Cost and Sustainability of Pathogen Genomics

06 July 2024

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Recent advances in genomics transform infectious disease detection and response capacity

Early detection of a new or rare pathogen
- polio, zoonotic spillover, outbreak investigation

Monitor levels of an existing pathogen
- SARS CoV-2 variants, drug resistant bacteria/TB

Assess intervention effects
- vaccine introduction, AMR stewardship

Genomic data: Building block for new tools

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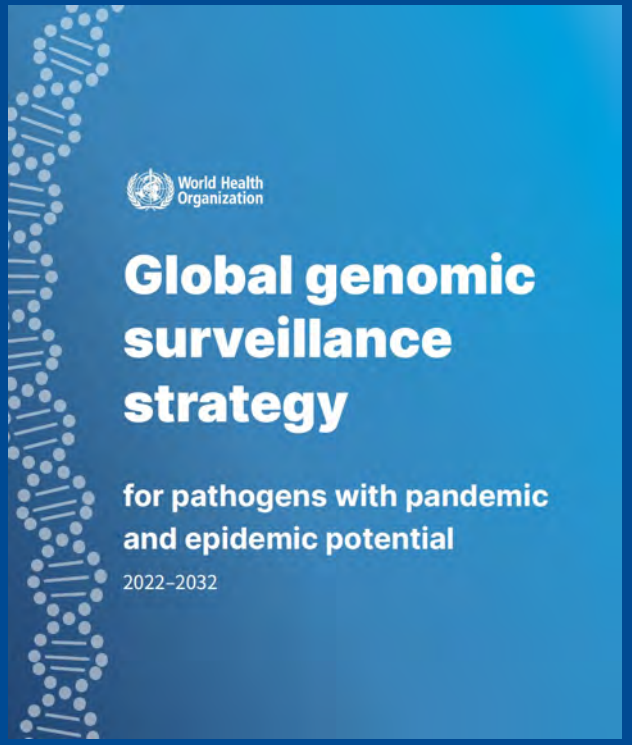
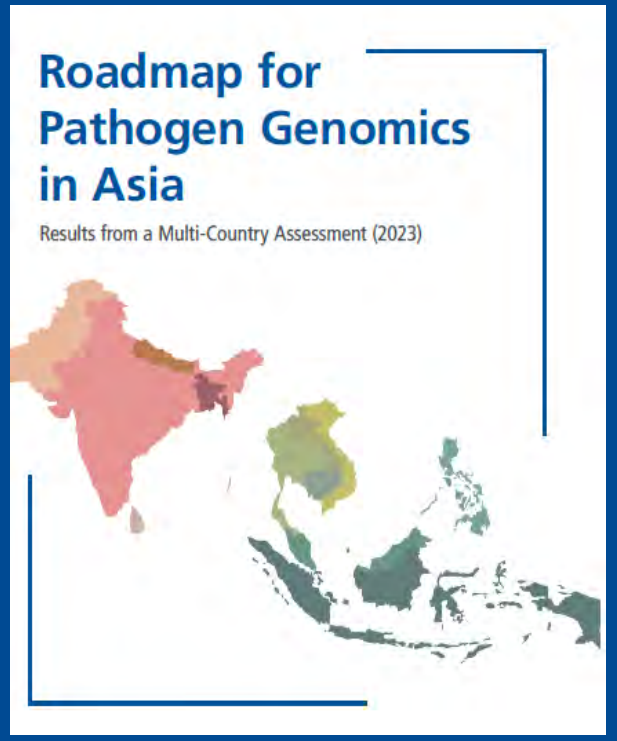
World Health Organization
- Global genomic surveillance strategy

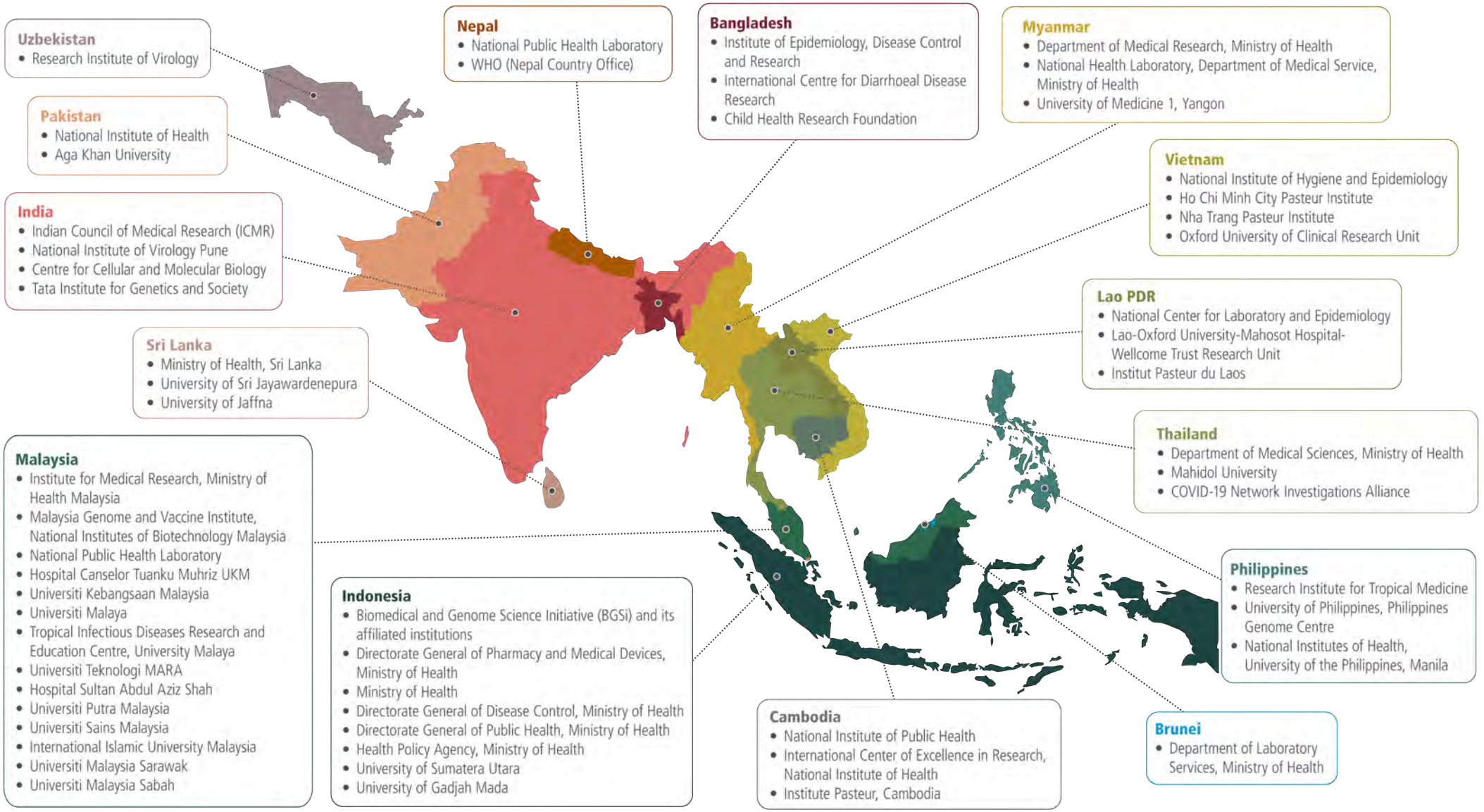
Asia Pathogen Genomics Initiative (Asia PGI)
- ***Regional Roadmap***: 14 country assessment with recommendations to accelerate implementation in Asia



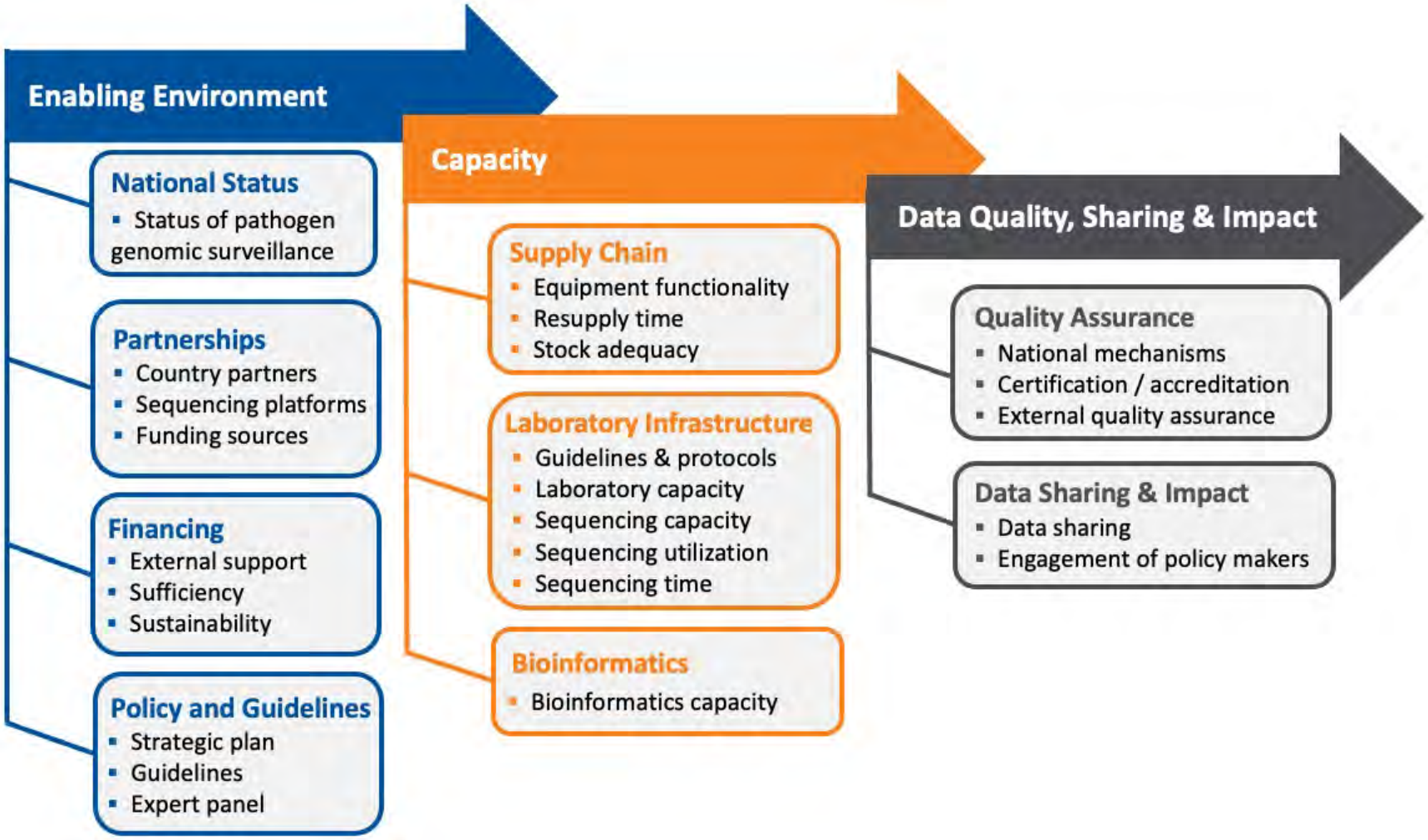


Source: Roadmap for Pathogen Genomics

Asia PGI: Pathogen Genomics Landscape Assessment



System-wide assessment: 14 countries - June 2022-May 2023



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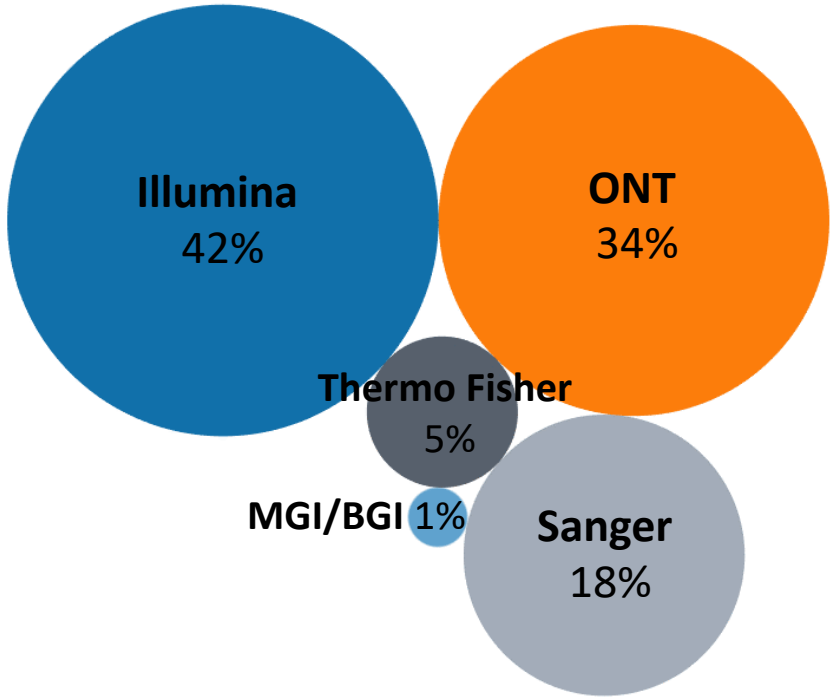
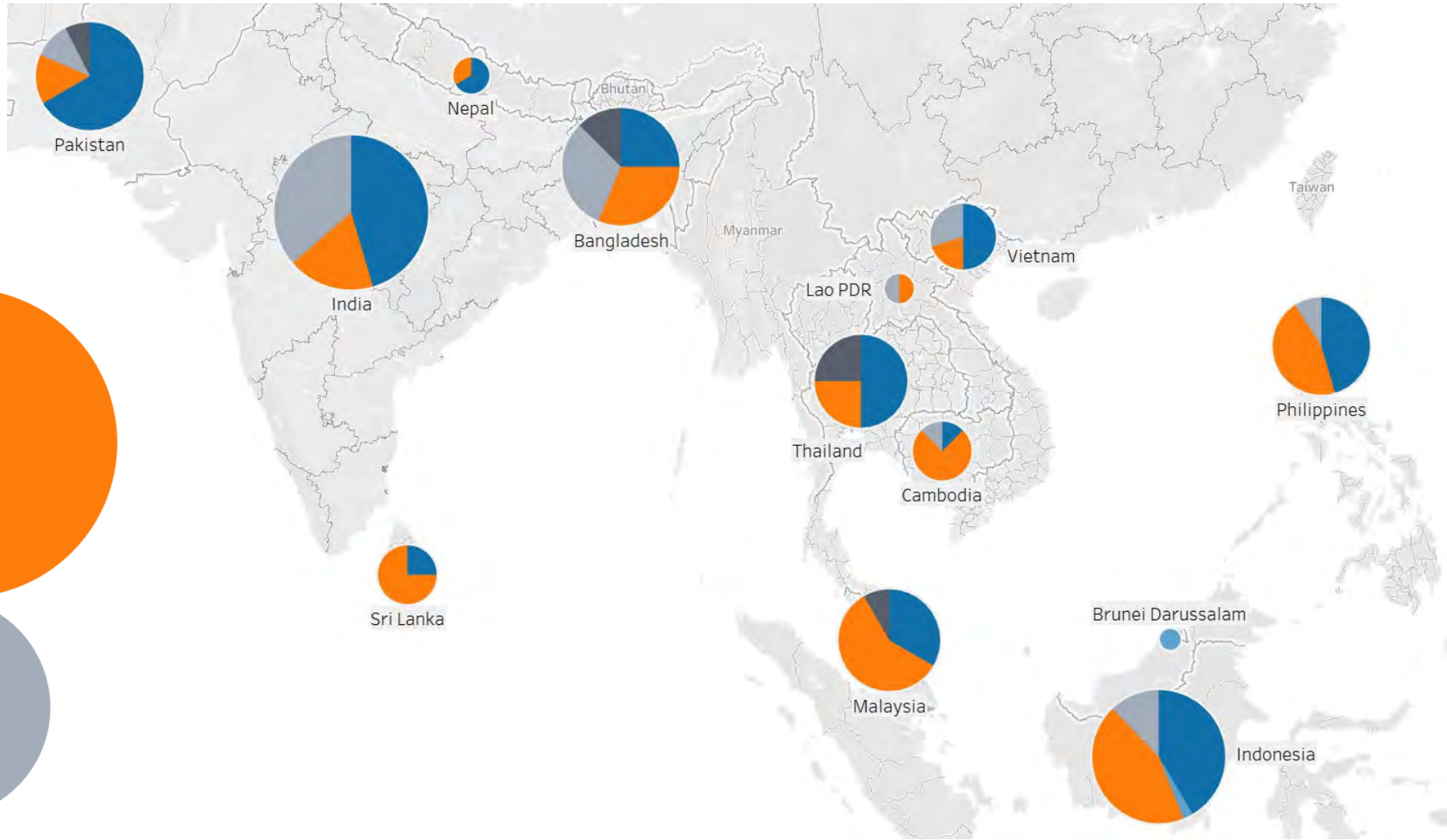
Sequencing exists across Asia. Capacity gaps remain

13 countries

253 sequencers

156 laboratories





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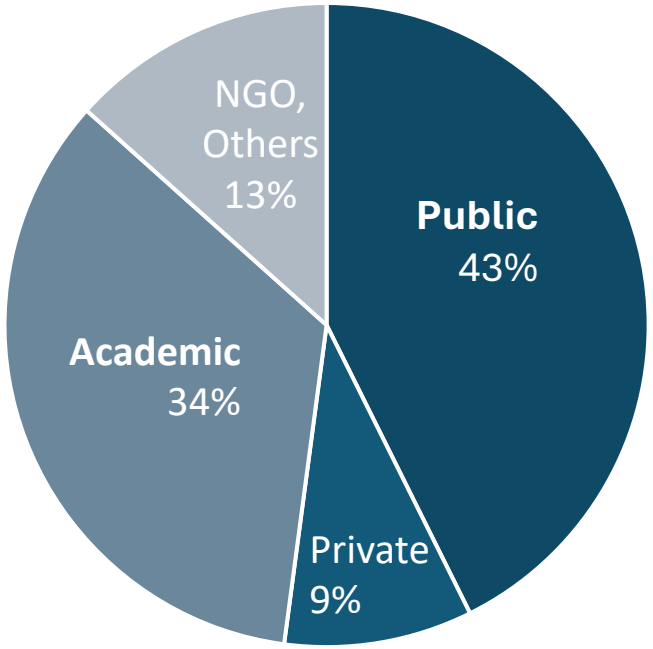
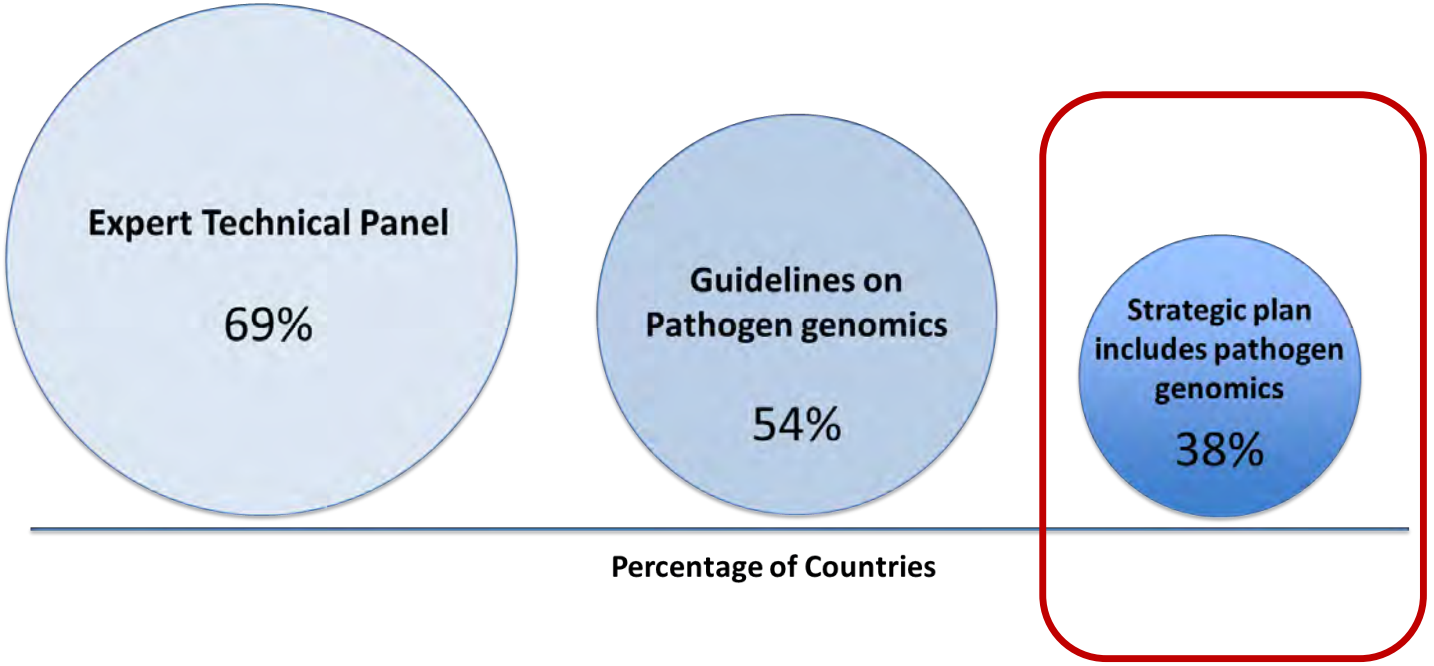
Diverse stakeholders. Few countries have national plans

Partners contributing to pathogen sequencing



Proportion of pathogen sequencing, by partner
Cross-country average



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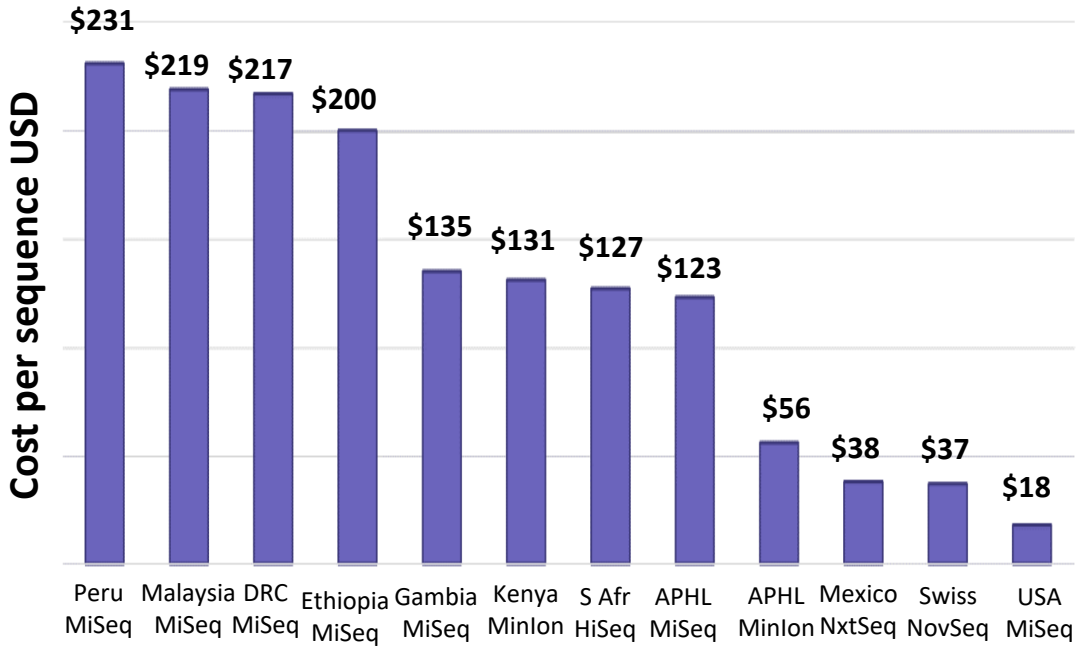
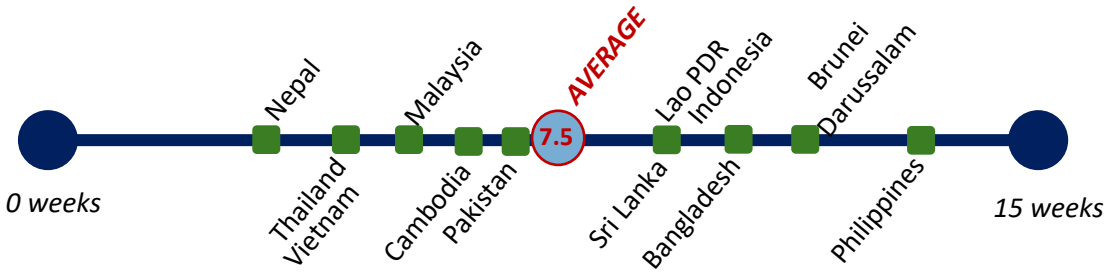
Cost and supply chain inequalities: Early detection delays

Poor countries: 10-fold greater cost per sequence



Source: FIND, June 2021

Average re-supply time = 7.5 weeks



Average 1 month delay: Sample to reporting

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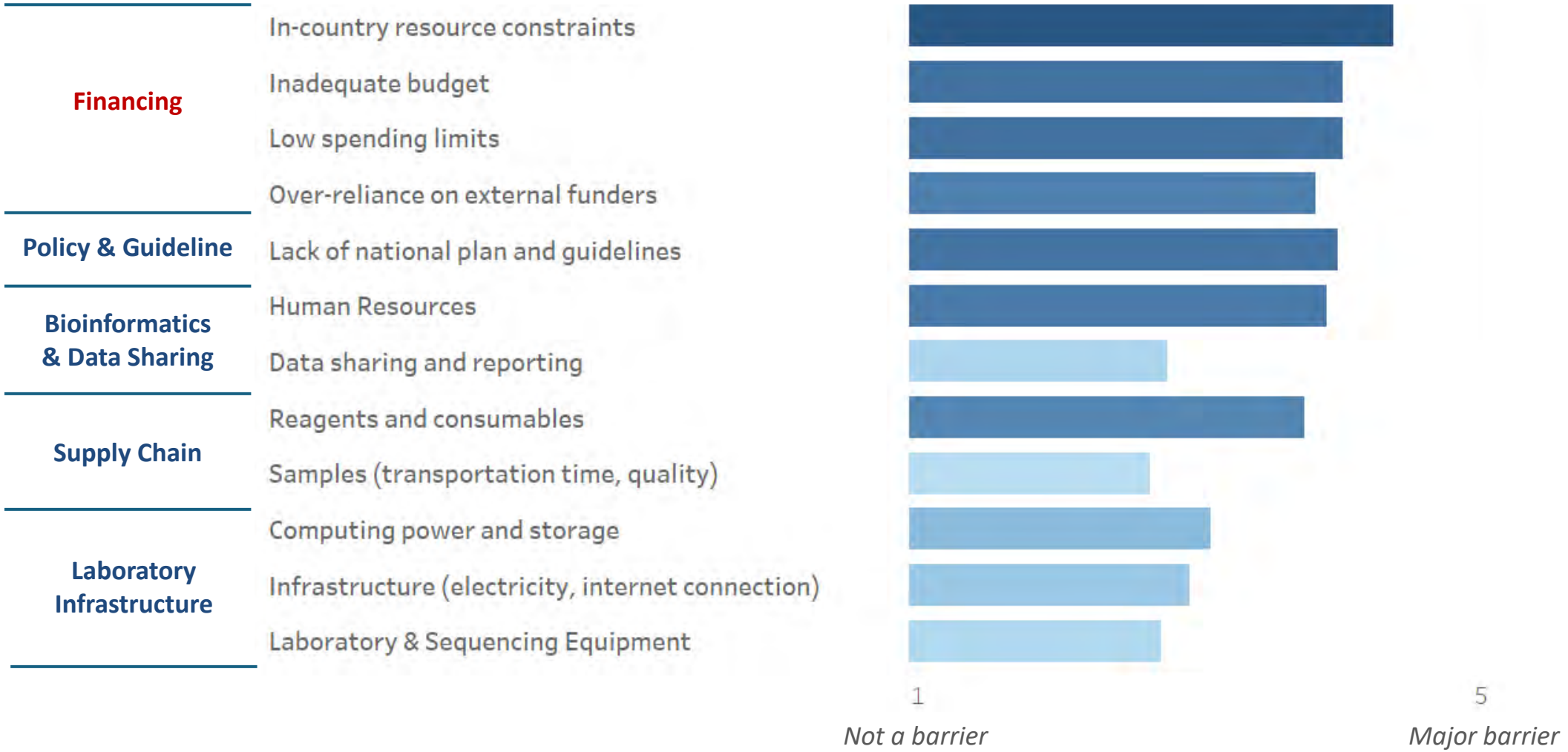
Barriers to pathogen genomic surveillance



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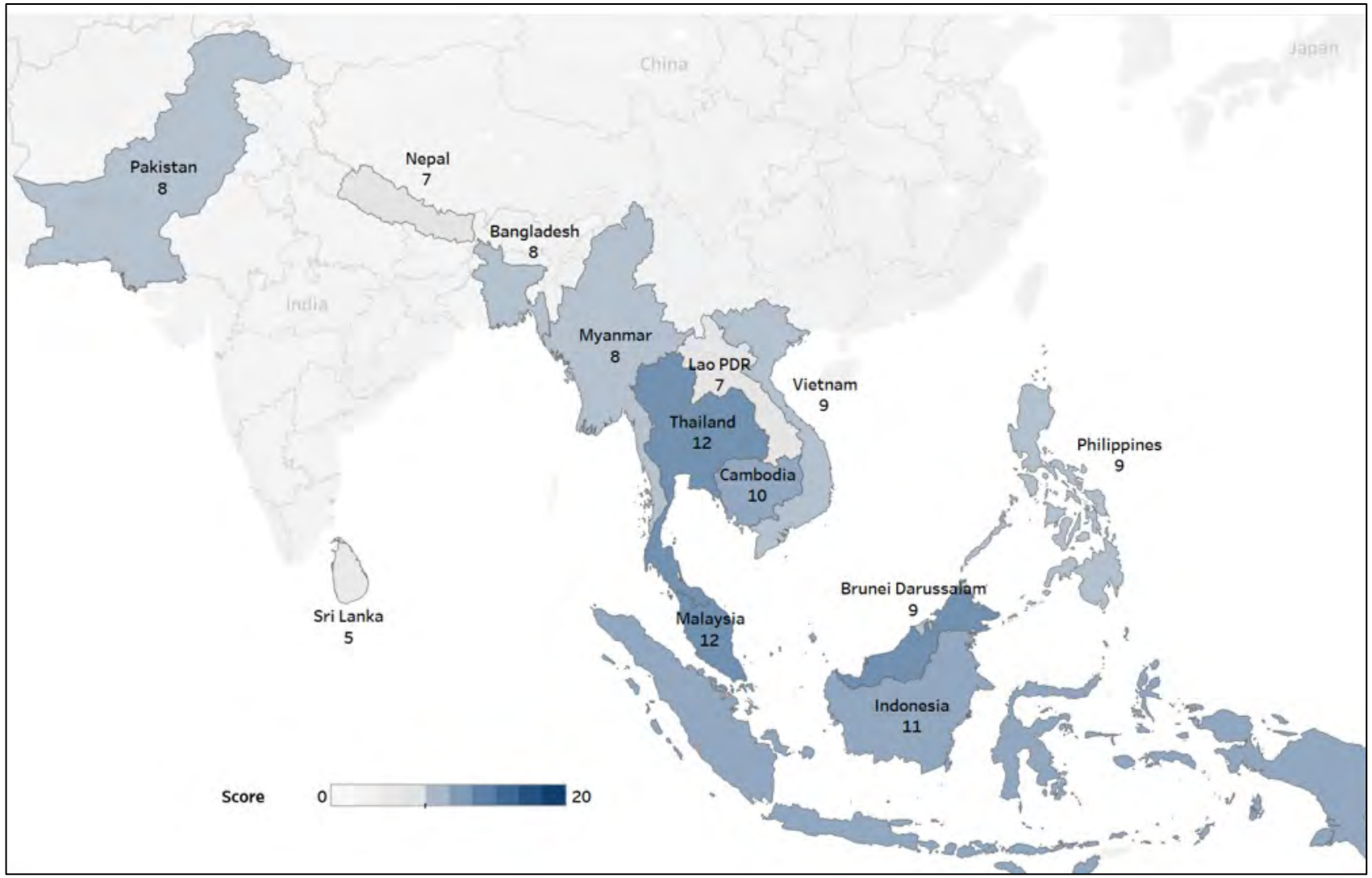
Pathogen genomic capacity varies across the region



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Most countries in Asia: Moderate-to-high capacity

	LIMITED CAPACITY	MODERATE CAPACITY	HIGH CAPACITY
SURVEILLANCE AND SAMPLING	Passive and ad hoc	Passive and active - moderate coverage	Passive and active - high coverage
LABORATORY AND BIOINFORMATICS	Minimal	Modest scale, slow turnaround time	Well-established, rapid turnaround time
POLICY AND GUIDELINES FOR PATHOGEN GENOMICS	Absent, or present only for SARS-CoV-2	Present for some pathogens	Clearly outlined for endemic and novel pathogens
QUALITY ASSURANCE MECHANISMS	Absent	Some national accreditation; no external quality assurance (EQA)	Well-established national accreditation and EQA
TECHNICAL EXPERT COMMITTEES	Absent	Established	Well-functioning

Limited utility of genomics

Genomics supports **Infectious disease control** efforts

Genomics supports **Infectious disease control & elimination**

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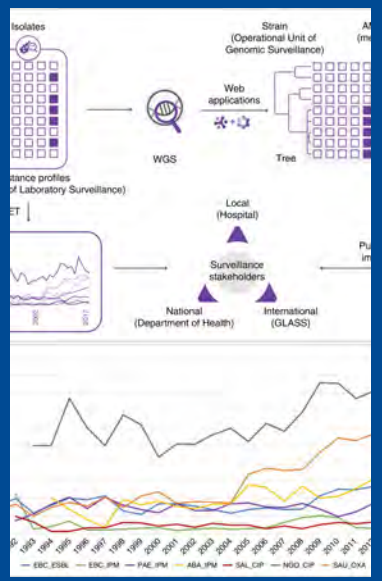
Public health approach to pathogen genomics

Multi-pathogen approach

One Health framework

Cost-efficient system design

Real-time information



Public health action

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Considerations prior to introducing genomic surveillance

Embed genomics within existing surveillance programs

TUBERCULOSIS

AFB Smears
TB culture
GeneXpert

ARBOVIRAL DISEASE

Serology, molecular tests
Human – Vector samples

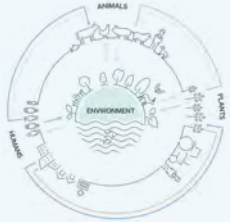
INFLUENZA CONTROL

SEVERE ACUTE RESPIRATORY INFECTION

Respiratory samples
Culture – Molecular testing

MICROBIOLOGY

Antimicrobial
Sensitivity Testing



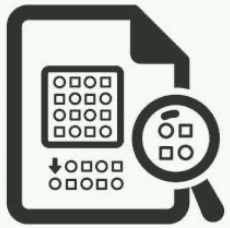
ONE HEALTH

Human-animal
interface

POLIO GLOBAL ERADICATION INITIATIVE

Wastewater
samples

Screening tests help target and interpret genomics



Where and how frequently to sample?

- Representative sample
- High-risk setting ie. wet market, migrant settlement

Link between genomics and conventional testing

- Antimicrobial resistance
- Genotype – Serotype ie. Dengue

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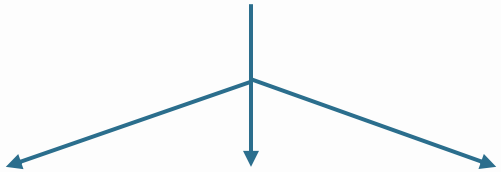
What question does genomics answer?



Rare or novel pathogen

Polio, Nipah, outbreak investigation

Track existing variants

COVID, influenza, MDR-TB

Assess intervention effects

Vaccination, isolation/travel restrictions, Wolbachia (Dengue)

Assessing the cost of pathogen genomics

Nucleic acid extraction

Average kit cost per sample

Library preparation + amplification

Amplification:
Total cost of kit, enzyme and nuclease water per sample
+
Thermocycler amortized cost per sample (10 years)

Library preparation:
Average kit and reagent costs per sample
+
Equipment (Qubit, Bioanalyser) amortized cost per sample
+
Other consumables cost per sample

Multi pathogen panels:
KingCreate, Twist, Illumina

Outsourcing (Singapore)

Sequencing (per GBp)

Average flow cell costs per sample per GBp
+
Average equipment (ONT, Illumina, MGI) amortized costs per sample

Outsourcing

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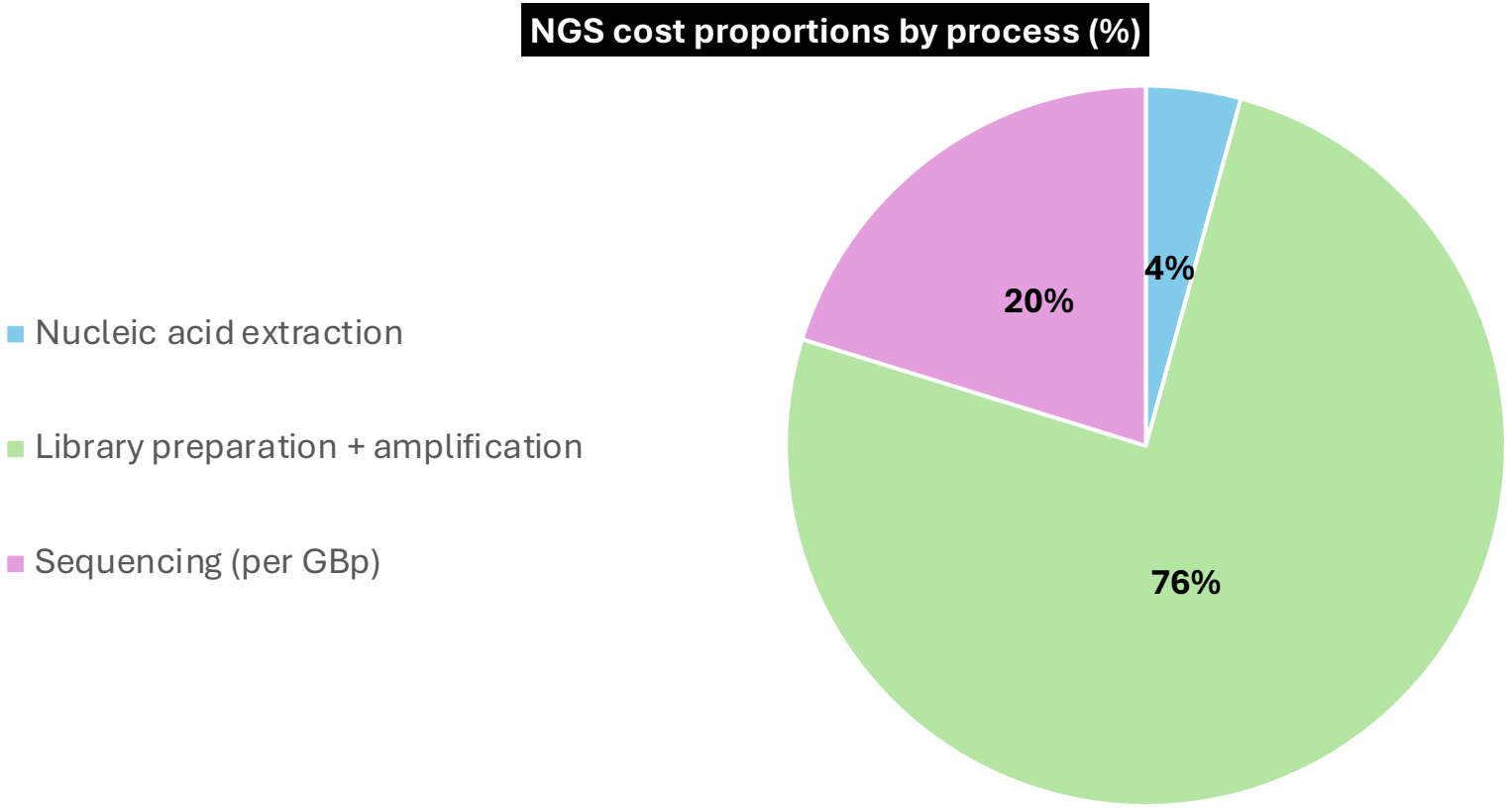
Total cost of NGS
USD $94/sample (1 GBp)



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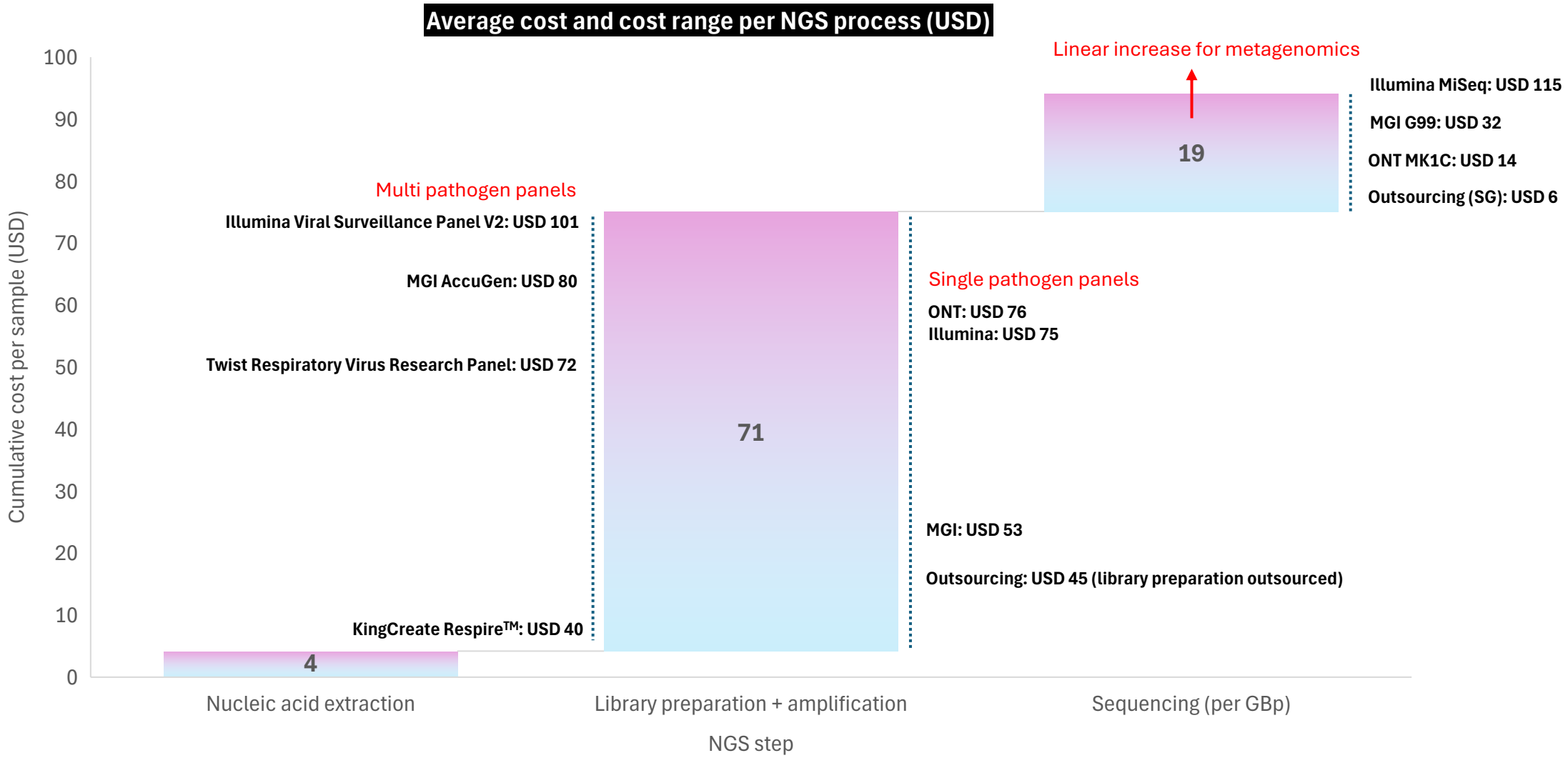
NGS cost drivers (USD)



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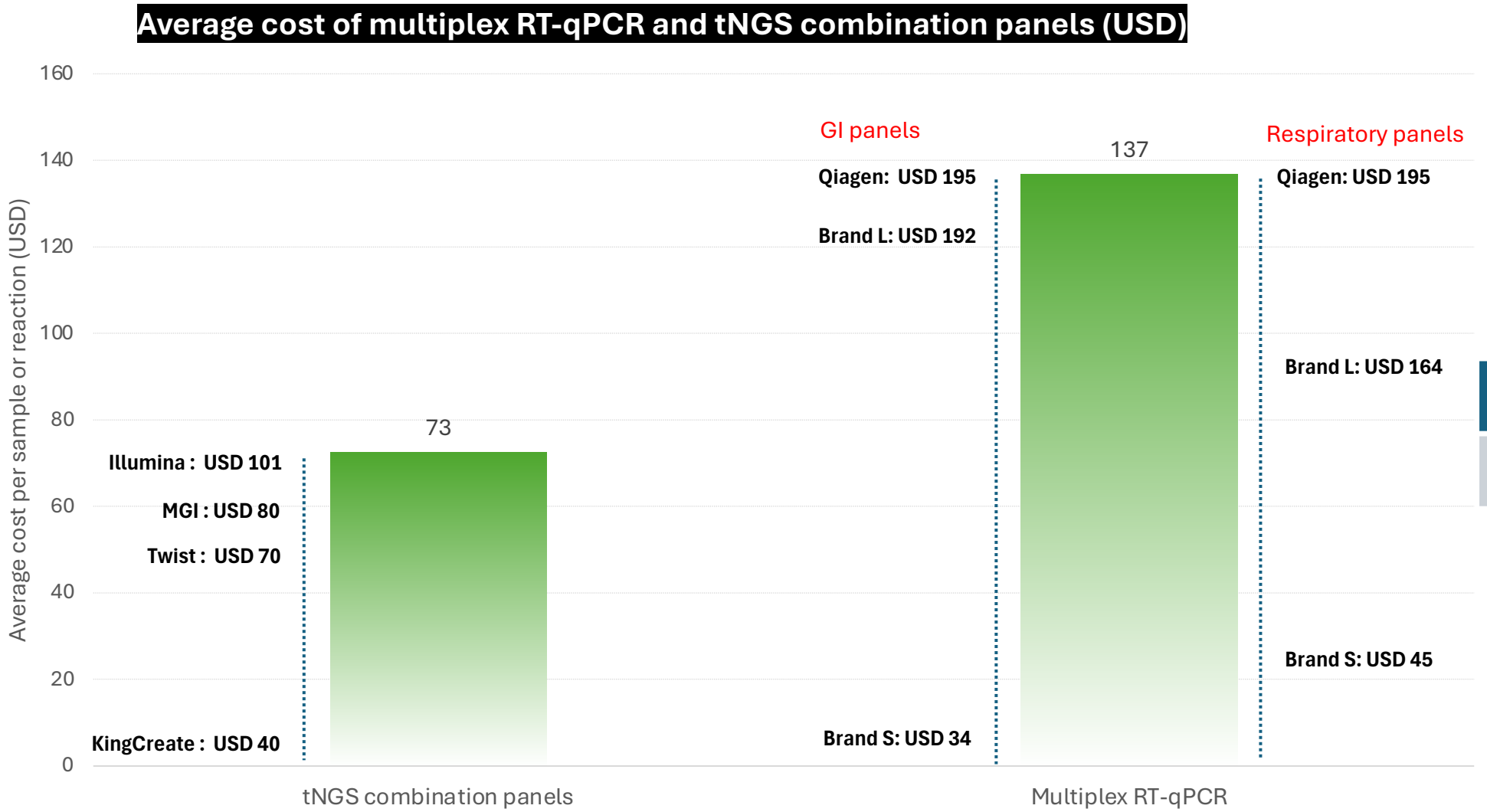
NGS combo panels vs Multiplex RT-qPCR



Pathogen coverage

tNGS	Multiplex RT-qPCR
29 – 330 (+ AMR genes)	7-8

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KEY CONSIDERATIONS

PUBLIC HEALTH AND SYSTEMS APPROACH

- One Health surveillance
- High-priority pathogens
- Real-time information
- Actionable data
- Timely public health response

SYSTEM REQUIREMENTS

- Surveillance and sampling
- Laboratory and bioinformatics infrastructure and capacity
- Policies and guidelines
- Quality assurance
- Technical expert committees

INVESTMENT CASE DEVELOPMENT

INPUTS/STEPS

1. Pathogen prioritization
2. Genomic utility assessment
3. Costing
4. Multi-pathogen planning

OUTCOMES

Tailored high-impact multi-pathogen genomics plan

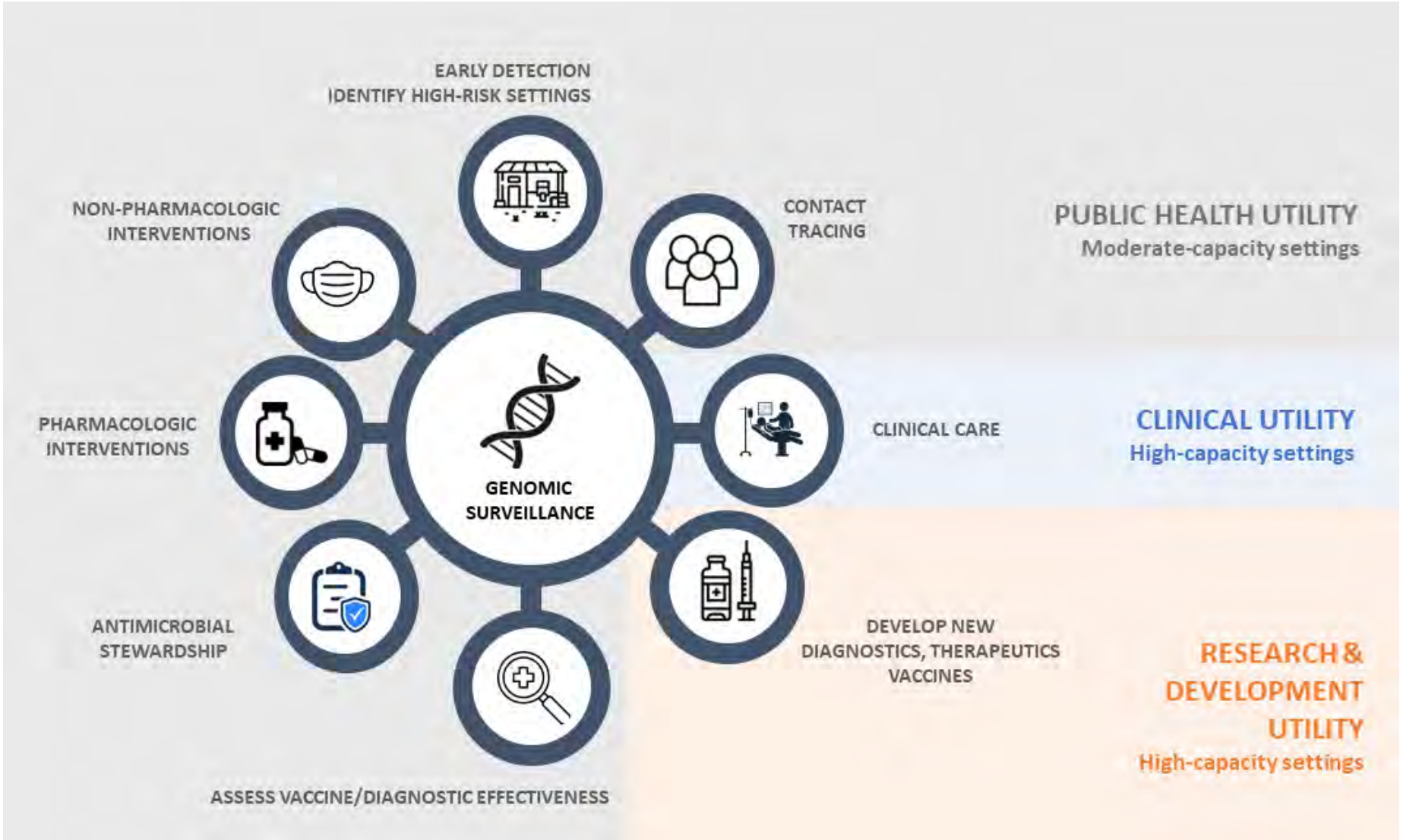
Cost-sensitive system design

National budgeting & partner alignment

Step 1: Pathogen prioritisation for genomics

II. GENOMIC PRIORITIZATION			
A	Diagnostic test coverage	*Estimated % of suspected clinical cases tested with laboratory diagnostic test*	20%
B	Pathogen significance	*Incidence rate*	20%
		Transmission rate (R0)	1 - 2
		Case Fatality Ratio (CFR)	13%
C	Mutation significance	*Increase in transmissibility*	Low
		Increase in disease severity	High
		Vaccine escape/ mismatch	Medium
		Antibiotic/ antiviral resistance	High
D	Genomic utility	*Public Health Utility*	
		Early detection/identification of high-risk settings	High
		Non-pharmacologic interventions	Medium
		Contact tracing	High
		Antimicrobial stewardship	High
		Clinical Utility	
		Pharmacologic interventions	Medium
		Diagnostic effectiveness	High
		Clinical Management	High
		Commercial/R&D Utility	
		Develop new diagnostics, therapeutics, vaccines	Medium
E	Economic significance	*Economic impact of pathogen detection or outbreak*	Medium

Step 2: Pathogen genomics utility assessment



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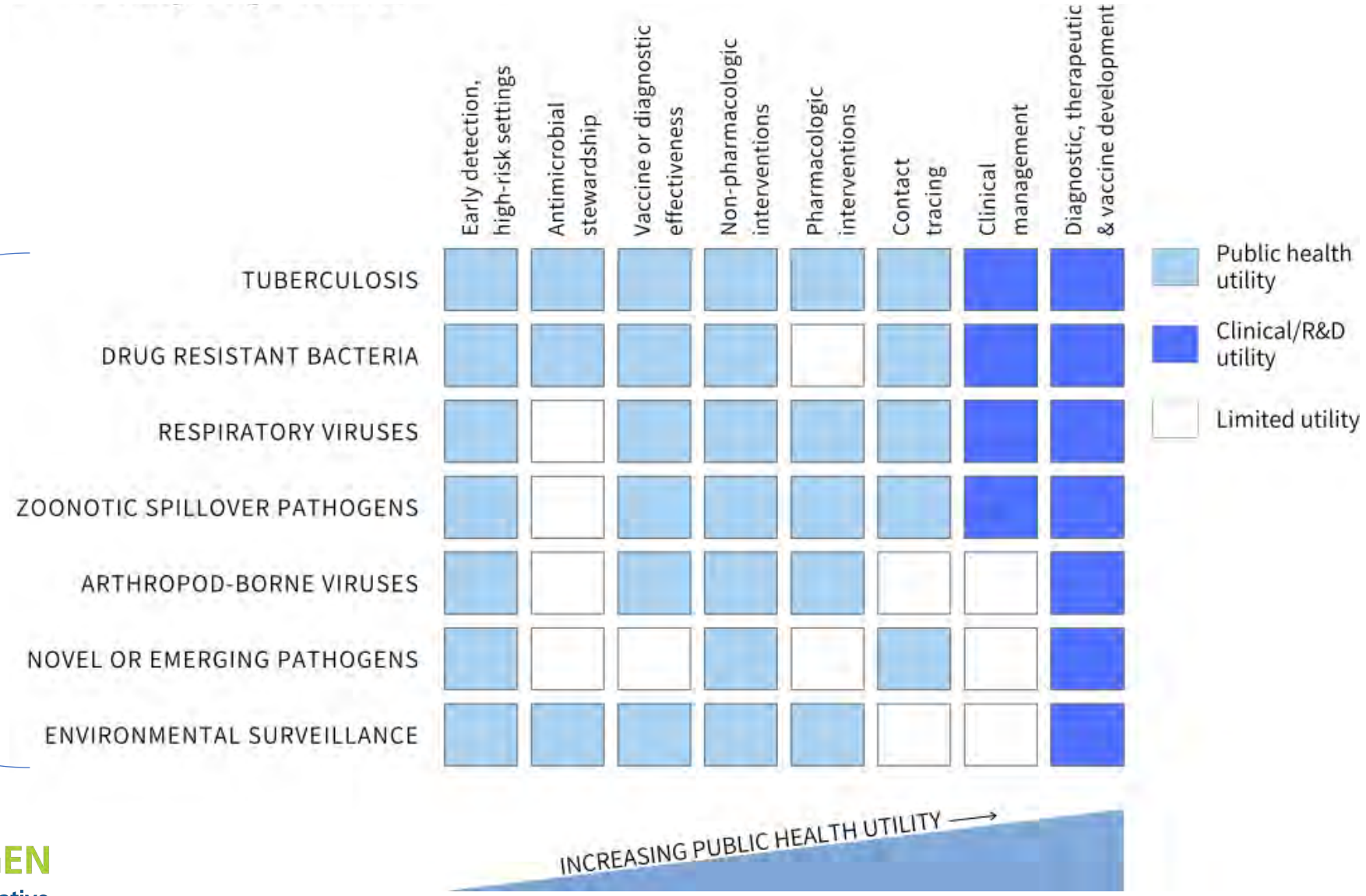
The utility of genomics differs by pathogen

Priority pathogens in Asia



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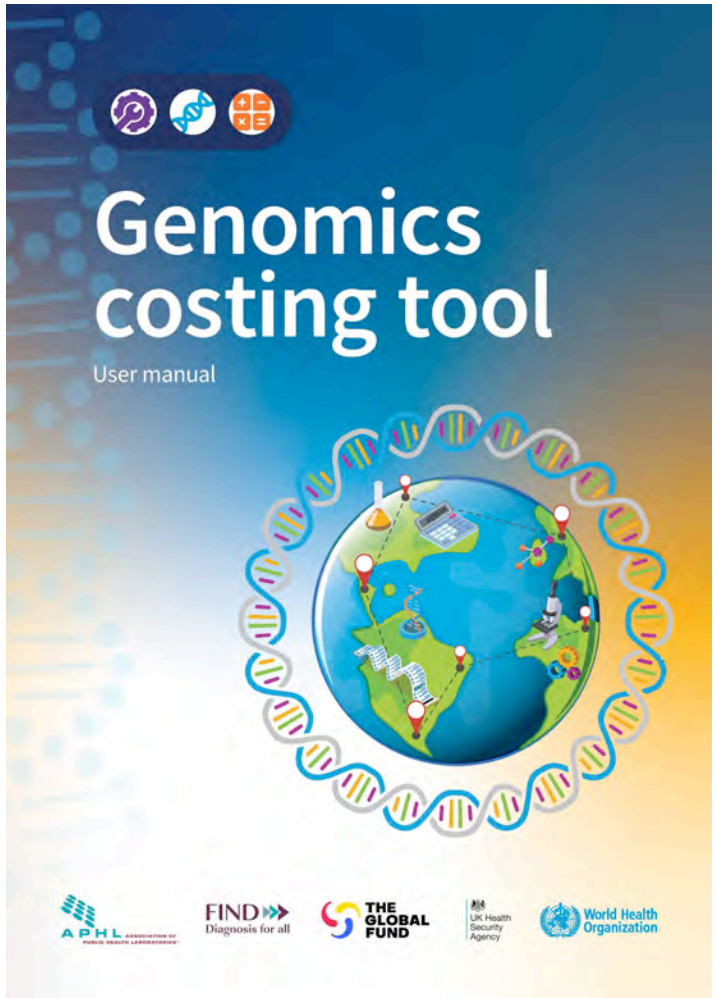
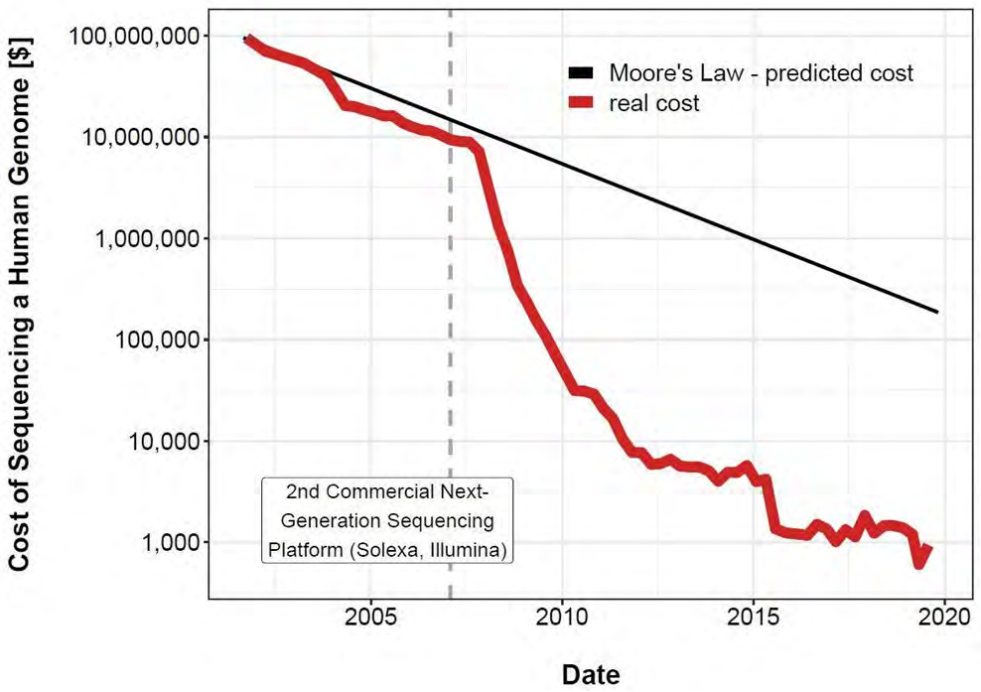
Step 3: Costing tools



Steps and cost-drivers

- Nucleic Acid Extraction
- Amplification
  Library Preparation
- Genomic sequencing
- Bioinformatics

Genomics: Cheaper and faster



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Step 4: Integrated multi-pathogen planning

PRIORITIZED PATHOGENS & PLATFORMS

- TB
- Respiratory Pathogens
- Arbovirus
- Environmental Surveillance
- AMR Bacteria
- Zoonotic

- Sampling Strategy
- Forecasting/volumes
- Costing

COST-EFFICIENT SYSTEM DESIGN

Conventional


Microbiology


Rapid Tests


Molecular

Genomics


Short-read


Long-read

INTEGRATED LABORATORY NETWORK

INVESTMENT CASE DEVELOPMENT

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Summary: Strategies to sustain pathogen genomics

Major progress in multi-pathogen genomics across Asia

- In-country capacity exists
- Wide range of use-cases

Priority to shift funding from external to domestic sources

Public health approach to multi-pathogen planning

- Genomics utility assessment
- Leverage existing surveillance systems
- Crucial to link genomics to public health action

Strategies to drive down costs

- Multi pathogen planning enables national and regional forecasting
- Cost reductions through pooled procurement or global mechanisms
- Innovations can drive down costs further
- Integrated laboratory network

Investment case framework

- Approach to translate global priorities into national plans/budgets