

***Aedes* Mosquito Control through Community Participation – An Android Application**

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Abstract

Mosquitoes are not only annoying insects they are the intermediate vector agents responsible for spreading many deadly or debilitating diseases like malaria, yellow fever, dengue, zika, chikungunya and lymphatic filariasis to human. The widespread female Aedes genus mosquitoes Ae. aegypti and Ae. albopictus play a vital role in the spread of dengue disease by transmitting dengue virus to humans through blood feeding. Eliminating Aedes mosquitoes emergence by abolishing the breeding sources are the best way to control dengue, because of the growth of insecticide resistance in mosquitoes. The communities have a dynamic role in combating and preventing dengue and also need to be educated in this regard. Technology enabled solutions like mobile applications facilitate a faster and an effective outreach to the public. Even though many android apps are available for dengue and Aedes mosquito, no apps for Aedes control through community participation. This motivated us to develop easily downloadable free Google play android application for the public to initiate Aedes mosquito control through awareness and registering breeding source complaints.

Keywords: *Android, Aedes, dengue, breeding source, control*

1. Introduction

Mobile technology esp. smart-phones have drastically changed the communication style of common men and is supplemented by technological advancements like Global Positioning System (GPS) capabilities, gestures, finger print sensors, scanning, and high definition camera [1]. A plethora of mobile applications available assists people in their communication, business, fashion, and health needs [2].

Mobile centric teaching/learning provides a flexible environment to the users and many educational institutes have adapted to mobile learning perception [3,4,5,6,7]. Also mobile phones has been successfully implemented as a surveillance tool for various practices [8,9,10,11,12, 13] and for resolving citizens' complaints [14]. This positive impression of mobile application in countless fields made us to develop mobile application for educating and reporting.

The *Aedes* genus mosquito's *Ae. aegypti* and *Ae. albopictus* are the well-recognized primary and secondary vectors of dengue virus throughout the world and in India [15,16]. Both the vector species distribution is getting increased because of the global trade and travel [16]. It is reported that in India, the dengue cases are increasing rapidly in the last ten years [17] and existing in around 125 tropical and subtropical countries worldwide [18]. The vector control measure is the only way to keep the dengue away from human as there exists no specific therapy for dengue.

Currently the *Aedes* mosquito control is based on insecticides and community engagement for their habitat management [19]. The mosquito control by insecticides is very challenging because of the development of insecticide resistance [20]. Infecting *Aedes* mosquito with *Wolbachia* (a gram-negative bacteria), sterile insect techniques and genetic manipulation are the other alternatives for *Aedes* control which needs lot of experimental trial in all ecosystem [21].

Since the dengue vector species prefer to live near people and have various breeding habitats like wet

coconut shell, grinding stone, money plant & mud pot, plastic container, tank, tyre and tree holes, the community-based approach is the best way to control dengue vectors [22].

Hence, by harnessing the power of mobile phones and the living style of people being adapted to mobile phone usage, a mobile application has been developed for the usage of people of Puducherry region, India to promote *Aedes* awareness and to participate them to control *Aedes* breeding sources by registering breeding source complaints to the control unit.

2. Related Works

A. Mobile App for *Aedes* Education & Control

Community education on *Aedes* mosquito is essential for the control of disease vectors. The community must be aware of *Ae. aegypti* and *Ae. albopictus*, its biology, behaviour and the breeding sources they prefer. This necessitates the mobile app development for community education. Even though there are certain apps for *Aedes* awareness, no apps for community participation, to prevent *Aedes* mosquito breeding places. Some of existing mobile application related with public health problem is listed as follows:

The large scale mobile communication data has been used to study the relation between human mobility and the vector-borne disease epidemics [23]. ICMR-National Institute for Research in Tribal Health, Jabalpur adapted mobile phone technology for timely diagnosis dengue disease and mosquito control activity [24]. In India the mobile application 'DISapp' has been developed to collect disease surveillance data from the community and the mobile application 'MOSapp' for uploading the surveillance data by the field workers [25].

The Tamil Nadu government launched the mobile application for Dengue awareness, which contains information on awareness, causes and prevention of dengue. The app do not promote community involvement on *Aedes* mosquito control [26]. In Nepal, mobile Short Message Service (SMS) has been used to afford dengue prevention knowledge and to improve dengue control practices [27]. In Fiji, mobile application with Global Positioning System (GPS) technology has been used to quickly identify dengue fever infected area [28].

A mobile surveillance tool on dengue fever has been developed by Sri Lanka for educating construction workers, schools & public, reporting dengue incidents to Public Health Inspectors and analyzing the dengue case reports [29]. The Geovanna Cristine de Souza Silva et al., studied the technologies that can prevent and monitor *Aedes* mosquitoes and to build a model for *Aedes* control based on smart city concept [30].

The mobile app to promote community involvement is developed to produce *Aedes* free environment by providing breeding source compliant registration facility. This may help the control unit to identify the area in dengue risk and need surveillance. The community can freely download the app through google play or from the URL <https://play.google.com/store/apps/details?id=com.community.aravindhakumaransm.aedes&hl=en>.

3. Method

A. Development process

The mobile application development uses the ADDIE (Analysis, Design, Develop, Implement and Evaluate) instruction design model, a framework which gives the view of all major components of the design and an opportunity for iterations and changes before moving to next stage [23]. The development of this mobile application follows the five development stages as shown in **Fig. 1**.

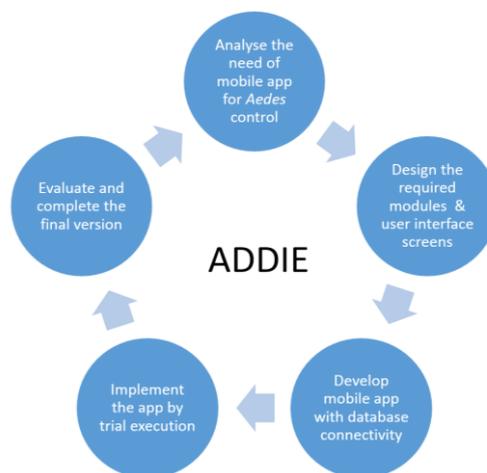


FIGURE 1. Development stages of Aedes Informatics

B. Analysis Stage

A through survey on the available mobile applications with respect to *Aedes* was done. As indicated in section II, very few applications exist related to *Aedes*. The applications have been designed in various aspects like education, games, awareness and helpline provision. But public need to be aware of the origin, causes and prevention of *Aedes* and dengue. Also they should be able to report and register complaints through evidence-based information to the concerned control unit about the vulnerable places in their habitat for necessary actions to be taken place. The application should be used by genuine complainants only. Thus, a mobile application for public that facilitate acquisition of the knowledge about the disease as well as the public participation in *Aedes* mosquito control by facilitating reporting to the control unit is required.

C. Design Stage

As the application focuses on two main functions like educating and reporting, the required modules for user interface to access, data entry, image uploading and analysis have to be designed. Two modules viz. community and vector control unit along with 59 user interfaces for the various functional activities have been designed. **Fig. 2** illustrates the design. The public can get information about *Aedes* mosquito related information, register the complaints and view registered complaints. As the application should be useable only by the genuine complainants, a registration and a login interface has been designed. The login screen has been designed for the control unit to process the registered complaints, to access dengue surveillance form and to analyse the surveillance details. As the complaints have to be viewed at a later stage, a database has to be designed for holding this information.

D. Development Stage

Android studio, was used as the front end tool for user interface design and Firebase, a real time database was used as the back-end data storage. The user interface data for each functional activity was stored in the firebase database in the form of tables built with the necessary attributes. **Fig. 4** shows the list of tables created. The different attributes of the table created using Firebase is illustrated in the form of Entity Relationship Diagrams (ERDs) and is shown in **Fig. 3**.

E. Implementation Stage

The developed mobile application “Aedes Informatics & Control in Puducherry” was first made available through personal links to the end users like student, public and domain experts for trial execution and evaluation. The users were made to registering complaints and to exercise all possible

options provided. Their comments were considered and the product was redesigned based on the suggestions. Based on the feedback given by the selective users modifications were done incrementally to achieve maximum efficiency and positive results. The mobile screen compatibility was the major issue.

F. Evaluation Stage

The usability of the mobile app has been evaluated to complete the final version. The help menu option has been included for the public to demonstrate the usage of the application. The screen compatibility issue has been resolved by the effective coding.

4. Results

The female mosquitos *Ae. aegypti* and *Ae. albopictus*, the carriers of dengue causative agent breed in freshwater bodies like storage tanks, buckets, plant pots, coconut shells, tyres, open grinding stones and discarded household waste. The dengue geographical distribution has been expanded because of vector control failure due to the development of insecticide resistance, long term sustainability failure and the lack in community support. Since there is no curative treatment for dengue targeting environmental and ecosystem management is appropriate [31]. The effective dengue vector control strategy is the community-based and integrated approach, combined with educational programmes to increase knowledge, awareness, attitudes and practices of people in the local community [32].

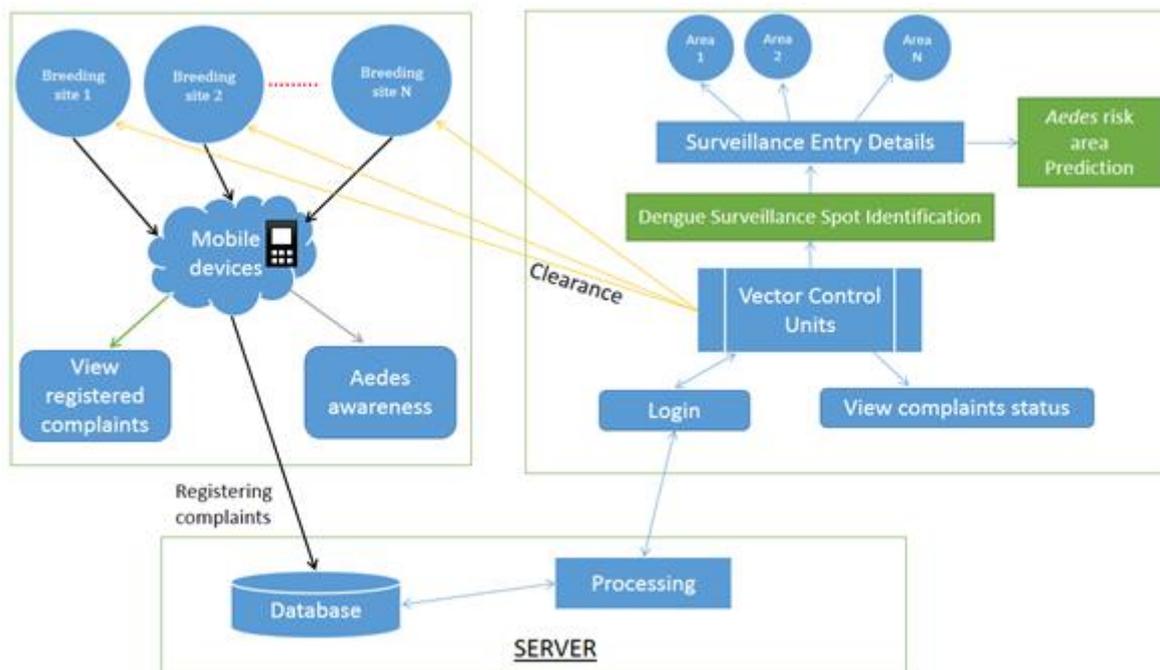


FIGURE 2. Overall flow of the project

This scenario mandates us to develop a mobile app 'Aedes Informatics and Control in Puducherry' for promoting *Aedes* mosquito awareness to the community and to encourage them to vector breeding source clearance by registering breeding source complaints to the vector control unit. The app provides a surveillance form for the vector control unit to predict dengue reported area and an area with abundant *Aedes* breeding sources.

The mobile application has been designed as two modules, one is for community and the other is for the control unit with login security. **Fig. 6** shows the home page and login screen for control unit access. The well designed interface has been designed for the community to acquire *Aedes*

information, habitat, diseases it spread and its life cycle. The community can capture the breeding source image and register complaints by filling the basic information of the user and the options provided in the form (Fig. 7). The registered complaints will deposit in the firebase real time database for the control unit access.

The provision has been made for the community to view the breeding source complaint status. As a trial 50 breeding source complaints has been registered to evaluate the working mechanism of the developed mobile app. The visualization graph has been generated from the booked complaints to identify the area accountable for more complaints and need dengue and *Aedes* surveillance.

In order to initiate the study on *Aedes* vector distribution and the dengue case incidence, the mobile surveillance form has been designed for the field workers to reduce the paper work during data collection and to avoid later data entry process into the computer which is time consuming and prone to errors. The surveillance area will be chosen from the breeding source complaints analysis graph. The existing hard copy dengue surveillance form has been converted into user friendly digital data entry form to assess *Aedes* mosquitoes and their breeding source prevalence.

The surveillance entry done with online facility and the data stored in the firebase database for future retrieval and analysis. The entry in the surveillance form has made simple and user friendly. The options like area name, breeding source list, house type etc., has been given as selective options. The area wise surveillance data can be easily visualized and manipulated. The analysis feature has been provided for the surveillance data in the form of graphical representation to find the area with abundant dengue reports and *Aedes* breeding sources.

As a trial five areas were chosen for surveillance and the survival data were recorded by using the developed mobile app. From the trial data, the area Kalapet was identified as dengue outbreak and the Muthialpet was identified as *Aedes* risk area (Fig. 8). The statistical details were shown in the table (Table 1 and Table 2).

5. Conclusion

The mobile application was successfully tested with client-server data storage to promote the community to involve *Aedes* breeding source clearance act and to help the control unit for timing actions to remove the breeding sources to retain the *Aedes* free ecosystem. The breeding source complaint registration requires the image of the breeding source to complete the submit process which is made as a key factor to ensure the compliant reliability. The cost, time and complexity of field surveillance has been significantly decreased with the proposed eSurveillance technique.



FIGURE 3. Firebase Database Tables

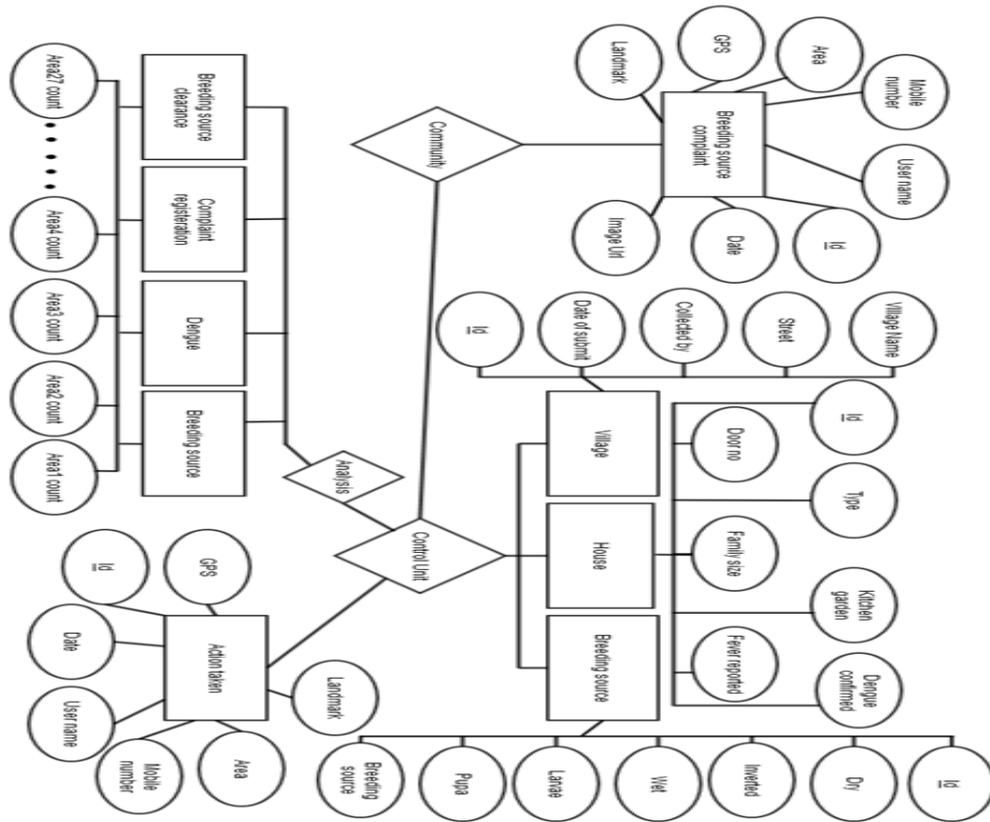


FIGURE 4. Entity Relationship diagram of the project

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout
xmlns:android="http://schemas.android.com/apk/res/a
ndroid"
xmlns:app="http://schemas.android.com/apk/res-auto"
xmlns:tools="http://schemas.android.com/tools"
android:layout_width="match_parent"
android:layout_height="match_parent"
android:background="#ffffff"
android:orientation="vertical"
tools:context="com.example.aravindhakumaransm.aed
es.welcome_screen">
<LinearLayout
android:layout_width="match_parent"
android:layout_marginTop="3dp"
android:orientation="vertical"
android:gravity="center"
android:layout_height="wrap_content">
<ImageView
android:src="@drawable/ic_aedes_title_cropped"
android:layout_width="wrap_content"
android:layout_height="wrap_content" />
<TextView
android:layout_width="wrap_content"
android:layout_height="wrap_content"
android:textAlignment="center"
android:textStyle="bold"
android:textAppearance="@style/Base.TextAppearanc
e.AppCompat.Large"
android:text="INFORMATICS \n AND \n CONTROL
IN PUDUCHERRY"/>
</LinearLayout>
</LinearLayout>
```

FIGURE 5. Sample coding



FIGURE 6. Home page and control unit login screen



FIGURE 7. Aedes Information and compliant registration screen



FIGURE 8. Dengue surveillance & Breeding source report

Sl. Number	Area Name	Number of Reports	Percentage
1	Ariankuppam	18	18%
2	Lawspet	22	22%
3	Muthialpet	23	23%
4	Gorimedu	8	8%
5	Kalapet	29	29%

TABLE 1. Number of dengue cases reported from trial surveillance data

Sl. Number	Area Name	Number of complaints	Percentage
1	Ariankuppam	20	10%
2	Lawspet	75	25%
3	Muthialpet	78	26%
4	Gorimedu	54	18%
5	Kalapet	63	21%

TABLE 2. Number of Breeding sources complaints – trial data

The application is portable, location finding using GPS, designed with suitable user interface and simple navigation. This mobile application system with real-time and validated data will definitely strengthen the dengue disease monitoring capacity. Currently the cleaning activity voluntaries act as a control unit for *Aedes* clearance and surveillance.

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