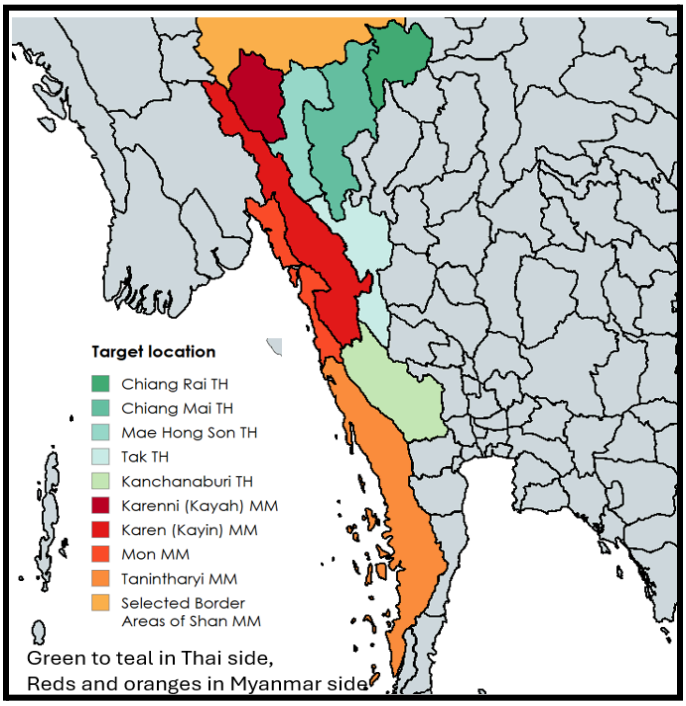
Final Report: A Study on Demand, Feasibility, and Development Approaches for Expanded Program on Immunization (EPI) Vaccine Management and Financing Systems for Non-Thai Children Along the Thai-Myanmar Border Areas.



[1]

Conducted by: The Global Health Research Team, National Health Foundation (NHF)

Piya Hanvoravongchai, Nyein Chan Oo, Natthawut Iangtaranat, Wasin, Laohavinij, Apinya Boonsu, Sirithorn Khositchaiwat, and Mana Chunsuttiwat

Agreement No. NSTDA 68-004 May 2026

[1] Selected Thai provinces represent areas with a high concentration of non-Thai and stateless children. Adjacent Myanmar states and regions were included based on cross-border population linkages and programmatic relevance.

Acknowledgement

The research team from the National Health Foundation (NHF) expresses its sincere gratitude to the Health Systems Research Institute (HSRI) for its trust and financial support for this project, *"A Study of the Demand, Feasibility, and Development Approaches for Expanded Program on Immunization (EPI) Vaccine Management and Financing Systems for Non-Thai Children in the Thai-Myanmar Border Region" (BVF)*, under Agreement No. 68-004.

We would like to express our sincere gratitude to all key informants in the five border provinces of Thailand—Chiang Rai, Chiang Mai, Mae Hong Son, Tak, and Kanchanaburi—as well as informants from health organizations across the five adjacent states and regions of the Republic of the Union of Myanmar: Kayin (Karen), Kayah (Karenni), Mon, Southern Shan, and Tanintharyi. This includes provincial and district public health administrators, medical and public health personnel from regional hospitals, community hospitals, and sub-district health promotion hospitals, village health volunteers, teachers and administrators of Migrant Learning Centers (MLCs), representatives of civil society organizations, ethnic health organizations, and multilateral agencies—a total of 128 participants (114 from Thailand and 14 from Myanmar). Their valuable time devoted to in-depth interviews and focus group discussions provided the research team with comprehensive and invaluable primary data for this study.

The research team would also like to acknowledge the many institutions and individuals who generously contributed secondary datasets, technical expertise, and operational support throughout the project. On the Thailand side, we are grateful to the Ministry of Public Health at all administrative levels, the Ministry of Interior, the Ministry of Labour, the Ministry of Education, Migrant Education Coordination Centers (MECCs), and the Tak Border Health Learning Center (TBHLC) for their support in providing data, facilitating coordination, and strengthening the evidence base of this study. On the Myanmar side, we sincerely thank the Health Information Systems Working Group (HISWG), Mae Tao Clinic (MTC) and its network partners for sharing data and technical insights related to cross-border and conflict-affected populations.

We are particularly grateful to Dr. Rapeepong Suphanchaimat and colleagues from the International Health Policy Program (IHPP) for generously sharing datasets and findings from previous studies that informed this research. We also wish to thank Dr. Peeriya Wattakulsin for his invaluable support in local coordination and stakeholder engagement in the border areas. The research team further acknowledges Professor Virasakdi Chongsuvivatwong and Dr. Sopon Iamsirithaworn for their guidance and contributions as academic advisors throughout the project. Special thanks are also extended to Ms. Shanzai Ikhlas, an intern from Brown University, for her dedicated assistance in designing, translating and editing the English version of this report.

Furthermore, the research team would like to express its gratitude to the Human Research Ethics Committee for reviewing and approving the research project, the expert panel for providing valuable suggestions and academic perspectives throughout the study, and all field staff and coordinators who supported and facilitated the data collection process.

The views, findings, and recommendations presented in this report are those of the research team and do not necessarily reflect the positions or policies of the funding agency, participating institutions, or data providers. Any shortcomings or errors remain the sole responsibility of the research team.

The Research Team
National Health Foundation (NHF)

Table of Content

Executive Summary

This study uses empirical evidence collected across five Thai-Myanmar border provinces to confirm that bridging the vaccination coverage gap for over 230,000 non-Thai children is a comprehensive, policy-feasible approach encompassing three key dimensions:

1) **Financial and Fiscal Feasibility:** The estimated budget required is approximately 93 million baht per year (for children aged 0-4 years in Thailand) or a maximum of 209 - 365 million baht per year (for children aged 0-12 years under the hybrid scenario), representing only 0.02-0.09% of the Ministry of Public Health's budget. Furthermore, research in middle and low-income countries has found that investing US$1 in the vaccine system yields an economic return of up to US$44 (Ozawa et al., 2016). Therefore, providing vaccine services across borders is an investment to protect future economic productivity, rather than merely a public expenditure burden (ThinkWell, 2020).
2) **Operational Feasibility:** The hybrid service model has been validated for practical implementation using data from the local level.
3) **Political Feasibility:** Advancing policies under the 'Health Security' framework is an effective way to forge policy consensus

The urgency of this investment increases significantly during 2025-2026 due to the withdrawal of international funding sources and the ongoing unrest in Myanmar. Therefore, the research team presents these findings to support evidence-based decision-making, aiming to drive systemic changes while the policy window remains open.

The Problematic Situation and the Need for Urgent Action

Currently, Thailand has over 179,000 stateless children living in border areas, ranking as the fourth country in the world with the highest number of vulnerable stateless people. This population is concentrated in five border provinces: Chiang Rai, Mae Hong Son, Tak, Kanchanaburi, and Chiang Mai. The Tak province alone has 115,645 stateless children (aged 0-5 years), representing more than 50% of the total target population. A major concern within the public health system is the low coverage rate of fully vaccinated children aged 0-4 years, at only 17.49% (95% confidence interval: 10.6-24.3%), according to the IHPP Feasibility Study (2024). This data reflects a coverage gap of 82%, significantly different from the 96-99% coverage rate for Thai children.

Such vaccine access gaps not only undermine human rights under the Convention on the Rights of the Child (CRC), ratified by Thailand, but also pose a direct threat to national health security. Vaccine-preventable diseases (VPDs) can easily spread across borders, as demonstrated by the December 2024 cholera outbreak in Shwe Kokko, Myanmar, resulting in ten cross-border patients seeking treatment in Mae Sot District, Tak Province, Thailand. This led to the declaration of an epidemiological surveillance area in four districts and the establishment of an Emergency Operations Center (EOC) by the Thai authorities. This disseminated outbreak

demonstrates that herd immunity gaps among migrant populations can escalate and have a rapid impact on the Thai public health system.

There are four complex geopolitical and epidemiological factors that are accelerating the severity of the situation and highlighting the urgent need for action during the years 2024-2026:

1) Political Unrest in Myanmar: The consequences of the coup in February 2021 have resulted in continued cross-border migration.
2) Natural Disasters: The 7.7 magnitude earthquake on March 28, 2025, damaged 83% of Myanmar's public health infrastructure, serving as a catalyst for increased population migration to Thailand.
3) Shift in International Donor Support: Following a $259 million cut in USAID forced the International Rescue Committee (IRC) to cease primary healthcare services at seven temporary shelters on July 31, 2025.
4) Epidemiological Situation Within the Country: The World Health Organization (WHO) assessed and maintained Thailand's status as an endemic area for Measles and Rubella in July 2025.

The four systemic risk factors is a clear indication that Thailand urgently needs to develop a resilient and sustainable domestic health management and health financing system to mitigate health security risks, instead of relying on temporary, uncertain, and unreliable foreign assistance mechanisms.

Research Methodology

This study employed a mixed methods approach using a convergent parallel design, as described by Creswell and Creswell (2018). The study was further informed by ThinkWell's Sustainable Immunization Financing (SIF) framework (2017), which provided a conceptual lens for examining vaccine financing and delivery systems. By integrating quantitative and qualitative data, the study combined empirical evidence with contextual insights from stakeholders across the study areas. The research consisted of three main components:

1) **Scoping Review:** The scoping review encompasses health insurance systems, vaccine financing arrangements, and international cooperation policies and frameworks. It also examines case studies and lessons learned from nine countries, drawing on the Sustainable Immunization Financing Country Brief series developed by ThinkWell .
2) **Quantitative Analysis:** An empirical analysis was conducted covering the Thai-Myanmar border area, using the proportion-inverse proportion methodology to estimate the target population and vaccine needs. This was combined with a cost structure analysis broken down by service delivery model to assess the budget impact analysis (BIA), and a sensitivity analysis to rigorously evaluate the fiscal feasibility and sustainability.

3) **Qualitative Research:** Data was collected from a total of 128 key informants: 114 participants from 5 border provinces of Thailand and 14 participants from 5 border states/regions of the Republic of the Union of Myanmar. The research tools included in-depth interviews, focus group discussions, and field observation. Data was analyzed using thematic analysis to describe in-depth context and examine discrepancies between the findings and quantitative research.

Key Findings

Based on integrated data and feedback from the field, the research team summarizes key findings reflecting both the overall structural picture and development opportunities as follows:

1) **Quantitative Dimension: Population Estimates and Budget Implications:** The analysis estimated approximately 230,056 non-Thai children across the five Thai border provinces adjacent to Myanmar, with an average vaccination coverage rate of 43.3%. Depending on the target population and service delivery scenario, the estimated annual budget requirement ranges from THB 209 million to THB 365 million. The analysis identified two primary cost drivers: population size and service delivery model. Among the models assessed, school-based vaccination was the most cost-efficient, with an estimated cost of THB 1,667 (US$51) per child, compared with THB 2,386 (US$73) per child for community outreach services. This represents a cost difference of approximately 30%, suggesting that school-based delivery can achieve substantial economies of scale where operationally feasible.

2) **Qualitative Dimension: Structure, Challenges, and Shared Vision** Information gathered from comprehensive feedback can be processed into four interconnected core elements forming a systemic chain:

   - **Spatial Context:** Challenges arise from rugged terrain, dynamic cross-border travel, and linguistic diversity.
   - **Systemic Barriers:** Increased workload for personnel, financial constraints, the cold chain system, and gaps in information connectivity.
   - **Systematic Leverage and Success Factors:** Utilizing school health services as the main foundation to drive collaboration across sectors and leveraging the potential of ethnic minority community health volunteers (VHVs).
   - **Pathways to Sustainable Policy:** A recurring theme across stakeholder groups was a shared recognition that sustainable progress requires a paradigm shift from viewing vaccination services for non-Thai children as a burden to viewing them as a strategic investment in national health security.

3) **Key Challenges and Interdisciplinary Data Validation (Triangulation):** From the perspective of the 128 key informants, the researchers found that the main obstacles affecting both service providers and service recipients are as follows:

   - **Issues with identity documentation and concerns about legal repercussions.**
   - **Geographical difficulties and limited access to services.**
   - **Language limitations and differences.**

These three obstacles are perfectly consistent between quantitative and qualitative evidence, rigorously confirming that these challenges are **"interconnected systemic issues".**The research team therefore kindly suggests that future policy initiatives should be holistic and comprehensive, rather than addressing the problem in isolation.

Policy Recommendations

Based on the integration of empirical evidence, both quantitative data and field experience, the research team would like to present four policy recommendations focusing on practical feasibility, as follows:

1) **Elevate "Targeted Outreach" as a Key Strategy for Early Childhood Education (0-5 years):** The research team recognizes that early childhood is the most critical clinical and epidemiological window of opportunity, during which children need to receive all basic vaccinations (such as BCG, HepB, DTP-HB-Hib, OPV, IPV, MMR, and Rotavirus) completely and in a timely manner before entering the education system. Supporting the establishment and integration of dedicated mobile teams (comprising professional nurses, interpreters, and ethnic minority community health volunteers) to work directly in border areas and communities serves as a proactive strategy. This approach directly and sustainably addresses the challenge of reaching unvaccinated populations (zero-dose) from the outset.

2) **Using "School-Based Vaccination" as a Safety Net and Secondary Catch-Up Strategy:** Studies indicate that providing services in schools is highly cost-effective and can save over 30% in budget through economies of scale. However, from an epidemiological perspective, relying solely on the school system as the primary mechanism may create gaps in protecting young children who may have dropped out. Therefore, the researchers propose using schools as a "safety net" to catch up and compensate for missed vaccinations for school-aged children (4-18 years) who bypassed the system previously. Furthermore, lessons from past health crises (such as COVID-19) demonstrate that school closures have hindered global vaccine progress (ThinkWell, 2020). Thus, maintaining a proactive community-based service system as the core (in alignment with the first recommendation) with schools as a supporting system will help build resilience in the frontier immunity chain in all crisis situations.

3) **Dual-Track Policy Communication Strategy:** To strengthen stakeholder engagement and policy support, communication strategies should be tailored to different audiences. The study recommends using a **health security framework** when engaging government agencies and policymakers, emphasizing the prevention of cross-border disease transmission and the protection of national public health. Simultaneously, a **child rights-based framing**, grounded in the Convention on the Rights of the Child (CRC), should be used when engaging civil society, development partners, and international organizations. Together, these complementary approaches can help build broader consensus and support for expanding vaccine access among non-Thai children.

4) **Establish a Dedicated Financing Mechanism: Border Vaccine Fund (BVF).** Given the unique operational challenges and cost structures associated with service delivery in border areas, the research team proposes establishing a dedicated Border Vaccine Fund with an annual budget of approximately THB 209–365 million. The

fund should operate separately from routine per-capita financing mechanisms to accommodate the higher and more variable costs of vaccine delivery in border settings.

Summary and Next Steps: The four aforementioned principles have been expanded and detailed into 24 operational recommendations for six target stakeholder groups (specifically public health agencies, academia, ethnic health organizations, non-profit/multilateral organizations, the private sector, and security/foreign affairs experts).

The research team suggests that the most crucial and urgent enabling action is to integrate the Border Vaccine Fund into the 13th National Health Development Plan (2027–2031), thereby creating the foundation for implementation of the broader set of recommendations proposed in this study.

Abstract

Background: Although Thailand's Universal Health Coverage effectively immunizes children, non-Thai children along the Thai-Myanmar border still face severe access barriers due to structural, financial, geographical, and cultural challenges. This study analyzes the needs, feasibility, and approaches for developing a vaccine management and financing system, striving to provide robust empirical evidence for policymakers.

Methodology: Employing a mixed methods convergent parallel design integrated with the sustainable immunization financing (SIF) framework, this study utilized: (1) a scoping review; (2) quantitative analysis using the proportion-inverse proportion (PIP) method to estimate demand, alongside a costing framework for budget impact analysis (BIA) and sensitivity analysis; and (3) qualitative research via in-depth interviews and focus groups with 128 key informants (114 from Thailand, 14 from Myanmar), analyzed thematically.

Results: The target population is highly concentrated in Tak province (28,251 children aged 0-4 out of 115,645 total). Alarmingly, the fully vaccinated rate among children aged 0-4 is only 17.49% (95% CI: 10.6-24.3), significantly below the national target. Key informants identified the primary barriers as documentation/legal fears (50.9%), geographical isolation (42.1%), and language constraints (35.1%).

With an estimated annual budget impact of THB 209–365 million across the five border provinces, the research team identified a cost-effective service delivery model that prioritizes targeted outreach for children aged 0–5 years and uses school-based vaccination as a safety net for school-aged children.

Conclusion: Based on solid empirical evidence, the research team respectfully affirms that developing a border vaccine system is both policy-feasible and a highly worthwhile investment. We humbly propose four actionable steps: (1) Prioritizing Targeted Outreach for children aged 0-5; (2) Utilizing School-based vaccination as a safety net for older children; (3) Employing a "Health Security" framework for policy advocacy; and (4) Establishing a dedicated "Border Vaccine Fund." This study provides comprehensive evidence to support executive decision-making while the policy window for systemic solutions remains open.

Keywords: Vaccine Financing, Health Security, Non-Thai Children, Thai-Myanmar Border, Budget Impact Analysis, Targeted Outreach

Explanation of Symbols and Abbreviations Used In Research.

Abbreviation	Full Term
ASEAN	Association of Southeast Asian Nations
BIA	Budget Impact Analysis
BVF	Vaccine Management and Financing Systems for Non-Thai Children
COVAX	COVID-19 Vaccines Global Access
CRC	Convention on the Rights of the Child
EHO	Ethnic Health Organization
EPI	Expanded Program on Immunization
EVM	Effective Vaccine Management
Gavi	Global Alliance for Vaccines and Immunisation
HDC	Health Data Center
HSRI	Health Systems Research Institute
IFFIm	International Finance Facility for Immunisation
IRC	International Rescue Committee
LMIC	Low- and Middle-Income Country
MLC	Migrant Learning Centers
MMR	Mixed Methods Research
MoPH	Ministry of Public Health
MoU	Memorandum of Understanding
NGO	Non-Governmental Organization
NHSO / สปสช.	National Health Security Office / สำนักงานหลักประกันสุขภาพแห่งชาติ
NIP	National Immunization Program
OBEC	Office of the Basic Education Commission
PEO	Population, Exposure, Outcome (กรอบคำถามวิจัย QUAL)
PICOT	Population, Intervention, Comparison, Outcome, Timeframe (กรอบคำถามวิจัย QUAN)

PIP	Population Immunization Planning
PPHO	Provincial Public Health Office
QUAL	Qualitative Research
QUAN	Quantitative Research
SDGs	Sustainable Development Goals
TDRI	Thailand Development Research Institute
UHC / UCS	Universal Health Coverage / Universal Coverage Scheme
UNICEF	United Nations Children's Fund
WHO	World Health Organization
WUENIC	WHO and UNICEF Estimates of National Immunization Coverage

Operational Definitions

Terminology	Definitions
Terminology Definitions	
Basic vaccines (Basic Vaccines)	Vaccines included in Thailand's National Immunization Program, prescribed for children aged 0-5 years according to the vaccination schedule of the Department of Disease Control.
Budget Impact	The overall financial impact of a measure on the budgetary system over a given period is typically assessed through Budget Impact Analysis (BIA).
Children who have never been vaccinated (Zero-dose Children)	Children who have never received any vaccines, not even once, as defined by WHO/Gavi.
Children without Thai nationality (Non-Thai Children)	Children aged 0-18 years who do not have Thai nationality include stateless children, refugee/displaced children, children of migrant workers, and children who cross borders temporarily.
Coverage	The proportion of children in the target population who have received all the required vaccinations according to the schedule.
Health security	The ability to prevent, detect, and respond to threats from infectious diseases and public health disasters that may have cross-border impacts.
Outreach Team	A proactive healthcare team that provides services in communities outside of healthcare facilities.
School Health	Healthcare services provided through educational institutions include health check-ups and vaccinations.
Systemic Impact	The impacts occur across components of the healthcare system, not limited to effects at a single point of service.
Vaccine Financing	The allocation, procurement, and management of financial resources for the purchase, storage, distribution, and provision of vaccines.

Vaccine gap (Vaccine Gap)	The difference between actual coverage and the target of the National Immunization Program.

Chapter 1: Introduction

1.1 Background and Problem Statement

Thailand has achieved remarkable success in developing its Expanded Program on Immunization (EPI), meeting international standards, with a coverage rate of 96–99% among Thai children. The EPI system has proven to be an economically cost-effective public health intervention for preventing disease burden and mortality in children. This aligns with global reports (ThinkWell, 2020) and empirical data in low- and middle-income countries (LMICs), which indicate that every US$1 invested in a vaccine system can generate a 44-fold return on investment (Ozawa et al., 2016).

Furthermore, vaccine provision is crucial within the context of the demographic transition, as Thailand has entered a **"Complete Aged Society".** Life-course immunization policies have become a crucial shield to reduce the risk of secondary infectious diseases that could undermine the capacity of the public health system, which faces constraints in fiscal space. Protecting the entire child population in the country, including border areas, is therefore not merely a localized disease control measure, but a prerequisite for maintaining the stability and sustainability of public health financing.

In terms of policy and international obligations, Thailand ratified the Convention on the Rights of the Child (CRC) in 1992, alongside the ASEAN Declaration on the Rights of Children in the Context of Migration and Sustainable Development Goal (SDG) 3 on Universal Health Coverage (UHC). Moreover, Thailand is partnering with the World Health Organization (WHO) to eliminate measles and rubella. Ensuring effective and comprehensive vaccine management across all populations is therefore a crucial factor in enabling the country to concretely achieve its national and international strategic goals.

Although the policy principles and legal obligations are clear, in practice, the provision of vaccine services to **"Children without Thai nationality" (Non-Thai children)** aged 0-18 years (including stateless children, refugee/displaced children, children of migrant workers, and temporary cross-border children) along the more than 2,400-kilometer Thai-Myanmar border continue to face severe operational gaps. Data from the 2024 Thailand Migration Report and estimates from the Ministry of Public Health indicate that the total migrant population in the country exceeds 5.3 million migrant workers. The Thailand Development Research Institute (TDRI) estimates that there are over 179,000 stateless children, densely concentrated in five border provinces (Chiang Rai, Mae Hong Son, Tak, Kanchanaburi, and Chiang Mai).

A critical challenge is that the coverage rate for fully vaccinated status among the target population area **remains remarkably low at only 17.49 %** (The 95% confidence interval is 10.6–24.3). According to the Awareness and Feasibility Study (IHPP Feasibility Study, 2024), this figure falls drastically short of the coverage levels in the general Thai population.

Between 2021 and 2026, several compounding crises have dramatically widened these operational gaps. This includes the impact of unrest in Myanmar; a 7.7 magnitude earthquake in

2025 that destroyed 83% of the public health infrastructure on the Myanmar side and a reduction in international funding that forced leading international organizations (such as the IRC) to cease primary healthcare services in seven temporary shelters. Furthermore, in late 2024, a cholera outbreak in Shwe Kokko rapidly spread to Mae Sot district. These overlapping events demonstrate that immediate response mechanisms and reliance on temporary external assistance are insufficient for sustainable solutions. Instead Thailand must shift towards a highly resilient, institutionalized domestic framework.

From the literature review, the researchers identified three significant knowledge gaps due to past research often focusing on specific areas (e.g., only Mae Sot district or certain shelters). This results in the Thai public health system lacking macro-level data and empirical evidence for decision-making, as follows:

1) There is a lack of systematic, cross-provincial population estimates for stateless children covering all five major border provinces and adjacent Myanmar states/regions.
2) There is a lack of analysis of cost drivers across different service delivery models (e.g., facility-based services, community outreach, and school-based programmes) to identify the most cost-effective approach.
3) There is a lack of policy analysis on sustainable vaccine financing mechanisms that are operationally feasible within Thailand's fiscal and administrative context.

This study aims to bridge the knowledge gap by integrating a convergent mixed methods design based on the Creswell & Creswell (2018) framework with ThinkWell's Sustainable Immunization Financing (SIF) theory. This theoretical model evaluates four pillars: fiscal space, prioritization, strategic purchasing, and decentralization. Furthermore, it incorporates a policy paradigm shift through a Health Security Framework lens in an attempt to transform the perception of these services from a "burden" to building a "shield against cross-border health threats" for the nation.

1.2 Research Objectives

Based on the principles and rationale, operational gaps, and systemic knowledge gaps mentioned above, the research team has defined the research objectives in a logical flow to systematically and concretely address these challenges as follows:

1) **To Assess the Size of Vaccine Demand:** Assess and estimate the actual population and the gap in basic vaccination needs for non-Thai nationals aged 0-5 years in 5 major border provinces (Chiang Mai, Chiang Rai, Mae Hong Son, Tak, and Kanchanaburi).
2) **To Analyze Systemic Causes and Obstacles:** This study examines the limitations and bottlenecks that hinder access to vaccination services, including health financing,

staff workload, geographical location, issues with identification documentation, and social, cultural, and linguistic factors.

3) **To Explore and Evaluate Financing Options:** Analyze and develop systemic alternatives for providing cost-effective and financially feasible budgeting mechanisms and vaccine delivery models.

4) **To Extract and Synthesize International Lessons:** To study and compare best practices from countries with similar contexts in managing vaccination systems for transnational target child populations.

5) **To explore the needs and acceptance of stakeholders (Map Stakeholder Needs):** Explore the perspectives, visions, and shared consensus of stakeholders at all levels, from national policymakers and regional administrators to civil society organizations, ethnic health organizations, and service users.

6) **To Synthesize Policy Recommendations and Fiscal Innovations:** The research findings were synthesized into policy recommendations, particularly guidelines for establishing a sustainable ad hoc fiscal mechanism to be included in the next national health development plan.

1.3 Expected Benefits and Impacts

By driving this research forward in alignment with its six primary objectives, the research team aims to synthesize empirical evidence to deliver value and create tangible outcomes across four levels, strengthening the operations of all stakeholders as follows:

1) **Policy Impact: Informing Strategic Decision-Making**

The study results will serve as an "evidence-based" database to support the work of national policymakers (e.g., the National Health Security Office, the Ministry of Public Health, the Ministry of Interior, and the Ministry of Labour). By providing information on budgetary burdens and costs of various service delivery models, this research will facilitate policymakers in evaluating and designing flexible fiscal mechanisms. Furthermore, it will aid in developing actionable cross-border health security policies anchored in successful international benchmarks.

2) **Operational Impact: Strengthening Frontline Service Delivery**

To resolve systematic bottlenecks within border-zone public health networks, the findings from this study will synthesize "Context-Specific Guidelines" tailored for health district administrators, provincial/district health offices, and frontline personnel. It will provide empirical evidence to guide the selection of appropriate service delivery models considering geographical and demographic challenges. Ultimately, the aim is to help reduce redundant workloads, improve resource

efficiency, and promote seamless collaboration with ethnic health networks or local organizations.

3) Academic Impact: Addressing Knowledge Gaps

This research will bridge literature and knowledge gaps regarding public health systems and health financing for stateless and transnational populations in Thailand. Furthermore, the application of a convergent mixed methods design combined with a public health economics framework aims to serve as an academic "methodological prototype" to guide further researchers and institutions when studying health vulnerability among marginalized populations.

4) Global Impact: Advancing Health Security and International Commitments

On a macro level, implementing and scaling the recommendations from this report will help advance Thailand's progress toward achieving the Sustainable Development Goals (SDG 3: UHC). The proposed recommendations also align with the WHO's Immunization Agenda 2030 for the prevention and control of vaccine-preventable diseases (VPDs). Finally, it reflects Thailand’s commitment to its obligations under the Convention on the Rights of the Child (CRC), ASEAN declarations and the Regional Framework and Action Plan (2021-2030), to contribute to the sustainable and dignified enhancement of health security in the region.

Chapter 2: Literature Review

Following the foundational overview in Chapter 1, which identified three main challenges and gaps in empirical evidence—(1) true scale of demand, (2) systemic causes and barriers, and (3) feasible fiscal mechanisms—Chapter 2 is designed to"expand upon and support" the purpose. Through this chapter, the research team aims to thoroughly explore both international and domestic knowledge bases. This review aims to identify key knowledge gaps in the existing literature and to provide a conceptual bridge between the current evidence base and the research methodology presented in Chapter 3.

In this chapter's literature review, the researcher team carefully applied the standard scoping review process of Arksey & O'Malley (2005) to comprehensively explore and understand the complex and interconnected systemic issues across multiple dimensions.

The research team has organized the content into 10 key sections, divided into 3 phases as follows:

- **Phase 1: Context and Systemic Problem (Parts 2.1 - 2.3)**

  This phase starts with (2.1) a survey of the vaccine coverage situation in the target population, followed by (2.2) an analysis of the overall health insurance system and health finance mechanisms, and (2.3) a review of the mechanisms and context of international cooperation.

- **Phase 2: Theoretical Framework and Empirical Lessons (Parts 2.4 - 2.8)**

  This phase introduces (2.4) presenting the Sustainable Immunization Financing (SIF) framework, which serves as the main theoretical framework driving this study; then (2.5) extracting lessons learned from international models; (2.6) analyzing vaccine financing systems specifically for migrants and stateless populations; (2.7) reviewing the linkages of policy frameworks both at the international level and in the Thai context; and (2.8) integrating insights and lessons learned from the academic sector.

- **Phase 3: Research Methodology and Conceptual Framework (Parts 2.9 - 2.10)**

  The final phase concludes with (2.9) a review of population estimation methodologies, before synthesizing the entire body of acquired knowledge (2.10) to highlight the literature gaps and develop a research framework for this study.

2.1 Vaccine Coverage Status for Non-Thai Children in the Thailand-Myanmar Border Zones

2.1.1 National Success vs. Border Zone Challenges

Thailand's Expanded Program on Immunization (EPI) represents a proud and highly successful national achievement, consistently maintaining a vaccination coverage rate of 96-99% among Thai children (WHO, 2025). However, beneath this macro-level success, numerous studies consistently show that non-Thai children in border areas still have significantly lower access to vaccinations than international and national standards. This phenomenon is not merely a temporary limitation in certain areas, but rather a reflection of systemic disparities. For example, a study by Kaji et al. (2016) in Mae Sot District, Tak Province, found that vaccination rates among cross-border children and migrants fluctuated and were significantly below the EPI target. Furthermore, a study by Hong et al. (2025) indicated that the proportion of non-Thai population in border areas is as large as 20-30%, directly impacting the workload of healthcare personnel and the capacity of hospitals in these areas, whose budgets are calculated based on standardized citizen formula.

2.1.2 The Phenomenon of "Zero-Dose Children" in Global and Regional Dimensions

To understand the root causes of the problem, the research team examined the situation through a global literature framework. Ingle et al. (2023) compiled empirical evidence and found that of the 17 million zero-dose children worldwide, 97.6 % live in developing countries (LMICs), classifying their vulnerability into three groups: (1) slums in urban areas, (2) remote/rural communities, and (3) conflict settings.

When this framework is analyzed in conjunction with the Thai-Myanmar border context, it becomes clear that the target population lies at an intersection between remoteness and vulnerability from conflict situations on the Myanmar side. This aligns with the World Health Organization (WHO, 2025) report estimating that there are as many as 1.2 million zero-dose children in Myanmar, mostly concentrated in border states (such as Kayin, Mon, Shan, and Gaya states). This complex situation requires systemic recommendations that integrate both community engagement and health systems strengthening, forming the basis of the policy proposals in this study.

2.1.3 Clinical Coverage and Gaps at the Regional Level

Focusing on the Thai side of the border, recent evidence from Uansri et al. (2025) reports that the overall coverage of basic vaccines among non-Thai children aged 0-5 years in border areas (e.g., Tak, Mae Hong Son, and Chiang Rai) is approximately 43.3 %, reflecting a coverage gap as high as 56.7 %.

Significantly, vaccine coverage decreases drastically as the complexity of the immunization schedule increases; multi-doses series requiring boosters exhibit highest dropout rates. This includes the second Measles-Mumps-Rubella MMR dose (35-45%), the third DTP-HepB-Hib dose (50-60%), and the third Polio dose (55-65%). This phenomenon reflects challenges in two main dimensions: (a) the migration of children, frequently causing children to miss scheduled follow up doses and (b) structural misalignments between the national immunization schedules of Thailand and Myanmar.

2.1.4 Determinants of Access and Impacts on Health Security

Through a comprehensive literature review, the researcher team identified five primary systemic barriers impeding successful immunization outcomes:

1. **Legal Status and Healthcare Financing:** Chamchan & Apipornchaisakul (2022) highlighted that more than half of migrant workers remain outside the health insurance system, and 83.2% of child workers in special economic zones lack health insurance coverage.
2. **Geography and Layout:** The difficulties in transporting vaccines (cold chain) to remote areas.
3. **Language and Cultural Barriers:** High ethnic diversity and varied traditional beliefs create communication divides.
4. **Health Information and System Navigation:** Limited access to clear, culturally and linguistically appropriate information, combined with the complexity of the healthcare system, can create barriers to understanding and accessing vaccination services.
5. **Economic Stability and Security:** Severe family time constraints due to manual labor, compounded by a fear of self-disclosure of status to state authorities when seeking healthcare services.

The accumulation of these vulnerabilities has led to tangible public health threats. A clear example was the cholera outbreak in Shwe Kokko in late 2024, which spread across the border into Mae Sot district. Additionally, the WHO's 2025 designation of Thailand as retaining endemic status for measles and rubella serves as a stark reminder that persistent immunity gaps along borders can inevitably undermine the health security of the Thai population within the country.

2.1.5 Summary and Innovations for Driving Forward

Although the existing literature mentions alternative strategies to increase access to services (e.g., school health, organizing ad-hoc teams, or leveraging the potential of ethnic minority community health volunteer networks), overall, these proposals remain fragmented pieces lacking macro-level data integration. The researcher team therefore humbly notes that current literature lacks a comprehensive and systematic survey of workload estimates and budgetary impacts at the provincial level. This knowledge gap is a key area this study aims to address in order to provide powerful empirical evidence to drive sustainable public health policies.

2.2 National Health Insurance System and Vaccine Financing for Non-Thai Populations

2.2.1 National Health Security System Structure and Systemic Gaps

Public health literature universally acknowledges the success of Thailand's health insurance system, which covers 99.8% of the Thai population through three main mechanisms: the Civil Servant Healthcare Scheme (CSMBS), the Social Security System (SSS), and the Universal Health Coverage System (UCS) administered by the National Health Security Office (NHSO). However, non-Thai citizens are automatically excluded from these systems and must rely on separate mechanisms.

Protection for non-Thai is fragmented based on status. For example, some workers are covered by the social security system, other stateless persons whose status has been verified enter the "T.99 Card" system, and another segment relies on the Ministry of Public Health's Foreigners' Health Insurance Card Scheme (HIS). This overlapping yet fragmented structure creates coverage gaps that leave many non-Thai and stateless children without effective access to health protection mechanisms. Furthermore, limitations in registering stateless children through the Ministry of Public Health's Health Data Center (HDC) system result in vaccine information not fully reflecting the population group.

2.2.2 Budgeting Allocation Mechanisms and Uncompensated Care

The management of the basic vaccine budget in Thailand's EPI plan is carried out through the National Health Security Office (NHSO) using a capitation payment mechanism and specific vertical programs. The Ministry of Public Health is responsible for centralized procurement and distribution to healthcare facilities. However, budget allocation for populations outside the Universal Coverage System (UCS) depends on the discretion of the regional and provincial levels, leading to inconsistencies in service delivery across different areas.

Empirical findings from a study by Hong et al. (2025) indicate that hospitals in border areas bear a massive burden of "uncompensated care" from a large non-Thai population, particularly for malaria, tuberculosis, and maternal and child health, significantly undermining the financial liquidity and capacity of these facilities to provide services.

2.2.3 Challenges of the Health Insurance Fund (HICS)

The HICS system was initiated in 2004 for migrant workers from Cambodia, Laos, and Myanmar (CLM) and expanded to include children in 2013. Current premium rates are THB 1,600 (approximately US$49) per year for adults and THB 365 (approximately US$11) per year for children under 7 years of age. Data from 2024 indicates a total of 197,727 cardholders, of which only 10,659 were children under 7 years old. The researchers respectfully note that the proportion of children holding the card remains very low compared to the Ministry of Interior's estimate of over 169,000 stateless children.

A study by Thanasitthichai et al. (2025) identified three practical limitations of HICS, all of which are important factors in future policy design:

1) **Policy Ambiguity:** Some medical facilities refuse to issue cards to children without identification documents due to a lack of clear regulations specifying whether this group is covered.
2) **Provider Cost Perception:** The insurance premiums are assessed as lower than the actual cost of providing the service, causing some medical facilities to hesitate to proceed.
3) **The Adolescent Gray Area (ages 8-15):** The lack of clarity on whether children in this age group should use the child price (365 baht) or the adult price (1,600 baht) results in frequent insurance denials. High cost, a lack of institutional communication, and a fear of self-disclosure create a systemic barrier.

2.2.4 Assessment of Budgetary Burden and Contemporary Pressures (2025-2026)

Although previous research estimated the budgetary burden for expanding vaccine coverage to children without Thai nationality (in the 5 southern border provinces) at 200-400 million baht per year, the calculation methods lacked a consistent standard (methodological variation). These inconsistencies include utilizing different reference prices (Gavi vs. NGOs) or calculating only the cost of the vaccine procurement while omitting operational service delivery expenditures.

The situation was further exacerbated by contemporary pressures in 2025-2026, including: (a) a $259 million cut in US aid, forcing the IRC to cease operations at seven shelters; (b) the increasing burden of refugees following the March 28, 2025 earthquake in Myanmar; and (c) continued reliance on temporary emergency financing measures. Although Thailand's 12-month response package (THB 159 million) and support from the Government of Japan and WHO (JPY 453 million) provided short-term relief, these initiatives did not constitute sustainable long-term financing mechanisms.

2.2.5 The Epidemiological and Economic Burden Of Life-Course Immunization

Analyzing the vaccine stockpile system requires understanding the overall macroeconomic context of the country, as reported in the academic paper, *"The Economic Case for Life-Course Immunization in Thailand" (2026).* The crisis of fragmented healthcare financing and passive service delivery has been highlighted, severely constricting Thailand's fiscal space shown by the following:

1) **Influenza and PCV Vaccines:** The influenza vaccine coverage rate among Thailand's elderly is only 47% (compared to 83% in South Korea), while PCV vaccine access remains below 20%. This deficit contributes to a substantial pneumonia burden (386 cases per 100,000 population), with the average cost of a pneumonia-related hospitalization estimated at THB 150,000 (US$4,620) per admission. Expanding coverage to 80% among chronically ill patients would yield health system savings of 1.4 billion baht (43.12 million USD) annually.
2) **Respiratory Syncytial Virus (RSV):** Elderly RSV patients requiring ICU admission have a high mortality rate of 12.1%, with average treatment cost of 70,000 baht (2,155 USD) per visit; yet this vaccine is not currently included in the National Intensive Care Plan (NIP).
3) **Cancer Caused by HPV:** Despite average medical costs reaching 400,000 baht (12,320 USD) per person, vaccination coverage for one dose in 2024 was only 57%. Furthermore, neglect of vaccinations in boys has led to a surge in the incidence of oropharyngeal cancers in males from 13% (2008) to 42% (2019-2020) - a rate five times higher than that observed in females.
4) **Dengue Fever:** The major outbreak in 2019 inflicted economic and tourism losses of 60 billion baht (1.85 billion USD), representing 0.33% of the national GDP, yet a dengue vaccine remains outside the NIP system.

This data reflects the immense pressure the Thai public health system faces from the hidden costs of vaccine-preventable diseases (VPDs). This evidence highlights the substantial but largely avoidable costs associated with vaccine-preventable diseases. From a health security perspective, preventing cross-border outbreaks is essential to safeguarding Thailand's healthcare capacity, strengthening system resilience, and ensuring the sustainable use of public health resources.

2.2.6 Policy Recommendations From Previous Studies

In response to systemic gaps, domestic and international literature outlines five key policy recommendations: (1) expanding the Universal Health Coverage (UCS) system to cover all stateless children; (2) establishing a Vertical Fund for border areas; (3) utilizing global financial mechanisms (such as Gavi or COVAX); (4) integrating management mechanisms with UNICEF; and (5) driving change through public-private partnership (PPP) mechanisms. These models serve as the foundational analytical baselines that this study seeks to evaluate and expand upon.

2.3 International Mechanisms to Support Vaccine Funding

2.3.1 The Global Vaccine Fiscal Landscape and Thailand's "Missing Middle" Status

The global vaccine management and financing landscape is driven by three pillars: (1) the World Health Organization (WHO), which sets technical standards and best practices; (2) UNICEF, which acts as the world's largest central procurement mechanism through its Supply Division to negotiate prices for developing countries; and (3) Gavi, the Vaccine Alliance, a public-private partnership that provides direct financial support to low- and lower-middle-income countries.

The research team would like to make the academic observation that, under this landscape, Thailand, as an upper-middle-income country (UMIC), faces the predicament of **"The Missing Middle Gap".** In other words, Thailand has a gross domestic product (GDP) level that exceeds the threshold for full Gavi funding. However, the country still has marginalized and vulnerable migrant populations that the regular health financing system cannot fully cover. Understanding this situation is crucial for designing specific fiscal mechanisms tailored to the border context.

2.3.2 The Role of Gavi and Global Innovative Financing Mechanisms

Gavi is a highly effective global mechanism. Since its inception in 2000, it has served over 1 billion children in 70 countries. Furthermore, between the years 2021-2025, Gavi has raised over USD18 billion to support both basic and emerging vaccines (PCV, Rotavirus, and HPV). In the context of Myanmar, Gavi contributed 80% of the country's total Employee Lifetime Intensive Care budget. However, as a consequence of the conflict, children in Myanmar's border areas are left without access to vaccines.

To address funding challenges, the global community has developed several innovative financing mechanisms. A notable example is the International Finance Facility for Immunisation (IFFIm), which has raised more than **US$8 billion** through vaccine bonds over the past 18 years. Another example is the establishment of COVAX during the COVID-19 pandemic. These initiatives demonstrate how innovative financing approaches can mobilize resources for immunization programmes and provide valuable lessons for the development of sustainable domestic vaccine financing mechanisms.

2.3.3 Bilateral and Multilateral Cooperation Mechanisms in the Thai-Myanmar Border Area

For areas along the Thai-Myanmar border, the current mechanisms for driving public health and vaccine initiatives require cooperation and funding from various sectors (fragmented support), including:

- **Bilateral Support:** Joint financing and implementation initiatives involving the Governments of Thailand and Japan in collaboration with WHO, including a JPY 453 million emergency health support programme.

- **International Development Support:** Contributions from international development and humanitarian partners, including the European Commission Humanitarian Aid Office (ECHO) and USAID-funded programmes. However, reductions in international assistance funding in 2025 highlighted the vulnerability of relying on external financing sources.

- **On the Ground NGO Operations:** The field operations of international non-governmental organizations (NGOs) such as Médecins Sans Frontières (MSF), the International Rescue Committee (IRC), Save the Children, and The Border Consortium (TBC) are carried out across nine shelters.

2.3.4 Policy Implications and Application Opportunities for Thailand

Given the limitations of being a "Missing Middle" country and the unsustainable nature of local assistance mechanisms, the literature suggests three main approaches for Thailand to strategically utilize international mechanisms for the development of domestic mechanisms:

1) **Utilizing Pooled Procurement Mechanisms:** Thailand can coordinate vaccine procurement through the UNICEF Supply Division mechanism to access vaccines at prices lower than the general market price, significantly reducing the budget impact.

2) **Enhancing Technical Assistance:** While Thailand is ineligible for direct Gavi funding, it can participate as a strategic partner to gain access to cutting-edge institutional knowledge, technology and technical support to manage immunization systems for vulnerable demographics.

3) **Designing National Innovative Financing Tools:** Lessons learned from the IFFIm mechanism can inform the development of innovative domestic financing instruments, including social impact bonds and other resource-mobilization mechanisms that could support a dedicated Border Vaccine Fund.

2.4 Sustainable Immunization Financing (SIF) Framework

2.4.1 Introduction and Overview of the SIF Framework

The Sustainable Immunization Financing (SIF) framework is an innovative theoretical framework developed by ThinkWell Institute in collaboration with Merck Sharp & Dohme (2017), formulated through in-depth comparative analysis of six leading countries in the

Asia-Pacific region (including Thailand), as well as other regions worldwide. This framework arose from the recognition of a new crisis:*"Referring solely to the epidemiological value and cost-effectiveness of vaccines is no longer sufficient".* This is particularly true for upper middle-income countries that are transitioning out of Gavi financial assistance and concurrently facing immense fiscal pressure from rapidly aging populations and non-communicable diseases (NCDs).

Suitability of the SIF Framework for This Study: Given that this study examines immunization financing and service delivery challenges among vulnerable populations in a country that has largely transitioned beyond eligibility for major international funding mechanisms, yet continues to face substantial internal inequalities and financing gaps, the SIF framework provides a particularly relevant analytical lens for understanding these challenges and identifying sustainable financing solutions.

2.4.2 The Four Pillars of SIF and their implications for Thailand

A Landscaping Analysis by Coe et al. (2017) identified four pillars of sustainable immunization financing. The research team applied these pillars to assess Thailand's current situation and identify potential areas for improvement.

Pillar I — Fiscal Space

Concept: The government's flexibility in allocating additional resources for immunization programmes.

Implications for Thailand: While the Philippines and Taiwan have successfully expanded fiscal space through innovative mechanisms such as earmarked sin taxes, Thailand currently allocates only 0.7% of its public health budget to EPI vaccines, suggesting potential opportunities for increased investment in preventive health measures.

Pillar II — Prioritization

Concept: Institutional mechanisms and decision-making processes for incorporating vaccines into the national immunization schedule.

Implications for Thailand: Thailand is widely recognized for its strong evidence-informed decision-making processes through institutions such as HITAP and ACIP. However, current assessment frameworks focus primarily on populations covered under the Universal Coverage Scheme (UCS) and may not fully account for the epidemiological and economic implications of migrant and non-Thai populations.

Pillar III — Strategic Purchasing

Concept: Designing payment methods and fiscal mechanisms that connect service providers and recipients cost-effectively.

International Context and the Situation in Thailand: Thailand is notable for being a single purchaser through the National Health Security Office (NHSO) mechanism, which uses a capitation payment system. However, this capitation system has structural conflicts when applied to border areas with high variable costs (e.g., cold chain transportation costs, compensation for outreach programs in remote areas), making the capitation payment unable to reflect true costs.

Pillar IV — Decentralization

Concept: The transfer of fiscal and healthcare roles to the local level.

International Context and the Situation in Thailand: Lessons from Indonesia and the Philippines reflect that decentralization without an accountability system results in significant fluctuations and declines in vaccine coverage. Conversely, Thailand has a centralized command system that helps maintain standards well, but this system lacks local flexibility to address the proactive needs of border contexts.

2.4.3 Applied Lessons: Innovative Financing Mechanisms

Beyond the core pillars, the SIF framework and UNICEF (2017) provided six innovative financial mechanisms that can be applied in Thailand, categorized by their feasibility level as follows:

1) **High Feasibility:** Examples include earmarked sin taxes like those in the Philippines (Thailand uses the Thai Health Promotion Foundation model as a template), promoting comprehensive insurance coverage, and public-private partnerships (PPPs).

2) **Moderate Feasibility:** The establishment of a National Vaccine Fund that accepts donations, similar to Taiwan's model, and a cross-subsidy mechanism.

3) **Low Feasibility (Short Term):** Capital market-based financing mechanisms, such as IFFIm-style vaccine bonds, are unlikely to be practical for border immunization initiatives in the near term. The scale of financing required remains relatively modest compared with the large, long-term funding needs that typically justify bond issuance. As a result, more conventional financing approaches, including dedicated public funding mechanisms and targeted resource mobilization strategies, are likely to be more appropriate in the current context.

2.4.4 Lessons on Vaccine Stockpiling Amidst a Health Crisis (Updates from ThinkWell 2020)

Analyzing fiscal sustainability requires consideration of how health financing systems perform during periods of crisis. As discussed in *Immunization Financing in the COVID-19*

Pandemic (ThinkWell, 2020), the COVID-19 pandemic served as a wake-up call for global health systems, highlighting three key vulnerabilities that are directly relevant to this study.

1) **The Scissor Effect:** Crises often cause a sudden drop in government revenue, while healthcare costs soar inversely. Reliance on temporary emergency financing is unsustainable and frequently "displacing" regular vaccine budgets, as seen in several countries that had to cut childhood vaccines to fund COVID-19 vaccines. This event underscores the need for Thailand to have a stable, dedicated funding mechanism.
2) **School-based Program Vulnerability:** The report indicates that the pandemic crisis forced school closures and instantly set back the effectiveness of the global vaccination system by more than 25 years. This is clinical evidence that a system designed to place all its hopes on schools is extremely fragile.
3) **Workforce Innovation:** Global health crises have highlighted the importance of workforce resilience and the need for task-shifting approaches that decentralize vaccine delivery. This aligns with the study's proposal to strengthen the role of community vaccinators and ethnic minority village health volunteers by providing formal recognition, appropriate training, and a clear legal mandate to support vaccination services at the local level.

2.4.5 Alignment of the SIF Framework with the Study Design

The research team summarizes the connection between the SIF framework and the research questions and objectives as follows:

Table 2.1

The core principles of SIF.	Empirical research questions that are responsive (Research Questions)	Position in the report
I: Fiscal Space	What is the budget impact of expanding vaccine coverage under various scenarios, and what are the sensitivities to changes in cost assumptions?	Quantitative analysis results (Chapter 4)
II: Prioritization	What do stakeholders at different levels perceive as systemic leverage points and the political conditions necessary for the sustainable development of the system?	Qualitative analysis (Chapter 4)
III: Strategic Purchasing	When integrating cost and budgetary data with on-site experiences and challenges, what service delivery models and fiscal mechanisms are feasible both financially and practically for children in border areas?	Synthesis and recommendations. (Chapters 4-5)
IV: Decentralization	How have border health systems and field workers adapted to cope with structural limitations (financial, geographical, personnel, language, and cultural)?	Qualitative analysis (Chapter 4)

2.5 Comparative Study of Vaccine Financing Management in Different Countries

From a comparative review of Thailand's health financing mechanisms and international models, the research team concludes that there is no one-size-fits-all approach to vaccine financing. Rather, each country offers distinct strengths and policy innovations that can help address specific public health challenges. Therefore, this section presents a comparative analysis of selected country experiences to identify policy lessons relevant to strengthening Thailand's border vaccination system. .

2.5.1 Case Study: Thailand (In-Country Contextual Review)

The success of the Exposure Program on Immunization (EPI), which has driven the coverage rate of basic vaccines in Thai children as high as 96-99 %, is considered the country's most valuable "structural and social capital". However, underlying this success lies Thailand's unique vaccine management and financing structure, which directly impacts policy direction for migrant populations.

According to the policy analysis report*"Thailand Country Brief: Sustainable Immunization Financing in Asia Pacific" (Coe & Gergen, 2017),* the systemic lessons learned regarding vaccine financing and management in Thailand can be synthesized into five primary dimensions, reflecting both foundational strengths and opportunities for future development:

1) Centralized Financing & Strategic Purchasing: Thailand utilizes a centralized budgeting and procurement approach through the National Health Security Office (NHSO) under the Universal Coverage Scheme (UCS), employing a capitation payment mechanism, whereby healthcare providers receive a fixed payment per enrolled beneficiary, to finance frontline health services. Although the EPI vaccine budget accounts for only 0.7% of the total public health budget, the centralization of procurement power has given the NHSO significant bargaining power and resulted in enormous economies of scale, enabling it to achieve the highest coverage rate in the region.

2) Purchaser-Provider Dynamics: Literature highlights structural tensions between the National Health Security Office (NHSO), as the purchaser, and the Ministry of Public Health (MoPH), as the primary provider. Ongoing policy debates have focused on whether vaccine procurement authority should remain with the NHSO or be transferred to the MoPH This phenomenon reflects the complex power dynamics and legal relationships between the institutions, which could impact the operational stability of vaccine stockpiles.

3) Evidence-Based Prioritization of Health Technologies: Thailand has been recognized as a world leader in using evidence-based approaches to inform the inclusion of new vaccines (NUVI) in the national vaccination schedule. This is achieved through a

cost-effectiveness analysis mechanism conducted by HITAP in collaboration with the Advisory Committee on Immunization (ACIP). This rigorous approach helps maintain excellent fiscal discipline. However, a word of caution: the stringent cost-effectiveness criteria may limit and delay the consideration of importing new vaccines compared to developed countries.

4) Innovative Financing and Vaccine Legislation: Amid the fiscal pressures associated with population ageing and the growing burden of non-communicable diseases (NCDs), Thailand has demonstrated considerable innovation in health financing through the use of earmarked sin taxes to support the Thai Health Promotion Foundation (ThaiHealth). In addition, the National Vaccine Institute (NVI) has explored legislative approaches to strengthen national vaccine security, including proposals for a dedicated vaccine financing mechanism supported by earmarked revenues. These efforts reflect Thailand's long-standing commitment to sustainable vaccine financing and health security. .

5) Constraints of Decentralization to Local Authorities: While Thailand has adopted policies to decentralize public health responsibilities to local administrative organizations, limited local budgets and workforce capacity continue to constrain implementation. As a result, centralized oversight of vaccine financing, procurement, and quality assurance remains important for maintaining equitable access and consistent service standards.

2.5.2 Case Study: Indonesia

Indonesia serves as a crucial policy case study reflecting the dynamics of vaccine equities in the Asia-Pacific region, given its status as the world's fourth most populous country and its archipelago of over 6,000 islands. According to a systems analysis report by ThinkWell *"Indonesia Country Brief: Sustainable Immunization Financing in Asia Pacific" (Coe et al., 2017b),* Indonesia is currently undergoing structural reforms to its healthcare system, and the research team has identified five key lessons to be learned:

1) Gavi Graduation & Transitioning: In the past, Indonesia relied heavily on foreign funding for vaccines (accounting for 15% of the total EPI budget, particularly from Gavi, which provided 9% or approximately US$14.3 million in 2014). However, due to stable economic growth, Indonesia surpassed the graduation requirement for vaccine funding in 2019. This situation has accelerated the government's need to urgently seek mechanisms for domestic resource mobilization to compensate for the funding gap.

2) Structural Impacts of Decentralization and Subnational Fragmentation: Since 2001, Indonesia has decentralized the authority and responsibilities for providing frontline health services to over 514 district health offices (DHOs) and local administrative organizations. A report by Coe et al. (2017b) highlights a critical challenge: approximately 61% of these local governments still lack adequate financial capacity, rendering them unable to meet their healthcare expenditure targets (Budget Under-execution).

Coupled with the central government's limitations in overseeing local budget allocations, spatial disparity is inevitable. Coverage rates for basic vaccines such as DTP3 and Measles have

declined or stalled to 81% and 69%, respectively, posing Indonesia undeniable challenges in addressing the problem of unvaccinated children.

3) Jaminan Kesehatan Nasional (JKN) Deficit & Strategic Purchasing): The government launched Jaminan Kesehatan Nasional (JKN), administered by BPJS Kesehatan, in 2014 with the goal of achieving universal health coverage. However, the JKN fund experienced substantial financial pressures (including an accumulated deficit of approximately US$1.48 billion in its first year and an out-of-pocket expenditure ratio of 47% of total health expenditure). Due to these fiscal constraints, JKN has not fully integrated EPI vaccine financing into its benefit package. As a result, vaccine financing continues to rely heavily on central government funding through a vertical programme. Importantly, the lesson is not that vertical financing mechanisms are inherently ineffective; rather, vaccine financing requires strong integration with primary healthcare delivery systems, information systems, and accountability mechanisms to ensure sustainability and equity. .

4) Domestic Production Policy and Technological Constraints: Indonesia's process for considering the inclusion of new vaccines (NUVI such as MR, HPV, PCV, JE, and Rotavirus) is closely linked to the policy of promoting domestic state-owned vaccine manufacturers (PT BioFarma). However, as BioFarma is in the process of developing its capabilities and technology to support new vaccine types, the country faces limited options, relying on imports through the UNICEF Supply Division mechanism in conjunction with Gavi to maintain price balance. This reflects the efforts to strike a balance between national self-reliance and rapid access to new public health technologies.

5) Strength of Community-Level Service Delivery Mechanisms (Posyandu Community Model): Despite structural limitations at the policy level, Indonesia has achieved remarkable success in creating the **Integrated Health Posts (Posyandu)** , a last-mile delivery system through village-level maternal and child care centers. Driven by local public health volunteers (Kader) and women's networks (PKK), this community mechanism is responsible for vaccinating and delivering basic services to 80-90% of the total rural child population. It serves as a powerful model of leveraging social capital and trust within community networks to drive public health initiatives.

Policy Implications for Designing and Developing Vaccine Management and Stockpiling Systems in Immunization Programs: According to the case study on Indonesia, the research team proposes the following leverage points that can be applied to Thailand's immunization strategy:

1. **Administrative Structure**: The caveats arising from decentralization underscore the necessity of operations in border areas requiring a centralized accountability mechanism . This prevents funds from being reallocated to other municipal priorities once disbursed to the local level.
2. **Fiscal Stability:** Maintaining the BVF as an independent special-purpose fund could help safeguard immunization resources for vulnerable populations from the fiscal volatility affecting mainstream health insurance systems. However, the fund should

function as part of a broader immunization strategy, integrated with service delivery, workforce, logistics, and information systems.

3. **Service Provision:** The success of the Posyandu system confirms the study's hypothesis that investing in and empowering frontline public health volunteer mechanisms (e.g., Developing a system for ethnic minority health volunteers or community vaccination administrators) is the most cost-effective strategy for breaking down barriers to access and creating a last-mile service tracking system for transnational families.

2.5.3 Case Study: Philippines

The Philippines is one of the fastest-growing economies in the Asia-Pacific region (averaging 5.1% annual growth) and has an advanced healthcare system. However, the management of the Philippines' healthcare system and vaccine stockpile is uniquely intertwined with a complex context of power dynamics and governance structures, as outlined in this systems analysis, *"Philippines Country Brief: Sustainable Immunization Financing in Asia Pacific" (Coe, Gergen, & Vilcu, 2017c).* The research team was able to extract structural lessons that can be applied in five key areas, as follows:

1) The Success of Expanding Fiscal Space Through Sin Tax Reform Act of 2012: The Philippines has achieved remarkable success and is highly recognized as a regional model for creating fiscal space to support health policy. The unhealthy tax reform law mandates that 85% of the additional revenue from tobacco and alcohol taxes be directly allocated to the public health budget. As a result, in 2015, the NIP program received a dramatic budget increase of 3.34 billion pesos, with 42% (1.4 billion pesos) coming directly from sin taxes. This fiscal innovation was key to enabling the Philippines to rapidly procure and incorporate expensive novel vaccines (NUVIs) such as PCV, HPV, and MR into the system.

2) Opportunities to Strengthen the Strategic Purchasing Role of PhilHealth's National Health Insurance Program (NHIP): Although PhilHealth's National Health Insurance Program (NHIP) covers more than 82% of the population, its role in immunization financing remains limited. PhilHealth currently supports only selected birth-dose vaccines (BCG and Hepatitis B) through a fixed payment mechanism of approximately 500 pesos per facility, while most routine childhood vaccines continue to be procured through the Department of Health's (DOH) vertical budgeting system. As a result, strategic purchasing for immunization remains only partially integrated within the national health insurance framework. This fragmentation contributes to continued reliance on household spending, with out-of-pocket expenditure accounting for approximately 54% of total health expenditure. Consequently, policy discussions have increasingly focused on expanding PhilHealth's role by incorporating routine childhood vaccines into the core benefit package.

3) Decentralization and Local Government Units (LGU): The Philippines' governance structure employs a highly decentralized system (under the Local Government Code of 1991),

granting administrative autonomy to local government units (LGUs). This structure creates systemic limitations in public health administration. Specifically, the Department of Health (DH) is solely responsible for centralized vaccine procurement, while personnel and operational expenses are the responsibility of the LGUs (each sharing 50% of the costs). Challenges arise when individual LGUs allocate health budgets vastly differently (varying from 1% to 9%) and lack a centralized feedback loop for inventory information. This has transformed the vaccine dispensing process from a "pull system" based on actual demand to a "push system" distributing vaccines without on-site data, impacting the national DTP3 vaccine coverage rate, which declined from 80% (2000) to 60% (2014).

4) Early Adopter Constraints: The Philippines had a remarkable vision of becoming the fastest early adopter of new vaccines in the region. However, due to limitations at the time, such as the lack of a systematic National Institute for Health Technology Assessment (NITAG) and Health Technology Assessment (HTA), many decisions were made without adequate preparation for fiscal sustainability and a thorough clinical risk assessment. A crucial international lesson is the dengue vaccine crisis during the years 2015-2016, where the national campaign was abruptly suspended due to safety concerns, an event that inevitably impacted public confidence in the overall vaccine system.

5) Community-Based and School-Based Service Delivery : To overcome geopolitical barriers and the vulnerability of certain areas, the Philippines developed a robust network of community health services (Barangay Health Stations) combined with proactive school-based immunization for elementary school students. Furthermore, in vulnerable or disaster-stricken areas, the government integrated collaboration with private pediatricians and NGOs to conduct house-to-house sweeps to effectively restore vaccine coverage.

Synthesis and Policy Implications for Thailand

Drawing on the five lessons identified from the Philippine experience, the research team proposes three considerations for the design of Thailand's Border Vaccine Fund (BVF)

Systemic lessons from the Philippines reflect the leverage points that the research team applied to design Thailand's BVF structure in three main dimensions:

- ***(a) On the Fiscal Mechanism:*** The Philippines' success confirms that securing funding for innovation, through **Earmarked Taxes** for instance proves effective**.** Alternatively, establishing a trust fund serves as a stable mechanism for generating new funds (additionality) without encroaching on the budget for basic public health.
- ***(b) Regarding the Administrative Structure:*** Limitations in information systems and budgets for LGUs underscore the need to use the **"Hybrid Model".** This involves centralizing oversight of standards and procurement (centralized procurement), while simultaneously granting provinces flexibility in operations and disbursement.
- ***(c) Regarding Policy Decision-Making:*** Lessons learned from vaccine imports underscore the need for rigorous institutional assessments to ensure clinical safety

and sustainable public health cost-effectiveness when incorporating new benefits for vulnerable populations.

2.5.4 Case Study: Vietnam

Vietnam is a rapidly growing economy (averaging 5.37% annual growth since the 1990s) and excels in mobilizing public resources for social causes resulting in significant success in achieving its national vaccine coverage targets. However, according to a systems analysis report by ThinkWell..."*Vietnam Country Brief: Sustainable Immunization Financing in Asia Pacific" (Coe & Gergen, 2017f),* Vietnam's public health system and vaccine supply are undergoing a significant policy transition, wherefrom the research team has extracted six structural lessons:

1) The Gavi Transition Plan, A Strategy for Fiscal Self-Reliance Transition: In the past, Vietnam's vaccination system received very high levels of funding from Gavi (e.g., subsidies for the purchase of the five-strain vaccine totaling US$4.7 million in 2016). However, economic growth led Vietnam to miss the funding eligibility threshold (graduation) in 2019. This marked a crucial turning point, forcing the country to accelerate the development of domestic fiscal mechanisms to offset nearly 100% of vaccine purchases independently, while simultaneously maintaining the stability of frontline healthcare facilities.

2) Health Insurance & Preventive Services: Health Insurance and Preventive Services: Although Vietnam's Social Health Insurance (SHI) scheme, administered by Vietnam Social Security (VSS), covers more than 71.6% of the population, current health insurance legislation restricts coverage primarily to curative services, excluding health promotion and routine immunization. This results in vaccination programs fragmented into vertical projects that are heavily reliant on the Ministry of Health's (MoH) budget. Currently, the MoH and its international partners are working to amend the law to include a preventive services package and propose increasing the per capita reimbursement rate, so the VSS can sustainably contribute to vaccination programs.

3) Challenges of Regional Budget Allocation (Decentralization & Financing Mismatch): Vietnam employs a decentralized healthcare management system. The Ministry of Public Health (MoH) is responsible for centralized vaccine procurement, while provinces and local administrative organizations bear the initial operational costs. However, in practice, disparities in financial status among provinces lead to significant inequality (most provinces contribute less than 10% of actual costs), resulting in shortages of funding and cold chain equipment in commune-level health centers. Consequently, over 91 districts have DTP3 vaccine coverage rates below 80%.

4) Innovative Fiscal Solutions to Create Frontline Incentives (Performance-Based Financing: PBF): To alleviate disparities at the provincial level, the central government initiated an innovative performance-based financing system for community health centers (CHCs), providing an incentive bonus of 3,000 VND per child completed all required vaccinations. This

budget allows facilities to manage independently (e.g., repair equipment or compensate staff), a powerful mechanism for boosting morale and enhancing proactive work on the last-mile.

5) Domestic Manufacturing and Health Technology Assessment (HTA): Vietnam maintains a highly stable vaccine supply chain, with state-owned manufacturers producing 10 of the 11 vaccines included in the National Immunization Program (NIP). This domestic production capacity has helped reduce costs and strengthen supply security. However, this domestically oriented strategy has also contributed to a relatively cautious approach by the National Immunization Technical Advisory Group (NITAG) toward the introduction of newer and more expensive vaccines. As a result, adoption decisions are often delayed until domestic manufacturing capacity or sustainable financing arrangements can be established.

6) Digital Immunization Registry & PPP: To overcome the limitations of paper-based data storage, Vietnam's Ministry of Health, under a public-private partnership (PPP) mechanism, collaborated with the telecommunications company Viettel to develop a national digital vaccination record system. This system links vaccination records to mobile phone numbers, enabling SMS reminders and accurately tracking groups of children who have migrated or are missing within communities. This effectively supports proactive vaccination campaigns for vulnerable populations.

Policy Implications for Designing and Developing Vaccine Management and Stockpiling Systems in Immunization Programs: The systemic insights gained from Vietnam reflect leverage points the research team can utilize to develop policy recommendations for the BVF project across three main dimensions:

1) **Fiscal Stability:** The context of declining international aid underscores the need for Thailand to establish **Vertical Border Vaccine Fund** to protect frontline vaccination budgets from being squeezed by limitations in the national health insurance fund.
2) **Employee Motivation:** The problem of resource inequality at the provincial level can be alleviated through the application of **performance-based financing** to motivate and compensate frontline personnel and ethnic minority health volunteers for their proactive duties.
3) **Data Innovation:** The success of the Viettel system highlights the potential for creation of a **Cross-border humanitarian health database system, or Humanitarian Data Trust.** Connected by digital technology, this will facilitate seamless tracking of vulnerable children and stateless populations who frequently move across borders.

2.5.5 Case Study: Malaysia

Malaysia is considered a leading example in the region for its centralized healthcare and vaccine management system, achieving near-total coverage amidst its goal of achieving high-income status, according to a ThinkWell analysis.*"Malaysia Country Brief: Sustainable*

Immunization Financing in Asia Pacific" (Moi & Gergen, 2017). The research team was able to extract five key structural lessons, as follows:

1) The Success of a Highly Centralized and Subsidized Healthcare System: The Malaysian government, through the Ministry of Health (MoH), functions comprehensively as both a budgetary provider, service provider, and regulator of the system. Vaccination services at public hospitals are nearly 100% subsidized, with virtually no fees charged to the public (the outpatient fee has been a fixed 1 ringgit, or approximately 8 baht, since 1982). This welfare state policy has resulted in highly equitable access to essential vaccines (EPI). In 2015, almost all states achieved DTP3 coverage exceeding 90%, and over 60% of states had coverage rates as high as 99%.

2) Sustained General Revenue & Financing Innovation: Malaysia's National Immunization Programme (NIP) is financed through a dedicated and stable budget allocation from general government revenue. As a result, the country has rarely experienced shortages of routine vaccines. Unlike some neighboring countries, Malaysia has not relied on earmarked taxes, trust funds, or other targeted financing mechanisms to support immunization. While this approach has provided stable financing for routine vaccine delivery, it may offer less flexibility when introducing newer and more expensive vaccines in the future. .

3) Political Will & Evidence-Based Prioritization: Although Malaysia has pioneered the establishment of a robust Malaysian Health Technology Assessment Section (MaHTAS) since 1995, in practice, MaHTAS's role in the import of new vaccines (NUVI) remains limited by institutional constraints. The report points out that policy decisions are often driven by **political will.** Fiscal readiness is a leading factor, more so than the economic cost-effectiveness assessment of public health programs alone. The NCIP subcommittee (established in 2016) is responsible for evaluating and coordinating these policies.

4) Health System Reforms & National Health Insurance (NHI) Transition: Domestic political hurdles have repeatedly delayed major healthcare reforms. Specifically, efforts to launch the National Health Insurance system (known as NHI or 1Care for 1Malaysia) stalled due to widespread public anxiety over potential privatization. However, if the NHI system can be implemented in the future, the Ministry of Public Health envisions integrating vaccination services as a core benefit, which would allow the government to systematically subsidize vaccination services through the network of private hospitals.

5) Private Sector Utilization & Vaccine Hesitancy: Despite the high coverage of government services, 20% of Malaysians still choose to receive vaccinations through private clinics and hospitals (out-of-pocket) for convenience, especially in major cities. Simultaneously, Malaysia is facing new challenges in **vaccine hesitancy/refusal.** This trend increased more than threefold between the years 2013- 2015. The phenomenon is rooted in safety concerns, belief in homeopathy, and cultural sensitivities regarding the status of halal. The government proactively responded through a joint venture with a foreign country to establish a domestic halal vaccine manufacturing plant (AJ Biologics).

Implications for Border Vaccine Financing and Service Delivery: The valuable lessons from Malaysia's case study provide strategic perspectives for designing Thailand's border vaccine storage facility (BVF) in three main dimensions:

1. **Policy Advocacy:** This confirms the hypothesis that decisions to include vaccine benefits for migrant populations cannot rely solely on epidemiological cost-effectiveness data, but must also consider **creating political will** and evidence-based communication on public health security to build consensus.
2. **Regarding the Integration of Service Delivery Systems:** To alleviate facility congestions and improve vaccine access in border regions with limited staffing, it is essential to establish a collaborative mechanism. Integrating the private sector and civil society can help ease the burden on public healthcare workers and expand immunization reach.
3. **Social and Cultural Aspects:** Vaccine hesitancy highlights the critical need for culturally and religiously sensitive communication strategies to build trust and reduce service refusal among migrant and ethnic populations.

2.5.6 Case Study: Taiwan

Taiwan is considered a leading comparative case study globally, boasting the most comprehensive National Health Insurance (NHI) benefit package, covering 99.9% of its population. However, according to the analysis report.*"Taiwan Country Brief: Sustainable Immunization Financing in Asia Pacific" (Gergen, Coe, & Mallow, 2017d),* in terms of vaccine financing, Taiwan employs a distinctly "protected and separated" policy structure, separate from regular health insurance budgets. The research team was able to extract five key systemic lessons, as follows:

1) Protecting Stability through the National Vaccine Fund (NVF): Between the years 2009-2010, Taiwan overhauled its vaccine financing by launching the independent National Vaccine Fund (NVF) under the Taiwan Centers for Disease Control (Taiwan CDC). Operating as the main national vaccine purchaser, the fund dedicates 82% of its budget to direct vaccine procurement and 15% to local cold chain system subsidies. Isolating the NVF from the general annual budget acts as a critical buffer, protecting the EPI from unpredictable financial shifts.

2) Legislative Exclusions from the National Health Insurance (NHI): Although Taiwan has a well-developed NHI system, the law explicitly prohibits the inclusion of NIP (National Immunization Program) vaccine procurement funds into the national health insurance fund. NHI benefits only cover personnel compensation and vaccination costs. This provision stems from experts at the Ministry of Health and Welfare who sought to protect vaccine administration, ensuring its flexibility and independence from the complex and time-consuming eligibility review process of the national health insurance board. However, this policy has a side effect, requiring some medical facilities (especially private clinics) to charge a small administrative fee ($0-5 USD per visit) to offset costs.

3) Fiscal Crisis Resulting from the "Scissor Effect": Taiwan is entering a super-aged society, necessitating the expansion of its services to include "life-course immunization." However, the NVF fund has faced a fiscal deficit since 2012 (accumulating to US$23 million in 2016). This crisis stems from the fund's primary income relying on **Sin tax on tobacco (Tobacco Surcharge).** Essentially, when the government's tobacco control campaigns are successful and smoking rates decrease, fund revenue shrinks accordingly. Furthermore, in 2017, the government increased tobacco taxes, but instead diverted the increased revenue to support long-term care funds for the elderly. This phenomenon reflects the threat of resource competition between NCDs and VPDs, serving as a crucial systemic warning for Thailand.

4) Public-Private Partnerships PPP & Philanthropic Donation: Despite the budget deficit, Taiwan has advanced legal mechanisms for soliciting private donations. A prime example is the Formosa Foundation's massive donation in 2014 to purchase pneumonia vaccines for the elderly nationwide free of charge, representing a powerful PPP model. However, the challenge lies in the fact that once the donation program ends and without government funding, the service cannot be sustained.

5) NIIS & Compensation Program: Taiwan has achieved the highest level of success in utilizing a National Immunisation Information System (NIIS) built on big data, enabling real-time tracking of vaccination coverage for all children and achieving a target of 95%. Furthermore, Taiwan was one of the first countries in the world to establish the Vaccine Injury Compensation Programme **(VICP).** Since 1986, by collecting a contribution of NT$1.50 per vial of vaccine purchased by the government, this system has helped to build strong institutional trust among the public.

Policy Implications for Designing and Developing Vaccine Management and Stockpiling Systems in Immunization Programs: Systemic lessons from Taiwan provide powerful strategies for driving Thailand's BVF project in three key areas:

1. **Financial Architecture:** The success of budget protection in Taiwan supports the hypothesis that the establishment of a **vertical border vaccine fund** is an effective solution for protecting frontline vaccine resources from limitations or deficits within the standard healthcare system.
2. **Stability of Capital Sources:** The lessons learned from the reduction in tobacco taxes clearly show that Thailand **should not rely on fiscal innovations from any single source.** It is advisable to integrate diverse funding sources (e.g., a combination of sin taxes and private sector/CSR funding like the Formosa model) to reduce volatility.
3. **Infrastructure and Confidence Mechanisms: "The proven efficacy of the** NIIS and VICP systems underscores the necessity of accelerating upgrades to the BVF **framework. Future integration should feature a** cross-border health information system (Humanitarian Data Trust) **and Adverse Events Following Immunization (AEFI)** safety surveillance mechanism**.** Together, these measures will mitigate risks and build lasting trust among migrant populations**."**

2.5.7 Case Study: Jordan

The research team would like to present a special case study of Jordan from a political economy and demographic perspective. It is the most similar comparative context to the situation along the Thai-Myanmar border. Specifically, Jordan is an upper-middle-income country (UMIC) that bears a very high burden of caring for refugees from its neighbor country, Syria.

A ThinkWell Jordan Country Brief on the Syrian refugee crisis indicates that non-Jordanians comprise more than 3 million of Jordan's 11.1 million population (27%). This demographic concentration resembles patterns observed in Thailand's border provinces adjacent to Myanmar. For example, Hong et al. (2025) estimated that non-local populations account for approximately 20–30% of the total population across the five Thai–Myanmar border provinces included in this study.

Strengths of Integrating Refugees into the National Vaccination System (Full NIP Integration): A cornerstone of Jordan's healthcare policy is the full, equitable integration of displaced populations into the National Immunization Program (NIP) .This approach helped sustain vaccination coverage for key childhood vaccines, including MMR, polio, and DTP, at levels above 90%, despite substantial demographic and fiscal pressures. Furthermore, during overlapping crises, including the COVID-19 pandemic, Jordan maintained a relatively stable annual NIP budget of approximately US$28–35 million, representing around 1% of total national health expenditure.

Policy Implications for Designing and Developing Vaccine Management and Stockpiling Systems in Immunization Programs: The most valuable aspect of this research is that the Jordanian government is actively considering and promoting these five fiscal strategies. **These targeted financial measures are designed to systematically address and alleviate the long-term public health burden associated with displaced refugee populations.**

1. **Improving Procurement Efficiency:** By leveraging the joint procurement mechanism through the UNICEF Supply Division, we can negotiate lower prices.
2. **Reframing Immunization as Investment:** By shifting the perspective on vaccinating foreigners from a "burden of charity" to "investment in health security (Health Security Framing)".
3. **Harmonizing Allocation and Disbursement at the Regional Level:** This involves establishing a local border health committee to increase flexibility in management to adapt to the specific context on the ground.
4. **Creating a Dedicated Protected Immunization Fund:** Establishing a vertical vaccine fund to separate and protect the budget from the volatility of general healthcare spending.
5. **Fundraising From Displaced Persons Networks and the Private Sector (Leverage Diaspora & Matching Funds):** developing innovative fiscal

mechanisms, such as vaccine bonds, and collaborating with the private sector to enhance liquidity.

The fact that Jordan, facing economic conditions and demographic pressures on a scale similar to that of Thailand's border, has analyzed and distilled a consistent set of strategic proposals constitutes powerful empirical validation. This phenomenon respectfully confirms the robustness and universal applicability of the BVF policy framework as a feasible and internationally recognized solution.

2.5.8 Case Study: Colombia

Colombia is recognized across Latin America for its advanced universal healthcare system and comprehensive NIP. However, according to the ThinkWell analysis *"Colombia Country Brief: Sustainable Immunization Financing"* (Coe & Madan, 2018), the financial stability of the country's healthcare system and vaccine rollout faces severe challenges due to economic strain and massive cross-border migration. From this analysis, the research team extracted five key systemic lessons:

1) The Pan American Health Organization (PAHO Revolving Fund): A distinctive feature of Colombia's fiscal architecture is that the NIP program has had an independent budget line, separate from the Ministry of Health's General Disease Prevention and Promotion Division (MSPS), since 2002. This structure provides excellent financial visibility and protects the budget from political interference. Furthermore, the government conducts centralized vaccine procurement through the **PAHO Revolving Fund.** It also gives Colombia access to the lowest vaccine pricing mechanisms in the world and creates an efficient and stable supply chain.

2) Macroeconomic Squeeze & Tranche-based Allocations: Following the decline in global commodity prices beginning in 2014, Colombia experienced a period of economic slowdown, with GDP growth falling to approximately 1.7% in 2017. These fiscal pressures affected immunization financing, with the national vaccine budget reportedly declining from US$114 million in 2013 to US$47.8 million in 2016. As a result, the country faced constraints in introducing new vaccines into the national schedule. Budgetary pressures also led to a shift from annual lump-sum allocations toward tranche-based disbursements, creating additional planning and implementation challenges for subnational health authorities. .

3) UHC Squeeze & Informality Premium: Although Colombia's healthcare system utilizes an Employment Permit System (EPS) to promote competition in service delivery, this structure faces significant pressure from its proportions. **The informal workforce accounts for as much as 47.3% of the labour force.** This phenomenon results in less than half of the country's population being able to contribute to the fund. Consequently, the government bears the burden of subsidizing insurance premiums for the majority of the population, severely straining the overall public health budget.

4) Decentralization Disparities and Performance Bonus Innovations: Under the Decentralization Law (Law 715), Colombia transfers operational funds to provinces and

localities in block transfers based on population size, without performance-based conditions. This type of decentralization has resulted in significant geographical disparities (for example, the remote province of Amazonas has only 11.1% DTP3 vaccine coverage). To address this, the government initiated an incentive-based subsidy program, providing a 10% budget bonus to municipalities that achieve vaccine coverage exceeding 95%. This model has proven highly successful in larger cities, although its effectiveness may be somewhat mitigated by the issue of installment payments from the central government.

5) Innovative Borderless Vaccination Services to Address the Venezuelan Refugee Crisis (Vacunación sin Fronteras): Colombia's experience with the Venezuelan refugee crisis closely mirrors the public health challenges observed in Thailand, highlighted by the fact that 24 out of 25 cross-border measles cases were identified among refugees. To mitigate this risk, the government executed a major paradigm shift via the *"Vacunación sin Fronteras"* campaign, eliminating health insurance and residency requirements to provide barrier-free, free-of-charge immunization services. Operationally, this strategy is backed by a cross-fund reimbursement architecture through the centralized ADRES entity and a national digital database to guarantee seamless tracking of multi-dose schedules.

Policy Implications for Designing and Developing Vaccine Management and Stockpiling Systems in Immunization Programs: Lessons from Colombia's crisis and response provide powerful evidence to support the policy proposals of the Thai Border Vaccine Fund (BVF) project in three key areas:

1. **Financial Architecture:** The separation of the NIP budget into specific budget lines and the existence of a centralized ADRES fund confirms the assumption that the establishment of **Vertical Border Vaccine Fund.** This is the best strategy for ensuring transparency and protecting frontline vaccine funding from the pressure of capitation payments.
2. **Regarding the Provision of Borderless Services:** The "Vacunación sin Fronteras" model serves as empirical validation for the BVF's proposal. Providing services to migrant children requires universal access by removing legal status barriers (decoupling), coupled with upgrading the level of accessibility and service provision. This model also highlights the necessity of a **cross-border health information system (Humanitarian Data Trust)** to track vaccination history systematically.
3. **Management and Motivation:** The failure to transfer unconditional funding underscores the need for Thailand's "Provincial Border Public Health Committee" to adapt its approach to **performance-based financing (PBF).** It serves as a tool to boost performance and fairly compensate frontline workers for their costs.

2.5.9 Synthesized Lessons on Regional Fiscal Sustainability (Latin America & Asia Pacific)

According to ThinkWell's global policy analysis report *"Sustainable Immunization Financing"* (2019), in both the context of Latin America (the region with the broadest

vaccination schedules, averaging 19.9 diseases) and the Asia-Pacific region (where 74% are middle-income countries or MICs similar to Thailand), the researchers found that despite having different geopolitical contexts, both regions are facing **structural challenges and opportunities for consistent innovation development.** This can be synthesized into lessons for designing border vaccine systems in three main dimensions, as follows:

1) Budget Stagnation and Gavi Transition Pressure: A common challenge among middle-income countries (MICs) is graduation from Gavi support, which requires governments to rapidly mobilize domestic resources to sustain immunization programmes amid constrained budget growth. Countries such as Indonesia, Vietnam, and India have faced this transition challenge . In Latin America, despite having laws supporting vaccine programs, only 13 countries have "protected budgets," while others often face budget cuts due to tight economic conditions. This is consistent with the Asia-Pacific region, where many countries face accumulating deficits (e.g., Taiwan's NVF). This phenomenon underscores the high vulnerability of reliance on a single central budget and the necessity of a systematic budget protection mechanism.

2) Fragmentation & Exclusion from UHC: Second is the problem of management efficiency. In Latin America, severely fragmented health insurance systems (e.g., Argentina and Mexico) result in overlapping benefits and a loss of up to 9% of the budget to systemic administrative costs. In the Asia-Pacific region, despite the rapid expansion of universal healthcare coverage (UHC), many countries (e.g., Taiwan, South Korea, the Philippines) have separated vaccine procurement into vertical programs without involving public purchasers, thus missing out on economies of scale. In this context, Thailand's centralized approach to financing and strategic purchasing, supported by the NHSO, offers an important model for improving efficiency and reducing fragmentation. However, it is still necessary to address the gaps in inequality arising from decentralization to local authorities without oversight mechanisms (as seen in Brazil and Argentina).

3) Regional Best Practices & Innovative Solutions: To overcome the aforementioned limitations, both regions have pioneered successful systemic mechanisms, which have become an empirical basis for this research, namely:

a. **Innovative Financing & Earmarks:** The use of "sin taxes" in the Philippines and Argentina, or revenue from state lotteries in Costa Rica, demonstrates the potential for creating stable additional budgetary resources (additionality).
b. **Performance-Based Financing (PBF):** Projects in Central America, Argentina, Vietnam, and South Korea use vaccine performance indicators to correlate budgets or provide bonuses to regions that meet targets, powerfully motivating frontline personnel.
c. **Cross-network Access and Digital PPPs Mechanism Agreements*:*** In Colombia and Mexico, where citizens can receive vaccines free of charge across health insurance funds, coupled with collaboration with the private sector (such as the Carlos Slim Foundation in Mexico or the Formosa Foundation in Taiwan) to develop digital medical records, this represents a leap forward in data integration and universal service delivery.

Policy Implications for Designing and Developing Vaccine Management and Stockpiling Systems in Immunization Programs: Based on a synthesis of theoretical and practical lessons learned across regions, the research team summarizes the leverage points leading to the recommendations of this research as follows:

1. **Fund Architecture:** The stagnant budget crisis in the country, according to MICs, confirms the core assumption that Thailand should establish a **protected vertical fund.** For cross-border vaccine distribution, a mixed financing system (e.g., special taxes and private sector funding) should be integrated to reduce vulnerability.
2. **Integration of Service Systems:** The innovative, seamless access model in Latin America aligns with the service-oriented concept of allowing individuals to walk in for free vaccinations, thereby bypassing the health insurance system. For border populations, this approach goes hand-in-hand with improvements to a **cross-border humanitarian health database (Humanitarian Data Trust)**.
3. **Frontline Management:** The challenges arising from regional inequality can be addressed through a universally accepted strategy for both regions, the adoption of **performance-based financing.** This will be used to enhance the efficiency of local border public health committees, in order to achieve cost-effectiveness and shared responsibility in a sustainable manner.

2.6 Immunization Financing for Migrants and Stateless Populations

The literature in this section reflects key findings for designing Thai policy, namely that migrants and stateless persons worldwide face similar systemic limitations. Lessons from successful countries show that solving this complex problem cannot rely on a single ministry, but requires a comprehensive mechanism, a **whole-of-government approach.** This represents a significant systemic challenge for policy implementation in Thailand.

2.6.1 Cold Chain & EVM Innovations

The most fundamental challenge in delivering vaccines in vulnerable areas is maintaining a cold chain temperature of 2-8°C. The World Health Organization (WHO) reports that vaccine losses in LMICs due to cold chain failures can be as high as 5-30%. While new technologies (such as solar-powered refrigerators) are costly ($1,500-5,000 USD per point), they are considered a worthwhile investment considering the long-term impact on vaccine losses.

To improve supply chain performance, WHO and UNICEF developed the Effective Vaccine Management (EVM) framework. Since its introduction in 2010, countries that actively implemented EVM principles, such as Kenya and Rwanda, have substantially reduced vaccine wastage rates. In addition, digital innovations, including electronic Logistics Management Information Systems (eLMIS), Internet of Things (IoT)-enabled temperature monitoring

technologies, and mobile alert systems, have significantly improved vaccine stock management and cold-chain performance, particularly in remote areas.

2.6.2 Global Frameworks & Systemic Barriers

The right of migrants to access vaccines is enshrined in key global policy frameworks such as the Sustainable Development Goals (SDG 3.8: UHC), the Immunization Agenda 2030 (IA2030), and the Global Compact on Refugees. However, the literature indicates that these populations still face challenges. **The six systemic obstacles** include: (1) legal status, (2) lack of documentation, (3) language and cultural barriers, (4) geographical difficulties, (5) lack of information, and (6) fear and distrust. This aligns with the Lancet Migration Commission's (2018) report, which emphasized the need for a whole-of-government approach to break down these barriers.

2.6.3 International Experiences in Migrant Contexts

To provide a perspective closely related to the Thai-Myanmar border context, the research team will present comparative case studies in four countries facing challenges from waves of migrants. The most important shared lesson is that...*"Open policies and adequate budgets will be meaningless without proactive service delivery mechanisms that can break down social barriers".*

1. **Lebanon (A Case Study on the Gap Between Policy and Practice):** The government integrated funding from Gavi into the state health system (blended financing) to provide free vaccinations for Syrian refugees. However, the coverage rate among children remained critically low at only 12.5 % (UNHCR, 2024). This lesson strongly underscores that benefits on paper cannot reach recipients if the system remains "reactive" at healthcare facilities. The implication for Thailand is that having a budget (such as the BVF fund) needs to be accompanied by practical implementation, **targeted outreach,** and giving flexibility to local areas.
2. **Türkiye (Human Resource Innovation):** Turkey has over 3.6 million refugees, but has successfully restored vaccine coverage through "workforce innovation," by implementing a sandbox certification policy that allowed more than 300 Syrian doctors and nurses to work in migrant health centers (MHCs) alongside the Turkish government. This lesson provides evidence to support the concept of **certification of foreign public health volunteers (Community Vaccinator Program)** to break down language barriers and build trust.
3. **Germany (Decoupling of Health Rights from Security):** Fear of deportation led to low vaccination rates, so the German government piloted a mechanism, **"Decoupling health rights from the immigration system".** By using electronic health cards in

conjunction with NGOs as intermediaries to create safe havens, this lesson reflects directly on Thailand's proposals for implementation of **Humanitarian Data Trust** to protect individual information and safeguard vulnerable populations.

4. **Bangladesh-Rohingya (Limitations of NGO mechanisms):** In the Cox's Bazar shelters, the formation of NGO consortiums facilitated the rapid implementation of vaccination campaigns in the initial stages. However, in the long run, creating a parallel system separate from the host state became highly vulnerable when foreign funding dwindled. This lesson serves as a clear warning that internationally-led public health initiatives must incorporate transition plans into the government system from the very beginning, rather than waiting until external funding runs out.

2.6.4 Empirical Evidence and Analysis of Barriers at the Local Level in Thailand

Field research in Thailand has provided clear reflections consistent with global theories, revealing "systemic blind spots" that urgently need to be addressed:

1. **Fiscal Reversal Phenomenon and Family Obstacles (Mae Sot District, Tak Province):** Chamchan and Apipornchaisakul (2022) found that 83.2% of migrant children lacked health insurance. Interestingly, caregivers without work permits were 4.12 times more likely to purchase health insurance for their children than those with permits. This counterintuitive finding may reflect a form of financial crowd-out, whereby expenditures on work permits reduce the financial resources available for other essential household expenses, including children's health insurance. Given the substantial cost of obtaining legal documentation, families that have already paid for work permits may have insufficient resources remaining to purchase insurance for their children. These findings support the exploration of innovative workplace-based co-financing mechanisms to reduce financial barriers to coverage. .
2. **Inequality and Declining Coverage Rates in the Metropolitan Area (Bangkok):** Kantayaporn et al. (2013) indicate that migrant children from Myanmar living in Bangkok have lower basic vaccination rates than both Thai children and children residing in Myanmar. Furthermore, only 46.2% of children retained a **Maternal and Child Health (MCH) handbook** after the age of two, reflecting the combined effects of language barriers and parents' work-related constraints. These findings suggest that gaps in vaccination coverage among migrant populations represent a broader national challenge rather than an issue confined to border areas.
3. **The Power of Knowledge and Information at the Local Level (Border district, Tak Province):** Research by Prakunwisit and Areesantichai (2015) confirms that one of the most important factors that motivates mothers to bring their children for continuous vaccination is the knowledge about the side effects of vaccines. The study found that mothers who had their children fully vaccinated had all previously received information and guidance regarding safety and post-vaccination fever. The lack of bilingual

documentation and an AEFI system in languages understood by the target population is therefore a major factor contributing to vaccination dropout.

To give all findings global epidemiological weight, the researchers refer to the Awoh and Plugge (2016) meta-study (sampling over 18,912 cases in LMICs), which summarizes two compelling theories:

1) **Migrant Disruption Theory:** Migration leads to the loss of previously supportive social networks, leaving migrants without health warnings. This theory supports the creation of **Humanitarian Data Trust** to serve as a notification function in place of traditional social networks.

2) **Migrant Adaptation Theory:** The failure was not due to the migrants themselves, but to the inflexibility of the end-user healthcare system. This theory justifies the support of the mechanism **foreign health volunteers (MHVs/BHWs)** to serve as a cultural bridge.

2.6.5 Synthesized Policy Directives

By compiling empirical evidence at international, regional, and local levels, the researchers were able to extract seven policy recommendations from the literature, which will serve as the basis for systematically designing the structure and mechanisms of this research study: (1) Expanding universal inclusion; (2) Breaking down documentation barriers (decoupling strategy); (3) Establishing targeted outreach teams; (4) Utilizing a health security framing framework; (5) Creating a specialized funding mechanism (vertical protected fund); (6) Integrating with educational institutions (school-based integration); and (7) Creating a robust cross-border data trust system.

2.7 International Policy Frameworks and the Thai Context

Designing mechanisms for accessing vaccine services and public health financing for vulnerable groups needs to be linked to international development frameworks to ensure policy alignment and sustainability. A literature review found that the most concrete framework for integrating vaccine benefits is **Global Vaccine Action Plan 2011–2020.** Endorsed by the World Health Assembly (WHA65.17), this action plan serves as a theoretical architecture guiding the policy direction of the vaccine stockpile at the forefront of this research study.

2.7.1 Overview and Guiding Principles of the Global Vaccine Action Plan (GVAP)

The GVAP action plan resulted from the integrated collaboration of global partners (such as WHO, UNICEF, Gavi, NIH, and the Gates Foundation) under a shared vision, *"Everyone in*

the world should be able to live a life free from vaccine-preventable diseases". To move toward the goal of universal health coverage (SDG 3.8) by driving through 6 guiding principles: (1) **Country Ownership,** (2) **Shared Responsibility,** (3) **Equity,** (4) **Integration with primary healthcare systems,** (5) **Fiscal sustainability,** and (6)**Service innovation (Innovation).**

2.7.2 The Thai Context and Spatial Challenges: Overcoming the Macro-Level "Information Masking Effect"

Internationally, Thailand is lauded for achieving the GVAP's ultimate goal by maintaining a high national vaccine coverage rate of 90-99%. However, the GVAP Action Plan provides one important strategic reminder, *"High national coverage figures often mask (masking effect) the problems and gaps faced by specific population groups at the local level".*

This phenomenon is clearly reflected in the context of Thailand, when an assessment report by the Ministry of Public Health and IHPP (2024) revealed worrying data that migrant children and stateless children under 4 years old in 5 of Thailand's border provinces had not received all the required vaccinations at **17.49 %** (95% CI 10.6%-24.3%), reflecting the underlying structural challenges beneath the surface of macroeconomic success.

2.7.3 Lessons from the Global Vaccine Action Plan (GVAP): Building More Resilient Immunization Systems

A decade-end performance review by a panel of WHO experts (SAGE, 2019), while finding success in reducing global child mortality, also frankly reflected that many strategic goals had not been achieved. These limitations provided invaluable lessons, which researchers synthesized into five core pillars to strengthen the BVF's architecture:

1) Transition from Top-Down to Country-Led: Top-down policies that focus on a single goal without considering context (equity without context specificity) often create rifts when translated into practical implementation.

2) Addressing Humanitarian Emergencies & Migration: The WHO acknowledges that traditional supply chain frameworks lack the resilience to accommodate the record high number of the migrant population.

3) Integration over Vertical Fragmentation: Creating sustainable coverage cannot rely solely on temporary vaccination campaigns, it must have primary care as its core.

4) Strengthening Sub-national Monitoring and Evaluation: A classic problem is that data is collected and sent centrally without feedback to be used to solve real-world problems, leaving local communities without the necessary information for management.

5) Fostering Private Sector & Civil Society Organization Partnerships: Past limitations have included overlooking the role of private capital and organizations outside the state system. This task is too large for the state to bear alone.

2.8 Cross-Sectoral Lessons from Education: A Model for Government Support

The research team presents a cross-sector reference based on lessons learned from the academic domain. Thailand's education sector provides the most progressive and tangible policy precedent for addressing vulnerable populations. The "Education for All" policy, which has explicitly included stateless children in the national education system since 2005, powerfully demonstrates that structural change is entirely possible when backed by sufficient political will. This comparison is not intended to critique the limitations of the healthcare system, but rather to offer new perspectives on how to apply the successful mechanisms of the education system to support and enhance the integrated and comprehensive frontline vaccine financing system.

2.8.1 Policy Evolution for Stateless Children

Based on a Cabinet resolution dated July 5, 2005 (which was reaffirmed by the Office of the Basic Education Commission (OBEC) in February 2026), the Thai government grants children without Thai nationality the fundamental right to attend all levels of public educational institutions. This comprehensive policy has resulted in over 200,000 children without Thai nationality currently registered in the regular education system and over 30,000 in Migrant Learning Centers (MLCs). This reflects the state's capacity to systematically access and regulate large-scale target populations.

2.8.2 Practical Challenges in the Education Sector (Implementation Challenges)

While national policies are open, underlying obstacles remain at the operational level. A report by Save the Children highlights that education systems continue to face a six-fold increase in dropout rates between 2020 and 2025, stemming from structural causes similar to those affecting public health, including: (a) a lack of documentation for enrollment; (b) language barriers and cultural differences; and (c) a lack of social acceptance in certain areas. This finding underscores that...*"An open rights policy must be accompanied by flexible support mechanisms at the local level (Local Flexibility)",* only then will true results be achieved.

2.8.3 Education as a Systemic Leverage Point

The researchers humbly assess that the education sector represents a powerful systemic leverage point if integrated with immunization programs, for four supporting reasons:

1. **Grouping of the Target population:** Most stateless school-aged children are in the school system and MLCs (Migrants Learning Centers), making it easier for

government agencies to proactively reach this population than searching within the community.

2. **Database Infrastructure Availability:** The school has a clear database and student record system, which can be further developed into a collaborative vaccination tracking system.
3. **Schools as Trusted Access Points:** Despite concerns about disclosing their legal status to state authorities, many migrant families continue to trust schools and enroll their children. This trust creates an important opportunity to deliver immunization and other public health services through education-based platforms
4. **Social Capital:** Teachers are respected and trusted by parents, and therefore have the potential to effectively act as a "bridge of understanding" regarding vaccines.

2.8.4 Synthesizing Cross-Sector Learning Gaps and Opportunities

When comparing institutional developments, it can be seen that while the education sector has had a well-established and implemented "open" policy for over 20 years, the healthcare sector is still in the process of developing mechanisms and policies to support the same population group. This policy gap opens up invaluable opportunities for cross-sectoral learning, driving the integration of public health priorities into all sectors through a comprehensive Health in All Policies (HiAP) strategy.

Proactive Vaccination Services in Educational Institutions and MLCs (School-Based Vaccination in MLCs): By leveraging close collaboration between the Ministry of Public Health and the Ministry of Education, transforming schools into health safety nets that sustainably provide knowledge and immunize children from diseases presents a crucial policy opportunity.

2.9 Methodology for Vaccine Demand and Budget Estimation

This section of the literature review compiles internationally recognized conceptual frameworks and technical tools, which the research team applied as a foundation for designing the research methodology in Chapter 3. The key is to select globally standardized tools that are flexible enough to adapt to the context and limitations of Thailand's border regions. This ensures that the study's results are robust, reliable, and can be fully referenced for policy decision-making.

2.9.1 Population and Vaccine Demand Estimation

For assessing targets in stateless and highly mobile populations, the researchers chose the following method: **multi-source triangulation.** By integrating data from the Ministry of Interior, the Ministry of Labour, the United Nations High Commissioner for Refugees (UNHCR), the

TBC organization, and the HDC system, instead of using traditional census data which often has omissions.

In calculating the vaccine dosage, the researchers referenced standards **Population Immunization Planning (PIP).** The WHO/UNICEF PIP framework uses the basic equation: Vaccine Requirement = Target Population × Number of Doses per Person × (1 + Loss Rate) × Target Coverage Rate. However, applying the PIP framework to stateless children presents unique challenges, including population size uncertainty, inconsistent vaccination schedules, and migration dynamics. Therefore, the researchers needed to adjust the equation to calculate "catch-up additionality" alongside regular vaccinations.

2.9.2 Costing and Budget Impact Analysis

1. **Cost Analysis (Ingredients Approach):**The researchers used WHO-CHOICE standards and UNICEF guidelines, which detailed the cost of vaccination into six categories: (1) vaccine costs, (2) medical supplies costs, (3) cold chain equipment costs, (4) personnel compensation, (5) logistics costs, and (6) administrative costs.
2. **Budget Impact Analysis (BIA):** Following standard guidelines, **ISPOR Task Force** (Sullivan et al., 2014) consisted of steps for population identification, calculation of pre- and post-illness burden, and assessment of cost differentials over a 1-5 year timeframe.
3. **Managing Uncertainty (Sensitivity Analysis):** Due to the highly volatile border context, the research team chose to use the following method: **scenario analysis.** This is achieved by developing a set of assumptions (low/medium/high levels) to provide policymakers with a comprehensive view of fiscal risks, as recommended by ISPOR.

2.9.3 Methodology for Assessing and Improving the Quality of Vaccine Coverage Data (WHO/UNICEF Heuristics Methodology)

The most significant methodological problem in managing transnational demographic data is the limitation of "denominators" in administrative data systems, which often lead to inaccuracies (e.g., calculated coverage rates exceeding 100%). Additionally, survey data is frequently susceptible to recall bias.

To address this root cause of the problem, the research team applied **WUENIC methodology** (WHO and UNICEF Estimates of National Immunization Coverage) based on the framework of Burton et al. (2009), which avoids the use of rigid statistical models and instead uses **"experiential heuristic rules".** Combined with the knowledge of local experts, there are 5 key rules as follows:

1) **Recall Bias Adjustment:** Use the calculated dropout rate from the group with actual vaccination records to calibrate memory-based reporting, in order to prevent overestimation of coverage.

2) **Maximum Cap Heuristic:** The maximum possible coverage should be capped at 99 % to acknowledge the epidemiological reality that there will always be a group of children who fall behind (zero-dose).

3) **Consistent Trends & Calibration Mechanism:** If management data and survey data conflict significantly, the system will prioritize the survey data, which is more rigorously methodological, and calibrate other data to ensure consistency.

4) **Country-Specific Autonomy:**They rejected the idea of using macroeconomic variables (proxy) in their calculations but insisted on assessing each district independently.

5) **Local Knowledge Incorporation:** The adjusted figures should be verified with community health volunteers, ethnic groups, and frontline staff to provide a logical and reasoned explanation for the phenomenon.

2.9.4 Application of Computational Logic and Artificial Intelligence (Computational Logic & Prolog Framework)

To enhance the transparency and verifiability of data, WHO and UNICEF further developed the WUENIC methodology in the following decade, based on the framework of Burton et al. (2012), by transforming heuristics into a **computational logic knowledge base.** Through the Prolog language, this framework has a powerful architecture consisting of four parts:

1. **Logic-Data Decoupling:** Separating raw statistical data (facts) from policy assumptions (rules) allows for adjustments to academic criteria without affecting the existing database.
2. **Supporting Expert Review and Exception Handling:** This allows the working group to enter "exception statements" to override automated computer rules in the event of a crisis (such as war or a sudden shortage of supplies).
3. **Closed World Assumption:** This enables the system to efficiently process cases where data is concealed or missing (negative logic).
4. **Review and Automated Explanations:** The system can instantly generate a natural language description of which rule was used to calculate or adjust each statistical figure, making the data 100% traceable.

2.9.5 Policy Implications for Designing Fiscal and Monetary Mechanisms

The adoption of the WUENIC methodology and computational logic (Prolog Framework) as a foundation for the study concretely legitimizes and strengthens the institutional basis of this study's recommendations in three main dimensions:

1. **Legitimacy of the "Humanitarian Data Trust:** The concept of separating raw data from data-processing rules provides a useful framework for developing a

Humanitarian Data Trust (HDT)—a secure data governance mechanism designed to facilitate transparent and controlled data sharing between Thailand's Health Data Center (HDC) and cross-border health networks, including Ethnic Health Organizations (EHOs). Such an approach could strengthen interoperability while safeguarding data security and reducing concerns about inappropriate access or interference

2. **The Decision-Making Role of the Provincial Border Health Committee:** The concept of exception handling within computational logic systems highlights the importance of expert validation mechanisms. Provincial Border Health Committees are well positioned to review unusual circumstances—such as disease outbreaks, population displacement, or border closures—and provide contextual information that enables statistical databases and planning assumptions to be updated in a manner that reflects operational realities. As the closest governance mechanism to frontline implementation, these committees possess strong legitimacy to validate critical local information and support evidence-informed decision-making.
3. **Accuracy of the Performance-Based Financing (PBF) System:** Applying a data calibration mechanism based on five heuristic rules can help ensure that performance assessments of frontline healthcare facilities are based on realistic and validated figures. This approach reduces the risk of unrealistic targets and may improve the efficiency and accountability of subsidy allocation.

2.10 Identified Literature Gaps and Integration Frameworks

Based on the literature review, the researchers have summarized seven key academic gaps, which serve as driving forces and milestones for this study to help fill and enrich the knowledge base:

1) Spatial Limitations: Most previous studies have been limited to research areas within a single province (especially Tak province), lacking a regional perspective. This study therefore aims to expand the scope to analyze and compare real-world situations across all five target border provinces.

2) Lack of Holistic Integration: Previous literature has often fragmented the analysis. However, this study is one of the first attempts to integrate all three dimensions: demand, feasibility, and financing.

3) Moving Beyond the Health Security Framing Framework: Traditional research is often driven primarily by a human rights framework, which may have limitations in attracting cooperation from security sectors. This study therefore adopts a new perspective, using the discourse of "national health security" as the central analysis.

4) Limitations on Standardized Bio-Intensive Impact Assessment (BIA): Past budget estimates have often been fragmented and based on differing assumptions. This study therefore

utilizes the International Standard Framework of ISPOR to assess budgetary burdens, ensuring reliable results that can be used as a basis for national policy.

5) Need for Systemic In-depth Understanding: Much of the literature is driven by quantitative surveys. Therefore, the research team filled this gap with qualitative research to find the answer to "why" systemic structures remain an obstacle, through the perspective of those actually working in the field.

6) Cross-Sectoral Learning Gap: This study initiated a process of bridging the gap between lessons learned and successful structures from the "education sector" and the "health sector" to identify common policy leverage points.

7) Bridging the Implementation Gap: Conventional literature often concludes with recommendations in principle, such as "UHC rights should be expanded," but without specifying details. This study therefore aims to design an operational strategy that clearly defines the "how" and "who is responsible" in a concrete manner.

Summary of Key Findings from the Literature Review

This literature review illustrates the complex architecture of public health financing and immunization systems for migrant populations. The key findings are synthesized as follows:

First, the vaccination gap among non-Thai children is not just an individual issue. Instead, it is the result of overlapping systemic barriers that the current national health insurance framework is not designed to accommodate.

Second, despite having powerful international aid mechanisms and funding sources (such as Gavi or UNICEF), Thailand, as an upper-middle-income country (UMIC), is currently in a precarious situation of the **"Missing Middle"**. Thailand cannot receive full vaccine procurement funding through Gavi, so there is an urgent need to develop innovative domestic fiscal policies.

Third, cross-border insights from Latin America, the Asia-Pacific region, and the Middle East (including Colombia, the Philippines, Taiwan, and Jordan), alongside cross-sectoral lessons from Thailand's education system, highlight several proven practices. These include deploying ad-hoc tax mechanisms, establishing vertical funds, utilizing data-trust technology, and decentralizing systems through performance-based financing (PBF). Adapting these strategies can help dismantle social barriers and accelerate targeted outreach.

Lastly, to ensure the highest credibility of policy recommendations, this study is prepared to apply internationally standardized methodologies and technical tools, including the WHO/UNICEF PIP model, the WUENIC data verification mechanism, and the ISPOR budget impact assessment framework.

The seven academic gaps in the existing literature underscore the necessity of this research, which aims to fill these gaps and systematically synthesize four dimensions of thought: security, finance, operational aspects, and information.

Chapter 3: Research Methodology

This study is driven by **Mixed Methods Research (MMR) Design** in the form of **convergent Parallel Design.** This is integrated with ThinkWell's (2017) Sustainable Immunization Financing (SIF) framework to enhance the validity of the findings, both in terms of empirical statistical data and in terms of in-depth understanding from the local context. The process involves three main parallel parts:

1) **Scoping Review:** This covers issues related to health insurance systems, vaccine financing mechanisms, international policy, and a comparative analysis of lessons learned from nine countries, based on the ThinkWell Institute's Country Briefs report (completed in Chapter 2).
2) **Quantitative Analysis:** In-depth analysis of the target population is conducted using the WHO/UNICEF Population Immunization Planning (PIP) framework for vaccine stockpiling, combined with four scenarios for vaccine demand estimation, along with Budget Impact Analysis (BIA) and Sensitivity Analysis.
3) **Qualitative Research:** Data was collected from a total of 128 key informants (114 from the Thai border area and 14 from the Myanmar border states) through in-depth interviews, focus group discussions, and field observation. The data was then analyzed using thematic analysis.

3.1 Research Approach and Worldview

3.1.1 Selection of Research Approach

According to the framework of Creswell & Creswell (2018), the selection of a research approach must integrate three components: worldview, design, and methods. This study requires the use of **Mixed-Methods Approach (MMR)** for four strategic reasons:

1. **Multidimensional Complexity:** This problem requires understanding both the "quantitative scale" (number of children, costs, budgetary burden) and the "qualitative context" (causes of obstacles, on-site adjustments).
2. **Information Balance:** We need to provide a generalization at the national level, along with a deep understanding of the local context.
3. **Responding to Stakeholders:** Policymakers want budget figures, while those on the ground want to know the mechanisms and methods that actually work on the ground.
4. **Triangulation:** To enhance credibility by integrating quantitative and qualitative evidence.

3.1.2 Pragmatic Worldview

The researchers adopted a pragmatic worldview, which Creswell identified as central to MMR because it is a framework that "focuses on problem-solving at the center, without being bound to any particular epistemological extreme." Five key aspects align with this study:

1) **Pluralistic:** Be open to using a variety of methods to understand the phenomenon.
2) **Problem-centered:** Let the problem dictate the research methodology.
3) **Real-world Practice Oriented:** The focus is on creating practical, actionable recommendations for the real world.
4) **Consequence-Oriented:**The value of research is judged based on its positive impact on society.
5) **Mixed Methods Compatible:** Supports the unified integration of quantitative and qualitative data.

3.2 Research Design: Convergent Mixed Methods Design

This study adopts a convergent mixed methods design from the options outlined by Creswell and Plano Clark (2018), guided by three supporting reasons:

1) **Theoretical Rationale:** The researchers aim to "compare and integrate" quantitative and qualitative results to provide a comprehensive picture of the problem, rather than simply using one method to explain another in a sequential manner.
2) **Practical Reasons:**Within a limited timeframe, concurrent quantitative and qualitative data collection helps to ensure efficient operations.
3) **Policy Rationale:** Both sets of data can provide a timely overview of the situation to inform policy decisions.

3.3 Unit of Analysis

This study defines three levels of systems analysis for comprehensive coverage:

1. **Population Level:** Children aged 0-5 years without Thai nationality in each target province (using QUAN data).
2. **Organizational Level:** Healthcare facilities (provincial/community/sub-district health centers), shelters, schools, and migrant learning centers.
3. **Individual Level:** Frontline staff, management, and service users (supports QUAL data).

3.4 Quantitative Research

The quantitative aspect focuses on answering questions regarding target population size, coverage, gaps, costs, and budgetary impacts, with the following details:

3.4.1 Thailand Side

Calculating the Target Population:

1. **The number and proportion of migrant children in the area:**
    a. According to the Thailand Migration Report 2024, the information consists of two parts:
        i. Number of foreign children registered with the Ministry of Interior.[1]
        ii. The median proportion of unregistered foreign children will be used in the analysis if the province has undergone more than one census.[2]
    b. Data Purpose: To estimate the number of migrant children in the area.
    c.
2. **A survey of the number of foreign children in the service area of hospitals under the Ministry of Public Health:**
    a. Information was received from 5 out of 9 district hospitals in Tak province.
    b. This data shows the number of foreign children by age (annually), from 0–12 years old, regardless of registration status.
    c. Data Objective: To be used in creating an age pyramid representation of foreign children in the area.
    d.
3. **Information on the Migration of Migrant Children Into and Out of the Area:**
    a. The information was received from the Ministry of the Interior.
    b. This is an overview of the number of foreign children who immigrate to and from each province.
    c. Data Purpose: To estimate the number of migrant children in the area.

Cost Calculation:

1. **Vaccine Cost Information:**
    a. Use vaccine cost data from the National Health Security Office.
    b. Refer to the number and types of vaccines that children aged 0-4 years must receive according to the Thai childhood vaccination schedule recommended by the Pediatric Infectious Diseases Society of Thailand in 2025.[3]
    c. The vaccine waste rate is based on UNICEF's report on the cost of childhood vaccinations.[4]
2. **Personnel Cost Data:**
    a. Collect data on the duration and number of personnel required for providing vaccination services from interviews with representatives from hospitals and community health centers.

b. Refer to personnel cost data from the salary rates for qualifications certified by the Civil Service Commission for appointment as regular civil servants (domestic educational institutions), effective from...
May 1, 2024[5]

3. **Medical Information for Vaccination Services:**
    a. Gather information on the types of medical supplies used for vaccination services from interviews with representatives from hospitals and community health centers.
    b. The cost of medical supplies is based on data from private distributors and retail stores.[6,7]
4. **Equipment Information for Providing Vaccination Services:**
    a. Gather information on the types of equipment used for providing vaccination services by interviewing representatives from hospitals and community health centers.
    b. The cost of general and medical equipment is referenced from the Standard Equipment Price List 2024 of the Budget Bureau.[8]
    c. Referencing computer equipment cost data from the Central Price Guidelines and Basic Specifications for the Procurement of Computer Equipment and Systems, December 2025 edition, Ministry of Digital Economy and Society.[9]
    d. Refer to the cost data for other medical equipment not included in the standard price list for medical equipment of 2024 from private distributors.[10]
    e. Set maintenance costs at 5% of the equipment price per year.
    f. The electricity consumption rates are based on product standard data from retail stores.
5. **Building and Site Information, Other Investment Budgets, and Other Indirect Costs:**
    a. Refer to the cost proportions of buildings, premises, other capital expenditures, and indirect costs from various studies related to the cost structure of vaccination operations in other countries.[11,12]

Hypothesis of the Study:

1. The age pyramid, based on data from the Ministry of Public Health, adequately reflects the relative age structure between children aged 0–4 years and 4–12 years.

2. The proportion of unregistered foreign children obtained from the foreign population census in 5 provinces provides a sufficiently representative representation of each area.

Estimation methods:

The estimation of vaccine demand is analyzed using the proportion-inverse proportion method, which consists of five main steps:

Step 1: Calculate the number of children aged 0–12 years from the data on the number of registered foreign children and the proportion of unregistered children, based on the Thailand Migration Report of 2024, using the following equation: $N_{0-12} = \frac{N_r}{1-p_{ur}}$

a. N_{0-12} Replace the total number of children aged 0–12 years with inclusive migration data by province.
b. N_r Replace the number of children registered in the Ministry of Interior's database as of the year 2023.
c. p_{ur} Substitute the median proportion of children not registered in the Ministry of Interior's database.

Step 2: Estimate the net migration of non-Thai children in each province using the following equation: ΔM = Min − Mout

where:

a. ΔM = net migration of non-Thai children in the province;
b. Min = number of non-Thai children moving into the province;
c. Mout = number of non-Thai children moving out of the province.
d. The total estimated number of non-Thai children in each province was then calculated as:

Ntotal = N0–12 + ΔM

where:

a. Ntotal = total estimated number of non-Thai children in the province after adjustment for migration;
b. N0–12 = estimated number of non-Thai children aged 0–12 years derived from Step 1.

Step 3: Estimate the number of non-Thai children aged 0–4 years using the age distribution derived from the age pyramid of non-Thai children aged 0–12 years, as follows: N0–4 = Ntotal × p0–4

where:

a. N0–4 = estimated number of non-Thai children aged 0–4 years in each province;
b. Ntotal = total estimated number of non-Thai children in the province after adjustment for migration;
c. p0–4 = proportion of children aged 0–4 years derived from the survey of non-Thai children in the catchment areas of Ministry of Public Health facilities.

Step 4: Estimate the number of children in each single-year age cohort by assuming an equal distribution of children aged 0–4 years across the age range, using the following equation: Nx = N0–4 / 4

where:

a. Nx = estimated number of children in each single-year age cohort (e.g., 1 to <2 years, 2 to <3 years, 3 to <4 years, and 4 to <5 years);
b. N0–4 = estimated number of non-Thai children aged 0–4 years in each province

Step 5: Estimate the annual number of newborns. The number of newborns was assumed to be equivalent to one annual age cohort (Nx).

Step 6: Estimate the number of children requiring vaccination under three coverage scenarios, as presented in Table below.

Table 3.1

Population	**Number of children vaccinated**	**Vaccine coverage**
Group of newborn babies	everyone	All items are listed in the vaccination schedule for Thai children aged 0-4 years.
Children aged 0 to less than 1 year.	For children who have not yet been vaccinated.	All items are listed in the vaccination schedule for Thai children aged 0-4 years.
Group of children aged 1 year to less than 4 years.	For children who have not yet been vaccinated.	This represents 70% of the recommended cost.

For data on vaccination coverage of foreign children, use information from the feasibility study report on providing basic vaccination services for foreign children in Thailand, published by the Foundation for International Health Policy Development (unpublished), using the following equation: $N_{vx} = N_x \, x \left(1 - p_{vac}\right)$

a. N_{vx} Replace the number of children each year who need to receive a vaccine with the number of vaccines available.

b. N_x Replace the total number of children in the area each year with the number of children in the area.
c. p_{vac} Instead of representing the proportion of children who have received all of their vaccinations,

3.4.2 Myanmar side

Source of information:

1. **The population census of Myanmar, 2019 and 2024[13]:**
   a. The 2019 Myanmar census provides the most complete population dataset currently available and was conducted prior to the major political and security disruptions that followed the 2021 military coup.
   b. The 2024 Myanmar census is the most up-to-date available, but it uses two survey methods: routine surveys for government-controlled areas and satellite imagery surveys and estimations for non-government-controlled areas. Furthermore, it lacks population pyramid data.
   c. To obtain up-to-date and sufficient data for estimating the number of children in each age group, this study used population pyramid data and total population figures for the area from the 2019 and 2024 censuses, respectively.

2. Vaccine Cost Information:

The primary analysis used standard vaccine cost data per child from the GAVI organization.

a. The sensitivity analysis was performed using standard vaccine cost data per child provided by a local non-profit organization in Tak province.
b. The cost information shown for both items includes transportation and vaccination fees.
c. Refer to the number and types of vaccines that children aged 0-2 years must receive according to the GAVI organization's recommendations.[4]
d. Calculate the number of children who need to receive vaccinations by dividing them into 3 cases, similar to the analysis used in Thailand.

Hypothesis of the Study:

1. The age pyramid from the 2019 census adequately reflects the age structure of children aged 0–4 years in 2024 and remains accurate in reflecting the age structure of children in conflict areas (educational areas).
2. The 2024 census data, estimated using satellite imagery (of the study area), is accurate enough to reflect the population size in the area.

Estimation Methods:

Step 1: Calculate the number of children aged 0-4 years using the 0-4 year age ratio based on the population pyramid in 2019 and the population of the area in 2024, using the following equation: $N_{0-4} = N\,x\,p_{0-4}$

a. N_{0-4} Replace the total number of children aged 0-4 years in the area with the figure for the year 2024.
b. N Replace the total population of the area with the figure for the year 2024.
c. p_{0-4} Replace the proportion of children aged 0-4 years from the population pyramid in 2019.

Furthermore, given the governance and administrative context of Myanmar, several self-administered and ethnic-controlled areas have implemented their own primary healthcare programmes and population enumeration systems. Therefore, separate analyses were conducted for these areas where data were available.

Following estimation of the population aged 0–4 years in Step 1, the remaining calculations followed the same approach applied on the Thailand side. Because migration-adjustment data were unavailable for Myanmar, the migration adjustment step used in Thailand (Step 2) was omitted. The estimated population was subsequently distributed across age cohorts, annual newborns were estimated, and vaccine demand was calculated using the same procedures described in Steps 4–6 of the Thailand analysis.

A key difference relates to vaccination coverage. Unlike Thailand, no reliable estimates of the proportion of children who had completed the full vaccination schedule were identified from either the literature review or stakeholder interviews in Myanmar. To generate a more realistic estimate of full vaccination coverage, the research team derived an adjustment factor based on the relative difference in BCG vaccination coverage between Myanmar children residing in Myanmar and Myanmar children residing in Thailand. Data on BCG vaccination coverage among Myanmar children in Thailand were obtained from reports of the International Health Policy Program (IHPP), while coverage estimates for Myanmar children in Myanmar were obtained from the available literature.14,15

The ratio between these two estimates was then used to derive an adjustment factor, as shown in the equation below: $discount = \frac{p_{bcg\,My}}{p_{bcg\,Thai}}$, $p_{son\,My} = discount\,x\,p_{vac\,Thai}$

a. $discount$ Replace the discount variable.
b. $p_{bcg\,My}$ Instead, the proportion of Myanmar children in Myanmar who have received the BCG vaccine.
c. $p_{bcg\,Thai}$ Instead of showing the proportion of Myanmar children in Thailand who have received the BCG vaccine.
d. $p_{son\,My}$ Instead, this represents the proportion of Myanmar children in Myanmar who have received all of their vaccinations.

e. $p_{vac\,Thai}$ Instead, the proportion of Myanmar children in Thailand who have received all their vaccinations is shown.The adjustment factor was calculated as follows:
   i. Adjustment Factor = pBCG,Myanmar / pBCG,Thailand
   ii. pvac,Myanmar = Adjustment Factor × pvac,Thailand

Where:

a. Adjustment Factor = relative adjustment coefficient derived from differences in BCG vaccination coverage;
b. pBCG,Myanmar = proportion of Myanmar children in Myanmar who received BCG vaccination;
c. pBCG,Thailand = proportion of Myanmar children in Thailand who received BCG vaccination;
d. pvac,Myanmar = estimated proportion of Myanmar children in Myanmar who completed the full vaccination schedule;
e. pvac,Thailand = observed proportion of Myanmar children in Thailand who completed the full vaccination schedule.

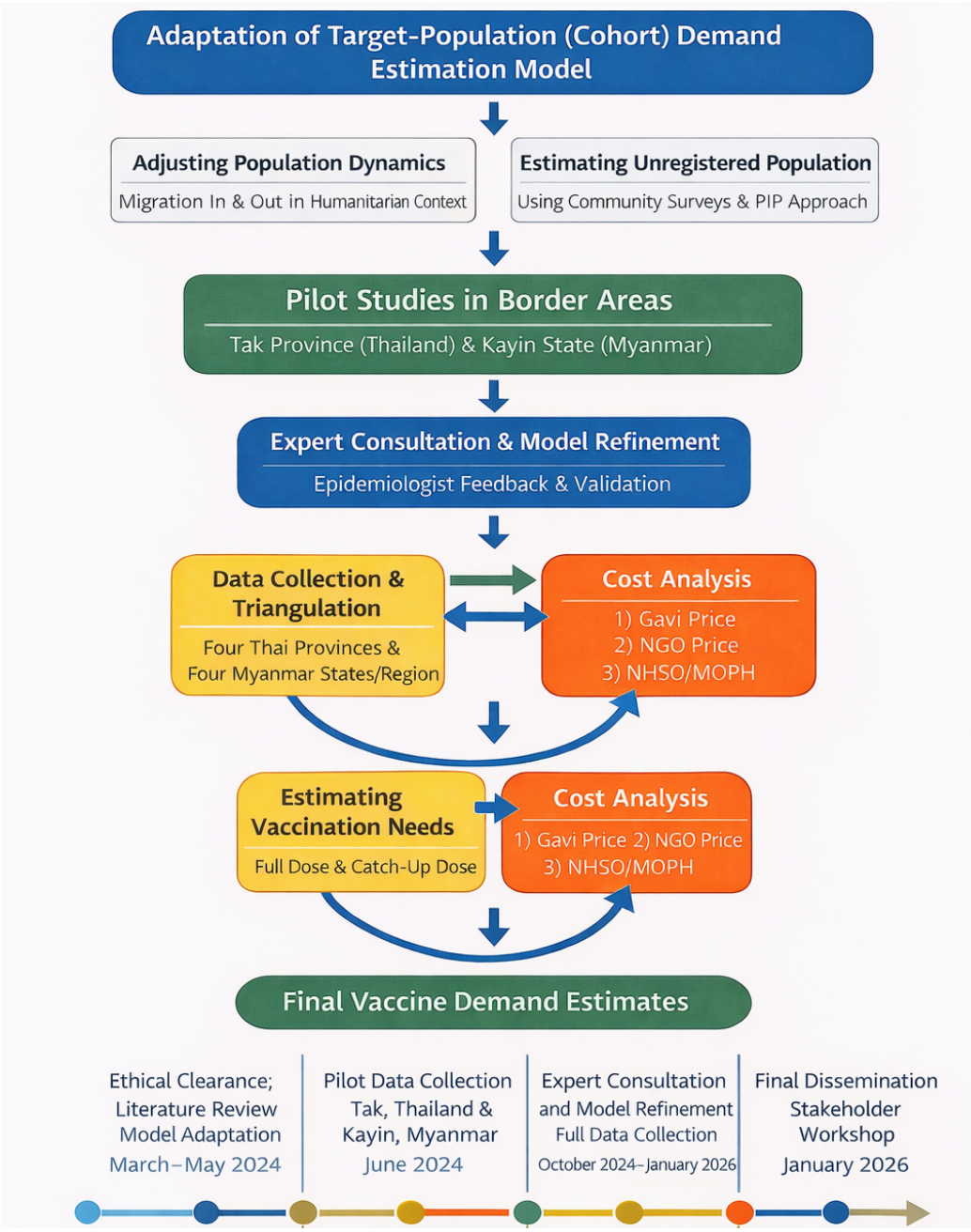


Figure : Analytical framework for population reconstruction, vaccine demand estimation, and costing across Thailand–Myanmar border settings.

3.5 Qualitative Research

To complete the research, the research team designed a qualitative study using the following methods: **multiple case study approaches** together with **thematic analysis** to find answers to "why" and "how" in a systems dimension that statistics cannot explain.

3.5.1 Study Area and Case Studies: Five Border Provinces

The selection process used purposive sampling in the 5 provinces with the highest systemic density and disparities:

Table 3.2 Selection of Case Study Areas in 5 Southern Border Provinces.

province	Reasons for choosing specific characteristics.	Spatial context
Tak	There are the highest number of stateless children (115,645) and 9 shelters.	Refugee and migrant worker center (Hub)
Chiang Rai	There is a high degree of ethnic diversity (Mae Fah Luang District, Mae Chan District).	Ethnic group context and highland areas.
Mae Hong Son	This remote area shares the longest border with Myanmar.	The biggest challenge in medical logistics.
Kanchanaburi	Central border area (Thong Pha Phum District, Sangkhla Buri District)	The security context is different from that in the North.
Chiang Mai	The school has a good health system (Ban Ton Pao Sub-district Health Center is a model).	It represents a best practice area for comparison.

(The research team also collected data from Mon, Kayah, and Gaya states of Myanmar in parallel for data completeness.)

3.5.2 Selection of Informants (Purposeful Sampling)

The researchers selected a total of 128 informants (114 from Thailand and 14 from Myanmar) using maximum variation sampling, covering four levels of informants (national, regional/provincial, district, and community) and four sectors (government, NGO, ethnic organizations, and private sector/employers). This sample size was considered sufficient to reach theoretical saturation.

3.5.3 Data Collection Methods

Perform Data Triangulation:

1. **In-depth Interview:** 78 individuals (60-120 minutes/individual) using a semi-structured interview guide.
2. **Focus Group Discussion:** 8 groups (36 individuals in total) focusing on practitioners for the purpose of exchanging experiences.
3. **Field Observation:** 18 times in the areas of sub-district health centers, shelters, and MLCs.

4. **Document Analysis:** Policies, annual reports, and authorized medical records.

3.5.4 Characteristics of Qualitative Participants

A total of 128 participants contributed to the qualitative component of this study through group discussions, in-depth interviews, online interviews, and field observations conducted between June and December 2025. Participants were purposely selected based on their direct involvement in immunization programmes, migrant health services, border health systems, vaccine logistics, health governance, and cross-border health collaboration.

On the Thailand side, 114 participants were recruited across five border provinces: Tak, Chiang Mai, Mae Hong Son, Chiang Rai, and Kanchanaburi. Participants represented a diverse range of stakeholder groups, including provincial and district public health administrators, physicians, nurses, pharmacists, public health officers, personnel from sub-district health promotion hospitals, immigration officers, university academics, staff from international organizations and non-governmental organizations, teachers and administrators of Migrant Learning Centers (MLCs), village health volunteers, and border security personnel.

On the Myanmar side, 14 key informants participated in online in-depth interviews. Participants included technical advisors, managers of ethnic health organizations (EHOs), programme managers, service providers, and representatives of international and non-profit organizations working in Karen, Karenni, Shan, Mon, and Tanintharyi areas. These participants were selected because of their direct involvement in immunization programmes, vaccine logistics, service delivery, and cross-border health coordination.

The inclusion of stakeholders from multiple sectors and administrative levels enabled the study to capture a broad range of perspectives regarding vaccine demand, financing, delivery systems, and governance arrangements for non-Thai children along the Thailand–Myanmar border. This diversity also strengthened the credibility of the findings through triangulation across different institutional and geographical contexts.

Table 3.3 Characteristics of Qualitative Participants: Thailand

Province	Group Discussions	In-depth Interviews	Total Participants
Tak	3	11	14
Chiang Mai	2	29	31
Mae Hong Son	7	15	22

Chiang Rai	10	18	28
Kanchanaburi	3	16	19
Total	25	89	114

Source: Fieldwork conducted by the research team, June–December 2025.

Table 3.4 Characteristics of Qualitative Participants: Myanmar

Area / Organization Type	Participants
Technical Advisors	1
International Organization Managers	1
Karen Health System Managers	2
Karenni Service Providers and Managers	2
Shan State Health Managers	8
Mon and Tanintharyi Health Organization Managers	1
Total	14

3.5. 5 Thematic Analysis & Reflexivity

The researchers analyzed the data through six steps based on Creswell's (2018) framework: (1) data preparation, (2) understanding the overall picture, (3) decoding (coding) using NVivo 14 software, (4) generating themes, (5) presenting the data, and (6) interpreting and making recommendations.

Throughout the research process, the team engaged in reflexive practice by maintaining **reflexive memos** that documented emerging assumptions, interpretations, and potential sources

of bias. In addition, experts from relevant government agencies were invited to review the findings, helping to ensure balanced interpretation and reduce the risk of relying on a single analytical perspective.

3.6 Methodological Scope and Boundaries of the Research Design

To ensure the convergent mixed methods research design is clear, accurately answers the research questions, and is within the scope of efficient educational resource management, the research team has defined the scope and initial agreements of the study in four dimensions, along with identifying limitations outside the scope (exclusions), as detailed below:

1) Spatial and Geographical Scope of Research: This study focuses on strategic research areas in five provinces along the Thai-Myanmar border, namely:**Chiang Rai, Chiang Mai, Mae Hong Son, Tak, and Kanchanaburi.** Because this is a vulnerable area with the highest proportion of refugees and migrant workers in the country, this research is conducted in conjunction with the collection of secondary data and interviews from public health organizations in the border states of Myanmar to obtain a complete and comprehensive reflection of the cross-border context.

2) Demographic Scope: The demographic unit of analysis for this study covers children without Thai nationality aged 0-18 years. However, in evaluating the budgetary impact analysis (BIA) and basic vaccine requirements, the researchers will **focus on young children aged 0-5 years.** This is an epidemiologically critical period, where vulnerable populations are classified into four main groups:

(1) Stateless children
(2) Refugee and Internally Displaced children
(3) Children who are dependents of migrant workers (Migrant workers' children)
(4) Transient cross-border children

3) Thematic and Content Scope: The research focuses on specific groups of basic vaccines included under Thailand's National Immunization Program (National EPI), with data extracted and evaluated across four core dimensions: (a) fiscal and budgetary mechanisms, (b) management and the supply chain, (c) frontline service delivery models, and (d) government policies related to rights of access.

4) Temporal Scope: Field research and data analysis were conducted up to March 2026. Secondary data from 2019 onwards were used to assess trends, and economic models were applied to forecast budgetary impacts for the period 2026–2030

5) Methodological Exclusions / Out of Scope: In order to maintain the rigor of research methodology and prevent the study results from deviating from the main objective, the research team would like to clarify what **outside of** the scope of this research includes:

(a) Clinical Dimensions: This study did not cover the clinical efficacy and medical safety assessments of individual vaccines.

(b) Technological Dimension: Research and development of new vaccine manufacturing technologies.

(c) Overall Dimension of Neighboring Areas: An in-depth analysis of Myanmar's healthcare system and medical institutions nationwide (with a focus on border states affecting Thailand).

(d) Other Spatial Dimensions: Children without Thai nationality residing outside the 5 target border provinces (e.g., in the Greater Bangkok area or the southern region).

(c) Dimensions of Special Benefits: Alternative or special vaccines that are outside the national immunization program (Non-EPI vaccines).

Chapter 4: Research Results

4.1 Quantitative Results

The quantitative analysis in this section provides a solid overview showing that while the problem is manageable in terms of resources, its **highly dispersed and variable nature requires careful consideration when designing border health policies**.The research team hereby reports the study results in accordance with the proportion-inverse proportional methodology outlined in Chapter 3, to serve as a statistical basis for systematic fiscal analysis and policy recommendations.

4.1.1 Target Population Size and Estimates of Foreign Children in Thailand.

Estimates of the number of foreign children by province in the five target study provinces (Chiang Mai, Chiang Rai, Mae Hong Son, Tak, and Kanchanaburi) clearly reflect the differences in the spatial size of the target population.

Applying the proportion-inverse proportion method, adjusted for the proportion of unregistered foreign children and the net migration factor, it was found that: **Tak province has the highest number of foreign children aged 0-12 years, totaling 115,645.** This accounts for over 50.2% of the total education population, followed by Chiang Mai (37,114 people), Kanchanaburi (30,019 people), Chiang Rai (27,528 people), and Mae Hong Son (7,746 people), respectively.

Detailed procedures for estimation and statistics by district and province for each age class cohort have been compiled and are presented in **Table 4.1** as follows:

Table 4.1: This section provides details on the estimated number of foreign children in Thailand.

Step	Indicator	Symbol	Chiang Mai	Chiang Rai	Mae Hong Son	Tak	Kanchanaburi
1	Number of children registered in the Ministry of Interior database (2023)	Nr	29,177	23,283	4,576	58,848	18,592

	Median proportion of unregistered children (%)	**pur**	**19%**	**14%**	**40%**	**49%**	**36%**
	Estimated number of non-Thai children aged 0–12 years	**N0–12**	**36,021**	**27,073**	**7,627**	**115,388**	**29,050**
2	**Net migration of non-Thai children**	**ΔM**	**1,093**	**455**	**119**	**257**	**969**
	Total estimated number of non-Thai children aged 0–12 years	**Ntotal**	**37,114**	**27,528**	**7,746**	**115,645**	**30,019**
3	**Proportion of children aged 0–4 years**	**p0–4**	**26%**	**26%**	**26%**	**26%**	**26%**
	Estimated number of non-Thai children aged 0–4 years	**N0–4**	**9,650**	**7,157**	**2,014**	**30,068**	**7,805**
4	**Estimated number of children per annual age cohort**	**Nx**	**2,413**	**1,789**	**504**	**7,517**	**1,951**

5	**Estimated annual number of newborns**	**N0**	**2,413**	**1,789**	**504**	**7,517**	**1,951**
6	**Estimated full vaccination coverage (%)**	**pvac**	**17.49%**	**17.49%**	**17.49%**	**17.49%**	**17.49%**
	Estimated number of newborns requiring vaccination	**Nv0**	**2,413**	**1,789**	**504**	**7,517**	**1,951**
	Estimated number of children requiring vaccination per annual age cohort*	**Nvx**	**1,991**	**1,476**	**416**	**6,202**	**1,610**

*Note: The estimated number of children requiring vaccination is identical across the four single-year age cohorts (0–1, 1–2, 2–3, and 3–4 years) because the analysis assumes an equal distribution of children across age groups (Step 4).

4.1.2 Cost Structure and Vaccine Service Provision in Thailand

The results of the cost analysis of childhood vaccination services according to Thailand's recommended schedule, categorized by type and cost combination, are shown below in **Table 4.2.** This significantly indicates that the format and location of service delivery are key factors in determining the actual cost per individual:

Table 4.2: The cost of vaccination services for Thai children, broken down by service type in Thailand.

Types and formats of service delivery.	Vaccine cost (%)	Vaccination service cost (%)	Indirect costs (%)	Total cost per customer (%)
hospital - In the place (Facility-Based)	2,341 baht (42%)	2,493 baht (45%)	722 baht (13%)	**5,556 baht (100%)**
hospital - school (School-Based)	2,341 baht (57%)	1,250 baht (30%)	537 baht (13%)	**4,128 baht (100%)**
Hospital - Village (Outreach)	2,341 baht (32%)	3,968 baht (55%)	943 baht (13%)	**7,252 baht (100%)**
hospital.St. - In the place (Facility-Based)	2,341 baht (51%)	1,650 baht (36%)	596 baht (13%)	**4,587 baht (100%)**
hospital.St. - school (School-Based)	2,341 baht (55%)	1,379 baht (32%)	556 baht (13%)	**4,276 baht (100%)**

Strategic Delivery Rationale: Analysis and Justification of Service Delivery

- **Highest-Cost Model (Community Outreach Services):** The estimated cost was THB 7,252 per fully immunized child. This reflects the relatively small number of children reached during each outreach session (typically 10–20 children), resulting in higher personnel and operational costs per child.
- **Lowest-Cost Model (School-Based Services):** The estimated cost ranged from THB 4,128–4,276 per fully immunized child, representing a cost reduction of approximately 30–40% compared with outreach services. Schools can assemble larger groups of children (typically 100–150 per session), generating substantial economies of scale and reducing the average cost per child.

Strategic Priority Paradigm Shift: Although school-based services offer the highest financial value, from a clinical and epidemiological perspective, the critical age group requiring basic vaccinations (e.g., BCG, OPV, MMR) is **early childhood (0-5 years).** Since this age group has not yet been integrated into the school system, reliance on schools as the primary mechanism creates blind spots. Therefore, the research team humbly proposes **targeted outreach.** This is a primary strategy that transforms the school health system into a secondary catch-up safety net.

4.1.3 Population Estimates and Budgetary Burden on the Myanmar Side:

To support cross-border collaboration planning, the researchers assessed the demand and scope of budget on the Myanmar side, categorized into two levels: the overall state level (Table 4.3) and the level of self-governing regions under EHOs (Table 4.4).

Table 4.3: Estimated number of children and cost of service provision in Myanmar (overall state level).

Analysis list	Karen	Kayan	Tanintharyi	Southern Shan	Mon
Number of children aged 0-4 years by state (persons)	138,000	27,000	128,000	235,000	159,000
Newborn babies who need to receive vaccinations (people)	34,500	6,750	32,000	58,750	39,750
Children aged 1-4 years who need to receive vaccinations (persons).	88,689	17,361	82,263	151,002	102,189
Cost based on GAVI criteria (million baht)	**298**	**58**	**276**	**507**	**343**
Cost-based assessment for NGOs (million baht).	**621**	**122**	**576**	**1,058**	**716**

Table 4.4: Estimates and Costs in Autonomous Regions (EHO Priority Zones)

Analysis list	Karen	Kayan	Tanintharyi	Southern Shan	Mon
Number of children aged 0-4 years in the area (persons)	62,223	18,303	8,178	6,541	5,017
Newborn babies who need to receive vaccinations (people)	15,556	4,576	2,045	1,635	1,254
Children aged 1-4 years who need to receive vaccinations (persons).	39,990	11,799	5,256	4,206	3,225
Cost based on GAVI criteria (million baht)	134	40	18	14	11
Cost-based assessment for NGOs (million baht).	280	83	37	29	23

4.1.4 Budgetary and Fiscal Comparison of Borderline Vaccines (Budget Impact Analysis)

A comparison of total budget burdens (BIA) leads to three key policy findings:

Table 4.5: Total cost of providing vaccination services to foreign children in Thailand (million baht).

Service format	Chiang Mai	Chiang Rai	Mae Hong Son	Tak	Kanchanaburi	Total

Hospital - on-site (Facility-Based)	47	35	10	148	39	**279**
Hospital - School (School-Based)	35	26	8	111	29	**209**
Hospital - Village (Outreach)	62	46	13	193	51	**365**
Community health center – on-site. (Facility-Based)	39	29	8	123	32	**231**
Community health center – School (School-Based)	37	27	8	115	29	**216**

Policy Revelations:

1) **Thailand Border Provinces:** Expanding services across the five border provinces would require approximately THB 209–365 million annually, depending on the service delivery model.

2) **Myanmar Scenarios:** Estimated annual financing requirements range from THB 58–507 million under Gavi pricing assumptions and THB 122–1,058 million under NGO pricing assumptions, demonstrating substantial sensitivity to vaccine procurement costs in conflict settings.

3) **EHO/Autonomous Area Scenarios:** Estimated annual financing requirements range from THB 11–134 million, suggesting that EHO-administered areas may represent feasible locations for pilot implementation.

Comparing Value Propositions (Value Proposition vs. Treatment Costs):

The budget for establishing the Border Vaccine Fund (BVF) is 209-365 million baht per year, which represents only **0.05% - 0.09%** of Thailand's annual public health budget**.** This budget allocation from the Ministry of Public Health helps protect over 230,056 vulnerable children. Proactive investment averaging 7,252 baht per person can prevent the burden of much more expensive treatment costs, such as:

1. **Treatment Cost of RSV in Older Adults:** Hospital treatment costs average approximately THB 70,000 per patient, around 10–17 times higher than the estimated cost of fully vaccinating one child.

2. **Treatment Cost of Influenza-Related Pneumonia:** Hospital treatment costs average approximately THB 150,000 per patient, around 20–36 times higher than the estimated cost of fully vaccinating one child.

3. **Macroeconomic Losses:** For example, the dengue fever outbreak in 2019 cost 60 billion baht.

4.1.5 Budgetary Sensitivity Analysis

The research team tested a one-way sensitivity analysis model using the ISPOR framework across four key variables and found that the variables having the greatest impact on budget stability were "target coverage level" and "vaccine price".

Table 4.6: Sensitivity Analysis of the Budget Impact on Thailand's side

Variable	base value (Base Case)	Lowest case	Maximum case (High)	Impact on BIA (million baht)
Population size	230,056 people	184,045 people (-20%)	276,067 people (+20%)	+/- 53.6
Vaccine price/cost	GAVI Standard	Deduct 15% from the purchase cost.	Plus a 30% private market rate.	-40.0 to +80.0
Level of target coverage	80 % (Target)	70 %	95%	-33.0 to +97.0
Vaccine loss rate	10 % (Wastage)	5 %	25%	-13.0 to +40.0

4.1.6 Operational Challenges and Logistics Performance

At the operational level, working in remote areas incurs hidden costs not reflected in standard budgets. An empirical example from Ban Mueang Pilok Sub-district Health Center, Thong Pha Phum District, Kanchanaburi Province, shows that a single mobile clinic trip takes two days and incurs additional costs of 20,000 baht for administering 50-60 vaccine doses. This results in travel costs alone reaching 333-400 baht per dose (compared to the normal average of 50 baht). This fact confirms the need for budget support for local flexibility.

4.1.7 Twelve Month Longitudinal Logistics Analysis (Warehouse and Front-Line Real-Time Logistics Analysis)

To provide a complete picture of the analysis, the research team extracted time series data from the NHSO's EPI1 system between January and December 2024. This data revealed structural limitations of the static order placement system (Static ROP/Max Limit), which does not keep pace with the fluctuations in cross-border demand, leading to **The Four Dimensions of Logistics Challenges (4 Logistics Failure Modes)** as shown in Table 4.7.

Table 4.7: Analysis of Challenges in Frontline Vaccine Inventory Management (Jan - Dec 2024)

Type biological materials	Warehouse fluctuation behavior over 12 months.	Logistics Challenge Modes
dT Vaccine	Inventory levels have remained at zero doses for 12 consecutive months, despite monthly orders of 320 doses.	Dimension 1: Persistent Severe Stockouts indicate a problem in the procurement process that is unable to meet front-line demand.
IPV Vaccine	Inventory is at 0 doses, totaling 10 out of 12 months.	Dimension 1: Cumulative and ongoing shortage of goods.
MMR Vaccine	Inventory levels fell below the ROP threshold in five major waves (February, May, July, September, December).	Dimension 2: Consumption Spikes & Recurrent Stockouts reflect the impact of specific, unmet demand.
OPV & Influenza	Inventories fluctuated wildly and dropped to zero on several occasions, forcing unusually large purchases to keep the system afloat.	Dimension 2: Sudden demand and duplicate shortages of goods.
DTP & Rotavirus	Inventories remained below the ROP level for almost the entire year (8-9 months) before falling to zero in December.	Dimension 3: Chronic Under-supply & Bullwhip Effect reflects inaccurate assessments of the target population.
J.E. Vaccine	From a shortage (0 doses in Sept, Novt), stockpiles soared to more than double the maximum limit in December.	The fourth dimension: Delayed Response Lag and Extreme Oscillation severely challenges the capacity of the refrigerator.

A Systematic Summary from the Warehouse Time Series:

The empirical evidence above confirms that **static reorder point (ROP) mechanisms** fail to address proactive border demand. The year-round shortage of key vaccines such as dT and IPV poses a vulnerability that directly undermines national public health security. These four dimensions of challenge serve as crucial logical bridges to support the proposals for logistics reform and fiscal decentralization outlined in Chapter 5.

4.2 Qualitative Findings

To gain a deeper understanding of the "hidden context behind the statistics," the research team conducted qualitative data collection in two parallel areas, covering a total of 128 key informants:

- **Thailand side (n=114):**The study was conducted through in-depth interviews, focus group discussions, and field observations in five southern border provinces (Chiang Mai, Chiang Rai, Mae Hong Son, Tak, and Kanchanaburi), involving medical personnel, academics, international organizations, and security officials.
- **Myanmar side (n=14):**The project involved online and on-site interviews across five states/border regions, focusing on leaders of ethnic health organizations (EHOs) such as KDHW, KNA, CHDN, and partner organizations.

All data was decoded and analyzed using thematic analysis via the NVivo 14 software, following Creswell's (2018) approach. The analysis of the Thai data revealed core themes that can be grouped into four main axes based on systemic logic (macro-themes: context, obstacles, response mechanisms, and policy direction), as detailed below:

4.2.1 Core Concept 1: Spatial Context and Vulnerabilities of Border Health Systems

The vaccination service system on the Thai-Myanmar border faces structural limitations that are too complex for normal public health mechanisms to handle, as reflected in five sub-issues:

1) Geographical Barriers and Infrastructure:

The 2,400-kilometer-long border, fraught with mountains, creates enormous logistical costs that the capitation budget system does not cover.

"For villages 2, 3, and 4, you have to travel by boat...in some places, you have to travel by water...During the rainy season, the distance might still be within the cold chain, but if the power goes out, we have to store it at the hospital."- Health center staff in Mae Hong Son and Kanchanaburi provinces.

2) Cross-Border Travel Dynamics:

Movement is a normal part of cross-border population growth, but the health information systems of the two countries are not interconnected. This means that children who received their first vaccine dose in one country may lose the opportunity to receive subsequent doses when crossing the border.

3) Cultural Diversity and Language Barriers (Linguistic Diversity):

The border area comprises over 15 ethnic groups. The fact that most healthcare personnel can only communicate in basic Thai or Myanmar creates a significant communication gap in healthcare settings.

4) Impacts of Political Instability:

The crisis following the coup (February 2021) and natural disasters led to a sudden surge of refugees entering Thailand, posing challenges in forecasting the demand for medical resources.

5) Local Adaptation:

Frontline workers must utilize their on-the-spot problem-solving skills (such as carrying vaccine containers on foot into the forest or relying on ethnic minority community health volunteers), reflecting commendable resilience, yet lacking formal systemic support.

4.2.2 Core Point 2: Systemic Barriers to Vaccine Coverage

1) Workload & Burnout:

The increased burden of service provision and paperwork from the undocumented population has led to burnout among personnel, resulting in high resignation rates in some provinces.

2) Financial and Cold Chain Constraints:

The budget discrepancy with actual costs in remote areas has resulted in some sub-district hospitals having outdated and unmaintained cooling equipment, leading to a risk of vaccine loss.

3) Information System Gaps:

The current HDC system is not designed to completely record the stateless population, so senior management lacks the visibility to assess the true scale of the problem.

4) Documentation & Fear of Arrest:

The fear of arrest or deportation is the thickest barrier preventing parents from bringing their children for treatment, even though the vaccines are free.

5) Adverse Effects Monitoring (Clinical Safety & AEFI Vulnerability):

This finding is critical: stateless parents frequently hide instead of seeking medical care for their children's severe vaccine reactions—like high fevers or blistering—due to fear of identity checks.

"If it's a foreign child who's hiding... when pus-filled blisters develop after the injection, their parents don't dare bring them to us. Sometimes they even flee, making it impossible to identify the cause and prevent errors."- EPI Coordinating Nurse, Umphang District

The lack of a user-friendly and rapid Clinical Adversarial Incident Investigation (AEFI) process leads to the spread of negative rumors and creates "vaccine hesitancy" in the community. This underscores the fact that simply having a budget to purchase vaccines is insufficient. A fair security monitoring system is necessary to build genuine trust.

4.2.3 Core Concept 3: Response Mechanisms and Factors Contributing to Success

1. The Power of Cross-Sectoral Collaboration:

In successful areas (such as Ban Ton Pao Sub-district Health Center, Chiang Mai Province), a common characteristic is the strong integration and collaboration between the Ministry of Public Health, the Ministry of Education, NGOs, and community leaders.

2. School Health as a "School-Based Safety Net":

"Once the children enroll, we check their vaccination records. If any are missing, we have a doctor come to the school to administer the vaccinations. Parents don't need to bring them, and they're not afraid of being arrested."— Director of the Learning Center for Migrant Children, Mae Sot District.

Although educational institutions are strategic locations that help save costs (according to the QUAN analysis), from an epidemiological perspective, school services cannot reach the target group of early childhood (0-5 years). Therefore, practitioners agree that school health should function as a "secondary catch-up" safety net while still needing to focus on "targeted outreach in the community", as the main mechanism.

3. **The Role of International Infrastructure:**

NGOs are a vital component that sustains the system in **refugee camps and temporary shelters along the Thai–Myanmar border**. A sudden withdrawal of aid (such as the case of USAID in 2025) therefore represents a systemic risk that the state must have a transition plan in place for.

4.2.4 Core Point 4: Policy Dimensions and Directions Towards Sustainability

Shifting the Paradigm from "Burden" to "Health Security" (Health Security Framing):

National policymakers and local practitioners have agreed that the promotion of this policy should be centered around the discourse of "national health security."

"This is for our fellow Thais. If we don't take care of them, the disease will spread to us."
-Sangkhlaburi Hospital

"We must say that if these children are not vaccinated, Thai children are at risk... This is our issue, not theirs."- Senior executives, Department of Disease Control.

4.2.5 Findings from Myanmar

Interviews with 14 Ethnic Health Organization (EHO) leaders in five border states provided findings that help fill in cross-border contexts on five key issues:

- **M1. Impact of the Coup:** The federal government's EPI system in border areas collapsed, forcing EHOs to fill the healthcare gap amidst massive limitations (it is estimated that over 50,000 children were left behind in Karenni state alone).
- **M2. Workforce Deficit:** One healthcare worker is now responsible for caring for a population 3-5 times larger than before the crisis.
- **M3. Reliance on assistance from Thailand and the International Community (Cross-border Support):** Thai organizations (such as Mae Sot Hospital, Umphang Hospital, Mae Tao Clinic) are crucial in providing training and vaccine support to EHOs (Ethnic Health Organizations).
- **M4. Cold Chain & Seasonal Friction:** Conflict areas without electricity rely on expensive solar-powered refrigerators, and the rainy season (May-September) paralyzes transportation, causing vaccination costs to fluctuate between $USD90 and $USD167 per person.
- **M5. Gray-zone Operations:** Under political constraints, EHOs operate with risks. The researchers estimate that sustainability can only be achieved when collaboration is elevated from a "grey area" to formal support within a humanitarian framework.

4.2.6 Integrated Synthesis: The Convergence on Health Security

The most powerful finding from qualitative data collection across both borders is the logical convergence under the concept of shared **health security.** The research team would like to synthesize the findings as follows:

"Providing vaccination services to migrant populations is a reactive strategy for protecting national security. Enhancing policy legitimacy to secure full resource allocation is crucial. Clear policies will help transition from a 'gray area' dependent on personal relationships to a sustainably funded 'state mission,' leading to true health security."

This synthesis not only strongly supports the empirical evidence in the literature (Tulchinsky & Varavikova, 2014), but also serves as a crucial foundation and "compass" leading to the design of policy recommendations in Chapter 5.

4.3 Within-Case Analyses

To illustrate the diversity of contexts and adaptation mechanisms in each area, the research team conducted an in-depth analysis following Stake's (2006) "Multiple Case Study" approach. The presentation sequence begins with the area facing the most intense challenges (Tak), moves to the area with the most complex topography (Mae Hong Son), and concludes with the area possessing outstanding primary data (Kanchanaburi), in order to create a systemic learning flow and lead to cross-case synthesis in the next section.

4.3.1 Case Study of Tak Province: The Epicenter of Migration and Shelters

Spatial Context: Tak Province serves as an epicenter of challenges in the border public health system, housing 115,645 stateless children aged 0-5 years (representing 50.2% of the total study area) and operating nine temporary shelters (including Mae Hla, Um Piang, Nu Pho, etc.), with Mae Sot District as the main service hub.

Mae Sot Hospital (Border Referral Center):

The hospital functions as a regional referral center that receives and refers refugee and migrant patients. To support this population, it has established a specialized migrant health unit under the Pediatrics Department utilizing an "M-card" system. This system records the medical histories of undocumented children who lack standard identification, linking them directly to regular Hospital Number (HN) codes. However, the hospital faces critical challenges: the patient workload vastly exceeds current staff capacity, and the withdrawal of financial assistance from the International Rescue Committee (IRC) has forced the facility to absorb a heavily increased burden of uncollectible medical expenses.

Mae Tao Clinic (MTC) Model of Civil Society Service:

The NGO founded by Dr. Cynthia Mong provides free basic health care and vaccinations to over 8,500 migrant children annually. MTC utilizes "mother health passport", the system which links children's vaccination records to accommodate frequent relocations, reflecting an adaptation to the lifestyles of service users.

Umphang Hospital (Model Cross-Border Vaccination Program):

Umphang Hospital is a prime example of cross-border service provision, encompassing three clinics in Kayin State and caring for over 300 children. It utilizes innovative systemic adaptation, including:

1. Cold Chain: Stored on the Thai side and shipped across the border only on days the unit is deployed.
2. Additional Workforce: Following the 2020 COVID-19 crisis, the replacement workforce was upgraded to include Volunteer Myanmar Medical Staff. Under the supervision of Thai officials, these medics administered the vaccines themselves.
3. *Triangulation system:* Use the EPI register + pink patient booklet + medical history from Umphang Hospital to verify the accuracy of the information.

Summary of Tak Province:

Tak Province serves as a "systems laboratory," showcasing the spectrum of comprehensive service delivery, from in-camp services and facility-based services to NGO-based services and cross-border services. This provides invaluable lessons learned for other provinces.

4.3.2 Case Study of Mae Hong Son Province: Challenges from Topographical and Remote Locations (Topographical Challenges)

Spatial Context: Mae Hong Son province shares the longest border with Myanmar (over 600 kilometers). All districts are border areas, and the terrain is characterized by complex, high mountains. There are approximately 25,502 stateless children (11.1%) in the province.

4.3.2.1 Pang Mapha Hospital (Services in High Mountainous Areas)

Located at an altitude of 1,200 meters above sea level, it is a crucial service point for the Muso (Lahu) and Shan ethnic groups. The critical challenges include extremely cold winter temperatures (below 5°C), which risk freeze-damaging vaccines, and road closures that last for 3-4 months during the rainy season.

4.3.2.2 Mae Sariang Hospital (Southern Zone Network Center)

It serves as a hub for four southern districts (Mae Sariang, Sop Moei, Mae Lan Noi, Khun Yuam) by utilizing innovation.**"Vaccine Convoy"**A four-wheel drive (4WD) vehicle equipped with a mobile cooler is deployed to work with sub-district health centers every three months.

4.3.2.3 Mae La-oon and Mae Rama Luang Shelters

The health program cares for a population of approximately 28,000 people (including about 3,200 children of vaccination age) under the support of The Border Consortium (TBC). When the IRC withdrew in 2025, the health mission was transferred to a partnership between TBC and the Provincial Public Health Office.

4.3.2.4 Summary and Adaptation of Mae Hong Son

To overcome logistical barriers and language diversity, health workers often carried vaccine cold boxes on foot through remote forest areas to reach underserved communities. Combined with the appointment of teachers and ethnic community leaders as interpreters, although the estimated coverage is only 38-45 %, it is considered a commendable achievement given the limited resources available.

4.3.3 Case Study of Kanchanaburi Province: The Central Border Context and the Completeness of Primary Data.

Spatial Context: Bordering the Mon and Karen states of Myanmar, Kanchanaburi encompasses four border districts (Muang, Sai Yok, Thong Pha Phum, Sangkhla Buri) and has approximately 26,255 stateless children (11.4%). A notable feature of Kanchanaburi is its highly detailed and comprehensive database system at the sub-district health center level, one of the best in this study.

4.3.3.1 Ban Pilok Sub-district Health Promotion Hospital, Thong Pha Phum District (Analysis of inequality at the village level)

This sub-district health center serves four villages with distinct demographic differences, as shown in Table 4.8:

Table 4.8: Analysis of Barriers and Vaccine Coverage at the Village Level (Ban Pilok Sub-district Health Center).

Village No. / Village Name	children (0-4 years)	childr en (4-12 years)	Tota l (peo ple)	Coverage (%)	Main problems and limitations (Key Bottlenecks)
1. Ban Pilok	11	55	66	98%	There were virtually no obstacles. (Permanently settled population)
2. Ban Bo Ong	8	51	59	95%	Time constraints (The parents, who are rubber tappers, were unable to arrive in time for the service.)
3. Aunt's New Farmhouse	6	25	31	90%	Logistical problems (remote areas are cut off during the rainy season).
4. Ban Pilokki	12	79	91	70%	Vulnerability problems (Illegal immigrants, lacking documents, and frequently changing addresses)
Total average	37	210	247	Average ~88%	

(Finding: This statistic reflects the empirical theory that if children are "in a stable settlement system," the Thai public health system can achieve nearly 100% coverage. However, the "tail group" consists of undocumented and hidden populations who require specifically designed access strategies.)

Ban Phra Chedi Sam Ong Sub-district Health Promotion Hospital and Sangkhlaburi Hospital:

The Three Pagodas Pass border crossing serves as a crucial hub for caring for 595 stateless children (mostly Mon and Karen). Sangkhlaburi Hospital was responsible for caring for 278 foreign newborns in 2024, with three infant deaths reported (a key indicator of infant mortality requiring systemic monitoring).

Ban Bongti Sub-district Health Promotion Hospital, Sai Yok Hospital, and Ban Phun Nam Rot Sub-district Health Promotion Hospital (Integrated Strategy):

These areas use a **mainstream integration** model. Instead of separate, vertical vaccination campaigns, foreign children receive immunizations alongside Thai children according to the standard age schedule, and their data is tracked via the regular public school health system.

Table 4.9: Summary of workload and service delivery patterns at the healthcare facility level in Kanchanaburi Province.

Service establishment	District	Children without state (0-12 years)	Newborn babies (2024)	Cross-border vaccination program	Learning center network
Ban Phun Nam Rot Sub-district Health Center	city	177	17	do not have	Use the public school system.
Sai Yok Hospital	Sai Yok	105	35	do not have	do not have
Ban Bongti Sub-district Health Center	Sai Yok	519	45	do not have	do not have
Ban Pilok Sub-district Health Center	Thong Pha Phum	247	19	do not have	-
Phra Chedi Sam Ong Sub-district Health Center	Sangkhlaburi	595	29	do not have	-
Sangkhlaburi Hospital	Sangkhlaburi	-	278	do not have	-

Summary of Kanchanaburi Province:

This area demonstrates that, even without a full-fledged cross-border program mechanism like in Tak province, the EPI system at the sub-district health center level has the potential to achieve coverage as high as 90% if the population in the area is firmly settled. The main challenge, therefore, focuses on designing proactive strategies to reach "hidden and undocumented individuals."

4.3.4 Case Study of Chiang Rai Province: Complexities of the Vaccination System in Ethnic Borderlands

Spatial context: Chiang Rai province is notable for its cultural diversity, being home to at least eight major ethnic groups (including Akha, Lahu, Lisu, Hmong, Mien, and Shan), each with differing legal statuses and access to healthcare. The area has approximately 33,083 children who

do not have Thai citizenship (14.4%) and shares borders with two countries (Myanmar and Laos), resulting in highly complex cross-border migration dynamics.

Mae Fah Luang Hospital (Ethnic Minority Medical Center)

Mae Fah Luang Hospital serves as a border hub responsible for an area with high ethnic diversity (especially the Akha ethnic group). To address the issue of missing vaccination records, the hospital has initiated an innovative system. **"VPD-EPI Tracker"** is a watch list for vaccine-preventable diseases, used to proactively monitor the status of children in the target group.

Synthetic Comparison: Flexibility of Cross-Border Service Models

From in-depth data collection in Chiang Rai, Kanchanaburi, and Tak provinces, the research team discovered that the nature of cross-border services is not a one-size-fits-all model, but is adapted to geopolitical conditions. This allows for the synthesis of three logistics management models:

- **Model 1: Targeted Outreach – The Case of Umphang Hospital (Tak Province)**
    - **Service Delivery Approach:** Myanmar Medics, including officials and volunteers, brought vaccines from the Thai side across the border to provide services in villages in Karen State.
- **Model 2: The Spillover Effect - Case Study: Tachileik-Mae Sai (Chiang Rai Province)**
    - **Service Delivery Model:** Children from Tachilek (Shan State) crossed the border to receive vaccinations at medical facilities on the Thai side (Mae Sai Hospital, Mae Fah Luang Hospital, Chiang Rai Hospital) on their own.
    - **Stakeholder Perspective:** *"Children from Tachilek come to receive vaccinations from the Thai side because it's only 30 minutes from the border. The vaccines are provided by a Thai hospital... This is a normal flow into our system."*(KII-16, EPI operator in Shan State) reflects the geographical advantages that facilitate attracting the target population for services (Pull System).
- **Model 3: Crash Course Approach - Case Study of the Mon National Health Commission (MNHC) in Kanchanaburi Province.**
    - **Service Delivery Model:** The MNHC organization receives vaccines supported by UNICEF through the Kanchanaburi Provincial Public Health Office (stored in Sangkhlaburi District) and then distributes them for day vaccinations in the Ye and Kawkareik areas.
    - **Stakeholder Perspective:** *"The biggest challenge is that the cold chain is on the Thai side, not the Myanmar side. Every time we administer vaccines, we have to take them across the border to administer them, and then bring the remaining*

vaccines back to the Thai side. That's why we use a crash course system, meaning we cross the border repeatedly."(KII-18, MNHC)

- **Systemic Limitations:** This model reflects the ability to solve immediate problems under political constraints, but it cannot be fully scaled up if a stable cold chain structure cannot be established in the country of origin.

The "70-Baht" Financial Barrier

In the Mae Fah Luang district, the research team found a micro-challenge with macro-level impacts: the "70 baht medical record opening fee". Although seemingly a small amount, for parents who work as daily wage earners, when combined with transportation costs and opportunity costs from missed work, this factor becomes a financial barrier that causes parents to decide to abandon bringing their children for vaccinations.

Data System Disconnect

The Ministry of Public Health's HDC system and the data recording systems of migrant child learning centers (MLCs) operate in a completely fragmented manner. This results in the loss of vaccination records when children change school systems, forcing medical personnel to restart the catch-up vaccination process from the beginning, reflecting a waste of resources.

Context of Elderly Caregivers and Topographical Constraints

In ethnic communities in the highlands (such as Mae Chan and Mae Sai districts), family structures have changed. Working-age parents are forced to work in urban areas, leaving their children in the care of their grandparents. These grandparents, in addition to having limitations in traveling down from the mountains, also lack accurate knowledge and understanding about vaccination schedules.

Workforce & Cold Chain Crisis

The border area of Chiang Rai faces an average of 3-4 cold chain failures per year, coupled with staff burnout, resulting in a high turnover rate of 30% per year for nurses in border health centers. This represents a structural vulnerability that challenges the long-term stability of service delivery.

Epidemiological Warning: Measles Outbreak 2025

Epidemiological data confirmed that the outbreak of 47 measles cases in Mae Sai District in 2025 was directly caused by an immunization gap. Statistics show that **73% of the patients were migrant children who had not received their second dose of the MMR vaccine.** This incident serves as a "near-miss" warning, providing concrete evidence that the vaccine access gap for foreign populations can escalate into a health security threat to Thai people in the area at any time.

Success Factors: Ethnic Health Volunteers

Despite these limitations, the researchers identified a significant strength: the role of ethnic minority health volunteers (HVs). These volunteers possess immense potential to break down communication and cultural barriers, thereby significantly reducing community mistrust. This finding aligns with internal academic evidence that supports strategic policy recommendations to establish **a Community Vaccinator Program**, which will be discussed further in Chapter 5.

4.3.5 Case Study of Chiang Mai Province: A Model of Best Practice in a Receiving Hub Context

Chiang Mai as a Receiving Hub: Chiang Mai province differs from the four provinces mentioned above because it does not have a direct border with Myanmar, but rather serves as a **"receiving hub".** With its large size accommodating migrant children from border areas, Chiang Mai serves as an educational hub with over 14,000 migrant students enrolled in Migrant Learning Centers and approximately 29,571 stateless children (representing 12.8% of the study area's population). Therefore, Chiang Mai is considered a best practice case study in managing vulnerable populations in urban areas.

Ban Ton Pao Sub-district Health Promotion Hospital, San Kamphaeng District (Innovation in Integrated Services):

This health center successfully developed a "vaccines-to-school" approach by integrating immunization and health screening activities into a **school breakfast programme**. The programme provides an additional incentive for parents to ensure regular school attendance, thereby improving access to preventive health services. As a result, coverage of the second dose of MMR vaccine among international students served by Ban Ton Pao Sub-district Health Promotion Hospital was **35 %age points higher** than the average across the five border provinces. . Furthermore, the system **"G-code student tracker"** has been initiated**,** to systematically track international students (which will serve as an important database for the research team to analyze data from 2022-2025).

Sankamphaeng Hospital (Logistics Innovation: Vaccine Bus)

To address the disparity in access to healthcare, Sankamphaeng Hospital has developed the **"mobile vaccine bus"** system**.** A mobile cold chain service, installed and deployed weekly to 12 sub-districts, achieves economies of scale by reducing service costs per patient by up to 22% compared to individual sub-district health centers operating their own units.

Chiang Mai Provincial Public Health Office (Policy and Financial Support):

From in-depth interviews, executives at the Chiang Mai Provincial Public Health Office identified three key success factors that served as crucial leverage points:

1. **Fiscal Will:** A commitment budget of 15 million baht per year has been allocated to provide healthcare for stateless children (this is the only province that has piloted this specific budget allocation in a tangible way).

2. **Cross-sector Partnerships:** Working closely with NGOs, particularly Save the Children and World Vision Thailand.
3. **Governance Mechanisms:** Establishing a provincial-level working committee that holds monthly evaluation meetings.**(This lesson serves as empirical evidence justifying proposal R1.4: the establishment of a provincial-level border public health committee, which the researchers will present in Chapter 5).**

Lessons for Scaling Up:

Chiang Mai serves as a valuable model, but in scaling up, policymakers should be aware that Chiang Mai's context is that of a "receiving city," which differs significantly from "crisis border areas" like Tak, Mae Hong Son, or Kanchanaburi. Therefore, school-based health strategies may need to be carefully adapted and integrated with the context of areas with refugee shelters and camps.

4.3.6 Cross-Case Synthesis of Lessons Learned

To provide a holistic view of the border public health system, the researchers conducted a cross-case analysis of data based on Stake's (2006) framework. The contexts, strategies, and structural obstacles of the five provinces can be identified as shown in Table 4.10.

Table 4.10: Analysis and Synthesis of Comparative Data from the 5 Target Border Provinces.

Dimensions of analysis	Tak	Mae Hong Son	Kanchanaburi	Chiang Rai	Chiang Mai
Target number of children	115,645 people	25,502 people	26,255 people	33,083 people	29,571 people
Proportion (from 5 provinces)	50.2 %	11.1 %	11.4 %	14.4 %	12.8 %
Prominent spatial context.	Refugee shelter and labor hub.	High, complex, and rugged mountains.	The central border region spans a wide area.	Ethnic diversity (8 groups)	Labor receiving hub
Shelters (Camps)	9 places	2 places	1 place	do not have	do not have
Cross-border program	There is (Umphang Hospital).	There are some.	do not have	do not have	do not have
Key NGO partners	MTC, IRC, MSF	TBC, MSF	TBC	World Vision	Save the Children

Dimensions of analysis	Tak	Mae Hong Son	Kanchanaburi	Chiang Rai	Chiang Mai
Key strategies	Mixed models	Vaccine convoy + Ethnic leaders	Mainstream Integration	Network of Village Health Volunteers from Ethnic Groups	School health + Provincial budget
Main challenges	Overwhelmed with workload + USAID budget cuts	Geography and logistical limitations.	Lack of documentation and population migration.	Fee 70 baht + language barrier	Data integration is not yet comprehensive.
Coverage (assessment)	30-50%	38-45 %	70-98% (high variability)	35-50 %	65-80 %
Factors for success	Cross-border organizational partnerships.	Convoy system	A community with stable settlements.	The use of ethnic minority community health volunteers in the area.	Provincial budget + cooperation with schools.
Structural constraints	The number of service users exceeds the capacity.	A geographical location that cuts off the cold chain.	Highly mobile transient population.	Linguistic and ethnic diversity	The complexity of urban structures.

4.4 Summary of Cross-Regional Synthesis Implications

This comparative analysis table confirms the key hypothesis that,**"There is no single public health policy that can address the needs of all areas (No one-size-fits-all solution)".** Tak province needs resource support to reduce congestion; Mae Hong Son needs logistical innovations; Chiang Rai needs a cultural bridge; while Kanchanaburi needs a system for tracking population migration.

However, one thing that all provinces face in common is **"Budgeting challenges and a lack of flexibility at the local level".** This is an empirical finding from this multi-case study.

Based on a multi-case analysis across regions, the research team summarizes five key structural findings that will form the basis for policy design:

First, the service model must be adaptive to the specific local context (Context-Adaptive Design: No One-Size-Fits-All).

Success in one area cannot be directly copied and pasted into another (e.g., the Chiang Mai school model cannot be applied to the high mountains of Mae Hong Son), the mechanism behind this is**"matching".** The correlation between the target population characteristics and service delivery models reflects the need for the healthcare system to reduce centralization (centralized standardization) and move adding **“decentralized implementation",** to provide local communities with the flexibility to design services that are appropriate for their own ecosystems.

Second: Stable communities have access to the system. The real problem lies in the "tail" of population distribution.

The most compelling finding is that foreign children living in "stable communities" achieve vaccine coverage rates on par with Thai children (90–98%), indicating that the low average coverage is not a systemic failure of the immunization program itself. Instead, it stems from a lack of accessibility for a highly mobile "tail population" (30–40%) driven by fear of identity tracking. To address this, the researchers propose a specialized **distribution-tail strategy.** This model demonstrates that deploying dedicated proactive service teams—despite a high marginal cost per case—provides the most significant epidemiological return on investment by effectively breaking the chain of disease transmission.

Third: Cross-border cooperation models are innovative and can completely close gaps, but they have systemic limitations (Cross-Border Partnerships Are Possible — But Bounded).

The success of Umphang Hospital (Tak Province) in using Myanmar medics as cross-border vaccine distributors demonstrates the power of **"relational innovation".** However, this model has geographical limitations if it needs to be extended into the deeper areas of neighboring countries (cold chains that are 100% dependent on the Thai side). Furthermore, the researchers also found parallel models, such as the phenomena **spillover.** This refers to children crossing over to receive vaccinations themselves in Chiang Rai province, and the model [of the program] Crash Course. The injection and withdrawal of troops in Kanchanaburi Province demonstrates that a "forward defense" strategy is feasible, but the government needs to provide technological support and legal protection to transform personal relationships into a national-level structure.

Fourth: Provincial budget commitment is the most powerful determinant of success.

Chiang Mai was the only province identified as allocating a dedicated budget of approximately THB 15 million annually for stateless children. This finding suggests that earmarked local investment can strengthen accountability and stimulate service innovation (e.g., mobile vaccination buses) more effectively than non-earmarked funding of a similar magnitude. It also supports the view that increasing provincial investment in proactive vaccination programmes may represent a feasible near-term policy pathway, subject to existing budgeting and regulatory frameworks.

Fifth: Provincial averages mask community-level inequalities (Heterogeneity Within Province Masks the Real Problem).

Using provincial averages is a tool that causes policymakers to overlook problems in hot spots. For example, in the same district, two sub-district health centers may have coverage differences of up to 28% points. This phenomenon reflects the framework**"aggregation bias".** The researcher team therefore emphasized the need for the HDC system to be restructured to be able to disaggregate data of vulnerable populations at least down to the sub-district level, in order to ensure that resource allocation is truly targeted.

4.4 Integrated Data Synthesis (Joint Display & Integration)

In accordance with the Convergent MMR methodology, the researchers integrated quantitative (QUAN) and qualitative (QUAL) data to arrive at a unified conclusion as suggested by Creswell & Creswell (2018), as follows:

Joint Display Table: Demand Size and Budget Burden:

Table 4.11: Integration of QUAN and QUAL data in the main study topics.

Issue	QUAN (Quantitative) Results	QUAL (Quarterly Quality Assessment) results	Integrated interpretation
Population size	Tak province: 115,645 people / Total: 230,056 people	*"These children don't stay still; they move around with the seasons."*	(Convergent): The figures are variable; the budget should be flexible (rolling).
School-based costs	Economies of scale	*"Injecting 50-60 people at once is a great way to save time."*	(Convergent): Confirms the commercial viability of school health.
Main obstacles	Documents 50.9%, Geography 42.1%	*"Afraid of being arrested / Can't enter the mountain."*	(Convergent): The obstacles are consistent across both statistics and real-world experience.
Budgetary burden	209-365 million baht/year	*"It must be a specific mechanism, not normal capitation."*	(Convergent): The figures are highly probable, but require a special fund mechanism.
Appropriate format	School-based learning is 30% cheaper than outreach.	*"School is the answer, but the most critical age range for children*	(Complementary): Proactive services (outreach) must be the primary mechanism for early childhood education, and school-based learning

		aged 0-5 years is still not attending school."	should serve as a supplementary channel.
Adjustment discourse	(Not included in quantitative surveys)	*"It should be described as Health Security, not Human Rights."*	(Complementary): High-quality data complements political dimensions that numbers cannot quantify.

Side-by-Side Comparison and Data Transformation:

When qualitative themes were converted into frequency numbers following the approach of Onwuegbuzie & Leech (2006), powerful findings were discovered:

- **89.5% of interviewed stakeholders** supported a service delivery model that prioritizes targeted community outreach for children aged 0–5 years while using school-based vaccination as a secondary catch-up mechanism for school-aged children.
- **87.0% of national-level stakeholders** emphasized the importance of health security framing as a policy lever for advancing immunization initiatives.

Summary of Integration: Three Dimensions of Convergence and Enhancement:

Data integration provides powerful answers in three dimensions:

1) **Convergence:** Statistical data and interviews point in the same direction on fundamental issues (population size, barriers, costs), confirming that the findings are unbiased.
2) **Complementarity:** Policy tools such as health security framing demonstrate that establishing the BVF is not solely a technical or economic challenge. Successful implementation also requires policy entrepreneurship and strategic communication that resonate with policymakers and decision-makers.
3) **Contradictions that Reveal Depth (Divergence/Probing):** Although the average cost of proactive services is 73 USD/person (according to QUAN results), qualitative data reflects that in remote areas, travel costs can exceed 400 THB/dose (outlier costs), confirming that the establishment of the fund requires a flexible "contingency reserve."

4.5 Synthesis of Findings:

Based on all the empirical evidence, the model that best meets both fiscal and operational requirements is the **hybrid model**. This model consists of: (1) proactive service delivery at specific locations, a key strategy for children aged 0–5 years; (2) school-based services, which serve as a safety net for older children; and (3) the establishment of the **Border Vaccine Fund (BVF)**. With an annual budget of 209–365 million baht, this model operates within the framework of shared public health security.

Summary of Chapter 4

- **Quantitative Study Results (4.1):** The estimated target is 230,056 people (43.3% coverage), with a budget burden of 209-365 million baht per year, and a time series analysis reveals cold chain bottlenecks causing prolonged stock shortages.
- **Qualitative Study Results (4.2):** An analysis of key findings from 128 informants across both sides of the border reveals geographical barriers, fear of arrest, and a vacuum in monitoring adverse events (AEFI).
- **Cross-Regional Case Studies (4.3):** Lessons learned from five provinces (Tak, Mae Hong Son, Kanchanaburi, Chiang Rai, and Chiang Mai) confirm the necessity of decentralization and avoiding "one-size-fits-all" policies.
- **Integrated Synthesis (4.4):** Both quantitative and qualitative statistics, when combined, support a proactive policy framework under the discourse of "health security".

In the next chapter (Chapter 5), the research team will synthesize all the findings into **"Actionable Policy Recommendations"**to further enhance the financial architecture and healthcare system in Thailand's border areas in a tangible way.

Chapter 5: Discussion and Conclusion

This chapter presents a discussion of the research findings based on the conceptual framework of Creswell & Creswell (2018), which states that,*"Good research interpretation requires summarizing key findings, comparing them to the literature, presenting a critical perspective, acknowledging limitations, and pointing towards future directions".* The researchers therefore compiled the content into 5 important parts: (5.1) discussion of results according to research questions, (5.2) policy recommendations categorized by recipients, (5.3) limitations of the study, (5.4) recommendations for further research, and (5.5) conclusion of the research.

5.1 Discussion of Findings based on Research Questions

5.1.1 Size of Requirements and Budgetary Burden

The quantitative analysis results provide empirical evidence suggesting that the scale of the problem is within Thailand's fiscal capacity to address. Estimates show that there are a total of 230,056 vulnerable children aged 0–5 years in the five target border provinces (with the highest concentration in Tak Province at 50.2%). However, coverage of basic vaccines remains low at only 43.3%, reflecting a disparity of 50.9 percentage points compared with the national average for Thai children (94.2%). Nevertheless, when assessing the budgetary burden required to close this gap, it was found that an annual investment of only 209–365 million baht is required, equivalent to approximately 0.05–0.09% of the Ministry of Public Health's annual budget (approximately 400 billion baht). This represents a relatively modest fiscal commitment that could potentially be accommodated within existing public health financing arrangements without substantially affecting other health priorities.

Triangulation with External Studies: The reliability of this assessment is confirmed by comparing it with parallel research from the **International Health Policy Program (IHPP)** under the Ministry of Public Health (published January 2025). Although the IHPP study utilized different methodologies and geographic scopes, it estimated the budget for a full-service provision scenario at 89.99–98.29 million baht. This finding is highly **consistent** with the estimates generated by our research team for comparable areas. Furthermore, the policy strategies proposed by the IHPP (such as separating vaccine services from the HICS insurance system, centralized procurement with UNICEF, developing a bilingual communication system, and linking databases with the Ministry of Labour) all have logical merit.

Convergence: The broad alignment between the findings of the present study and those of the IHPP study provides additional support for the feasibility and policy relevance of the proposed recommendations. However, an important contribution of the present study is its emphasis on the long-term sustainability of financing mechanisms. Relying on annual emergency budgets, as has often been the case in the past, may address immediate needs but is unlikely to support sustained system capacity. Therefore, the research team proposes strengthening existing fiscal channels through the establishment of a dedicated Border Vaccine Fund (BVF) to facilitate long-term planning, workforce development, and sustainable cold-chain management.

5.1.2 Systemic Obstacles and Paradigm Shift "From Burden to Security"

Qualitative analysis using a systems thinking framework reveals that low vaccine coverage is not solely a technical problem, but is the **symptom** of the fundamental structural problems.

According to Senge's (1990) Shifting the Burden archetype, past systems have often chosen the approach of, "**solving immediate problems"**(for example, relying on NGOs or emergency donations) instead of **"solving the problem at its root".** According to Senge's (1990) *Shifting the Burden* archetype, systems often rely on short-term solutions—such as emergency donor funding or NGO-led service provision—rather than addressing underlying structural weaknesses. Over time, this dependence can reduce incentives to invest in sustainable domestic capacity. As a result, when external support is reduced or withdrawn, as occurred following the USAID funding cuts in 2025, the vulnerability of the system becomes readily apparent.

Policy Leverage Points and Health Security Framing: When analyzed according to Meadows' (1999) approach, the leverage point with the greatest impact and the lowest cost is **mental models shift.** The most powerful finding from data collected from national-level executives is the consensus that communication about the rights of migrant populations should move beyond the single dimension of "human rights" and adapt to a broader framework, **"national health security framing"**

"Communicable diseases do not recognize nationality or borders. Maintaining high vaccination coverage among migrant populations is therefore essential for protecting the health of everyone living in Thailand." To maximize impact, the researchers recommend a **dual-track narrative** strategy. Deploying a "security" framework navigates state funding mechanisms, while a "human rights and children's rights" discourse mobilizes civil society and international arenas, demonstrating advanced policy entrepreneurship in practice.

The Reverse Phenomenon - The Financial Crowd-Out Effect: Chamchan and Apipornchaisakul (2022) identified a counterintuitive finding: caregivers without work permits were 4.12 times more likely to purchase health insurance for their children than those holding work permits. This phenomenon may reflect a form of financial crowd-out, whereby expenditures on work permits and nationality verification reduce the financial resources available for other essential household expenses, including children's health insurance. Given the substantial cost of documentation and status verification (approximately THB 8,000–10,000 per person), some families may have limited resources remaining to invest in health protection for their children.

These insightful findings support a workplace-based co-financing strategy that proposes public and private sectors sharing the cost of welfare benefits, ensuring that "legal documentation" goes hand-in-hand with "health security" in a sustainable manner.

5.1.3 Hybrid Service Model: Integrating Three Strategies Based on the Local Context

The integration of quantitative and qualitative data leads to the clear conclusion that no single model can address the complexities of borderline issues (No One-Size-Fits-All). Effective policy design therefore requires the **"hybrid model".** This consists of three main strategies as follows:

1) **Targeted Outreach – a key strategy for early childhood education (0-5 years):** Children aged 0-5 years are the critical age group requiring the highest number of EPI vaccines, but they are not yet in the school system. This strategy therefore relies on proactive teams (nurses + community health volunteers, ethnic minorities + interpreters) to deliver vaccines to these children. Although this increases the per capita cost (73 USD/child), clinically it is considered a fundamental measure for reaching marginalized children (zero-dose) and is resilient enough to withstand lockdowns or school closures.

2) **(School-Based Vaccination - A Safety Net for School-Age Children:** For children growing up and entering cross-border MLCs, this strategy acts as a catch-up safety net, which is calculated to save 30% (51 USD/child) through economies of scale.

3) **Cross-Border Partnership - A Case Study of Umphang Hospital:** For populations within safe zones along opposite borders, the use of transnational public health volunteers as vaccine distributors (relational innovation) has proven to achieve nearly 100% coverage.

The challenge of a hybrid model isn't in having three separate models, but in **"orchestration mechanism".** To avoid duplication or loopholes, which is the primary responsibility of the **Provincial Border Health Committee,** the approach would involve centralized control of standards but giving local communities the freedom to choose the model proportions that best suit their own ecosystem.

5.1.4 Lessons from the International Context and their application in Thailand

Comparative literature reviews across other countries (Latin America, Asia Pacific, and the Middle East) provide valuable lessons and ensure academic validity for the synthesis of recommendations:

1. **Lessons from Türkiye (Workforce Innovation):**The successful expansion of vaccine benefits for Syrian refugee children was not just a policy announcement, but stemmed from integrating Syrian doctors and nurses into the state's service provision (Sandbox Certification). This model supports the proposal to upgrade the status of migrant health volunteers (MHVs) to be recognized within the system.
2. **Lessons from Lebanon ((Financing Alone Is Not Enough)):** Despite the Lebanese government having vast funding to support free vaccinations, the system was still lagging behind in hospitals, resulting in only 12.5% of children

having access to vaccines. This lesson underscores the need for the BVF fund to always be driven by "proactive service delivery."

3. **Lessons from Germany (Decoupling of Rights):** Germany has broken down the wall of fear of arrest by using an "electronic health card" that is independent of security forces. This lesson has led to Thailand's proposal to implement a similar system, **"Humanitarian Data Trust"**to manage data independently and securely.
4. **Lessons from the Asia-Pacific and Latin American regions:** Warnings are issued about the crises of "decentralization without accountability mechanisms" and "the health insurance treasury debt crisis," all of which highlight the urgent need to establish a **Vertical Border Vaccine Fund** in conjunction with **engaging local authorities and employers in co-financing** systematically
5. **WUENIC/Prolog computational logic innovation:** Managing data on migrant children lacking precise denominators requires moving away from rigid models and adopting the Prolog Framework, which deconstructs data logic and allows local experts to override statistical anomalies using on-the-job knowledge.

5.1.5 Agreements and Differences in Stakeholder Perspectives

In-depth interviews with 128 stakeholders revealed a remarkably high level of consensus, with over 89.5% agreeing on proactive service strategies coupled with school safety nets, and recognizing that standard fixed-rate systems cannot adequately address border vulnerabilities.

The only contradiction identified is a misalignment in discursive framing. While national leaders heavily emphasize a 'health security' framework (87%), NGO networks prioritize 'human rights,' and frontline personnel focus on 'budgetary mechanisms and logistics.' This insight underscores that driving a border vaccine stockpile is not hindered by a deficit of political will; rather, it lacks an integrated coordination mechanism and the nimble policy entrepreneurship required to tailor rhetoric to specific target groups and unify these shared intentions

5.2 Policy Recommendations

In order for the suggestions to be implemented in a concrete and targeted manner, the researchers divided the suggestions into 2 dimensions: (1) contacting with **Sustainable Vaccine Fiscal Framework (SIF 4 Pillars)** which is based on Chapter 2 and (2) classification according to **six groups of stakeholders (Audiences)** according to the methodological guidelines of Creswell & Creswell (2018).

For Government Agencies within the public health system (Public Health Authorities):

National policy level (NHSO, Department of Disease Control, Office of the Permanent Secretary, Ministry of Public Health):

1. **Expand the Scope of the National Health Insurance System:** The Ministry of Public Health should designate health promotion and disease prevention as a "fundamental right," integrating the care of children without Thai nationality (0-18 years) into the 13th National Health Development Plan.
2. **Establish the "Border Vaccine Fund (BVF)":** It should be established as a vertical fund with a clear separation of budget from the per capita allocation, with a budget of 209-365 million baht per year, to serve as a buffer to protect the budget from economic recession. This would utilize a co-financing mechanism, and a pilot "capped copayment" mechanism for high-cost vaccines, similar to Hong Kong's vaccination subsidy scheme, could be considered.
3. **Create a "Humanitarian Data Trust":** Improve the HDC system by assigning a trusted third-party organization (e.g., the Thai Red Cross Society) to hold individual health ID data to create a safe haven. Security forces would receive only aggregate data for planning purposes, coupled with a "quota-backed health pass" system based on the Kanchanaburi Model to guarantee access to services without arrest.

Regional and Provincial Health Levels:

1. **Establish a "Provincial Border Health Committee":** To serve as a cross-ministerial coordination mechanism and have the authority to promote "Border Vaccine Buffer Stock" to directly address logistical bottlenecks and stockout crises at frontline areas.
2. **Allocate Budget For Regional Support and Performance-Based Payment (Local Flexibility & PBF):** Approve 5% of local budget for proactive services and initiate mechanisms.
3. **Results-Based Financing:** This involves providing bonuses to local communities and personnel who can improve coverage to meet targets, following the successful models of Colombia and Vietnam.
4. **Establishing the "Border AEFI Safety Protocol":** Establish a friendly and fair Adverse Event (AEFI) investigation mechanism that exempts from immigration law enforcement in the investigation process, in order to reduce fear and stop rumors in vulnerable communities.

For Academics in Public Health Systems and Economics (Academic & Research Institutes):

1. Develop a nationally standardized methodology for assessing the size of the hidden population through triangulation from multiple databases.

2. Expand the research scope to include full-scale cost-effectiveness assessments (CEA/CUA) and long-term cohort follow-up.

For Ethnic Health Organizations and Civil Society (EHOs & Civil Society):

1. **Upgrading the "Community Vaccinator Program":** Develop the capabilities and provide official certification (Sandbox Certification) to ethnic minority community health volunteers and migrant personnel (Myanmar Medics) to enable them to perform targeted outreach services properly, following the successful models of Umphang Hospital and Turkey.
2. **Employer-led Co-financing:** Encourage the private sector in border economic zones to contribute funds for providing vaccines to migrant workers' families as part of their welfare program, in order to help share the financial burden on workers (Financial Crowd-Out).

For International NGOs & Agencies:

1. **Upgrading Pooled Procurement:** Utilizing the UNICEF Supply Division's mechanisms, one can negotiate vaccine prices to meet international standards (GAVI rate) in collaboration with the Food and Drug Administration (FDA).
2. **Transition Fund:** International organizations should shift their role from "providing direct services" to "system strengthening" and should support a 12-24 month transition budget to sustainably transfer their missions to host states.

For Business Networks and the Private Sector:

1. Develop vaccine benefits within organizations to ensure workforce stability.
2. Study the feasibility of raising funds through **Health Impact Bond** at the Provincial level

For Security and Foreign Affairs Professionals:

1. The National Security Council (NSC) should designate the "border vaccine gap" as a national health security agenda.
2. Utilize diplomatic mechanisms within the ASEAN framework (ASEAN Health Cluster) to negotiate cross-border public health cooperation and seek regional funding sources.

5.3 Limitations of the Study (Methodological Limitations)

To ensure the transparency and integrity of the research findings according to academic principles, the research team would like to acknowledge the following eight limitations:

1. **Geographic Scope:** It covers only the 5 target border provinces, and does not cover the southern or eastern border regions.

2. **Quantitative Methodology:** Population assessments rely on secondary data, which may include under-registration.
3. **Qualitative Methodology:** Because purposive sampling was used, the sample cannot be statistically representative of the population.
4. **Time Constraints:** This is a cross-sectional study, which means it cannot assess longitudinal trends.
5. **Language Limitations:** Interviews conducted through an interpreter may result in the loss of some in-depth nuances.
6. **Safety Context:** Border conflict restrictions make access to some vulnerable areas difficult.
7. **Economic Evaluation:** The scope of the research focuses specifically on Budget Impact Assessment (BIA).
8. **Political Dynamics:** The information may become outdated quickly due to political crises in neighboring countries.

5.4 Suggestions for Future Research

To pave the way for the expansion of knowledge, the research team proposes the following future research directions:

1. Expand the area of comparative studies to the southern border provinces (Cambodia/Malaysia).
2. A longitudinal cohort study conducted on a group of stateless children aged 3-5 years.
3. Conduct a full cost-effectiveness/utility analysis.
4. Conducting implementation science research to pilot the establishment of the Border Vaccine Fund.
5. Researching the feasibility of developing a bilingual vaccine passport system that is practical for cross-border use.

5.5 Conclusion

This study presents the first comprehensive empirical evidence-based approach in Thailand to address the critical vaccine demand for stateless children in the Thai-Myanmar border region, utilizing a convergent mixed methods design.

Summary of Systematic Findings:

This study found that over 230,056 children without Thai nationality in five southern border provinces have a low rate of receiving basic vaccinations at **43.3%.** This creates a large gap in public health security. This phenomenon is a consequence of systemic barriers, including documentation barriers (50.9%), rugged terrain (42.1%), and language barriers (35.1%), reflecting a long-standing approach of shifting the burden of problem-solving to frontline workers rather than having supporting systems in place (shifting the burden).

Exit strategies and leveraging points:

The most rational and sustainable fiscal and operational framework is the **hybrid service model**. This approach relies on Targeted Outreach as a core mechanism for early childhood immunization, while utilizing **school-based health services** as a comprehensive safety net for school-aged children. These initiatives are structurally sustained through a dedicated **Border Vaccine Fund (BVF)** with an estimated annual budget of **209–365 million baht** (representing a mere **0.05–0.09%** of the Ministry of Public Health's total budget). Achieving this national policy reform requires a profound **mental model shift**—moving away from viewing the refugee population as a **human rights burden** and instead elevating the issue to a **shared health security agenda** designed to protect everyone living on Thai soil.

References

1. Ministry of Interior. Report on Statistics of Stateless Persons for September 2024. Bangkok: Ministry of Interior; 2024.
2. Barber S, Sciortino R. Thailand Migration Report 2024. Bangkok: United Nations Network on Migration in Thailand; 2024.
3. Thailand Development Research Institute (TDRI). Estimates of the Stateless Population in Thailand, 2024. Bangkok: TDRI; 2024.
4. International Organization for Migration (IOM). Multi-sectoral Assessment of Needs in Thailand: Household-level survey data on Myanmar migrants (2023-2025). Geneva: IOM; 2025.
5. United Nations. Convention on the Rights of the Child. Adopted 20 November 1989. New York: United Nations; 1989.
6. ASEAN Secretariat. ASEAN Declaration on the Rights of Children in the Context of Migration. Jakarta: ASEAN; 2019.
7. ASEAN Secretariat. Regional Plan of Action on the Rights of Children in the Context of Migration 2021-2030. Jakarta: ASEAN; 2021.
8. United Nations General Assembly. Global Compact on Refugees. UN Doc A/73/12 (Part II). New York: UN; 2018.

Vaccines and coverage.

9. Kaji A, Parker DM, Chu CS, Thayatkawin W, Suelaor J, Charatrueangrongkun R, et al. Immunization coverage in migrant school children along the Thailand-Myanmar border. J Immigr Minor Health. 2016;18(5):1038-1045.
10. Uansri S, Thanasitthichai S, Pananpong N, et al. Feasibility of providing basic vaccination services for migrant children in Thailand. Health Policy Plan. 2025; (in press).
11. Hong R, Pongpirul K, Saengkaew S, Kunpeuk W, Sirilak S, Suphanchaimat R. Healthcare utilization and economic burden of non-Thai populations in border provinces. BMC Health Serv Res. 2025;25:312.
12. Fishbein D, Aung HT, Nyein A, et al. Nurse-Led Vaccination Program for Zero-Dose Children in a Conflict-Affected Area of Myanmar: A Longitudinal Participatory Mixed Methods Evaluation. Soc Sci Res Netw. Preprint posted online January 26, 2026:6120755. doi:10.2139/ssrn.6120755
13. World Health Organization. WHO Immunization Data portal — South-East Asia Region. WHO; 2025. Available from: https://immunizationdata.who.int/dashboard/regions/south-east-asia-region
14. World Health Organization. Global routine immunization summary: Myanmar. Geneva: WHO; 2024.
15. World Health Organization. Tenth Meeting of the South-East Asia Regional Verification Commission for Measles and Rubella Elimination. Geneva: WHO; 2025 Jul.

Health insurance system and finance

16. National Health Security Office (NHSO). Annual Report 2024. Bangkok: NHSO; 2024.
17. Ministry of Public Health. Guidelines for the Issuance of Health Insurance Cards for Aliens, Revised Edition 2023. Nonthaburi: Ministry of Public Health; 2023.
18. Tangcharoensathien V, Witthayapipopsakul W, Panichkriangkrai W, Patcharanarumol W, Mills A. Health systems development in Thailand: a solid platform for successful implementation of universal health coverage. Lancet. 2018;391(10126):1205-1223.
19. Suphanchaimat R, Kantamaturapoj K, Putthasri W, Prakongsai P. Challenges in the provision of healthcare services for migrants: a systematic review through providers' lens. BMC Health Serv Res. 2015;15:390.

International mechanisms

20. Gavi, the Vaccine Alliance. Gavi Strategy 5.0: 2021-2025. Geneva: Gavi; 2020.
21. International Finance Facility for Immunisation (IFFIm). Annual Report 2023. London: IFFIm; 2024.
22. World Health Organization. Immunization Agenda 2030: A Global Strategy to Leave No One Behind. Geneva: WHO; 2020.
23. UNICEF. Immunization Roadmap 2018-2030. New York: UNICEF; 2018.
24. UNICEF. Costs of Fully Vaccinating a Child. New York: UNICEF; 2024.

Lessons from abroad

25. Khan MM, Hotchkiss DR, Berruti AA, Hutchinson PL. The role of mobile vaccination teams in reaching out to vulnerable population in conflict zones: lessons from Indonesia. Vaccine. 2020;38(15):3149-3155.
26. Department of Health, Republic of the Philippines. Routine Immunization Strategic Plan 2018-2025. Manila: DOH; 2018.
27. Vu LH, Tran NTH, Hoang TG. Achievements and challenges of Vietnam's Expanded Programme on Immunization. Vaccine. 2019;37(46):6968-6972.
28. Schütte C, Chansa C, Marinda E, et al. Cost analysis of routine immunisation in Zambia. Vaccine. 2015;33(Suppl 1):A47-A52. doi:10.1016/j.vaccine.2014.12.040
29. UNHCR. Operational Update: Lebanon, Syria refugee health. Geneva: UNHCR; 2024.
30. World Health Organization Europe. Health systems response to migrants and refugees: Turkey country case study. Copenhagen: WHO Europe; 2018.
31. UNICEF Bangladesh. Immunization in Cox's Bazar refugee camps: Annual Report 2023. Dhaka: UNICEF; 2024.

Contemporary events

32. Department of Disease Control, Ministry of Public Health Thailand. Cholera outbreak situation report — Mae Sot district, Tak province, December 2024. Nonthaburi: DDC; 2025.
33. ASEAN Coordinating Centre for Humanitarian Assistance (AHA). Myanmar Earthquake 28 March 2025: Situation Update. Jakarta: AHA Centre; 2025 Apr.
34. International Rescue Committee. Press release: IRC discontinues primary healthcare in 7 temporary shelters along Thai-Myanmar border. New York: IRC; 2025 Jul 31.

35. Cabinet Resolution dated August X, 2025, authorizing refugees to work outside temporary shelters. Bangkok: Office of the Prime Minister; 2025.
36. Office of the Basic Education Commission (OBEC). Confirmation Letter Regarding Admission of Foreign Children to All Levels of Education, dated February X, 2026. Bangkok: OBEC; 2026.
37. Save the Children Thailand. Migrant Learning Centers in Thailand: Trends 2020-2025. Bangkok: SCT; 2025.

Effective Vaccine Management and Cold Chain

38. World Health Organization. Effective Vaccine Management (EVM) Initiative. Geneva: WHO; 2010.
39. World Health Organization. WHO PQS Performance specifications for vaccine cold chain equipment. Geneva: WHO; 2022.

Research methodology

40. Creswell JW, Creswell JD. Research design: Qualitative, quantitative, and mixed methods approaches. 5th ed. Thousand Oaks, CA: Sage Publications; 2018.
41. Creswell JW, Plano Clark VL. Designing and conducting mixed methods research. 3rd ed. Thousand Oaks, CA: Sage Publications; 2018.
42. Yin RK. Case study research: Design and methods. 5th ed. Thousand Oaks, CA: Sage Publications; 2014.
43. Stake RE. Multiple case study analysis. New York: Guilford Press; 2006.
44. Lincoln YS, Guba EG. Naturalistic inquiry. Beverly Hills, CA: Sage Publications; 1985.
45. Charmaz K. Constructing grounded theory. London: Sage Publications; 2006.
46. Miles MB, Huberman AM. Qualitative data analysis: An expanded sourcebook. 2nd ed. Thousand Oaks, CA: Sage Publications; 1994.
47. Guetterman TC, Fetters MD, Creswell JW. Integrating quantitative and qualitative results in health science mixed methods research through joint displays. Ann Fam Med. 2015;13(6):554-561.
48. Gibbs GR. Analyzing qualitative data. Thousand Oaks, CA: Sage Publications; 2007.
49. Onwuegbuzie AJ, Leech NL. Linking research questions to mixed methods data analysis procedures. Qual Rep. 2006;11(3):474-498.
50. Tashakkori A, Creswell JW. Exploring the nature of research questions in mixed methods research [Editorial]. J Mix Methods Res. 2007;1(3):207-211.
51. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. Int J Soc Res Methodol. 2005;8(1):19-32.
52. Sullivan SD, Mauskopf JA, Augustovski F, Jaime Caro J, Lee KM, Minchin M, et al. Budget impact analysis-principles of good practice: report of the ISPOR 2012 Budget Impact Analysis Good Practice II Task Force. Value Health. 2014;17(1):5-14.
53. Haacker M, Hallett TB, Atun R. On discount rates for economic evaluations in global health. Health Policy Plan. 2020;35(1):107-114.
54. The Health Technology Assessment and Policy Project (HITAP). Thailand's Health Technology Assessment Handbook, 2nd Edition. Nonthaburi: HITAP; 2020.

Systems Thinking and Health Policy

55. Senge PM. The fifth discipline: The art and practice of the learning organization. New York: Doubleday; 1990.
56. Meadows DH. Leverage points: Places to intervene in a system. Hartland, VT: The Sustainability Institute; 1999.
57. Stroh DP. Systems thinking for social change: A practical guide to solving complex problems, avoiding unintended consequences, and achieving lasting results. White River Junction, VT: Chelsea Green Publishing; 2015.
58. Tulchinsky TH, Varavikova EA. The new public health: An introduction for the 21st century. 3rd ed. San Diego: Academic Press; 2014.
59. McInnes C, Lee K. Global health and international relations. Cambridge: Polity Press; 2012.
60. Wickramage K, Vearey J, Zwi AB, Robinson C, Knipper M. Migration and health: a global public health research priority. BMC Public Health. 2018;18:987.

Additional reference documents (Methodology Sources)

61. Belmont Report. The Belmont Report: Ethical principles and guidelines for the protection of human subjects of research. Washington, DC: U.S. Department of Health, Education, and Welfare; 1979.
62. The Nuremberg Code (1947). In: Mitscherlich A, Mielke F. Doctors of infamy: The story of the Nazi medical crimes. New York: Schuman; 1949. p. xxiii-xxv.
63. Hoffman SJ. Knowledge translation in global health: A research agenda. Glob Health Action. 2012;5:18510.
64. Cummings SR, Browner WS, Hulley SB. Conceiving the research question and developing the study plan. In: Hulley SB, et al. Designing clinical research. 4th ed. Philadelphia: Lippincott Williams & Wilkins; 2013.
65. Richardson WS, Wilson MC, Nishikawa J, Hayward RS. The well-built clinical question: a key to evidence-based decisions. ACP J Club. 1995;123(3):A12-A13.

Sustainable Immunization Financing (SIF) Series

66. Coe M, Gergen J. Thailand Country Brief — Sustainable Immunization Financing in Asia Pacific. Washington, DC: ThinkWell; 2017 Aug.
67. Coe M, Gergen J, Mallow M, Moi F, Phily C. Landscaping Analysis — Sustainable Immunization Financing in Asia Pacific. Washington, DC: ThinkWell; 2017 Oct.
68. ThinkWell. Sustainable Immunization Financing in Asia Pacific Policy Brief. Washington, DC: ThinkWell; 2017.
69. ThinkWell. Sustainable Immunization Financing in Asia Pacific — Indonesia Country Brief. Washington, DC: ThinkWell; 2017.
70. ThinkWell. Sustainable Immunization Financing in Asia Pacific — Malaysia Country Brief. Washington, DC: ThinkWell; 2017.
71. ThinkWell. Sustainable Immunization Financing in Asia Pacific — Philippines Country Brief. Washington, DC: ThinkWell; 2017.

72. ThinkWell. Sustainable Immunization Financing in Asia Pacific — Taiwan Country Brief. Washington, DC: ThinkWell; 2017.
73. ThinkWell. Sustainable Immunization Financing in Asia Pacific — Vietnam Country Brief. Washington, DC: ThinkWell; 2017.
74. ThinkWell. Sustainable Immunization Financing — Colombia Country Brief. Washington, DC: ThinkWell; 2018.
75. ThinkWell. Sustainable Immunization Financing — South Korea Country Brief. Washington, DC: ThinkWell; 2018.
76. ThinkWell. Sustainable Immunization Financing — Mexico Country Brief. Washington, DC: ThinkWell; 2018.
77. ThinkWell. Sustainable Immunization Financing — Indonesia Brief (Extended). Washington, DC: ThinkWell; 2018.
78. ThinkWell. Sustainable Immunization Financing — Taiwan Country Brief (Extended). Washington, DC: ThinkWell; 2018.
79. ThinkWell. Sustainable Immunization Financing — Jordan Country Brief. Washington, DC: ThinkWell; 2018.
80. European Observatory on Health Systems and Policies. Sustainable Immunisation Financing in the European Union. Copenhagen: WHO Regional Office for Europe; 2019.
81. ThinkWell. Towards Sustainable Immunization Financing: A Global Call to Action. Washington, DC: ThinkWell; 2019.
82. UNICEF. Innovative Financing for Immunization. New York: UNICEF; 2018.
83. ThinkWell. Public-Private Partnerships (PPPs): Why, What, and How for Sustainable Immunization Financing. Washington, DC: ThinkWell; 2019.
84. ThinkWell. Immunization Financing in the COVID-19 Pandemic: Investing in Immunization Systems for Today and Tomorrow. Washington, DC: ThinkWell; 2020.
85. ThinkWell. Sustainable Immunization Financing in Latin America. Washington, DC: ThinkWell; 2018.

Life-Course Immunization Series

86. International Federation on Ageing (IFA). The Economic Case for Life-Course Immunization in Thailand. Toronto: IFA; 2026 Jan.
87. International Federation on Ageing (IFA). The Economic Case for Life-Course Immunization in Malaysia: An Investment in Population Health and Economic Prosperity. Toronto: IFA; 2023.
88. International Federation on Ageing (IFA). Beyond Childhood — Securing the Future of Immunization Financing in Malaysia. Toronto: IFA; 2024.

Additional Primary Data Sources

89. Srinet S, Thanasitthichai S, Uansri S, Pananpong N, Khutsutthipipat C, Mingmuang P, White W, Thumb K, Suphanchaimat R. Feasibility of Providing Basic Vaccination Services for Migrant Children in Thailand [Complete research report]. Nonthaburi: International Health Policy Foundation, supported by Health Systems Research Institute (HSRI); 2025 Jan.

90. Ministry of Immigration and Population, Myanmar. Myanmar Population Census 2024. Naypyidaw: Department of Population; 2024.
91. Ministry of Immigration and Population, Myanmar. The 2019 Inter-Censal Survey: Union Report. Naypyidaw: Department of Population; 2019.
92. International Organization for Migration (IOM). Displacement Tracking Matrix (DTM) Multi-Sectoral Assessment — Thailand Province Factsheets (Tak, Mae Hong Son, Chiang Mai, Chiang Rai, Kanchanaburi). Geneva: IOM; 2023-2024.
93. Health Information System Working Group (HISWG). Programmatic datasets on ECBHO-covered priority zones (Karen, Karenni, Mon, Shan, Tanintharyi) [Confidential dataset]. HISWG; 2024.
94. Ethnic Health Systems Strengthening Group (EHSSG). Ethnic Demographic and Health Survey (EDHS) 2024 Factsheet. Mae Sot: EHSSG; 2025 Mar.
95. Migrant Education Coordination Center (MECC), Ministry of Education Thailand. Migrant Learning Centers Enrollment Data — Tak Province 2024. Bangkok: MECC; 2024.
96. The Border Consortium (TBC). Annual Report on Refugee Population in Temporary Shelters along the Thai-Myanmar Border 2024. Mae Sot: TBC; 2024.
97. Karen Department of Health and Welfare (KDHW). Annual Population Data and Vaccination Targets 2022-2025. KDHW; 2025.
98. Karenni National Army & Community Health and Development Network (KNA+CHDN). Targeted Immunization Children Plan 2025. Readers: KNA+CHDN; 2025.
99. Mae Tao Clinic. MTC Biennial Report 2021-2022. Mae Sot: Mae Tao Clinic; 2023.
100. Mae Tao Clinic. EPI Data Sharing — Mae Tao Clinic Immunization Utilization Data 2023. Mae Sot: Mae Tao Clinic; 2024.
101. National Statistical Office Thailand (NSO). Thailand Migration Survey 2024. Bangkok: NSO; 2024.
102. United Nations Network on Migration in Thailand. Thailand Migration Report 2024. Bangkok: UN Network on Migration; 2024.
103. UNICEF, Gavi the Vaccine Alliance. Costs of Fully Vaccinating a Child: Countries Eligible for Gavi Vaccine Prices. New York: UNICEF; 2024.
104. World Health Organization. How to Cost an Immunization Programme: A Practical Guide for Sub-National Costing. Geneva: WHO; 2009.
105. Pediatric Infectious Diseases Society of Thailand (PIDST). Recommended Immunization Schedule for Children in Thailand 2025. Bangkok: PIDST; 2025.
106. Thanasitthichai S, Uansri S, Mingmaung P, Panapong N, Suphanchaimat R. Assessing Potential Budgetary Impact for Providing Basic Vaccination Services to Cambodian, Lao and Myanmar Migrant Children in Thailand [Manuscript revised]. International Health Policy Foundation & Department of Disease Control, MOPH; 2025.
107. ThinkWell. Sustainable Immunization Financing in Asia Pacific — Korea Country Brief. Washington, DC: ThinkWell; 2018 Feb.
108. Fishbein D, Aung HT, TinOo C, et al. Expanding Vaccination of Children in a Conflict-Affected Area of Myanmar: A Longitudinal Participatory Mixed Methods

Evaluation [Karenni Nurses Association Expansion Study, manuscript under review]. 2025.
109. Health Information Systems Working Group / Burma Medical Association (HISWG/BMA). Submission of Population Estimates for Children Under 5 and Under 12 [Memorandum to NHF]. Mae Sot: HISWG; 2025 Nov 18.
110. ThinkWell. Sustainable Immunization Financing — Jordan Country Brief. Washington, DC: ThinkWell; 2024.
111. ThinkWell. Sustainable Immunization Financing in Latin America. Washington, DC: ThinkWell; 2018.
112. International Federation on Ageing (IFA). The Economic Case for Life-Course Immunization in Malaysia: An Investment in Population Health and Economic Prosperity. Toronto: IFA; 2025 Mar.
113. Poe A, Emily, Aurora, Aung HT, Saw Ei Reh A, Grissom B, Tinoo C, Fishbein DB. Struggling to resume childhood vaccination during war in Myanmar: evaluation of a pilot program. Int J Equity Health. 2024;23:121. doi:10.1186/s12939-024-02165-9
114. Ingle EA, Shrestha P, Seth A, Lalika MS, Azie JI, Patel RC. Interventions to Vaccinate Zero-Dose Children: A Narrative Review and Synthesis. Viruses. 2023;15(10):2092. doi:10.3390/v15102092
115. Ozawa S, Clark S, Portnoy A, Grewal S, Brenzel L, Walker D. Return on investment from childhood immunization in low- and middle-income countries, 2011–20. Health Aff. 2016;35(2):199-207.
116. ThinkWell. Sustainable Immunization Financing in Latin America. Washington, DC: ThinkWell; 2019 Jul.
117. ThinkWell. Sustainable Immunization Financing in Asia Pacific. Washington, DC: ThinkWell; 2019 Jul.
118. Chamchan C, Apipornchaisakul K. Health insurance status of cross-border migrant children and the associated factors: a study in a Thai-Myanmar border area. BMC Health Serv Res. 2022;22(1):1276. doi:10.1186/s12913-022-08681-0
119. Coe M, Gergen J, Phily C, Ozaltin A. Indonesia Country Brief. Sustainable Immunization Financing in Asia Pacific. Washington, DC: ThinkWell; 2017 Aug.
120. Moi F, Gergen J. Malaysia Country Brief. Sustainable Immunization Financing in Asia Pacific. Washington, DC: ThinkWell; 2017 Aug.
121. Coe M, Gergen J, Vilcu I. Philippines Country Brief. Sustainable Immunization Financing in Asia Pacific. Washington, DC: ThinkWell; 2017 Aug.
122. Gergen J, Coe M, Mallow M. Taiwan Country Brief. Sustainable Immunization Financing in Asia Pacific. Washington, DC: ThinkWell; 2017 Aug.
123. Coe M, Gergen J. Thailand Country Brief. Sustainable Immunization Financing in Asia Pacific. Washington, DC: ThinkWell; 2017 Aug.
124. Coe M, Gergen J. Vietnam Country Brief. Sustainable Immunization Financing in Asia Pacific. Washington, DC: ThinkWell; 2017 Aug.
125. Coe M, Madan Y. Colombia Country Brief. Sustainable Immunization Financing. Washington, DC: ThinkWell; 2018 Jul.
126. Burton A, Monasch R, Lautenbach B, Gacic-Dobo M, Neill M, Karimov R, Wolfson L, Jones G, Birmingham M. WHO and UNICEF estimates of national infant

immunization coverage: methods and processes. Bull World Health Organ. 2009;87(7):535-541. doi:10.2471/BLT.08.053819
127. World Health Organization. Global Vaccine Action Plan 2011-2020. Geneva: World Health Organization; 2013.
128. Strategic Advisory Group of Experts on Immunization. The Global Vaccine Action Plan 2011-2020: Review and lessons learned. Geneva: World Health Organization; 2019. (WHO/IVB/19.07).
129. Kantayaporn T, Archavanitkul K, Peerapatanapokin W, Disthawong N, Singkul N, Sinvuttaya S, Chinvarasopak P, Panatanasan K. Expanded Program on Immunization (EPI) for Children of Myanmar Migrants Living in Bangkok, Thailand. J Popul Soc Stud. 2013;21(2):227-242.

Appendix A—Sample questions for in-depth interviews.

Interview Protocol — Semi-Structured

Part 1: Interview Background Information

- Name-Surname (specify as code):
- Position / Affiliation:
- Level (National/Regional/Provincial/District/Sub-district/Community):
- Work experience in border areas (years):
- Date/Time/Location:
- Interviewer:

Part 2: Statement (Read aloud to the informant)

"Thank you for your time in this interview. This interview is part of a BVF research project funded by the Health Systems Research Institute (HSRI), Agreement No. 68-004, and conducted by the National Health Foundation. The interview will take approximately 60-90 minutes. Your information will be kept confidential, pseudonyms will be used in the report, and it will be used solely for research purposes. You may decline to answer any questions and can withdraw your informed consent at any time. Audio recording is permitted to ensure the accuracy of the data summaries..."

Part 3: Key Questions (with probes)

1. Geographic context and general situation.

- From your perspective, what is the vaccination situation for non-Thai nationals in your area?
- *Probes:*What differences do you see between them and Thai children? What has changed in the past 5 years?

2. Obstacles and causes.

- What do you think is the main obstacle preventing these children from accessing vaccines?
- *Probes:* Documentary barriers? Geography? Language? Beliefs? Economic issues? Security?

3. Financial and fiscal system and resources.

- Is the current financial system sufficient to provide vaccinations for this group of children?
- *Probes :*Capitation? Alien health insurance card? NGO assistance? Outreach budget?

4. What type of service do you think is suitable?

- Which service model do you think would be most effective in your local context?
- *Probes:* School health? Mobile unit? Mobile clinic? Integration with other services?

5. Adaptation and innovation in the area.

- What methods do you use to overcome obstacles in the area?
- *Probes:* Using ethnic minority community health volunteers? How to transport vaccines across mountains? Collaboration with teachers?

6. Requirements for additional support.

- What additional support do you require from the government/other agencies?
- *Probes:* Budget? Personnel? Policy? Equipment? Data connectivity?

7. Directions towards sustainability.

- From your perspective, what characteristics should a sustainable vaccination system for this group of children look like?
- *Probes:*What is the role of NGOs? What is the role of the federal government? What about bilateral cooperation?

Part 4: Closing Statement

"Thank you very much for your time and valuable information. The research team will discuss the synthesized results with you in February 2026. If you have any further questions, please contact us at [email/phone]. Thank you."

Appendix B—Dummy Tables (Sample Data Storage Tables)

This appendix presents "sample tables" or dummy tables that the research team used as a template for collecting and organizing data before analysis. The main benefit of displaying four blank tables in this section is it **allows readers to understand the structure of the data that needs to be collected before seeing the results in Chapter 4.**This makes it possible to assess the completeness of the methodology and trace the information back to its source.

Table B.1 Number of target child population, broken down by age group and province (2026).

province	0-1 year	1-2 year	2-5 year	5-12 year	together
Chiang Rai					
Mae Hong Son					
dry					
Kanchanaburi					
Chiang Mai					
Including 5 provinces.					

Table B.2 Vaccine coverage by type and age (%)

Vaccine	Age at which vaccination is administered.	Thai children (average)	Stateless children (5 provinces)	space
BCG	newborn			
HepB1	newborn			
DTP-HepB-Hib1	2 months			
DTP-HepB-Hib2	4 months			
DTP-HepB-Hib3	6 months			
OPV1	2 months			
OPV2	4 months			
OPV3	6 months			

MMR1	9 months			
MMR2	2 years 6 months			
JE1	1 year			
JE2	2 year			

Table B.3 Cost per customer by service type (USD)

Cost category	School-based	Facility-based	Outreach	Mobile
Vaccine cost				
Medical supplies				
Personnel costs				
logistics costs				
fee cold chain				
Administrative costs				
together				

Table B.4 Provincial Budgetary Burden, Annual (Million Baht)

province	Year 1	Year 2	Year 3	Year 4	Year 5	Total 5 years
Tak						
Chiang Rai						
Mae Hong Son						
Kanchanaburi						
Chiang Mai						
together						