Proposed Innovations on Contact Tracing System using Contactless Smart Cards in the Philippines

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Abstract
Contact tracing is a process that is used to control the spread of diseases such as COVID-19 that was being processed manually in most of the areas of the Philippines. Technology-based approaches such as Quick Response (QR) Codes and Bluetooth had emerged to provide better solutions. However, these solutions require the use of smartphones, which can be a problem for countries such as the Philippines with a low smartphone penetration level. Contactless smart cards use Radio Frequency Identification (RFID) Technology, which is utilized in a variety of applications, among which is automating transactions, personal identity verification, and contact tracing in hospitals. This research explores the applicability of contactless smart cards in the development of a reliable contact tracing system. The study made use of a survey questionnaire to determine if smart card technology is perceived positively thus, acceptable to the users. Results of the data gathered presented a high adoption rate following a high overall rank in preference over the existing solutions in the Philippines which implies that the proposed solution is more likely to be accepted by users.

Keywords
Smart Card, Covid-19, RFID, Adoption, Contact Tracing.

1. Introduction

1.1. Background of the Study
The digitization of the personal identification process through the widespread use of smart IDs is an advancement for society. Smart identification cards can streamline a number of everyday tasks such as transacting with both private or public organizations or verifying a person's identity. This means that with smart card technology, tedious processes such as doing money transfers, opening up a bank account, and performing other tasks that would usually require the presence of several valid IDs and sometimes took hours to accomplish as well, could substantially be made more convenient by requiring fewer sources of identification (Adrian,2020). Additionally, contactless smart cards can have heightened relevance in a pandemic because of the protection that contactless payments can provide against a contagious disease (McKee 2020). Contactless smart cards have an RFID chip inside them that enables them to store data and be read by a scanner (Petsinger 2000). A variant of the same technology (RFID) has also been utilized for contact tracing purposes in hospitals in (Chang et al. 2011, Ho et al. 2020). Contact tracing is one of the methods that is being used to help keep the spread of contagious diseases manageable. It has become more popular over the last few months due to the COVID-19 pandemic, but the principle behind it actually already has a history (Lovette et al. 2016)— it was also used before in the control of sexually transmitted diseases (STDs), tuberculosis, and other viral infections such as the Ebola virus. Contact tracing today helps slow down the spread of COVID-19 by narrowing down the list of possible sources of infection and letting people who may have been exposed to a COVID-19 infected person know about the incident. As stated by the World Health Organization (WHO) in [9], a good systematic application of contact tracing will "break the chains of transmission" of COVID-19 and other infectious diseases, and should thus be used by the public in the event of the outbreak of a disease. This research explores the applicability of contactless smart cards in solving some of the biggest contact tracing challenges that the Philippines is facing in the context of the COVID-19 pandemic.

1.2. Research Problem
Traditional contact tracing is often done by calling and manually notifying individuals who test positive to the disease, as well as the people that the infected individual has come in contact with (Dyrda 2020). The identification of the people whom the infected individual has come in contact with relies on the infected individual's memory and ability to recall his/her whereabouts (Anglemyer 2020). This method is inefficient and may be inaccurate because relying on the infected individual's memory may not give clear or complete details. Some places make use of logbooks that contact tracers can look at to help them trace the whereabouts of an infected individual. However, contact tracers are still experiencing difficulties because the information that some people had provided in logbooks often contained false names, wrong addresses, or contact numbers that did not exist (Comanda 2020). These problems are common due to the ineffectiveness of the methods being used (Marshall 2020). As an attempted solution, several forms of technology were proposed, developed, and/or deployed in different places around the world, especially those that are going through a health crisis. However, some of the methods used by these digital contact tracing solutions were also either faulty or lacking (Newton 2020, Biddle

2020). Furthermore, these digital contact tracing solutions, which are discussed in detail in later sections of this paper, were reliant on the public's smartphone usage and their adoption of the technology. This could pose a problem in most developing countries whose smartphone penetration levels are relatively low, with the Philippines at 63.6%, as of 2020, (Sanchez 2020) because three-quarters (75%) or more of the total population is the optimal number of users in the case of contact tracing apps for them to be effective (Orallo et al 2020, Baharudin et al 2020). TraceTogether, a digital contact tracing app, addressed this issue by introducing a physical device named "TraceTogether Token", which was distributed among the 5% of the population of the Singaporean community who did not own a smartphone, to achieve at least 70% of the population (Lee, 2020)

1.3. Gap Analysis

Researchers and developers from different countries and cities were able to develop technology-based solutions using various approaches, with some addressing the flaws of the other solutions that came before it, and all of which had proven to be useful to a certain degree. However, there still are a number of factors and concerns that are yet to be addressed by the existing solutions. In this article, the researchers aim to fill this gap by exploring the applicability of contactless smart cards in the development of a reliable contact tracing system.

1.4. Research Objectives

The objective of this paper is to determine whether the implementation of a contactless smart card system for contact tracing is a feasible method that is also inclusive of the non-smartphone-owning population and to propose and develop a contact tracing system that is based on contactless smart cards, which would serve as the proof of concept for the approach that was explored on by this study.

1.5. Research Questions

The research questions that this study aims to answer are:

- **RQ-1** What technologies are involved in the current most popular existing contact tracing solutions in the Philippines, and how do they work?
- **RQ-2** Which factor or combinations thereof should be considered for a contact tracing solution to work reliably?
- **RQ-3** Can a contactless smart identification cards system satisfy the requirements for a reliable contact tracing solution?
- **RQ-4** What key features, based on user requirements, should be prioritized in a contact tracing system?

2. Literature Review

2.1. Review of Existing Systems—International

In this section, the researchers will discuss a list of existing technologies that were developed as a means to battle a disease outbreak in one way or another. The technologies discussed here are ones that can be found in foreign countries.

CommCare

Commcare is an open-source mobile platform that aids frontline workers to track and support clients, facilities, transactions, or any other subject that needs surveillance over time. Sacks and colleagues in their paper "Introduction of Mobile Health Tools to Support Ebola Surveillance and Contact Tracing in Guinea" equipped human contract tracers with a system where real-time information is used for contact tracing in Guinea (a country heavily affected by the epidemic)(Sacks et al 2020).

Aarogya Setu

Aarogya Setu is India's main contact tracing technology and also currently the world's most popular contact tracing application based on the number of users; Aarogya currently has reached more than 150 million installs as a mobile application and claims to have tested over 50 million samples. Aarogya, like many existing contacts tracing solutions, incorporates Bluetooth and GPS to track coronavirus infections, it uses Bluetooth to keep records of devices within 6 feet of another Aarogya Setu user in case you or another user tests positive for coronavirus in the last 14 days (Banerjea, 2020).

TraceTogether

TraceTogether is a digital contact tracing system implemented by the Singaporean Government, it adopts a community-driven approach to support the country's contact tracing effort and help slow down the spread of COVID-19. TraceTogether works by requiring Bluetooth and location services technology to be actively on at all times on phones running the application, if a device encounters another device running the app, four types of information are exchanged; a timestamp, the Bluetooth signal strength, the phone's model and a temporary ID. However, the system doesn't track users using location services, despite the feature being on the entire time, instead, it utilizes the feature to calculate the distance between them. Additionally,, due to the low adoption rate of the app which is is three- quarters or at least 75% of the population is optimal for a contact tracing system to work well, a physical device named "TraceTogether Token" is introduced and distributed among the Singaporean community with the goal of achieving at least 70% of the population using TraceTogether Token or the app version (Baharudin et a 2020, Lee et al 2020).

Zwaai

Zwaai relies on a QR code-based infrastructure to perform contact tracing, the app generates a continuously refreshed QR code for each user and gives them the ability to scan other users QR codes, when scanned QR codes trigger an app installed on the user's phone to record certain types of information relevant to contact tracing (Hoffman et al 2020). When users share their personal QR code with others, both parties exchange random numbers using QR codes, which together forms a unique QR code, this is then stored locally on the user's phone with an option to upload these records to a central server if you have caught the virus, which is of course preceded by a health check .

2.2. Review of Existing Systems — Local

In this section, the researchers will discuss a list of existing technologies that were developed as a means to battle a disease outbreak in one way or another. The technologies discussed here are ones that can be found in the Philippines.

StaySafe.ph

StaySafe.ph is the Philippine government's official digital contact tracing system. It is a project by the Inter-Agency Task Force on Emerging Infectious Diseases (IATF-EID) and National Task Force (NTF) on COVID-19 response. In this contact tracing system, the success of the application relies on its users (the public) to report health conditions/statuses of themselves or even their family members, provided that they have given their consent, all while maintaining user's anonymity.

WeTrace

WeTrace is yet another contact tracing application in another part of the Philippines, in Cebu province located in the Central Visayas Region. WeTrace is decentralized contact tracing software which means that there is no central authority that controls and oversees the system; WeTrace as stated in [28], performs contact tracing by using Bluetooth LE (Low Energy) to keep track of individuals who were in close contact of fewer than 2 meters from your device, in addition, timestamp containing the date, time and geolocation of when and where the contact happened is also collected. To make this possible, a user gets a random ID assigned to them that will be broadcasted to other users in close contact with you, this ID is subject to time and will change as time goes on to circumvent security and privacy issues.

BinD360

BinD360 is a community-based contact tracing mobile application to help the City Health Officer, Barangay Health Emergency Response Team (CTO, BHERT) of Biñan City to monitor the city residents for fast COVID-19 contact tracing. The application, other than the updates on the COVID-19 statistics, includes features like the personal QR Codes for BinD360 users and a scanner to scan establishments where users enter.

ValTrace

ValTrace is a recently developed and launched contact tracing application used by the Valenzuela City Government in the Philippines, the authorities mandate everyone in Valenzuela including establishments to comply and register their own QR codes as part of the city's preventive measures from COVID-19. All Valenzuela residents and non-Valenzuela residents are subject to present their own unique QR codes before entering an enclosed establishment. QR code system (ValTrace) would then record relevant information such as body temperature and contact details to allow contact tracing between visitors and employees.

Traze

Traze is yet another contact tracing system introduced by the Philippine Ports Authority (PPA) to trace movements of individuals inside PPA facilities without the need of an internet connection [32]. The app utilizes QR codes to automate the traditional and manual contact tracing methods which take several days to process, with QR codes, however, it could be done in just a few minutes.

eSalvar

eSalvar is a QR code-based contact tracing system similar to *Traze, BinD360,* and *ValTrace*. *eSalvar* is Naga City's official contact tracing system that mandates anyone who enters enclosed establishments to use and register with the app (Laguardia 2020). *eSalvar* works similar to *Traze, eSalvar* equips establishments with the eSalvar app ready to scan anyone entering (followed by a temperature check) and exiting the premises, an internet connection won't be needed when scanning the QR ID's, however, an internet connection would be needed when syncing the app with a server.

2.3. Technologies

In this section, the researchers will have a closer look at the technologies that were used by the previous/existing contact tracing methods and evaluate how well these technologies perform in the tasks expected of them as the core of contact tracing solutions.

Bluetooth

Bluetooth is a technology that enables devices equipped with it to communicate wirelessly or without any cables. Bluetooth communication persists despite physical obstructions, which is an excellent feature when used with wireless headphones and file transfers. However, this can be a rather problematic specification for a technology that will be used for proximity measurement in the context of determining the exposure of an individual to pathogens (Chowdhury et al 2020). The authors also wrote that contact tracing mobile apps that use Bluetooth utilize the Received Signal Strength Indicator (RSSI) of Bluetooth to calculate an estimated value of the distance between two people that use a Bluetooth-based mobile app. With this method, close contacts are determined without revealing locations, which results in relatively more security and privacy. While this may be a good thing, it is often pointed out by critics that Bluetooth has a number of problems regarding its capability to provide reliable contact tracing data, with one of the co-inventors of Bluetooth technology himself saying that the "RSSI value can be rather crude and not well calibrated" (Newton 2020, Biddle 2020). Moreover, it is revealed that factors such as device hardware and software specifications, obstacles, interfering radio waves, and even device battery levels can affect RSSI (Zhao et al 2020). The use of Bluetooth in contact tracing in a real-world setting was evaluated and was found out that the signal strength of Bluetooth can be affected by a device's orientation and the physical obstacles on the way including human bodies and other surfaces (Leith et al 2020) Thus, the authors inferred from their findings that it would be very challenging to use Bluetooth in getting reliable proximity detectiondata.

Barcodes and Quick Response (QR) Codes

The study conducted byHoffman identified one downside of QR-code-based applications, and that is the directly proportional relationship between the success of QR-code-based apps to the compliance of the users—as with almost all other existing solutions to contact tracing. In that same study, the authors evaluated several QR-code-based applications from different places around the world, with their primary focus projected towards the *Zwaai app*, a QR-code-based contact tracing app in the Netherlands. The *Zwaai app*—due to it requiring its users to constantly and consistently "wave" their phones over QR codes, or the QR codes generated in their phones over other scanners—was classified as an app with a "seamful" design. In other words, it did not prioritize the simplicity and ease of use aspects that a solution with a seamless design does, and thus, possibly demands more active engagement from the users compared to solutions based on other technologies like Bluetooth.

Radio-Frequency Identification (RFID)

RFID is used in a variety of applications such as the logistics of a warehouse management system as it can automate the process of checking for stocks and tracking item delivery status, the precise positioning of trains in railway stations, and the automation of keeping and maintaining records while also making the process paperless. The proposed IoT-based contact tracing model that was presented by Garg involved the use of (what seemed to be UHF) RFID tags that were embedded in moving objects such as cars and animals so that the location of the said objects can be tracked and functions via strategically-placed RFID readers that would update the location information of an object based on the serial number of the RFID tag embedded to it (Garg et al 2020). The primary focus of their study, however, was to address the lack of contact tracing measures for animals and moving objects. RFID technology was also used in the development of a Contact History Inferential Model (CHIM) in a hospital setting (Chang et al 2020). Their evaluation study results showed that the proximity sensing capability of RFID is accurate, and the researchers then suggested that the RFID-based CHIM can be "applied in other wards" as well. An RFID-based real-time location system (RTLS) for contact tracing at a health center during the COVID-19 pandemic was evaluated. The RTLS system used location-based tracking instead of measuring the proximity between people, which is a similar system design to many of the existing COVID-19 contact tracing systems, especially those that use QR codes. The result of their study demonstrated that the performance of RTLS, in terms of sensitivity and specificity, is higher than that of the electronic medical record (EMR) based methods, which involves making use of data from the databases of clinics, but what really provided the best performance was the combination ofboth (Ho et al2020).

3. Methodology

3.1. Conceptual Framework

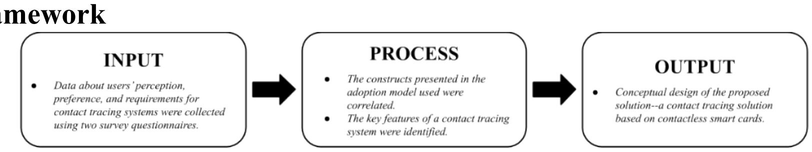

Figure 1. *Paradigm of the Study*

This study makes use of an adoption model to identify which factors can influence the application of contactless smartcard in contact tracing activities. After that, the key features of contact tracing systems will be identified to aid the researchers in the development of their conceptual design. Figure 1 shows the diagram to visualize the describedframework.

3.2. Research Design

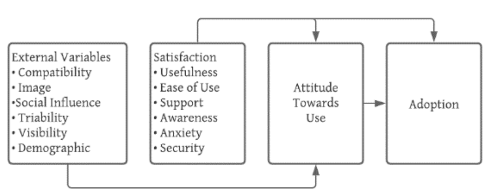

Figure 2. *The Adoption Model*

Figure 2 shows the adoption model of smart card technology developed in the study conducted by Taherdoost. The success of a technology is heavily influenced by whether people will use it or not [43]. Thus, the researchers decided to make adoption response rate as the primary indicator that would dictate the success of their proposed solution. The model that the researchers used was developed based on other highly-recognized models such as the Technology Acceptance

Model (TAM) by Fred D. Davis, the Extended Technology Acceptance Model (TAM2), Diffusion of Innovation Theory, and the Unified Theory of Acceptance (UTAUT).

3.3. Questionnaire Design

Two survey questionnaires were used in this research. The first survey questionnaire consisted of four parts and fifty-three (53) items. The first part of the first questionnaire is the participant consent form, where details about the study were described, as well as details about the participation of the respondents in the questionnaire. It was mentioned there that in order to participate in the study, they have to be a Filipino adult (at least twenty-one years old), have experienced using QR code technology, and have experienced using contactless smart identification cards. This part of the questionnaire contained only one of the fifty-three items, which simply asked whether they agreed to participate in the study or not. Answering with "No" finished the filling up process and answering with "Yes" took them to the second part of the questionnaire, the demographic information part, where they provided their age. The third part of the first questionnaire contained thirty-six (36) subjective measure items that were designed using a five-point Likert scale whose measures were specified as (1) Strongly Agree, (2) Agree, (3) Neutral, (4) Disagree, and (5) Strongly Disagree. These subjective measure items, as well as the fifteen (15) preference measure items on the third part of the first questionnaire, were based on the Adoption Model in [42]. The second survey questionnaire consisted of only two parts: a participant consent form that is similar to that of the first questionnaire, and a thirty (30) item section that asked participants to rate the importance of the items which represented certain features of a contact tracing system.

3.4. Hypotheses

H1 User satisfaction of contactless smart cards has a significant impact on the users' attitude towards the use of the technology.

H2 User satisfaction of contactless smart cards has a significant impact on the users' adoption of the technology.

H3 External variables relating to contactless smart cards have a significant impact on the users' attitude towards the use of the technology.

H4 The attitude of users towards the use of contactless smart cards have a significant impact on their adoption of it.

H5 People will prefer to use a smart contactless card contact tracing system over others.

3.5. Settings and Participation

For the first questionnaire, eligible study participants were people that resided in the Philippines during the COVID-19 pandemic, have experienced using smart card and QR code technology, and were within the age range of 21–59 years old, which is the age bracket that is allowed to leave their houses and are allowed to issue IDs or passes to be permitted to work outside of their homes, as stated by the Inter-Agency Task Force for the Management of Emerging Infectious Diseases (IATF) on [44]. The survey was conducted online and was distributed via Google Forms in the following link: https://forms.gle/FNNmJBjHFM8cutBV6 to several social media groups and websites. For the second questionnaire, eligible study participants were also people that resided in the Philippines during the COVID-19 pandemic and have participated in any of the contact tracing measures put in place by the Philippine government or local government units. The second survey was distributed via Google Forms in the following link: https://forms.gle/zcU58Bqkr1sz7WCQ8 to several social media groups and websites.

4. Results and Discussions

A total of 140 respondents, whose age distribution is displayed in Table 1, was gathered for the first questionnaire, and a total of 58 respondents was gathered for the second questionnaire.

Table 1. *Age of the Respondents from Questionnaire 1*

Age	Frequency (N)	Percentage (%)
21-28	124	88.57
29-36	6	4.29
37-44	5	3.57
45-52	5	3.57

Table 2 shows the results of the subjectively measured constructs from the first questionnaire and the items under them. The Likert scale questionnaire answers were arranged in descending order; Strongly Agree was assigned the number 1 and Strongly Disagree was assigned the number 5. The mean of the constructs, except for the External Variables construct, were less than 2.5. This suggests that most of the participants of the survey have a generally positive attitude and perception towards and of contactless smart identification cards. Furthermore, all constructs, except for Adoption, had a standard deviation of less than 1, while Adoption had a standard deviation of 1.07. This indicates that most constructs have a high level of consistency.

Table 2. *Statistics of the Subjectively Measured Constructs and the Items.*

	Mean	SD
Adoption	1.97	1.07

Attitude Towards Use	2.2	0.05
External Variables	2.6	0.31
Satisfaction	2.19	0.08

4.1. Hypothesis Testing

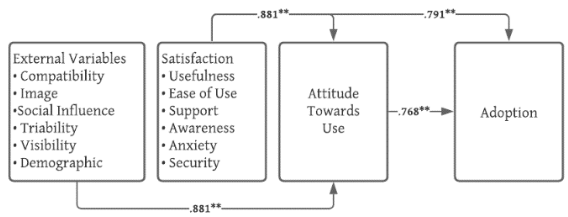

Figure 3. *The Results of the Hypothesis Testing.*

Table 3. *Statistics of the Constructs and the Items Measured by Preference.*

		β
H1	Satisfaction → Attitude Towards Use	.881**
H2	Satisfaction → Adoption	.791**
H3	External variables → Attitude Towards Use	.881**
H4	Attitude Towards Use → Adoption	.768**

Figure 3 and Table 3 shows the correlations of the constructs based on the results of the Bivariate Correlation. The total score of the Satisfaction construct was correlated with the total score of both the Attitude Towards Use construct, with a Pearson Correlation of 0.881, and the Adoption construct, with a Pearson Correlation of 0.791. The total score of the External Variables construct was correlated with the total score of the Attitude Towards Use construct, with a Pearson Correlation of 0.881. However, the demographic information, which the authors of the model had proposed to be among the "external variables" that may affect the user acceptance of smart card technology, were not included in the total score of the construct. Lastly, the total score of the Attitude Towards Use construct was correlated with the Adoption construct. The findings are in agreement with the points discussed in the study made by Taherdoost et al.

Table 4. *Statistics of the Constructs and the Items Measured by Preference.*

	Satisfaction	Rank	External Variables	Rank	Attitude Towards Use	Rank	Adoption	Rank	Overall
Traditional paper-based system	1839	3	534	3	159	3	166	3	2539
QR code system	2632	2	787	2	276	2	257	2	3676
Contactless smart identification card system	3389	1	1037	1	351	1	363	1	4789

Table 4 shows the ranking of the existing contact tracing systems in the Philippines in the proposed contact tracing system by preference. The proposed system ranked the highest overall and in all constructs against both traditional paper-based systems and QR code systems for contacttracing.

4.2. House of Quality

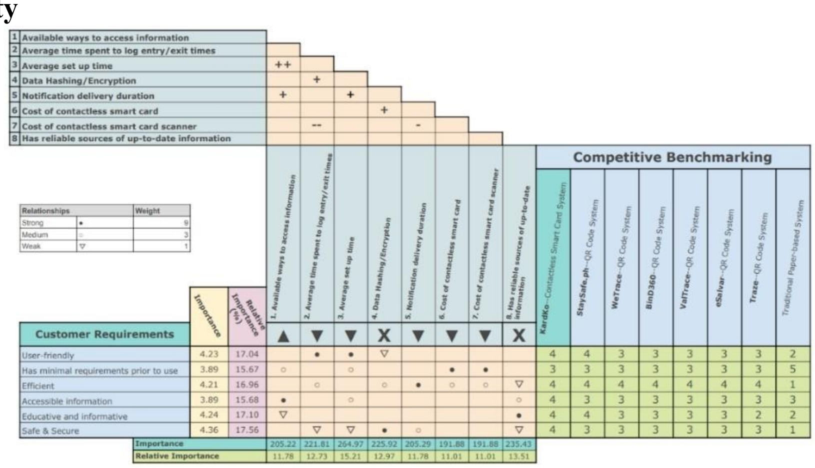

Figure 4. *The House of Quality*

The results from the second questionnaire were analyzed using the house of quality approach to identify which contact tracing system key features need to be prioritized in order for the final product to reflect the needs and wants of the ultimate users. Figure 4 shows an overview of the said approach: the importance and relative importance of the customer requirements were taken from the results of the second questionnaire, and the customer requirements were correlated with the technical specifications. After that, the importance and relative importance of each technical specifications were calculated, and the following values were obtained: having a relatively large number of options to access information from the contact tracing had a relative importance of 11.78%, the quickness of the logging of entry and exit times process had a relative importance of 12.73%, the quickness of the setup time had a relative importance of 15.21%, securing data through hashing or encryption had a relative importance of 12.97%, the time it takes for notifications to be delivered to the users had a relative importance of 11.78%, both the cost of the smart card and the cost of the scanner had a relative importance of 11.01% each, and the reliability of the sources of data and information had a relative importance of 13.51%. Based on these results, it can be concluded that each item in the list of technical specifications was almost equally important, but the time it takes to set up the contact tracing system and start using it emerged as the most important among the others with a relative importance of 15.21%.

4.3. Proposed System

Figure 5. *KardKo Contactless Smart Card Scanner Design*

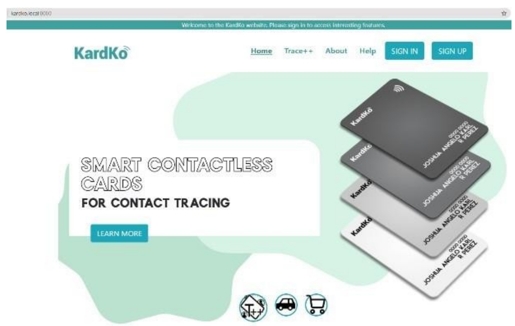

Figure 6. *KardKo Starting Page*

The researchers have developed a proof-of-concept contact tracing system based on contactless smart cards called KardKo. KardKo is divided into four parts: (1) the contactless smart cards, (2) the contactless card scanners, (3) the KardKo website, and (4) the backend systems such as the databases and servers. Mifare Classic 1K cards, a brand of cards manufactured by a company called NXP Semiconductors, were the cards used for the proof of concept. In building the scanner, the researchers used an RC522 RFID module to read the cards, which was connected to a CH340G Arduino board. A buzzer module and a 4-pin RGB LED was also attached to the Arduino so that the scanner can give its users visual and aural cues that would indicate whether or not a card was successfully read and recognized. The aforementioned components were tied together using a few resistors, jumper wires, and a breadboard. Figure 5 shows the KardKo contactless smart card scanner that was described, and Figure 6 contains a snippet of the website's starting page. The front-end of KardKo's website was built using HTML, CSS, and Javascript, while the back-end was built using PHP, Python, and MariaDB.

4.4.1 Logging and Notification

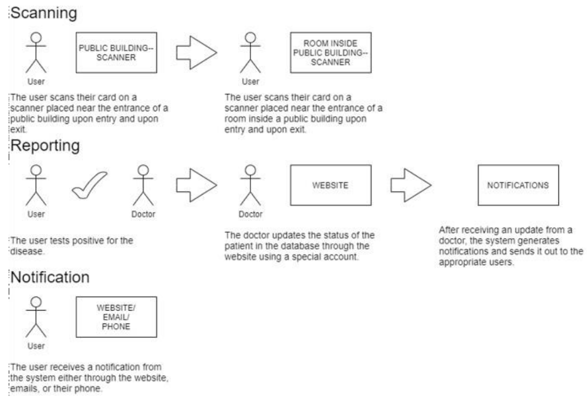

Figure 7. *KardKo User Flow Diagram*

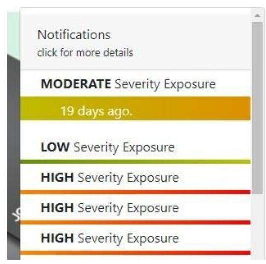

Figure 8. *KardKo Notification Menu*

Figure 7 shows the user flow diagram of the proposed system. The fast and simple "tap and go" entry and exit time logging process is under the Scanning activity. The reason why the user has to scan twice—in the main entrance building and in rooms such as stores and restaurants—is so that the system can give flexible notifications with varying severities of exposure to its users. The details of this process will be discussed in the later parts of this section. The Reporting activity is the process of getting tested for the disease. In the KardKo system, a doctor needs to sign in to the website using an account with special privileges and report the status of their patients to the system. If a user is reported to be positive for the disease, the system automatically generates notifications to the affected users and sends them out depending on the said users' preference (receive a notification from the website, receive an Email notification, or receive a text message notification). Figure 8 shows a screenshot of the notifications menu that can be found on the KardKo website. Affected users may receive a maximum of one of the following notifications from each positive case of the disease:

1. Low Severity Exposure Notification—when the recipient was in the same vicinity on the same day as the infected individual,
2. Moderate Severity Exposure Notification—when the recipient was in the same room/store/restaurant on the same day as the infected individual, and
3. High Severity Exposure Notification—when the recipient was in the same room/store/restaurant at the same exact time as the infected individual.

4.4.2 Privacy and Security

Figure 9. *KardKo's Hashed Database Table Columns*

Figure 9 shows that the necessary columns in the database table of KardKo are secured using PHP's password_hash() function. This function applies a bcrypt salted hash algorithm to the provided parameters and is considered to be a secure cryptographic algorithm.

4.4. Data Source

Figure 10. *KardKo's Trace++*

The KardKo website features a page called "Trace++" where the users can access a data dashboard of the most important COVID-19-related data in the Philippines, and as well as data generated by the KardKo system.

5. Conclusion

Contact tracing is an important process in halting the spread of the disease in a disease outbreak. However, the process is not easy as the methods used—especially the traditional paper-based method—have a number of flaws that render contact tracing efforts ineffective. A lot of countries looked into technologies such as GPS and Bluetooth and the creation of digital contact tracing methods as a solution to this problem, but a lot of digital contact tracing solutions themselves that have been developed and deployed have their own set of flaws that prevent them from effectively fulfilling the purpose of contact tracing. This study looked into one possible method of contact tracing that, to the best of the researchers' knowledge, has not yet been given enough consideration: contactless smart cards that use RFID technology. The researchers were able to identify the technologies involved in the current most popular contact tracing solutions in the Philippines, which are QR codes, Bluetooth, self-reporting apps, and traditional paper-based logging. The existing digital solutions rely primarily on smartphones, which the study has also found to be problematic due to the relatively low smartphone penetration level of the country and the necessity of contact tracing apps to cover a large portion of the country's population in order to be effective. The researchers were also able to get an idea about which factors should be considered for a contact tracing solution to work reliably; A high adoption response rate or, in other words, a large number of users is a highly significant factor, and the researchers were able to use that information as the basis of investigation of the proposed contact tracing solution. The results support the hypotheses; It was found that the adoption of smart card technology can be facilitated by a user's satisfaction with it and their attitude towards its use, and the latter is also significantly impacted by the former, as well as external variables such as perceived compatibility of the technology with existing ones and the likelihood of the technology the enhance their image, among others. Furthermore, the results also suggest that a contactless smart card system for contact tracing is likely to be accepted by users because it was preferred over the currently existing contact tracing methods in the Philippines. The researchers were also able to develop a proof-of-concept contact tracing system based on contactless smart cards. The conceptual design of the proposed system was derived from a set of technical specifications and user requirements that were determined from a survey questionnaire and a house of quality analysis. Unlike the existing digital solutions, the proposed method for contact tracing does not require people to own a smartphone to become their user, as the logging process can be achieved with the possession of acontactless smart card.

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