Abstract – Dengue affects nearly 50 million people annually and specially threatens populations living in tropical regions like Sri Lanka. Based on the findings of a needs assessment of dengue management practices in Colombo, Sri Lanka, we have designed a socially mediated health information system for dengue surveillance and education. This system integrates the power of digital surveillance, digitized dengue monitoring and mapping, and digitized dengue education. We identify specific loopholes in existing workflows and describe how our system has been designed to address these, resulting in greater efficiency leading to better dengue management. The paper culminates with a discussions of lessons learned from our experiences and the next steps of our applied innovation.

Keywords: dengue; social media; surveillance; education

1 Background

With nearly 50 million cases occurring annually, dengue poses an immense threat to global health, especially populations living in tropical regions [1]. Sri Lanka, a small island nation located in the Indian subcontinent, exemplifies this situation with dengue epidemics over the period 2010-2015 recording more than 200,000 cases [2]. The epicenter of the dengue epidemic in Sri Lanka curiously lies in the Western Province – home to the nation’s political capital of Colombo – that alone accounts for nearly half of the country’s dengue burden [3].

Sri Lanka’s challenges in grappling with dengue since 2009 have interestingly coincided with the meteoric rise of mobile penetration rates in the aftermath of the civil war. Mobile services in Sri Lanka are now among the most affordable in the world and have been increasingly used in the mobile health and education sectors. However the dengue information infrastructure, whose efficiency had been adversely affected by traditional paper-based systems, had failed to benefit from such technological interventions.

1.1 Technological interventions for dengue prevention and management

Elsewhere, technological interventions for bolstering dengue surveillance have mainly focused on the use of geographical information systems (GIS) and other surveillance systems to facilitate early notification or warnings of potential outbreaks. For instance, Chang et al [4] used Google Earth and ArcGIS 9 to create a surveillance system in Nicaragua that can allow public health workers to identify high indices of mosquito infestation in relation to larval development sites like garbage piles and stagnant water pools. In Brazil, researchers developed the SMCP-Aedes, an entomological surveillance system focused on collecting, storing, analyzing and disseminating mosquito-related information online [5]. In Thailand, Ditsuwan et al [6] used a combination of a national surveillance system database and GIS to evaluate the burden of dengue and chikungunya fever.

2 Methodology

Drawing upon existing evidence and driven by the mandate of the Centre of Social Media Innovations for Communities’ (COSMIC), we first conducted a field study to identify the core needs of public health inspectors (PHIs) in Sri Lanka in relation to dengue surveillance and prevention practices. The objective was to also identify areas of concern in existing practices that could be strengthened through the use of mobile-based technologies and social media.

We focused on the PHIs as potential adopters, as they constitute the last mile of the public health delivery system in Sri Lanka and are hence the most critical cog in the wheel of dengue prevention efforts. Recent reports reveal that existing inefficiencies in the public health system might be partially explained by the PHI’s overburdening workload: one PHI in
Colombo covers the public health concerns of nearly 50,000 people. Colombo comprises 47 wards (administrative units) that are covered by six Medical Officers for Health (MOH) units. Each MOH is served by 5-7 PHIs. Our needs assessment was conducted through 30 in-depth interviews lasting 45-60 minutes in the premises of the Colombo Municipal Council (CMC).

3 Findings

We present three main summary findings that pertain to dengue information issues among the PHIs in Colombo.

3.1 Current dengue information flow

We obtained a comprehensive understanding of the flow of dengue-related information between different agencies involved in the dengue surveillance programs in Colombo. As can be seen in Figure 1, the existing dengue information architecture reflects a circuitous and time-consuming process. This process commences with a patient who experiences symptoms visiting the hospital who in turn hand over a paper-based record of suspected dengue cases to the PHI who is assigned to that particular hospital. All PHIs who receive this information pass it along to the CMC's Epidemiological Unit, where an official is assigned to create a separate file for individual patients. The official categorizes all these files according to the MOH jurisdiction under which they are covered, and dispatches this information to each of the MOH offices through the CMC’s Epidemiological Unit (CMC-EU). The MOHs then distribute the files to their PHIs for follow-up through patient visits. Each PHI visits the patient to confirm his/her diagnosis for dengue, upon which a decision is taken to either fill a Communicable Disease Form (CDF) and a Dengue Investigation Form (DIF) or only the former, depending on whether the patient is tested positive or negative. Also, in case of a positive diagnosis, the PHI is required to conduct a house and area inspection to identify possible mosquito breeding sites and educate the patient and his family on protecting themselves from dengue. After obtaining the entire set of CDFs and DIFs from the PHIs under their jurisdiction, the MOHs officially approve the forms before dispatching them to the CMC-EU. The CMC-EU manually collates the information from all the DIFs to create a record, map dengue cases on a manual map, and ensure that all the cases are within the CMC jurisdiction. At the end of this process, a formal report is sent to the CMC’s Public Health Department (CMC-PHD) who officially sign off on it before dispatching it to the Ministry of Health. The whole process could take anywhere from 7-10 days.

Figure 1: Typical flow of dengue information by the Colombo Municipal Council
3.2 Barriers in existing data collection and reporting practices

The workflow shown in Figure 1 suffers from a principal weakness in steps 8 and 9, where the PHI physically interacts with the client and obtains critical details about the case. The first challenge was recording information in the CDF and DIF which, the PHIs claim could consume between 30-60 minutes including being exposed to the risks of information inaccuracy and the work was itself logistically inconvenient. Secondly, the standalone GPS device used by PHIs was technically unreliable (lack of signals, inaccurate readings) and other officials found it difficult to decode the geographically coordinate quickly and efficiently. Lastly, PHIs were educating dengue-affected individuals and families using outmoded means of health communication such as pamphlets and brochures. With minimum persuasive impact and lack of audience engagement, PHI reported that these materials bore minimum effects on the attitudes, knowledge and behaviors of the public related to dengue.

3.3 Need for technological intervention

The profusion of media penetration in the aftermath of 2009 was also reflected in the number of PHIs who used simple mobile phones or smartphones. The younger PHIs were familiar with mobile applications and demonstrated enthusiasm for integrating mobile-based innovations into their workflow; the senior PHIs, despite their lack of prior experience with smartphones, recognized the need for using mobile devices as part of their daily tasks. Broadly, the PHIs expressed a need for a portable solution that would allow them to accurately record geographical coordinates, capture pictures and was powered by the Internet. These functionalities would ease their effort in executing the most challenging tasks related to dengue surveillance on a daily basis.

4 Mo-Buzz: A socially mediated system for dengue surveillance, engagement and education

The needs assessment helped to identify the key gaps and constraints in the existing dengue information flow and also opportunities to address these using mobile social media. The challenge was to facilitate easier and more efficient exchange of information between actors without changing the existing workflow that has been established according to national guidelines. Instead of digitally transforming the information flow in its entirety, the priority for our innovation would be to address the bottlenecks in steps 8 and 9 identified in Figure 1 and to facilitate a more effective and efficient client visit by the PHIs. The following sections describe our proposed solution, namely Mo-Buzz, which is a socially mediated system that is built upon integrated information architecture and is available for PHIs on portable tablets.

4.1 Technical specifications

The overall system architecture is shown in Figure 2. The system is built on open source technologies and is mainly purposed for mobile and web based application which can be accessed through an Android platform or a web browser. The Android solution forms part of the main application by running as an agent on mobile devices. The PHIs and MOH can report information in various forms (photo or text) using mobile devices. The web-based solution is designed mainly for the management as it offers an interactive system for geospatial visualization, reports for reported Dengue Investigation Form, summaries and graphs, and web forms for other details. The solution is developed using Java related technologies. The server side of this system is supported by Apache, Tomcat, and MySQL.
4.2 System Description

The Mo-Buzz system digitizes three main functions of PHIs and presents the capability on handheld mobile devices and web interfaces: a) capturing, storing and recording visual, textual and geographical information from patient visits and house/area inspections, b) staying updated of dengue spread patterns in the Colombo region on a real-time basis and c) providing dengue education to the public in an engaging format that will retain their attention and interest.

a) Digital surveillance: As seen in Figure 3, this component allows the PHI to capture patient information on a digitized DIF form which is easy-to-use and includes alerts in case the PHI has missed filling out certain fields. The system thus ensures that the DIF forms are not only complete, but that they are also stored for later reference, and can be sent to all the relevant authorities in the different agencies (see Figure 1) with the click of a button, thereby drastically reducing reporting time. Additionally, the DIFs are automatically linked to Google Map, thus bolstering every individual DIF with accurate geographical coordinates that can be reviewed by the authorities. The main advantage of this functionality is that the authorities can view, on a continuous, real-time basis, the geographical areas from where dengue cases are being reported and take swift action instead of waiting for paper-based reports to arrive in a delayed manner. This component also allows the PHI to capture photographs of breeding sites, which are automatically geo-tagged, and share it with all relevant authorities in the chain of command to view and take necessary action (such as fogging and pest control).

b) Digitized dengue monitoring and mapping: In contrast to the CMC’s existing manual pin-maps that can only be updated at the end of every case reporting cycle, the Mo-Buzz system offers a live real-time dengue map that is updated as and when PHIs submit a DIF form to the system. This allows the CMC’s public managers to obtain real-time updates of dengue spread and allocate dengue prevention and management resources strategically and efficiently. This component also automatically draws information from the geo-tagged breeding site reports and represents this information visually in a map format so that the MOH and their respective PHIs can plan their prevention activities accordingly.

c) Digitized dengue education: In order to increase engagement between the PHI and their clients, the
Mo-Buzz system offers a tablet-based health education component. This has been done in the backdrop of mounting evidence which suggests positive outcomes resulting from mobile-mediated health education modules for health workers in other contexts. The first version of the health educational module includes digitized versions of the CMC’s dengue education materials that the PHI presents to his clients complemented by verbal explanations of dengue prevention concepts. For future versions, we are building graphics, animations and tailoring capabilities into the health education component.

Figure 3: Screenshots from Mo-Buzz depicting the home screen (left), mosquito reporting form (center) and health educational component (right)

5 Current status and next steps

The Mo-Buzz system is currently being used by all (55) PHIs in the CMC. It is made available to them on tablets that are powered by a data plan from Mobitel, Sri Lanka’s second largest telecommunication provider. In the future, the research team plans to integrate the PHI system with the Mo-Buzz dengue system for the general public. The general public version uses the concept of crowdsourcing-based disease surveillance and enables users to report mosquito breeding sites to the CMC through geotagged pictures captured with their smartphones. In addition, it also includes real-time dengue maps and dynamic health educational components that together provide necessary information for users to take adequate personal protection measures against dengue in advance, as they are constantly updated about dengue danger zones in their city.

6 Discussion

The introduction and adoption of Mo-Buzz among PHIs in Colombo provided several lessons from the standpoint of health information system innovations in developing countries. For instance, our conversations with PHIs and subsequent meetings revealed that the PHIs and other actors were primed to the existing dengue information system (despite its circuitous nature) and that a complete overhaul would cause important delays apart from causing systemic disturbances. We suspect that the organizational acceptance of Mo-Buzz might have been facilitated by a perception of our system as one that was seeking to make an incremental change, instead of a wide-ranging transformation. Secondly, we acknowledge the importance of local public-private partnerships in executing a project of this nature as common cultural attributes act as a catalyst in creating sustainable relationships. Lastly, we observe that the discourse surrounding health information technology interventions in developing countries is situated in the debate on ground-up versus top-down approaches. Our intervention demonstrates that an integration of the two approaches is possible and might provide unique benefits. For instance, our “top-down” approach of using mobile social media functionalities (driven by the intellectual expertise available in our team) blended with a grounded understanding of the local needs and challenges, providing potential users with new options that might or might not have previously envisaged.

7 Conclusion

We have proposed and outlined the Mo-Buzz solution to overcome the weaknesses of the existing workflow and situation of managing the dengue situation in Colombo. The system for the PHIs is currently being used and evaluated along with the parallel development of the public Mo-Buzz version.

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9 References


