

Development and Functional Testing of a Web Based Dengue Weather Alert Prototype with WhatsApp Notifications in Palu, Indonesia

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Abstract

Background: Weather information may support dengue preparedness, although software functionality alone cannot establish forecasting accuracy. **Objectives:** This study developed a web based weather alert prototype integrating meteorological data and WhatsApp notifications for dengue preparedness in Palu, Indonesia. **Methods:** Research and development followed the Analysis, Design, and Development phases of the ADDIE model from January 14 to February 4, 2026. CodeIgniter 4 and MySQL supported coordinate based weather retrieval through OpenWeather, data storage, user registration, and automated notifications. **Results:** The prototype covered 46 urban villages across eight districts. Nine functional testing categories were reported as successful, including website accessibility, geographic data, weather integration, storage, notifications, decision logic, registration, profile management, and interface responsiveness. However, detailed test inputs, execution counts, and notification delivery receipts were unavailable. The 22 day development period could not independently establish a complete 30 day rainfall dataset without historical records. Weather thresholds remained literature informed assumptions without local predictive validation. **Conclusions:** The prototype demonstrated preliminary software integration capabilities. Reproducible functional testing, rainfall data verification, governance safeguards, and independent epidemiological validation are required before operational implementation for dengue preparedness.

Keywords: Application programming interface; Environmental monitoring; Health communication; Software testing; Vector-borne diseases.

Introduction

Dengue remains a major vector borne public health problem in tropical urban settings. The World Health Organization reported more than 14.6 million cases and over 12,000 dengue-related deaths worldwide in 2024¹. Sustainable prevention requires attention to vector ecology, community practices, and the limitations of insecticide based control². Temperature, humidity, and rainfall can influence mosquito survival, breeding habitats, and virus transmission; these effects interact with population movement, immunity, and surveillance quality³. Mechanistic models demonstrate nonlinear thermal responses rather

than a universal temperature cutoff⁴. The overlapping distribution of several Aedes borne viruses further illustrates the broader surveillance context⁵.

Palu experiences a substantial and fluctuating dengue burden. A descriptive study recorded 604 cases in 2019, 309 in 2020, 305 in 2021, 641 in 2022, and 541 in 2023; South Palu accounted for 657 cases over the five year period⁶. These findings establish local relevance, but they do not validate weather thresholds or prove that climate caused the observed fluctuations. Published Healthy Tadulako Journal evidence emphasizes coordinated health promotion and community

participation⁷. Another study found an association between mosquito breeding site control practices and the presence of *Aedes* larvae⁸. Timely information therefore needs a clear link to practical prevention activities.

Local vector control research also cautions against assuming that a proposed intervention is effective: a Tadulako study found no meaningful larvicidal effect of pandan leaf extract under the tested conditions⁹. The same distinction between a plausible idea and demonstrated performance applies to digital alerts. Established dengue warning systems already combine meteorological, epidemiological, or entomological information and evaluate alarm performance¹⁰. EWARS additionally links warning generation to response procedures¹¹. The present contribution is the assembly of a coordinate-based weather and messaging workflow for Palu, rather than the invention of dengue forecasting or evidence of superior prediction.

This study asks whether a web based prototype can integrate an administrative location inventory, weather retrieval, database storage, and WhatsApp notification functions. Its objective is to develop the prototype and describe the functional checks reported during development. The study does not test a hypothesis about dengue incidence, estimate individual infection risk, or evaluate community behavior. Forecasting research demonstrates the need for independent evaluation against observed epidemic outcomes¹², while seasonal dengue prediction in Vietnam illustrates the additional data and time-series validation required for a forecasting claim¹³. These requirements define the boundary of the current development study.

A successfully integrated prototype could provide a starting point for a future preparedness communication service. Its practical value would depend on complete and traceable weather records, reproducible

decision logic, reliable message receipt, and appropriate governance of contact details. Prevention advice should remain available even when weather alert criteria are not met¹. The current study therefore reports preliminary technical feasibility and specifies the evidence needed before operational adoption. Epidemiological validation and community evaluation are subsequent research stages, rather than outcomes inferred from the existence of the website.

Materials and Methods

Study Design

This research and development study used the Analysis, Design, and Development phases of the ADDIE model in Palu, Indonesia, from January 14 to February 4, 2026. Analysis identified candidate weather variables and administrative query locations; Design defined the interface, database, and information flow; Development implemented the prototype and reported black-box functional checks. Implementation and Evaluation with end users were outside the stated study scope and timeframe. The outcome was a software prototype, not an evaluated public health intervention.

The reported technology stack comprised PHP, CodeIgniter 4, MySQL, OpenWeather integration, and a third party WhatsApp interface. The model view controller pattern separates data handling, presentation, and request processing¹⁴. The source manuscript did not report the precise framework/database versions, deployment build, messaging provider, or provider API version. These omissions limit reproducibility and are not evidence that a particular provider or production configuration was used.

Sample

The geographic units were the 46 urban villages (kelurahan) listed across eight districts

(kecamatan) of Palu. Each listed coordinate was a weather query point, not a human participant or an independent meteorological station. The inventory included 45 urban-village office locations and one terminal location in Tipo. The technical assessment units were nine reported functional test categories. Counts of individual executions, weather observations, registered accounts, and delivered messages were not provided; therefore, neither a human sample size nor an execution level sample size can be stated.

Data Collection Technique

The source manuscript described a literature review, compilation of geographic coordinates, retrieval of temperature, relative humidity, and precipitation from OpenWeather, and storage in MySQL. Coordinates were supplied as signed decimal latitude and longitude (Table 1). Their original source, acquisition date, coordinate reference system, administrative-boundary verification, and the reason for selecting the Tipo terminal were not documented. Coordinate specific requests identify where the service is queried; they do not demonstrate village scale weather resolution.

The exact OpenWeather product, endpoint/version, subscription, retrieval schedule, and historical data access were not identified in the supplied record. For the documented Current Weather product, metric temperature is expressed in degrees Celsius, humidity in percent, and rain.1h in mm/h; the response includes a data timestamp.¹⁵ This documentation clarifies field interpretation but does not establish which endpoint the researchers actually used. A current-weather response or one snapshot per day cannot, by itself, establish a complete daily rainfall total or a preceding 30 day accumulation.

A reproducible rainfall series requires documented precipitation amounts for non-

overlapping intervals or a verified accumulated rainfall product, deduplication by location and observation interval, and complete temporal coverage. Daily aggregation should use a declared local-day convention, such as Asia/Makassar (UTC+8), with source and retrieval timestamps retained separately. An absent precipitation field in a valid fresh response must be distinguished from a failed request, stale record, or incomplete day. Missing intervals must not be silently filled with zeros. These are requirements for the next auditable build; their implementation was not established by the submitted testing summary.

The reported development interval contains 22 calendar days. A 30 day window ending February 4, 2026 would require complete daily data from January 6 through February 4 under an inclusive calendar-day definition. No earlier imported series, warm-up log, or labeled simulated test data was supplied. The rainfall rule is therefore described as a design feature whose complete historical input coverage remains unverified.

Data Analysis Technique

Analysis was descriptive. The geographic inventory and nine functional categories were summarized, retaining the success labels reported by the researchers. These labels were not converted into a success probability, a 100% execution pass rate, or estimates of message delivery. No inferential tests were performed because no dengue outcome series, comparison group, or execution level dataset was supplied. Sensitivity, specificity, positive predictive value, usability, response time improvement, and prevention effectiveness were not measured.

The candidate rule used a three day mean temperature of 25–30°C, a three-day mean relative humidity greater than 60%, and a preceding 30-day rainfall total of 100–400 mm. Indonesian ecological studies support

considering climate variables^{16,17}, including spatial and temporal variation¹⁸, but do not independently validate this combination of operational thresholds for Palu. A weather-focused review provides contextual support for variable selection¹⁹. The numerical intervals and averaging windows are consequently treated as literature informed design adaptations, not fitted or externally validated predictors (Table 2).

The original narrative did not specify the logical operator or boundary handling. For reproducible future testing, Table 4 defines a proposed conservative specification: all three criteria must be met (AND), temperature and rainfall bounds are inclusive, and humidity is strictly greater than 60%. A missing or incomplete required window yields an insufficient data state. Otherwise, criteria outside these intervals yield “weather alert criteria not met,” including temperature above 30°C or rainfall above 400 mm. This specification requires checking against source code and boundary tests before being described as implemented behavior; no dengue-risk absence is implied.

Ethical Consideration

This study involved the development and functional testing of a web based dengue weather alert prototype without clinical interventions, biological sample collection, or direct assessment of human health outcomes. Ethical considerations focused on data privacy, confidentiality, responsible information management, and minimizing potential risks associated with digital health communication. Although meteorological and geographic information did not directly identify

individuals, the system's registration and WhatsApp notification features introduced potential risks involving personal contact information. Accordingly, informed consent, voluntary participation, secure data storage, restricted access, and appropriate management of personal information should be established before public implementation. Weather alerts must also be communicated responsibly to prevent misleading interpretations of dengue risk, particularly because the proposed warning thresholds have not undergone epidemiological validation. The available research documentation did not establish formal ethical approval or exemption; therefore, an appropriate determination from an authorized research ethics committee should be obtained before subsequent studies involving end users or community deployment.

Result

Findings are organized using the HTJ template subitems. Because this is a development study, the geographic configuration and functional checks are reported in place of participant demographics and statistical hypothesis tests.

No end user respondent characteristics were collected in this study. The configured inventory comprised 46 urban villages in Mantikulore (8), West Palu (6), South Palu (5), East Palu (5), North Palu (5), Tatanga (6), Tawaeli (5), and Ulujadi (6). All latitude values were negative and longitudes positive. The query points comprised 45 urban-village offices and the Type C terminal in Tipo. Table 1 retains the complete coordinate inventory supplied by the researchers; the number of decimal places does not establish geographic accuracy.

Table 1. Configured weather query coordinates in Palu

District (kecamatan)	Urban village (kelurahan)	Query-point location	Latitude	Longitude
Mantikulore	Kawatuna	Urban-village office	-0.885561	119.977519

District (kecamatan)	Urban village (kelurahan)	Query-point location	Latitude	Longitude
Mantikulore	Lasoani	Urban-village office	-0.902831	119.906431
Mantikulore	Layana Indah	Urban-village office	-0.810761	119.919611
Mantikulore	Poboya	Urban-village office	-0.845281	119.979411
Mantikulore	Talise	Urban-village office	-0.868731	119.886769
Mantikulore	Talise Valangguni	Urban-village office	-0.879061	119.890911
Mantikulore	Tanamodindi	Urban-village office	-0.897528	119.892694
Mantikulore	Tondo	Urban-village office	-0.843417	119.885583
West Palu	Balaroa	Urban-village office	-0.906431	119.843619
West Palu	Baru	Urban-village office	-0.893969	119.853369
West Palu	Kamonji	Urban-village office	-0.900189	119.851819
West Palu	Lere	Urban-village office	-0.887711	119.849411
West Palu	Siranindi	Urban-village office	-0.899819	119.857711
West Palu	Ujuna	Urban-village office	-0.902411	119.863181
South Palu	South Birobuli	Urban-village office	-0.928509	119.894500
South Palu	North Birobuli	Urban-village office	-0.918401	119.892720
South Palu	Petobo	Urban-village office	-0.9408053	119.924089
South Palu	Tatura Selatan	Urban-village office	-0.9174239	119.8691305
South Palu	Tatura Utara	Urban-village office	-0.9114281	119.8740846
East Palu	Besusu Barat	Urban-village office	-0.888714	119.866918
East Palu	Besusu Tengah	Urban-village office	-0.890180	119.874656
East Palu	Besusu Timur	Urban-village office	-0.893620	119.881072
East Palu	Lolu Selatan	Urban-village office	-0.902946	119.882733
East Palu	Lolu Utara	Urban-village office	-0.902209	119.873810
North Palu	Kayumalue Ngapa	Urban-village office	-0.749126	119.864844
North Palu	Kayumalue Pajeko	Urban-village office	-0.758997	119.863399
North Palu	Mamboro	Urban-village office	-0.796389	119.8513269
North Palu	West Mamboro	Urban-village office	-0.793179	119.8585967
North Palu	Taipa	Urban-village office	-0.7774679	119.85914
Tatanga	Boyaoge	Urban-village office	-0.914465	119.853614
Tatanga	Duyu	Urban-village office	-0.920053	119.837831
Tatanga	Nunu	Urban-village office	-0.908618	119.861568
Tatanga	Palupi	Urban-village office	-0.926217	119.857150
Tatanga	Pengawu	Urban-village office	-0.923534	119.847017
Tatanga	Tawanjuka	Urban-village office	-0.919755	119.866084
Tawaeli	Baiya	Urban-village office	-0.729729	119.863711
Tawaeli	Lambara	Urban-village office	-0.733679	119.863693
Tawaeli	Panau	Urban-village office	-0.741168	119.863234
Tawaeli	Pantoloan	Urban-village office	-0.704282	119.850552
Tawaeli	Pantoloan Boya	Urban-village office	-0.690712	119.856579
Ulujadi	Buluri	Urban-village office	-0.848990	119.823163
Ulujadi	Donggala Kodi	Urban-village office	-0.899036	119.838991
Ulujadi	Kabonena	Urban-village office	-0.888401	119.834909
Ulujadi	Silae	Urban-village office	-0.874565	119.830098

District (kecamatan)	Urban village (kelurahan)	Query-point location	Latitude	Longitude
Ulujadi	Tipo	Type C terminal, Tipo	-0.8631314	119.8223598
Ulujadi	Watusampu	Urban-village office	-0.8158172	119.8087714

Source: geographic inventory in the supplied 2026 development manuscript.

The prototype used temperature, relative humidity, and rainfall as weather inputs. Table 2 summarizes the candidate calculations and thresholds. These values describe the proposed software rule; they are not observed

distributions of weather measurements or estimates of dengue risk. No raw weather series was supplied for computing means, ranges, or a verified 30 day total.

Table 2. Literature informed candidate criteria and study specific adaptations

Variable	Proposed calculation/unit	Candidate criterion	Evidence status
Temperature	3-day mean; °C	25–30	Interval described in a weather review. ¹⁹ The 3-day mean is a design adaptation; neither is validated for Palu.
Relative humidity	3-day mean; %	>60	Lower bound described in the same review. ¹⁹ The 3-day window and combined rule remain unvalidated.
Rainfall	Preceding 30-day total; mm	100–400	Exact cutoff/window derivation not traceable in the supplied evidence; complete rainfall provenance unverified.

Source: thresholds retained from the supplied prototype design.

No statistical hypothesis was tested and no association between weather and dengue was estimated. Technical verification instead comprised the nine black-box categories in Table 3, each labeled successful in the original manuscript. Execution inputs, observed output

records, repetition counts, tester identity, build/date, and prespecified acceptance criteria were not supplied. The table therefore reports category level claims without presenting an auditable test pass rate or delivery rate.

Table 3. Reported functional test categories and limits of the available evidence

No.	Functional category	Reported check and qualification	Source status
1	Website access	Website displayed without errors.	Success reported
2	District and urban-village data	Configured location data displayed.	Success reported
3	OpenWeather integration	Weather response returned for requested coordinates.	Success reported
4	Weather storage	MySQL records stored in the intended format; duplication not reported.	Success reported
5	WhatsApp notification function	Recipient format checked and notification submission reported; delivery/read receipts not supplied.	Success reported
6	Weather decision logic	Original “Safe”/“Alert” scenarios reportedly switched status; inputs, operator, and boundary outputs absent.	Success reported
7	Registration	Malformed/country-code-deficient numbers reportedly rejected; profile created and stored.	Success reported
8	Profile management	Viewing, editing, and deleting a profile reported; downstream deletion verification absent.	Success reported
9	Interface/navigation	Page links and display on different devices reportedly worked; device list and usability measures absent.	Success reported

Source: the supplied development manuscript.

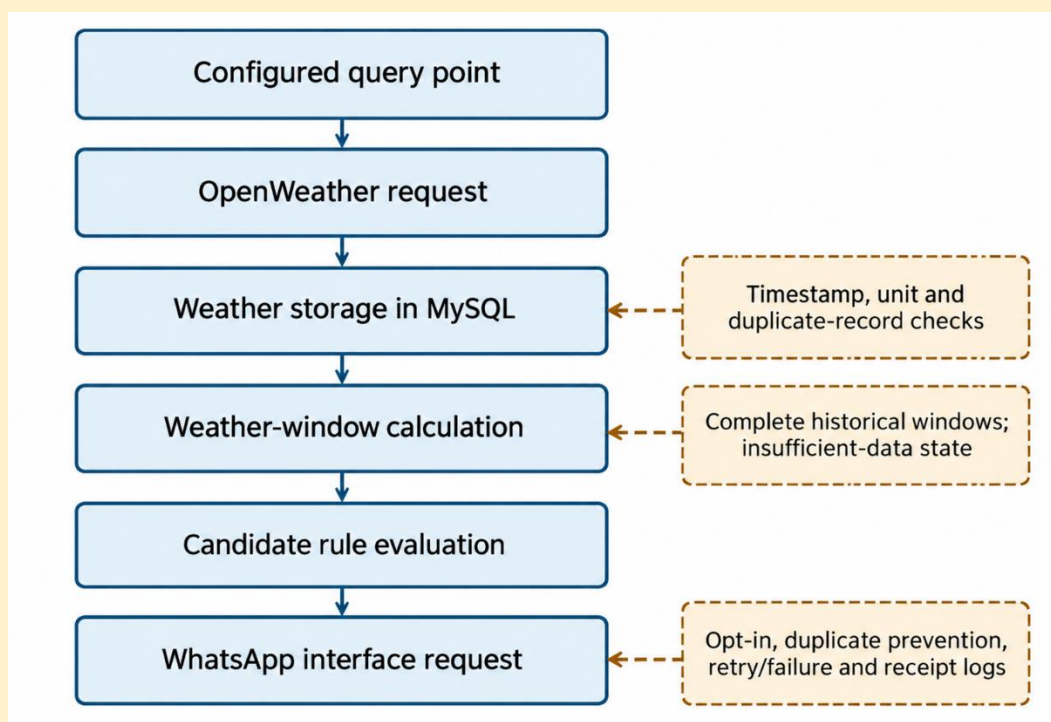
Table 5. Proposed decision specification for code confirmation and subsequent testing

Input condition	Proposed display state	Interpretation
Required data missing, stale, or incomplete	Insufficient data	Do not infer a no-alert status; retain routine prevention advice.
Complete data AND $25 \leq T3 \leq 30$ AND $H3 > 60$ AND $100 \leq R30 \leq 400$	Weather criteria met	Eligible for an opt-in weather message under the proposed rule.
Complete data, but any condition fails	Weather criteria not met	Includes partial matches, $T3 > 30$, or $R30 > 400$; dengue risk may persist.

T3 = mean of three complete daily temperature values (°C); H3 = mean of three complete daily relative-humidity values (%); R30 = sum of 30 complete daily rainfall totals (mm).

Figure 1 redraws the documented integration architecture in English and distinguishes recommended safeguards from reported components. Figure 2 plots the supplied query coordinates. Neither figure represents an observed dengue-risk map, confirmed administrative-boundary accuracy, or evidence

of WhatsApp delivery. The manuscript reported an online launch at <https://wasantika-dbd.my.id>; its date, deployment build, account eligibility, and distinction between demonstration and public enrollment were not documented.

**Figure 1.** Documented integration architecture with recommended safeguards shown by dashed boxes.

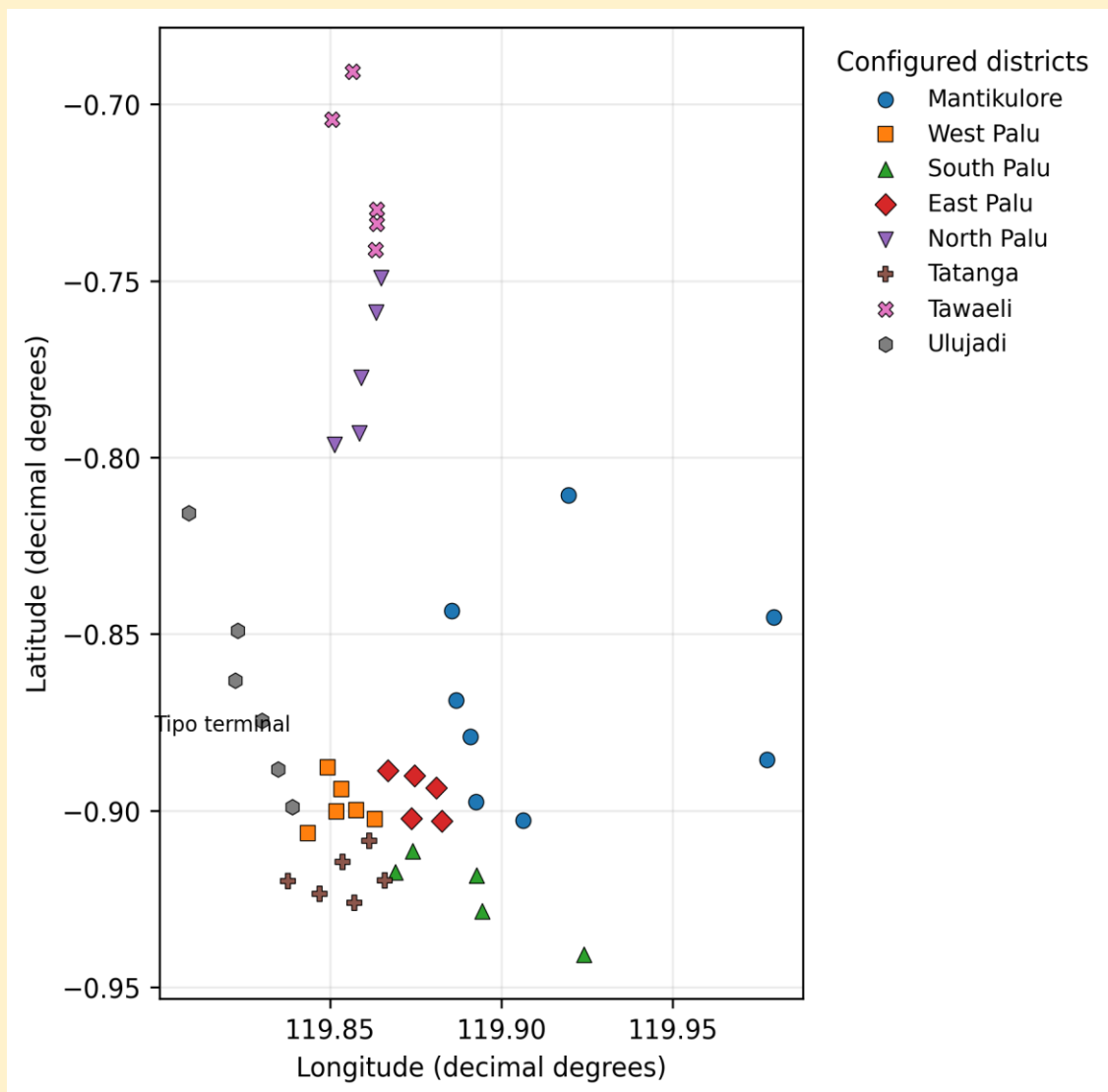


Figure 2. Distribution of the 46 supplied weather query points by configured district.

The development record describes a functioning integration prototype with 46 configured urban villages, three candidate weather inputs, and nine reported functional categories. The completeness of rainfall histories, deployed decision rule details, receipt of notifications, and operational privacy safeguards remain unverified. No epidemiological or end-user evaluation was reported. Thus, the research question is addressed at the level of reported software integration rather than validated dengue prevention.

Discussion

The main finding is the reported integration of weather retrieval, database storage, registration, and notification features within a web prototype. Its 46 configured locations and nine reported functional categories describe geographic configuration and developer verification, respectively. They do not establish 46 independent weather observations, reliable message receipt, or forecasting accuracy. Weather-dependent vector biology provides a rationale for environmental monitoring³, but daily thermal variability can alter transmission-related processes even when mean temperature is similar²⁰. Experimental evidence on

mosquito life-history traits likewise shows why a short mean cannot substitute for validation of a warning window²¹. Site-specific survival estimates remain relevant when extrapolating laboratory relationships²².

The appropriate comparators are systems with explicit inputs, outcome definitions, and evaluation periods. Bowman and colleagues assessed alarm variables against dengue outbreaks¹⁰, and EWARS links alarms to organized response¹¹. Probabilistic forecasting studies evaluate performance using observed epidemics or time-series validation^{12,13}. An Indonesian weather-dashboard study demonstrates a related technical integration approach²³, but weather reporting alone is not dengue validation. The prototype's contribution is a Palu-specific administrative query and communication workflow. Claims that existing geographic information systems are inherently retrospective, that this prototype is more precise, or that WhatsApp shortens response times cannot be supported without a direct comparison.

Future notifications should state the location, data time, meaning of the weather signal, and practical prevention steps approved by health personnel. Routine container management and personal protection should continue when criteria are not met¹. HTJ evidence on community participation supports linking messages to coordinated action⁷, while the association between breeding-site control and larvae supports the prevention focus⁸. The negative pandan-extract experiment reinforces the need for tested control measures rather than unverified remedies⁹. These sources inform communication content; none validates the prototype's thresholds. Users without smartphones, reliable connectivity, or WhatsApp need alternative channels, and service responsibilities must be assigned before community deployment.

The prototype combines a named software stack, a complete supplied coordinate inventory, and a concise functional-test summary. The main limitations are the unverified 30-day rainfall provenance, unspecified endpoint and retrieval schedule, unknown weather-product spatial resolution, and absent comparison with local meteorological observations. Neighboring query points may return identical values. The test record lacks inputs, execution counts, build/date, tester identity, boundary results, and delivery receipts. No end-user acceptability, dengue outcomes, economic evaluation, or security audit was supplied. The online launch cannot establish public enrollment or field implementation. Maintenance costs, service outages, alert fatigue, digital exclusion, and privacy risks further constrain operational generalization.

First, audit the weather pipeline and implement a preregistered functional-test matrix, including threshold boundaries, repeated timestamps, incomplete histories, service outages, invalid recipients, profile deletion, and duplicate-alert prevention. Then link historical weather to independent case surveillance, define a dengue/outbreak outcome and prediction horizon, and choose biologically justified lags. Evaluate on a later time period without information leakage and compare with a simple seasonal baseline. Report sensitivity, positive predictive value, false-alert burden, and lead time; assess calibration if probabilities are produced²⁴. Machine learning may be compared with simpler methods when adequate data exist, rather than assumed to improve performance²⁵. Relevant transparent model-reporting guidance can inform that later stage²⁶. Community evaluation should subsequently measure message receipt, understanding, action, and acceptability, with formal governance and an appropriate ethics determination.

Conclusion

A web based weather alert prototype was developed for 46 urban villages across eight districts in Palu, with successful functionality reported in nine test categories. The available record supports preliminary software integration but does not establish dengue prediction accuracy, reliable WhatsApp delivery, or prevention effectiveness. Complete rainfall provenance, code-confirmed decision rules, auditable testing, appropriate data governance, and independent epidemiological and end-user evaluation are required before operational adoption.

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Conflict of Interest Statement

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