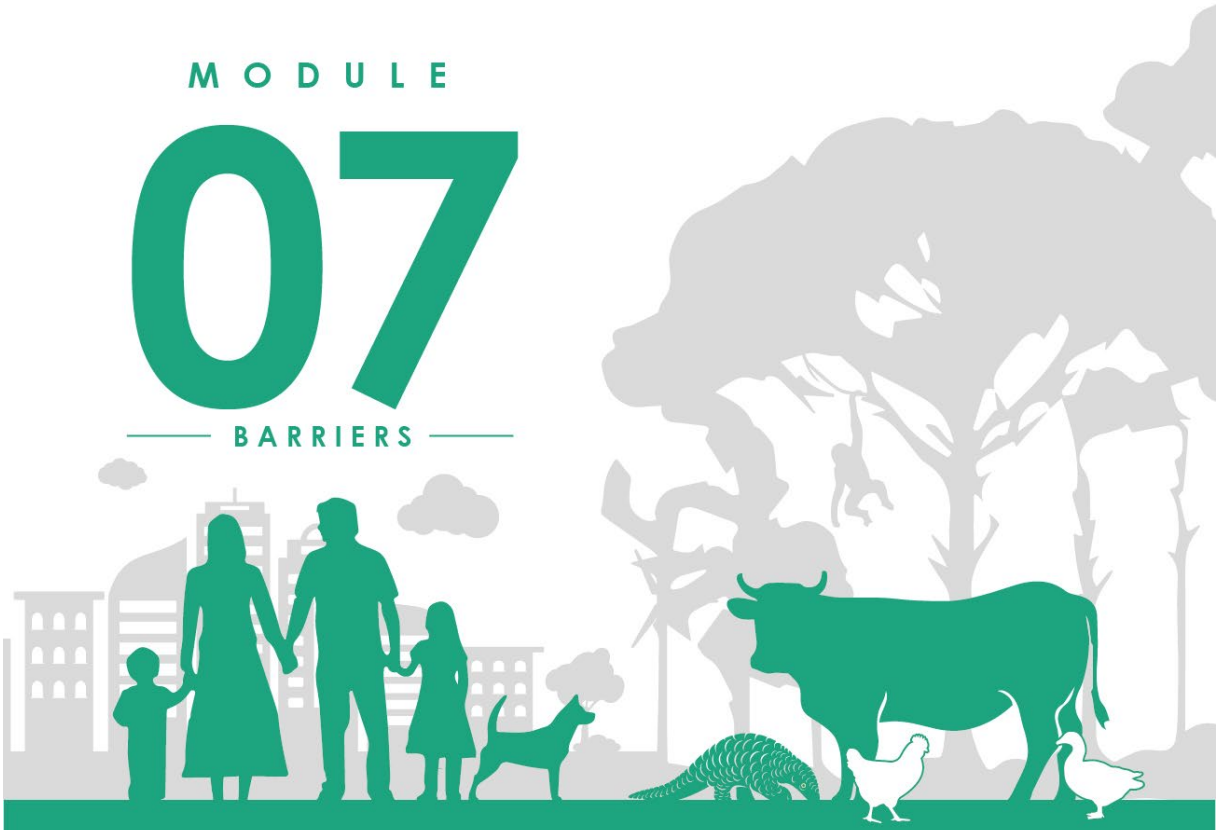
MODULE

07

BARRIERS



How to Enhance Zoonotic Disease Management by Addressing Knowledge Gaps and Implementation Barriers

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HOW TO ENHANCE ZOONOTIC DISEASE MANAGEMENT BY ADDRESSING KNOWLEDGE GAPS AND IMPLEMENTATION BARRIERS

Introduction

In the face of evolving disease threats, the need for adaptable and integrated public health measures cannot be overstated. This module examines barriers to implementing public health strategies to prevent and mitigate zoonotic spillover and the critical knowledge gaps (areas where we need more information to act) preventing implementation to give the reader tools for improvement in their local, regional and national environment. Key areas where knowledge is lacking include information to inform health security plans at every level, supply chain infrastructure, determining the most effective education and training methods, tools to assess the spillover problem throughout the chain, and ways to evaluate the best policies to affect change in the human-animal-environmental interface.

The module details practical actions to address technical, coordination, collaboration, communication and institutional challenges that hinder the effective implementation of integrative public health strategies. It features several case studies from Southeast Asia and other regions to illustrate how individuals and organizations overcame barriers to enhance outcomes. The focus spans local, national, and regional supply chain interactions, emphasizing an integrated approach to One Health implementation for preventing and mitigating zoonotic spillover. Integration is particularly crucial in the context of low- and middle-income countries (LMIC) and areas in Southeast Asia known to have an intricate and dynamic interface between humans, animals, and the environment (see Module 6: Strategies to Engaging Diverse Stakeholders Across the Live Animal Value Chain to Address Risk).

The module is structured around nine key barriers or gaps (Figure 7-1), and actionable plans addressing these challenges within the summarized framework for enhancing resilience against zoonotic disease threats in Southeast Asia (Box 7-1):

1. **Resource constraints**
2. **Operationalizing One Health**
3. **Communication, collaboration, and coordination**
4. **Data management, sharing and security**
5. **Transboundary disease surveillance**
6. **Human behavior and consumption**
7. **Workforce and human capacity development**
8. **Laboratory capacity and biosafety**
9. **Engagement of commercial entities**

FIGURE 7-1. Overview of the 9 key areas of barriers and gaps for implementation of policies related to zoonotic spillover. These interconnected barriers necessitate a collective approach to lay the foundation for a robust strategy aimed at enhancing Southeast Asia's resilience against zoonotic disease threats.

BOX 7-1. Framework for enhancing resilience against zoonotic disease threats in Southeast Asia

The following framework proposes three cross-cutting strategies to enhance Southeast Asia' resilience against zoonotic disease threats, emphasizing the importance of collaboration, resource optimization and coordinated action to safeguard public health and ecosystem in the region:

1. **Coordinated and collaborative action:** Harmonize efforts through collaboration and coordination of activities among diverse sectors and agencies responsible for human health, animal health (domestic and wildlife), and environmental health. These efforts should include cross-border cohesion and regional strategies that integrate various sectors across borders through joint efforts in surveillance, research, and response initiatives.
2. **Efficient resource allocation:** Address existing disparities, inadequacies and variation (Coker et al, 2011) (in resources such as weak and varied surveillance systems, services, research, etc. Variation leads to challenges in estimating disease burden and difficulty in conducting transboundary, cross-country comparisons, as well as substantial underreporting of diseases. To overcome this, strategies such as increasing public awareness and education about disease reporting and improve capacity that enhances healthcare worker capacity to detect, diagnose, and report zoonotic diseases.
3. **Expertise pooling:** Sustain a reservoir of skilled professionals adept at addressing the interface of human, animal, and environmental health in the region. Encourage collaboration and knowledge exchange among experts in various fields extending beyond national borders enables Southeast Asia to tap into a wealth of collective intelligence. Cross-border collaboration enable experts from different countries to perform joint research projects, collaborative data analysis, and policy development.

BARRIER 1: RESOURCE CONSTRAINTS

Unequal Allocation: Limited resources pose a significant barrier to effectively prevent and mitigate spillover from zoonotic diseases in SEA. While adequate financial, human capacity, and infrastructure resources are essential for effective control strategies, the region faces challenges in both the availability and equitable allocations of these resources. In Southeast Asia, unequitable distribution is a major obstacle where more funding is usually directed to the human health sector, leaving agriculture, veterinary establishments, and animal surveillance under-resourced (Coker et al., 2011). This imbalance hinders comprehensive disease prevention efforts, as all sectors are crucial in mitigating spillover risk. This challenge is highlighted in "Module 3: Efforts to Prevent Transboundary Disease Outbreaks in the Southeast Asia Region".

Neglected issues and misaligned priorities: Zoonotic diseases of wildlife origin are also often neglected globally, partly due to the challenge of integrating across sectors, as well as limited funding and lack of awareness. Promoting transdisciplinary systems approaches such as One Health or Ecohealth underscoring the interconnectedness of humans and wild animals within ecosystems, considering environmental and ecological changes is crucial. Unfortunately, while collaborative effort offers opportunities for strategic investment, securing financial resources remains challenging. Donor priorities further complicate the issue, as programs funded by donor - which are commonly external to Southeast Asia, may not align with the specific needs of individual countries or the region (Coker et al., 2011).

Inadequate funding: Historically, health policies and programs, including the International Health Regulation (IHR) (**2005**), have predominantly focused on disease prevention, preparedness, and response (PPR), often neglecting the upstream drivers of disease emergence. Emerging evidence highlights the pivotal role of these drivers in disease outbreaks, necessitating a re-evaluation of primary prevention measures upstream at the driver interface. However, securing financial resources for effective PPR remains a limitation that requires attention from policymakers at the country level.

Siloed government funding: Traditionally government funding often channeled through a siloed sector-specific system, hindering cross-sectoral fund and resource sharing. Fortunately, a shift towards collaborative effort where governments, global funders, and partners are now recognizing the importance of collaborative efforts to combat zoonotic diseases, embracing theOne Health approach. This collaborative efforts between donors and local authorities offer opportunities to determine strategic investment priorities across relevant sectors. The need for such collaboration becomes more pronounced during epidemics and pandemics, particularly in low resource developing regions, as it allows for efficient use of all available funding and financing mechanisms.

Case Study 7-1. Lessons from SARS in Singapore

A recent study examined how the Singapore government's effort to combat the SARS outbreak informed its effort to control both the country and cross border spread of SARS-CoV-2 (Kim et al., 2022). The study indicates that Singapore successfully used lessons learned during SARS to implement a "whole-of-government" response to combat COVID-19. Here are four (4) key approaches that Singapore adopted:

1. **Ensuring essential healthcare resources and developing contingency plans.** Singapore's experience with SARS underscored the importance of maintaining access to essential healthcare infrastructure. This led to the establishment of sufficient essential healthcare resources with contingency plans, including the stockpiling and distribution of resources, the creation of temporary medical facilities, and the government's swift designation of the National Centre for Infectious Diseases as the main hospital for critically ill COVID-19 patients - showcasing their proactive crisis preparedness and prevention strategies (Kim et al., 2022).
2. **Mobilizing private sector and collaborations for whole-of-society response.** Recognizing the limitations of relying solely on public health institutions, the Singapore government-initiated collaborations with private hospitals through initiatives like the Public Health Preparedness Clinic (PHPC) scheme. This program harnessed the capacity of private entities such as clinics and hospitals to partner with the government, providing essential healthcare services, medications, tests, and vaccines (Lum et al., 2021; Kim et al., 2022). Additionally, private entities such as Grab, a Singapore-based app that provides ride-sharing and food delivery series, played a pivotal role, offering rides for healthcare professionals (Baharudin, 2020; Kim et al., 2022).
3. **Combine bottom-up with top-down approaches.** Singapore's management policies utilized both top-down, centralized styles and bottom-up approaches during the COVID-19 pandemic. The government partnered with NGOs to support vulnerable populations, ensuring equal access to essential services. Collaborations like the VIsualAId project highlighted the importance of involving private actors and volunteers beyond the healthcare sector, including local and international business actors, non-profit organizations, academia, and other countries, ensuring a holistic and inclusive response (Kim et al., 2022; Lee, 2020).
4. **Leveraging science, research, and digital technology.** As the pandemic continued, the Singapore government tapped into the expertise and knowledge of the private sector, including private telemedicine providers. These partnerships enabled virtual consultations and supervised self-swab tests, easing the burden on hospitals. Additionally, the collaborations between academia, tech industries, and the government led to innovative solutions,

including diagnostic tools, contact-tracing apps like TraceTogether, and health passports for safe border reopening (Chow et al., 2023; Kim et al., 2022).

Actionable guidelines to address resource constraints for zoonotic disease prevention

1. **Strengthen local and regional collaboration:** Encourage collaboration among governments, NGOs, communities, and other relevant stakeholders to develop a comprehensive approach to address high-risk health behaviors associated with zoonotic disease spillover. Engage local communities, civil society groups that are already active in the target area, traditional leaders, religious organizations, and indigenous groups to ensure the development of culturally sensitive strategies.
2. **Develop targeted resource mobilization:** Focus on allocating resources strategically to enhance preparedness and response capabilities in regions identified as disease 'hotspots'. This approach should span local, transboundary, and international levels to ensure a coordinated response to potential outbreaks.
3. **Sustain funding for One Health:**
    - Establish funding mechanisms for applied research that operates within the One Health framework, through collaboration with the Quadrilateral UN agencies.
    - Reallocate funds strategically to address Sustainable Development Goals (SDGs), including funding for transboundary disease surveillance as outlined in the IHR.

BARRIER 2: OPERATIONALIZING ONE HEALTH

FIGURE 7-3. One Health is the interconnected idea linking human, animal, environmental, and plant health. See also Figure 1-1, Module 1).

While the concept of linking human, animal, environment, and plant health under the One Health framework is now widely accepted, practical implementation of its integrated approach remains challenging. In the Asia-Pacific region-specific core competencies for preventing, controlling, detecting, and responding to zoonotic diseases capacities have been defined as: (1) Management, (2) Culture and Beliefs, (3) Leadership, (4) Values and Ethics, (5) Collaboration and Partnership, (6) Communication and Informatics, and (7) Systems Thinking. (2013). Achieving these core competencies are crucial for effective implementation of the One Health approach and aligns with several international strategic and action-oriented programs and initiatives such as the International Health Regulations (IHR). In 2005, the World Health Organization (WHO) Regional Offices for South-East Asia and the Western Pacific devised the Asia Pacific strategy for Emerging Diseases (APSED), providing a common framework for countries in the two regions to strengthen their capacities to manage and respond to emerging infectious diseases (EIDs), in line with the core capacity requirements of the IHR.[1]

The avian influenza A (H5N1) crisis in 1997 in Hong Kong, China highlighted the need for functional, multisectoral coordination between human and animal health (Chan, 2002; Ching, 2018). It is a turning point for adoption of the One Health concept in the region. In response, a guidance was jointly developed in 2009 by WHO, FAO, and WOAH called *Zoonotic diseases: a guide to establishing collaboration between animal and human health sectors at the country level* (WHO, 2009). In 2019, given the growing need for a global standardized guidance on the One Health approach, FAO, WHO and WOAH, published *Taking a multisectoral One Health*

[1] In the decade since, the remit of APSED has broadened to an all-hazards approach to include non-infectious hazards (APSED III).

approach: a Tripartite guide to addressing zoonotic diseases in countries (FAO, 2019). In 2021, the previously tripartite organizations later expanded to include the United Nations Environment Programme (UNEP) to form the Quadripartite. A year later, in 2022, the Quadripartite launched the *One Health Joint Plan of Action* (2022-2026), the first, joint One Health plan aimed at creating an integrated systems framework to better prevent, detect and respond to health threats (FAO, 2022). Examples of standing One Health coordinating bodies in the Southeast Asia region that support this framework can be found in Box 7-2.

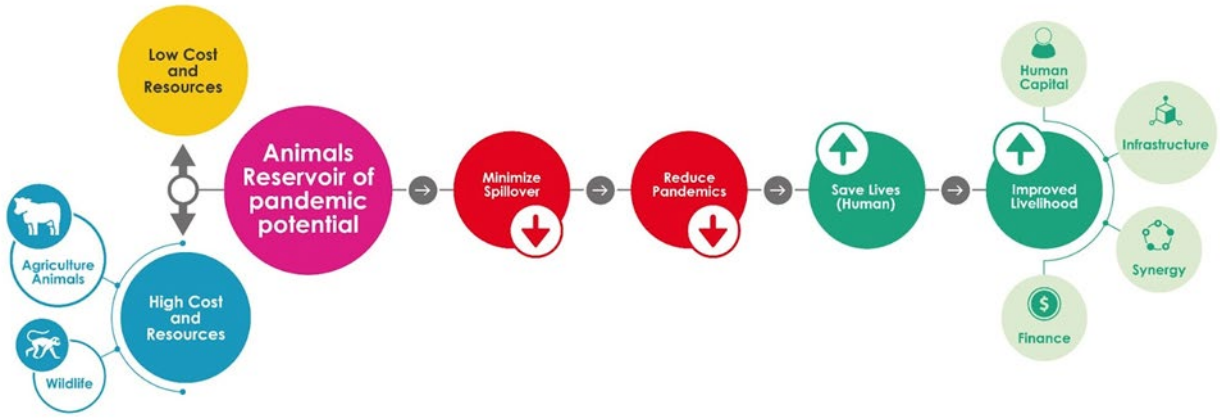

FIGURE 7-4. One Health operational framework. (Interconnected factors of negative drivers of spillover in red and improving livelihoods and saving lives in green). Source: NASEM spillover Workshop, Singapore 2023

Operationalizing One Health requires undertaking specific collaborative efforts across sectors at the human-animal-environmental interface, involving actors in sustainable agriculture, animal health, plant health, forest health, aquaculture, food safety, antimicrobial resistance (AMR), food security, nutrition, and livelihoods (FAO et al., 2022; FAO, 2024 ;Velazquez-Meza et al., 2022). Political will, adequate financing, collegiality, trust-building, and reducing territorialism among sectors are also essential for successful implementation (Nzietchueng et al., 2023; EMPHNET, 2023).

Local engagement and partnership building with key players such as industries, conglomerates, food-animal producers, consumers, government regulators, academia, non-governmental organizations (NGOs) and civil society organizations (CSOs) are essential (FAO, 2024). In addition, integrating environmental and socioeconomic factors related to disease emergence and spread into the development and implementation of One Health interventions is essential. Currently, collaboration primarily focuses on domestic animal and human health sectors, with passive involvement of wildlife, ecosystems, and environmental health sectors. Many activities remain to be sector-specific, lacking multi-sectoral integration and transdisciplinary approaches therefore hindering the effectiveness of a holistic one health systems-based approach.

In the context of operationalizing the One Health approach, it's crucial to recognize that monitoring and evaluation (M&E) are integral parts of the successful implementation of the programs that integrate human-animal-environmental-plant health (Hall and Le, 2015). While current M&E efforts in Southeast Asia often rely on qualitative insights such as case studies and

success stories, and supplemented by descriptive statistics, there is a need to aim for longer-term evaluations and broaden evaluation frameworks that involve incorporating measurable key performance indicators that mirror the region's defined core competencies.

Case Study 7-2. The Lawa Model in Khon Kaen Province, Thailand

The following case to eradicate a foodborne trematode (fluke) in Thailand illustrates the importance of an innovative approach that integrates the One Health and EcoHealth concepts, emphasizing biodiversity as part of the main strategy (Lerner and Berg, 2017). The *Opisthorchis viverrini* is primarily transmitted to humans through the consumption of traditional freshwater fish dishes and results in liver fluke infection.

Endemic to Southeast Asia, particularly Thailand, Laos, Cambodia, and Vietnam (Sripa et al., 2010; Sithithaworn et al., 2012), human cases of Southeast Asian liver fluke *O. viverrini,* are persist in certain Thai regions and beyond (Crellen et al., 2021). Despite prior and longstanding control efforts in Thailand, *O. viverrini* infection rates remained high in Northeastern provinces. In response, a joint One Health/EcoHealth strategy, known as the Lawa Model, was implemented in the Lawa Lake region of Khon Kaen province, an area endemic for liver fluke infections. The Lawa Model, developed by the Tropical Diseases Research Center (TDRC) at Khon Kaen University, incorporates anthelminthic treatment, intensive health education initiatives in communities and schools, ecosystem monitoring, and active community participation (**Figure 7-5)** (Sripa et al., 2015).

Thanks to the integrated nature of the strategy, the Lawa Model has achieved remarkable success in reducing *O. viverrini* infection rates from 50% to approximately one-third and has reduced bile duct cancer occurrences across 10 villages surrounding the Lawa Lake community (Sripa et al., 2015). Additionally, prevalence of intermediate host fish species (**Figure 7-6)** dropped to less than 1% from a baseline of 70%. Due to the success of this initiative, it is being expanded to other parts of Thailand and neighboring Mekong countries. This exemplifies a transdisciplinary strategy fostering collaboration among various stakeholders, including government agencies, academia, and local communities, while enhancing disease surveillance and control at the intersection of human, animal, and environmental health.

FIGURE 7-5. Community-based health programs run by village health volunteer workers in Khon Kaen province, Thailand. Source: Sithithaworn et al., 2011.

FIGURE 7-6. Panel A. *Bithynia* species nails, the intermediate host of *Opisthorchis viverrini*; Panel B. A fisherman in Chonnabot district, Khon Kaen province, Thailand. Panel C. Cyprinoid fish, about 10 cm in length, caught in natural water courses in Chonnabot district, Khon Kaen Province, Thailand. Panel D. A plate of *koi-pla*, a traditional, widely consumed dish prepared from uncooked cyprinoid fish (as shown in panel C), salad vegetables and condiments. Koi-pla is frequently contaminated with viable, infectious metacercariae of *O. viverrini.* Source: (Sripa et al., 2010).

Case Study 7-3 - Interagency task force response to Reston Ebola outbreak in The Philippines

FIGURE 7-7. The Reston ebolavirus has been implicated in cross-species transmission among pigs, macaques and humans, which prompted extensive epidemiological inquiries involving Philippine health and veterinary authorities, alongside experts in filoviruses (source: Pixabay) and Flickr.

This case outlines the response efforts in the Philippines following Reston Ebola outbreak among monkeys and pig farms in the 1990s and 2000s, which subsequently led to infection among farm workers who had close contact with sick pigs in 2009 (Miranda and Miranda, 2011; WHO, 2009).

The Philippines has faced challenges in managing infectious disease outbreaks.[2] Response teams, formed in reaction to such outbreaks, usually disband after the crisis subsides but the agility and flexibility of outbreak management is dependent on the continuity and maintenance of operational groups. To reverse this trend, experts recommended establishing a task force with consistent and frequent meetings of operational groups to maintain awareness and preparedness for infectious diseases' potential risks over time. A taskforce was established with external funding and support and composed of individuals from organizations such as the Department of Health (DOH), Department of Agriculture (DA), and the Department of Environment and Natural Resources (DENR).

The Philippines also grapples with the autonomy of local governments, leading to diverse and sometimes conflicting policies at the local level, further complicating national coordinated efforts. To help integrate more collaboration across levels, the College of Public Health at the University of the Philippines with support from USAID and Chevron, established a Master's program on One Health, through the Southeast Asia One Health University Network (SEAOHUN)[3]. The Philippine One Health University Network

[2] Such as Henipavirus sourced from bats and transmitted through infected horses in Mindanao in 2014 (Ching et al., 2015).

[3] Graduate school curriculum includes 'Fundamentals of One Health' and related modules

collaborates with the Bureau of Animal Industry to investigate Leptospirosis in swine, specifically in food production farms in Los Banos. Furthermore, the IHR PVS National Bridging workshop, organized by the Tripartite (WHO, FAO, WOAH) and hosted in the Philippines, exemplifies the nation's commitment to strengthening its preparedness and response mechanisms despite the challenges faced (WHO, 2024).

Actionable guidelines for operationalizing One Health

1. **Institutionalize collaboration:** Establish permanent inter-ministerial bodies for a sustained collaborations across ministries and institutions, moving away beyond transient inter-ministerial committees.
2. **Develop a national One Health joint action plan**: Develop a comprehensive national plan involving all relevant sectors, leveraging global guidance, such as Quadripartite One Health Joint Plan of Action, while customizing it to the specific, local context (FAO, 2022).
3. **Promote active coordination and information sharing:** Facilitate collaboration and the exchange of information among a broad spectrum of stakeholders.
4. **Implement country-specific coordination framework:** Institute a country-level coordination framework within an agreed-upon structure, e.g., Thailand's One Health Steering Committee rooted in the Ministry of Public Health (Tangwangvivat et al., 2019; Coker et al., 2011; Ruegg et al., 2018).
5. **Strengthen and expand national capacities:** Utilize existing resources such as the Tripartite Zoonoses Guide and operational tools to augment existing national capabilities (FAO, 2019) in one health implementation.
6. **Invest in workforce development:** Equip professionals from various sectors with the skills and knowledge necessary for effective collaboration and coordinated action on zoonotic disease threats.

BARRIER 3: COMMUNICATION, COLLABORATION, AND COORDINATION

The integration of sectors along the human-animal interface that spans local, national, and regional domains hinges on effective and efficient communication, collaboration and coordination. However, limited capacity and siloed organizational systems can hamper these activities, leading to a loss of trust and prevent sustainable collaboration across ministries, disciplines, and sectors (Delesalle et al., 2022 ; Ribeiro et al., 2019). Foster a culture of cooperation and information-sharing among partner organizations is critical to address the spread of infectious disease. Providing knowledge integration for stakeholders and leaders across various disciplines is fundamental to operationalizing the One Health approach. Introducing One Health concepts into educational curricula, from medical schools to social sciences and relevant business and engineering units facilitates a deeper understanding of the concept and its practical applications.

For outreach and communication with community partners, fostering engagement in a multicultural and multidisciplinary manner is critical, given that policies and practices are better received if they are simple and easy to understand, compatible with pre-existing community

behaviors, have observable benefits, and offer relative advantages to the implementing community.[4] In this, management of bidirectional information flow (between government entities and communities) is essential and includes attention to misinformation and disinformation. Strategies for risk management need to be built within narratives that empower behaviors to reduce risk without creating or promoting unintended consequences like stigmatization of groups of people or animals, e.g. global media attention on bats associated with the COVID-19 pandemic (Nanni et al., 2022). Accurate and appropriately timed information sharing is critical to address preventive, control and mitigation efforts when epidemics of zoonotic spillover origin happens. Efforts for accurate communication must be based on reliable data evidence. Communication based on unreliable data could lead to confusion, costly product rejection, as well as lack of trust of the public health (including veterinary) system.

In addition to these approaches, the successful adoption of the One Health concept often requires a top-down initiative. International agreements such as the IHR, the Cartagena Protocol on Biosafety, and Biological Weapons Convention serve as international models, catalyzing top-down changes within member countries (Eggers & Mackenzie, 2000; Millett, 2010). These agreements have spurred local efforts like the APSED III, demonstrating the potential for regional collaboration. Compliance with these agreements is evaluated through mechanisms like the Joint External Evaluation (JEE), highlighting progress and areas needing improvement (Razavi et al., 2021).

BOX 7-2: Southeast Asian countries with a Standing One Health Coordinating Body

Thailand: The Coordinating Unit for One Health (CUOH) in Thailand is designed to expedite One Health implementation in the country (Tangwangvivat et al., 2019).

Vietnam: The One Health Partnership for Zoonoses (OHP) brings together national and international governmental and non-governmental One Health stakeholders under the leadership of the Government of Vietnam (Nguyen-Viet et al., 2022).

Indonesia: Legislation of One Health in Indonesia, Presidential Instruction number 4 of 2019, strengthened coordination and implementation of One Health in Indonesia under the leadership of the Coordinating Ministry for Human Development and Cultural Affairs (Cabinet Secretariat of the Republic of Indonesia, 2019).

Singapore: The One Health Framework in Singapore highlights involvement of a transdisciplinary approach and multiple agencies to learn, prevent, prepare and respond to cross-sectoral public health threats across human, animal, water and environment health sectors (Lim et al., 2019).

Malaysia: The Emergency Ordinance of 1979 can activate the National Security Council to create an authoritative platform for multi-sectoral collaboration and resource sharing during period of impending need. The interagency one health activities for

[4] How to overcome language and cultural barriers to communication, collaboration and coordination, along with how to balance priorities are addressed in "Module 8: How to Use this Guidance - Applying Participatory Methodologies to Countering Spillover."

zoonoses and other one health relevant issues are based on rotational chairmanship among ministries, with close intersectoral coordination for zoonoses between human, animal and environmental health ministries. The One Health concept and training is championed by the Malaysian One Health University Network (MyOHUN).

Case Study 7-4. Regional initiatives in fostering communication and collaboration in One Health

A. Strengthening One Health communication: INGSA and NASEM's exchange with Thai NIH

In 2022, as part of the data gathering process to create this guidebook, INGSA and NASEM undertook a collaborative visit to Thailand's Ministry of Public Health and the National Institute of Health (NIH). Thailand's Department of Disease Control (DDC) shared information about the resources employed in Thailand to address public health challenges and delved into the intergovernmental networks established by Thai officials to effectively tackle the complexities of zoonotic spillover. Furthermore, the delegation shared comprehensive details on Thailand's One Health operating procedures specifically tailored for disease outbreak control, offering a glimpse into the nation's strategies for promoting integrated and collaborative approaches to safeguard public health. The information presented was used to inform the creation of this guidebook.

FIGURE 7-8. Building bridges for One Health. INGSA and NASEM workshop participants visit the Thailand Ministry of Health. Photo credit: Meghan Davis.

B. Southeast Asia One Health University (SEAOHUN)

FIGURE 7-9. Some of the more than 300 health practitioners, educators, and researchers from 30 countries who gathered at the 2022 SEAOHUN International Conference. Photo source: Nation Thailand, 2022.

The Southeast Asia One Health University Network (SEAOHUN) was formed to be a catalyst for fostering effective communication and collaboration among diverse stakeholders committed to the intersection of human, animal, and environmental health and to enhance country-level capacities for infectious disease preparedness, detection, and outbreak response in the region. SEAOHUN's collaborative efforts extend beyond academic realms, involving partnerships with other public agencies. Through these collaborations, SEAOHUN actively contributes to strengthening One Health education across SEA, creating a robust foundation for addressing complex health challenges. A noteworthy initiative undertaken by SEAOHUN is the organization of student summits, aimed at developing the next generation of One Health leaders. This approach is designed to ensure that a cohort of young professionals are well-equipped to navigate the intricacies of interconnected health domains.

C. Field simulation exercises between Malaysia and Thailand

Malaysia-Thailand[5] conduct annual field simulation exercises focused on zoonotic diseases, including Avian Influenza and Rabies. These exercises play a crucial role in strengthening the "3Cs" - Communication, Collaboration, Coordination - within and between the two countries. Practicing against realistic zoonotic disease outbreaks scenarios allow participants to test the readiness and effectiveness of outbreak response mechanisms by simulating realistic scenarios (Jahis, 2021). Additionally, Malaysia conducts similar multi-sectoral exercises at state and national levels, involving various stakeholders from government, academia, and local authorities, to enhance coordinated efforts in disease detection, response, and control.

[5] Malaysia-Thailand exemplify multinational and multi-sectoral efforts to combat rabies

Actionable guidelines for improving communication, collaboration and coordination

1. **Empower local communities:** Empower local leaders through targeted training programs to enhance early warning, detection, and outbreak response skills. Foster local leadership in public health initiatives.
2. **Engage diverse public service expertise:** Redesign public service hiring and employment to include diverse expertise from various sectors, e.g., Thailand's One Health Steering Unit employs veterinarians and environmental health experts.
3. **Share staff among ministries:** Facilitate staff exchanges among ministries to foster cross-agency familiarity that will enhance coordination in the event of an outbreak. Recognize this is a short-term solution while workforce systems adapt to changing needs.
4. **Integrate manuals and coordination methods:** Develop and implement integrated manuals and coordinated methods for harmonized surveillance efforts.
5. **Share leadership and cross-sectoral engagement:** Promote shared leadership, conduct high level cross-sectoral field engagements. Leaders incentivize cross-sectoral communication, collaboration, and coordination in organizations.
6. **Use team-based and participatory approaches:** Utilize team-based and participatory approaches in outbreak/pandemic response:[6] planning and implementation.
    1. Engage agribusinesses when implementing safety and agriculture practices (HSSCP) (see Barrier # 9, below) to create long-term relationships, reciprocal policies, and fewer foodborne illnesses. Although increased costs can be associated with implementing safety measures, discussions with agribusiness and locals might identify ways to reconcile differing viewpoints.
    2. Pursue government-led incentives – possibly including legislative requirements - to encourage prompt reporting of outbreaks by farmers and locals (e.g., WOAH). Destigmatize outbreak and disease identification and reporting amongst local stakeholders, including smallholder animal keepers.
    3. Develop regional biosecurity policies engaging governmental agencies and other partners in farming, wildlife, and conservation communities. Experts can facilitate communication of long-term benefits of conservation beyond costs (i.e., disease prevention, health security, natural capital accounting) to government officials.

BARRIER 4: DATA MANAGEMENT, SHARING, AND SECURITY

Integrating One Health to stop zoonotic spillover and to better respond to disease outbreaks requires overcoming data-related challenges and better ways to track, store and share information between organizations and across initiatives.[7] The challenges lies in collecting and integrating data

[6] As discussed in Module 8 (How to use this guidance: applying participatory methodologies to countering spillover)

[7] More information is in Module 5 How to Design and Conduct Risk-Based Surveillance for Zoonotic Diseases at the Human-Animal Interface.

from diverse sectors,[8] establishing compatible robust data management systems, ensure smooth data integration and analysis of diverse data types such as pathogen information, human and animal case data and relevant meta-data. The latter has the added challenges of dismantling silo-minded and credit-seeking behavior among stakeholders.

Case Study 7-5. Examples of data sharing that strengthened surveillance and response efforts

A. Thailand: Participatory One Health Digital Disease Detection (PODD)

In Chiang Mai, Thailand, the PANORAMA project introduced the PODD platform to combat zoonotic spillovers and monitor emerging animal and environmental health threats (Yano et al., 2018). A diverse team, including veterinarians, public health and livestock officers, community volunteers, technologists, economists, social scientists, and critically, GIS experts, collaborated on this initiative. Community volunteers using the PODD mobile app, play a crucial role in reporting potential disease outbreaks and environmental hazards. The PODD platform used a smartphone and web application to make the information as accessible as possible to the community, empowering individuals to report unusual disease events involving domestic pet and wild animals, as well as humans. These reports inform local health officials who then investigate and may have a better idea of the diseases within the community and can more efficiently take action as needed.

B. Kenya: Mobile-Based Surveillance for Rift Valley Fever

Kenya's Ministry of Agriculture, Livestock, and Fisheries (MALF) initiative, funded by the Global Health Security Agenda (GHSA), created a mobile phone based network to monitor for outbreaks of Rift Valley fever (Oyas et al., 2018; Munyua et al., 2019).[9] Trained healthcare workers and community volunteers collect data related to RVF in their respective areas, including information on animal health, human cases, and vector (mosquito) populations. Using a specially designed mobile applications and/or text message reporting, the data are transmitted in real-time to a central database or directly to public health authorities. By continuously monitoring this data, health authorities can swiftly identify potential outbreaks or emerging RVF trends.

[8] Common gaps often include environmental sector data to income sustainable land-use planning as a preventive measure against disease emergence and commercial data particularly from livestock surveillance.

[9] This viral disease primarily affects animals but can also be transmitted to humans, leading to flu-like symptoms and severe complications like hemorrhagic fever and encephalitis, or even death.

Actionable guidelines for better data management

1. **Prioritize data collection at high-risk areas**: Focus data collection efforts emphasizing high-risk animal populations and environments, and animal-human interfaces.[10] To optimize resource allocation and effectiveness.
2. **Harmonize processes and improve data interoperability:** Standardize processes for data collection, management, and access across One Health domains; develop strategies to enhance interoperability among relevant datasets, including opportunities to link governmental surveillance data with academic research or NGO activities.
3. **Map existing datasets:** Create comprehensive maps detailing high-priority existing datasets for use when needed.

BARRIER 5: TRANSBOUNDARY DISEASE SURVEILLANCE

Cross border well-coordinated surveillance systems are imperative to the early detection of priority pathogens in both the environment and in human and animal hosts, allowing for a swift response across all pertinent sectors. However, balancing the economic benefits of animal trade with the crucial need to safeguard public health and biodiversity presents a significant challenge. Encouragingly, many Southeast Asia countries, for example, Vietnam[11], have taken initial steps by implementing bans on wildlife trade and consumption, indicating a shift towards prioritizing health and conversation.

Efforts are often siloed by respective countries with no transboundary considerations (Module 3). It is important to have the call for a unified, cross-border approach focusing on strengthening law enforcement and regulation, and the integration of health professionals into wildlife management. Additionally, a holistic strategy that combines stakeholder perspectives and community engagement aligning with national and regional strategies, within the One Health framework, is needed for managing zoonotic disease outbreaks while ensuring a sustainable coexistence between humans and wildlife.

Box 7-3. The importance of assessment tools for improving disease surveillance

The importance of robust assessment tools for assessing surveillance systems in the context of wildlife and environmental services is important. While there are established evaluation tools in the public health and veterinary services, such as the WHO Joint External Evaluation (JEE) and WOAH's Performance of Veterinary Services (PVS) Pathway by the World Organisation for Animal Health (WOAH) (de la Rocque et al., 2023). a similar emphasis on initiatives like the Tripartite tool for Surveillance and Information Sharing Operational Tool (SIS OT) meets the need for comprehensive evaluation mechanisms across all facets of disease surveillance. The introduction of these evaluation tools would help pinpoint surveillance gaps and

[10] See Modules 2 and 3.
[11] See Module 3

opportunities for enhancement. This has been noted in "Module 2: How the Past Informs the Future - Opportunities in Southeast Asia to Prevent and Respond to Zoonotic Spillover," wherein it was mentioned that cost and effort are some of the greatest barriers in establishing effective spillover surveillance across the region. This involves money, detection capability, field workers, and laboratory capability. A solution for this is the data reduction strategy - by conducting surveillance at high-risk human-animal interfaces and at geographical areas known to have been the site of pathogen emergence (Gray et al., 2021).

The broader implementation of evaluation tools and the standardization of surveillance practices and priority disease selection across countries remain challenges. Addressing these issues is crucial for incorporating wildlife health and environmental considerations into public health surveillance systems, risk assessments, health security plans, training, financing, and implementation efforts (Machalaba et al., 2021).

Case Study 7-6. Regional initiatives in preventing transboundary disease outbreaks: The Mekong Basin Disease Surveillance (MBDS) Network

The MBDS network was established in 2001 by six Ministers of Health of the countries in the Greater Mekong sub-region: Cambodia, China (Yunnan and Guangxi), Lao PDR, Myanmar, Thailand, and Vietnam. It aims to strengthen national and regional capabilities in infectious disease surveillance, inter-regional collaboration, outbreak response and information sharing for rapid and effective control of public health threats.[12]

Actionable guidelines to improve transboundary disease outbreaks response

1. **Establish sentinel surveillance systems:** Develop and implement sentinel surveillance systems that regularly monitor and collect data on wildlife populations, domesticated animals, and human communities to detect potential disease threats early.
2. **Move from reactive to proactive surveillance**: Implement a registration or permitting system for farms and hunters involved in wildlife and domesticated animal trade. Ensure activities are conducted in a controlled and traceable manner, facilitating better disease monitoring and management.
3. **Regulate wildlife movement:** Establish policies to monitor the movement of wildlife across borders, particularly by human traders. Establish and enforce wildlife trafficking laws and measures to reduce illegal wildlife trade.
4. **Develop registries, documentation, and incentive structures:** Develop comprehensive registries and documentation systems to track the movement of animals and animal

[12] For a broader understanding of these efforts and to access additional case studies, please refer to Module 3: "Case Studies and Other Efforts," where we explore in greater detail the lessons learned and strategies employed in various regions to strengthen transboundary disease surveillance and response.

products along the value/supply chain. This information should be transparent and accessible to relevant authorities in multiple countries.

5. **Implement penalty structures**: establish and enforce penalties for those who do not adhere to regulations or fail to report disease outbreaks promptly. Penalties should be sufficient to deter risky behavior.

BARRIER 6: HUMAN BEHAVIOR AND CONSUMPTION

In some communities[13], encouraging sustainable behavioral change is essential to prevent zoonotic spillover and control potential disease threats. Human behavior plays a critical role in either driving or mitigating the transmission of zoonotic diseases and can increase or decrease the risk of spillover events. Several human behaviors are associated with animal trade, both wild and livestock, including hunting, culling, selling, trading, cooking and consuming animals (**Figure 7-11**). These behaviors are influenced by various factors such as limited awareness of zoonoses risks, poor literacy and education, poverty, the need to sustain livelihoods, cultural beliefs, religious practices involving animals, traditional or long-standing animal handling practices, limited access to personal protective equipment, and the high demand and value of wild animal products.

To prevent and protect against spillover events, each country in SEA can benefit from identifying and analyzing behavioral factors, patterns, and intervenable control points related to wildlife hunting and trade and domestic and peri domestic animal keeping that may pose risk for spillover. Practitioners may then design culturally congruent behavioral interventions that effectively convey risks to critical populations including the Indigenous Peoples, which could include changes to animal handling practices, conducting community training, or raising awareness about potentially risky behaviors.

Figure 7-11. The image presents a sequence of human behaviors that can potentially drive disease spillover from animals to humans. These behaviors include hunting, which typically involves wild animals, but the cycle extends to livestock, through processes like culling, trading, cooking, and consuming.

[13] See Module 6.

Despite numerous instances of animals (wild or domesticated) carrying known or potentially unknowable viruses, epidemiological data are often collected in, and analyzed by scientists who are based in high-income nations (Alba et al., 2020; Skopec et al., 2020). Low- and middle-income countries are underrepresented in the literature, leading to a skewed perception of global risk (Yegros-Yegros et al., 2020). Investing and improving local data collection and analysis would provide more accurate and evidence-based information for informing public health measures.

Qualitative methods that could be used to characterize high-risk behaviors include participant observations, in-depth interviews, and focus-group discussions. Further, engaging social and behavioral scientists in the identification of high-risk health behaviors and possible intervention points, as well as designing and implementation will likely improve the quality and sustainability of the behavioral interventions, given their expertise in behavior change theories and practice, as well as past successes and failures in behavior-based interventions. In addition, integrated behavior change models can be developed and used to identify opportunities for intervention and changes in behaviors that mitigate the risk of spillover.

Case Study 7-7. Regional initiatives to minimize human behavior factors that contribute to zoonotic spillover: The Wildlife Conservation Society (WCS) in Cambodia

The WCS's goal is to protect wildlife and promote sustainable practices related to wildlife trade and works to raise awareness about the importance of wildlife conservation and safe and sustainable wildlife trading practices in countries in the region. In Cambodia, WCS conducts policy advocacy, research, and education initiatives designed to reduce the risks associated with wildlife trade and consumption (WCS, 2024). They intervene to achieve sustainable behavioral change by advocating for supportive policies, and through community engagement by educating key local populations.

Actionable guidelines for addressing human behaviors

1. **Identify how and why people engage in unique risky behavior, by employing qualitative research methods:** human behavior that can contribute to zoonotic spillover is often unique to the context, and may differ among villages, provinces, or subnational regions. It is important for those trying to affect behavior to understand how and why individuals engage in such behaviors within the target population and their surrounding social environment.
2. **Design and implement culturally congruent interventions and risk communication methods:** Prospective interventions benefit from social listening efforts, in which they attempt to understand individuals' primary interests, concerns, and misconceptions about the topic (i.e., animal to human spillover of zoonotic pathogens). Based on the social listening findings, interventions that resonate with the target population's values, beliefs, and communication styles can be developed. This might involve using local metaphors,

partnering with trusted community leaders, or leveraging existing communication channels.

3. **Promote participatory approaches:** Involve communities in intervention design and implementation to ensure their ownership, sustainability, and effectiveness.

BARRIER 7: WORKFORCE AND HUMAN CAPACITY DEVELOPMENT

A resilient workforce, capable of addressing the dynamic challenges posed by zoonotic disease and global health threats, relies on professionals with transdisciplinary skills and competencies. In addition, health literacy is an important requirement for the management and prevention of disease after spillover, and to emphasize competencies to access, understand, appraise, and apply information to make health decisions. In SEA, local and national-level strategies for strengthening workforce and human capacity to combat infections disease are pivotal, impacting overall system performance and ensuring the viability of any reforms. Historically, the different specialties have been created separately but combating zoonotic spillover necessitates a cross training strategy to enable professionals to navigate seamlessly across sectors and agencies. To address the complex challenges of zoonotic diseases, we need a multifaceted approach to workforce development:

- Transdisciplinary Expertise: Professionals must move beyond their silos, developing cross-training that allows them to collaborate effectively across sectors. This includes strong communication skills for interacting with diverse audiences, as well as experience in team-based problem-solving and conflict resolution (Togami et al., 2023).
- Public Health Literacy: Empowering individuals with the ability to access, understand, and apply health information is crucial for disease prevention and management, especially after spillover events (Ellwanger and Chies, 2021; Vora et al., 2023)
- Strategic Planning in SEA: Southeast Asian nations must proactively strengthen their health workforces through local and national initiatives. This includes creating leadership roles to overcome institutional hurdles and foster cross-sectoral collaboration.
- Sustainable Training: Interdisciplinary training programs must be designed with long-term career progression in mind to ensure the continued impact of these initiatives (Nicholson et al., 2019).

Box 7-4. Existing barriers and gaps in workforce development

An overarching impediment in developing workers who are comfortable across sectors and disciplines are disparities in investment and funding among human health and agriculture/veterinary and environmental education programs. For example, agricultural relevant tertiary education in some SEA countries, including veterinary education often lacks robust quality assurance measures pose a significant challenge in developing a workforce comfortable navigating diverse sectors in the changing disease landscape. A rigid curriculum structure limits adaptability and responsiveness to evolving needs in the One Health workforce. The table below details specific concerns with workforce development in SEA. These barriers and gaps must be addressed

strategically to strengthen the workforce in SEA to effectively tackle complex zoonotic disease spillover challenges.

Table 7-1. Challenges and its impact on workforce development in Southeast Asia

Challenge	Impact
Limited university autonomy	Ministerial oversight restricts universities' ability to recruit diverse faculty, develop relevant curricula, and adapt programs to meet emerging needs. This limits the talent pool and curriculum alignment with zoonotic disease preparedness.
Inadequate workforce data	Lack of comprehensive data on workforce composition (disciplines, subspecialties, distribution) hinders effective planning and development. This makes it difficult to identify shortfalls and prioritize areas for investment.
Workforce structure imbalances	Imbalances based on specialization, location, gender, or resource allocation led to disparities in capacity across different aspects of zoonotic spillover disease response (e.g., surveillance, outbreak management). This can create critical gaps in preparedness.
Limited cross-sectoral training	Absence of institutionalized cross-disciplinary training programs hinders collaboration and development of comprehensive skills needed for tackling complex challenges like zoonotic diseases. Professionals struggle to work effectively across sectors due to lack of shared knowledge and understanding.
Limited workforce capacity and engagement	Many professionals lack the necessary knowledge, skills, or resources to effectively participate in cross-sector initiatives. This hinders their ability to collaborate effectively with colleagues from other sectors and contribute to the success of these initiatives.
Lack of enabling institutional ecosystems	Existing institutional structures often impede, rather than promote, collaboration across different sectors. These structures may favor individuals with specific backgrounds or expertise, hindering the inclusion of diverse perspectives and skillsets crucial for tackling complex challenges like zoonotic diseases.

Case Study 7-8. Regional initiatives to improve workforce and human capacity to combat zoonotic spillover

One Health Workforce and One Health Next Generation Projects

Between 2015 and 2023, over 52500 multidisciplinary students and officers in eight Southeast Asian countries participated in country-specific one health trainings. These programs encompassing locally curated competency-based education, research opportunities, fellowships, internships, and student clubs provided the knowledge and skills necessary for students, academics, and officials to collaborate effectively to address complex One Health challenges.

Field Epidemiology Training Programs (FETPs)

FETPs play a vital role in building the capacity of the public health workforce to conduct field epidemiology and other critical services for disease surveillance and spillover prevention and enhanced epidemiology capacity at the local levels. These programs are modeled after the Epidemic Intelligence Service (EIS) of U.S. CDC and have been adapted to include veterinarians (FETPV). This collaboration provides services with countries and communities across the region and aligns with the One Health Joint Plan of Action (Seffren et al., 2022) implemented through Tephinet. Examples are listed in Appendix A.

FIGURE 7-12. Thailand FETPs working on COVID-29 management guidance for factories. Source: CDC.

FIGURE 7-13. Opening ceremony of the 22nd cohort of the Advanced Chinese Field Epidemiology Training Program on March 1, 2023. Source: Chinacdc.cv

TVET Program in Southeast Asia

The Technical and Vocational Education and Training (TVET) program can serve as a valuable roadmap for addressing workforce development challenges and enhancing collaboration in the One Health domain (UNHCR, 2024). For example, in Malaysia, MyOHUN has started engaging vocational students in one health innovations and teaching and learning activities since 2021 with the aim to "meet the industry demand and contribute to economic growth, in line with globalization while supporting knowledge-based economy, technological advancement and enhancing global workforce mobility".

Global Laboratory Leadership Programme (GLLP)

The GLLP provides specialized leadership and management training for the leaders of human and animal health laboratories, as well as laboratories with public health impact (environmental, agricultural, food, or chemical laboratories). The six partners (Association of Public Health Laboratories (APHL), US CDC, European Centre for Disease Prevention and Control (ECDC), FAO, WHO and WOAH) enlisted the expertise of over 140 global experts in human and animal health and laboratory science for the development of the GLLP. The partners are committed to the programme's vision of laboratory leaders empowering national laboratory systems across the globe using a One Health approach to strengthen health security (WHO, 2023).

Indonesia's cross-sectoral training initiative for zoonotic diseases

Indonesia has implemented a cross-sectoral training initiative for zoonotic diseases[14]. This initiative utilizes Joint Risk Assessment (JRA) within its training modules, empowering 761 officers from 17 provinces with the necessary knowledge and skills for zoonoses prevention and control using the One Health system based approach.

Actionable guidelines for One Health workforce development in the region[15]

1. **Invest in faculty development in One Health understanding and increasing necessary skill sets.**

The demand for professionals equipped with transdisciplinary skills can be met through workforce development via education and cross-sectoral trainings.

2. **Enhance or develop interprofessional education among One Health domains.**

Develop and incorporate interprofessional education modules in existing curricula that explore interconnected aspects of one health domains focusing on a wide range of topics like genetics, biodiversity, economics, and healthcare in the specific context of Southeast Asia.

3. **Develop subspeciality or certification programs for One Health in related degree programs.**

Create subspecialty or certification programs in One Health within relevant degree programs to build expertise and establish key referral points for individuals or teams within the field to improve local, national, and regional expert capacities in addressing critical health challenges related to zoonotic diseases.

4. **Define and clearly outline target One Health skill sets and competencies for in-service professionals.**

Clearly outline the essential One Health skill sets and competencies required for in-service professionals, focusing on their ability to collaborate effectively across disciplines and sectors.

5. **Institutionalize integrated and multisectoral programs/trainings**

Formalize and integrate multisectoral training programs into existing institutional frameworks to ensure their sustainability and systematic execution.

6. **Develop robust leadership training programs for top management.**

Develop robust leadership training programs that focus on building strategic thinking, decision-making, communication, and team-building abilities towards shared goals

7. **Diversify the public health workforce**

Actively recruit individuals from non-traditional disciplines and fields with relevant expertise in public health agencies (e.g., veterinarians, environmental scientists). Encourage engagement with both government and non-governmental organizations to bridge

[14] Indonesia's multidisciplinary and multisectoral collaboration in Implementing Joint Risk Assessment (JRA),Training of Trainers (ToT) and many other initiatives like IHR-PVS National Bridging Workshop

[15] When possible, engage ASEAN (e.g., ASEAN Workplan on Education) and SEAMEO (SEA Ministers of Education Organization) for high level buy-in for One Health workforce transformation.

sectoral gaps. For example, Thailand Ministry of Public Health hires veterinarians and other cross disciplinary expertise into their pool of workforce[16].

8. Actively utilize internship programs for trainees from different backgrounds

Foster inclusivity, collaboration, and synergy by engaging individuals with diverse experiences, all while maintaining shared focus on addressing zoonotic disease.

9. Modernize hiring and recruitment systems and their terms of references

Adapt hiring and recruitment processes to accommodate evolving workforce needs and foster a more dynamic work environment. Revising job descriptions and utilizing modern methodologies will ensure that workforce remain relevant and effective in meeting demands of today's rapidly changing landscape.

BARRIER 8: LABORATORY CAPACITY AND BIOSAFETY

Laboratory infrastructure and capability play a pivotal role in the early detection and effective management of zoonotic diseases. The strengthening of diagnostic capacity in laboratories within national animal health and public health systems is essential for effectively controlling zoonotic spillovers. Adequate laboratory analysis capability contributes significantly to the early detection of diseases and ensures rapid response during outbreaks. Good laboratory capacity includes the ability to conduct robust diagnostic techniques such as genotyping and phenotyping, the development of genome-based tracking systems with necessary bioinformatics, integration into regional and global platforms, and should be accompanied by enhanced of biosafety measures.

Laboratory biosafety in SEA encompasses the practices, guidelines, and regulations that ensure the safe handling, containment, and disposal of biological agents and materials within laboratories. While biosafety practices can vary between countries in the region,[17] there are overarching principles and initiatives aimed at promoting biosafety and biosecurity. Web-based tracking studies have gathered information about existing and emerging biological containment laboratories. These studies also evaluate the biosafety and biosecurity oversight efforts to coordinate the function of these laboratories. In addition, there are resources to assess public health or pandemic preparedness in individual countries that include data about labs and biosafety/biosecurity programs.[18]

[16] Thailand's experience and strategy in enhancing public health with cross-disciplinary expertise

[17] The ASEAN report, Regional Strategic Framework for Laboratory Capacity Building and Networking in ASEAN (2009), identified significant disparities in laboratory capacity among ASEAN member states. A notable concern was the limited sharing of high-quality data, which was particularly evident during the control stages of multi-country outbreaks, such as the High Pathogenic Avian Influenza outbreak.

[18] See for example: 1) WHO Health Emergency Dashboard 2) WHO IHR State Party Self-Assessment Annual Reporting 3) WHO JEE Biosafety and Biosecurity 4) International Federation of Biosafety Organizations 5) Global Biolabs 6) Global Health Security Index

Case study 7-9. Leveraging existing laboratory infrastructure integrating animal health and zoonotic diseases at local, national, and regional levels

Effective management of emerging infectious diseases pertinent to zoonotic origins requires robust infrastructure, continuous specialized training, and the adoption of advanced, rapid, and accurate diagnostic technologies. These efforts, along with continuous infrastructure upgrades and maintenance, can be cost-and resource-intensive. Southeast Asia countries have the opportunity to actively participate in a range of collaborative efforts and approaches, collectively enhancing regional disease surveillance networks and regional health security[19]. This includes knowledge exchange, joint research and development, and the establishment of a unified framework for biosafety and biosecurity training.

Across the globe, clinical laboratories dedicated to improving human health are well-established. In Southeast Asia, the focus on communicable and noncommunicable human diseases are central to the health of each nation (Fritz and Fromwell, 2022). This can be seen through many development programs for infectious diseases specialists, and public health professionals, training programs conducted by many agencies such as ASEAN Plus 3 FETN[20], and center of excellences in tropical diseases across region. Moreover, recognizing the interconnectedness between tropical diseases and zoonotic diseases – in their causes and environments in which they emerge - promotes multi-disciplinary approach to finding solution. This understanding encourages participation of veterinarians, exemplified by programs like The Regional Field Epidemiology Training Program for Veterinarians (R-FETPV)[21]. A similar context can be adapted to enhance laboratory clinicians and scientists, by integrating technologies used in human diseases laboratory capacity planning, biosafety measures, fundings, research activities, capacity buildings, human resources, with veterinary diagnostic and research laboratories – a key strategy for comprehensive pandemic preparedness and response.

Actionable guidelines for strengthening laboratory capacity and biosafety in the region

1. **Standardize laboratory-associated training in both biosafety and biosecurity:** Ensuring that laboratory personnel are well-trained is critical for effective laboratory operations and biosafety. Implement comprehensive, standard biosafety training for all laboratory personnel involved in zoonotic disease research and diagnostics (see Appendix B).
2. **Standardize laboratory services**: Ensure the provision of standardized, proficient, and quality laboratory services for the detection of zoonotic disease outbreaks for timely and accurate e-diagnosis.

[19] See Module 5
[20] ASEAN Plus 3 Field Epidemiology Training Network (ASEAN+3 FETN)
[21] The Regional Field Epidemiology Training Program for Veterinarians (R-FETPV) in Thailand

3. **Mobilize resources for field-based systems**: Mobilize resources for the development and deployment of field-deployable diagnostic systems via the ASEAN regional Strategic Framework for Laboratory capacity to facilitate resource allocation.
4. **National strategy**: Implement national strategies and policies that support the effective and sustainable provision of laboratory services. These strategies should encompass infrastructure development, personnel training, and quality assurance.
5. **Establish laboratory information systems**: Encourage the establishment of interoperable laboratory information systems and facilitate data sharing among stakeholders. This promotes efficient data exchange and collaboration in disease surveillance and response efforts.

BARRIER 9: ENGAGING COMMERCIAL ENTITIES

Animal and animal-product trading, along with the livestock and agriculture sectors form a significant role in the economy of Southeast Asia, catering both national and regional markets[22]. The region records some of the highest number of foodborne illness-related deaths globally. The risk of contamination spans the entire supply chain (*from farm to fork).* The emergence of zoonotic diseases is closely linked to various factors. The list below, while not comprehensive, outlines key vulnerabilities[23] that predispose animal-based food industry in Southeast Asia, to the risk of spread of zoonotic pathogens:

- Limited biosecurity measures, veterinary care, and infrastructure: inadequate preventive and response measures in animal health management
- Complex supply chains: the presence of multiple intermediaries and informal markets complicates traceability and biosecurity
- High-density livestock production: farming in densely populated areas elevates the risk of disease spread
- Environmental changes: urbanization, land use changes, and climate change contribute to the emergence and spread of diseases
- Diverse agricultural practices: variability in animal farming techniques can influence disease risk
- Regulatory challenges: limited enforcement of health and safety regulations exacerbates vulnerabilities
- Wildlife Trade: Both legal and illegal wildlife trades are significant risk factors for zoonosis
- Cross-Border Dynamics: Porous borders facilitate the cross-border movement of diseases due to trade and travel

[22] See Module 6

[23] Relevant reports for animal farming from Institute of Animal Law of Asia; Farm Animal Investment Risk and Return (FAIRR)

Within commercial ecosystems tied to the animal-based food industry, there exist hotspots for future emerging zoonotic diseases and practices that facilitate the spread of disease. Beyond production losses, animal diseases incur substantial costs due to the need to implement mitigation strategies. The engagement of commercial entities within Southeast Asia in the fight against zoonotic spillover of high-consequence pathogens is paramount but challenging.

Industrial food animal production has seen a global surge in market share. These operations often exceed the carrying capacity of the local ecosystem, leading to numerous challenges such as persistent viral presence and the risk of strain reassortment, both of which can contribute to the emergence of dangerous pathogens (Davis et al., 2011).

Some challenges at these large facilities include the persistence of viruses in large-scale production facilities. The high stocking density and continuous thruput and frequent introduction of immunologically naïve animals perpetuate viral circulation. Achieving full decontamination without depopulation is challenging. Large inventories of live animals increase the potential for viral strain reassortment and host selection. This can lead to the emergence of viruses with critical traits like high transmissibility and virulence. Finally, the global trade in animals, feed, and food products involves multi-national corporations. Regional and country-level efforts may need to leverage economic and political drivers to drive change.

Case Study 7-10 The need of innovative business models integrating preventative measures for the spread of zoonotic pathogens

Industrial-scale animal-based food and food products in Southeast Asia faces significant challenges related to foodborne and waterborne zoonotic diseases, which are often caused by pathogenic microorganisms contaminating food, water, or surfaces within the production process, leading to outbreaks (Todd, 2014; Hassan, 2014). While quality assurance measures like HACCP (Hazard Analysis and Critical Control Points) are in place within the value chain before products reach consumers, there is a need to shift focus to the early stages of the value chain to prevent the spread of zoonotic pathogens. To address this challenge, it is essential to implement innovative business models that incorporate early-stage interventions and embrace inclusive approaches that foster active participation from all relevant stakeholders, including the broader public who collectively play a crucial role in addressing the emergence and spread of zoonotic pathogens.

The circular economy, with its principles of sustainability and resource efficiency, offers a promising framework for mitigating these risks. The circular economy movement is gaining momentum across Southeast Asia with ASEAN at the forefront of promoting circular economy through its five strategic priorities[24]:

Standard harmonisation and mutual recognition of circular products and services

[24] Framework for Circular Economy for the ASEAN Economic Community (AEC) ASEAN adopts framework for Circular Economy - ASEAN Main Portal

Trade openness and trade facilitation in circular goods and services

Enhanced role of innovation, digitalisation, and emerging/green technologies

Competitive sustainable finance and innovative environmental, social, and governance (ESG) investments

Efficient use of energy and other resources

While circular economy concepts and initiatives have gained traction in Southeast Asia[25], efforts have predominantly focused on the sustainable environmental perspective, with limited attention given to preventing the spread of zoonotic pathogens - a critical aspect in accelerating the success of the commercial, trade and industries.

Moving forward, there is a need for initiatives that integrate preventative measures for the spread of zoonotic diseases, into circular economy strategic priorities. Measure may include:

identify priority areas within the circular value chain where disease transmission can be effectively mitigated

research and development focusing on disease risk mitigation efforts

collaboration between circular economy stakeholders, veterinarians, healthcare and scientists, and policymakers

consider disease prevention as a key performance indicator

By integrating preventative measures, such as circular initiatives designed with disease risk reduction in mind, Southeast Asia can create a more resilient and sustainable food industry that prioritizes human-animal-environmental well-being.

Actionable guidelines to engage commercial entities.

1. **Enforce environmental decontamination and fallow period:** For all-in, all-out production models, emphasize thorough environmental decontamination. Include a fallow period before re-population to prevent viral persistence. (i.e. don't leave the poultry litter on the floor - clean it out and disinfect, consider environmental reservoirs at all height levels and consider the importance to decontaminating the air and water systems too. **Improve waste management:** Develop waste management practices that minimize the export of infectious agents. Avoid exporting waste into neighboring communities, other sectors of the agricultural system, or across local, national or regional boundaries.
2. **Tailor engagement to the entity:** large, powerful corporations often function like state-like entities with the ability to influence policymaking. Countries often let large-scale companies set their own policies. Tailor engagement strategies based on the size and

[25] Other organizations advocating circular economy: Asian Development Bank (ADB) A Systems Approach for Transitioning Southeast Asia to a Circular Economy | Development Asia

influence of the corporation. Consider other relevant issues, such as occupational health, to craft effective approaches. Promote the idea that adopting public health behaviors is the easiest path for large companies, encouraging them to align their practices with spillover prevention efforts.

CONCLUSION

The module outlines 9 key obstacles to boosting resilience against zoonotic disease threats in Southeast Asia, showcases examples of existing efforts, and presents actionable plans within a structured framework overview organized thematically. These 9 barriers are interconnected, have persisted through past local and regional disease outbreaks, impacting various societal sectors, with vulnerable communities facing disproportionate effects. Bridging efforts, scalable and adaptable strategies, tailored to varied operational capacities and governance structures across Southeast Asia are necessary to address existing gaps and barriers. As of the publication of this guidebook, issues such as resource constraints, porous borders, and the need for improved global surveillance (among others) remain major challenges in the region. This calls for a stronger integrated approach, resources, and expertise to find impactful solutions. The responsibility spans multiple sectors for realizing the solution to these issues, requiring cooperation among public health officials, veterinarians, and scientists, and calls for community engagement, policy advocacy, and research support, underlining a collective duty to protect public health and regional biodiversity.

Appendix A: Field Epidemiology Training Programs (FETPs)

Country	Program	Entities	Target sector	Topical focus	Refs
Thailand (National and regional)	R-FETPV	Thai gov't FAO (UN)	veterinarians	Veterinary epidemiology of animal diseases	Yamada et al., 2014
China	FETPV	Chinese gov't FAO (UN)	veterinarians	Veterinary epidemiology of animal diseases	China-FETPV
Malaysia	MyOHUN	MyOHUN	Inter-sectoral	Field Epidemiology AMR	myohun.com
Indonesia	PELVI	INDOHUN CDC	Veterinarians Public health	Veterinarian epidemiology	FAO, 2017).
Singapore	S-FETP	NUS-SPH NCID Nat'l Parks	Medical and public health officers veterinarians	Field epidemiology	S-FETP
Viet Nam	V-FETP	Vietnamese gov't WHO US-CDC	Medical officers Veterinarians	Outbreak investigation, surveillance, SciComm	
Regional	FETP	WHO Western Pacific			

Appendix B: Region biosafety organizations and resources

Burma (Myanmar) National Health Laboratory, Myanmar 10.1371/journal.pone.0273380
Cambodia National Institute of Public Health; Institut Pasteur du Cambodge http://hismohcambodia.org/public/fileupload/EMP%20of%20NIPH%20Lab%20FINAL.pdf; https://pasteur-network.org/en/members/asian-region/institut-pasteur-du-cambodge/
China National Security Commission; Wuhan National Biosafety Laboratory; Biosafety Lvel 4 training; *Biosafety Law of the People's Republic of China*, October 17, 2020 https://lssf.cas.cn/en/facilities-view.jsp?id=ff8080814ff56599014ff59e677e003d; https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6478205/; http://www.npc.gov.cn/npc/c30834/202010/bb3bee5122854893a69acf4005a66059.shtml
Indonesia Indonesia Biosafety Clearing House; Indonesian Biorisk Association https://indonesiabch.menlhk.go.id/; https://internationalbiosafety.org/ifba_members/indonesian-biorisk-association/
Lao PDR Institut Pasteur du Laos https://www.pasteur.la/project-carried-on-in-the-lab/project-03/biosafety-lab/
Malaysia Malaysian Biosafety and Biosecurity Association https://mbba.my/ https://internationalbiosafety.org/ifba_members/malaysian-biosafety-biosecurity-association/
The Philippines Biorisk Association of the Philippines; National Training Center for Biosafety and Biosecurity https://internationalbiosafety.org/ifba_members/biorisk-association-of-philippines/

https://nih.upm.edu.ph/institute/national-training-center-biosafety-and-biosecurity
Singapore Biorisk Association of Singapore; Ministry of Health Biosaftey https://internationalbiosafety.org/ifba_members/biorisk-association-of-singapore/https://www.moh.gov.sg/biosafety/useful-info/useful-info-and-guidelines
Thailand Biosafety Association of Thailand; BIOTEC Biosafety Program http://biosafetythailand.org https://www.biotec.or.th/home/en/biosafety-program-en/
Viet Nam Viet Nam Field Epidemiology Training Program https://www.tephinet.org/training-programs/vietnam-field-epidemiology-training-program