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Understanding the Status Quo of Contact Tracing Solution for Front Liners During the Covid-19 Pandemic

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Abstract:- The world has embarked into Smart Healthcare era in which, it is a construct under the context of Smart City towards making solutions in healthcare to be smart. Even with extensive advancement in Smart Healthcare solutions, the world especially Malaysia were caught unprepared for smart contact tracing solutions in facing Covid-19 pandemic. Although four main contact tracing solutions were developed by Malaysia and implemented nationwide, there is still no solution yet made viable for the front liners in preventing the spread of Covid-19 infection in the quarantine centers. Thus, this study dissects the gap between Malaysia's current contact tracing solutions with respect to the front liners. Methods utilized are: (1) Systematic Literature Review (SLR) for front liners' working condition during Covid-19 pandemic, (2) Thematic analysis for the SLR conducted and (3) Gap analysis. Outcome from this study shows the absence of smart contact tracing solution for the front liners is a critical gap in Malaysia while proving that mobile-based solution is not a viable option. Contributions from the study are two-fold: (1) Comprehensive front liners' Covid-19 working conditions and (2) Front liners' requirement criteria for a solution during Covid-19 which are: (a) Autonomous, (b) Ability to last adequate period of time, (c) Complacent daily use, (d) Durable, (e) Radio interference operable and (f) Close contact tracing.

Keywords:- *Smart Healthcare, Contact Tracing, Covid-19.*

I. INTRODUCTION

A new concept known as 'Smart Healthcare' has emerged in Smart City context due to vast advancement in information technology and the usage of smart devices. It is one of the pillars that serve as a foundation to Smart City framework. Similar to Smart City context, Smart Healthcare is born from the concept of "Smart Planet" by IBM in 2009 [1]. The concept is an enhancement from digital healthcare, where the aim is making all services to be digitalised. While in Smart Healthcare, it focuses on comprehensive digitisation of all aspects in healthcare and build its foundation with combination of technologies such as Internet of Things (IoT) in making it smart [2]. Even with enormous efforts toward Smart Healthcare, almost all countries including Malaysia, were not prepared in terms of smart solutions to contain and manage the highly contagious Covid-19 virus pandemic. It is true especially for contact tracing where it is one of the main smart solution adopted by the authorities to trace the people who had close contact with the patients. In general, contact tracing is the process of identifying the close contacts of the people who have been exposed to Covid-19 at human-to-human level. Requirement from the Centre for Disease Control and Prevention states a distance of less than 6-feet and duration of 15-minutes for a person to be identified as one, in which, it is the standard that is being used worldwide [3]. With that being said, many countries if not most, have implemented smart contact tracing solutions in combating the pandemic, mainly utilising mobile phones and Bluetooth as its core technology [4].

Malaysia in this case, implemented three mobile-based smart contact tracing solutions by the name of My Trace, My Sejahtera and Gerak Malaysia [5]. Nevertheless, the number of solutions became four after SELangkah was developed to cater for the Selangor region. My Sejahtera and SE Langkah are having similar functionality that adopts venue-based tracing where users have to scan a QR code before entering a venue. It is after several months later on that SELangkah was adopted into MySejahtera becoming one, in order to have a better coverage. While for Gerak Malaysia, it implements movement-based tracing towards people who are conducting interstate travel using GPS's location data. As for My Trace, it utilises Bluetooth network connectivity in order to do contact tracing between the public at human-to-human level. Nevertheless, MySejahtera was the only solution being used nationwide while the other three were discarded after several months from the official launch date. Figure 1 below shows the progression of Covid-19 cases in Malaysia along with the contact tracing solution launchings. It should be noted that the commencement of the solutions were not far apart from one another with each having its own objectives.

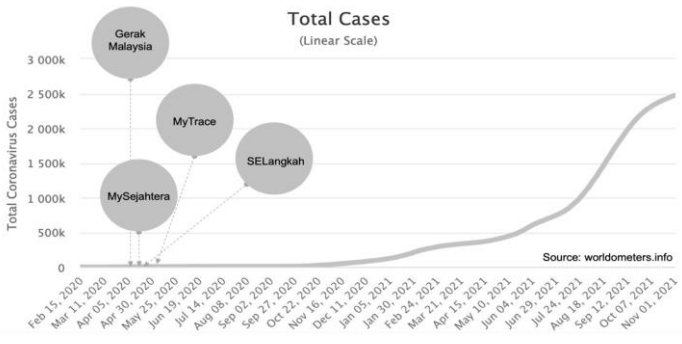

Fig. 1 : Total Covid-19 Cases in Malaysia from February 2020 and Launch of Contact Tracing Solutions

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From Figure 1, despite the fact that there are external factors, Malaysia's number of daily Covid-19 cases keeps on spiking throughout year 2021 even though four contact tracing solutions were implemented. Many setbacks such as surge in number of daily case, shortages of staff, political instability and inadequate supply of Personal Protection Equipment (PPE) and masks, Malaysia loses its focus to further enhance or improve on its own contact tracing solutions that are mainly aimed for the public. Scrutinised carefully, these four applications are not able to effectively conduct contact tracing in accordance to what Centre for Disease Control and Prevention requires. This is because, all of Malaysia's solutions are utilising proximity–based method rather than close-contact method in order to identify close contacts. Proximity tracing has a lower efficiency but comes with easier implementation as it does not require high technicality. Due to that reason, reports are showing that MySejahtera has been missing thousands of close contacts daily [6]. Difference between proximity-tracing and close contact tracing are shown in Figure 2 below. As Malaysia's contact tracing solutions especially MySejahtera, is not able to effectively deliver its purpose for the public, it will be unviable for the front liners at the quarantine centres as well. It is an environment where there are substantial number of Covid-19 patients placed temporarily to treat them in which, requirements needed for a solution implementation are higher and stricter. Thus, in highlighting the gap which is the absence of smart contact tracing solution for the front liners and providing some closure to it, Figure 3 below shows the general flowchart for the methods used.

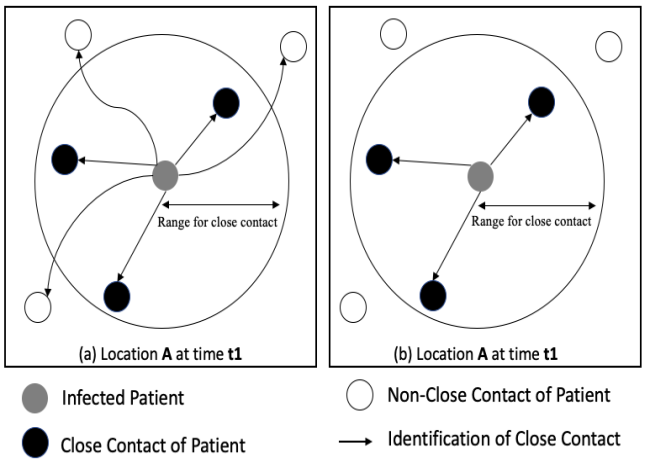

Fig. 2 : (a) Proximity tracing; (b) Close Contact Tracing

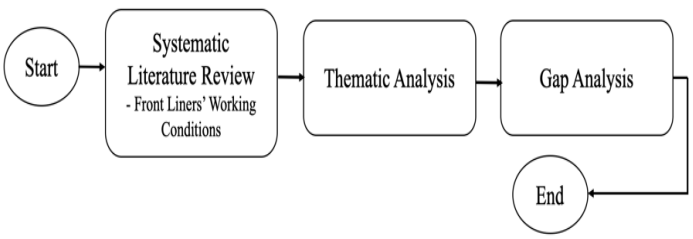

Fig. 3 : General Flowchart of Methods Used

II. SYMPTOMATIC AND ASYMPTOMATIC SCENARIO

It is a well-known fact that many of Covid-19 patients do not display any signs of infection even though there are several common symptoms to it. In a study published by [7], it was stated that 48% of 78 of patients whom tested positive for coronavirus in Wuhan, China do not exhibit any symptoms. Similarly, a study led by Nir Menachemi also stated that, 45% of those infected with coronavirus does not display any signs of symptom [8]. Malaysia in this case reported a shocking percentage of 80% from the confirmed patients which happens to be asymptomatic [9]. The percentage of people who are positive Covid-19 and does not display signs of infection is worrisome because sources have shown that in most cases, more than half of the infected people are asymptomatic. What makes it more alarming is that quarantine centres cater hundreds up to thousands of patients at one time. Thus, if a healthcare professional was infected at a quarantine centre, it is hard to trace back to the source due to the fact that almost half of the people are not showing any sign of symptoms. Nevertheless, it is also difficult to identify the exact source although the source can be symptomatic unless the solution utilizes correct technological approach. This is because, as shown in Figure 4, in order for a solution to have the ability in identifying the source of infection, it needs to use retrospective approach that requires high technicality. Summing up, Table 1 shows the summary of the issue discussed with its justification.

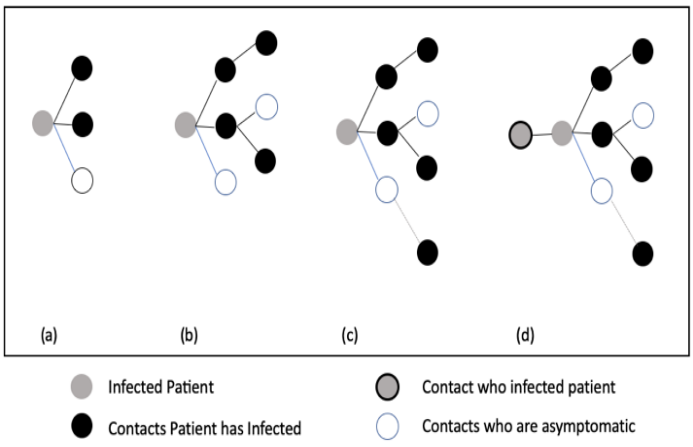

Fig. 4 : (a) First-order; (b) Single-step; (c) Iterative; (d) retrospective Contact Tracing

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Problem	No.	Effects	Justifications	Pandemic Stage
Absence of contact tracing solution for the front liners	1.	Inability to trace the source of infection from symptomatic patients	To prevent further spread from the symptomatic patient in the quarantine centers	Early
	2.	Inability to trace the source of infection from asymptomatic patients	To prevent further spread from the asymptomatic patient in the quarantine centers	Early
	3.	Inability to trace to whom the infected front liners may have spread	To prevent further spread within the front liners in the quarantine centers	All stages

Table 1 : Effects and Justifications from the Absence of Contact Tracing Solution for the Front Liners

From Table 1, all of the three effects are separated into difference pandemic stages. Effect number 1 and 2 are in early pandemic stage is because, quarantine centers tend to group all the patients together whether the patients are symptomatic or asymptomatic when the number of cases are too big. This is to ease the workload and manpower to treat and monitor the patients. Therefore, in order to really manage the pandemic well, ability to identify source of infection for symptomatic or asymptomatic need to start from the early stage. Else, relevancy of symptomatic case and asymptomatic case will be reduced as pandemic gets worse. Nevertheless, the main objective combining all the three effects bring back to one main aim: identification for source of infection in the quarantine center to stop the spread of infection.

III. GLOBAL CONTACT TRACING SOLUTIONS

Prior to smart contact tracing solutions, governments around the globe had relied on traditional method of interviewing for Covid-19 that can be divided into four-steps process. They are, (1) Interview of symptomatic patients, (2) Visit of contact of the persons pointed, (3) Carry out Step 1 and 2 for new cases and (4) Development and merge of infection trees [10]. This conventional method is highly time consuming, very inefficient, not scalable and prone to errors [11]. It is not an easy task actually to remember all those information for that prolonged period of time. Thus, governments turn towards technology for smart solutions and mobile phone as the choice is seen to be a powerful selection. One of the reason why mobile-based solution is being the preferred choice is because, mobile phones can be used to automate proximity quite efficiently although there were many concerns on privacy-related information. Not just that, proximity technologies such as GPS, Bluetooth, Wi-Fi, NFC and GSM are already available in the mobile phone enabling government to construct the solution according to their country' needs. Depending on the conditions and aims in each of the country, the choice of technology in the solutions also will be different. However, what is common between countries is the usage of mobile-based solution, as the preferred choice towards contact tracing in combating the pandemic.

IV. FRONT LINERS' WORKING ENVIRONMENT

Developing or adopting a solution for front liners, require the developers to know and understand the conditions of the working environment which has been more hectic and tedious than the usual. [12] clearly stated six working conditions that sums of overall situation for front liners during Covid-19. They are, (1) Longer and irregular duty hours, (2) Higher-risk environment, (3) Frequent hand hygiene practices, (4) Wearing of full personal protective equipment (PPE), (5) Shortages of staff and (6) Higher workload. These six conditions, although administers a good general idea, does not able to portray the overall view. Thus, through SLR and thematic analysis, a comprehensive front liners' working conditions for Covid-19 and solution criteria requirements were developed. Table 2 shows the Eligibility Criteria used in obtaining comprehensive front liners' working conditions.

	Inclusion Criteria	***Exclusion Criteria***
Language of Publication	English	Languages other than English
Date of Publication	2019 (since Covid-19 started)	Published before the year 2019
Journal	- Peer reviewed - Access to full-text versions	Non peer reviewed
Research Design	- Qualitative Research - Mixed Method research - Pilot research - Observational research	-
Outcomes	Front Liners' Working Conditions / Attributes / Environment	-

Table 2 : Eligibility Criteria for Systematic Literature Review's Eligibility Criteria for Front Liners' Working Environment

Data were searched in major journal databases from Springer, DOAJ, Science Direct, PudMed, IEEE Explore, SAGE, Wiley and Emerald Insight. Keywords used were "Covid-19" AND "front liners". After results came in, title and abstract were screened for relevancy and the duplicates were removed. Afterwards, only those literature that fulfills the eligibility criteria were selected for the next stage. The literatures that made it through were scrutinized and searched for key areas that are stating towards front liners' working conditions, attributes or the environment. Commonality of attributes amongst them were grouped and coded using thematic analysis.

From SLR that has been conducted, many of the literature describes the mental states of the front liners due to

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Covid-19. From anxiety to depressions, many of them have fallen into either one of the mental disorders. Apart from that, literatures also describe harsh and longer working hours that are being subjected on them. Again, it is due to big number of daily cases that creates a lot of task for them to execute. Managing the patients, prescribing medications, logistics matter and so on, are not a small thing that can be managed easily. As the amount of work increases, the number of staffs needed also increases. Nevertheless, the number of front liners resign from their post also are not in a small number as they cannot bear to take on the new challenges that comes with the pandemic. This in return, creates even more shortages in the number of front liners. While so, literature also describes the fast pace learning curve for new procedures at the workplace. The reason being is to adopt to changes in the healthcare system and also the emergence of various Covid-19 variants that needs adaptation in the procedures. As the virus keeps on evolving, healthcare system needs to follow suit as well. On another area, hygiene also becomes an area to look into where front liners due to having longer and irregular working hours, have to wear the Personal Protection Equipment (PPE) throughout the day. A full PPE covers the whole body from head to toe which makes front liners sweaty especially in a tropical country like Malaysia. Thus, it creates an issue where there will be a lot of front liners feeling uncomfortable as well as unhygienic to have been wearing the suit till their shift ends. Apart from that, literature also indicates on the restriction of movements within the working place. This is due to some of the areas have been reserved for hygiene and emergency purposes. Not just that, due to their dealings with the patients, front liners have to do constant isolation so that risk of infection within the family of front liners can be reduced. The matters discussed previously were for front liners in general. As for those in the quarantine centers, two extra attributes were obtained. First and foremost is there will be a lot of medical and other types of devices within the compound as it hosts thousands of people.

Second, the environment will be packed with people as governments will try to cater as many people as possible in order to be efficient and reduce cost. These two attributes will be an extra working attributes for the front liners. Table 3 shows comprehensive front liners working conditions from the study conducted.

No.	Working Condition	Source	Justification
[1]	Longer and irregular working hours	World Health Organization (2020)	-
[2]	Higher-risk environment	World Health Organization (2020)	-
[3]	Frequent hand hygiene practices	World Health Organization (2020)	-
[4]	Wearing of full personal protective equipment (PPE)	World Health Organization (2020)	-
[5]	Shortages of staff	World Health Organization (2020)	-
[6]	Higher workload	World Health Organization (2020)	-
[7]	Higher stress	SLR	Higher demand and harder job settings
[8]	Sharp learning curve	SLR	Emergence of new Covid-19 variants and new findings on the virus makes changes in the ways of healthcare is being delivered.
[9]	Lower hygienic aspect	SLR	Dealing with multitude of people and sweating while working due to PPE.
[10]	Restriction on freedom of movement	SLR	As front liners are dealing with higher risk-environment, the restrictions to move around freely will be more limited than usual.
[11]	Constant isolation	SLR	To reduce the risk of infection within the family of front liners, they themselves have to consistently self-quarantine.
*[12]	Vicinity in multitude of electronic devices	SLR	There will be big number of electronics devices in vicinity whether medically related or not.
*[13]	Vicinity in multitude of people	SLR	Handling of hundreds to thousands of people depending of size of the center and number of cases.

Table 3: Summary of Comprehensive Front Liners' Working Conditions for Covid-19 Pandemic

* indicates working condition for front liners in quarantine center specifically

From the information gained from the systematic review in Table 3, several conclusions can be made. First, a new or an extra task should not be added for the front liners as they already have enough on their scope of work. Especially when the conditions are hectic, it can bring more harm than good. Thus, adding an extra assignment for them to do for smart contact tracing solution is not a practical nor a

smart move. Mobile-based solution in this aspect will require several clicks on the application which will be impractical. Secondly, front liners will not be able to carry devices such as smart phones if it is being used as a solution due to wearing of full personal protective equipment (PPE), hand hygiene practices and higher-risk environment. Wearing of PPE will make it hard for them to hold small delicate items such as the mobile phone. While so, hand hygiene practice makes holding or handling items to be troublesome and higher-risk environment means that, the mobile phone may need to be sanitize before it can be brought in. Overall, what this scenario is indicating is, solutions that utilize mobile phones (which is the main solution worldwide), will not be applicable for them. While so, mobile-based solutions do not have the battery capacity to last for acceptable long-term usage. What it means is that, a solution needs to be operable for a certain period of time so that there will be no extra task to do a recharge.

Whether the acceptable period of time be a day up to several weeks, it is not possible with mobile-based solution that requires charging every now and then. Thus, a solution that has the ability to last for a long period of time is required. With that being said, the contact tracing solution also needs to be complacent for daily usage as it is intended for to be used for a long duration. Thus, the solution needs to be durable enough to withstand wear and tear depending on the conditions of the quarantine center. Water-resistant and dust-resistant will be an added value if the solution is a wearable. While so, with so many people and electronic devices in vicinity, the solution needs to be able to operate through radio interference. It needs to be efficient enough that interference that are caused by those multitude of devices will still give a good accurate tracing.

Not just that, the solution also needs to be able to conduct close contact tracing rather than proximity tracing. This is because, it has higher efficiency and conducts tracing within a venue rather than using a venue as a tracing point. Table 4 below shows the summary of the thematic analysis conducted

No.	Insights Gained	Relation to Working Condition	Criteria Needed for Solution
a.	Front liners will not be able to utilized mobile-based solution as it brings more disadvantages than benefits	[1], [2], [3], [4], [6]	Autonomous
b.	No extra task should be added for the front liners	[1], [4], [5], [6], [7]	Autonomous
c.	A solution that requires a recharging will be impractical	[1], [2], [3], [4], [5], [6]	Ability to last adequate period of time
d.	Solution need to be able to handle wear and tear of daily usage	[1], [3], [4], [6], [13]	Durable
e.	Solution will need to be comfortable enough for long term usage	[1], [4], [9]	Complacent daily use
d.	Solution will need to be able to operate through radio interference	[10], [12], [13]	Radio interference operable
e.	Solution need to be able to conduct close contact tracing	[10], [13]	Close contact tracing

Table 4 : Front Liners' Requirement Criteria for a Solution during Covid-19 from Thematic Analysis

V. MALAYSIA'S CONTACT TRACING SOLUTIONS

Malaysia has adopted four mobile-based contact tracing solutions for the public in which, each possess different objectives. MyTrace was developed for human-to-human tracing where it utilizes Bluetooth signal strength in order to determine proximity [13]. When two users or more are in vicinity for a stipulated period of time, contact tracing data will be captured. MySejahtera and SELangkah on the other hand, were developed for mass-type venue-based for the people when visiting public places. The concept used is where people have to scan a QR code printed at premises before entering it in which, information such as phone number, time and venue will be saved [14-15]. My Sejahtera utilizes Wi-Fi as well as GSM for the network connectivity and SELangkah has an extra option of using a text message whenever Wi-Fi or GSM network are not available.

While for Gerak Malaysia, it was developed for movement-based solution for interstate travel when tracing close contacts between movements from point A to B. The application will continually track the movement of the people using geolocation function in the smart phone until a user has reached to an end point [16]. From its functionality, contact tracing solutions can be grouped into three main types according to their objectives. They are (1) Individual-type (human-to-to-human), (2) Mass-type and (3) Movement-type. It should be noted that all of the solutions utilize smart phones as the core technology and device. Thus, a general conclusion can already be constructed that all of them are not viable for the front liners due to smart phones being the choice of solution. Not just that, front liners require human-to-human close contact tracing solution in which, **only MyTrace** is able to cater the issue. However, MyTrace has many major operating systems limitations (for both iOs and Android) that sets it back to be unusable even for the public. For iOS devices for example, MyTrace requires the mobile phones to be on active mode which means that, the application cannot run in the background as well as phone cannot be locked. As for Android devices, MyTrace require users to turn on the geolocation function even though the function is not being utilized [13]. This overall scenario shows that Malaysia has yet to have a contact tracing solution available for the front liners in preventing asymptomatic

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human-to-human Covid-19 infection. Table 5 shows the limitations that MyTrace has with respect to the front liners.

No.	*Limitations*	*Commentaries*	*Effected Platform(s) / Parties*
1.	iOS devices require MyTrace to be in active mode (cannot run in the background mode)	- Unable to use different application at the same time - Heavy usage of battery - Due to limitations in the operating system	iOS
2.	Usage of MyTrace requires Android users to turn on their geolocation function	- Drains the batter even though the function is not being utilised	Android
3.	May give many false positives	- This is because front liners may be next to a passer-by or next to the person working on other side of the wall that will count as close contact within the application as it is meant for public	All
4.	**Front liners will not be able to utilise MyTrace** **(Highlighted issue)**	- Front liners solution requirements which are: (a) Autonomous, (b) Ability to last adequate period of time, (c) Complacent daily use, (d) Durable, (e) Radio interference operable and (f) Close contact tracing are not being able to fulfilled by MySejahtera.	Front liners

Table 5 : Major Limitations of Malaysia's My Trace

From the case study conducted on Malaysia contact tracing solutions, gap analysis was performed using the criteria needed from the systematic literature review as show in Table 6 below. It should be noted that the requirement for 'Current State' in the gap analysis does not take into account on effectiveness and if any of the four Malaysia's contact tracing solution is able to fulfil the criteria, then the criteria will be fulfilled.

No.	**Criteria**	**Current State**	**Desired State**	**Gap Identification** (normal, severe, critical)
1.	Autonomous	No	Not achieved	Critical
2.	Ability to last adequate period of time	No	Not achieved	Critical
3.	Durable	Some devices	Not achieved	Severe
4.	Complacent daily use	No	Not achieved	Critical
5.	Radio interference operable	Yes	Achieved	None
6.	Close contact tracing	Only MyTrace	Not achieved	Critical

Table 6 : Gap Analysis for Malaysia's Contact Tracing Solution against Front Liners' Solution Criteria Requirement for Covid-19

From Table 6, it shows that the gap for Malaysia is critical at this moment as most of the criteria is not being fulfilled making the gap to be in a critical state. This, it is proven that there is an absence for contact tracing solution for the front liners that needs to be addressed as soon as possible for Covid-19 and future similar pandemics to come.

VI. CONCLUSION

From the study conducted, it can be concluded that Malaysia although has established quite comprehensive contact tracing solutions for the public in combating Covid-19, is still lacking a comprehensive contact tracing solution for the front liners. Not just that, the gap is also an issue that needs to be closed urgently in order to contain and manage Covid-19 in a better manner.

While so, this study also shows that front liners will not be able to use mobile-based solution in their working environment. This is mainly due to wearing of full PPE, higher-risk environment and practise of constant hand hygiene that makes them unpractical to utilise mobile-based solution. Thus, in providing some closure for the gap, a better method that derives away from current mainstream solution is needed in solving it using the six front liners' solution requirement gained from the thematic analysis. They are, (a) Autonomous, (b) Ability to last adequate period of time, (c) Complacent daily use, (d) Durable, (e) Radio interference operable and (f) Close contact tracing

VII. ACKNOWLEDGMENT

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