CHAPTER

11

Governance of wastewater surveillance systems to minimize the impact of COVID-19 and future epidemics: Cases across Asia-Pacific

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11.1 State of COVID-19 in selected countries

On December 31, 2019, China reported an outbreak of pneumonia of unknown etiology occurring in Wuhan (WHO, 2020a). This disease caused by a novel coronavirus was named coronavirus disease 2019 (COVID-19) by the World Health Organization (WHO) on February 11, 2020 (WHO, 2020b). On March 2, 2020, the coronavirus causing the outbreak was officially designated severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) by the Coronaviridae Study Group of the International Committee on Taxonomy of Viruses (2020). COVID-19 was declared a global pandemic on March 11, 2020 (WHO, 2020c). As of August 27, 2020, there have been 24,018,969 confirmed cases including 821,471 deaths globally (WHO, 2020d).

Table 11.1 shows cases of COVID-19 in selected countries across Asia-Pacific as of August 27, 2020. The number of COVID-19 cases ranges from 0 (Samoa) to 160,165 in Indonesia. In each country, testing for COVID-19 has been performed in less than 1% of the total population. Considering that some individuals are tested multiple times, it is expected that the actual number of people tested is lower than the number of cases tested. For example in Japan, the number of people tested (1,259,365) is 71% of the total number of cases tested (1,766,115), and comprises 1% of the total population. Even in countries which have been fortunately free from COVID-19 to date, procurement of testing equipment, training of testing personnel, and testing rollout, have been rigorously conducted. However, financial and logistical challenges remain before testing can be carried out on a nationwide scale, especially in island nations where transportation of samples or persons is a challenge.

Socio-political countermeasures such as lockdown or travel restrictions differed greatly between the countries studied and could not be compared by their timings alone due to their qualitative nature.

In Indonesia, the government released two regulations on April 3 (PP no.21/2020, PerMenKes no.9/2020), to pave the way for large-scale social restrictions (PSBB), the country's equivalent to partial lockdown (Government of the Republic of Indonesia, 2020a; Government of the Republic of Indonesia, 2020b). A week later (April 10, 2020), Jakarta

TABLE 11.1 Reported cases of COVID-19 in selected countries (as of August 27, 2020 unless otherwise specified).

State	Total population*	First case reported**	Cases of COVID-19 testing	Confirmed cases of COVID-19	Deaths by COVID-19	Data source
Fiji	896,444	March 19, 2020	7986 (cases tested)	28 (0.4% of cases tested)	2 (7.1% of COVID-19 cases)	Ministry of Health and Medical Services, Government of Fiji (as of 25 Aug, 2020)
Indonesia	273,523,621	March 2, 2020	1,212,468 (cases tested)***	160,165 (13.2% of cases tested)	6944 (4.3% of COVID-19 cases)	WHO (2020d)
Japan	126,476,458	January 15, 2020	1,766,115 (cases tested) 1,259,365 (persons tested) (1% of population)	65,351 (3.7 % of cases tested)	1237 (1.9% of COVID-19 cases)	MHLW Japan (2020)
Myanmar	54,409,794	March 24, 2020	147,820 (cases tested)	580 (0.4% of cases tested)	6 (1.0% of COVID-19 cases)	WHO (2020d)
Samoa	198,410	- (no cases as of August 27, 2020)	26 (persons tested) (0.01% of population)	0	0	Government of Samoa (2020)
Sri Lanka	21,413,250	January 27, 2020	202,248 (cases tested) (1.0% of population)	2986 (1.5% of cases tested)	12 (0.4% of COVID-19 cases)	HPB-LK (2020)
Thailand	69,799,978	January 13, 2020	840,416 (cases tested)	3404 (0.4% of cases tested)	58 (1.7% of COVID-19 cases)	WHO (2020d)
Viet Nam (As of August 29, 2020)	97,401,417	January 24, 2020	1,080,467 (cases tested)	656 (0.06% of cases tested)	32 (4.9% of COVID-19 cases)	MoH Viet Nam (2020)

**Source:* *UN DESA (2020).*
***Source:* *WHO (2020d).*
****Source:* *Our World in Data (2020).*

became the first local government to implement partial lockdown to contain the spread of COVID-19, with other local governments following suit. After the PSBB period, Jakarta declared a transition PSBB (adaptation to a new normal).

However, COVID-19 cases continued to rise, and Jakarta is undergoing its second phase of PSBB as of September 2020 (Sutrisno, 2020).

In Japan, the government updated the Novel Influenza Countermeasures Act (no.31/2012) on March 13, 2020 to include measures against SARS-CoV-2 (Government of Japan, 2020b). Based on the Act, the government declared a state of emergency in seven prefectures on April 7, and expanded it nationwide on April 15. This declaration was accompanied by a nonmandatory "request" for people to social distance themselves and noncritical businesses to refrain from operation. There were no penalties involved. The soft nature of this declaration was due to the legal framework in Japan, mainly the Local Autonomy Act (no.67/1947) which gives more autonomy to local governments, and leaves such decision-making accompanying mandatory actions of citizens up to local governments rather than the national government (Government of Japan, 2020a). The main outcome of the emergency declaration in April 2020 was to authorize local governments to request an expansion of their abilities, as well as issue directives and requests to citizens.

Restrictions on travel also differed between countries. Island countries such as Fiji, Japan, Samoa, Sri Lanka, put in place measures for air and sea travel, while the other countries in this study also needed to consider land borders.

Thailand issued an emergency declaration effective March 26, 2020, based on the emergency decree on public administration in emergency situations (2005) and state administration act (1991). This declaration closed all borders to all except for: (i) those with a permit from the Prime Minister or Chief Official, (ii) carrier of necessary goods, (iii) vehicle operators and crew required to enter, (iv) diplomats or international organization employees and their families with approval from the Ministry of Foreign Affairs, (v) non-Thai nationals with work permits or permits from a Thai embassy/consulate, (vi) Thai nationals with a permit from a Thai embassy/consulate or with a medical certificate. Immigration officers were granted authority to refuse immigration of non-Thai nationals positive for COVID-19, with suspicion of infection, or who refused to be tested (CAAT, 2020).

In Myanmar, the government suspended all travel of non-Burmese nationals in and out of land borders from March 19, and suspended all international commercial flights into Myanmar effective March 30, 2020 (U.S. Embassy in Burma, 2020). However, informal border crossings have been difficult to manage even during normal times, and recent reports of cross-border COVID-19 transmissions have led to heightened security measures in Thailand (Bangkok Post, 2020) and China (Strangio, 2020) as of September 2020.

11.2 Wastewater surveillance of COVID-19

An estimated 18%–31% of SARS-CoV-2-infected individuals within a population are likely to be asymptomatic (Mizumoto et al., 2020; Nishiura et al., 2020), but nevertheless still carry and contribute to the spread of the virus. This makes it difficult to ascertain the actual degree of viral circulation in a community based on clinical testing of symptomatic patients. Meanwhile, as asymptomatic patients can also excrete SARS-CoV-2 in feces (Tang et al., 2020; Kitajima et al., 2020), and reported in urine with low frequency (Nomoto et al., 2020; Peng et al., 2020), wastewater surveillance could potentially provide a method of evaluating the spread of infection in a community, even where resources for clinical testing is limited. It could also act as an indicator for unbiased comparison between geographic locations and helping to track the evolution of the viral genome over time (Nemudryi et al., 2020). Traces of SARS-CoV-2 RNA have been detected in sewage (Ahmed et al., 2020, Haramoto et al., 2020), both in wastewater and treated wastewater (Wurtzer et al., 2020), and in some locations even before the first positive case in clinical testing (Medema et al., 2020). Wastewater surveillance can thus be useful as an indication of whether the introduction or reintroduction of SARS-CoV-2 or other novel viruses has occurred in a community, or to evaluate the effectiveness of public health interventions (Kitajima et al., 2020).

11.3 Wastewater management in selected countries

Service coverage rates (shown here as percentage of population) of centralized wastewater treatment systems and decentralized or on-site wastewater systems are shown in Table 11.2. It can be observed that the coverage of centralized wastewater treatment systems range from less than 1% of the total population (Indonesia, Myanmar) to over 10% (Fiji, Japan, Viet Nam).

Fig. 11.1 shows the overview of the proposed wastewater surveillance system. As depicted, raw domestic wastewater comes from three groups in the population: (i) known or documented cases of the epidemic, (ii) unknown or

TABLE 11.2 State of wastewater treatment in each country (year of data in brackets).

Country	Service coverage rate of centralized wastewater treatment systems	Service coverage rate of decentralized/on-site systems	No/unimproved wastewater treatment	References
Fiji	22% (2007)	69% (2015)	9%*	Calculated by authors based on SPREP (2007) WHO (2016)
Indonesia	0.5% (2017)	76.4% (2017)	23.1%*	Perkasa (2018)
Japan	75.8% (2018)	24.1% (2018)	0.1% (2018)	MoE Japan (2020)
Myanmar	0.6% (2017)	84.0%*** (2010)	15.4%*	UNICEF (2011) Win (2017)
Samoa	3.6%****	94.5%*** (2020)	1.9%*	UNICEF (2020)
Sri Lanka	3.5% (2020)	92.5%** (2016)	4%*	NWSDB-LK (2020) ADB-LK (2016) Statistica, 2020)
Thailand	7.8% (2015)	89.4%*** (2015)	2.8%*	NSO and UNICEF, 2016
Viet Nam	12.5% (2019)	50% (2012)	37.5%*	World Bank (2019)

**Calculated by subtracting centralized and decentralized service coverage rates from 100%.*
***Decentralized wastewater treatment coverage has been calculated based on the rural and urban sanitation coverage data of ABD-LK, 2016 and urban/rural population data in 2016 (Statistica, 2020).*
****Calculated by subtracting population covered by centralized wastewater treatment systems from population with improved sanitation facilities.*
*****Estimated as 20% of the population of Apia (7149 persons) based on personal conversation with Samoa Water Authority as of September, 2020.*

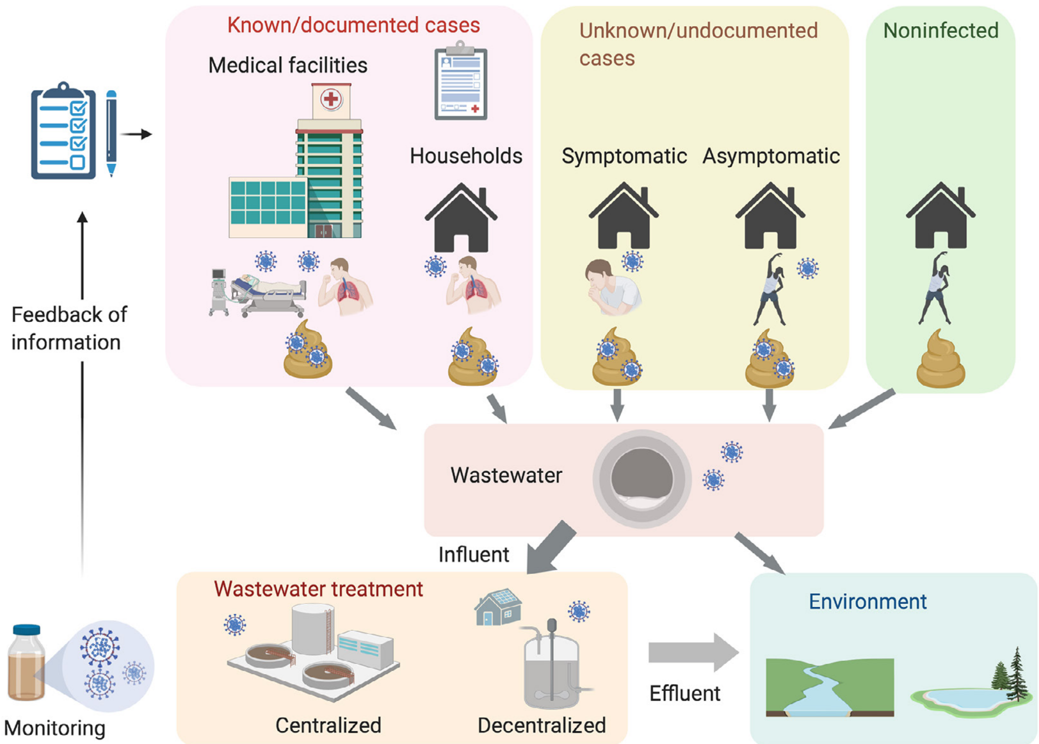

FIG. 11.1 Overview of the proposed wastewater surveillance system.

undocumented cases of epidemic, and (iii) the noninfected. Wastewater flows into either a centralized treatment system, a decentralized system, or is discharged into the environment without any treatment. In the case of centralized wastewater treatment systems, it is possible to collect and monitor influent and effluent samples given the local authorities agree, with information fed back into society via national or local governments (Kitajima et al., 2020). As observed in Table 11.2, some countries in this study rely mostly on decentralized systems to manage wastewater. Decentralized wastewater systems would be challenging to monitor, as it would be a resource-intensive process to collect samples from each household.

A possible solution would be to analyze points of high risk, such as hospitals, health care facilities, or temporary quarantine facilities. Another solution would be to collect sludge samples from the sludge treatment plants where septage or sludge from the decentralized systems is taken. However, in many cases the septage or sludge is not collected very often, either due to the lack of collection mechanisms, legislation for septage/sludge collection, or enforcement of the legislation (MoE, 2019). It becomes more difficult to base a regular or systematic early warning system on sludge collection which does not happen frequently. Untreated wastewater is an even greater challenge to monitor, and would require a whole-of-community approach to find a solution which best addresses the needs and risks of the community.

It is important to note that although decentralized treatment or untreated wastewater constitutes a larger challenge than centralized systems, communities with decentralized treatment or untreated wastewater may also have the most to gain from wastewater surveillance systems. These communities include informal settlements, evacuation shelters, and refugee camps, and in many cases face socio-economic challenges such as availability or affordability of clinical testing, in addition to being disproportionately affected by the health and economic risks (UNDP, 2020).

11.4 Stakeholders for wastewater monitoring

Various stakeholders need to be involved in the cycle of a monitoring framework, which includes the sampling, analysis, information feedback and any subsequent action or decision-making. Table 11.3 shows the stakeholders responsible for each process. The Committee of COVID-19 Handling and National Economy Recovery in Indonesia is placed directly under the President, and has the authority to issue binding instructions to ministries. The Cabinet Office (CAO) of Japan is directly managed by the Prime Minister. The National Steering Committee for COVID-19 Prevention and Control in Vietnam was established by the Decision of the Prime Minister on January 30, 2020 and is headed by a Deputy Prime Minister. In Japan and Viet Nam, the jurisdiction of centralized and decentralized wastewater treatment systems falls under different ministries. The actual implementation and operation of wastewater treatment systems as well as COVID-19 countermeasures are managed by local governments in all countries. The analysis of samples and development of technological solutions including monitoring equipment is mainly carried out by academic/research institutions and private sectors. Therefore, it is critical to involve all agencies when building a national platform for wastewater surveillance systems. Furthermore, special care needs to be taken that the views of the disproportionately affected, including women (UN, 2020), LGBTI people (OHCHR, 2020), youth and children, persons with disabilities (UNDP, 2020), are taken into consideration when institutionalizing such systems, for example through a consultative process to ensure that their rights and needs are not neglected, including their right to education.

11.5 Legislation and frameworks

When establishing a governance system to monitor pathogens in wastewater, relevant legislations under respective ministries may need to be consulted. Considering the involvement of stakeholders shown in Table 11.3, legislative frameworks which may need examination include laws and regulations related to:

- Epidemic management;
- Public health (including monitoring);
- Centralized wastewater (construction, operation, etc.);
- Decentralized wastewater (construction, operation, etc.);
- Environmental water (standards, monitoring, etc.);

TABLE 11.3 Main entities responsible for each field related to wastewater surveillance systems for COVID-19 in selected countries.

Parameters	Fiji	Indonesia	Japan	Myanmar	Samoa	Sri Lanka	Thailand	Viet Nam
Overall coordination of COVID-19 countermeasures	Ministry of Health and Medical Services (MHMS)	The Committee of COVID-19 Handling and National Economy Recovery*	Cabinet Office (CAO)	General Administration Department under Ministry of Home Affairs	Samoa National Emergency Operation Centre (SNEOC)	Presidential task force on COVID-19	Centre for the Administration of the Situation due to the Outbreak of the Communicable Disease Coronavirus (COVID-19)	The National Steering Committee for COVID-19 Prevention and Control
Public health	Ministry of Health and Medical Services (MHMS)	Ministry of Health (KEMKES)	Ministry of Health, Labour and Welfare (MHLW)	Ministry of Health and Sports	Ministry of Health (MoH)	Ministry of health (MoH-LK)	Ministry of Public Health	Ministry of Health (MoH)
Wastewater treatment (centralized)	Ministry of Infrastructure	Ministry of Public Works and Human Settlement (KeMenPUPR)	Ministry of Land, Infrastructure, Transport and Tourism (MLIT)	City Development Committee (Municipality)	Ministry of Works, Transport and Infrastructure	National water supply and drainage board (NWSDB-LK)	Ministry of Natural Resources and Environment (MNRE), Wastewater Management Authority under the Ministry of Interior (MOI), local governments	Ministry of Construction (MoC)
Wastewater treatment (decentralized)	Ministry of Housing and Community Development	Ministry of Public Works and Human Settlement (KeMenPUPR)	Ministry of the Environment (MoE)	City Development Committee (Municipality)	Samoa Water Authority (SWA)	National water supply and drainage board (NWSDB-LK)	MNRE, MOI, local governments	Ministry of Natural Resources and Environment (MoNRE)
Environmental water management	Ministry of Waterways & Environment	Ministry of Environment and Forestry (MENLHK)	Ministry of the Environment (MoE)	City Development Committee (Municipality)	Ministry of Natural Resources and Environment (MNRE) and Samoa Water Authority (SWA)	Local Authorities (municipal councils, urban councils and divisional councils)	MNRE	Ministry of Natural Resources and Environment (MoNRE)
Implementation of countermeasures	Perspective ministry in charge	Local Governments	Local Governments	Ministry of Home Affairs	MoH, Police force and MNRE (under the authority of SNEOC)	Central government through MoH-LK, police and defense forces	MNRE, local governments	Local Governments
Analysis of samples, development of technological solutions	Academic/research institutions, public sector	Academic/research institutions, public sector	Academic/research institutions, public sector	Ministry of Health and Sports	Scientific Research Organization of Samoa	Epidemiology unit, MoH-LK	Academic/research institutions, public/private sectors	Academic/research institutions, public sector/private sector

*Source: *Government of the Republic of Indonesia (2020)*.

- Epidemic countermeasures (especially at local government / community levels); and
- Analysis of samples and development of technological solutions (intellectual property rights, demarcation of responsibilities, etc.).

Institutionalizing wastewater surveillance systems requires characterization of the organizational structure. Once the characterization is conducted, the intervention strategies can be formulated. For example, in a particular country or a system, the lack of willingness to implement a wastewater surveillance system could be an obstacle. Once it is identified, the intervention can be implemented through several methods such as information or/and finance (Cummings and Worley, 2018). Monitoring and evaluation mechanisms are required to assess the degree of implementation as well as to continuously improve and upgrade the entire system.

The governance framework for wastewater surveillance systems should not be a temporary measure, but preferably established as an early warning system for future pandemics. As illustrated during the COVID-19 pandemic, virome analysis of wastewater can potentially detect novel viruses before their clinical recognition in a community (Medema et al., 2020) and opens up the possibility of expansion to other pathogens.

In 2018, "Disease X" was added to the WHO list of priority diseases and represents the idea that an international pandemic could be caused by pathogens currently unknown to cause human diseases (WHO, 2020e). By institutionalizing wastewater monitoring of pathogens, there is a potential for risks associated with Disease X to be reduced. Therefore, we believe that the proposed governance system should be set up to include not only SARS-CoV-2 but also unknown or unforeseen pathogens in wastewater. Having a system in place will allow speedy policy interventions at international, national and local levels including preventative measures and allocation of resources to potentially affected areas in the future.

The establishment of a wastewater surveillance system against COVID-19 and Disease X will contribute not only to national and local targets and goals, but also to implementation of the following Sustainable Development Goals (SDGs) under the 2030 Agenda for Sustainable Development:

- SDG 3.3 "By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases";
- SDG 3.9 "By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination";
- SDG 3.d "Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks";
- SDG 6.3 "By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally"; and
- SDG 6.b "6.b Support and strengthen the participation of local communities in improving water and sanitation management." (UN, 2015).

11.6 Challenges and opportunities

Based on informal consultations with various stakeholders in each of the case study countries, challenges and opportunities for institutionalizing wastewater surveillance systems are listed in Table 11.4. Interestingly, good practices or opportunities can already be observed to address each challenge raised. In most cases these good practices were observed in a country different from where the challenge was raised, indicating that an international information sharing would be beneficial in addressing various challenges to implement wastewater surveillance systems.

11.7 Recommendations

Multiple challenges exist before wastewater surveillance systems can be formally institutionalized, or woven into the governance fabric at national or local government levels. Based on the preceding discussion, the following recommendations are proposed as a way forward in institutionalizing wastewater surveillance as a tool to reduce risks from COVID-19 in the selected countries in Asia-Pacific.

- Establish both the hardware (infrastructure) and the software (operating protocols and legislation) of a monitoring system to support the wastewater surveillance system, as depicted in Fig. 11.1;
- Conduct a stocktaking of existing processes and frameworks to integrate wastewater surveillance systems into;

TABLE 11.4 Governance challenges and potential solutions.

Governance level	Challenges	Good practices or opportunities identified
National government	Siloed governmental/budget structure restricting cross-cutting collaboration	Mandate coordination by overarching government entity (e.g., organizations directly under the head of state)
	Short-term political agenda and short-term economic gains	Incentives/pressure through international bodies and funding mechanisms. Public pressure to influence long-term policies and economic outcomes for well-being.
	Prioritization of national mechanisms over international mechanisms during emergency situations, undermining the authority of international organizations, potentially leading to limitations in emergency response actions	Transparency in ongoing initiatives and sharing of information.
National and local government	Lack of political will. Inadequate science-based decision-making	Awareness raising toward decision-makers. Information sharing at international/regional levels. Improvement of science-policy interface.
	Difficulty in legislating new procedures due to lengthy legislative processes depending on physical contact/documents	Digitize legislative processes while taking security concerns into account
	Difficulty in accessing different finance mechanisms for prevention and response	Establish flexible budgets which can be used both for response (monitoring during epidemic) and prevention (early warning) within a short period of time.
	Lack of proper information sharing mechanism to all levels of decision-making. Difficulties in demarcation of responsibilities	Formation of national committees and task forces comprising multistakeholders
Local government	Limited human/financial resources. Lack of adequate tools, techniques and guidelines to cope with the situation. Unity and solidarity in the internal system	Cross-organizational collaboration to share the burden between organizations/individuals and foster a culture of cooperation
	Fear of negative reaction by public/mass media against detection of pathogens in wastewater leading to disinclination toward monitoring or information disclosure	Education/awareness raising of public/mass media. Have robust communication policy/framework in place
Academic/ research institutions, private sector	Limited human/financial resources. Lack of effective coordination. Administrative challenges including bureaucracy, duplication, delays and unnecessary cost	Cross-organizational collaboration to share the burden. Diverse financing mechanisms to support needs in a timely manner. International grants made available in a timely/accessible manner
	Peer competition leading to nondisclosure of information until publication/patent	Incentivizing sharing of outputs with high social benefit. Creation of an overarching platform at international/regional levels to share information
Civil society	Limited formal mechanisms for inclusive decision-making. Lack of effective coordination, weak financial base, and lack of transparency, lack of commitment. Fear of negative impacts such as discrimination or economic loss if epidemic is detected, leading to opposition toward surveillance systems	Formalize inclusive processes during institutionalization. Sharing of good practices regarding inclusivity at international/regional levels. Education/awareness raising of public/mass media including training of trainers

- Build a multicountry or regional platform to exchange information and experiences, including discussion of postpandemic collaboration;
- Convey findings and recommendations to and from other international platforms;
- Develop a national platform for multistakeholder coordination and collaboration (Bivins et al., 2020), especially including disproportionately affected communities and groups as active agents;
- Cultivate an environment of sharing knowledge and information across various stakeholders; and
- Integrate robust monitoring and evaluation process into the system for continuous improvement toward future pandemics including disease X.

This study will benefit from further research into more countries with diverse backgrounds, as well as case studies at local levels.

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