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# Technology-Enabled Innovations to Combat Covid-19 Pandemic: A Case Study between Thailand and Taiwan

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**ABSTRACT**

The COVID-19 pandemic has been disrupting people's lives for the past two years. Countries worldwide tried to control the number of infections with new and enhanced information technology with varying results. This case study compares the information technologies used to control and combat the COVID-19 pandemic in Thailand and Taiwan. This study aims to identify the contributing factors that make information technology become more effective in controlling the COVID-19 pandemic. This data was gathered retrospectively from December 2019 to August 2021 from 46 subjects in both countries. The results have shown that the category of technology released was inconsistent with entering the stage of transmission of the COVID-19 pandemic. In addition, policy factors such as the rigor of policy, credibility of government or related agencies, including social factors such as the public engagement, communication technology, and the diffusion of innovation, play a key role in enabling the technology to be more efficient for the control of COVID-19 pandemic.

*Keywords*: Coronavirus, Covid-19, pandemic, digital governance, public trust, communication, technology

## INTRODUCTION

The COVID-19 pandemic started in late 2019 and still continues into 2021. To deal with the COVID-19 pandemic, governments worldwide have leveraged different types of Information technologies to help control and combat the pandemic in many countries (Ye *et al.*, 2020). Thailand is one of the countries that has responded quickly and effectively to the Covid-19 pandemic during Phase I – Phase III, between March 2020 – March 2021. Thailand also has strong public health systems to support general healthcare during that phase. During the period between 30 January 2020 to 30 June 2020, Thailand had only 3,171 confirmed cases and 58 deaths from COVID-19 infection (WHO, 2020). Thailand was recognized by the WHO for good handling and response to the COVID-19 pandemic in the early phase (Royal Thai Embassy Washington D.C., n.d.). Thailand has introduced mobile applications such as ThaiChana (Thais- Must-Win) to be used for tracking and controlling the spread of COVID-19 infection in a timely manner. Subsequently, different mobile applications were created and used by Thai citizens such as Mohpromt (Doctor Is Ready), Thai Ruamjai (Thais Together), and Rao-Chana (We Will Win) are some of the leading mobile applications that emerged from both government and private sectors.

Another country that has been recognized for successfully controlling the COVID-19 pandemic is Taiwan. Taiwan was the first country to provide information to the World Health Organization about the infection that can spread from person to person, and the Taiwan government had authorities performing onboard inspections of passengers on direct flights from Wuhan City immediately. For a period of approximately five months, after the World Health Organization announced the pandemic situation on January 30, 2020, until July 1, 2020, Taiwan has only 447 confirmed cases and only seven deaths (Cumulative total of 447 COVID-19 Cases Confirmed in Taiwan; 438 Patients Released from Isolation) (Taiwan Centers for Disease Control, n.d.-a). Taiwan leveraged its national health insurance database and integrated it with its immigration and customs database to begin the creation of big data for analytics; it generated real-time alerts during a clinical visit based on travel history and clinical symptoms to aid case identification.

In addition, the Taiwanese government has also used telecommunication systems to send immigration confirmation documents in the form of SMS, which will facilitate immigration for those possible people with a low risk of infection (Wang, & Brook, 2020). The technologies adopted by each country have produced many benefits; the question is, "What technologies are the most effective in controlling a health crisis such as the COVID-19 pandemic?" The two countries mentioned above are both recognized as being able to respond well to the situation. In addition to its strength in the healthcare system, both countries have rapidly developed technology for more effective epidemic control policies.

For this research, the researcher's intention is to conduct comparative case studies and determine the similarities and differences of Thailand and Taiwan's information technology to combat the COVID-19 pandemic.
The research objectives are to find lessons learned from both countries in terms of how they use different types of information technologies to respond to the COVID-19 pandemic. Given the main purposes, two key research questions are as follows:

1. Which information technology that Thailand and Taiwan utilize in controlling the spread of the COVID-19 pandemic?
2. Which factors for the technology need to be focused on in the disease control situation?

To further clarify the questions, this research will approach the problems by:

1. Identifying the severity of the epidemic situation using criteria based on the Definition of the categories for transmission pattern from the World Health Organization.
2. Identifying the type of information technology framework based on relevant previous research.

## LITERATURE REVIEW

### Information Technology for COVID-19 Pandemic

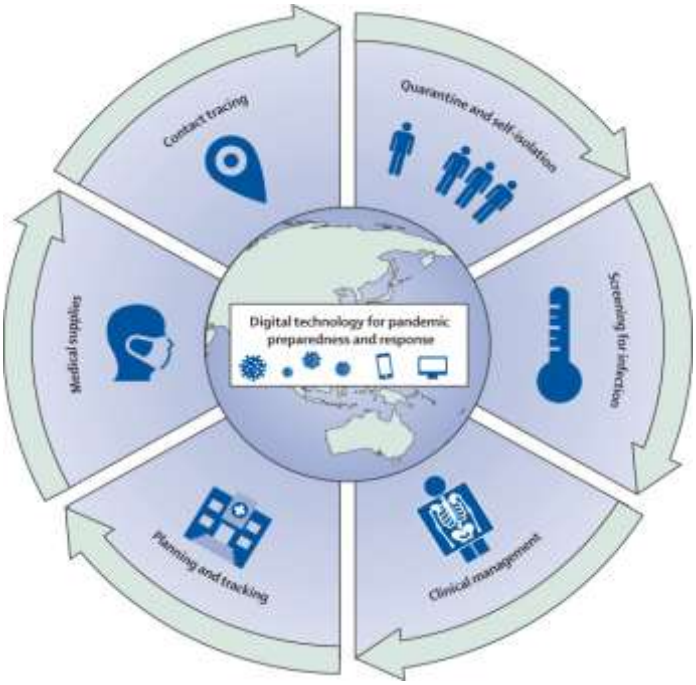
Epidemic Control and Prevention Organization describe the severity level of infection according to the epidemiological principle of 7 types (1) Endemic or local epidemic for diseases that populate within a geographic area but are not violent. (2) **Sporadic** refers to a disease that occurs intermittently and irregularly. 3) **Hyperendemic** refers to persistent, high levels of disease occurrence. (4) **Epidemics** refer to an epidemic with an increasing number of cases but normally expected in that population in that area. (5) **Outbreaks** refer to the same definition as the epidemic but are often used for a more limited geographic area. (6) **Clusters** refers to increases in clusters over a period of time, according to the place and time of suspicion being greater than the number expected. (7) **Pandemic** refers to an epidemic that has spread over several countries or continents, usually affecting a large number of people (Centers for Disease Control and Prevention, 2012) World Health Organization declared a COVID-19 Pandemic on 11 March 2020 and divided the categories for transmission for Coronavirus (Covid-19) into four stages according to the level of spread in each area or country as follows (see Table 1).

Table 1: Definition of the categories for transmission pattern

| Category name | Definition |
|---|---|
| No (active) cases | No new cases were detected for at least 28 days. This implies a near-zero risk of infection. |
| Imported / Sporadic cases | Cases detected in the past 14 days are all imported or sporadic (e.g., laboratory-acquired or zoonotic), all linked to imported/sporadic cases, and imply a minimal risk of infection for the general population. |
| Clusters of cases | Cases detected in the past 14 days are predominantly limited to well-defined clusters that are not directly linked to imported cases but are all linked by time, geographic location, and common exposures. It is assumed that there are a number of unidentified cases in the area. This implies a low risk of infection to others in the wider community if exposure to these clusters is avoided. |
| Community transmission – level 1- level 4 (CT1-CT4) | **Low incidence** (CT1) of locally acquired widely dispersed cases detected in the past 14 days are not linked to specific clusters; transmission may be focused in certain population sub-groups. Low risk of infection for the general population. **Moderate incidence** (CT2) refers to the Moderate risk of infection for the general population. **A high incidence** (CT3) refers to a High risk of infection for the general population. **A very high incidence** (CT4) refers to a Very high risk of infection for the general population. |

*Source*: Wenger, Halperin, and Ziga (2009)

Social distancing is a key success to curb the epidemic, but the use of other policies, such as space restrictions, isolation, and quarantine further, enhance the effectiveness of the policy to control the spread of the disease (Chen *et al.*, 2020) and creating the digital age (Guy, 2019) The research compiled the application data generated for preparing and responding to an epidemic situation and categorized them into six categories (1) Planning and tracking (2) Medical Supplies (3) Screening for infection (4) Contact tracing (5) Quarantine and self-isolation (6) Clinical management (Whitelaw, Mamas, Topol, & Van Spall, 2020). This framework showed that the adoption of technology in conjunction with the epidemic policy might contribute to lower rates of infection and death rates. During the severe epidemic period, it is necessary to accelerate the adoption of technology as soon as possible. To facilitate front-line operations, planning, surveillance, testing, contact tracing, quarantine, and clinical management can be carried out on larger and more intensive scales, as shown in Figure 1.




*Source*: Whitelaw *et al*. (2020)
Figure 1: Digital technology as a tool for pandemic preparedness and response

**The Diffusion of Innovations & Privacy Communication Technology**

Information technology is increasingly becoming a part of everyday life (Kirk, Ractham, & Abrahams, 2016). The diffusion of technology so that it is accessible to all has become an important aspect of technology adoption along with national policy (Tim *et al.*, 2013). The diffusion of innovations has been explained by categorizing the entire society into five categories: (1) **Inventors,** the first people to initiate new innovations, (2) **Early Adopters**, people who are able to accept new innovations quickly (3) **Early Majority**, people who must allow innovation to demonstrate usefulness and efficiency before adoption can occur, (4) **Late Majority**, this group tends to have questions about the usage and wait until the majority of people find success in using it before they begin to accept the use, and (5) **Laggards**, people who tend to be strict in their traditional practices, making it difficult to accept change (Rogers, 1962). Even though people can accept the use of new technology, there are other negative factors, besides the usefulness of the technology, that are significant for people to be wary of it (Firpo *et al.*, 2009). For example, users are increasingly concerned about security issues and the accidental use of consumer information provided. In terms of privacy, some researchers view trust as a mediating variable between privacy concerns and disclosure (Metzger, 2004; Xu *et al.*, 2005). Building trust is more effective than trying to reduce consumer concerns.

**Communication Technology**

During the Covid-19 epidemic situation, social media has been the most effective news channel for broadcasting and publicizing medical knowledge (McGowan *et al*., 2012). Social media has been used to bridge the gap between government organizations and the general public; therefore, the government's social media has been used as a tool to help make intended goals more effective (Bryer & Zavattaro, 2011; Mergel, 2013). Moreover, the public view of the media is more embodiment than other public communication. The public media might be even more inductive that information dissemination can help control this epidemic (Lipsitch *et al.*, 2020). Early-stage emergency adoption situations of people lead to enthusiasm for people's participation in society, both the private sector and education sector (WHO (Thailand), 2020). Emerging of social media and restrictions policy during the epidemic situation clearly showed the help from the public in society. The Thai community have expressed through public engagement that they help each other through online channels by doing good deeds, such as making donations, helping to share or forward salutary information (Wiederhold, 2020)

**Trust & Governance & Public Engagement**

Trust in information and willingness to trust others, as moderated by personal attitudes, can be a contributing factor or a catalyst for change, such as civic participation (Tang *et al.*, 2012). Gaining public confidence and trust in an organization or institution is tendentious to achieve the goal of engagement, particularly in decision-making situations. The role of trust in a civic context seems to be most salient where the individual is assessing the fairness of a decision outcome or decision-making process (Gordon *et al.*, 2013; Terwel *et al*., 2010). The research of Hu, Tang, and Smith (2008) shows that comprehensive government regulations gain consumer trust, but rules might not be appropriate for a particular society nor in certain circumstances.

The COVID-19 epidemic situation illustrates one of the country's dominant concepts that constitute Digital Governance, which has evolved from network governance, including contemporary considerations of governance, which helps to solve social,

government, and personal problems (Kitchin, 2014). These concepts change the people's roles into active citizens who can communicate with others and their government through the use of information technology. Digital governance strategies or approaches are becoming the cornerstone of organizations and institutions, transcending traditional perspectives and attitudes

**Conceptual Framework**


*Adapted from*: Whitelaw *et al*. (2020)
Figure 2: Conceptual Framework

This research has extended the model to create a clearer picture of technology development by synthesizing the previous research as described in the literature review. The conceptual framework combined Stage of Transmitted with Digital technology as a tool for pandemic preparedness and response (Whitelaw *et al*., 2020). Stage of Transmitted, according to WHO documents, outbreaks are categorized into four levels: 1) No cases reported 2) Sporadic cases refers to entering a phase where more than one infection has been detected or is an infected case caused by traveling from outside the area (imported case) or a specific area detected. 3) Clusters of cases refers to infection detected in a specific group spread over a period of time or only in a certain area or region 4) Community transmission refers to locally acquired widely dispersed cases with evidence by the inability to relate confirmed cases through chains of transmission for a large number of cases, or by increasing positive tests through sentinel samples (routine systematic testing of respiratory samples from established laboratories). Transmission classification is based on WHO analysis of available official data (may be subject to reclassification as additional data become available). Not all locations within a given country/territory/area are equally affected. Areas experiencing multiple types of transmission are classified in the highest category.

By combining this knowledge with the research (Whitelaw *et al*., 2020), criteria were used to classify the technologies used in the COVID-19 epidemic into six categories: 1) **Planning and Tracking** refers to technology with functionality for tracking disease and activity in real-time. 2) **Medical Supplies** refer to the technology used for the management of medical equipment especially necessary equipment for disease control, such as face masks, medicines, and alcohol sanitizer. 3) **Screening for information** refers to technology that has the function of screening and monitoring the symptoms of both individual and collective diseases. It can identify groups of people at risk for infection and track the spread of infection and quarantine. 4) **Contact tracing** refers to technology that has a function to track the information of people who were in contact with infected people. It involves searching for exposed persons for examination and tracking information on quarantine and further transmission of infection. 5) **Quarantine and self-isolation** refers to technology with the function of individualized symptom monitoring and quarantine monitoring 6) **Clinical management** refers to technology with the function of diagnosis, following and monitoring the treatment situation, assessing treatment outcomes, and providing virtual treatment care services.

To find the answers to the second research question, this research identified the effective factor in six factors that are expected to affect the effectiveness of pandemic control technologies, 1) The diffusion of innovation 2) Communication technology 3) Trust in information 4) Digital privacy 5) Digital governance 6) Digital public engagement and all of that can be summarized as shown in Figure 2.

## RESEARCH METHODOLOGY

**Data Collection**

To find the answers to the questions, the qualitative method was selected to find results in this study via data collection of academic information from documents of government agencies or from related organizations, including information that was announced by the government and publication from reliable news agencies or publishers. The historical information was collated since the beginning of Coronavirus spreading. Data were collected from December 2020 to June 2021. The online survey and semi-structured interview were used to collect the data. Subjects were selected by purposive sampling solution (Palinkas *et al*., 2013) as users' specification who lived in Thailand and Taiwan during the Covid-19 pandemic or stayed in that country for a period of at least 180 days. The total number of volunteers was 46, divided into two groups. There were 26 subjects who lived in Thailand and 20 subjects who lived in Taiwan. See Tables 2, 3, and 4.

Table 2: The number of volunteers who participated in the survey and interviews

| Age | Thai | Taiwanese |
|---|---|---|
| 18-24 | 1 | 1 |
| 25-35 | 18 | 12 |
| 36-44 | 3 | 3 |
| 45-55 | 1 | 1 |
| 56-60 | 1 | 1 |
| >60+ | 2 | 2 |
| Total | 26 | 20 |

Table 3: Residential area of the volunteers who participated in the survey and interviews from Thailand

| Residential area | Thailand |
|---|---|
| Bangkok | 13 |
| Bangkok metropolitan area | 2 |
| Eastern | 1 |
| Northeastern | 3 |
| Northern | 4 |
| Southern | 3 |
| Total | 26 |

Table 4: Residential area of the volunteers who participated in the survey and interviews from Taiwan

| Residential area | Taiwan |
|---|---|
| Taipei | 13 |
| Taichung | 5 |
| Others | 2 |
| Taipei | 13 |
| Total | 20 |

Questions of the survey were similar between the two groups and followed a semi-structured interview format. There were face-to-face interviews, video call interviews, phone call interviews, and email questionnaires. All interviews and surveys were collected between July 2021 and August 2021, or 7 weeks, to explore the in-depth factors that supported or influenced the use of technology for controlling COVID-19 spreading.

**Case Study**

This research gathered the data technology that supports the pandemic disease control from both private and government agencies during the period from December 2019 to June 2021 and identified the period of first release date technology matched with the stage of transmission, as defined by the World Health Organization, and categorized technology in 6 Category according to previous research. Technologies that have more than one function will be identified as both categories of technology, and technologies that cannot be identified in 6 functions would be added in other categories. The technology that emerged before the first case was announced, researchers would match in Stage 1. After the first case was detected, the situation entered Stage 2 or Sporadic case. Entering stage 3 was based on information from direct regulatory agencies such as CECC, CDC, or WHO.

Table 5: Technology of Thailand under the conceptual research framework.

| Stage of transmitted | Categories of Technology | Name of technology |
|---|---|---|
| Stage 1 No cases reported | Screening for Information & Clinical Management | Doctor Near U (Klai Mua Moh) |
| Stage 3 Clusters of cases | Planning and Tracking | Away Covid-19 |
| | | Thailandplus for travelers |
| | Screening for Information | COVID-19 Tracker |
| | | Thaisavethai |

| | | |
|---|---|---|
| | | Thai Stop COVID Plus |
| | Contact tracing | Thaichana |
| | Quarantine and self-isolation | AOT DIGITAL AIRPORTS |
| | | Sydekick |
| | Clinical Management | Thai raum jai |
| | | Mohpromt |
| | Medical supplies | MASK MAP THAI |
| | Screening for Information and Planning and Tracking | Mohchana |
| | | Goo care |
| | Screening for Information and Clinical Management | Clicknic |
| | Screening for Information and Quarantine and self-isolation | DDC Care |
| | Screening for Information and Others (Source of information) | Card2u by Thaifight Covid |
| | Screening for Information and Medical supplies and Clinical Management and Other (Quarantine supplier) | Pedthaisupai |

Thailand has announced the first detected case that entered Stage 2 or Sporadic case from 13 January 2021 to stage 3 on 28 February 2020 until the end of the data collection period of this research (August 2021) (Novel Coronavirus in Thailand, nd). Thailand has a total of 18 technologies to cope with the Covid-19 epidemic situation. This research data found that the technology available during Stage 1 (No cases reported) is an application Doctor Near U (Klai Mua Moh). There are 0 technologies in Stage 2 (Sporadic case). In Stage 3 (Local Transmitted), Thailand emerged with 17 technologies, including Away Covid-19, Thailandplus for travelers, COVID-19 Tracker, Thai Save Thai, Thai Stop COVID Plus, Thaichana, AOT AIRPORTS, sydekick, Thai ruam jai, MohPromt, MASK MAP THAI, MorChana, Clicknic, DDC Care, Card2u by Thaifight Covid, Goo care and Pedthai Suphai. See Table 5.

Table 6: Technology of Taiwan under the conceptual research framework.

| Stage of transmitted | Categories of technology | Type of technology used |
|---|---|---|
| Stage 1 No cases reported | Contact tracing | Tracing |
| | Quarantine & Self-isolate | Digital Quarantine tracking system |
| | Planning and tracking & Screening for Information & Contact tracing | Big data analysis |
| | Clinical Management | National health insurance management |
| Stage 2 Sporadic cases | Quarantine & Self-isolate | Disease Containment Expert LINE Bot |
| | Clinical Management | V-Watch |
| | Medical supplies | Mask Map |
| | Other | Google Assistant Chatbot |
| Stage 3 Clusters of cases | Contact tracing | Taiwan Social Distance |
| | | SMS for contact tracing |

Taiwan announced their entering into Sporadic case as of 21 January 2020 (Taiwan Centers for Disease Control, n.d.-b) and entered Local transmission, stage 3, on 11 May 2021 until the end of the data collection period of this research (August 2021). Taiwan has a total of 10 technologies to cope with the Covid-19 epidemic situation. There are four technologies, namely Trace, Digital Quarantine tracking system, big data database system, and National health insurance. There are four technologies in Stage 2 (Sporadic case), namely Disease Containment Expert LINE Bot, vTaiwan, face mask map app, and Google Assistant Chatbot. There are two technologies in stage 3 (Local Transmitted), namely Taiwan Social Distance and SMS for contact tracing. See Table 6.

For example, Taiwan has devised several different mobile apps to help deal with the epidemic situation and to share this technology with other countries. According to Central Epidemic Command Center (CECC), for example, people in Taiwan can use a smartphone app to help the government's contact tracing effort; this is especially critical during stage 3. To increase the motive of the usage of mobile apps, users who access the contact tracing feature are eligible to participate in a lottery on the CDC's Facebook page for a chance to win a NT$500 (US$17.87) voucher with purchases made at designated supermarkets. More importantly, this app does not require typing in personal information because all the collected data is stored anonymously on the device, reducing the possibility of leakage of personal information.

Another example of how new technology can be helpful as an early warning system is an application called "The Taiwan Social Distance app." This app aims to prevent transmission of COVID-19 by notifying the users if they come within two meters from a confirmed case location that occurred less than two minutes ago. This has become extremely useful, especially during stage 3, when the pandemic cases are skyrising in early May 2021. Furthermore, this social distancing app applies Bluetooth technology to automatically save distance records from the last 14 days and allows users to be informed when exposed to confirmed cases.

It also meets the EU regulation on data protection and privacy, so neither the government nor the developer can gain access to the records, which increases the users' willingness to use new digital service technology.

## RESULTS AND DISCUSSION

The researchers collected data and compared the types of technologies from both Thailand and Taiwan by following the proposed conceptual framework. The information can be summarized as follows in Table 7.

Table 7: Comparison of technology of Thailand and Taiwan under the conceptual research framework.

| Stage of transmitted | Similarity technology of Thailand and Taiwan | Difference technology | |
|---|---|---|---|
| | | Thailand | Taiwan |
| Stage 1 No cases reported | Screening information<br>Clinical Management | | Planning and tracking |
| | | | Quarantine and self-isolation |
| | | | Contact tracing |
| Stage 2 Sporadic case | | | Quarantine & Self-isolate |
| | | | Clinical management |
| | | | Medical supplies |
| | | | Others |
| Stage 3 Local transmission | Contact tracing | Planning and tracking | |
| | | Screening information | |
| | | Quarantine and self-isolation | |
| | | Clinical management | |
| | | Medical supplies | |
| | | Others | |

**Stage 1**

During the first stage of transmission, Stage 1, with No case reported, it was found that Thailand and Taiwan have similar technology in Screening Information and Clinical Management. Thailand has Doctor Near U (Klai Mue Moh). This is a collaboration between the Thai Health Promotion Foundation and the private agency was released in November 2019. Doctor Near U is a mobile application and serves as a virtual clinic where people can be diagnosed at their fingertips. Furthermore, users can request additional consultation from a doctor via chat. The main purpose of the Doctor Near U application is to provide people with free access to basic medical care. In addition, it includes features to diagnose and screen for early symptoms of the Covid-19 disease, which matches the technology in the Screening Information category and can provide nearby hospitals or specialist doctors to contact users for treatment in the next step, which classifies the technology of the Doctor Near U as Clinical Management as well.

In Taiwan, a national health insurance system has been developed over two decades and is now available in the application technology. Taiwan citizens can access the health insurance system from every hospital or healthcare service via a smart card. In addition, Taiwan has connected the database of the National Health Insurance System, immigration information, and telecommunications. Consequently, Taiwan can integrate a Huge Big Data database system, making it possible to assess for signs of disease in an apparently asymptomatic population with real-time monitoring of the spread of infection across locations. The Taiwanese government also connects existing databases with telecommunication systems and third-party application data for the use of tracing a history of infected people traveling to different places. It will detect people who visit the same location and period and, thus, send SMS to mobile phones to inform people directly (Jian *et al.*, 2020). Taiwan's big data systems covered categories of Screening Information, Planning and Tracking, and Contact tracing technologies. Furthermore, in the first stage, the difference in technology between Thailand and Taiwan is that Taiwan has planning and tracking, quarantine and self-isolation, and contact tracing technologies that are developed and available during this No case report phase.

**Stage 2**

Sporadic cases, or the second stage of transmission, are all linked to imported/sporadic cases or a specific area detection. The obvious observation is that Thailand has no technology developed during this period while Taiwan has developed Quarantine & Self-isolate namely Disease Containment Expert LINE Bot that sends daily messages and monitors a person's health during home quarantine, and Clinical Management Namely V-Watch, which was developed to support public health messages for monitoring and tracking post-vaccination. This system provides appropriate medical advice and calculates the date of the second dose of vaccination, and sends a message for advance notification. Taiwan also has Mask Map, which is classified as Medical supplies technology to divide the quota for citizens purchasing face masks to prevent product domination. Another technology is Google Assistant Chatbot which is classified in the other types of technology. The purpose of the Google Assistant Chatbot is to provide information or answer questions on matters relating to the infection for the public.

Comparing the stage of transmission between Thailand and Taiwan, Thailand has stepped into the second stage, the Sporadic case, since 13 January 2021 and entered the third stage, Local transmission, on 28 February 2020, which took only 41 days. While Taiwan has stepped into the second stage, sporadic case, since 21 January 2021 and announced to enter the third stage, local transmission, on 11 May 2021, that means Taiwan keep the number of infection cases in the second stage for one year three

months and 21 days. For this reason, all four technologies can help to slow down the spread of the disease from sporadic cases to local transmission.

**Stage 3**

Local transmission, the third of the transmission stage, locally acquired widely dispersed cases detected. The essential technology of disease control that Thailand and Taiwan similarly focus on is Contact Tracing. In this period, Taiwan has developed only two technologies, which all contact tracing technologies, including the Taiwan Social Distance application, notified users who had visited the same areas as confirmed case in the last 14 days. The other one is SMS for contact tracing or QR system for sending SMS messages to track the timeline by QR code scanning; then, the system will automatically sync into the messaging system and show the specifying code by shop location and sending the message out, with no fee charged and no internet needed besides elaborate tracking and thoroughly reaching the population. Like Thailand builder Thaichana platform, Contact tracing technology, one of 17 technologies developed in the third stage. Thai-Chana is available on both websites and applications to track people's timelines in shopping malls or shops by collecting check-in and check-out information with QR codes. Department of Disease Control Ministry of Health is solely authorized to access data tracking and quarantine.

The results of the volunteers, both the interviewee and the survey respondents, show that the most used technology in both Thailand and Taiwan is the Contact Tracing category. Among 26 users from Thailand, there were 20 users who use Thaichana technology, and among 20 users from Taiwan, there were 12 users who opted for SMS Tracking and eight users who opted for TAIWAN Social Distancing. The obvious observation, all three technologies developed and enabled similarly during the countries' local transmission stage. Taiwan users opted for technologies that emerged during Stage 2 by three technologies, like the following, Google Covid trackers seven users, Mask maps six users, Disease Containment Expert LINE Bot 1 User.

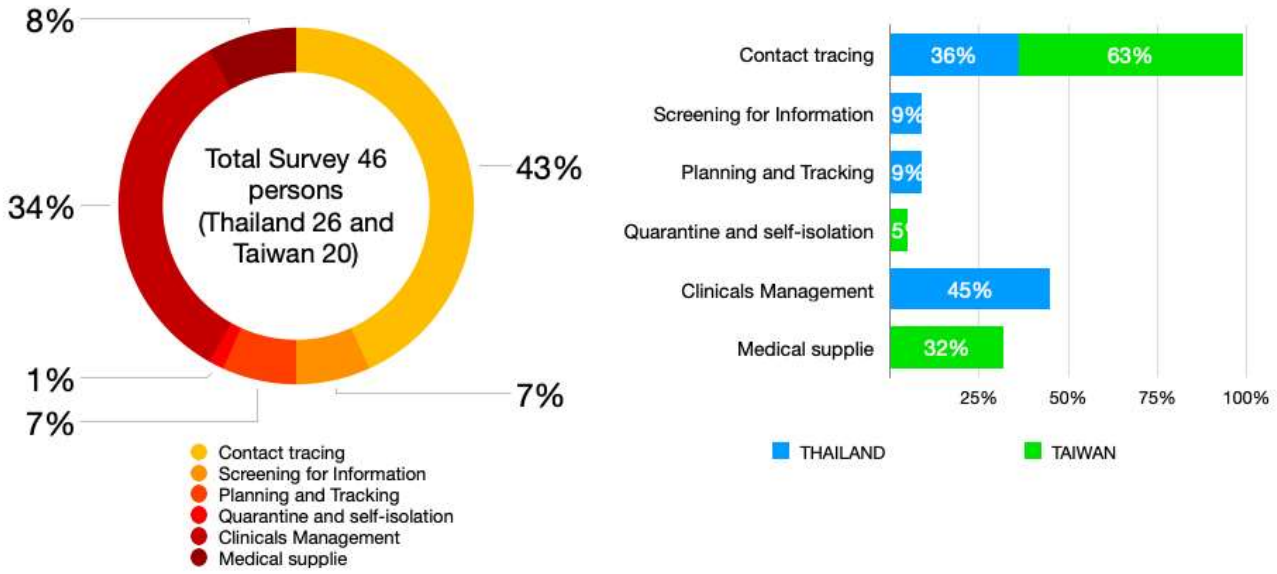



Figure 3: Usage of Covid-19 pandemic technology Survey

Through Analyzing responses from user groups in both countries, it was found that adoption technology is used for (1) Social and legal regulations, (2) Social responsibility, (3) Used applications (4) Needed Features. The reasons for refusal of using can be grouped into three main reasons: (1) Not having used the technology before, (2) No need for use (3) Not tech-savvy. The responses from the user group are consistent with Riemer, 2020 research which states that mandated enforcement makes people adopt tracing technology and efficiency for public health. See figure 3.

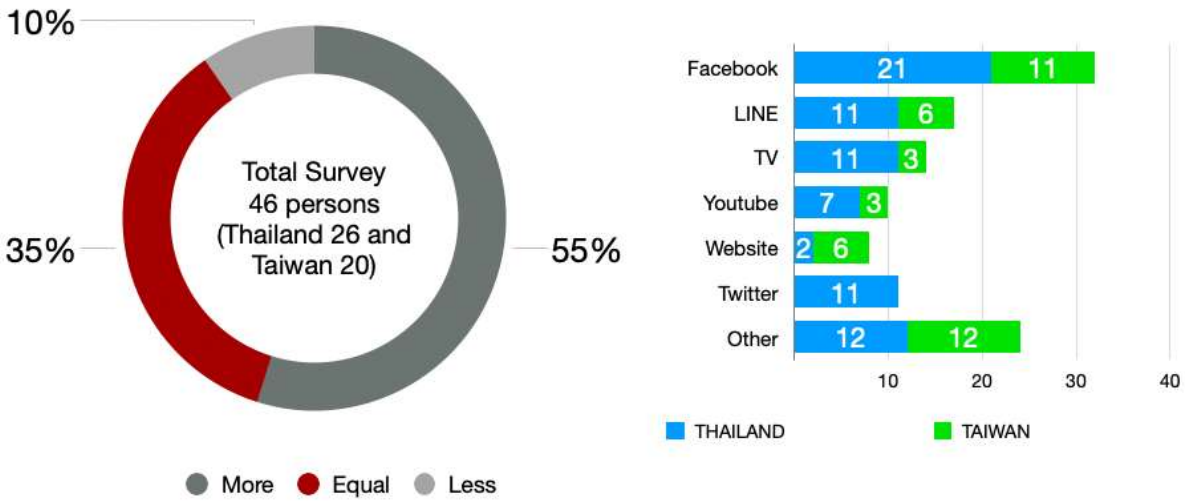



Figure 4: Communication technology of Covid-19 pandemic technology survey

To further delve into the behavior of technology usage in communication (Communication Technology & Society), it was found that more than 55% of users felt that they consume more information, such as the news from social media and all sources of information, during the epidemic situation than the preceding period of emerging infectious diseases. Only 35% responded that they were consuming the same amount of news (as a preceding period), and only 6% consumed less information than in the preceding period. In line with an academic document from the World Health Organization (WHO) titled Joint Intra-Action Review of the Public Health Response to COVID-19 in Thailand, it states that acceptance of the situation of people in society at an early-stage lead to enthusiasm for the participation from both groups of people in society and in the private sector. The most popular communication channel used by volunteers in both countries is Facebook, with 33 users, whereas 17 people use LINE. See figure 4.

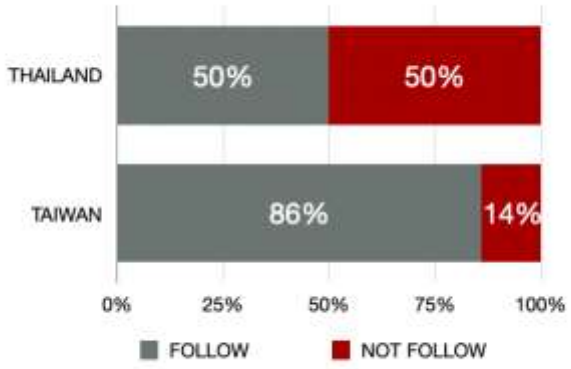



Figure 5: Public Trust of Covid-19 pandemic technology survey

In addition, only 50% of Thai users follow official news or information from government agencies. On the contrary, Taiwan users have a higher official news consumption rate of 86% Bryer and Zavattaro (2011); Mergel (2013) research said social media was designed to bridge the gap between organizations or Government agencies and the general public. This gives the government the tools to make the intended goals more effective. See figure 5.

Apart from the result, both Thailand and Taiwan residents circulate rumors or fake news on the Internet about infectious diseases. Users of both countries have similar ways to counter fake news, which can be summarised in three ways, (1) search more information, (2) recheck with a variety of news sources for more consideration (3) ask close people. The difference between Thailand and Taiwan is that Thailand users have a way to deal with fake news by deciding to trust reputable news channels or agencies and use personal judgment. Contrary to this, Taiwan users decide to trust announcements from the CECC Organization - Taiwan Centers for Disease Control official. Consistent with research by (Qiuyan *et al.*, 2020), governments should closely monitor social media channels to provide communication during the epidemic to update the information of news or policies in order to keep up with the interests of the people. Also, government agencies should adopt easy-to-understand language to address

what people are concerned about. The results of Thailand and Taiwan also show the government's ability to communicate affects people's trust in information, which is compatible with (Hu *et al.*'s, 2008) research. Gaining public confidence and a trusted organization or institution is tendentious to achieve the goal of engagement, particularly in decision-making situations. The role of trust in a civic context seems to be most salient in which the individual is assessing the fairness of a decision outcome or decision-making process. (Gordon *et al.*, 2013; Terwel *et al.*, 2010) In the research of Hu *et al*. (2008) According to Bengio *et al.* (2020) mentioned encouraging control the spread of infection effectively, as people's trust in technology is a key to diffuse adoption of technology.

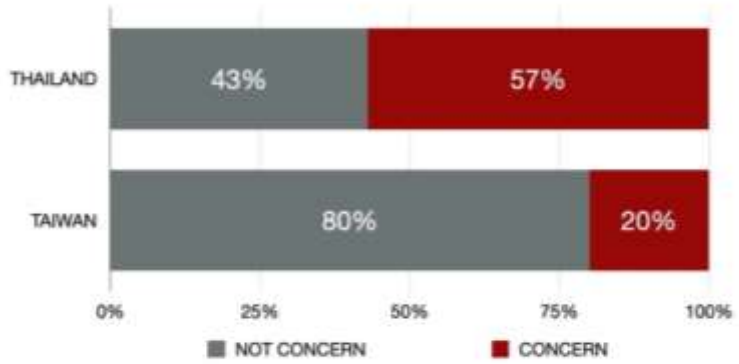



Figure 6: Digital Privacy of Covid-19 pandemic technology Survey

Penetrating the usage of technology, it was found that as many as 57% of Thai users were concerned about the safety and privacy of their personal data, while only 20% of Taiwan users were concerned. The result is consistent with the research by Bengio *et al.* (2020); Hung and Wong (2009), which mentioned that users need more concise information surrounding privacy protection, especially in a democratic society, and they tend to be more concerned about personal privacy and violation of personal privacy. If government continuously neglects the infringement of people's privacy rights or lacks an attitude on privacy concerns, people's trust in that technology will decrease. See figure 6.

Another reason why Thai volunteers continue to use technology is due to mandatory regulation of pandemic disease control policy, such as vaccine certificates for entering some the area, and vaccine registration and strictly check-in areas. On the other hand, even though concerned for personal safety but for the benefit of the public, Taiwan users argue about their continued use, in case of being infected or under surveillance. This is consistent with the research of Bimber (1994) that concluded technology-driven approaches might yield good results when enforced by laws, regulations, or objective proposals from governments and may result in reduced human freedom. From the results of collecting all the above-mentioned data, we can summarize the issues to answer research questions, as shown in Figure 7.

From the results of collecting all the above-mentioned data, we can summarize the issues to answer research questions, as shown in Figure 7.

The core technology to encourage the pandemic disease control situation in this study was divided into four stages. The study was limited in terms of duration, allowing only three stages to be studied. From a comparative study in Stage 1, Thailand and Taiwan had technologies in Screening for Information and Clinical Management before the occurrence of the Covid-19 epidemic. In Stage 2, technology in Quarantine & Self-isolation and medical supplies are technologies that Taiwan has developed and enhanced control of infectious disease, which is related to the number of infected people in the country. For Stage 3, Contact tracing technology is important as both Thailand and Taiwan successfully implemented this, with results showing that most volunteers use it. The factors affecting the usage of technology in a pandemic situation are regulations or policies announced by the authorities and the security of privacy protection. In addition, from in-depth interviews and questionnaires from 46 real users in both countries, it was found that factors in the diffusion of innovation and factors of communication technology contributed to enabling the technology released along with the situation control policy to be effective. Furthermore, the difference in users of Thailand and Taiwan is the factor of trust in information towards the center of government affect to public engagement lead to makes the policy effective in controlling the epidemic situation. In addition, users in Thailand also have privacy concerns, but the reason for the adoption of the technology comes from policy regulations or digital governance.

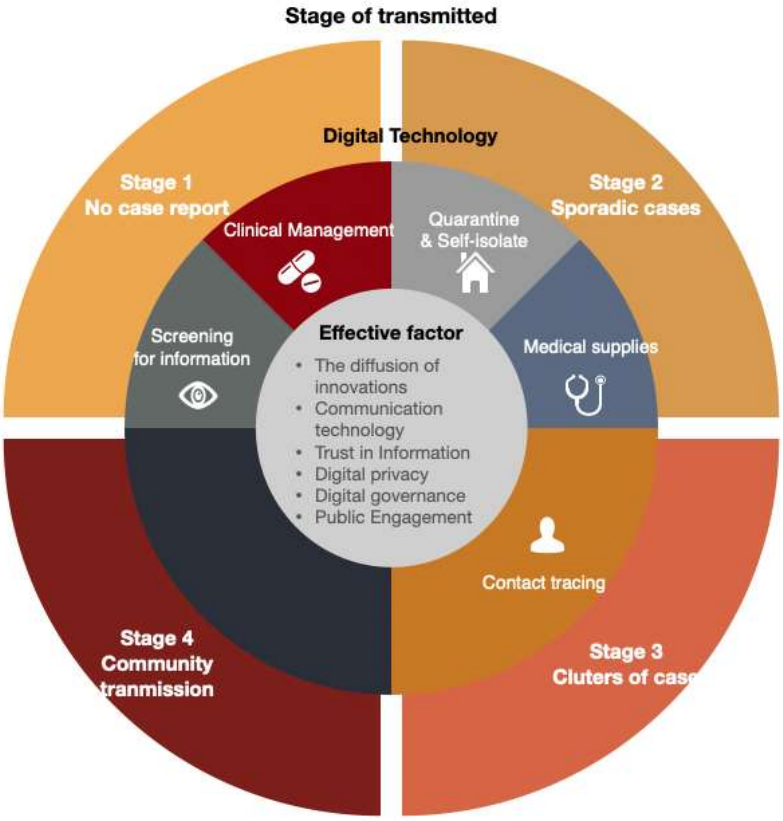



Figure 7: Technology-enabled innovations to combat Covid-19 pandemic

## CONCLUSIONS

Table 7 summarizes the technology and Effective factor to focus under this research. During the first stage, or before the outbreak in the country, screening for Information and Clinical Management technologies are the main part of a support for the pandemic situation, although there were other types of technology developed during this period. However, the factor in the diffusion of innovation limited people to adopt the technology timely manner. For example, Taiwan focuses on an organization's technology using in-house development along with regulations that encourage better infection disease control. In addition, during the first stage, communication technology is an important part of making people aware of and understanding the nature of the epidemic as quickly as possible, such as using more variety of social media channels to communicate with other people. In order to access more information from all groups, governments or regulators should focus on building trust that concerned with information because it plays an important role in building public trust, leading to the adoption of technology in the long term, including the creation of public engagement that will have a positive effect of the policy to have better control over the epidemic.

In Stage 2, Quarantine & Self-Isolate and Medical Supplies technology have contributed to Taiwan's success in controlling the pandemic situation and kept the number of detected in Stage 2 for a long time or slowly disseminated to entering Stage 3. In this stage, the spread of information and regulations will encourage people to adopt the use of technology.

In Stage 3, Contact Tracing technology plays an important role in controlling the infectious disease situation in this period. From in-depth interviews, factors of public engagement and the enforcement of policies have contributed to the adoption of contact tracing technologies. However, although enforcement will enable the adoption of the technology, the privacy factor is still a major concern for users who refuse to use technology. Through non or weak regulations, factors in the public trust to regulators may have an effect on public privacy concerns, but not enough to convince the public to concede technology at first. Therefore, digital governance is a very significant factor in Stage 3. Governments or regulators should be closely monitored to ensure that the technology's privacy policy is beneficial and accessible to the people.

Additionally, the increasing number of technologies during this period did not contribute to controlling the pandemic situation. The governments or regulators should focus on developing practical technology and relay the benefits of technology to the people so they can understand how to use the technology at its full compacity and usability.

Table 7: Technology and Effective factor to focus under this research

| | Stage 1 | Stage 2 | Stage 3 |
|---|---|---|---|
| Technology to focus | • Screening for Information<br>• Clinical Management | • Quarantine & Self-isolate<br>• Medical supplies | • Contact tracing |

| | | | |
|---|---|---|---|
| Effective factor to focus | • Diffusion of innovation<br>• Communication Technology | | • Digital Privacy |
| | | • Digital Governance | |
| | • Trust in information<br>• Public Engagement | | |

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