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Ineffectiveness of the COVID-19 Tracking and Tracing Application in Japan¹

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Keywords: COVID-19, contact confirmation, tracking and tracing, COCOA, network externality, privacy

1. Introduction

This paper aims to analyze how and why Japan's new coronavirus contact tracking and tracing application has not been supported by people and in effect been ineffective in preventing the spread of infection of COVID-19. Ministry of Health, Labor and Welfare of Japan released COCOA on June 17, 2020. It has been expected to work as a platform for capturing people's close contact with infected persons. However, it is pointed out that COCOA is not working well enough despite its high expectations.

In December 2019, a pneumonia case was reported in Wuhan, China. Within a few months a new infectious disease spread across the world. World Health Organization (WHO, 2020) reported in March 2020 that the disease was caused by a new virus called COVID-19. Since it takes a few days for the symptoms to appear, the virus spreads to close contacts. It is crucial to break the chain of transmission in order to cut off the route of infection. WHO suggested that contact tracing is one of the key strategies to break the chain of infection.

In response to WHO advice, many countries have utilized a digital tool for tracing close contact and introduced a mobile application. The concept is to have each people install the application for monitoring its own activity. The application can trace the close contact either with the Global Positioning System (GPS) using satellites, or Bluetooth for wireless data exchange between devices. The application notifies a close contact with a person who develops symptoms once it is detected. It aims to reduce the transmission within a community, for instance, household

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contact, workplace, school, or public transportation. Since the application runs on the platform, network externality may work and then bring the best performance to society. That is, the more people download and the more patients register, the more effective the application will be.

This paper is a part of project research on the efficacy of Japan's smartphone-based COVID-19 Contact-Confirming Application (COCOA). The research focuses on the trade-off between the efficacy of the app and privacy protection, and how trust is important for enhancing the efficacy of the app. The project is composed of two parts: (1) analyzing the process of COCOA dissemination, and (2) exploring the reasons why people are hesitant to download the application and register positive. This paper focuses on the first part, i.e., the low effectiveness of the application. In addition to demonstrating the slow spread of the application, it approaches the research question:

RQ. What are the factors influencing the diffusion of the application and how they affect the diffusion?

2. Literature review

Evidence from a cross-country survey indicates that the application can suppress the spreading once sufficiently high population penetration is attained (Altmann et al, 2020). In the study, an online survey was carried out in France, Germany, Italy, the United Kingdom, and the United States in March and April 2020 and sampled over a total of 5,995 respondents. The survey investigated the intention to install the application under two conditions, opt-in and opt-out, then multivariate regression analysis was applied. The finding shows that the application gained a strong support in all countries but points out that there is an obstacle that may interfere with the adoption: concerns about cybersecurity and privacy, and lack of trust in government. In Germany and the United States where the concern of security and privacy is high, support for the application is less. Lower trust in government yielded a negative effect on the intention to install the application on their phone. The result of the study suggests that the effectiveness of a contact tracking and tracing application depends on the level of its adoption in the country.

From a governmental government point of view, Jacob and Lawarée (2020) studied the adoption of a contact tracking and tracing application by the European governments through collecting documents and articles from print media. It is notable that relevance and security, and data protection play an important role in the adoption of the app. It also referred to the influence of digital divide since people who do not own a smartphone cannot access the app. In addition, the security and data protection are considered as a political challenge.

3. COCOA, Japan's contact-confirming application

3.1 Dissemination of COCOA

Ministry of Health, Labor, and Welfare of Japan has released the coronavirus close contact tracking and tracing application on June 17, 2020. The ministry requests to install the application COCOA to prevent the spreading of COVID-19 in Japan.

It is pointed out that COCOA is not working well enough despite its high expectations. As of March 31st, 2021, the number of downloads of COCOA reached 26.53 million which is approximately 21.3% of the total population⁵. For the application to be more effective, positive patients should also register in the application that they are positive. On the other hand, there were only 12,068 positive registrants, which was 2.6% of the total number of infected people. Mass media questions the government's capability to manage the application. For example, Nikkei Asia (Ando, 2021) criticized that the application failed to run at full capacity, and the Asahi Shimbun (Yamamoto, 2021) reported the bug that could not be solved despite the ministry's attempt to fix it. While Reuters (Swift, 2021) reports the application's malfunction that failed to notify some warnings.

Figures 1 (a) – (d) show the weekly new number and the cumulative number of COCOA downloads and positive registrations. It seems that the adoption of COCOA and the registration of positive are both smoothly increasing. However, as shown in the weekly downloads, the number of weekly downloads is showing a declining trend and still limited as compared to the total population. The number of positive registrations shows a peak in January 2021. It is affected by the second peak of infection spread as shown in Figure 2.

[Figure 1\(a\) – \(d\)](#) [Figure 2](#)

3.2. Why the low penetration rate?

COCOA is an app developed by the Japanese government. When COCOA was introduced, Prime Minister Abe held a press conference⁶ and emphasized the following two points:

- 1) The app takes privacy protection very seriously and does not collect any personal information.
- 2) According to a study by the University of Oxford, if the app is available to nearly 60% of the population, and if it can lead to early isolation of close contacts, lockdowns can be avoided.

⁵ The estimated total population of Japan as of the end of 2020 is approximately 12.5 million. (MIC, 2021)

⁶ https://www.kantei.go.jp/jp/98_abe/statement/2020/0618kaiken.html

P.M Abe urged as many people as possible to adopt the app as soon as possible. He also stressed that the app does not store any personal information and all personal information used is highly encrypted, so that no one can identify any positive or close-contact person. The system uses the API developed jointly by Google and Apple. It does not record personally identifiable information such as phone numbers and location information. The contact history and other information are not transmitted to anyone, including the government, but will be encrypted and recorded only in each individual's smartphone, which will automatically become invalid after 14 days. Subject to the consent of individuals, privacy is ensured by using the proximity communication function (Bluetooth) of smartphones so that they do not know each other.

Since Japanese citizens are reluctant to have their personal information collected by the government, he wanted to emphasize strict privacy protection of COCOA for the sake of relieving people and promoting the app. In addition, downloading apps and registering positives are totally at the discretion of each individual. Consent to use can be withdrawn at any time, the app can be deleted, and the records can be erased. This means that users can quit using the app at any time.

The function of the app is also limited. It provides only the fact of close contacts. The information that the recipient wants to know, such as when and where, is not provided. Excessive privacy protection and information limitation have limited the benefits this app brings. Consequently, most people do not possess strong incentives to use. As a first step in approaching this problem, we will examine how the number of new downloads and the number of new positive registrations remain stagnant, and what are the factors influencing the numbers of new downloads and the number of new positive registrations.

4. Method

We will investigate the spread of the application using the data on the number of downloads and positive registrations as the indicators of the utilization of COCOA. We use the weekly data between July 16, 2020, and March 31, 2021. The data has been published by the Ministry of Health, Labor and Welfare (MHLW) (2020b) since the middle of June 2020, as daily data. It is not appropriate for time series analysis because data for weekends and holidays are not available. Instead, we aggregate the data on a weekly basis. Positive registrations started on July 16. We have excluded the data after April 1 since the Ministry's data aggregation method has been changed. The indicators representing the situation of COVID-19 are collected from the open data released by MHLW (2020a).

Multiple regression analysis is applied for confirming the correlation of the number of new downloads and the number of new positive registrations with other indicators representing the

spread of infection. Furthermore, we will examine how the network externality affects diffusion. The data used in the analysis are as follows:

1) COCOA-related indicators

- ① *NWnd*: Number of weekly new downloads
- ② *CNnd*: Cumulative number of new downloads
- ③ *NWnpr*: Number of weekly new positive registrations
- ④ *CNnpr*: Cumulative number of new positive registrations⁷

2) COVID-19-related indicators

- ⑤ *NWnp*: Number of weekly new positives
- ⑥ *CNnp*: Cumulative number of new positives
- ⑦ *NWpcr*: Number of weekly PCR tests
- ⑧ *CNpcr*: Cumulative number of PCR tests
- ⑨ *Dummy*: Emergency state declaration

In addition to the indicators related to COCOA and COVID-19 infection, an emergency state declaration may have an influence on people's behavior and thus on the indicators. A state of emergency has been declared three times so far: the first from April 7 to May 25, 2020 (nationwide), the second from January 8 to March 21 (11 prefectures), and the third from April 25 to the present (10 prefectures). The second one was declared during the observation period. It was included as a dummy variable in the models. Japan cannot issue a lockdown to restrict individual sovereignty, but a declaration of a state of emergency restricts people's movement and the operation of stores and restaurants.

This paper focuses on the number of downloads of the app and the number of positives registered for the app. We assume that the effectiveness of the application can be defined by the number of downloads and the number of positive registrations. The former represents how it is adopted by Japanese people. It is evident that, if the majority of the population adopts the app, more contacts will be monitored and it will eventually increase the chances to capture the contact with positive persons. The latter relates to how many positive persons are actively captured in the app and as it increases, contacts with positive persons can be more accurately confirmed. If all positive patients register positive in the app, it will provide a maximum chance to get contact with positive persons in the app.

The models to be estimated are listed in Table 1. For the number of weekly new downloads, the four models of log-linear regression are to be estimated. The basic model (D-1) assumes that the number of weekly new downloads is explained by the number of weekly new positives and

⁷ This variable is not used in the analysis in this paper.

the number of weekly PCR tests, defined as:

$$(D-1) \quad NWnd = C_1 + a_{11}\ln NWnp + a_{12}\ln NWpcr + Dummy + u_1 \quad (1)$$

Each of the models (D-2) through (D-4) includes one cumulative indicator. Here, we assume the cumulative number of downloads or new positives or PCR tests may accelerate weekly new downloads due to the existence of network externality. The model (D-2) is represented as Eq. (2).

$$(D-2) \quad NWnd = C_2 + a_{21}\ln NWnp + a_{22}\ln NWpcr + a_{23}\ln CNnd + Dummy + u_2 \quad (2)$$

As the coefficient for the indicator, a_{23} , represents the elasticity of the number of downloads with respect to the indicator, it suggests the existence and scale of network externality.

In the same way, models can be formulated for the number of weekly positive registrations. The basic model that does not include cumulative indicators is given as Eq. (3).

$$(P-1) \quad NWnpr = K_1 + b_{11}\ln NWnd + b_{12}\ln NWnp + b_{13}\ln NWpcr + Dummy + e_1 \quad (3)$$

Models including a cumulative indicator are defined as (P-2) – (P-4) in Table 1, formulating the existence of network externality. For example, the model (P-2) is expressed as:

$$(P-2) \quad NWnpr \\ = K_2 + b_{21}\ln NWnd + b_{22}\ln NWnp + b_{23}\ln NWpcr + b_{24}\ln CNnd + Dummy + e_2 \quad (4)$$

Table 1

5. Results: Factors influencing the diffusion of the application

5.1 Impacts on the number of downloads

Since the estimation is still ongoing, tentative results are shown here. Table 2 shows the estimation results of the models (D-1) – (D-4).

(D-1)

The result indicates that the coefficients are both significant, but the latter is negative. This means that the number of weekly PCR tests is negatively correlated with downloading the app. The result is difficult to interpret and seemingly not satisfactory. One reason for this would be that some other factors influencing downloading are missing. There is room for improvement in this analysis.

(D-2) – (D-4)

As explained in the previous section, the coefficient for each cumulative indicator represents

the elasticity of the number of downloads with respect to the indicator, and the existence of network externality is implied if it is more than unity. The estimated coefficients are -.455, -.1.1 and -.581 for the cumulative number of new downloads, new positives and PCR tests, respectively. They are all significant but negative. None of the results does support the existence of positive network externality. This implies that in the diffusion of COCOA, the cumulative number of new downloads, new positives, or PCR tests is not working as an accelerator.

Table 2

5.2 Impacts on the number of positive registrations

In addition to the basic model, three models including a cumulative indicator were estimated.

(P-1)

Among the three weekly indicators, only the number of PCR tests significantly affected the number of positive registrations. The dummy variable representing the emergency state declaration has a significantly negative impact on the number of positive registrations. It is interpreted that the declaration substantially reduces the number of positives and consequently the number of positive registrations because activities and mobility of people are restricted during the declaration.

(P-2) – (P-4)

The models with a cumulative indicator showed similar characteristics. Throughout the models, the number of weekly downloads and the number of weekly new positives are significant and they have a positive impact on the number of positive registrations. In each model, the cumulative indicator demonstrated a positive influence. Since the estimated coefficients are 1.536, 1.216 and 1.221 for the models (D-2) – (D-4) respectively, positive registration is elastic with respect to the indicators. The more the app is downloaded, or the more positive people exist, or the more people take a PCR test, the more people will register positive. Therefore, these cumulative indicators accelerate the registration. In addition, the coefficient for the dummy variable is significantly negative for (D-3) and (D-4). The emergency state declaration had the effect of suppressing the number of positive registrations.

Table 3

6. Conclusion

This paper focused on the insufficient use of COCOA, Japan's new coronavirus contact confirmation application. Using the statistical data published by MHLW, we tried to explain how

the number of downloads and the number of positive registrations in the app are affected by the indicators related to the use of COCOA and the diffusion of COVID-19. The eight regression models were estimated in the analysis. The analysis on the number of downloads was not fully satisfactory. We ran another estimation to check the existence of a time lag, but the result did not suggest this. Further investigation is needed.

The models on the number of positive registrations yielded overall consistent results. The analysis indicated that it has a positive correlation with the number of weekly downloads and the number of new positives. The existence of network externality was also observed in terms of the three cumulative indicators.

In Japan, COVID-19 seems to be relatively controlled, compared with many other countries. Despite the lack of government leadership, people think well and restrain their behavior. It is sometimes called a “Japan” model. Insufficient government policies appear in various aspects of COVID-19 measures. The COVID-19 contact confirmation application is not an exception. When the app was developed, the Japanese government was extremely afraid of being accused of collecting personal information or infringing privacy. As the result, the function of the app was limited and the number of downloads has shown only a slow increase. In addition, even if people become PCR test positive, very few of them register positive. Consequently, its efficacy remains extremely low. It seems that a trade-off between efficacy and privacy exists.

However, this is not the case that happened only in Japan. A phenomenon of low app penetration is observed in the countries that have adopted the Apple/Google API for the contact confirmation application. AFP (2020) and Lowy Institute (2020) suggest that none of the top 10 countries with successful corona countermeasures have adopted the API.

In order to increase the effectiveness of COCOA, it is necessary to increase the number of registrations, which are left to the autonomy of infected persons. Alternatively, in order to make COCOA effective, at least one of the following measures should be taken:

- Government incentives e.g. subsidizing people
- Government enforcement or stronger leadership
- Implementation of a system that allows individuals to feel the benefits of using COCOA in society.

Comparison with South Korea and China where the utilization of personal data is prioritized will show an interesting contrast. In these countries, people were frustrated by the lack of privacy protection but finally relieved when the actions of positive people were made public. Although there are differences in social systems and privacy concepts, it would suggest that, by making

people realize private benefits, privacy concern can be overcome. Bringing a sense of security may take precedence over privacy in time of emergency. In addition, the formation of trust in the government and society must also be an important factor for the application to be more effective. These are under study and will be presented in the near future.

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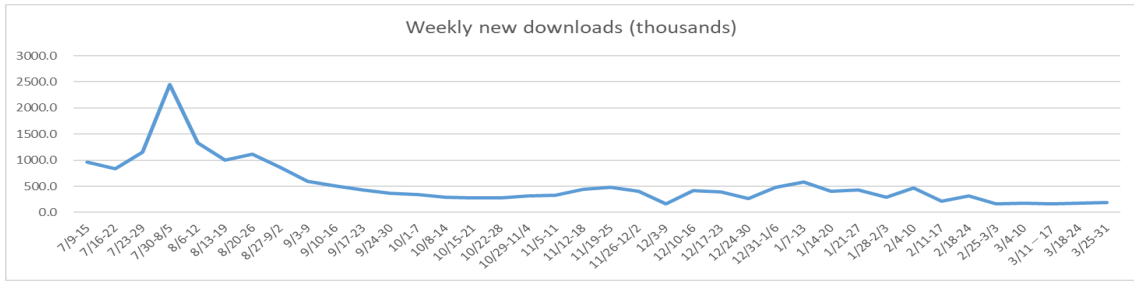


Figure 1(a): Weekly new downloads (July 9, 2020 – March 31, 2021)

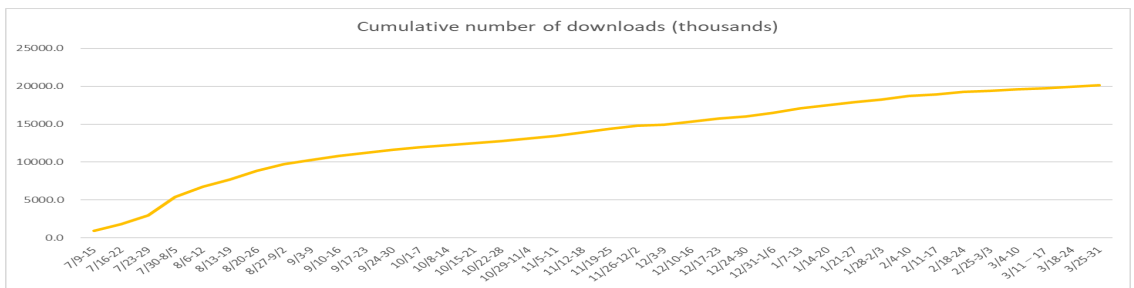


Figure 1(b): Cumulative number of downloads (July 9, 2020 – March 31, 2021)

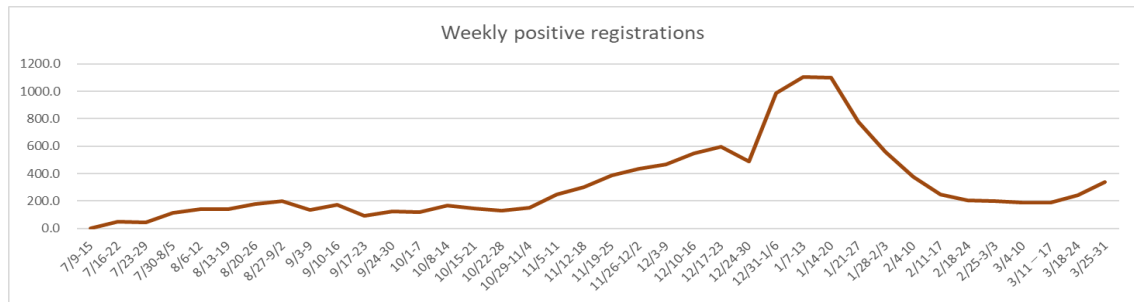


Figure 1(c): Weekly new positive registrations (July 9, 2020 – March 31, 2021)

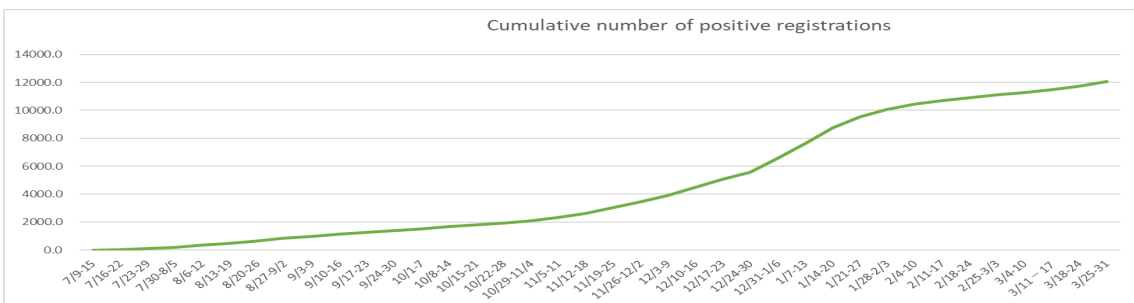


Figure 1(d): Cumulative number of positive registrations (July 9, 2020 – March 31, 2021)

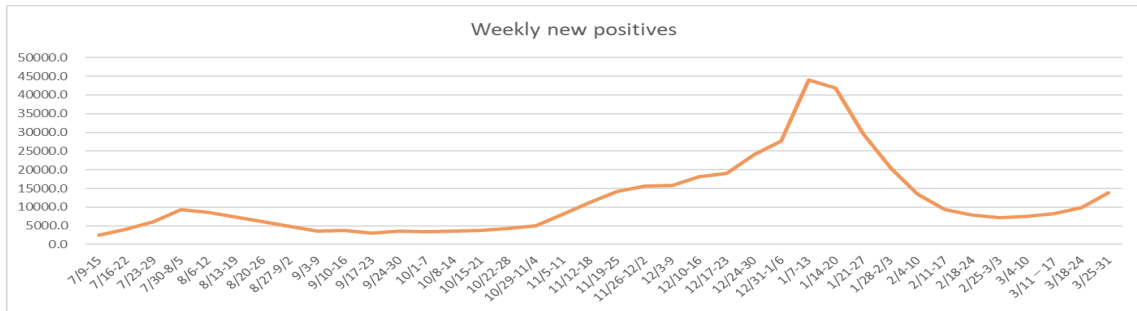


Figure 2: The number of weekly new positives

Table 1: List of the models to be estimated

Model		Dependent variable	Independent variables	Dummy variable
(D-1)	Basic	① Number of weekly new downloads	⑤ Number of weekly new positives ⑦ Number of weekly PCR tests	⑨ Emergency state declaration
(D-2)	Network externality		② Cumulative number of new downloads ⑤ Number of weekly new positives ⑦ Number of weekly PCR tests	
(D-3)			⑤ Number of weekly new positives ⑥ Cumulative number of new positives ⑦ Number of weekly PCR tests	
(D-4)			⑤ Number of weekly new positives ⑦ Number of weekly PCR tests ⑧ Cumulative number of PCR tests	
(P-1)	Basic	③ Number of weekly new positive registrations	① Number of weekly new downloads ⑤ Number of weekly new positives ⑦ Number of weekly PCR tests	
(P-2)	Network externality		① Number of weekly new downloads ② Cumulative number of new downloads ⑤ Number of weekly new positives ⑦ Number of weekly PCR tests	
(P-3)			① Number of weekly new downloads ⑤ Number of weekly new positives ⑥ Cumulative number of new positives ⑦ Number of weekly PCR tests	
(P-4)			① Number of weekly new downloads ⑤ Number of weekly new positives ⑦ Number of weekly PCR tests ⑧ Cumulative number of PCR tests	

1) COCOA-related indicators

- ① Number of weekly new downloads
- ② Cumulative number of new downloads
- ③ Number of weekly new positive registrations
- (④ Cumulative number of new positive registrations)

2) COVID-19-related indicators

- ⑤ Number of weekly new positives
- ⑥ Cumulative number of new positives
- ⑦ Number of weekly PCR tests
- ⑧ Cumulative number of PCR tests
- ⑨ Emergency state declaration

Table 2: Estimation result for the number of weekly new downloads

Model	Constant <i>Ci</i>	② <i>CNnd</i>	⑤ <i>NWnp</i>	⑥ <i>CNnp</i>	⑦ <i>NWpcr</i>	⑧ <i>CNpcr</i>	⑨ <i>Dummy</i>	Adjusted R ²
(D-1)	25.236		.797***		-1.606***		.273	.477
(D-2)	25.313	-.455**	.570***		-.832*			.538
(D-3)	16.476		.437**	-.546***	-.101		.197	.632
(D-4)	17.484		.345*		.063	-.581***	.079	.693

Significant level: *** 1%, ** 5%, *10%
The colored variables are cumulative numbers.

Table 3: Estimation result for the number of weekly new positive registrations

Model	Constant <i>Ki</i>	① <i>NWnd</i>	② <i>CNnd</i>	⑤ <i>NWnp</i>	⑥ <i>CNnp</i>	⑦ <i>NWpcr</i>	⑧ <i>CNpcr</i>	⑨ <i>Dummy</i>	Adjusted R ²
(P-1)	-15.485	-.125		.457		-1.519***		-.890**	.673
(P-2)	-27.888	.356**	1.536***	.841***		-.322		-.299	.538
(P-3)	-13.769	.579***		.696***	1.216***	-.698		-.913***	.839
(P-4)	-21.982	.778***		.687***		-.539	1.221***	-.728***	.693

Significant level: *** 1%, ** 5%, *10%
The colored variables in the top row are cumulative indicators.