INVENTORY OF SUPPLIMENTARY INFORMATION

Supplementary Table 1. Asia Pathogen Genomics Initiative (Asia PGI) consortium list. All authors below contributed equally. Author names are ordered in alphabetical order first by country, then by organization and finally by last name.

Supplementary Table 2: List of participating countries and institutions

Supplementary Table 3: Reference Tools for System-wide Pathogen Genomics Assessment Framework Development

Supplementary Table 4: System-wide Pathogen Genomics Assessment Tool

Supplementary Table 5: Binary indicators used for calculating country summary scores.

Supplementary Table 1. Asia Pathogen Genomics Initiative (Asia PGI) consortium list**.** All authors below contributed equally. Author names are ordered in alphabetical order first by country, then by organization and finally by last name**.**

No.	Name	Organization	Country
1	Manjur Hossain **Khan**	Institute of Epidemiology, Disease Control and Research (IEDCR)	Bangladesh
2	Hassan **Afrad**	International Centre for Diarrhoeal Disease Research (icddr,b)	Bangladesh
3	Dinesh **Mondal**	International Centre for Diarrhoeal Disease Research (icddr,b)	Bangladesh
4	Mustafizur **Rahman**	International Centre for Diarrhoeal Disease Research (icddr,b)	Bangladesh
5	Nor Azian Binti **Hj Hafneh**	Department of Laboratory Services, Ministry of Health	Brunei
6	Nur Amirah **Ibarahim**	Department of Laboratory Services, Ministry of Health	Brunei
7	Sokelaph **Cheng**	Institut Pasteur du Cambodge (IPC)	Cambodia
8	Vireak **Heang**	Institut Pasteur du Cambodge (IPC)	Cambodia
9	Nimol **Khim**	Institut Pasteur du Cambodge (IPC)	Cambodia
10	Koen **Vandelannoote**	Institut Pasteur du Cambodge (IPC)	Cambodia
11	Sophana **Chea**	International Center of Excellence in Research (ICER)	Cambodia
12	Sreyngim **Lay**	International Center of Excellence in Research (ICER)	Cambodia
13	Lyhourng **Long**	International Center of Excellence in Research (ICER)	Cambodia
14	Mengheng **Oum**	International Center of Excellence in Research (ICER)	Cambodia
15	Christina **Yek**	International Center of Excellence in Research (ICER)	Cambodia
16	Chanthap **Lon**	International Center of Excellence in Research (ICER)	Cambodia
17	Chau **Darapheak**	National Institute of Public Health	Cambodia
18	Prum **Sitha**	National Institute of Public Health	Cambodia
19	Chhe **Visal**	National Institute of Public Health	Cambodia
20	Ines **Atmosukarto**	Biomedical and Genome Science Initiative (BGSi)	Indonesia
21	Ririn **Ramadhany**	Biomedical and Genome Science Initiative (BGSi)	Indonesia
22	Kindi **Adam**	Health Policy Agency, Ministry of Health	Indonesia
23	Hana Apsari **Pawestri**	Health Policy Agency, Ministry of Health	Indonesia
24	I Gede **Wirabrata**	Health Policy Agency, Ministry of Health	Indonesia
25	Hana **Krismawati**	Strategic Delivery team for the Minister of Health	Indonesia
26	Elizabeth **Ashley**	Lao-Oxford University-Mahosot Hospital-Wellcome Trust Research Unit (LOMWRU)	Laos
27	Audrey **Dubot-Pérès**	Lao-Oxford University-Mahosot Hospital-Wellcome Trust Research Unit (LOMWRU)	Laos
28	Manivanh **Vongsouvath**	Lao-Oxford University-Mahosot Hospital-Wellcome Trust Research Unit (LOMWRU)	Laos
29	Bouaphan **Khamphaphongphone**	National Centre for Laboratory and Epidemiology (NCLE)	Laos

30	Boualay **Norchaleun**	National Centre for Laboratory and Epidemiology (NCLE)	Laos
31	Virasack **Somoulay**	National Centre for Laboratory and Epidemiology (NCLE)	Laos
32	Rahman **Jamal**	Universiti Kebangsaan Malaysia (UKM)	Malaysia
33	Mohd Istiaq **Anasir**	Institute for Medical Research (IMR)	Malaysia
34	Khayri Azizi **Kamel**	Institute for Medical Research (IMR)	Malaysia
35	Norhidayah **Kamarudin**	International Islamic University Malaysia (IIUM)	Malaysia
36	Mohd Noor **Mat Isa**	Malaysia Genome and Vaccine Institute (MGVI)	Malaysia
37	Yusuf **Muhammad Noor**	Malaysia Genome and Vaccine Institute (MGVI)	Malaysia
38	Nor Azila **Muhammad Azami**	Universiti Kebangsaan Malaysia	Malaysia
39	Eric **Chong** Tzyy Jiann	Universiti Malaysia Sabah (UMS)	Malaysia
40	**Lee** Ping Chin	Universiti Malaysia Sabah (UMS)	Malaysia
41	Syafinaz **Amin-Nordin**	Universiti Putra Malaysia (UPM) /Hospital Sultan Abdul Aziz Shah	Malaysia
42	Narcisse Mary **Sither Joseph**	Universiti Putra Malaysia (UPM)	Malaysia
43	**Chan** Yean Yean	Universiti Sains Malaysia (USM)	Malaysia
44	Rosline **Hassan**	Universiti Sains Malaysia (USM)	Malaysia
45	Nurfadhlina **Musa**	Universiti Sains Malaysia (USM)	Malaysia
46	Wardah **Yusof**	Universiti Sains Malaysia (USM)	Malaysia
47	Sazaly **Abu Bakar**	University Malaya (UM)	Malaysia
48	**Chan** Yoke Fun	University Malaya (UM)	Malaysia
49	**Tan** Kim Kee	University Malaya (UM)	Malaysia
50	David **Perera**	University Malaysia Sarawak (UNIMAS)	Malaysia
51	Mohd Nur Fakhruzzaman **Noorizhab**	University Teknologi MARA (UiTM)	Malaysia
52	Mohd Zaki **Salleh**	University Teknologi MARA (UiTM)	Malaysia
53	**Teh** Lay Kek	University Teknologi MARA (UiTM)	Malaysia
54	Wah Wah **Aung**	Advanced Molecular Research Centre, Department of Medical Research, Ministry of Health	Myanmar
55	Myat Htut **Nyunt**	Advanced Molecular Research Centre, Department of Medical Research, Ministry of Health	Myanmar
56	Moe Myat **Aye**	National Health Laboratory, Department of Medical Service, Ministry of Health	Myanmar
57	May Pyone **Kyaw**	University of Medicine 1 Yangon	Myanmar
58	Nirajan **Bhusal**	World Health Organisation (WHO) country office for Nepal, Nepal	Nepal
59	Allison (Eugenio) **Gocotano**	World Health Organisation (WHO) country office for Nepal, Nepal	Nepal
60	Junaid **Iqbal**	Aga Khan University	Pakistan
61	Furqan **Kabir**	Aga Khan University	Pakistan

62	Waqasuddin **Khan**	Aga Khan University	Pakistan
63	Dodge **Lim**	National TB Reference Laboratory/RITM	Philippines
64	Ramon **Basilio**	Research Institute for Tropical Medicine (RITM)	Philippines
65	Criselda **Bautista**	Research Institute for Tropical Medicine (RITM)	Philippines
66	Joseph **Bonifacio**	Research Institute for Tropical Medicine (RITM)	Philippines
67	Jennifer **Luchavez**	Research Institute for Tropical Medicine (RITM)	Philippines
68	Mayan **Lumandas**	Research Institute for Tropical Medicine (RITM)	Philippines
69	Amado Ona **Tandoc** III	Research Institute for Tropical Medicine (RITM)	Philippines
70	Angelica **Tujan**	Research Institute for Tropical Medicine (RITM)	Philippines
71	Marc Edsel **Ayes**	University of the Philippines, Philippine Genome Center	Philippines
72	Francis **Tablizo**	University of the Philippines, Philippine Genome Center	Philippines
73	Eva Maria **Cutiongco-De La Paz**	University of the Philippines, Philippine Genome Center	Philippines
74	Benedict **Maralit**	University of the Philippines, Philippine Genome Center	Philippines
75	Joel Hassan G. **Tolentino**	University of the Philippines, Philippine Genome Center	Philippines
76	Victor Marco Emmanuel N. **Ferriols**	University of the Philippines, Philippine Genome Center	Philippines
77	Elcid Aaron R **Pangilinan**	University of the Philippines, Philippine Genome Center	Philippines
78	Renato Jacinto Q **Mantaring**	University of the Philippines, Philippine Genome Center	Philippines
79	Dinuka **Ariyaratne**	University of Sri Jayewardenepura	Sri Lanka
80	Tibutius T. P. **Jayadas**	University of Sri Jayewardenepura	Sri Lanka
81	Waritta **Sawaengdee**	Medical Life Science Institute, Department of Medical Sciences	Thailand
82	Sukanya **Wattanapokayakit**	Medical Life Science Institute, Department of Medical Sciences	Thailand
83	**Hoang** Vu Mai Phuong	National Institute of Hygiene and Epidemiology (NIHE)	Vietnam
84	Ung Thi Hong **Trang**	National Institute of Hygiene and Epidemiology (NIHE)	Vietnam
85	H Rogier **Van Doorn**	Oxford University Clinical Research Unit (OUCRU) Hanoi	Vietnam
86	Nguyen To **Anh**	Oxford University Clinical Research Unit (OUCRU) HCMC	Vietnam
87	Quang Duy **Pham**	Pasteur Institute, Ho Chi Minh City	Vietnam
88	Huynh Kim **Mai**	Pasteur Institute, Nha Trang	Vietnam
89	Nguyen Bao **Trieu**	Pasteur Institute, Nha Trang	Vietnam

Supplementary Table 2: List of participating countries and institutions

Country	Institution	Percentage of total SARS-CoV-2 sequences submitted to GISAID (Jan – Dec 2022)
Bangladesh	1. Child Health Research Foundation (CHRF)	71%
	2. Institute of Epidemiology, Disease Control and Research (IEDCR, Bangladesh)	
	3. International Centre for Diarrhoeal Disease Research (icddr,b)	
Brunei	4. Department of Laboratory Services, Ministry of Health	100%
Cambodia	5. Institute Pasteur Cambodia (IPC)	100%
	6. International Center of Excellence in Research (ICER), National Institutes of Health	
	7. National Institute of Public Health (NIPH)	
Indonesia	8. Health Development Policy Agency, Ministry of Health	82%*
	9. Biomedical and Genome Science Initiative (BGSI), Ministry of Health	
Lao PDR	10. Lao-Oxford University-Mahosot Hospital-Wellcome Trust Research Unit (LOMWRU)	100%
	11. National Centre for Laboratory and Epidemiology (NCLE)	
Myanmar	12. Department of Medical Research, Ministry of Health	2% **
	13. National Health Laboratory (NHL) Department of Medical Service, Ministry of Health	
Malaysia	14. Malaysia Genome and Vaccine Institute (MGVI), National Institutes of Biotechnology Malaysia (NIBM)	84%
	15. Institute for Medical Research (IMR), Ministry of Health Malaysia	
	16. Hospital Canselor Tuanku Muhriz UKM (HCTM)	
	17. Universiti Kebangsaan Malaysia (UKM)	
	18. Universiti Malaya (UM)	
	19. Tropical Infectious Diseases Research and Education Centre (TIDREC), University Malaya	
	20. Universiti Teknologi MARA (UiTM)	
	21. Hospital Sultan Abdul Aziz Shah (HSAAS)	
	22. Universiti Putra Malaysia (UPM)	
	23. Universiti Sains Malaysia (USM)	
	24. International Islamic University Malaysia (IIUM)	
	25. Universiti Malaysia Sarawak (UNIMAS)	
	26. Universiti Malaysia Sabah (UMS)	
	27. National Public Health Laboratory	
Nepal	28. World Health Organisation (WHO) country office for Nepal, Nepal	68%
	29. National Public Health Laboratory	
Pakistan	30. National Institute of Health (NIH)	85%
	31. Aga Khan University (AKU, Pakistan)	
Philippines	32. Research Institute for Tropical Medicine (RITM)	100%
	33. Philippine Genome Center (PGC), University of the Philippines	
Sri Lanka	34. Ministry of Health	92%
	35. University of Sri Jayewardenepura	
Thailand	36. Department of Medical Sciences, Ministry of Health	86%
	37. Mahidol University	
	38. COVID-19 Network Investigations Alliance	
Vietnam	39. National Institute of Hygiene and Epidemiology	73%
	40. Oxford University of Clinical Research Unit	
	41. Institute Pasteur, Ho Chi Minh City (IP HCMC)	
	42. Institute Pasteur, Nha Trang (IP Nha Trang)	

*Indonesia: Ministry of Health and BGSI have oversight over all public sector genomic surveillance
**Myanmar: Asia PGI partnership is with Ministry of Health. However, 98% of SARS-CoV-2 sequences for 2022 were submitted to GISAID by the Defence Services Medical Research Center (DSMRC) under the Ministry of Defence.

Supplementary Table 3: Reference Tools for System-wide Pathogen Genomics Assessment Framework Development

No.	Title
1	Laboratory Mapping Tool. Food and Agriculture Organization; 2014.
2	Regulatory System Profiling Instrument (RSPI). Centre of Regulatory Excellence (CoRE), Duke-NUS Medical School.
3	Laboratory Sequencing Capacity Needs Assessment. Centers for Disease Control and Prevention (CDC).
4	Sparkes S., Durán A., Kutzin J. A system-wide approach to analysing efficiency across health programmes. Geneva: World Health Organization; 2017. (Health Financing Diagnostics & Guidance No 2) Licence: CCBY-NC-SA 3.0 IGO; http://apps.who.int/iris/bitstream/10665/254644/ 1/9789241511964-eng.pdf.
5	Global Influenza Surveillance and Response System - GISRS 2019 Interim Guidance. World Health Organization; 2019.
6	GISRS: Operational considerations to expedite genomic sequencing component of GISRS surveillance of SARS-CoV-2. World Health Organization; 2021.
7	Genomic sequencing of SARS-CoV-2: a guide to implementation for maximum impact on public health. World Health Organization; 2021.
8	SARS-CoV-2 genomic sequencing for public health goals. World Health Organization; 2021.
9	Whole genomic sequencing for foodborne disease surveillance. World Health Organization; 2018.
10	Global Genomic Surveillance Strategy 2022 - 2032 DRAFT. World Health Organization; 2021.
11	GLASS Whole Genome Sequencing for surveillance of antimicrobial resistance. World Health Organization; 2020.
12	Guidance for the surveillance of drug resistance in tuberculosis; sixth edition. World Health Organization; 2020.
13	FIND Next Generation Sequencing (NGS) Global Capacity Mapping for SARS-CoV-2. 2021. (https://www.finddx.org/covid-19/covid-19-genomic-surveillance/covid-19-next-generation-sequencing-global-capacity-mapping/)
14	New Variant Assessment Programme (NVAP). UK Health Security Agency; 2021.
15	Pan African Bioinformatics Network for H3Africa. H3AbioNet. (https://www.h3abionet.org/)
16	Human, Heredity and Health in Africa. H3Africa consortium. (https://h3africa.org/)
17	Public Health Alliance for Genomic Epidemiology. PHA4GE. (https://h3africa.org/index.php/consortium/consortium-documents/)
18	Narayanasamy S, Markina V, Thorogood A, Blazkova A, Shabani M, Knoppers BM, Prainsack B and Koesters R (2020) Genomic Sequencing Capacity, Data Retention, and Personal Access to Raw Data in Europe. Front. Genet. 11:303. doi: 10.3389/fgene.2020.00303
19	Black, A., MacCannell, D.R., Sibley, T.R. et al. Ten recommendations for supporting open pathogen genomic analysis in public health. Nat Med 26, 832–841 (2020). https://doi.org/10.1038/s41591-020-0935-z
20	Phillips KA, Douglas MP, Wordsworth S, et al. Availability and funding of clinical genomic sequencing globally. BMJ Global Health2021;6:e004415. doi:10.1136/bmjgh-2020-004415
21	COVID-19 genomics surveillance regional network. Pan American Health Organization. (https://www.paho.org/en/topics/influenza-sars-cov-2-rsv-and-other-respiratory-viruses/covid-19-genomic-surveillance)
22	WHO Laboratory Assessment Tool and System Questionnaire. 2012. World Health Organization/GOARN. https://www.who.int/publications/i/item/WHO-HSE-GCR-LYO-2012.2
23	Next generation sequencing of influenza viruses: General information for national influenza centers. World Health Organization; 2019.
24	The use of next-generation sequencing technologies for the detection of mutations associated with drug resistance in Mycobacterium tuberculosis complex: technical guide. World Health Organization; 2018.
25	Regulating the unknown: A guide to regulating genomics for health policy makers (policy brief). European Observatory on Health & Policies, World Health Organization; 2020.

Supplementary Table 4: System-wide Pathogen Genomics Assessment Tool (*see proceeding pages*).

Landscape Assessment Tool

Pathogen Surveillance and Genomic Sequencing in Asia

Participant Information – Responder 1		
a.	Name/Job title/Email	
b.	Country	
c.	Organisation	
d.	Date of survey completion	

Participant Information – Responder 2		
a.	Name/Job title/Email	
b.	Country	
c.	Organisation	
d.	Date of survey completion	

Participant Information – Responder 3 *(add additional responder information tables as needed)*		
a.	Name/Job title/Email	
b.	Country	
c.	Organisation	
d.	Date of survey completion	

Section 1: Enabling Environment

Part 1.1: Status

1.1.1	Does Next Generation Sequencing (NGS) capacity exist in-country? **This refers to NGS capacity regardless of whether it is used for pathogen genomic surveillance*	Yes ☐ No ☐ What proportion of NGS capacity lies in: Sector / Proportion (%) Public Private Academic Institution Other (List)
1.1.2	Has NGS been used to support **pathogen genomic surveillance** between 2020 and 2022?* **In this survey, pathogen genomic surveillance refers to the adoption of NGS for public health purposes and includes metagenomics or targeted approaches.*	Yes ☐ No ☐ What proportion of NGS-related pathogen genomic surveillance takes place in: Sector / Proportion (%) Public Private Academic Institution Other (List)

1.1.3	Do laboratories conducting NGS for pathogen genomic surveillance need to be registered?	Yes ☐ No ☐ → Skip to 1.1.5
1.1.4	If yes to the question above, what institution(s) oversee the registration?	
1.1.5	What proportion of samples collected for pathogen genomic surveillance by the government are processed out-of-country in the past year?	

Process step	Proportion processed out-of-country (%)
Sample pre-processing	
Library preparation	
Sequencing	
Data processing and bioinformatics	
Data analysis	
Data sharing	
Data reporting	

**Definitions of the NGS process used throughout this survey:*

- *Sample pre-processing: laboratory procedures prior to sequencing such as nucleic acid extraction and/or preamplification steps.*
- *Library preparation: the first step of the NGS process where samples are prepared for loading into a sequencer.*
- *Sequencing: loading of prepared libraries into the NGS machine and ensuing reactions.*
- *Data processing and bioinformatics: genomic sequence generation from raw NGS data.*
- *Data analysis: how genomic data is utilized (e.g. for variant analysis, phylogeny or molecular epidemiology)*
- *Data sharing: upload of data on public repositories*
- *Data reporting: reporting of results to government for public health purposes*

Part 1.2: National Partners		
1.2.1	Is there a national institution or consortium responsible for coordinating national and sub-national NGS for pathogen genomic surveillance? *National coordination mechanism may refer to any national network/entity*	Yes ☐ No ☐
1.2.2	Who are the national partners currently involved in public health pathogen genomic surveillance in the country?	*List*
1.2.3	Has a national expert panel/technical advisory group been established to advise government on pathogen genomic surveillance and data interpretation/use?	Yes ☐ No ☐

Part 1.3: Planning, Financing, and External Partnerships		
1.3.1	Is there a national strategic plan in which pathogen genomic surveillance capacity is included?	Yes ☐ No ☐ → Skip to 1.3.6
1.3.2	Which ministry is responsible for the national pathogen genomic surveillance strategic plan?	Open text
1.3.3	Does the genomic surveillance plan identify priority pathogens?	Yes ☐ No ☐
1.3.4	Does the plan contain indicators and targets for pathogen genomic surveillance?	Yes ☐ No ☐
1.3.5	Has the plan for genomic surveillance been costed?	Yes ☐ No ☐

1.3.6	Is there a national annual budget allocation for genomic surveillance?	Yes ☐ No ☐ → Skip to 1.3.8
1.3.7	Which ministry is responsible for managing the NGS budget?	*Open text*

1.3.8 What estimated proportion of spending on NGS capacity for pathogen genomics surveillance from the last year was derived from:

Sector	Proportion (%)
Public funding	
Private funding	
Academic grants	
Donations	
External partner based funding	
Other (e.g. NGOs, civil societies etc.)	

Public funding includes funding from public treasury
Private funding includes investments from private companies, firms and industry partners
Academic grants include seed funding from educational/research institutions
Donations include funding from philanthropic organisations
External partner-based funding includes international organisations and collaborators from public, private or academic institutions

1.3.9 Post COVID-19, have **sufficient and sustainable sources of funding** been identified to support the following areas of pathogen genomic surveillance?

"Sufficient and sustainable funding" refers to sources committed to provide resources for at least a 5-year period

Process step	National Partners (LIST)	External Partners (LIST)	**Sufficient funding** *Scale: 1 (scarce funds) – 5 (excess funds)*	**Sustainable funding** *Scale: 1 (not sustainable) – 5 (very sustainable)*
Sample pre-processing (Reagents etc.)				
Wet lab sequencing (Reagents, equipment, staffing, training etc.)				
Data processing and bioinformatics (Equipment, infrastructure, training etc.)				
Data analysis				
Data storage				
Data sharing				
Data reporting to government				
Training				

1.3.10 Was external partner support received for COVID-19 related NGS in the past year?

Type of support provided out-of-country (or locally via external partners)	Tick all that apply
Financial	
Donation of equipment	
Donation of reagents	
Laboratory training	
Bioinformatics training	
Data processing and bioinformatics	
Data analysis	
Other in-kind support: *[short open text]*	

1.3.11 Are discussions underway with potential new partners to support genomic surveillance capacity? Yes ☐ No ☐ → Skip to section 1.4

1.3.12 If yes, please list the partner(s) and identify the potential area(s) of new support:

Process step	National Partners (List)	External Partners (List)
Sample collection		
Sample pre-processing (Reagents etc.)		
Wet lab sequencing (Reagents, equipment, staffing, training etc.)		
Data processing and bioinformatics (Equipment, infrastructure, training etc.)		
Data analysis		
Data storage		
Data sharing		
Data reporting to government		
Training		

Part 1.4: Cost Drivers	
1.4.1	Which of the following were major cost drivers for genomic surveillance over the past year:

Direct Sample and Processing Costs	Scale: 1 – 5 *
Laboratory equipment (sequencing machines, sample storage equipment)	
Laboratory supplies & consumables (reagents, PPE, etc)	
Bioinformatics and computing infrastructure/equipment	
Transportation of samples	
Labour costs (laboratory staff, bioinformatics staff)	
Staff training	
Waste management	

Indirect Costs	Scale: 1 - 5 *
Regulatory requirements (inspection, proficiency testing, quality assurance processes)	
Supply chain & procurement (supplier, distributor, shipping)	
Maintenance contract costs (for equipment, facilities, storage)	
Facilities costs (rental, land costs)	
Administrative expenses	
Insurance costs	

** Scale: **1** = Not a cost driver, **2** = Minor cost driver, **3** = Neutral, **4** = Moderate cost driver, **5** = Major cost driver*

Section 2: Policy Context

Part 2.1: Policy Framework and Priority Pathogens

2.1.1 In your country, which pathogen/pathogen groups have been identified or discussed as priorities for pathogen genomic surveillance?

Pathogen/Pathogen group	Scale: 1 (Low priority) - 5 (Essential)*
Tuberculosis	
Other bacterial pathogens for antimicrobial resistance surveillance	
Other bacterial pathogens for food and water safety surveillance	
Malaria	
SARS-CoV-2 and other coronaviruses	
Influenza viruses	
Respiratory syncytial virus	
Polio	
Measles and Rubella	
HIV	
Henipaviruses	
Arboviruses	
Viral hemorrhagic fevers (Filoviruses/ arenaviruses)	
Others (Please specify)	

(1** Not a priority, **2** Low priority, **3** Medium priority, **4** High priority, **5** Essential)*

2.1.2 Other than NGS, which of the following complementary molecular diagnostic capabilities does your country have for the detection of identified priority pathogens?

Select all that apply

Pathogen/pathogen group	Traditional PCR and gel electrophoresis	Sanger sequencing	Real-time PCR assays	Multiplexed pathogen PCR / syndromic panels*
Tuberculosis				
Other bacterial pathogens for antimicrobial resistance surveillance				
Other bacterial pathogens for food and water safety surveillance				
Malaria				
SARS-CoV-2 and other coronaviruses				
Influenza viruses				
Respiratory syncytial virus				
Polio				
Measles and Rubella				
HIV				
Henipaviruses				
Arboviruses				
Viral hemorrhagic fevers (Filoviruses/ arenaviruses)				
Others (Please specify)				

Examples of syndromic panels include BIOFIRE® FILMARRAY®, TaqMan® array cards, Seegene Allplex™ assays etc.

2.1.3 For which pathogen/pathogen groups have pathogen genomic surveillance been conducted in the past 5 years? In what context (human, animal, environmental samples during routine surveillance and/or outbreak response)?

Select all that apply. (RS= routine surveillance, O=outbreak, R=research)

	Human			Animal			Environment			Sequencing primarily conducted out of country? (Y/N)
	RS	O	R	RS	O	R	RS	O	R	
Tuberculosis										
Other bacterial pathogens for antimicrobial resistance surveillance										
Other bacterial pathogens for food and water safety surveillance										
Malaria										
SARS-CoV-2 and other coronaviruses										
Influenza viruses										
Respiratory syncytial virus										
Polio										
Measles and Rubella										
HIV										
Henipaviruses										
Arboviruses										
Viral hemorrhagic fevers (Filoviruses/ arenaviruses)										
Others (Please specify)										

2.1.4 Which sampling sites (e.g. primary, secondary or tertiary level of care) are included in the sampling strategy for pathogen genomic surveillance?

Select all that apply

Pathogen/pathogen group	Primary care clinics	Secondary hospitals	Tertiary hospitals	Animal/ vector
Tuberculosis				
Other bacterial pathogens for antimicrobial resistance surveillance				
Other bacterial pathogens for food and water safety surveillance				
Malaria				
SARS-CoV-2 and other coronaviruses				
Influenza viruses				
Respiratory syncytial virus				
Polio				
Measles and Rubella				
HIV				
Henipaviruses				
Arboviruses				
Viral hemorrhagic fevers (Filoviruses/ arenaviruses)				
Others (Please specify)				

2.1.5 Is sequencing being performed in research or surveillance to detect unknown pathogens?

Select all that apply

Human	Animal	Environment

2.1.6 Is there a national research agenda or plan for additional use of pathogen genomics data other than for surveillance purposes?

Yes ☐
No ☐

2.1.7 What other applications is PGS data being used for in your country?

Select all that apply:

☐ Development of molecular assays
☐ Functional immunology studies
☐ Development of therapeutics
☐ Evaluation of vaccine effectiveness
☐ For policy making
☐ Others (please specify)

<table>
<tr><th colspan="3">Part 2.2: Guidelines & Standard Operating Procedures (SOPs)</th></tr>
<tr><td>2.2.1</td><td>Are there in-country policy guidelines for public health surveillance using NGS?</td><td>Yes ☐
No ☐→ Skip to 2.2.3</td></tr>
<tr><td>2.2.2</td><td colspan="2">If yes, do they contain the following?
<table>
<tr><th>Policy guidelines for NGS surveillance</th><th>Scale: 1 (No guideline) - 5 (Guideline for all pathogens)*</th></tr>
<tr><td>Sampling strategy</td><td></td></tr>
<tr><td>Interface with animal & environmental health</td><td></td></tr>
<tr><td>Laboratory network</td><td></td></tr>
<tr><td>Metadata collection</td><td></td></tr>
<tr><td>Genome data sharing</td><td></td></tr>
<tr><td>Reporting to relevant Ministries</td><td></td></tr>
<tr><td>Reporting to other stakeholders</td><td></td></tr>
<tr><td>Data management & storage</td><td></td></tr>
<tr><td>Sample tracking, inventory & repository</td><td></td></tr>
<tr><td>Storage of reagents & consumables</td><td></td></tr>
</table>
*Scale:(**1** = No guideline, **2**= Under development, **3**= Exists for some pathogens, **4**= Exists for most pathogens, **5**= Exists for all pathogens)*</td></tr>
<tr><td>2.2.3</td><td>Are NGS laboratory guidelines and protocols for genomic surveillance and sequencing available for sharing across testing laboratories in country?</td><td>Yes ☐
No ☐→ Skip to Section 3</td></tr>
<tr><td>2.2.4</td><td colspan="2">If yes, do they contain SOPs for the following?
<table>
<tr><th>NGS Laboratory guidelines and protocols</th><th>Scale: 1 (No guideline) - 5 (Guideline for all pathogens)*</th></tr>
<tr><td>Sample pre-processing</td><td></td></tr>
<tr><td>Library preparation</td><td></td></tr>
<tr><td>Sequencing</td><td></td></tr>
<tr><td>Data processing & bioinformatics</td><td></td></tr>
<tr><td>Data analysis & sharing</td><td></td></tr>
</table>
*Scale:(**1** = No guideline, **2**= Under development, **3**= Exists for some pathogens, **4**= Exists for most pathogens, **5**= Exists for all pathogens)*</td></tr>
</table>

<table>
<tr><th colspan="3">Section 3: Infrastructure & Supply Chain Management</th></tr>
<tr><th colspan="3">Part 3.1: Laboratory availability</th></tr>
<tr><td>3.1.1</td><td>Number of laboratories in the country performing NGS for pathogen genomic surveillance.</td><td>Laboratories performing NGS = Number</td></tr>
<tr><td>3.1.2</td><td>What is the total number of laboratories in country performing NGS for public health surveillance? Of the total, what is the breakdown by institution type?</td><td>Laboratories performing NGS for public health surveillance = Number
- Public = Number
- Academic = Number
- Private = Number
- Others = Number</td></tr>
</table>

Part 3.3: Sequencing Equipment	
3.3.1	Which platform(s) are used for pathogen genomic surveillance in country?

Sequencing Platforms	Number	Performing at full capacity? (Y/N)
Sanger sequencing		
Illumina (e.g. iSeq, MiniSeq, MiSeq, NextSeq, HiSeq, NovaSeq)		
Oxford Nanopore Technologies (Flongle, MinION, GridION, PromethION)		
Thermo Fisher (e.g. Genexus, Ion GeneStudio)		
MGI/BGI (e.g. DNBSEQ-G50/G-400/T-7)		
Others (please specify)		

Part 3.2: Laboratory capacity		
3.2.1	What is the highest biosafety level (BSL) laboratory available in country?	BSL 1 BSL 2 BSL 3 → provide number BSL 4 → provide number
3.2.2	Are there national biosafety regulations governing use and access to BSL 3 and BSL 4 agents?	☐ Yes ☐ No → skip to 3.2.5
3.2.3	If yes, are there provisions to access materials for sequencing?	Yes No
3.2.4	If yes, which protocols exist?	*Select all that apply:* ☐ NGS performed in BSL2 on verified inactivated BSL3 or BSL4 pathogens. ☐ NGS performed within BSL3 ☐ NGS performed within BSL4
3.2.5	What is the **maximum monthly sequencing** capacity (number of sequencing reactions) for all laboratories conducting NGS for pathogen genomic surveillance?	*Provide a maximum number (X) of sequencing reactions that can be done*
3.2.6	What is the **actual monthly sequencing** output on average?	*Provide the average number (X) or a range, e.g..: 0, <50, 100-200, 200 - 500, 500 - 1,000 and >5,000*
3.2.7	What is the estimated time between specimen collection and sequencing for priority pathogens?	*Number of days*
3.2.8	Is NGS bioinformatics (data processing) conducted in-country?	*Scale 1 – 5 (Never/Rarely/Sometimes/Often/Always)*
3.2.9	How long does data processing usually take per NGS run? *This refers to the time taken to analyse raw sequencing data for final consensus sequence generation.*	*Number of days*
3.2.10	What is the estimated time between sequence generation and reporting to government (if applicable)?	*Number of days*

Part 3.4: Supply Chain Management									
Sequencing platform: Sanger									
3.4.1a	Where do you purchase these components from?	Direct from manufacturers		Distributors *Please list down name of distributor*		Group purchasing organisations (e.g., UNICEF)/collaborators	Others (please specify)		
		In country *(Y/N)*	External *(specify country)*	In country *(List, eg: Company A)*	External *(Company A, Country X)*				
	Sequencing machine & related equipment								
	Reagents								
	Non-reagent consumables								
3.4.2a	Is the procurement process centrally coordinated by the public health entity in charge of genomic surveillance and sequencing or conducted by individual facilities?	*(Central / By individual facilities)*							
3.4.3a	Is the supply forecasting process centrally coordinated or conducted by individual facilities?	*(Central / By individual facilities)*							
3.4.4a	Have there been any breakdown of sequencing equipment in the past 6 months?	Yes ☐ No ☐							
3.4.5a	Does the country face supply chain constraints for sequencing-related equipment or reagents?	Yes ☐ No ☐ → Skip to 3.4.7							
3.4.6a	If yes, which supply chain components are a barrier to sequencing capacity?	Distributor responsiveness / technical support	Customs clearance	Cold chain maintenance	Equipment purchasing lead time *(time taken from order to arrival)*	Equipment repair lead time *(time taken from repair to full function)*	Reagents and consumables purchasing lead time *(time taken from order to arrival)*	Reagents and consumables stock availability	Expiry date on arrival for reagents
	***1** Not a barrier, **2** Rarely a barrier, **3** Sometimes a barrier, **4** Often a barrier, **5** Always a barrier*	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
3.4.7a	What is the average re-supply time between order and receipt at the laboratory for:	Reagents: ____ *weeks*				Consumables: ____ *weeks*			
3.4.8a	In the past 6 months have reagents/consumables stock outputs for this platform been a challenge?	Scale 1-5 *(least challenging to very challenging)* 1 2 3 4 5							

Part 3.4: Supply Chain Management									
Sequencing platform: Illumina									
3.4.1a	Where do you purchase these components from?	Direct from manufacturers		Distributors *Please list down name of distributor*		Group purchasing organisations (e.g., UNICEF)/collaborators	Others (please specify)		
		In country *(Y/N)*	External *(specify country)*	In country *(List, eg: Company A)*	External *(Company A, Country X)*				
	Sequencing machine & related equipment								
	Reagents								
	Non-reagent consumables								
3.4.2a	Is the procurement process centrally coordinated by the public health entity in charge of genomic surveillance and sequencing or conducted by individual facilities?	*(Central / By individual facilities)*							
3.4.3a	Is the supply forecasting process centrally coordinated or conducted by individual facilities?	*(Central / By individual facilities)*							
3.4.4a	Have there been any breakdown of sequencing equipment in the past 6 months?	Yes ☐ No ☐							
3.4.5a	Does the country face supply chain constraints for sequencing-related equipment or reagents?	Yes ☐ No ☐ → Skip to 3.4.7							
3.4.6a	If yes, which supply chain components are a barrier to sequencing capacity?	Distributor responsiveness / technical support	Customs clearance	Cold chain maintenance	Equipment purchasing lead time *(time taken from order to arrival)*	Equipment repair lead time *(time taken from repair to full function)*	Reagents and consumables purchasing lead time *(time taken from order to arrival)*	Reagents and consumables stock availability	Expiry date on arrival for reagents
	***1** Not a barrier, **2** Rarely a barrier, **3** Sometimes a barrier, **4** Often a barrier, **5** Always a barrier*	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
3.4.7a	What is the average re-supply time between order and receipt at the laboratory for:	Reagents: ____ *weeks*				Consumables: ____ *weeks*			
3.4.8a	In the past 6 months have reagents/consumables stock outputs for this platform been a challenge?	Scale 1-5 *(least challenging to very challenging)* 1 2 3 4 5							

Part 3.4: Supply Chain Management									
Sequencing platform: Oxford Nanopore Technologies									
3.4.1a	Where do you purchase these components from?	Direct from manufacturers		Distributors *Please list down name of distributor*		Group purchasing organisations (e.g., UNICEF)/collaborators	Others (please specify)		
		In country *(Y/N)*	External *(specify country)*	In country *(List, eg: Company A)*	External *(Company A, Country X)*				
	Sequencing machine & related equipment								
	Reagents								
	Non-reagent consumables								
3.4.2a	Is the procurement process centrally coordinated by the public health entity in charge of genomic surveillance and sequencing or conducted by individual facilities?	*(Central / By individual facilities)*							
3.4.3a	Is the supply forecasting process centrally coordinated or conducted by individual facilities?	*(Central / By individual facilities)*							
3.4.4a	Have there been any breakdown of sequencing equipment in the past 6 months?	Yes ☐ No ☐							
3.4.5a	Does the country face supply chain constraints for sequencing-related equipment or reagents?	Yes ☐ No ☐ → Skip to 3.4.7							
3.4.6a	If yes, which supply chain components are a barrier to sequencing capacity?	Distributor responsiveness / technical support	Customs clearance	Cold chain maintenance	Equipment purchasing lead time *(time taken from order to arrival)*	Equipment repair lead time *(time taken from repair to full function)*	Reagents and consumables purchasing lead time *(time taken from order to arrival)*	Reagents and consumables stock availability	Expiry date on arrival for reagents
	***1** Not a barrier, **2** Rarely a barrier, **3** Sometimes a barrier, **4** Often a barrier, **5** Always a barrier*	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
3.4.7a	What is the average re-supply time between order and receipt at the laboratory for:	Reagents: ____ *weeks*				Consumables: ____ *weeks*			
3.4.8a	In the past 6 months have reagents/consumables stock outputs for this platform been a challenge?	Scale 1-5 *(least challenging to very challenging)* 1 2 3 4 5							

Part 3.4: Supply Chain Management

Sequencing platform: ThermoFischer

3.4.1a	Where do you purchase these components from?	Direct from manufacturers		Distributors *Please list down name of distributor*		Group purchasing organisations (e.g., UNICEF)/collaborators	Others (please specify)
		In country *(Y/N)*	External *(specify country)*	In country *(List, eg: Company A)*	External *(Company A, Country X)*		
	Sequencing machine & related equipment						
	Reagents						
	Non-reagent consumables						

3.4.2a	Is the procurement process centrally coordinated by the public health entity in charge of genomic surveillance and sequencing or conducted by individual facilities?	*(Central / By individual facilities)*							
3.4.3a	Is the supply forecasting process centrally coordinated or conducted by individual facilities?	*(Central / By individual facilities)*							
3.4.4a	Have there been any breakdown of sequencing equipment in the past 6 months?	Yes ☐ No ☐							
3.4.5a	Does the country face supply chain constraints for sequencing-related equipment or reagents?	Yes ☐ No ☐ → Skip to 3.4.7							
3.4.6a	If yes, which supply chain components are a barrier to sequencing capacity?	Distributor responsiveness / technical support	Customs clearance	Cold chain maintenance	Equipment purchasing lead time *(time taken from order to arrival)*	Equipment repair lead time *(time taken from repair to full function)*	Reagents and consumables purchasing lead time *(time taken from order to arrival)*	Reagents and consumables stock availability	Expiry date on arrival for reagents
	***1** Not a barrier, **2** Rarely a barrier, **3** Sometimes a barrier, **4** Often a barrier, **5** Always a barrier*	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
3.4.7a	What is the average re-supply time between order and receipt at the laboratory for:	Reagents: ____ *weeks*				Consumables: ____ *weeks*			
3.4.8a	In the past 6 months have reagents/consumables stock outputs for this platform been a challenge?	Scale 1-5 *(least challenging to very challenging)* 1 2 3 4 5							

Part 3.4: Supply Chain Management									
Sequencing platform: MGI									
3.4.1a	Where do you purchase these components from?	Direct from manufacturers		Distributors *Please list down name of distributor*		Group purchasing organisations (e.g., UNICEF)/collaborators	Others (please specify)		
		In country *(Y/N)*	External *(specify country)*	In country *(List, eg: Company A)*	External *(Company A, Country X)*				
	Sequencing machine & related equipment								
	Reagents								
	Non-reagent consumables								
3.4.2a	Is the procurement process centrally coordinated by the public health entity in charge of genomic surveillance and sequencing or conducted by individual facilities?					*(Central / By individual facilities)*			
3.4.3a	Is the supply forecasting process centrally coordinated or conducted by individual facilities?					*(Central / By individual facilities)*			
3.4.4a	Have there been any breakdown of sequencing equipment in the past 6 months?					Yes ☐ No ☐			
3.4.5a	Does the country face supply chain constraints for sequencing-related equipment or reagents?					Yes ☐ No ☐ → Skip to 3.4.7			
3.4.6a	If yes, which supply chain components are a barrier to sequencing capacity?	Distributor responsiveness / technical support	Customs clearance	Cold chain maintenance	Equipment purchasing lead time *(time taken from order to arrival)*	Equipment repair lead time *(time taken from repair to full function)*	Reagents and consumables purchasing lead time *(time taken from order to arrival)*	Reagents and consumables stock availability	Expiry date on arrival for reagents
	***1** Not a barrier, **2** Rarely a barrier, **3** Sometimes a barrier, **4** Often a barrier, **5** Always a barrier*	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
3.4.7a	What is the average re-supply time between order and receipt at the laboratory for:					Reagents: ____ *weeks*		Consumables: ____ *weeks*	
3.4.8a	In the past 6 months have reagents/consumables stock outputs for this platform been a challenge?					Scale 1-5 *(least challenging to very challenging)* 1 2 3 4 5			

Part 3.4: Supply Chain Management									
Sequencing platform: Other – please specify (Copy for additional platforms as needed)									
3.4.1a	Where do you purchase these components from?	Direct from manufacturers		Distributors *Please list down name of distributor*		Group purchasing organisations (e.g., UNICEF)/collaborators	Others (please specify)		
		In country *(Y/N)*	External *(specify country)*	In country *(List, eg: Company A)*	External *(Company A, Country X)*				
	Sequencing machine & related equipment								
	Reagents								
	Non-reagent consumables								
3.4.2a	Is the procurement process centrally coordinated by the public health entity in charge of genomic surveillance and sequencing or conducted by individual facilities?					*(Central / By individual facilities)*			
3.4.3a	Is the supply forecasting process centrally coordinated or conducted by individual facilities?					*(Central / By individual facilities)*			
3.4.4a	Have there been any breakdown of sequencing equipment in the past 6 months?					Yes ☐ No ☐			
3.4.5a	Does the country face supply chain constraints for sequencing-related equipment or reagents?					Yes ☐ No ☐ → Skip to 3.4.7			
3.4.6a	If yes, which supply chain components are a barrier to sequencing capacity?	Distributor responsiveness / technical support	Customs clearance	Cold chain maintenance	Equipment purchasing lead time *(time taken from order to arrival)*	Equipment repair lead time *(time taken from repair to full function)*	Reagents and consumables purchasing lead time *(time taken from order to arrival)*	Reagents and consumables stock availability	Expiry date on arrival for reagents
	***1** Not a barrier, **2** Rarely a barrier, **3** Sometimes a barrier, **4** Often a barrier, **5** Always a barrier*	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
3.4.7a	What is the average re-supply time between order and receipt at the laboratory for:					Reagents: ____ *weeks*		Consumables: ____ *weeks*	
3.4.8a	In the past 6 months have reagents/consumables stock outputs for this platform been a challenge?					Scale 1-5 *(least challenging to very challenging)* 1 2 3 4 5			

<table>
<tr><th colspan="3">Section 4: Performance, Quality and Feedback</th></tr>
<tr><td colspan="3">Part 4.1: Quality Management</td></tr>
<tr><td>4.1.1</td><td>Is there a national laboratory quality assurance mechanism for governance of national laboratory quality?
This question is intended to gauge in-country quality governance. Please answer “yes” even if current oversights do not cover NGS.</td><td>Yes ☐
No ☐</td></tr>
<tr><td>4.1.2</td><td>What proportion of laboratories conducting genomic surveillance and sequencing have been certified or accredited by any local or internationally recognized programs?
This question is intended to gauge quality management systems within participating laboratories, regardless of whether NGS protocols are included in the list of accredited tests.</td><td>% of laboratories
☐0%
☐≤25%
☐≤50%
☐<75%
☐>75%</td></tr>
<tr><td>4.1.3</td><td colspan="2">Which of the following certification/accreditation standard(s) were used?
(Select all that apply)
☐College of American Pathologists (CAP)
☐International Organization for Standardization (ISO)
☐Clinical Laboratory Improvement Amendments (CLIA)
☐Good Laboratory Practice (GLP)
☐Others (please specify)</td></tr>
<tr><td>4.1.4</td><td colspan="2">How is patient data managed and how is this linked to resulting genomes?
<table><tr><th>Patient data management</th><th>Scale: 1 (0%) - 5 (>75%)*</th></tr><tr><td>Fully integrated laboratory Information Management Systems (e.g. LIS/ LIM)</td><td></td></tr><tr><td>Partially integrated LIS/LIM with separate tagging and storage of genome data</td><td></td></tr><tr><td>Manual system (e.g. excel lists)</td><td></td></tr><tr><td>Genomic data is not currently tagged to patient metadata</td><td></td></tr></table>Scale 1 – 5 (% of laboratories: 0%, ≤25%, ≤50%, <75%, >75%) for each option</td></tr>
<tr><td>4.1.5</td><td>What proportion of laboratories are estimated to have participated in any proficiency testing or external quality assurance audits for NGS?</td><td>☐0% → If 0%, skip to 4.2
☐≤25%
☐≤50%
☐<75%
☐>75%</td></tr>
<tr><td>4.1.6</td><td>What proportion of these laboratories have a system to review results to enable corrective action?</td><td>☐0%
☐≤25%
☐≤50%
☐<75%
☐>75%</td></tr>
</table>

Part 4.2: Data sharing and Reporting

4.2.1 What components of genomic surveillance and sequencing data has been shared (nationally/internationally) in the past year?

Description:
1) Genome sequence refers to the final .fasta obtained after bioinformatics analysis.
2) Deidentified metadata refers to information such as age, gender, collection date, place of residence, travel history, disease severity and vaccination/treatment history.
3) Raw fastq file is the collection of reads generated by NGS machines. It contains quality score information and is accepted by Sequence Read Archives (SRA) at NCBI, EBI, DDBJ and GISAID.

Select all that apply:

☐ Genome sequence
☐ Deidentified metadata
☐ Raw fastq

4.2.2 For each of the above data type, who are you sharing data with?
Select all that apply.

Data type	Local/ in-country	International
Genome Sequence		
Deidentified Metadata		
Raw fastq		

Description:
- *Local/ in-country sharing refers to sharing with national partners/stakeholders only*
- *International sharing refers to making the data publicly available via databases such as GISAID and NCBI.*

4.2.3 What is the estimated **monthly** proportion of sequences shared on public databases compared to total sequenced?

Select one:
☐ *0%*
☐ *≤25%*
☐ *≤50%*
☐ *<75%*
☐ *>75%*

4.2.4 How often are genomic surveillance results reported back to relevant government Ministries?

Reporting results to Gov. Ministries	Scale: 1 (Never) - 5 (Always)*
For routine surveillance	
For notifiable diseases or events	

Scale: (1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Always)

What genomic data is being reported to government ministries?

Genomic data reported	Scale: 1 (Never) - 5 (Always)*
Sample results	
Cluster analysis/ Phylogeny	

Scale: (1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Always)

4.2.5 How often are results discussed in conjunction with epidemiological findings or with policymakers?

Discussion of results with epidemiological findings	Scale: 1 (Never) - 5 (Always)*
For routine surveillance	
For notifiable diseases or events	
Discussion of results with policymakers	**Scale: 1 (Never) - 5 (Always)***
For routine surveillance	
For notifiable diseases or events	

Scale: (1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Always)

Part 4.3: Reproducibility of Bioinformatics pipelines

4.3.1 How is bioinformatics analysis being performed?

Bioinformatics analysis	Scale: 1 (0%) - 5 (>75%)*
Using containerized workflows	
Using locally installed published workflows	
Using tools provided by NGS manufacturer	
Using proprietary software	
Using in-house pipeline created from individual open-source tools	
Others (pls specify):	

**Scale 1 – 5: 1 = 0%, 2 = ≤25%, 3= ≤50%,4 = <75%, 5 = >75%*

Description:
1) Containerized workflows refer to direct access to centrally maintained standardized bioinformatics pipelines via container platforms (e.g., Docker) directly from local computer. Popular examples include: nf-core and ViralFlow.
2) Locally installed published workflows refer to the local installation of published bioinformatics pipelines from github. It requires users to ensure installation of dependencies in order to run the pipelines on their own machines. Version control is user dependent.
3) From NGS manufacturer refers to software provided with the sequencer.
4) Proprietary software refers to paid licensed software such as CLC genomics.
5) In-house pipelines refer to unpublished workflows created by the laboratory to analyse sequence data and usually involves installation of several separate open access tools (e.g., fastqc, samtools, BWA) for each analysis step

Section 5: Barriers and Priorities for NGS

Part 5.1: Main Barriers

5.1.1 Rate the top barriers faced by laboratories for conducting adequate and effective NGS

Contextual/Process Barriers for NGS	Scale: 1 (Not a barrier) – 5 (Always a barrier)*
Infrastructure (electricity, internet connection)	
Human Resources (availability of trained personnel)	
Samples (transportation time, quality)	
Reagents and consumables (availability, lead time, expiry dates on arrival)	
Laboratory & Sequencing Equipment	
Computing power and storage	
Data sharing and reporting	
Others (pls specify):	

Financing Barriers for NGS	Scale: 1 (Not a barrier) – 5 (Always a barrier)*
Inadequate budget	
Lack of national plan and guidelines	
Over-reliance on external funders	
Lack of Industry/private-sector involvement	
In-country resource constraints	
Low spending limits	

(1** Not a barrier, **2** Rarely a barrier, **3** Sometimes a barrier, **4** Often a barrier, **5** Always a barrier)*

Part 5.2: Priority Areas

5.2.1 Please identify the future priority areas where **human capacity strengthening** is required to enhance NGS capacity:

Training Priorities	Scale: 1 (Not a priority) – 5 (Essential)*
Sample pre-processing	
NGS library preparation and sequencing	
Data processing, quality assurance and storage (Bioinformatics)	
Data analysis	
Data Reporting, sharing & policy making	
Other (please specify)	

(1** Not a priority, **2** Low priority, **3** Medium priority, **4** High priority, **5** Essential)*

5.2.2 Please identify the future priority areas where **infrastructure support** is most urgently required to enhance NGS capacity:

Laboratory & Sequencing Equipment	Scale: 1 (Not a priority) – 5 (Essential)*
Availability	
Calibration, Service & maintenance	
Lead time	

Computer Infrastructure for NGS	Scale: 1 (Not a priority) – 5 (Essential)*
Computer equipment	
Computing processing power	
Computing memory & Storage capacity	

Sequencing Reagents	Scale: 1 (Not a priority) – 5 (Essential)*
Availability	
Lead Time	
Cold Chain	

Other consumables *(e.g. dishes, gloves, pipettes, tubes, etc.)*	Scale: 1 (Not a priority) – 5 (Essential)*
Availability	
Lead Time	

(1** Not a priority, **2** Low priority, **3** Medium priority, **4** High priority, **5** Essential)*

Supplementary Table 5: Binary indicators used for calculating country summary scores.

INDICATOR NAME	DEFINITION	SUMMARY SCORING
NGS for unknown pathogens	Proportion of countries using NGS to detect *unknown pathogens*	1 = Yes (for Human surveillance) 0 = No (for Human surveillance)
External support	Proportion of countries where reliance on external support is low/ not a barrier for NGS	1 = Likert score <4 0 = Likert score ≥4
Sufficient funding	Proportion of countries who perceive sufficient funding for pathogen genomic surveillance systems over the coming 5 year cycle	1 = Likert score ≥4 0 = Likert score <4
Sustainable funding	Proportion of countries who perceive sustainable funding for genomic surveillance systems for the coming 5 year cycle	1 = Likert score ≥4 0 = Likert score <4
Strategic plan	Proportion of countries where a national strategic plan exists that includes pathogen genomic surveillance	1 = Yes 0 = No
Guidelines	Proportion of countries where national guidelines exist for pathogen genomic surveillance	1 = Yes 0 = No
Expert panel	Proportion of countries where a national expert panel or technical advisory group exist to advise government interpretation/use of pathogen genomic surveillance data	1 = Yes 0 = No
Equipment repair lead time	Proportion of countries who perceive equipment repair lead time as low/ no barrier to sequencing capacity	1 = Likert score <4 0 = Likert score ≥4
Resupply time length	Median re-supply time between order and receipt of reagents and consumables	1 = <4 weeks 0 = ≥4 weeks
Stock adequacy - reagents and consumables	Proportion of countries reporting no stock out of reagents /consumables in the past 6 months	1 = Likert score <4 0 = Likert score ≥4
Laboratory guidelines and protocols	Proportion of countries where laboratory guidelines and protocols exist for genomic sequencing of one or more pathogens	1 = Yes 0 = No
Sequencing capacity	Median monthly pathogen sequences generated in the past year, per million population	1 = ≥ regional average 0 = < regional average
Sequencing utilization	Average monthly sequencing output relative to maximum monthly sequencing capacity for the past year	1 = ≥75% 0 = < 75%
Sequencing time	Median estimated time required for NGS surveillance between specimen collection, sequence generation and reporting	1 = ≥ regional average 0 = < regional average
Bioinformatics capacity	Proportion of countries with in-country bioinformatics expertise (defined as the ability to utilize published workflows (containerized or locally installed) or in-house pipelines for >75% of genomic data analysis)	1 = >75% sequences performed in containerized workflow or locally installed workflow or in-house pipeline 0 = Proprietary software or tools by manufacturer or other
National quality assurance mechanism	Proportion of countries where national quality assurance mechanisms exist for governance of national laboratory quality (not specific to NGS)	1 = Yes 0 = No
Laboratory certification or accreditation	Proportion of countries where > 75% of laboratories conducting NGS have been certified or accredited by any local or internationally recognized body	1 = ≥75% labs certified 0 = < 75% labs certified
External quality assurance	Proportion of countries where >75% of laboratories have participated in any proficiency testing or external quality assurance audits for NGS	1 = ≥75% labs participated in proficiency testing or external quality assurance 0 = < 75% labs participated in proficiency testing or external quality assurance
Data sharing	Proportion of countries reporting > 75% of total sequences are shared on public databases	1 = ≥75% 0 = < 75%
Engagement of policymakers	Proportion of countries reporting regularly sharing genomic data to policymakers to inform decision making	1 = Likert score ≥4 0 = Likert score <4