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Original Research Report

A Unified Operational Model for Dengue Control: Bridging Community Data and Clinical Surveillance

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Abstract: Dengue fever continues to be a significant urban health issue in Bangkok, fueled by dense population, environmental factors, and incomplete surveillance systems. Even with continuous public health measures, a disparity remains between local vector control initiatives and institutional clinical surveillance, leading to slower outbreak responses and inefficient use of resources. This research seeks to create a cohesive clinical, environmental model that combines community-driven mosquito monitoring, clinical dengue tracking, and public health initiatives into one operational system. Employing a mixed-methods approach, the study took place from January to November 2025 in high-incidence districts within Bangkok and surrounding provinces. Data gathering comprised focus group discussions, interviews with key informants, and secondary analysis of dengue case statistics, vector density measures, and fogging operations. A four-phase model development approach was utilized, incorporating co-design with stakeholders, thematic coding of qualitative information, and triangulation of quantitative data sets. Results show that present response efforts are obstructed by data disconnection, poorly timed fogging, and restricted community involvement. The suggested model enhances real-time data exchange and feedback among community health volunteers, clinics, and city officials, allowing for improved vector management and quicker outbreak responses. It enables communities to serve as proactive participants in surveillance systems, rather than merely as beneficiaries of interventions. Moreover, the model is created to be flexible and suitable for different urban settings. Subsequent studies should aim at conducting pilot tests of the model in chosen districts of Bangkok, incorporating mobile reporting tools, and assessing cost-effectiveness and scalability in larger Southeast Asian urban areas.

Keywords: Aedes Surveillance, Clinical Surveillance, Community Health System, Dengue Control, Integrated Dengue Surveillance Model.

1. Introduction

Dengue fever remains an increasing public health issue in tropical urban areas, and Bangkok is similarly affected. In recent years, the city has experienced a steep rise in dengue cases. By mid-2023, Thailand has recorded more than 19,503 dengue cases and 17 fatalities, marking an astonishing 475% rise compared to the same timeframe last year [1]. The increase is especially noticeable in cities such as Bangkok, where environmental factors and high population density provide ideal conditions for mosquito vectors.

The World Health Organization affirms that dengue is still endemic in Bangkok and across Thailand, with seasonal increases influenced by climatic and ecological factors [2] [3]. In the initial half of 2023, Bangkok reports 122 dengue cases and a single death, with national totals hitting 48,679 cases [4]. The illness shows a distinct seasonal trend, worsening during the rainy months from June to August, when stagnant water collects in cities, forming perfect breeding grounds for Aedes mosquitoes [5].

Changing demographics in case rates further complicate the situation. Children of school age and young adults now account for a considerable share of infections, suggesting that immunity related to age and social behaviors might be affecting transmission trends [3] [6]. Public health initiatives frequently highlight household mosquito management, yet recent patterns indicate that these strategies might be inadequate or not aligned with true transmission hotspots.

Vector control efforts in Bangkok mainly depend on reactive fogging and the application of larvicides, frequently carried out without comprehensive understanding of the distribution of epidemiological cases. These interventions are generally executed separately from the clinical monitoring systems, leading to a disjointed approach to outbreaks [5] [7]. Clinical surveillance largely remains passive, relying extensively on hospital reporting, which might underestimate community transmission and postpone prompt interventions.

This division between clinical and environmental systems creates a significant barrier to successfully controlling dengue. In the absence of coordination, early warning indicators, whether due to increasing case numbers or vector population, are frequently overlooked or inadequately addressed. The city's response to vector control often starts only after significant outbreaks occur, rather than being based on real-time monitoring or predictive analysis.

Several countries are now exploring integrated approaches that link entomological monitoring, clinical case data, and community-based interventions as a more effective way to prevent and manage dengue outbreaks [7] [8]. For instance, lethal ovitraps used in Brazil and the Philippines show significant effectiveness in decreasing mosquito numbers and disrupting transmission cycles when applied within a comprehensive approach [9]. These strategies are guided by epidemiological data and community involvement, providing insights for the dengue management framework in Bangkok.

Urban environments such as Bangkok pose distinct difficulties because of substantial population density, transient populations, and diverse urban infrastructure. They also provide opportunities, including the capacity to utilize digital health platforms and mobile technologies to enhance monitoring and communication between communities and health organizations [7]. A more cohesive strategy is crucial for prompt identification, effective vector management, and lasting alleviation of disease impact.

This research seeks to create and suggest a clinical, environmental framework that combines community-centered mosquito management with immediate dengue monitoring in Bangkok. The aim is to connect environmental management activities with clinical oversight by creating a model that facilitates two-way communication among vector control agents, healthcare professionals, and public health policymakers.

The suggested model is based on four foundations. It includes community-centered mosquito control efforts, such as source reduction, home inspections, and health awareness. Secondly, it combines clinical monitoring data from hospitals, clinics, and community health workers, making certain that suspected and verified cases are quickly reported and examined. Third, the model connects vector control tactics like fogging, ovitrap placement, and larvicide application to real-time entomological and clinical information. Ultimately, it integrates these elements into a wider structure of public health initiatives, encompassing behavioral messaging, school-centered campaigns, and community engagement.

Bangkok is chosen as the case study location because of its significant dengue prevalence, established health infrastructure, and community connections that can facilitate integrated surveillance. The research utilizes the city's public health areas, urban planning information, and current dengue prevention initiatives to demonstrate how the model can be applied in reality. The model facilitates adaptive and responsive dengue management by creating feedback loops between clinical and environmental elements.

The integration highlights the importance of digital data platforms in connecting field observations to surveillance dashboards, enabling predictive analytics and the visualization of outbreak patterns. This model seeks not only to address incidents but also to avert outbreaks by employing early warning systems reliant on environmental indicators and syndromic monitoring.

The importance of this research is found in its capacity to enhance the early identification of dengue outbreaks and bolster the capability of health officials in Bangkok to react proactively. By integrating clinical case information with entomological monitoring, the suggested model improves situational awareness and enables focused interventions prior to outbreak intensification.

The model is centered around decision-making based on data. Health professionals and vector control units can focus on areas experiencing higher mosquito counts or more reports of febrile illnesses, thus enhancing resource distribution and reducing transmission risk. The combination of data streams improves the promptness, precision, and efficiency of dengue management activities, particularly in crowded urban areas.

The model further emphasizes the significance of involvement from the community. Involving residents in monitoring, eliminating sources, and providing feedback helps develop local ownership and sustainability in dengue management. Public trust and adherence grow when communities view themselves as collaborators in disease prevention instead of merely passive recipients of imposed interventions.

Moreover, the model provides a flexible and expandable framework that can be utilized in other cities encountering comparable problems. Bangkok acts as a model, yet these principles can be applied to urban areas in Southeast Asia, Latin America, and Africa, where dengue increasingly endangers public health.

Ultimately, by fostering integration between clinical and environmental sectors, this research aids global initiatives to enhance vector-borne disease monitoring. The strategy corresponds with global health guidelines promoting one-health approaches, digital health incorporation, and cross-sectoral teamwork in managing arboviral diseases.

2. Literature Review

2.1. Dengue and Public Health in Southeast Asia

Bangkok and various cities in Southeast Asia are witnessing an increase in dengue cases, primarily influenced by shifts in climate and urban development. A recent study forecasts that climate change, urban expansion, and population increase will influence future dengue incidence in the region, with expected peaks occurring around mid-century in high-emission scenarios [18]. Colón-González et al. validate that urban heat islands and heightened human mobility serve as major risk amplifiers in the area [18].

Bangladesh shows a thirty-fold rise in dengue cases between 2013 and 2022, mainly driven by climate fluctuations and urban expansion, a trend also seen in Thailand [19]. Rahman Ritu and others examine seasonal rainfall trends and show significant associations with dengue incidence [19].

Forecasts from 30 sites in South and Southeast Asia indicate that increased temperatures and rainfall patterns greatly affect dengue's reproductive capacity (R_t), yet urban development aspects modify those ecological effects [20].

2.2. Community-Based Mosquito Control

Community involvement is essential for successful Aedes management. A worldwide systematic review indicates that participatory interventions, such as larval source reduction and health education, result in significant reductions in entomological indices and enhance community knowledge [21].

In Honduras, a focused community education initiative results in the detection and removal of container habitats like flowerpots and toys, showcasing a replicable model for urban tropical environments [22]. Comparable community-centered programs in Central America geared towards containers demonstrate persistent decreases in mosquito breeding locations [22].

Myanmar is conducting a cluster-randomized trial involving schools and households, combining education with larvicide application, and initial results indicate better entomological outcomes [23]. The writers highlight the importance of community involvement in maintaining vector control.

Brazil’s EVITA-Dengue trial embeds community advisory boards into its Wolbachia mosquito deployment, thus facilitating public acceptability and uptake of novel interventions [24].

2.3. Dengue Surveillance Systems

In Southeast Asia, clinical surveillance systems are progressively depending on reporting from hospitals and primary care facilities. Nonetheless, delays in notifying cases hinder prompt responses; research indicates that these systems are disjointed, relying on paper reports that arrive at the national level weeks post-symptom onset [25].

In Thailand, difficulties in merging data from clinical, laboratory, and environmental systems lead to overlooked early warning signals [26]. Overgaard et al. highlight delays caused by the lack of standardized digital reporting and the lack of integration among health agencies [26].

Predictive epidemiological dashboards in the Mekong Delta indicate that ensemble statistical models can anticipate outbreaks up to three months in advance, but these systems frequently lack inputs from entomological data [27].

2.4. Environmental-Clinical Integration Models

Single-domain methods are inadequate for managing dengue. Models that integrate environmental monitoring with clinical data are gaining popularity. In Vietnam, a district-level ensemble forecasting model combines meteorological and epidemiological indicators, highlighting the significance of cross-domain integration [27].

In Yogyakarta, Indonesia, the introduction of Aedes aegypti infected with Wolbachia results in a 77% decrease in symptomatic dengue cases, as evidenced by a cluster-randomized trial, reflecting significant epidemiological effectiveness [28].

Additional studies in Indonesia and Singapore indicate a 57, 77% decrease in dengue cases following the introduction of Wolbachia, alongside entomological and epidemiological surveillance [29] [30].

BMC Medicine indicates that Wolbachia impacts extend to nearby non-release zones, reducing dengue risk in surrounding areas by 45%, underscoring indirect advantages for the community [31].

In spite of these achievements, the majority of models concentrate on either vector or clinical aspects, seldom incorporating community-focused involvement. The EVITA-Dengue trial in Brazil incorporates stakeholder suggestions but still lacks a clinical feedback mechanism to local health authorities for prompt detection [24].

Although integrated entomological, clinical models show potential, none have been tested in Bangkok that integrate community-driven mosquito control, real-time clinical monitoring, vector-control tactics, and public health strategies within a cohesive framework. Research remains fragmented, with no published model explicitly designed for Bangkok that incorporates digital reporting, community inspection, and clinical data flows.

3. Methodology

3.1. Study Design

This research employs a mixed-methods strategy, integrating qualitative and quantitative methods to guarantee thorough model creation. The approach combines field observations, interviews with stakeholders, and document analysis to create a clinical-environmental framework tailored for community-oriented dengue control in Bangkok. The process of developing the model starts with a comprehensive review of existing literature to pinpoint effective strategies for vector surveillance and community involvement. Subsequent to this, there are on-site evaluations and collaborative discussions with pertinent stakeholders to identify operational issues and system shortcomings.

During 2025, the research group engages in a co-design process for the model that integrates findings from scientific data and real-world experiences. The method is cyclical, progressing from initial ideas to expert confirmation and improvement. The research highlights the importance of inclusive involvement from various stakeholders, guaranteeing that community viewpoints and institutional needs are incorporated into the ultimate model.

3.2. Study Area and Population

The research takes place in two high-risk dengue districts in Bangkok: Bang Khen and Don Mueang, as well as nearby suburban regions in Nonthaburi and Pathum Thani Provinces. The selection of these areas is based on past dengue case occurrence, the existence of ongoing community health initiatives, and the ease of continued field involvement.

The research includes 120 participants, categorized into four primary groups:

(1) Staff from health centers (primary caregivers and public health officials)
(2) Local government officials and community health volunteers
(3) Residents living in neighborhoods with high incidence rates
(4) Dengue surveillance officials from the Ministry of Public Health and Bangkok Metropolitan Administration (BMA).

Participants are selected through purposive sampling to guarantee the involvement of individuals directly engaged in dengue prevention and response efforts.

3.3. Data Collection

The data gathering process covers January to November 2025 and employs three primary approaches: focus group discussions (FGDs), key informant interviews (KIIs), and analysis of secondary data. FGDs involve community members and local volunteers to reveal behavioral trends, issues in mosquito management, and views on current interventions. Simultaneously, comprehensive interviews are conducted with public health officials, surveillance personnel, and clinical staff to investigate system bottlenecks and coordination challenges.

Quantitative data consist of reported dengue cases, indices of vector density (for example, larvae count per household), and the frequency and locations of fogging conducted by local health departments. Extra information is collected from community reporting tools like mobile applications, logbooks kept by health volunteers, and health dashboards at the district level. These datasets offer a detailed perspective on the dynamics of dengue transmission and the present condition of environmental management.

3.4. Model Development

The creation of the suggested clinical-environmental model proceeds through a four-step process, namely:

(1) The research performs a synthesis of empirical data and existing literature, pinpointing essential variables and structural deficiencies in present surveillance and mosquito management systems. The outcomes of FGDs and interviews are coded and examined through thematic analysis software, whereas the quantitative datasets are triangulated to evaluate consistency between vector activity and case reporting.
(2) The research team develops an initial model framework, illustrating the connections between community-level vector control, clinical case identification, and data-sharing systems. This version is subsequently submitted to a panel of specialists including entomologists, epidemiologists, and public health planners from Mahidol University, the Bangkok Metropolitan Administration, and global NGOs.
(3) Utilizing expert input, the model is revised and refined, especially concerning communication pathways, feedback mechanisms, and monitoring metrics. Particular emphasis is placed on the functions of community participants, guaranteeing that the model stays applicable and inclusive.
(4) The model is completed and recorded, consisting of visual flow diagrams, operational procedures, and essential metrics for oversight. The end result is a tailored, community-connected clinical-environmental model prepared for pilot testing and policy implementation by regional health agencies.

4. Findings and Discussion

4.1. Finding

This research creates a unified clinical-environmental model for managing dengue that incorporates community-oriented mosquito monitoring, reporting of clinical cases, vector control methods, and public health actions within a single operational structure. It directly addresses the fragmentation issues recognized in Bangkok's existing dengue response framework. The model illustrates how various stakeholders, such as community members, health volunteers, local medical facilities, and city officials, can collaborate for immediate, data-informed dengue prevention and response.

Key findings emphasize underlying issues: inadequate coordination exists between community-sourced data and clinical monitoring, leading to incorrect fogging timings and postponed outbreak reactions. Information gathered from focus group discussions and stakeholder interviews consistently indicates a disparity between larval surveillance carried out by local volunteers and the epidemiological data utilized by health centers. Furthermore, reliance on fixed fogging schedules diminishes the agility of vector control teams, especially during peak transmission periods.

The research also reveals significant community enthusiasm. Individuals from Bang Khen, Don Mueang, Nonthaburi, and Pathum Thani show enthusiasm to engage actively, particularly when provided with training and easy-to-use reporting tools. This discovery highlights the importance of creating a feedback mechanism that enables communities to communicate risks and get prompt updates.

The completed model, illustrated in Figure 1 and implemented via Figure 2, shows that incorporating real-time feedback loops between the community, clinics, and local health authorities enhances coordination effectiveness. The model includes community submissions about mosquito breeding locations, which are channeled through local health volunteers to primary healthcare facilities. These clinics notify the Bangkok Metropolitan Administration (BMA), which subsequently initiates vector control measures, such as fogging and larviciding. Finally, public health communications are sent back to communities, completing the feedback loop.

This approach bridges institutional silos by allowing vector control actions to be directly informed by both larval indices and clinical case surges. It encourages co-ownership of health interventions among all actors involved and promotes transparent communication and accountability.

Figure 1 illustrates how community-based mosquito control, dengue surveillance, vector control strategies, and public health interventions are integrated into one operational system.

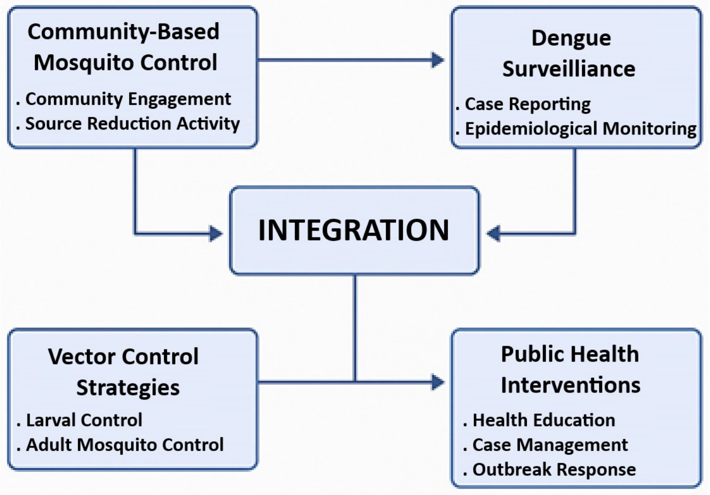

Figure 1. A Clinical-Environmental Model:
Integration of Vector, Clinical, and Community Systems

Figure 1 shows the ultimate result of this research: a comprehensive model linking four essential areas of dengue prevention and response, Community-Based Mosquito Control, Dengue Surveillance, Vector Control Strategies, and Public Health Interventions, through a core operational framework termed Integration.

The model illustrates how community involvement (top left) directly contributes to epidemiological surveillance by producing larval data, hotspot reports, and behavioral insights. These reports are integrated into the Dengue Surveillance system (top right), which collects clinical case information and conducts epidemiological tracking. Both areas provide real-time insights that activate the suitable Vector Control Strategies (bottom left), encompassing control measures for both larvae and adult mosquitoes.

At the same time, information from both vector presence and case data trigger Public Health Interventions (lower right), which encompass health education, clinical case management, and outbreak response initiatives. The center point where these four domains intersect is Integration, symbolizing the coordination mechanism, both institutional and technical, that facilitates prompt, data-informed, and community-oriented actions.

The research process and field application indicate that fragmentation has been a significant flaw in dengue management systems in Bangkok. Previously, vector data gathered by communities was not integrated with clinical case reporting systems, and both frequently did not impact fogging or outbreak response timelines. This model shows that connecting these systems via two-way communication and data feedback loops greatly enhances coordination and responsiveness.

Stakeholders consulted during the fieldwork indicate that when the community can notify mosquito breeding sites or cases through a direct channel (like mobile apps or health volunteers), authorities can prioritize interventions more effectively. In simpler terms, initial warning indicators from the field are now aligned with centralized reactions, a process that has not been consistently executed in the past.

The model also uncovers the unexploited capabilities of community members, not merely as passive recipients of information but as collaborative creators of surveillance data. Incorporating their involvement into official dengue strategies improves both reach and long-term viability.

This clinical-environmental framework stands out from current models in several aspects:

1) Multisectoral Integration: While many conventional dengue models emphasize either clinical (hospital-related) or entomological (mosquito index) information, this model combines both aspects along with public involvement and policy initiatives. It implements an ecosystem strategy instead of isolated actions.
2) Data Flow Driven by the Community: Previous models frequently depend only on government oversight from above. This model includes bottom-up reporting systems, allowing residents and health volunteers to directly participate in risk mapping and control actions.
3) Interactive Feedback Systems: Rather than unidirectional reporting (e.g., from clinics to health agencies), this framework encourages bidirectional loops where information circulates back to communities as alerts, training, and resource allocation. It enables the system to be dynamic and immediate.
4) Modular and Expandable: This model is created to be modular, allowing it to be adapted to various urban environments by incorporating local institutions and communication technologies. This differs from previous models that tend to be context-dependent and hard to reproduce.

The model illustrated in Figure 1 presents numerous strategic benefits:

1) Promptness: Connecting larval monitoring to increases in clinical cases enables vector control teams to respond more rapidly and accurately, particularly during outbreak periods.
2) Efficiency: Resources like fogging chemicals, health initiatives, and staff can be allocated according to composite data instead of relying on assumptions or predefined schedules.
3) Empowerment: Communities are now active participants rather than passive targets, leading to enhanced compliance and more sustainable behavioral change.
4) Policy Significance: The model can be directly applied to health policy as it corresponds with WHO’s integrated vector management and Thailand’s decentralization approach.
5) Flexibility: It supports integration with digital tools, such as mobile reporting apps or GIS dashboards, enabling Bangkok’s health system to modernize and respond to future vector-borne disease threats.

Figure 1 serves as more than just an illustration; it's a design for an effective, expandable, and inclusive dengue management system. It demonstrates the integration of field conditions, stakeholder requirements, and institutional mechanisms into a model that is both applicable and transformative. In contrast to previous fragmented historical methods, this model presents a novel framework for urban dengue management, where communities, clinics, and control programs collaborate in a synchronized manner rather than operate separately.

While, Table 1 provides a thematic overview of empirical findings obtained from stakeholder interviews and field observations carried out during the execution of the integrated dengue surveillance and control model in Bangkok. These results emphasize important operational and systemic factors that influence the effectiveness and constraints of the existing public health response. Three main themes arose from the data: data fragmentation, fogging timing, and community readiness.

Table 1. Summary of Key Findings from Stakeholder Interviews and Field Observations

Key Theme	Observations from Field Data
Data Fragmentation	Community data not integrated with clinical reports
Fogging Timing	Delays and misalignment with dengue case surges
Community Willingness	High motivation with structured support and reporting tools

1) Data Segmentation
A commonly expressed worry among both community health volunteers and clinical staff is the disintegration of data systems. Field observations indicate that community reports on mosquito breeding sites are frequently not combined with clinical dengue case reports held at primary health centers. This absence of interoperability implies that environmental surveillance (i.e., vector presence) and epidemiological data (i.e., clinical case alerts) function separately, diminishing the ability to create targeted, prompt responses.
This fragmentation obstructs early warning systems and reduces the effectiveness of vector control implementation. Stakeholders highlighted that in the absence of a cohesive reporting platform or protocol, critical field-level insights do not influence strategic decisions at higher tiers, like fogging schedules or interventions at the community level.

2) Timing for Fogging
The second theme relates to the disparity between fogging efforts and the true peaks of dengue case occurrences. Based on insights from both interviewees and observational data, fogging aimed at eradicating adult mosquitoes is frequently performed either too late or in locations not currently facing outbreaks. This timing difference arises from delays in data transmission, bureaucratic slowdowns, and a reactive instead of proactive approach in existing practices.
Improperly timed actions diminish the effectiveness of vector management and could squander scarce public health resources. The field teams noted that by the time fogging begins, local transmission may have already decreased or moved to nearby communities. This disconnect also reduces public confidence in government responsiveness, as communities might view actions as more symbolic than impactful.

3) Community Readiness
Unlike the aforementioned structural challenges, the third major theme illustrates a significant eagerness among communities to engage actively in mosquito control and monitoring, as long as adequate tools, training, and feedback systems are established. Field data indicate that community members display strong motivation, especially when they recognize the direct link between their behaviors and public health results.
Conversations with community health volunteers, locals, and neighborhood leaders consistently highlight a willingness to identify breeding locations, engage in source reduction efforts, and share health information. Nonetheless, this potential is still not fully harnessed because of a lack of organized reporting tools, regular communication, and significant involvement in decision-making processes. When structured assistance is available, participation levels and monitoring precision increase markedly.

These three themes collectively highlight the necessity for a more cohesive, data-informed, and community-focused strategy for managing dengue. Tackling data fragmentation via interoperable systems, syncing vector control efforts with clinical epidemiology, and methodically empowering communities are vital strategies that arise from these insights. The table functions not only as a summary of on-ground situations but also as a guideline for improving the suggested clinical-environmental model for urban dengue monitoring.

Figure 2 depicts the information and actions flow within a community-oriented dengue surveillance and vector control system. The framework highlights an organized and cooperative method that includes various stakeholders to efficiently identify, address, and avert dengue outbreaks. The procedure progresses in this manner:

1) Community Reports (Locations of Mosquito Breeding)
   The local community serves as the initial focus, actively recognizing and notifying about mosquito breeding locations. This phase utilizes community involvement and local insights to identify possible vector habitats promptly.
2) Community Health Volunteers:
   Community reports are collected and handled by local health volunteers. These volunteers are essential in collecting data from the community level and act as links between the population and established health systems.
3) Primary Health Clinics (Case Notifications):
   Volunteers send the gathered information to primary health centers. Here, alerts for cases linked to suspected or confirmed dengue infections are tracked. This guarantees that clinical monitoring is combined with environmental information regarding mosquito reproduction.
4) Bangkok City Administration (Response Team):
   The main health centers forward the information to the response unit of the metropolitan administration. This unit organizes a citywide approach, guaranteeing that resources and actions are utilized effectively.
5) Vector Management (Fogging, Larval Treatment):
   Targeted vector control strategies, including fogging (insecticide application) and larviciding (treatment for larvae in water bodies), are carried out based on the alerts and data. These measures seek to decrease mosquito numbers and halt the spread of diseases.
6) Community-Focused Public Health Communication:
   Ultimately, following intervention efforts, health messages are shared with communities to enhance awareness, foster preventive actions, and support ongoing alertness.
7) Involvement of the Community & Cycle of Feedback:
   A key aspect of this model is the feedback system that provides communities with updates and motivates them to stay involved in monitoring. This ongoing cycle promotes ongoing teamwork and adaptability.

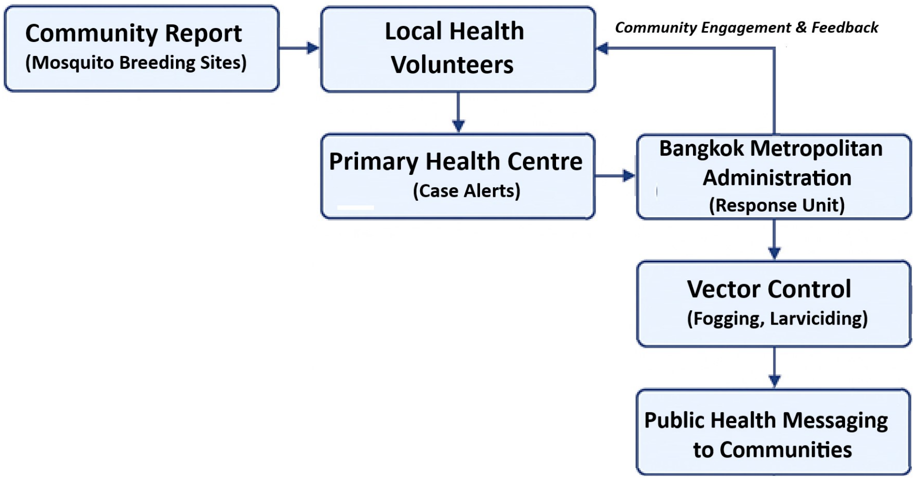

Figure 2. Data Flow and Action Loop in the Proposed Integrated Model

Table 2 presents significant obstacles faced while implementing the integrated community-based dengue surveillance and vector control model in Bangkok, along with tactical suggestions to address these issues. The recognized obstacles indicate systemic, operational, and governance-related limitations that, if not addressed, may impede the model’s effectiveness and sustainability.

Table 2. Implementation Challenges and Strategic Recommendations

Challenge	Recommendation
Data System Incompatibility	Develop standardized, interoperable digital reporting tools
Limited Human Resources	Provide regular training, capacity-building, and volunteer incentives
Regulatory Barriers	Promote decentralized decision-making and cross-sector coordination

1) Incompatibility of Data Systems
A major challenge is the mismatch between the data systems employed by different stakeholders, including community volunteers, primary health centers, and municipal authorities. The absence of uniform reporting formats, restricted data-sharing systems, and varied platforms hinder real-time collaboration and diminish the effectiveness of public health responses.

Strategic Suggestion:
To tackle this, the research suggests creating and implementing standardized, interoperable digital reporting instruments. These tools ought to enable smooth integration of case notifications, reports of mosquito breeding sites, and logs of vector control activities among institutions. A centralized dashboard available to all stakeholders in the chain, including local volunteers, would enhance data visibility, minimize duplication, and improve decision-making at all levels.

2) Restricted Human Resources
Another major challenge is the lack of skilled staff, especially in community-level and peripheral positions. Health volunteers frequently operate without steady assistance or rewards, whereas professional staff experience overload because of their small numbers. This weakens the sustainability of monitoring efforts and limits the scalability of the framework.

Tactical Suggestion:
To address this, the model suggests ongoing training sessions, capacity-building workshops, and offering incentives for volunteers and health workers. These might consist of monetary assistance, accreditation, acknowledgment initiatives, and chances for advancement in one's career. Enhancing human resource capacity guarantees that community involvement stays strong and that the technical quality of data gathering and vector control initiatives is preserved.

3) Regulatory Obstacles
The model likewise recognizes regulatory and institutional obstacles as hindrances to rapid and coordinated reactions. Centralized decision-making frequently hinders prompt action, and fragmentation across sectors, including inadequate coordination among health, environmental, and municipal departments, diminishes the efficacy of integrated methods.

Strategic Suggestion:
An essential solution is to encourage decentralized decision-making, enabling district- or ward-level response teams with the power and resources needed to respond quickly. Moreover, collaborative coordination systems, including joint task forces, multi-agency planning meetings, and common operational procedures, are crucial for achieving aligned efforts among health services, environmental agencies, and local authorities.

These suggestions serve as both technical remedies and institutional advancements intended to secure the model's enduring success. By actively tackling these three types of implementation obstacles, technological, human, and regulatory, the model strengthens its objective of evolving into a sustainable, community-oriented, and clinically responsive system for dengue prevention in Bangkok.

4.2. Implications

The results have significant policy ramifications for the public health system in Bangkok. The suggested clinical-environmental framework can act as a model for local health agencies aiming to enhance collaboration among vertical systems of surveillance, vector management, and community involvement. By implementing early identification and focused actions, the model decreases resource waste and enhances public confidence.

Considering that Bangkok experiences repeated seasonal dengue outbreaks, the model improves readiness by connecting fixed health infrastructure with dynamic, localized information. Public health officials can utilize it to prioritize fogging sites based on case surges as well as current vector data, thereby implementing interventions in a more strategic manner.

The model is also significant for other tropical urban areas that share comparable epidemiological and infrastructural characteristics. Cities like Jakarta, Manila, Ho Chi Minh City, and Colombo could implement and modify the model by customizing its reporting processes and involved institutions. Its modular structure permits contextual adjustments, including the incorporation of extra elements such as water sanitation monitoring or electronic health records.

Crucially, the model's collaborative aspect enhances robust health governance. By engaging communities as active participants instead of passive recipients, the framework promotes enduring behavioral change in mosquito source reduction and prompt outbreak reporting.

Additionally, this model aids in bridging the persistent divide between environmental risk factors and clinical outbreak management. It conforms to the World Health Organization’s (WHO) Integrated Vector Management (IVM) framework and promotes One Health principles by considering both vector ecology and human health results.

4.3. Recommendations

According to the findings of the study, three main suggestions are offered to guarantee effective implementation and influence:

Initially, the model needs to be tested in a controlled field environment. A practical trial in 2, 3 districts of Bangkok can assist in confirming its practical viability, encompassing data movement, response time, and community participation dynamics. Pilot testing will enable adjustments to logistical limitations like reporting frequency, technical capabilities, and collaboration among local offices.

Secondly, the abilities of local health volunteers and community health workers need to be enhanced. Training initiatives must prioritize digital literacy, pest inspection, and emergency response management. These individuals are the foundation of the system; they collect larval information, inform households, and act as the main connection to official health services. Incentive programs might also be necessary to maintain volunteer involvement in the long run.

Third, the research suggests incorporating real-time reporting technologies into the system. An app for mobile reporting, featuring geo-tagging and photo upload options, can enable immediate reporting of mosquito breeding locations and symptomatic instances. The application must be compatible with current health databases overseen by the BMA and Ministry of Public Health. Authorities can dynamically prioritize high-risk areas by optimizing data collection and visualization.

In the long run, Bangkok should think about integrating this model into its city health planning systems, potentially via a dengue control task force that spans multiple sectors. Ongoing studies are required to investigate the cost-effectiveness of this model and its potential for scaling in rural areas.

This research indicates that effective dengue management in urban Southeast Asia relies not just on scientific advancements but also on integrating systems, building community trust, and ensuring responsive governance. The suggested clinical-environmental framework provides a functional guide for bridging the gap between community awareness and institutional initiatives.

5. Conclusion

This research presents and illustrates a cohesive clinical-environmental framework for dengue monitoring and vector management in Bangkok, unifying community-driven observation, clinical documentation, and health interventions into one operational system. The model tackles significant deficiencies in the current dengue response system, including fragmented data, poorly timed fogging, and insufficiently utilized community resources. By promoting immediate feedback channels among community members, clinics, and local health officials, the system allows for more accurate, prompt, and cooperative reactions to outbreaks. Essential characteristics like bottom-up data movement, modular integration, and community-engaged public health measures guarantee the model's flexibility in different urban environments. Additionally, the model aids policy by conforming to WHO's Integrated Vector Management framework and Thailand's decentralization plans, fostering collective responsibility for disease control among the public and institutions.

For future research, conducting a pilot implementation in chosen districts of Bangkok is essential to confirm the model's practical application, evaluate technical systems, and assess its effect on response times and community involvement. Additional studies should investigate the integration of this model with digital health ecosystems, including GIS-based dashboards and electronic health records, to improve data visualization and coordination. Furthermore, comparative research in other tropical urban areas like Jakarta or Manila might evaluate the model's ability to scale and adapt to different contexts. Ultimately, an economic assessment of the model's cost-effectiveness and long-term sustainability would enhance its policy significance and promote ongoing institutional backing.

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