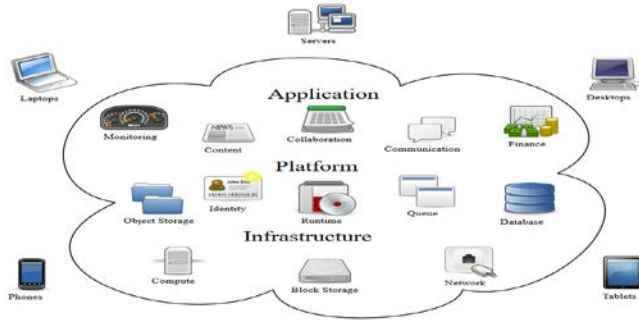


Figure 3. Cloud Computing Concepts

3.2. Analysis and Design Phase

The researchers then assigned the system development for the back-end side's internal policies before making the codes/script from the native Oracle scripting of the database as identified during the design phase of the researcher's methodology. Finally, the researchers secure the action plan workflow of the Inter-Agency Task Force (IATF) to automate the flow instead of developing something that is not compliant with the action plan of IATF. Figure 4 shows the contact tracing workflow against COVID-19 below.

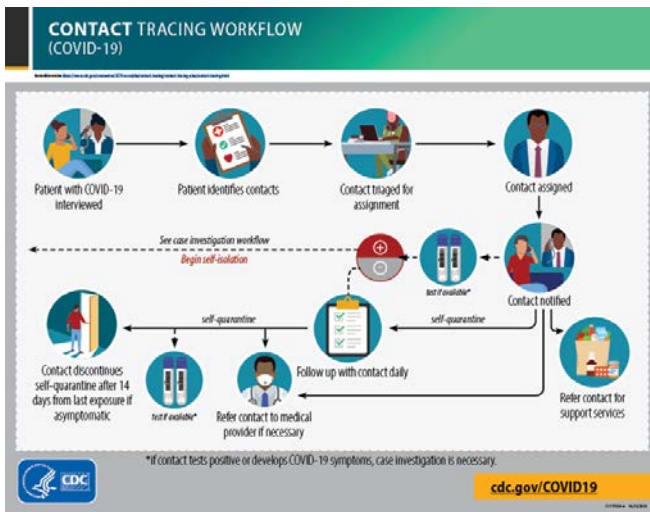


Figure 4. Contact Tracing Workflow

While developing the forms in an Oracle application of the system, the researchers developed a dashboard representing the visual data analytics of the content in the database registered per barangays with bar and pie graphs. Figure 5 shows the dashboard of the command center.

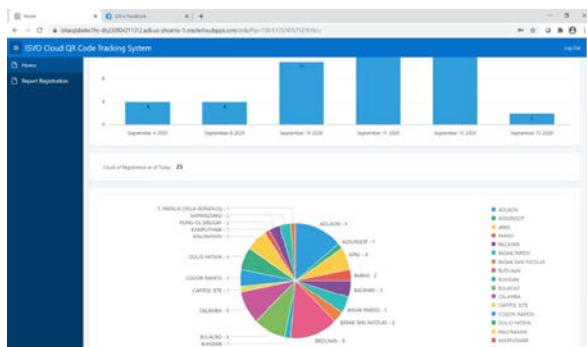


Figure 5. Command Center Dashboard

3.3. Data Analytics

The data analytics is an essential function of the system because the contact tracing officer can view the number of registered residents, the infected individual per barangays of possible PUI, PUM, and cured patients in pie and bar charts.

3.4. Graphical User Interface Design

The researchers analyzed the workflow of the government's requirements for the basis of their action plan nationwide. They formulated the user interface based on the IATF (Inter-Agency Task Force) format for data gathering upon entering the person, the establishment, or public areas for contact tracing records. Figure 6 shows the user-interface design for the smartphone view.

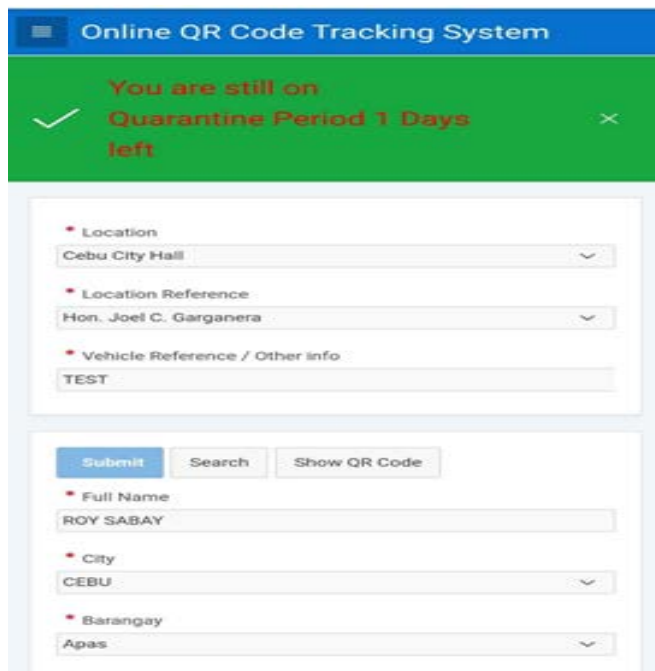


Figure 6. User interface for Scanning officer at Mall area

There were six (6) user interfaces developed:

1. A registration form for barangays and other designated areas.
2. An online registration entry.
3. Scanning officer for checkpoints.
4. Scanning officer for malls and other establishments.
5. Command Center.
6. Update record for positive and person under investigation patient to identify her/her status to trace easily his/her possible future contacts.

3.4. Prototype Cycles Phase

In this study stage, the researchers identify the cloud infrastructure requirements for the Central Processing Unit (CPU) Core, Random Access Memory (RAM) storage, and Hard disk storage as the initial setup for the oracle cloud provider. One of the researcher's members is a gold partner of Oracle Enterprise, in which everything was made accessible because all the resources were ready for wide-area implementation.

3.5 Testing Phase

In the course of testing, the researchers test the system's integrity by enabling the database to the cloud server in Phoenix, Texas, the United States of America, as the cloud service provider's location. Upon testing, the database record stored thousands of information to test its process time and response time while other users accessed the database. Hence, the Oracle database is reliable and secure Worldwide. Additional inputs from a possible end-user were acknowledged during the testing proceedings and considered the researcher's revision. It was essential for the accuracy of giving an alert when patients under quarantine were visiting the mall wherein the quarantine period was still ongoing. An alert screen displays one of the scanner screens as deflected in Figure 6. While in Figure 7 shows the Oracle database record with data analytics below.



Figure 7. Oracle Database Record with Data Analytics

3.6 System Deployment

The researchers developed a solution that is ready to deploy the entire system because, in the testing process, the system already enables the proper testing of the software in the cloud. The system's final implementation is to sign up and acquire a domain name system (DNS) to easily access the system with the desired application name in the universal resource locator (URL) of the internet browser. The entire system needs six (6) domain names to complete the whole package of the system with the following application names:

1. scanning officer for checkpoints
2. scanning officer for malls and establishments
3. online registration
4. barangay level registration
5. update patients' status
6. Command Center database access

4. RESULTS AND DISCUSSION

After the complex algorithms and analysis of the system's architectural structure, including the contact and quarantine tracing software's internal policies, the researcher's sign-up for hosting the system to Oracle cloud service provider to make the system accessible on the web. The researchers gradually unfold finally, the results based on the desired function of the system. Figure 8 shows the database login screen below.

When the login is complete, and the password is correct, Figure 9 shows the dashboard display of the database's content in a Pie graph, and Figure 10 is a Bar Graph that displays on the screen representing the content of data with legends, including the data analytics of records in a database.



Figure 8. Database Login

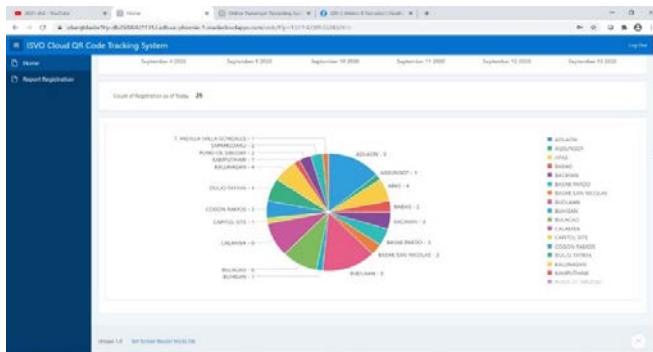


Figure 9. Report Pie Graph with Data Analytics

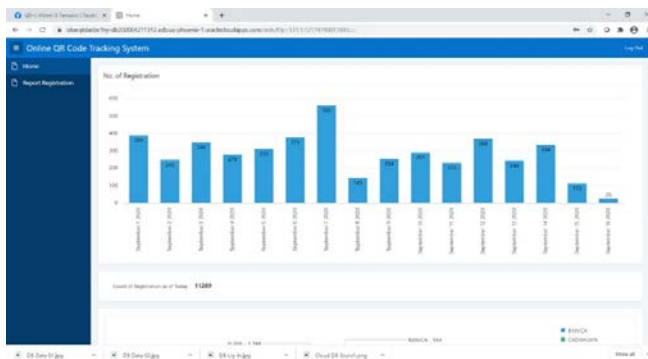


Figure 10. Report Bar Graph with Data Analytics

The command center controls this database server because the contact tracing personnel can analyze, trace, and update the possible COVID positive based on the DOH (Department of Health) report. Presently, the command center gives the information to correct the patient's record for a possible alert when going outside the residence or in the quarantine facilities.

Figure 11 shows the updated record of a specific person. The Department of Health can access this domain for updating the patients. Presently, all the reports from DOH will be sent to the command center for the contact tracer to trace possible contacts of the positive patient. They can set a person under quarantine for a variable day, depending on the desired quarantine period per PUI and PUM person. It is also possible to put an alert for PUI and PUM and Cured COVID-19 patients.

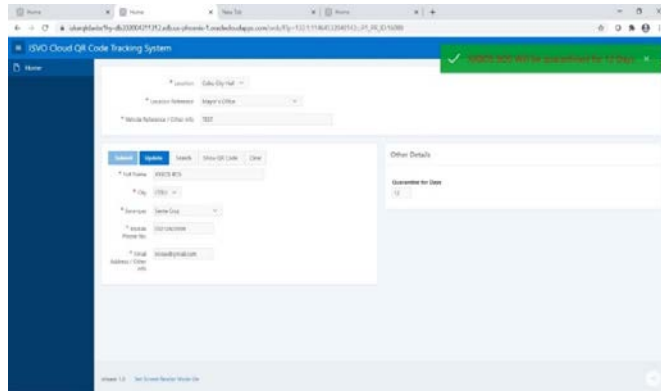


Figure 11. Update Patient Record Form

In an update entry, the command center can input the number of days quarantine period so that the patients can be monitored if they go/went outside the quarantine area. By the time that their QR code scans, the screen will display that the person is under quarantine with days remaining prompted on the screen of the scanning officer for the mall and establishments applications. Then, automatically send the information to the command center to alert that one person violates the quarantine rules that can impose immediate sanctions on the violator. Figure 12 shows the display of the smartphone of the scanning officer in the mall.



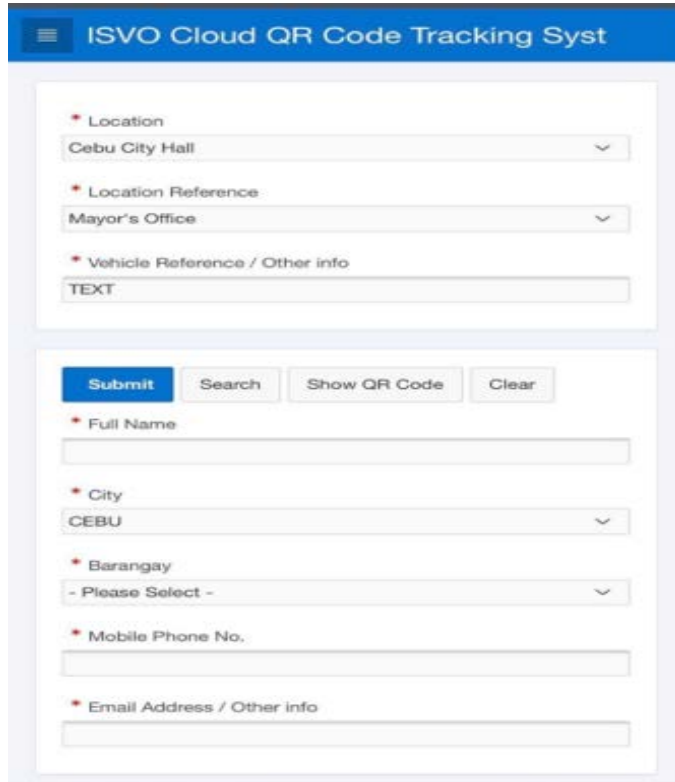
Figure 12. Scanning officer smartphone display for malls

The Cebu City residents and neighboring cities and provinces can register and secure the QR codes in two ways. First, barangay registration. After encoding necessary information and validation of ID and the person's presence in a barangay level registration, the system automatically generates the QR code and takes screenshots by the registrants. It's up to them if he/she printout the QR code or leaves as is in his/her phone for future scanning when he/she leaves the house or going to the market or anywhere. Figure 13 shows the registration procedure at the barangay level area.



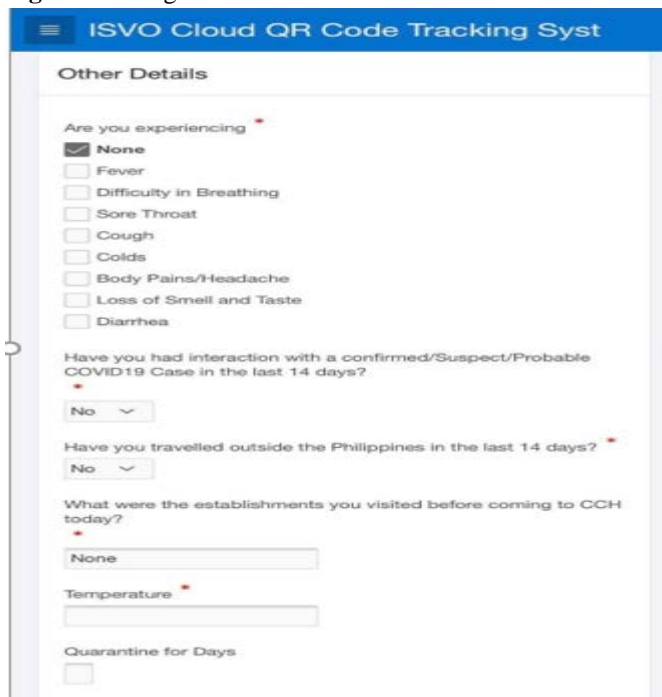
Figure 13. Barangay Registration

While in Figure 14 shows the registration form of the barangay level. And Figure 15 is the additional information that needs to follow the IATF mandate to fill-up the required information. Finally, in Figure 16 is the equivalent QR code of the registrants.



The screenshot shows the 'ISVO Cloud QR Code Tracking Syst' interface. It features a blue header with a menu icon. Below the header, there are three dropdown menus: 'Location' (set to 'Cebu City Hall'), 'Location Reference' (set to 'Mayor's Office'), and 'Vehicle Reference / Other info' (set to 'TEXT'). Below these are four buttons: 'Submit' (highlighted in blue), 'Search', 'Show QR Code', and 'Clear'. Further down, there are five input fields: 'Full Name', 'City' (set to 'CEBU'), 'Barangay' (set to '- Please Select -'), 'Mobile Phone No.', and 'Email Address / Other info'.

Figure 14. Registration Form



The screenshot shows the 'ISVO Cloud QR Code Tracking Syst' interface with the 'Other Details' section expanded. It contains several questions with checkboxes and dropdown menus. The first question is 'Are you experiencing' with a red asterisk, and the 'None' checkbox is checked. Other options include 'Fever', 'Difficulty in Breathing', 'Sore Throat', 'Cough', 'Colds', 'Body Pains/Headache', 'Loss of Smell and Taste', and 'Diarrhea'. The second question is 'Have you had interaction with a confirmed/Suspect/Probable COVID-19 Case in the last 14 days?' with a red asterisk, and the 'No' dropdown is selected. The third question is 'Have you travelled outside the Philippines in the last 14 days?' with a red asterisk, and the 'No' dropdown is selected. The fourth question is 'What were the establishments you visited before coming to CCH today?' with a red asterisk, and the 'None' text box is filled. The fifth question is 'Temperature' with a red asterisk, and the text box is empty. The sixth question is 'Quarantine for Days' with a red asterisk, and the checkbox is unchecked.

Figure 15. Registration Form Other Details



Figure 16. Equivalent QR Code

Second, Online registration. Here, the registrants would have an email account before registering the system. It needs a valid ID to validate the person who will write if it is credible and a Cebu City resident and Cebu province. The registrants will access the website for the online registration page and fill up the registration form on either a PC, Tablet, or smartphone, as long as there is an Internet connection. After submitting the registration, the command center will verify the integrity of the registrants' ID. The approved unique QR code will be sent through email by the command center after the validation. Figure 17 deflected the online registration on desktop PC or Laptop.

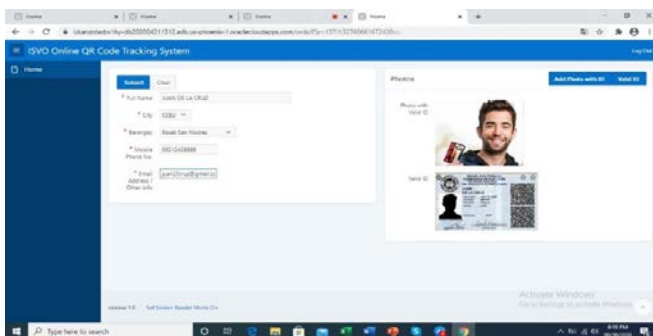


Figure 17. Online Registration Screen for PC

However, it is also possible to register using a smartphone or Tablet, particularly the android operating system, for better performance. Figure 18 shows the registration screen utilizing an android smartphone.

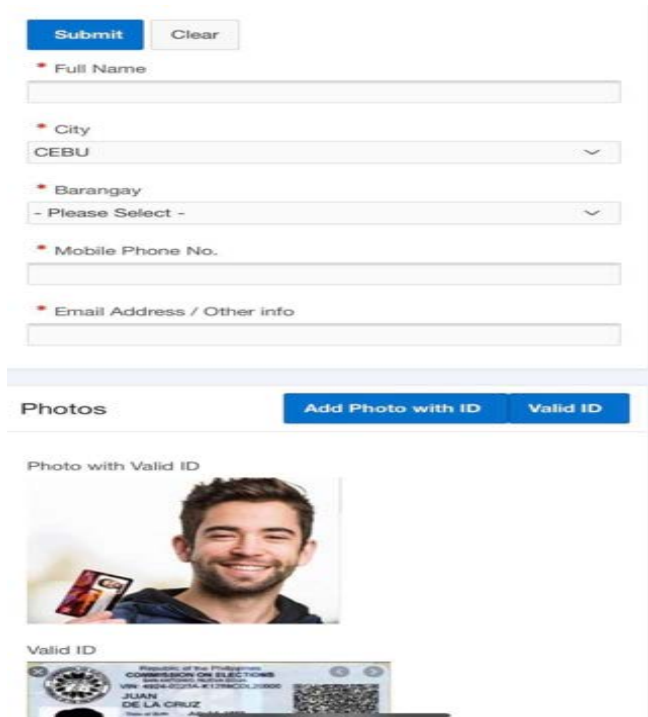


Figure 18. Online Registration using android smartphone

The researchers had developed two modules for contact and quarantine tracing; first, the application for malls and establishments based on the IATF recommendation that the person who will enter the establishments must fill up the needed information before entering the establishments. After the scanning officer finishes scanning the QR code, a thermal scanner also checks the person and encodes it to a form displayed during QR scanning. Simultaneously, other details set the default as none to ensure the speed of accepting the person and clicking the submit button to send the information to the cloud. Figure 19 shows the scanning screen for malls and establishments.

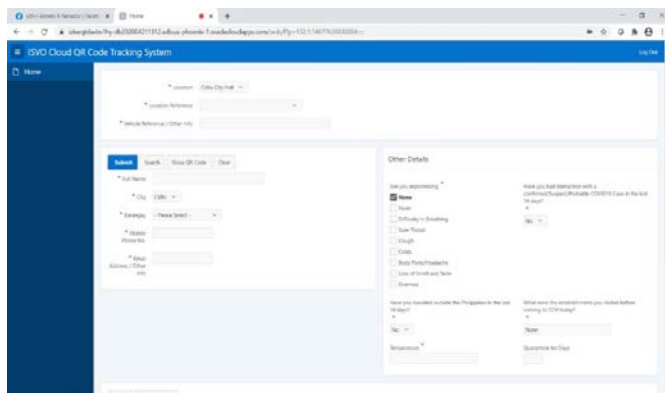


Figure 19. Mall and Establishments Scanning officer Screen

Second, the scanning officer for checkpoints and other barangay areas or designated installation for deputized scanning officers are different scanner applications. It needs a faster scanning process to avoid the car congestion passing to the border or the significant thoroughfares with police/scanning officers on vital installations. Figure 20 shows the smartphone application screen of the scanning officer for checkpoints.

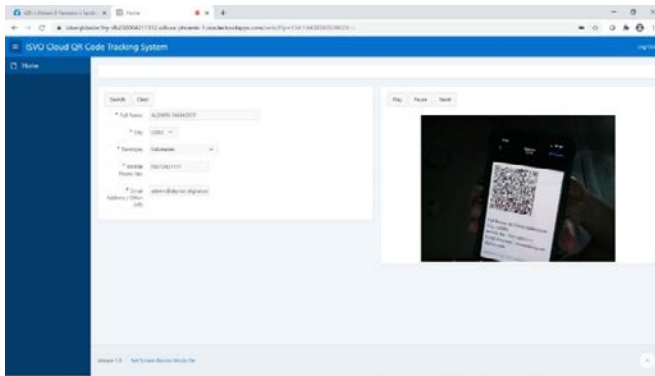


Figure 20. Checkpoints Scanning officer Screen

After scanning the QR code, the system automatically sends the information to the cloud without touching any buttons to submit the scanned data to avoid traffic. When the system detects the violator automatically displays to the scanning officer's screen, similar to Figure 21, as reflected below.

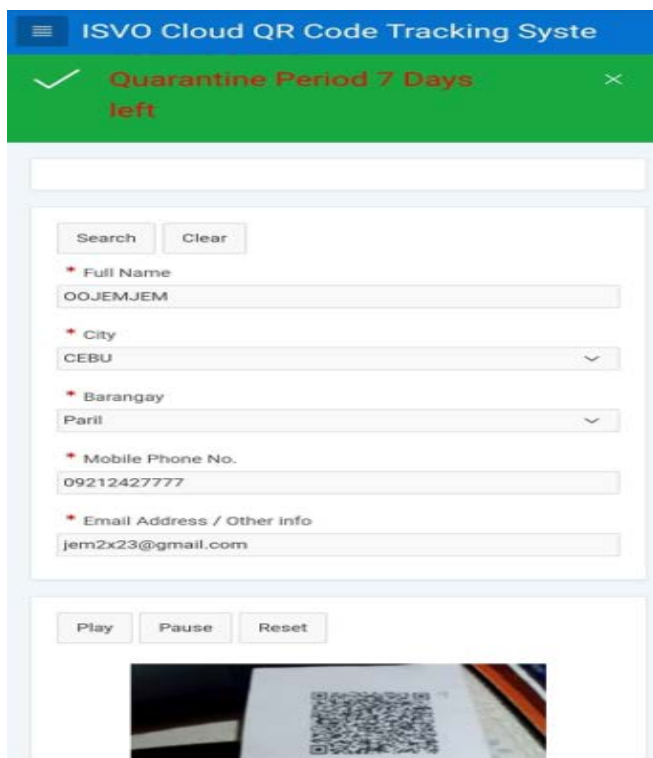


Figure 21. Violators detected Screen

The command center is the in-charge of all contact tracing jobs because all the data would send to the database, and the only authorized to access the database are those who have access to database admin. The contact tracer will analyze the data anytime if there are positive COVID-19 people. The researchers developed an unlimited multi-layer field search to ensure the easy detection and filtering of possible infected viruses. Figure 22 shows the multi-layer search of the oracle database.

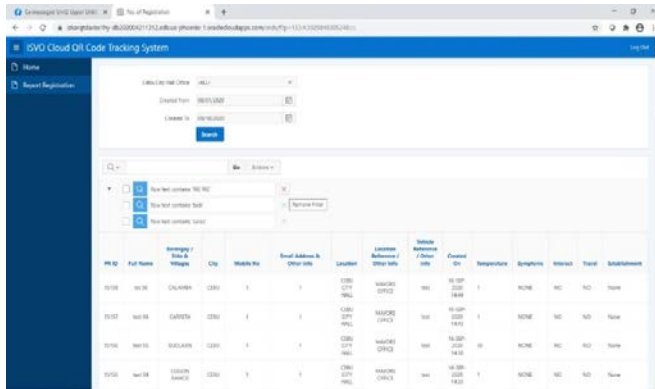


Figure 22. Multi-layer database record search

In a search engine field, the contact tracing officer can type the name of a COVID-19 positive person; by clicking search, all the possible whereabouts of the person inputted in the search engine field will display in a matrix format, as shown in Figure 22. Backtracking the days of the person's whereabouts can also check its close contact during those days before they are detected as positive. During the analysis, the system automatically determines the PUI and PUM through a small space area that the patient caught, like the vehicle's plate number, small stores, and other establishments that are very close to a positive person. While looking for a possible PUI and PUM, the contact tracer can load another field in the search engine until they can conclude the possible PUI and PUM in much less time than tracing a positive person's contact.

Take a closer look at the database record reflected in Figure 23 below. Notice that all the table columns can be searchable to ensure that the analysis makes the contact tracer easy.

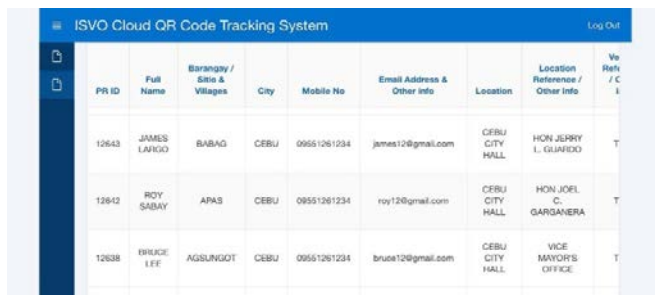


Figure 234. Closer look of Database Record

5. SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 SUMMARY

The researchers had developed the contact and quarantine tracing based on the action plan imposed by IATF to mitigate COVID-19 infected virus to track and trace the possible contact of infected virus easily using the Cloud QR code contact and quarantine tracing software. Upon writing this paper, the researchers continuously convinced Cebu and neighboring cities' City governments to implement this system because the researchers believe that it can reduce the spreading of COVID-19 viruses. After all, the system can monitor the person's whereabouts without infringing their privacy.

The researchers offer this software for free to the City government of Cebu as Software as a Service. Still, the Infrastructure as a Service and Platform as a Service is paid by the City government to run the system as the data center of Cebu City and Cebu province that can carry BIG DATA. The idea of Infrastructure as a Service and Platform as Service is that the private establishment will pay monthly Cloud service provider used. In this way, the application can sustain its availability to the Cloud while still struggling for this pandemic to cater to Cebu City and Cebu province and the entire country if needed.

5.2 CONCLUSION

The researchers concluded that if the system implements appropriately in Cebu City or the entire Country, the system is ready to handle BIG DATA because the Oracle platform is a trusted database enterprise vendor. Furthermore, contact tracing is made easy because the individual's whereabouts will be traced through the device used by the scanning officers in any strategic location. Similarly, the home quarantine will possibly solve the congestion of our quarantine facilities for those diagnosed as COVID-19 positive but mild symptoms or asymptomatic patients because they can trace at barangay checkpoints or to any police checkpoint installations. As to social responsibility, the researchers seek the IT solution to trace easily using the existing technology like data analytics, cloud computing, quantum computing, and Big Data to help the government mitigate the spreading of COVID-19 viruses to humanity. Lastly, at the end of this pandemic, the researchers can share their families and friends for their effort to develop this one-of-a-kind solution. It is opposite to other contact tracing software that uses Android apps with no restrictions of locations and no verifications of integrity as to the person who will register and download the apps. Lastly, this solution did not use GPRS and Bluetooth technology to protect an individual's privacy.

5.3 RECOMMENDATION

The researcher's primary recommendations for this one-of-a-kind Information Technology solution using QR code, Cloud Computing, Data Analytics, Quantum Computing, and Big Data are the following:

1. Implement the system in a nationwide setting so that the government can easily trace law-abiding people for the COVID-19 rules and regulations tailored by IATF.
2. Invest in an extensive Cloud infrastructure suitable for nationwide implementation that can carry BIG DATA.
3. It is an Independent Software Vendor Oracle (ISVO) concerning the software and platform. The researchers are open to further improving and modifying the system to be suitable for broad applications.
4. This system is ready to adopt a nationwide ID system for the second phase if the government utilizes this to distribute any government activities efficiently.

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To the man who has shared his passion for helping out the community, he shared his vision of integrating Information Technology into the Cebu City Government's system—for giving us the guidance and time whenever we need it. Thank you very much, Councilor Renato "Junjun" Osmena, Jr.

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