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Mobility and Contract – Tracing App Using QR-Code

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Abstract: This study explored the challenges and issues related to monitoring and contact tracing conducted by the Local Government of Sta. Ana, Cagayan, especially at the Welcome Arc checkpoint. To address these challenges, the researcher created questionnaires and evaluation tools to collect data, review current processes, and find suitable solutions. As a result, a mobility and contact tracing application using QR codes was developed and evaluated to help the Local Government Unit improve its monitoring system. Employing a descriptive research design and following the ISO 25010 software quality metrics, the application earned high ratings in usability (4.42), reliability (4.58), and efficiency (4.75). The findings indicate that the proposed system is a contactless, effective, and dependable tool for tracking and monitoring visitors in the municipality.

Keywords: *"Administrator", "Barcode" "Barcode Scanner", "Contact Tracing", "Data", "Government ID", "Microsoft Excel", "MIT App Inventor", "Mobile Application", "QR-Code".*

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I. INTRODUCTION

The COVID-19 pandemic began in late 2019 and caused significant disruptions to public health, the economy, and social mobility globally. In the Philippines, the national government imposed strict community quarantines and health measures to control the spread of the virus. However, local government units (LGUs) struggled with contact tracing, movement monitoring, and enforcing safety protocols. These challenges were especially noticeable in regional areas where manual record-keeping and inconsistent data collection limited the effectiveness of monitoring systems.

In Sta. Ana, Cagayan, the Local Government faced issues with its manual contact tracing process, especially at the Welcome Arc checkpoint. Visitor information was recorded inaccurately, which required a lot of time and effort. The absence of an automated system made it hard to track visitors, spot exposure risks, and manage reports effectively. To tackle this problem, the study aimed to develop and assess a QR code-based mobility and contact tracing application. This app would simplify monitoring, ensure accurate data, and assist the LGU in addressing public health issues. The project emphasizes system development, usability testing, and implementation within Sta. Ana's local monitoring operations.

- *Objectives*

The proponent has decided to propose a tracking application to improve the current method of listing the visitors in visitor's log without fully knowing their places of interaction. The proponent aims to transform the current method into a contactless transaction of tracking and monitoring the visitors of Sta. Ana using QR-CODE that will also minimize the resources consume. It also provides efficiency in the records for the tourist monitoring team since they can have a softcopy of the visitors for the day and print it when they need to. This serves as a way to innovate the Local Government of Sta. Ana toward a more efficient system. The study aims to improve "accuracy, reliability, security, functionality, portability, usability, maintainability, and efficiency."

II. REVIEW OF RELATED LITERATURE

- *Barcode Scanner Based Student Attendance System (SAS)*

A study in Selangor, Malaysia, found that teachers and administrators struggle with manually recording and tracking student attendance. To tackle this, the researchers created the Student Attendance System (SAS), an automated solution meant to make attendance management easier and improve data accuracy. User testing provided positive feedback, but suggested a few minor improvements.

This study shows the need for automated tracking systems to take the place of manual methods. However, unlike the SAS, this research focuses on contact tracing and visitor monitoring for public safety. It aims to extend automation to government-level monitoring of mobility and health, rather than just school attendance.

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- *Smart Wireless Attendance Monitoring Using NFC*

Puja Rani and Oshin (2015) developed a system that allows staff to record student attendance automatically with an NFC reader connected to a central computer. This setup simplifies attendance logging, reduces human error, and improves data accuracy and access for teachers. The system's wireless, collision-free NFC technology ensures secure, efficient, and low-power communication between several devices.

While this study shows the potential of NFC-based automation in education, the current research addresses a different need. It applies similar automation concepts to contact tracing and mobility monitoring. Instead of focusing on classroom attendance, it tracks individuals' movements in public areas to help local governments manage health and safety data effectively, transmission and reception among various units.

- *Attendance System Using NFC Technology and Embedded Camera Device on Mobile Phone*

RajaMurugan, Rohan, and SakthiSankarapandian (2015) found that traditional attendance methods in Thai universities, such as roll-calling and manual signing, were time-consuming and often inaccurate. There were cases where absent students were marked as present. To fix this, they created an NFC-based attendance system. Each student used a unique NFC tag that the instructor scanned with a mobile device, which ensured accurate and efficient attendance tracking.

While their study aimed to improve classroom attendance through NFC technology, the current research expands this idea to public contact tracing. Instead of just tracking classroom presence, the new system monitors visitor entries and movements using QR codes. This approach tackles problems of inefficiency and inaccuracy in local government monitoring systems, like those in Sta. Ana, Cagayan.

- *NFC Based Attendance Monitoring System with Facial Authorization*

Wani, Khubani, and Thoutam (2014) discussed the benefits of Near Field Communication (NFC) as a cost-effective and secure wireless technology for automating attendance systems. Their setup allowed students and staff to record attendance by tapping their devices on an NFC reader. This method produced accurate reports and even supported entry-exit detection and facial recognition. Similarly, studies by Aquilan (2015) and Cantoma (2015) showed how automation and computerization improve record management and reduce human error in attendance and administrative systems.

While these studies show how effective automation is in managing records for educational and organizational settings, the current research addresses a new need by applying digital tracking to public health monitoring. It specifically introduces a QR code-based contact tracing system for Sta. Ana, Cagayan. This system offers a low-cost, efficient, and contactless option for local government monitoring during and after pandemic conditions.

- *Mobile Barcode Based Examination Attendance System*

The study on the Mobile Barcode-Based Examination Attendance System introduced a smartphone app that automates attendance tracking during classes and exams. It offered a clear, time-saving option compared to manual attendance methods. This allowed administrators to manage subjects, schedules, and classrooms easily through a simple, user-friendly interface. The system's connection with database servers ensured that data was stored accurately and could be retrieved easily.

While this research showed how mobile barcode technology can improve academic attendance monitoring, the current study expands this idea to public health and safety applications. Instead of being used in classrooms, it uses QR code technology for visitor tracking and contact tracing. This addresses problems in manual monitoring systems within local government operations, specifically in Sta. Ana, Cagayan.

- *Barcode Based Student Record System*

The researchers behind the Barcode-Based Student Record System (B.B.S.R.S.) highlighted the need to keep student records accurate, secure, and easy to access in schools. Their system replaced manual recordkeeping with a centralized database that used barcode scanning to manage student information, attendance, and library transactions. This method reduced human error and improved data security and efficiency.

While their study focused on making academic record management more efficient in schools, the current research looks at a wider community issue. It aims to improve public health monitoring through digital tracking. By using similar principles of secure data handling, the proposed QR code-based contact tracing system in Sta. Ana, Cagayan seeks to help local government manage visitor records and enhance the efficiency of contact tracing efforts.

- *Student Attendance System by Barcode Scan*

An article on Academia.edu suggested a barcode-based attendance system that aims to replace traditional manual attendance recording. This system removes the need for physical attendance sheets by enabling quick and accurate verification through barcode scanning. This change greatly reduces the time and effort required for both students and instructors.

While this project simplifies attendance tracking in schools, this research takes automation further by introducing a QR code-based contact tracing system for the public sector. This system seeks to improve how visitors are monitored in Sta. Ana, Cagayan, tackling local issues with manual data collection and managing responses during a pandemic.

- *Developing and Implementing a Barcode Based Student Attendance System*

Chauhan et al. created a facial recognition-based attendance system. This system automates student attendance

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by detecting, aligning, and encoding faces into unique digital identifiers. It uses a Support Vector Machine (SVM) classifier to recognize students accurately and generates attendance reports that are sent to instructors via email. Built with ASP.NET, it includes a secure login process that ensures data validity and controlled access to the system.

While this study demonstrates how facial recognition can effectively automate attendance in schools, the current research focuses on a different area: community-level contact tracing and visitor monitoring. The proposed system in Sta. Ana, Cagayan uses QR code technology instead of facial recognition. This approach provides a cost-effective, privacy-friendly, and easily deployable solution for local governments during public health crises.

- *Barcode based Student Attendance System*

A 2015 study published in the IJCA Journal introduced a Barcode-Based Student Attendance System to automate attendance tracking in colleges. The system replaced manual paper registers with barcode scanners. This change allowed students to log their attendance by scanning ID cards that contained their personal information. It provided secure access for teachers and administrators, which helped improve record accuracy and prevent fraudulent entries.

While this system effectively improved attendance management in schools, the current research expands its use to public health and visitor monitoring. By implementing a QR code-based contact tracing system, this study addresses the need for a contactless, accurate, and efficient way to help the Local Government Unit of Sta. Ana, Cagayan manage visitor records and reduce issues with manual monitoring.

- *Student Attendance Online System Using Bar Code Reader*

Nurul Liyana Binti Mahmod developed a computerized student attendance system to replace manual record-keeping with a secure, automated process. The system uses a card reader and student matric cards to record attendance directly to a centralized server. This allows lecturers to generate attendance reports quickly. It improves security, reduces student dishonesty, and makes record access easier through a simple interface.

While this study focuses on automating academic attendance tracking, the current research broadens the idea to include public visitor monitoring and contact tracing. By using QR code technology instead of ID cards, the proposed system in Sta. Ana, Cagayan improves data accuracy, accessibility, and real-time tracking. This addresses problems with manual health monitoring and supports the local government's pandemic response efforts.

- *Students Smart Card Using VB.NET SQL, Barcode*

The publication highlights the increasing global use of smart card technology due to its convenience, portability, and versatility. In education, smart cards can be integrated into various systems, such as attendance tracking, library management, and cashless transactions in canteens or offices, to automate manual processes and improve efficiency. By incorporating supporting technologies like RFID, barcodes, and QR codes, smart cards provide a unified solution for managing multiple campus operations securely and effectively.

While this study focuses on the multifunctional use of smart cards in schools, the current research applies similar automation ideas to local government operations. Using QR code-based monitoring and contact tracing, this study addresses Sta. Ana, Cagayan's need for a reliable, contactless, and efficient system to record and track visitors. It connects educational automation with community-level health and safety management.

- *Events Attendance Monitoring System Using Biometrics and SMS*

The Institute of Information and Communication Technology (IICT) at Isabela State University, Echague Campus, struggles with monitoring student attendance during institutional events. The current manual process requires students to sign attendance sheets. This leads to long queues, record-keeping errors, and frequent complaints about inaccurate attendance reports. Miscommunication among student organizations makes the process more complicated, causing frustration during clearance validation.

To fix these issues, the researchers proposed an Event Monitoring System that uses Biometrics with SMS notifications to track attendance automatically, improve accuracy, and give instant feedback to students. This study builds on that idea by developing a QR code-based monitoring and contact tracing system. This system is not for tracking student attendance; instead, it is for monitoring visitors within local government operations. It aims to create a more efficient, contactless, and reliable process for public monitoring and reporting.

- *Faraon Institute Students Monitoring System with SMS Support*

The study at Isabela State University, Echague Campus, found significant challenges in tracking student attendance during events. The current manual process leads to long lines, inaccurate data, and frequent miscommunication. To solve these problems, researchers created an Event Monitoring System that uses biometric technology and SMS notifications to automate attendance recording. This system also improves communication between students and organizers. The study shows the need for reliable monitoring systems. It connects to this research's goal of using QR code-based contact tracing to improve data accuracy and reduce human error in tracking attendance or visitor records.

- *Student Attendance Monitoring and Identification System Using Barcode and SMS*

The study conducted in Isulan, Sultan Kudarat, revealed that most schools still depend on manual attendance tracking, which often leads to inaccurate records and limited parental awareness of student attendance. To solve these issues, researchers proposed a Student Attendance Monitoring and Identification System using Barcode and SMS, designed to automate attendance tracking and notify parents in real-time. This research underscores the importance of computerized

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and real-time monitoring systems, a gap that the current study addresses through a QR code–based application that enhances accuracy, automation, and communication in tracking attendance or visitor data.

➢ *The Features of Quick Response (QR) Code as an Attendance Monitoring System: Its Acceptability and Implication to Classroom s Attendance Monitoring System Using Biometrics and SMS*

The study at Isabela State University, Echague Campus, found significant challenges in tracking student attendance during events. The current manual process leads to long lines, inaccurate data, and frequent miscommunication. To solve these problems, researchers created an Event Monitoring System that uses biometric technology and SMS notifications to automate attendance recording. This system also improves communication between students and organizers. The study shows the need for reliable monitoring systems. It connects to this research's goal of using QR code-based contact tracing to improve data accuracy and reduce human error in tracking attendance or visitor records.

- *QR Code Formats:*

QR Quick Response (QR) codes can store data in several ways, depending on the type of information they are designed to hold. There are four standard encoding modes, each defining how data is interpreted and how much information a QR code can contain. These include numeric, alphanumeric, byte, and kanji modes. The encoding mode used by a QR code is identified within its version information field (Denso Wave, 2023).

✓ Numeric mode – used exclusively for digits from 0–9; this mode is the most compact and can hold up to approximately 7,089 characters.
✓ Alphanumeric mode – includes digits, uppercase letters (A–Z), and a few symbols such as $, %, *, +, -, ., /, :, and space, storing a maximum of 4,296 characters.
✓ Byte mode – designed for characters in the ISO–8859–1 set, allowing roughly 2,953 characters and supporting more diverse languages and symbols.
✓ Kanji mode – encodes Japanese characters using the Shift JIS format, storing up to about 1,817 characters. An optional Extended Channel Interpretation (ECI) feature enables encoding in UTF–8, though not all QR code readers support this mode (Denso Wave, 2023; ISO/IEC, 2015).

- *Common Styles of Two-Dimensional Codes*

Different two-dimensional barcode systems exist alongside the standard QR code, each varying slightly in appearance and data structure but serving the same goal—storing information that can be scanned digitally (Wang, 2011; Welch Allyn, 1992).

✓ QR Code – The original version developed by Denso Wave in 1994, easily recognized by its three corner positioning markers that assist scanners in orientation.
✓ Aztec Code – Designed by Welch Allyn, this symbol places its central finder pattern at the center rather than in the corners.
✓ MaxiCode – Used by the United States Postal Service, featuring a honeycomb structure and a central locator symbol.
✓ PDF417 – Created in 1991 by Ynjiun Wang at Symbol Technologies, this rectangular 2D barcode combines linear and matrix elements.
✓ Semacode – A type of data matrix created by the company of the same name, visually similar to a QR code but without distinct finder patterns (Denso Wave, 2023; Wang, 2011).

- *An Overview of QR-Code System's History*

The QR code was developed in 1994 by Denso Wave, a subsidiary of Toyota Motor Corporation, to improve part tracking efficiency in automobile production. Unlike standard barcodes, which can only store numeric data, QR codes were designed to encode alphanumeric and Japanese character sets while maintaining high-speed readability. Over time, the technology was standardized internationally under ISO/IEC 18004, leading to its adoption in logistics, retail, and, more recently, digital contact tracing systems (Denso Wave, 2023; ISO/IEC, 2015).

III. TECHNICAL BACKGROUND

➢ *Description of the Proposed System*

The Mobility and Contact Tracing App will help the Local Government Unit of Santa Ana, including the RHU and Contact Tracing Team, monitor and manage travel within Santa Ana. Its goal is to lower Covid-19 cases in the area. The app is a mobile application that works offline and online. It allows authorized users to quickly gather visitor information using QR codes and check their identity and vaccination status.

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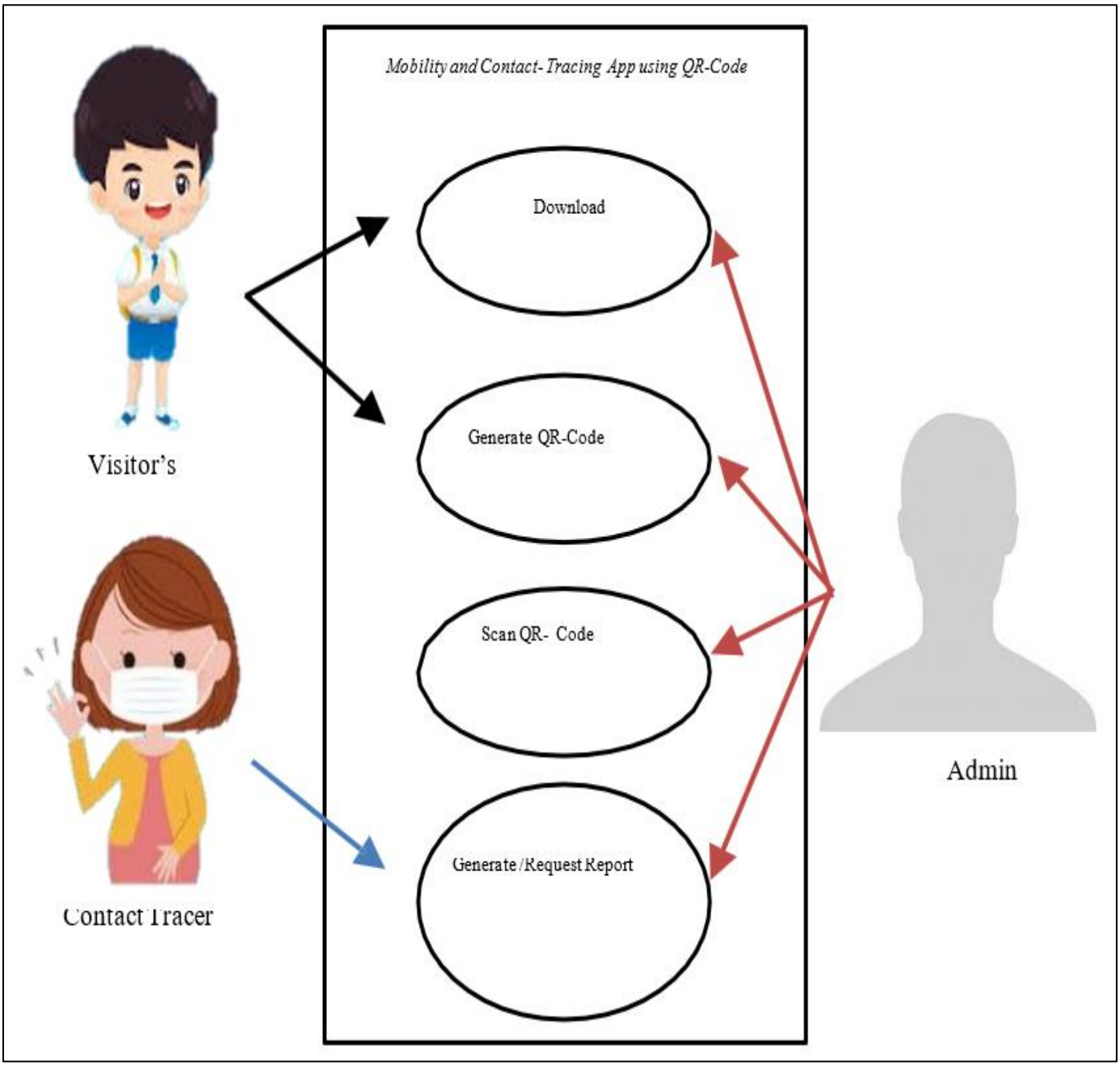

Fig 1 Schema of the "Mobility and Contact Tracing App"

The Use Case diagram for the "Mobility and Contact Tracing App" illustrated in the figure showcases the tasks carried out by both users and administrators. By using the MIT App, users can download and generate their own QR codes based on the information they provide in the application; it effectively saves the Visitor's Log through Google Sheets, a tool intended for monitoring and tracing contacts; it is easy to use and relevant.

In the administrator section, the admin user can temporarily store the Data on their devices offline; upload it to Google Sheets when an Internet connection is available, and it is secure and restricted to authorized personnel, capable of capturing Visitors' identities and vaccination cards while managing database flow.

The preceding figures display screenshots of the developed system. The database schema outlines the back-end of the application. The application can be used with or without Internet access. Additionally, it functions properly across various Android versions. The developed application, "Mobility and Contact Tracing App," employs Google Sheets as its database through.

- *The User Interface (Home Page)*

The homepage serves as the main interface visible to both users and administrators. Included here are: Description of the application, Bida Solusyon sa Covid-19, Latest update of Covid Positive in Santa Ana, frequently asked questions in terms of Covid-19 symptoms, accurate Time and Date.

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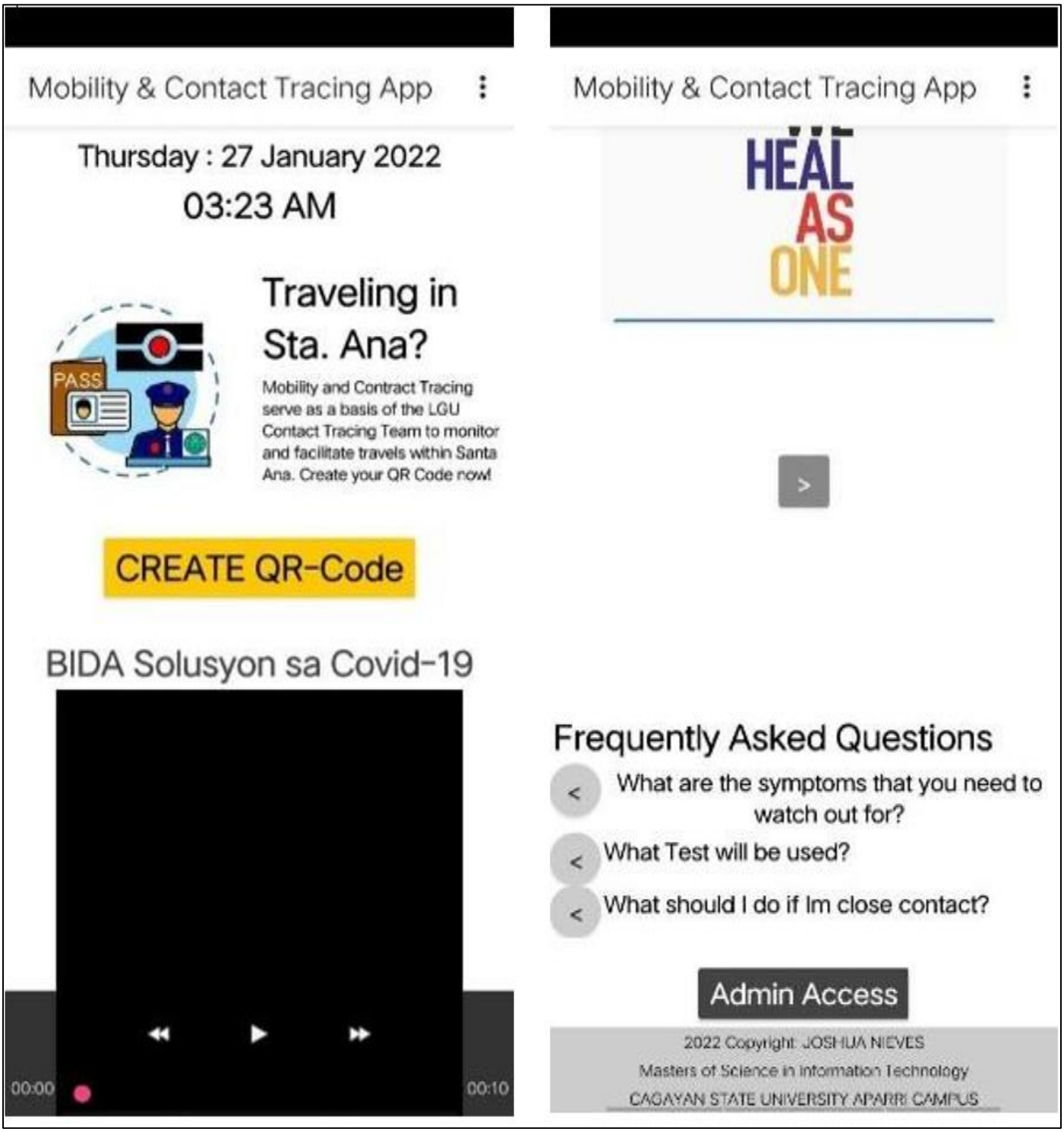

Fig 2 Homepage of "Mobility and Contact Tracing App"

➢ *Visitors Space*

When users press the CREATE QR-Code button, they will be taken to the subsequent screen, which includes the splash screen and the Visitor's Space where a Disclaimer will appear. This is to guarantee users that the gathered data privacy will be utilized solely for Contact Tracing and Monitoring of Visitors in Santa Ana and will be accessible only to authorized personnel. The pop-up will close simply by clicking Confirm.

In this section, users must enter the necessary information to generate a QR code. Users are required to provide their personal information, which includes their contact number, their originating location, or if they are coming from outside Cagayan, the reason for their visit to Santa Ana, the type of vehicle they will be using, and the dates that indicate how long they plan to stay in Santa Ana. If any information is missing, users will be unable to create a QR code.

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Fig 3 Visitors Information form Sample

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Visitors Space provides guidelines on the extra requirements necessary for entering the municipality of Santa Ana. When the user clicks on Generate QR-Code, it will be automatically saved in their Gallery (internal storage). Below the Generate QR-Code button, there is a list of contact numbers for the RHU Santa Ana, PNP Santa Ana, MDRRMO, and the Tourism Office.

➢ *Admin Access (Security)*

The Admin access can be found at the lower section of the application. Users are able to view it, but they will need to enter a security pass when attempting to click in, ensuring the protection of the Admin Space. Only the authorized officer or designated individual will have the ability to enter the Admin Space.

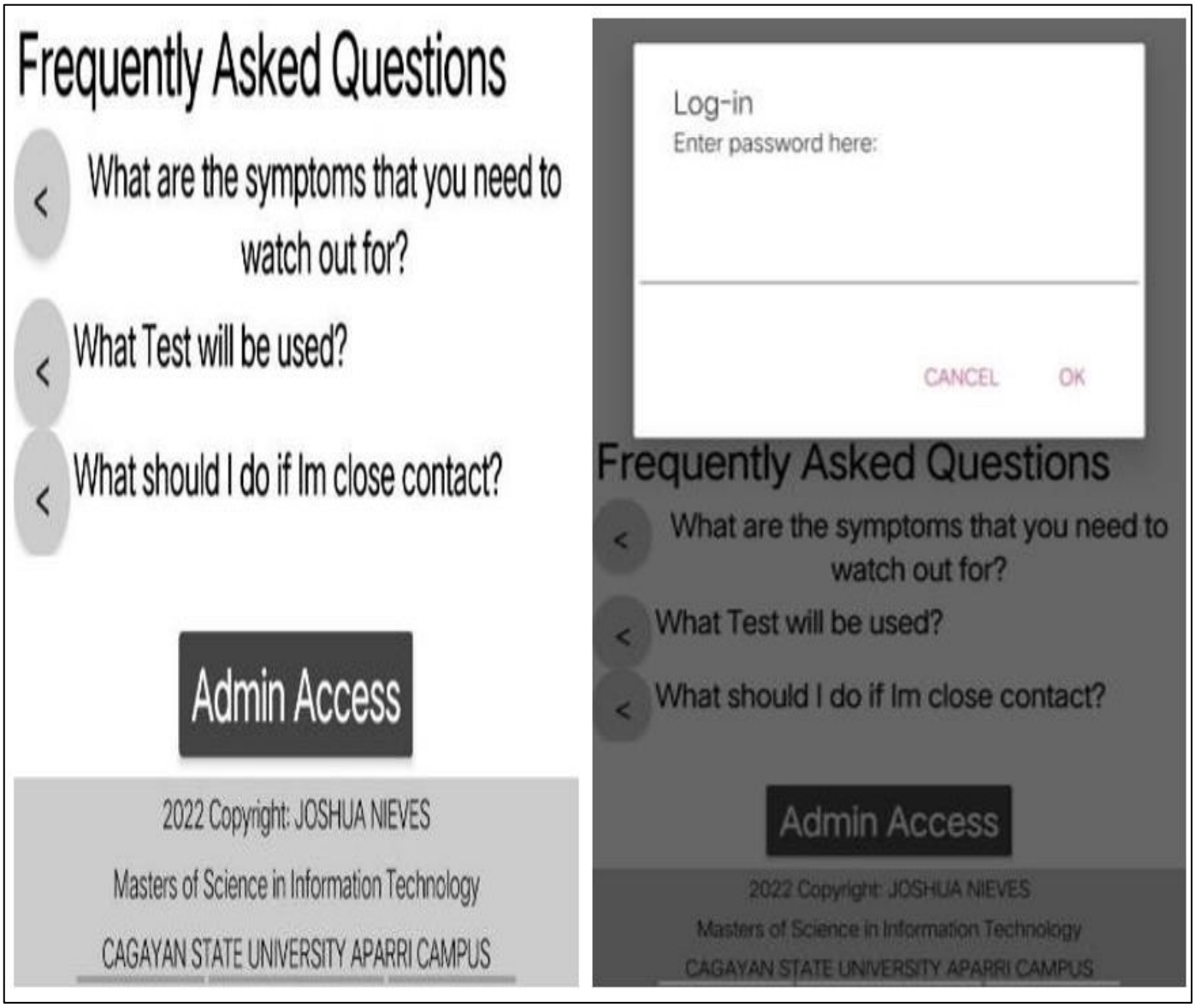

Fig 4 FAQ and Log-in Sample

➢ *Admin Space*

The administrator will simply SCAN the QR-Code created by the visitors, which will automatically input their information. Additionally, visitors must provide further identification to confirm their identity. Any government-issued identification is acceptable, along with proof of vaccination. The administrator can temporarily save each record on their mobile device and upload it when an internet connection is available. Participants are allowed to change, modify, delete, and save information if there are errors, typos, or missing data in the visitors' information. Any establishment in Santa Ana can utilize the application to track and monitor visitors within their locations, offering greater convenience for establishments where data connectivity is limited. Google Sheets will serve as the temporary database.

Google Sheets will serve as the database for the application, with the accumulated data being stored in the Visitors Log for safekeeping. As it is already in Excel format, sorting, modifying, and printing the data for future use will be straightforward. To ensure data integrity and security, the Google Sheet (Database) will be designated for use by a single account for each establishment.

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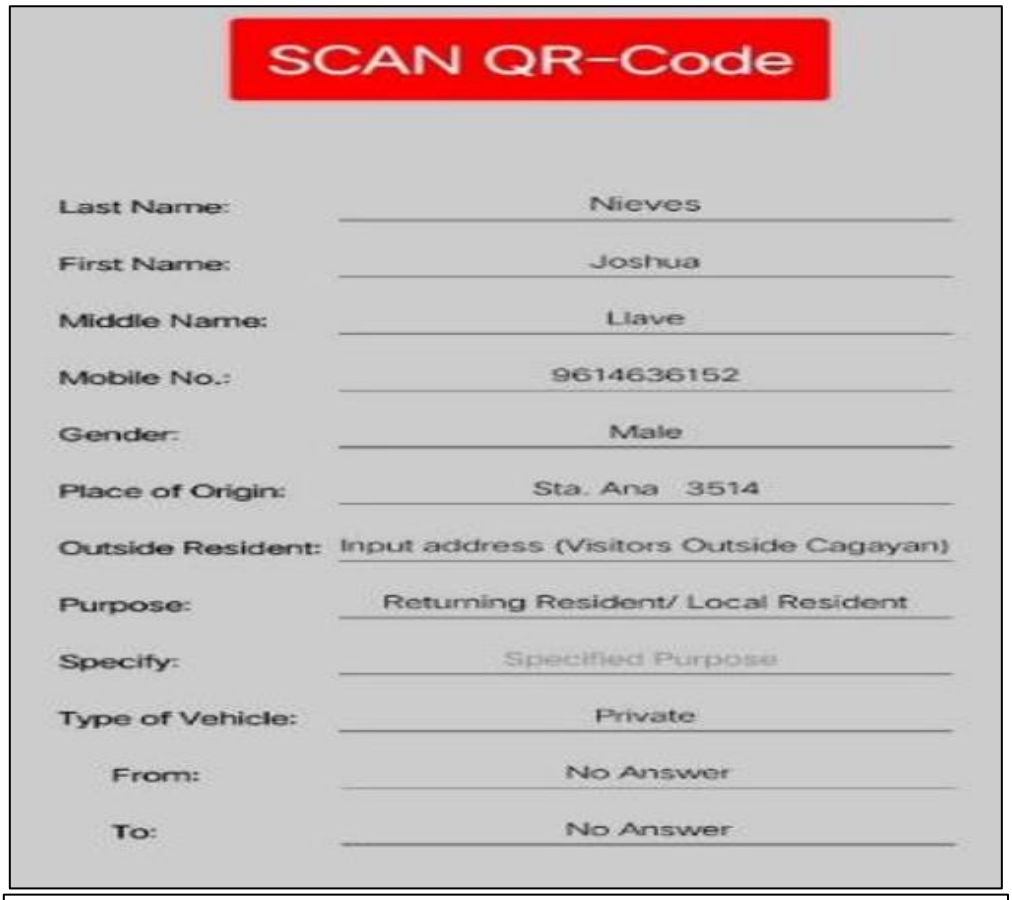

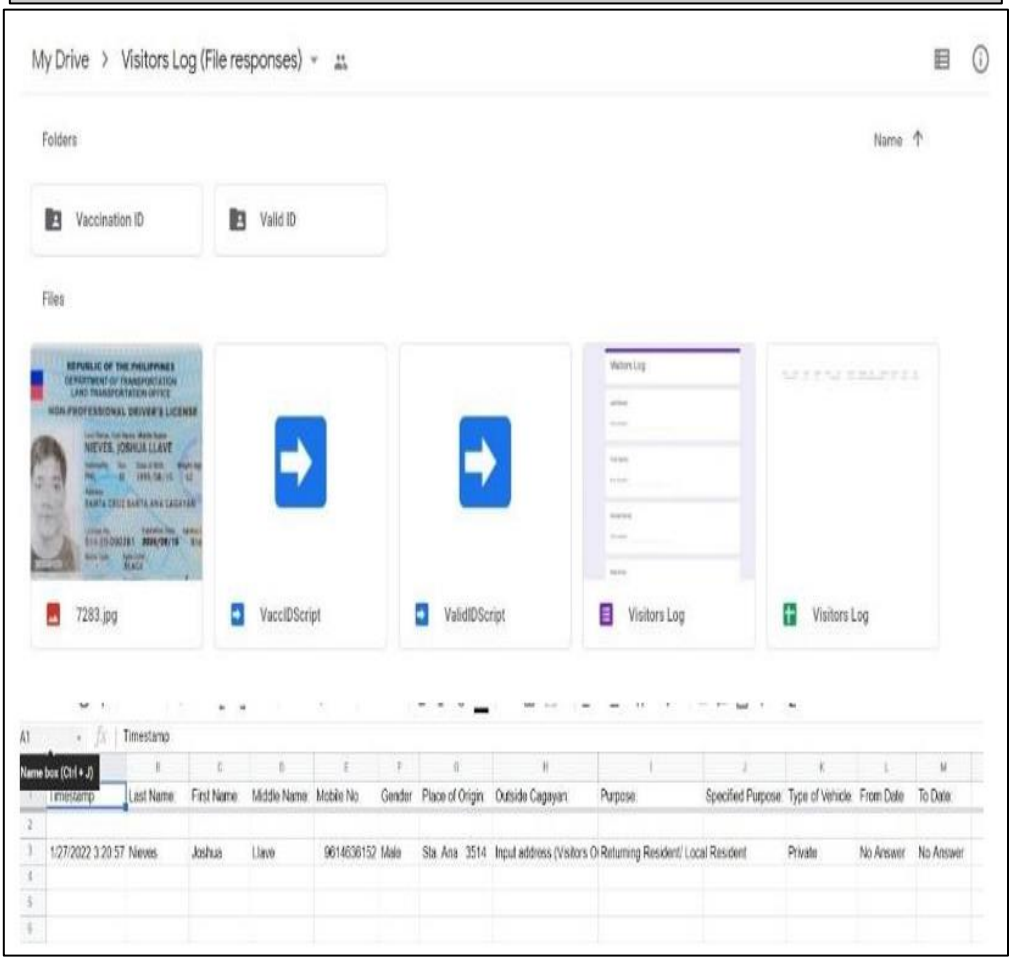

Fig 5 Records Showing in the Google Sheet

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IV. METHODOLOGY

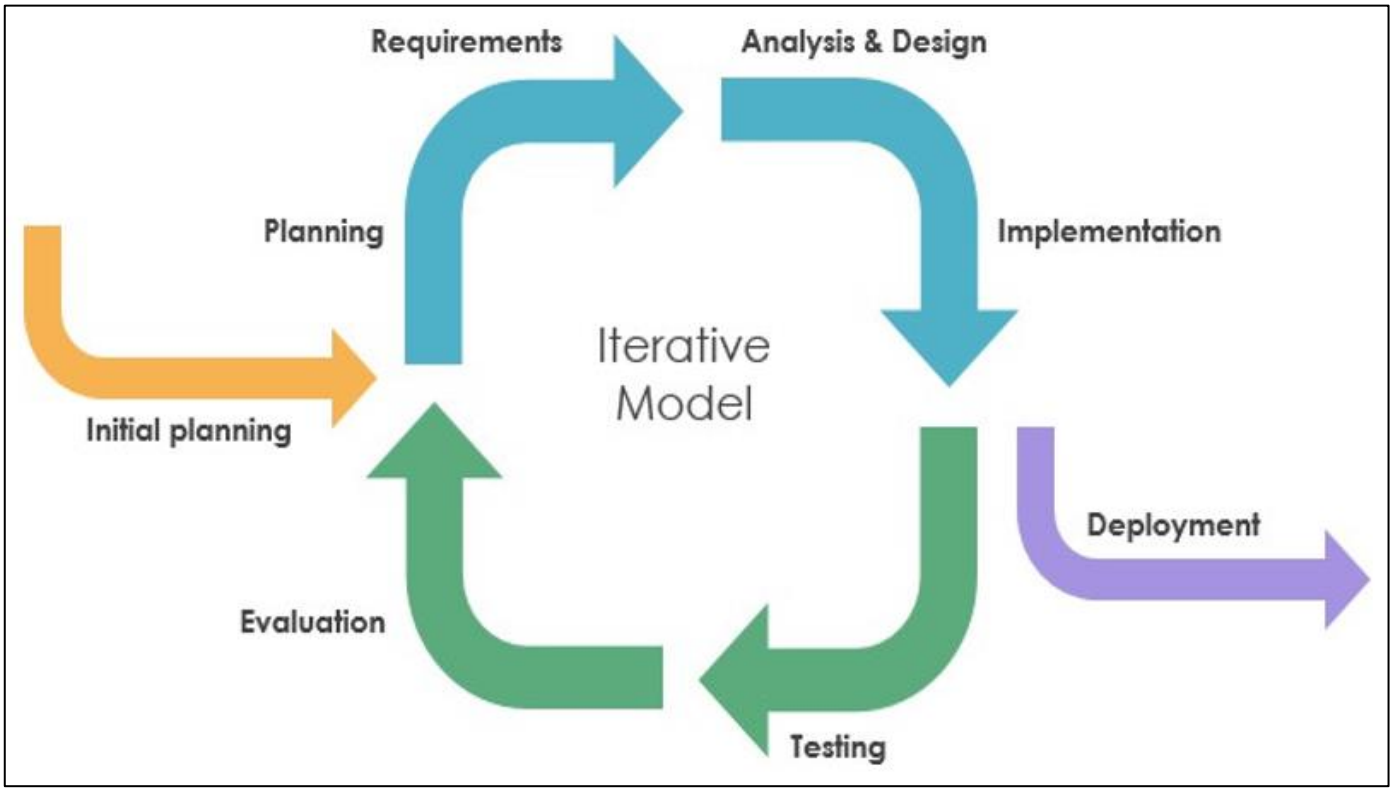

Fig 6 Iterative Model

This chapter will explore the techniques employed in gathering and analyzing data. These methods concentrate on the experiences of individuals involved while striving to understand the motivations behind specific behavior descriptions. The evaluation was conducted utilizing data collection methods and interviews.

➢ *Research Design*

The study utilized a descriptive research design. This method aimed to present a comprehensive arrangement of data and information gathered through a survey questionnaire. Additionally, unstructured interviews were carried out to reinforce the study's findings, which were then analyzed, synthesized, and categorized accordingly. It detailed the characteristics of the application and assessed the flexibility of QR-Code as a Contact Tracing and Monitoring tool. The evaluation employed a standardized instrument adapted from ISO 9126.

- *Planning Phase*

This initial stage of the study sees the researcher concentrating on existing practices and processes essential for entering Sta. Ana Arch. Communication with the local government unit (LGU) will be established. The researcher then devises a method for data collection and organizes the limited time available for conducting interviews. Planning encompasses analysis, design, software development, testing, evaluation, implementation, and ultimately deployment. The researcher will prepare the necessary items or checklists to gather the required information.

- *Analyzing*

To collect the necessary data for the research, the researcher conducted an interview at Sta. Ana Arch. A portion of the interview aimed to comprehend the current system or method employed by the LGU. After collecting and analyzing the data, the researcher assessed how to provide a concrete solution based on the gathered information. Process flows were scrutinized, and existing policies and procedures were reviewed. The analysis of current issues was essential for designing the prototype through wireframes or design diagrams.

- *Designing*

During this phase, the researcher concentrated on developing the application's user interface (UI). This includes information gathering, QR-Code generation, reporting, and admin management, all crafted for user-friendliness with minimal complexity.

- *Software Development*

For system development, the researcher utilized MIT App Inventor for both the UI and the underlying source code, ensuring straightforward and accurate data and information collection.

- *Coding Implementation*

The user guide has been assembled for the final deliverable to the Local Government Unit. This encompasses both documentation and software. At this phase, we will carry out administrative orientation and training sessions on how to operate the system.

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Table 1 Testing Priority Matrix Form

Matrix Form	1st phase	2nd Phase	3rd Phase	4th Phase
Data Collection				
System Process				
Database				
User Design				

➢ *Input-Process-Output Diagram*

In the system development process, the researcher chose MIT App Inventor 2 due to its basic structure as a block programming language, which is especially simple in creating executable code for mobile devices.

- *Testing*

The testing phase allowed the researcher to identify both minor and major errors within the application, providing valuable insights into further development.

- *Research Procedure*

Red – Priority, Orange – High, Yellow – Normal, Green – Low

Table 2 Implementation Schedule

Planning	Data Gathering and Planning		Jan 20
Analyzing		Interview and Prototyping	
Designing		User Interface and Database	
Implementation			Final Test

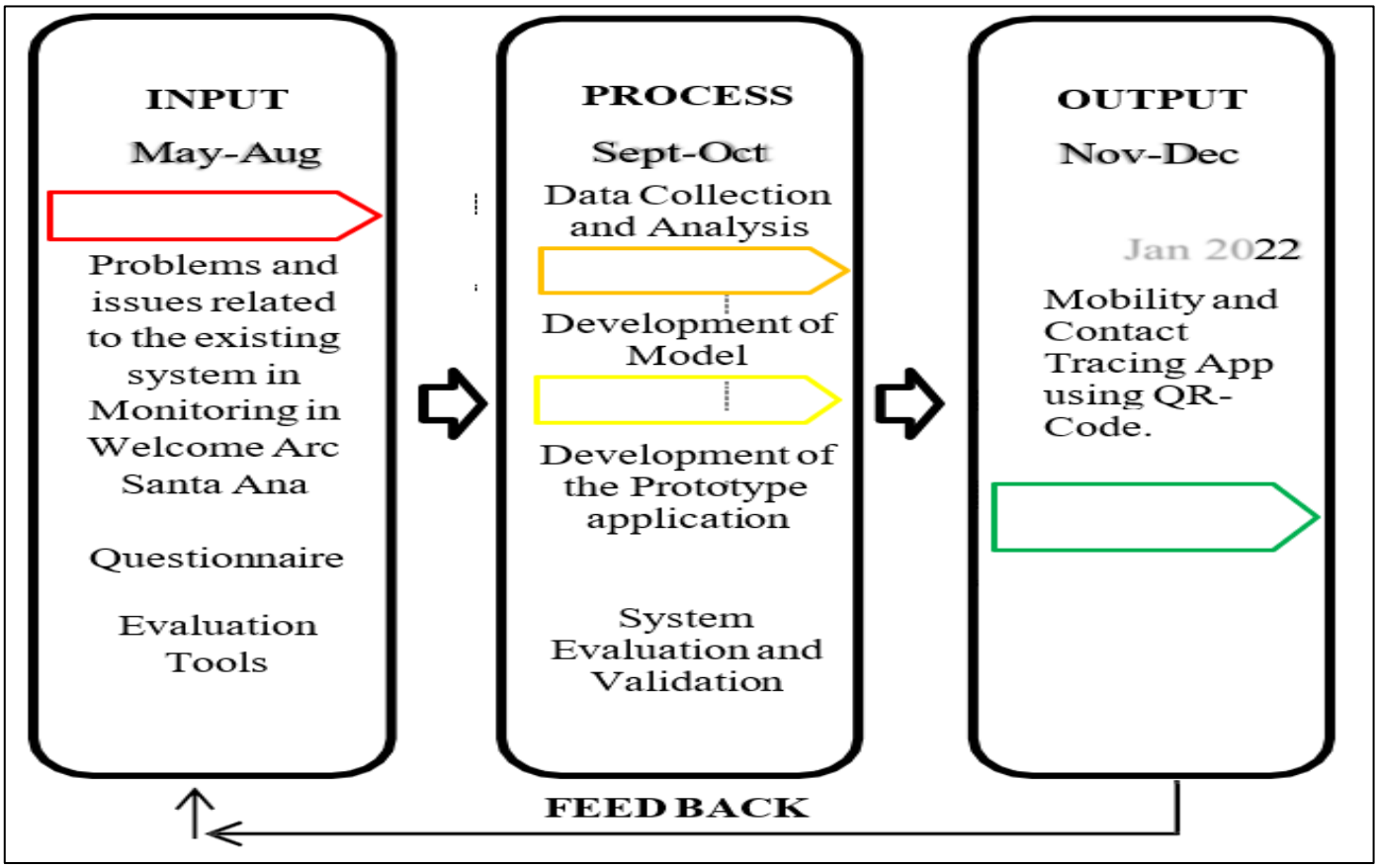

Fig 7 IPO Diagram

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The researcher utilized the input-process-output (IPO) model depicted above as a framework. This model illustrates the system's functionality during its operation.

The first section (Input) signifies the various problems and issues that need to be gathered in order to pinpoint potential solutions. The middle section (Process) encompasses the collection and analysis of the collected data, as well as the development of the application's prototype for evaluation. Finally, the last section (Output) represents the finalized application, which users will utilize to submit feedback and report any errors, which will consequently lead back to the Input.

➢ *Context Diagram*

The illustration above shows the manual process for using the system and identifies the individuals involved in the operation. Visitors are required to create their QR code, which they will scan at the QR code scanner to gain entry to the tourist spot, serving as their admission pass. The tourist administrator can produce a report in Excel format that can be utilized for monitoring visitor entry and exit.

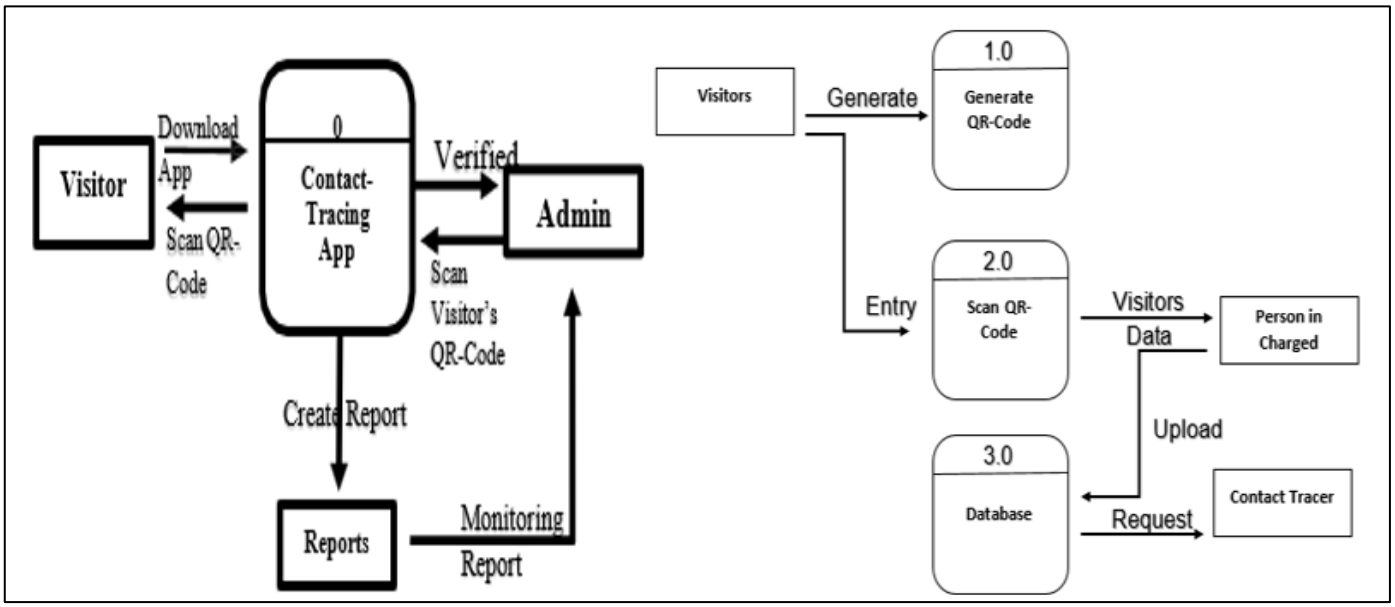

Fig 8 Context Diagram

➢ *Use Case Diagram*

The illustration above depicts the individuals engaged in utilizing the application. Initially, the Visitor will create a QR-Code containing his or her details and will display it at each entrance of a Tourist Attraction. The admin is responsible for scanning the QR-Code of each visitor and has the ability to produce a printed report, as well as generate a report if needed by the Contact Tracer Team.

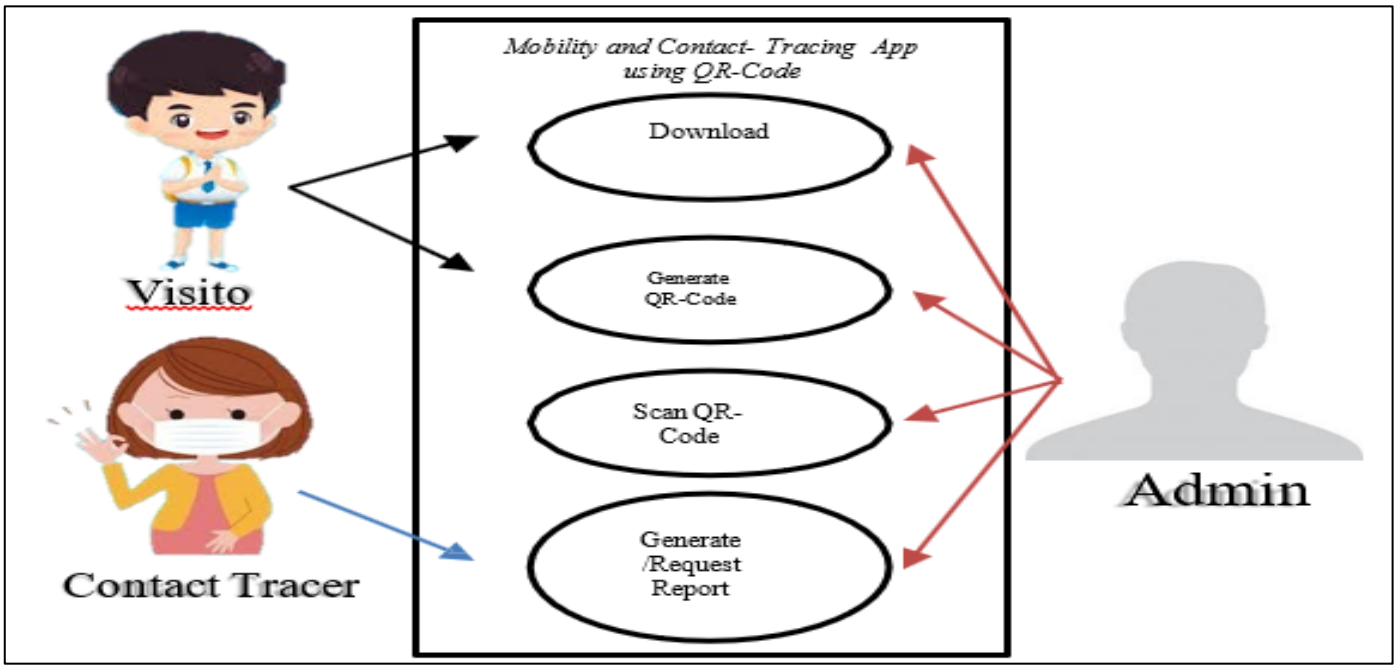

Fig 9 USE CASE Diagram

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➢ *Data Flow Diagram*

The illustration provided depicts the data flow of the application. Visitors will create their QR code through the application and scan it to enter each location they visit, after which the Admin Staff will SCAN and authenticate the details, updating the system in the database. The Staff can then produce daily or monthly reports. Meanwhile, the Contact Tracer team can ask the tourist staff for a printed copy of the Visitor Log.

➢ *System Architecture*

The architectural diagrams presented above will be utilized in the "Mobility and Contact-Tracing App using QR-Code." The application process involves visitors downloading and generating a QR-Code image file containing their data. This QR-Code will serve as a means of entry at various tourist locations in Cagayan, adhering to the IATF protocols for contactless transactions. When entering the area, the admin or staff will use their mobile devices to scan the visitor's QR-Code and confirm their information against the database. The verification results will be displayed on the screen, indicating successful entry. Additionally, the entry record can be saved to the phone's storage or printed as a hard copy.

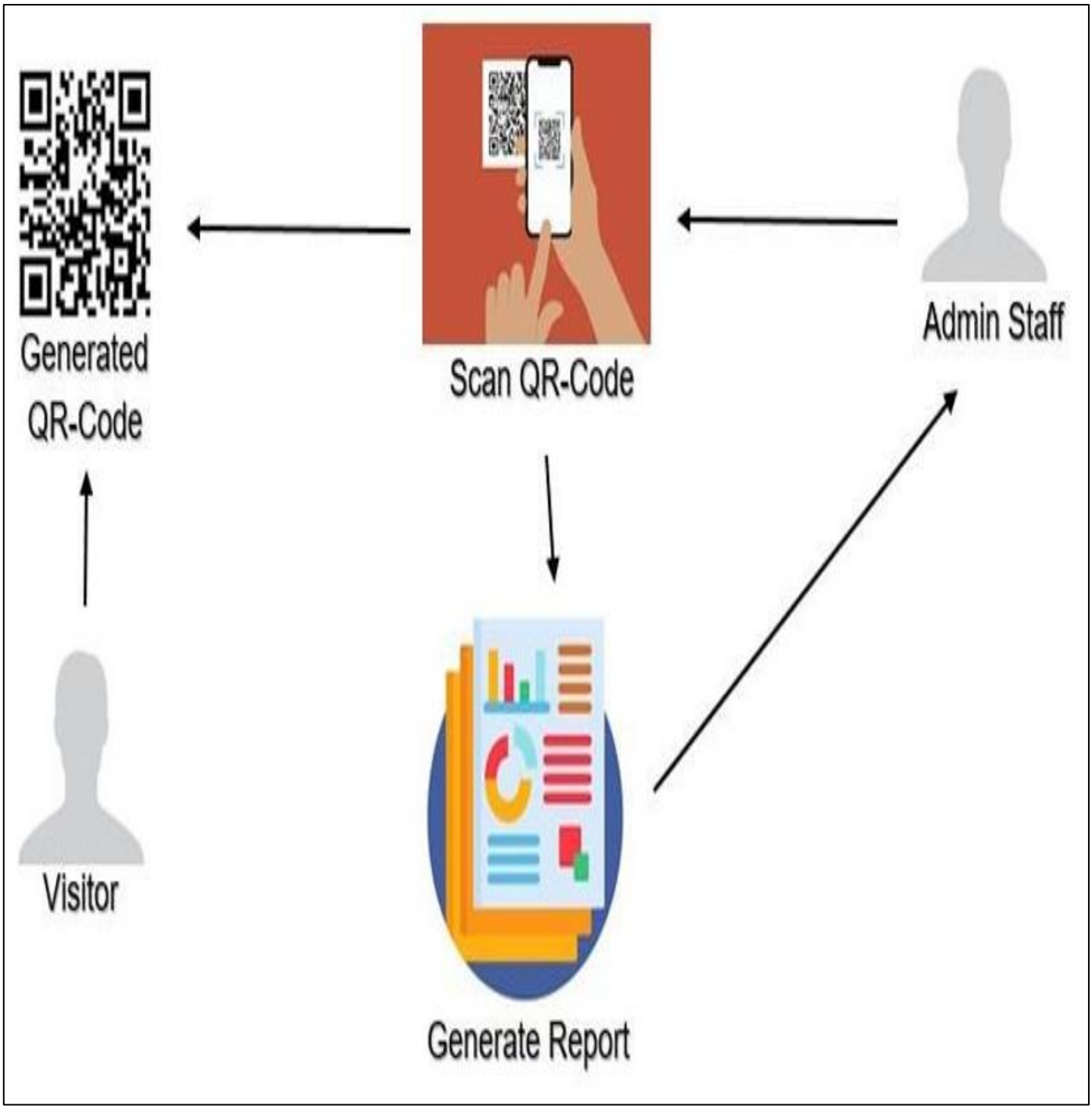

Fig 10 System Architecture

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➢ *Participants of the Study*

The participants listed below will assist in the analysis, design, testing, and implementation of the "Mobility and Contact-Tracing App using QR-Code," as well as in the systems assessment and addressing both major and minor issues and concerns throughout the process.

Table 3 Participants of the Study

Participants	N	%
Tourist Admin / Staff	5	25
MDRRMO, RHU Office and Staff	5	25
LGU Staff/Employees	5	25
PNP Officer and Personnel	5	25
Total	20	100

➢ *Data Gathering Tools*

The instruments utilized for gathering and analyzing the necessary data are outlined as follows.

- Interview Guide – This consists of a series of questions posed to participants during interviews to gather information about the procedures, practices, challenges, and current issues in the execution and management related to monitoring and tracking documents in Sta. Ana Arch. The interview guide included in the appendices comprises 10 questions that were derived from interviews with participants.
- Questionnaire - The assessment questionnaire employed to evaluate the level of compliance of the developed system with ISO 25010:2011 was derived from that standard (International Standards Organization, 2019). This tool has been utilized globally for assessing various information and web systems and has been reported to demonstrate reliability. A copy of the questionnaire can be found in the appendices.
- Document Analysis – The documents related to the implementation and practices of the system, as well as the authorized personnel involved, were examined to understand the actual practices, processes, and operations of the system.

➢ *Data Gathering Procedure*

The data collection process involved the following steps.

- A formal request was made through communications to initiate the data collection. A letter was sent to the mayor's office to obtain consent for interviews, document analysis, and the collection of data via questionnaires, with the graduate school adviser and dean being informed.
- The project objectives, the study's purpose, and its benefits for the participants were presented, and their consent was secured through a form to encourage their active participation in the study.
- Before developing the system, participants were interviewed using a guide to discuss the practices, issues, and challenges associated with the current system. Document analysis was conducted to review reports, formats, and established guidelines.
- Ongoing communications were maintained throughout different phases of the system development to address the necessity of the system while finalizing its modules.
- A prototype test was carried out with participant involvement, where their feedback and suggestions were critical for enhancing the system, which were then incorporated.
- Once all modules and processes were integrated into a single system, it was put through initial utilization. Participants were given a week to test the system for bugs and evaluate its features, during which all feedback was once again considered.
- The application will be used with QR-Code functionality during its operation. The assessment of the app's compliance with ISO 25010 was conducted using a validated questionnaire.
- Data will be organized and analyzed, and the results will be discussed and presented.
- All collected data will be stored until it is no longer needed for data presentation and the completion of the research, after which it will be disposed of.
- Copyright registration for the application will be pursued to safeguard intellectual property rights.

➢ *Data Analysis and Statistical Tools*

The information gathered from the participants was organized, confirmed, and examined using descriptive statistics. Frequency counts, percentages, and weighted means were utilized to evaluate the system based on the following 5-point Likert scale:

Table 4 Data Analysis and Statistical Tools

Numerical Inputs	Weighted Mean	Verbal Interpretation
5	4.21 – 5.00	To the highest extent / Excellent
4	3.41 – 4.20	To high extent / Very Good
3	2.61 – 3.40	To moderate extent / Good
2	1.81 – 2.60	To least extent / Fair
1	1.00 – 1.80	To very least extent / Poor

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V. FINDINGS AND RESULTS

This chapter outlines various findings and elaborates on the involved processes. The structure of the chapter is as follows: (1) a summary of the existing practices and methods employed to monitor visitors at Welcome Arc Santa Ana, along with the challenges encountered in monitoring, operations, and management; (2) an overview of the proposed application, "Mobility and Contact Tracing App"; (3) an evaluation of the "Mobility and Contact Tracing App" in key offices based on the ISO/IEC 25010:2011 or ISO 9126 Quality Standards; and (4) an examination of feedback and recommendations from key offices (PNP Santa Ana, RHU Santa Ana, LGU of Santa Ana, MDRRMO, and Tourism Office) focused on enhancing the "Mobility and Contact Tracing App".

➢ *Current Practices and Processes in the Conduct of Monitor in the Welcome Arc Santa Ana*

The current practices and processes for monitoring the Welcome Arc regarding Visitors or Guests are described in the previous paragraphs. Based on observations and interviews, the following issues, concerns, and practices were noted:

- Monitoring at the Welcome Arc in Santa Ana involves close coordination with the RHU, MDRRMO, PNP Santa Ana, and the Local Government Unit of Santa Ana.
- Since 2020, during the lockdowns and quarantine, the Municipality of Santa Ana has enforced strict border control, guided by the Inter Agency Task Force, to prevent Covid-19 cases in the area.
- Monitoring in Santa Ana begins at the Welcome Arc, established by the Local Government Unit of Santa Ana. An assigned staff member from the Municipal Health Office oversees this, with support from the PNP and Military.
- The health officer conducts inspections of Quarantine Passes issued by the person's original Barangay or Municipality. This follows the National Government's instructions regarding travel between municipalities.
- Individuals who cannot show their Quarantine Pass will be required to turn back and will not be allowed to enter the Municipality of Santa Ana.
- Another requirement for entering Santa Ana is the Swab Test result (certificate), which indicates whether a person is negative or positive for Covid-19. If someone shows symptoms of the virus, they must undergo an RT-PCR Swab Test, which is more accurate for confirming the infection.
- When vaccines became available, showing a Vaccination Card became part of the requirements for entering the Municipality of Santa Ana at the Welcome Arc.
- The Health Officer then prepares a paper report for the Regional Health Office of Santa Ana to monitor and identify individuals entering Santa Ana.

The current flow of monitoring in Santa Ana Arc as well as the preparing the reports for the Regional Health Office of Santa Ana are presented in the foregoing figures.

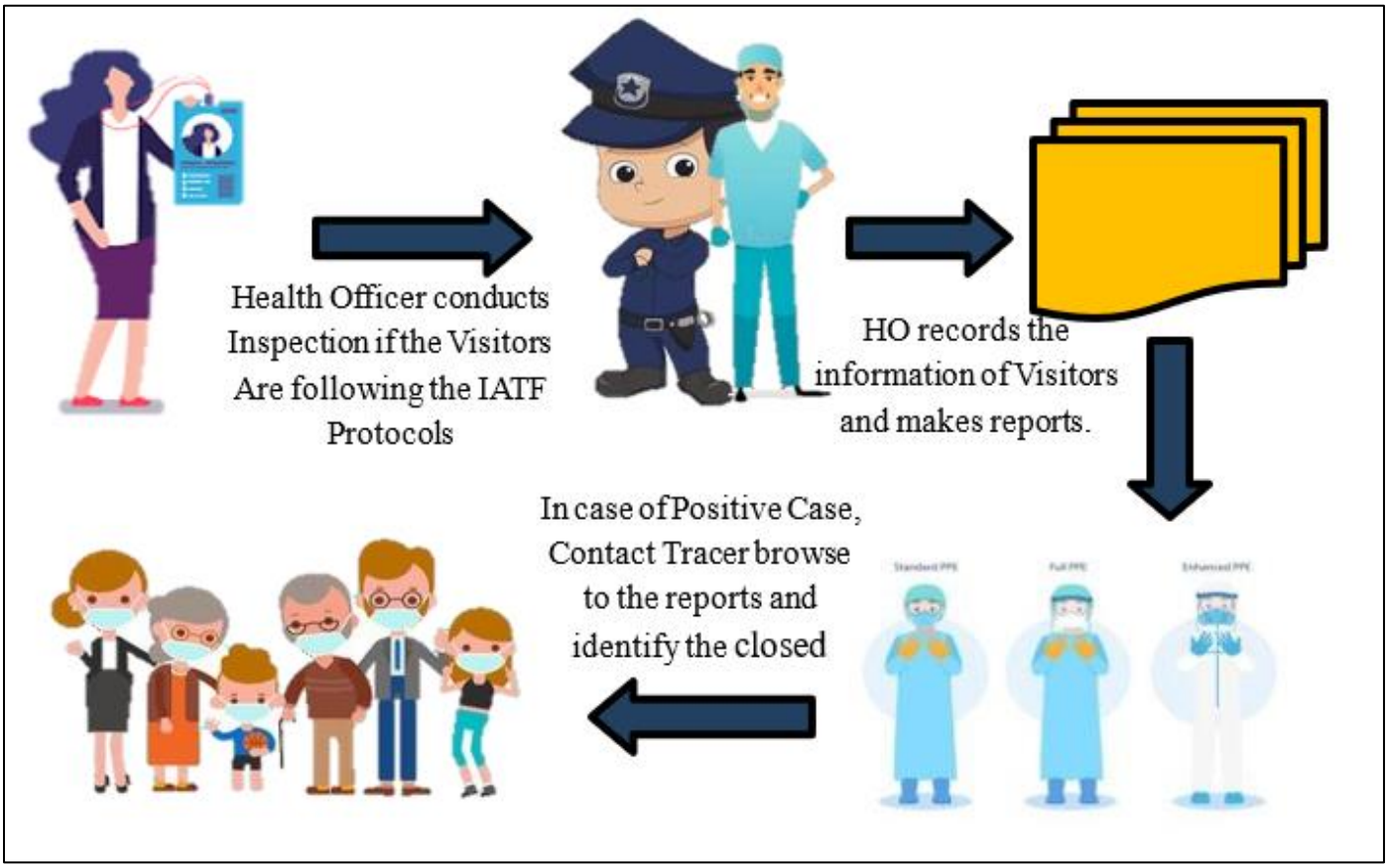

Fig 11 Current Flow of Reports in Sta. Ana

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As shown in figure 11, the process begins with the Health Officer monitoring visitors at the Welcome Arc of Santa Ana. The assigned officer manually records all visitor data and sends it for report preparation to the Regional Health Unit of the Local Government Unit of Santa Ana.

- Contact Tracers identify and communicate with people who were in close contact with a positive individual.
- The Health Officer at the Santa Ana Welcome Arc creates inaccurate and inefficient reports.
- Visitor logs have inconsistencies, including missing, unorganized, and uncategorized data, along with discrepancies in the available reports.
- It is difficult to monitor the Welcome Arc due to the large number of vehicles, which can cause traffic build-up. This leads to the risk of exposure when trying to gather information from drivers and passengers, including their quarantine passes or vaccination cards.

➢ *The Proposed Application, "Mobility and Contact Tracing App"*

Mobility and Contact Tracing App will help the Local Government Unit of Santa Ana, including the RHU and Contact Tracing Team, monitor and manage travel within Santa Ana. This is to prevent Covid-19 cases in the area. The application is an offline mobile app that can be used with or without the Internet. It allows the person in charge to easily get information about visitors using their QR code, along with their proof of identity and vaccination card.

Powered by MIT App, users can download and create their own QR codes based on the information they provide in the app. It also offers a reliable backup of visitor logs using Google Sheets, a tool for monitoring and contact tracing. The app is simple and relevant to use.

In the administrator space, the admin user can temporarily save data offline on their devices. They can upload it to Google Sheets when Internet access is available. The system is secure and restricted to authorized personnel. It can capture visitor identities, vaccination cards, and manage the database flow.

The database schema outlines the backend of the application. Users can access the application with or without Internet connectivity, and it works well on different Android versions.

The developed application, "Mobility and Contact Tracing App," uses Google Sheets as its database through app scripting and programming blocks. The app was created using an agile approach, making it available and accessible offline with the help of MIT App Inventor.

➢ *The Assessment in the Key Offices on the "Mobility and Contact Tracing App" Using the ISO/IEC 25010:2011 or ISO 9126 Quality*

- *Standards*

The assessment of how well the "Mobility and Contact Tracing App" meets ISO 25010 software quality characteristics was done after getting formal consent, presenting the results, and using the app. The following discussion focuses on the developer's goal of measuring the app's compliance with ISO 25010. This measurement uses the characteristics and sub-characteristics from the Quality Model for External and Internal Quality. The evaluation includes the following characteristics: Accuracy, Reliability, Security, Functionality, Portability, Usability, Maintainability, and Efficiency.

➢ *Extent of Compliance of the "Mobility and Contact Tracing App" to ISO 25010 in Terms of Accuracy*

The assessment of the participants regarding the "Mobility and Contact Tracing App" and its accuracy is shown in Table 1. The participants rated the accuracy of the app as high, with an average score of 4.0.

➢ *Extent of Compliance of the "Mobility and Contact Tracing App" to ISO 25010 in Terms of Reliability*

The assessment of the participants regarding the "Mobility and Contact Tracing App" and its reliability is shown in Table 2. Participants rated the reliability of the app as very high, with an average score of 4.58.

Assessment of Different participants on the Reliability aspect of the developed "Mobility and Contact Tracing App"

Assessment of Different participants on the Accuracy aspect of the developed "Mobility and Contact Tracing App"

Table 5 Accuracy Evaluation of the Mobility and Contact Tracing App

A. **Accuracy**	**Local Government Unit Officer**	
	Weighted Mean	Desc. Rating
1. The generated QR-Code presents the correct Information of the Visitors.	4.5	VHE
2. The scanned QR-Code captures the exact time of entry.	3.5	HE
3. The proposed application provides accurate reports without error encountered.	4.0	HE
Overall Weighted Mean	4.0	HE
Legend: VHE – Very High Extent, HE – High Extent, ME – Moderate Extent LE – Least Extent, VLE – Very Least Extent		

Table 6 Reliability Evaluation Results

B. Reliability		
	Weighted Mean	Desc. Rating
1. The proposed application	4.5	VHE

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shows the proper reports.		
2. The proposed application gives valuable result.	4.75	VHE
3. The proposed application requires simple effort.	4.5	VHE
Overall Weighted Mean	4.58	VHE
Legend: VHE – Very High Extent, HE – High Extent, ME – Moderate Extent LE – Least Extent, VLE – Very Least Extent		

Assessment of the reliability aspect of the proposed "Mobility and Contact Tracing App." Users confirmed the app's reliability due to its accurate reports, valuable results, and ease of use.

➢ *Extent of Compliance of the "Mobility and Contact Tracing App" to ISO 25010 in terms of Security*

The evaluation of the participants regarding the "Mobility and Contact Tracing App" and its security is shown in Table 3. The participants rated the security of the app as Very High Extent, with a mean score of 4.50.

Assessment of Different participants on the Security aspect of the developed "Mobility and Contact Tracing App"

Table 7 Security Evaluation Results

C. **Security**		
	Weighted Mean	Desc. Rating
1. The proposed application shows the proper reports.	4.25	VHE
2. The proposed application gives valuable result.	4.50	VHE
3. The proposed application requires simple effort.	4.75	VHE
Overall Weighted Mean	4.50	VHE
Legend: VHE – Very High Extent, HE – High Extent, ME – Moderate Extent LE – Least Extent, VLE – Very Least Extent		

Delivering information accurately from the gathered data will improve the app's reliability. As a result, users will find it easy to use the app without any issues. This suggests that the proposed application meets the requirements for a complete, suitable, and correct solution for the Local Government Unit of Santa Ana, thus producing the expected results for users.

The app's compliance with the security criteria of ISO 25010 is also assessed and presented in Table 3. The "Mobility and Contact Tracing App" was found to be compliant to a high degree. For security, every system, especially the admin side, needs a secure passcode to protect privacy and prevent unauthorized access to users' confidential information. Any unattended access could lead to a leak of personal information that may be misused against the user.

➢ *Extent of Compliance of the "Mobility and Contact Tracing App" to ISO 25010 in Terms of Functionality*

The assessment of the participants for the "Mobility and Contact Tracing App" and its functionality is shown in Table 4. The participants rated the functionality of the app as Very High Extent, with a mean of 4.42.

Assessment of Different participants on the Functionality aspect of the developed "Mobility and Contact Tracing App"

Table 8 Functionality Evaluation Results

D. **Functionality**		
	Weighted Mean	Desc. Rating
1. The proposed application performs well without any errors/ problems encountered.	4.0	HE
2. All the devices (QR-Code) and QR-Code Scanner performs well.	4.75	VHE
3. If errors occur, the Application will display errors committed by the user.	4.50	VHE
Overall Weighted Mean	4.42	VHE
Legend: VHE – Very High Extent, HE – High Extent, ME – Moderate Extent LE – Least Extent, VLE – Very Least Extent		

Table 9 Portability Evaluation Results

E. Portability		
	Weighted Mean	Desc. Rating
1. The proposed application is easy to use.	4.25	VHE
2. The proposed application is easy to install.	4.0	HE
Overall Weighted Mean	4.125	HE

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Legend: VHE – Very High Extent, HE – High Extent, ME – Moderate Extent LE – Least Extent, VLE – Very Least Extent

Portability has a high rating, with a mean of 4.125, and meets the ISO 25010 standard. Users can install and use the application easily.

- *Extent of Compliance of the "Mobility and Contact Tracing App" to ISO 25010 in terms of Usability*

The evaluation of the participants regarding the "Mobility and Contact Tracing App" and its usability is shown in Table 6. The participants rated the app's usability as Very High Extent, with a mean score of 4.42.

Assessment of Different participants on the Usability aspect of the developed "Mobility and Contact Tracing App"

Table 10 Usability Evaluation Results

F. **Usability**		
	Weighted Mean	Desc. Rating
1. The proposed application is easy to operate and control.	4.50	VHE
2. The Application facilitates the Visitor's retrieval and data entry.	4.25	VHE
3. The application is easy to understand in terms of concept and usage.	4.50	VHE
Overall Weighted Mean	4.42	VHE
Legend: VHE – Very High Extent, HE – High Extent, ME – Moderate Extent LE – Least Extent, VLE – Very Least Extent		

The results highlighted the app's ability to run smoothly without any problems or errors. The QR code and QR code scanner work well, and if there is an error, the app displays a message to inform the user about the mistake. These findings suggest that users can learn easily, operate the app with little effort, and understand it without difficulty, which significantly impacts the app's functionality.

- *Extent of Compliance of the "Mobility and Contact Tracing App" to ISO 25010 in terms of Portability*

The assessment of the participants regarding the "Mobility and Contact Tracing App" and its portability is shown in Table 5. The participants rated the portability of the app as high, with a mean score of 4.125.

Assessment of Different participants on the Portability aspect of the developed "Mobility and Contact Tracing App"

The results on the usability of the "Mobility and Contact Tracing App" are in Table 6. It meets usability requirements to a high extent, with a mean score of 4.42 based on the system's usability. Users can easily navigate the application without assistance, and it fulfills their needs.

- *Extent of Compliance of the "Mobility and Contact Tracing App" to ISO 25010 in Terms of Maintainability*

The assessment of the participants regarding the "Mobility and Contact Tracing App" and its Maintainability is shown in Table 7. Participants rated the Maintainability of the app as high, with a mean score of 3.6.

Assessment of Different participants on the Maintainability aspect of the developed "Mobility and Contact Tracing App"

Table 11 Maintainability Evaluation Results

G. **Maintainability**		
	Weighted Mean	Desc. Rating
1. The application can find errors easily when it occurs.	4.25	VHE
2. The application has a great risk when changes are made.	3	ME
Overall Weighted Mean	3.6	HE
Legend: VHE – Very High Extent, HE – High Extent, ME – Moderate Extent LE – Least Extent, VLE – Very Least Extent		

The results on the Maintainability aspects of the "Mobility and Contact Tracing App" are also in Table 7. It was assessed for compliance with Maintainability requirements to a moderate extent, with a mean score of 3.6 based on the system's Maintainability. The results indicate that users have different views about sudden changes in the application and whether they pose a significant risk. However, users believe that the app can detect incorrect inputs and missing data during the QR-Code generation process.

- *Extent of Compliance of the "Mobility and Contact Tracing App" to ISO 25010 in terms of Efficiency*

The assessment of the participants regarding the "Mobility and Contact Tracing App" and its efficiency is shown in Table 8. The participants rated the app's efficiency as "Very High Extent," giving it a mean score of 4.75.

Assessment of Different participants on the Maintainability aspect of the developed "Mobility and Contact Tracing App"

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Table 12 Efficiency Evaluation Results

H. **Efficiency**		
	Weighted Mean	Desc. Rating
1. The application provides efficient contact less procedure.	4.75	VHE
2. The application provides convenience entry in Tourist Spot by Scanning QR-Code into QR-Code Scanner.	4.75	VHE
3. Minimal manpower is necessary in maintaining the Application,	4.75	VHE
Overall Weighted Mean	4.75	VHE
Legend: VHE – Very High Extent, HE – High Extent, ME – Moderate ExtentLE – Least Extent, VLE – Very Least Extent		

The results focus on the app's efficiency and meet the efficiency requirements to a high extent, also with a mean of 4.75. These findings indicate that the admin can use the application to easily monitor the flow of visitors in Santa Ana. It also supports contactless transactions with users and does not require unnecessary manpower to operate.

- *Summary Table on the Extent of Compliance of the Developed Application to ISO 25010 Software Quality Standards.*

Summary Table of the Assessment of the Participants of Extent of compliance to ISO 25010 of "Mobility and Contact Tracing App"

Table 13 Summary Table of Participants Assessments

Criteria	**Weighted Mean**	**Description**
Accuracy	4	High Extent
Reliability	4.58	Very High Extent
Security	4.50	Very High Extent
Functionality	4.42	Very High Extent
Portability	4.125	High Extent
Usability	4.42	Very High Extent
Maintainability	3.6	High Extent
Efficiency	4.75	Very High Extent
Overall Weighted Mean	4.3	Very High Extent

The overall assessment of the LGU Officers is shown in table 8. The findings suggest that users strongly recognize the value of the "Mobility and Contact Tracing App" for the Municipality of Santa Ana. This is due to its ability to provide reliable information, support contactless transactions, enable QR-Code monitoring, and function offline.

➢ *Analysis of the feedback and suggestions of Key offices (PNP Santa Ana, RHU Santa Ana, LGU of Santa Ana, MDRRMO and Tourism Office) towards the enhancement of the "Mobility and Contact Tracing App".*

Based on the suggestions made, there are minimal improvements to consider in the "Mobility and Contact Tracing App." This includes Geographic Location, which will show visitors exactly where they have been scanned. Each establishment, such as resorts, beaches, municipal offices, and food restaurants, will have separate admin access.

On a positive note, the ICT Officer, Mr. Jonathan Poblete, highly appreciates the proposal for the application, as it is very timely. The MDRRMO office is impressed by the application, as it will serve as a great tool for monitoring and contact tracing within the municipality of Santa Ana. Lastly, the Tourism Office recommends developing the application and is interested in implementing the "Mobility and Contact Tracing App" for future use in cooperation with the Cagayan Economic Zone Authority.

VI. SUMMARY AND CONCLUSION

This chapter summarizes the development of application work that was done, the conclusions drawn, and the recommendations made based on the main findings. These were guided by the researcher's vision to improve the process for monitoring and tracking visitors in Welcome Arc Santa Ana. The aim was to enhance accessibility, efficiency, and contactless transactions.

➢ *Findings*

The study aimed to analyze, design, develop, and implement a practical mobile application for the Local Government Unit of Santa Ana. This included the introduction of contactless transactions using QR codes. Based on the study's results, here are the key findings:

- There is no specific contact number for the agency; instead, they use personal phone numbers. This leads to poor communication with the people of Santa Ana, and there is no clear system that unifies the offices.
- There is a risk of disease transmission to the contact tracer in the event of a close contact case.
- An assessment of how well the "Mobility and Contact Tracing App" meets the software quality characteristics outlined in ISO 25010:2011 was conducted with the heads of the LGUs.
- The "Mobility and Contact Tracing App" was found to comply with the software quality criteria of ISO 25010, as assessed by the heads of the LGUs. Users generally

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viewed the application as relevant and timely during this pandemic and felt it would greatly improve the use of technology in the local government of Santa Ana. This indicates the application's overall usefulness and effectiveness in supporting operations, tracking, and monitoring to combat disease transmission.

Additional features suggested for enhancing the "Mobility and Contact Tracing App" include: (a) Geographic Location, which would show visitors where they have been scanned, and (b) Separate Admin Access for each establishment (resorts, beaches, municipal offices, food restaurants). On a positive note, the ICT Officer, Mr. Jonathan Poblete, appreciated the proposal for the application, noting its timeliness. The MDRRMO office is impressed by the application, as it will serve as a valuable tool for monitoring and contact tracing within the municipality of Santa Ana. Finally, the Tourism Office has recommended developing the application and is interested in implementing the "Mobility and Contact Tracing App" for future use in cooperation with the Cagayan Economic Zone Authority.

➢ *Conclusion*

Based on the results, the researcher concludes that the design, implementation, and analysis of the "Mobility and Contact Tracing App" for the Local Government Unit of Santa Ana is a valuable tool. It allows for quick monitoring of visitors and tracking of close contacts in case of a positive case. This application improves the processes of monitoring and managing the database.

The "Mobility and Contact Tracing App" meets the ISO 25010 software quality standards, as confirmed by the thorough evaluation by LGU officials. Thus, with its features and usability, the "Mobility and Contact Tracing App" fulfills technical, management, and user needs. It is designed to be effective and user-friendly.

RECOMMENDATIONS

From the findings and conclusions, the following recommendations are suggested:

➢ *For the Local Government Unit of Santa Ana:*

- Implement the developed App.
- Purchase ICT equipment if funds are available.
- Set up a dedicated mobile phone for the offices where the App will be installed.

➢ *For Future Researchers:*

- Add features and improve the source code (from MIT App Inventor to Android Studio).
- Move the database to a dedicated server.
- Include geographic location.

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