INTRICACIES OF IMPLEMENTING AN ITU-T X.1303 CROSS-AGENCY SITUATIONAL-AWARENESS PLATFORM IN MALDIVES, MYANMAR, AND THE PHILIPPINES

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ABSTRACT

Maldives, Myanmar, and the Philippines are vulnerable to natural disasters [1]. Sendai Framework[1] of Action calls for risk reduction by implementing early warning systems [2]. A prevailing challenge is for authorities to coordinate warnings across disparate communication systems and autonomous organizations [3]. Cross-Agency Situational-Awareness platforms and the ITU-T X.1303 Common Alerting Protocol (CAP)[2] interoperable data standards presents themselves as solution for diluting the inter-agency rivalries and interconnection disparities [4]. The Sahana Alerting and Messaging Broker (SAMBRO) was designed to overcome these issues by providing a Common Operating Picture and a platform for all Stakeholders to share early warnings. To that end, the CAP-on-a-MAP project is implementing SAMBRO and the CAP standard along with the policies and procedures in the Maldives, Myanmar and Philippines. The project is applying an agile development methodology with a design, build, test, and redesign strategy for implementing the cross-agency situational-awareness and warning system in the respective countries. This paper discusses the country context implementation challenges and discusses strategies fostered through the introduction of the CAP content standard for warning system designers to consider for overcoming similar challenges.

Keywords— interoperability, electronic services, early warning, common alerting protocol, situational awareness

1. INTRODUCTION

Disasters are a major problem worldwide and a serious threat to sustainable development. The rapid and often unplanned expansion of human settlements, especially in cities, is exposing more people and economic assets to the risk of disasters and the effects of climate change [5]. Coastal cities are made vulnerable by the low-lying land that are often built upon and as such are susceptible to flood, storm surge, tsunami, and sea-level rise [6]. Many coastal cities in Asia and the Pacific region are found in tropical areas with hot and humid climates and low-lying land, both of which heighten their vulnerability to extreme events.

As a consequence of climate change, the world is facing an increasing threat of extreme events. Especially in developing countries, this heavily affects equal access to opportunities and development and is a main reason for poverty. As a result the Sustainable Development Goals (SDGs)[3] emphasis on the need to reduce poverty and inequalities. It also emphasizes on strengthening climate actions and sustainable economies, communities and cities [7]. Early warning systems for disaster response are critical to fighting the consequences of climate change contributing to the factors that influence the SDGs.

Disaster Risk Management interventions such as alerting/early warning, evacuation planning, and coastal zone management are important for addressing the challenges faced by the coastal communities. The project titled “CAP on a Map” was designed to improve the institutional responsiveness to coastal hazards in Maldives, Myanmar, and the Philippines. It would augment the capabilities of the National Disaster Management Organizations (NDMOs), National Warning Centers (NWCs), line-agencies and other relevant stakeholders in disaster management to interchange and share early warning information.

A prevailing challenge is for NDMOs, NWCs, line-agencies and relevant stakeholders to coordinate and interchange alerts and warnings. To overcome this dilemma, the CAP on a Map project introduced a Cross-Agency Situational Awareness platform for coordinating alerts and warnings and the Common Alerting Protocol (CAP) content standard for interchanging warning messages across disparate systems. These are the underpinning design concepts of the Sahana Alerting and Messaging Broker (SAMBRO). In this

[1] "Sendai Framework for Disaster Risk Reduction - UNISDR." 2015. 11 Jul. 2016 <http://www.unisdr.org/we/coordinate/sendai-framework>

[2] "Common Alerting Protocol - Oasis." 2015. 11 Jul. 2016 <https://docs.oasis-open.org/emergency/cap/v1.2/CAP-v1.2-os.html>

The “CAP on a Map” project was made possible through the United Nations Economic and Social Commission for Asia and the Pacific Trust Fund.

[3] "Sustainable development goals - United Nations." 2015. 11 Jul. 2016 <http://www.un.org/sustainabledevelopment/sustainable-development-goals/>

paper we discuss the Maldives, Myanmar, and Philippine case studies, their warning requirements and the strategy for customizing SAMBRO and CAP for them.
This work was made possible through the United Nations Economic and Social Commission for Asia and the Pacific Trust Fund for Tsunami, Disaster, and Climate Preparedness.

2. TECHNOLOGY

The technology provides an overview of the CAP version 1.2, the Sahana software suite, and the SAMBRO web and mobile applications.

2.1 Common Alerting Protocol

CAP is an OASIS (Organization for the Advancement of Structured of Information Standards) advocated Emergency Data Exchange Language (EDXL) content standard. CAP is designed for all-hazard all-media warnings; a standard that is recommended by the ITU-T (2008) documented as X.1303. The World Meteorological Organization and the International Federation of Red Cross and Red Crescent are also key advocates of the standard. Google Crisis Response offers to publish NWC generated CAP feeds through their products including Google Public Alerts. Federation of Internet Alerting is a consortium of online advertising agencies that have extended the service of rendering alerts on their online ad-spaces. Meteo-alarm and Accuweather are other, among several, online services that help Nations publicize CAP messages.
Figure 1 shows the CAP Document Object Model. It is essentially a XML document that inherits the interoperability aspects of the XML technology. The data structure consists of a main node element <Alert> and its sub elements (node) <Info>, <Area>, and <Resources>. Each of the sub elements are composed of several other elements. The ITU-T X.1303 document defines each of these elements with respect to semantic interoperability. X.1303, is broadly recognized internationally as the key standard to achieve the goal of all hazards, all-media public alerting.

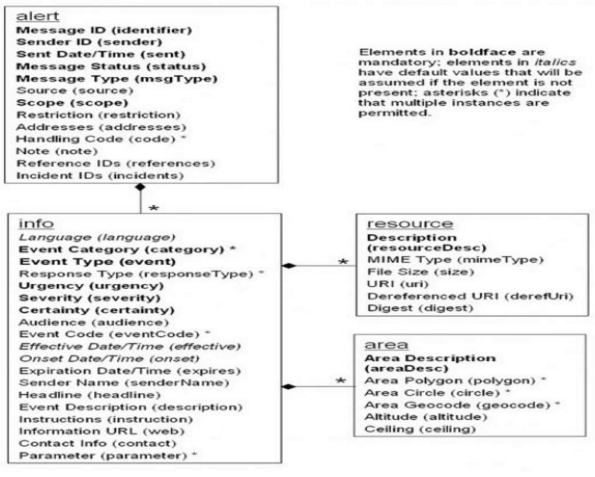

Figure 1: CAP Document Object Model

2.2 Sahana Eden Platform

Sahana is a collection of disaster management modules that work as a platform for integrating multi-organizational response efforts in providing critical information and communication needs. It advocates international data standards, it is internationalized and localized [8]. Sahana software is a wrapper around the Python Web2Py software development framework. Sahana strictly follow the HTTP standard and RESTful concept, making it is easier for third party application to add/edit/delete the information. Sahana follows a Model, View, Controllers (MVC) architecture. The code-base is hosted in GitHub and free to use and edit under the MIT license.

2.3 Sahana Alerting and Messaging Broker (SAMBRO)

SAMBRO, is a specialized Sahana solution (i.e. a Sahana template), designed with CAP version 1.2 as the underlying interoperable data standard to serve as a warning and situational-awareness tool. The original SAMBRO (version 1.0) design, as described in [9], was transformed with newer features. The current SAMBRO version 2.0 builds on a decade of action research as discussed in [10], [11], and [12]. SAMBRO is designed to serve as a CAP message publisher, aggregator, and a disseminator.

2.3.1. Control

Implementers define the metadata and ready the system defining the event types, warning classification, predefined alerting areas, CAP message templates, and grants user permissions. Publishers are authorized users who creates CAP warning messages in consent of their seniors and approve for their dissemination. Subscribers are authenticated users with minimum roles allowing them to subscribe to receive warnings of their choice.
The access control and permission of SAMBRO allows us to control the access of the application at different level. The permission access can be controlled at the module levels, particular table levels, functional levels, and/or individual record level. This is a much needed use-case for the warning, as there are many data which are only shared at organization level or between some closed user group and not to public.
SAMBRO's Audit trail is another distinguishing feature in the system. The system keep records of who logged into the system, who created the alert, when it was created, when it was submitted for approval, who approves it, when it was approved and many of the essential information that are needed for the audit purpose. After an alert is issued, a snapshot of the record independent of all the external references are kept in another table.

2.3.2. Features

All workflows are guided by the initial selection of the event type. Cyclone, Flood, Earthquake, Mass Movement, Civil Unrest, are examples of event types. They are the high

level category of disaster. The system adopts a set of rules for each event type, such as filtering the set of relevant CAP message templates, warning classification, predefined alert areas, and message recipients. The warning classification are for message recipients to summarize the severity, certainty, and urgency CAP properties of the warning message. The warning classification is not to be confused with the scale of the hazard such as the Saffir-Simpson Hurricane wind scale[4].
CAP message templates are predefined CAP messages. It allows for the Implementers to generate consistent messages that can be changed to suit the context at the time of issuing the warning. SAMBRO CAP templates are generally defined for Cyclone, Flood, Heavy Rain, Earthquake, Tsunami, and Landslide, so on and so forth. While most of the CAP elements would carry predefined text some elements such as the CAP message "description" would contain blanks that need to be filled in based on the event specifics.

2.3.3. Workflows

There is a two stage workflow for warning message dissemination. The Editor (or CAP message author) creates/edit the alert, and requests for an Approver to verify the message and approve for dissemination. Approvers receive an Email and a SMS with a URL pointing to the message awaiting approval. The Approver does not need to be at an office table to use a Personal Computer. They can be anywhere and use their Smartphone, provided they have Internet connectivity, to approve the warning message.
Relying warnings is a common practice among NDMOs and Response Organizations. CAP makes it easy to implement a warning message relay workflow with SAMBRO. When a NWC issues a bulletin (alert) or a warning, the NDMO can relay that message. SAMBRO is capable of subscribing to National and International CAP feeds. These are, typically, through RSS feeds but has the option of integrating specific APIs. When a message is received through an external source, SAMBRO offers a feature to relay the message allowing the Authority to make changes to the original message before disseminating through the SAMBRO communications engine.

2.3.4 Communications

The single entry of a CAP message can be disseminated, to the end recipients, through multiple channels. Short Message Service (SMS), Email, File Transfer Protocol (FTP), Real Simple Syndication (RSS), Google Cloud Messaging (GCM), Websites, and social media like Facebook, twitter are the available communication channels. SAMBRO uses a simple Extensible Stylesheet Transformation (XSLT) to produce the text outputs for the various media channels.

[4] "Saffir-Simpson Hurricane Wind Scale - National Hurricane Center." 2012. 5 Jul. 2016 <http://www.nhc.noaa.gov/aboutsshws.php>

SAMBRO also acts as an Alert Hub. The advantage of using any protocol is the standardization of the disseminated message from the system. So any CAP 1.2 implemented system can interact with SAMBRO system. Each published CAP compliant warning from other organization can be imported into the local database. More exciting is that those warnings coming from other organization can be relayed to the respective organization. Here SAMBRO has bridge the gap between the inter-organizational communications.

2.3.5. SAMBRO Web

Figure 3 show the Common Operating Picture gives an overview of "What is happening and Where and When". The GIS enabled mapping provides more interaction with the audience. The warnings can be filtered to move into the area of interest. Each warning has its own main profile that overview the associated alerting qualifiers, detailed information relating to warning, any instructions, descriptions and many more.
The SAMBRO Web Application is localized allowing the user to choose their choice of the Graphic User Interface (GUI) language. The localization is fairly easy under Sahana because of the multi-language capabilities the Web2Py platform offers.

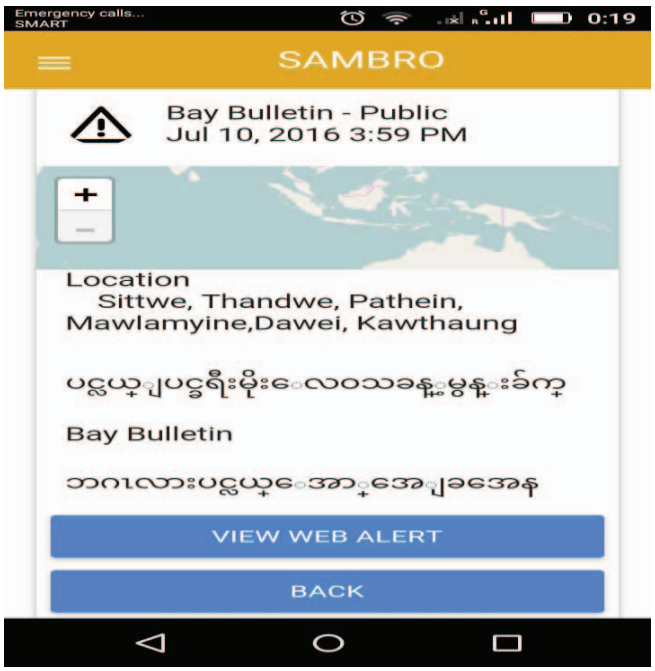

Figure 2: SAMBRO Mobile App for the first responders

2.3.6. SAMBRO Mobile

The SAMBRO Mobile can run on both Android and iOS Smartphones. The mobile application was developed with the Cordova based "PhoneGap" with HTML, CSS and JavaScript; allowing the mobile-app to be independent of the operating system: Android, iOS or Windows. The mobile-app adopt GCM for pushing messages in real-time

onto the phones. This requires a dedicated internet connection. Future version is looking at transporting the information over SMS.

The SAMBRO Mobile is for local Alerting Authorities to issue localized alerts. For example, be able to quickly warn a local village of a chemical spill or a large factory fire opposed to waiting for central national authority to issue the same. It was also designed to serve as a wakeup call with an audible siren to wakeup first-responders in the middle of the night or to get their attention if they were at distant from the device.

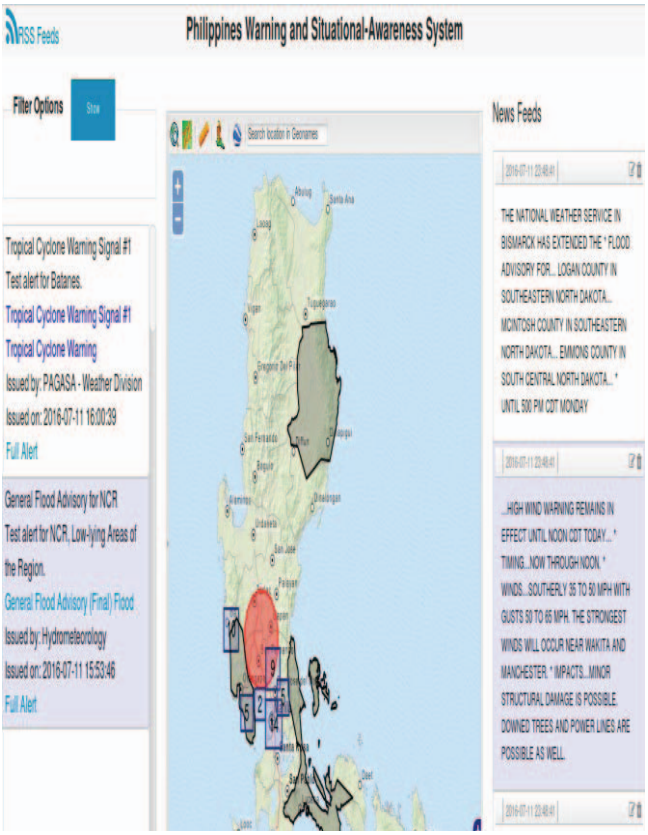

Figure 3: SAMBRO Web Application for Disaster Management

3. METHODOLOGY

The design and implementation methodology considered a scientific approach. [13] discuss the intricacies of applying a waterfall method with well-defined elicitation and documentation of complete requirements, followed by an architectural and high-level design development and inspection. Given the dilemma of introducing CAP to novices who haven't been exposed to the content standard but are engaged in early warning, it is cumbersome to follow a plan-driven method because they can become frustrating to the users and the implementers. We identified four related areas of study and practice within the broad field of information system design. These four areas are (1) User-Centered Design (UCD); (2) rapid prototyping; (3) agile software design (SCRUM); and (4) action research.

UCD is "a general term for a philosophy and methods which focus on designing for and involving users in the design of computerized systems." [14]. Rapid prototyping "involves creating a realistic model of a product's user interface to get prospective customers involved early in the design of the product. With rapid prototyping, the user model, the work flows and information needs without investing the time and labor required to write actual code [15]. Thereafter, revise the prototype to address the user's comments and keep iterating the process until we agree on the design parameters before creating the product [16].

Agile software design is defined as "a lightweight software engineering framework that promotes iterative development throughout the life-cycle of the project, close collaboration between the development team and business side, constant communication, and tightly-knit teams." With the Scrum, the light-weight process framework for agile development, initially the user stories[5] are collected by involving the user. These are the wish-lists that client like to have at the end of the product development. These user stories goes into the backlog catalogue, which are placed under the order of priority. The software development begins with small chunks of the backlog catalog called as sprints. With scrum, using sprints we can build pieces of software and the client can experience each part and determine what to do next.

Action research is typically regarded as an approach to research that balances knowledge generation with planned action. According to Hearn & Foth [17], "action research not only aims to understand the problem, it aims to provoke change through actionable outcomes." It is also known by other related terms such as participatory action research, collaborative inquiry, emancipatory research, or action learning [18].

The information, gathered from the preliminary stakeholder rapid prototyping interactions, was compiled to produce a set of customer requirements. The requirements were transformed to a set of User Experience (UX) and User Interface (UI) designs to customize SAMBRO. Selected participants from the three countries were invited to trial the preliminary release of SAMRBO.

Subsequently all stakeholders from each country were invited to experiment with SAMRBO. This, second iteration of the rapid prototyping, was, once again, used to further enhance SAMBRO. Throughout this cycle the lead Organizations engaged in weekly and monthly interactions with the development team to discuss their requirements and test the system. The lead Organization liaised with the stakeholders to update them on the new developments as well gather information on their requirements.

[5] User stories are documented in the Sahana Wiki Blueprints for: Maldives (http://eden.sahanafoundation.org/wiki/BluePrint/CAPBroker/Maldives), Myanmar (http://eden.sahanafoundation.org/wiki/BluePrint/CAPBroker/Myanmar), and Philippines (http://eden.sahanafoundation.org/wiki/BluePrint/CAPBroker/Philippines)

4. DISCUSSION

4.1 Stakeholder Engagement

The project partnered with a National Government Organization in each country to lead with the multi-stakeholder participatory approach with the design and implementation. They were the Maldives National Disaster Management Center (NDMC), Myanmar Department of Meteorology and Hydrology (DMH), and the Philippines Atmospheric Geophysical and Astronomical Administration Service (PAGASA). Table 1 identifies the list of SAMBRO Cross-Agency Situational-Awareness platform primary beneficiaries.

4.1.1. Warning Practices

Currently, the warning dissemination practices in the three countries are similar. Typically, the NWC issues a bulletin that is received by the NDMO and other focal agencies. The NDMO would use a phone tree to disseminate the messages from the National nodes to the branches and then eventually to the leaf nodes. The method is reliable but slow and laborious because they use telephones, fax, and VHF radios. Some social media and SMS is used. Such practices are acceptable for slow onset hazards such as disease outbreaks, cyclones and floods that provide a long warning horizon. Present day warning dissemination practices in the three countries are inefficient in serving rapid and sudden onset hazards such as dam burst, tsunami, or storm surge, with very short warning horizons. SAMBRO removes the laborious paper and manual hierarchical tree structure and provides a hub and spoke architecture. The SAMBRO software works much faster than human-based procedures involving multi-phase message relays.

Maldives NWC: Maldives Meteorological Service	**Maldives NDMO**: National Disaster Management center
Maldives Response Orgs: Maldives National Defense Force (Coast Guard and Fire Search and Rescue Department); Maldives Red Crescent Society; Local Atoll Councils; Local Island Councils; Maldives Police; Maldives Red Crescent Society; Department of Health; Ministry of Tourism Arts and Culture; Ministry of Education	
Myanmar NWC: Department of Meteorology and Hydrology	**Myanmar NDMOs**: Relief and Resettlement Department; General Administration Department;
Myanmar Response Orgs: Department of Irrigation; Department of Health; Department of Agriculture; Department of Fisheries; Department of Inland Transportation; Fire Services Department; Myanmar Red Cross Society	
Philippines NWC: PAGASA; Philippines Institute of Volcanology and Seismology	**Philippines NDMO**: Office of the Civil Defence (OCD)
Philippines Response Orgs: Department of Social Welfare and Development; Local Government Units, Disaster Risk Reduction and Management Councils	

Table 1: National beneficiary Organizations

Another inherent characteristic is the National EWS is that they have not developed an integrated approach to EWSs to foster an all-hazard approach. Each Organization is developing their own early warning dissemination mechanism forcing the public and Response Organizations to interface with multiple data feeds. For example, each agency will host their own twitter and Facebook accounts to share their information; opposed to a single source publishing warnings on all-hazards; i.e. a "one stop shop" approach.

Any entity that has privileges to edit CAP messages, can relay a received CAP message allowing them to change the content (e.g. description and instructions) and rebranding the message with qualifying elements associating them as the message sender. The relay function extends beyond messages issued through the SAMBRO system. For example, SAMBRO can receive any CAP message published by any other system in the world and offer the relay feature to the users of the SAMBRO instance. All the National stakeholders might consider collaborating to make full use of such features offered by SAMBRO that brings efficiencies to coordinating early warnings.

4.2 CAP Implementation Strategy

The common practice is for NDMOs to lead and be mandated with warning dissemination. The NWCs are mandated with detection and monitoring. Meteorological, Hydrological, and Seismological agencies, serving as NWCs, would feed daily information bulletins and hazard event information of significant interest to the NDMOs. The NDMOs would, then, transform and disseminate those messages to the closed user group alerts or public. SAMBRO was designed to serve such a workflow. Realizing, this important relationship and workflow, SAMRBO was designed for NDMOs to own and operate SAMBRO and for NWCs to interface with SAMBRO through CAP information feeds.

Even though it is in their mandate and best interest to foster such a platform, the project learned that NDMOs (Myanmar RRD and Philippines OCD) expressed interest but were less inclined to operationalizing a CAP-enabled situational-awareness platform. Maldivian NDMC proved the contrary

with operationalizing SAMBRO before MMS. NWCs were more inclined to adopting the CAP standard as in the case of PHIVOLCS and PAGASA in the Philippines and DMH in Myanmar. A primary factor might be is that NWCs realize the importance of interoperability and practice monitoring/detection and alerting on a daily basis. A second realization was the NWCs already had competent technical capacity who were able adapt to the introduced technologies. The World Meteorological Organization's program on advocating CAP might be a third factor. Although NDMOs are mandated with warning dissemination, given their detachment from practicing on a daily basis, might be the fourth factor.

To that end, the project administered a strategy that combined the NWCs in leading the project implementation alongside the NDMOs. Thereafter, the NWCs would gradually transfer the technology over to the NDMO to own and operate. In the Philippines PAGASA would support NDRRMC, Myanmar's DMH would support RRD/GAD. Maldives has now established technical competency and does not require the support of MMS.

4.3 Organizational Interactions

SAMBRO web and mobile software applications were perceived, by the users, to be useful tools for creating, disseminating, and sharing early warnings. SAMBRO was designed to dilute the inter agency rivalries and bureaucratic barriers by introducing the CAP interoperable standard for the siloed organizations to interchange lifesaving information. However, a challenge faced by the beneficiary countries is coordinating the implementation and operationalization the systems involving all relevant stakeholders. Government bureaucratic layers require formal procedures for engaging the stakeholders. Often Government Officials are reluctant or are discouraged by these bureaucratic formalities to pursue the project objectives of operationalizing a Cross-Agency Situational-Awareness platform for improving institutional responsiveness to hazards. This situation relates to the chicken and egg causality dilemma.

To overcome the dilemma the project was persistent with engaging the stakeholders through workshops. Using workshops as a platform reduces the need for bureaucratic formalities. However, the downfall to this is that without a formal Memorandum of Understanding (MOU) between the stakeholders they do not invest their time, take ownership, and make the project a priority. The participants active in the design, build, test, and re-design process were junior level staff. These staff members were unable to convey the utility of SAMBRO and the project to their Directors and Decision-makers at the root of the organizational chain. Therefore, these participants treated the exercise simply as another ad-hoc activity. Nevertheless, the lead Organizations have shown a keen interest in operationalizing the system. Strategy is to prove its utility over a period of time, then the other Stakeholders would want come on board.

4.4 Technology related challenges

In this section we discuss the challenges of transforming the country context warning requirements, including the workflows and procedures and how those were mapped to design parameters involving the CAP content standard and the process variables involving SAMBRO feature. Generally, technology is perceived as the least challenging component in implementing any system. Relatively, the organizational challenges are leaps and bounds. We discuss some of the challenges CAP on a Map faced.

4.4.1. Short Message Service

Acquiring a bulk SMS service for a Government entity is difficult than for a private entity. In all three countries, the lead Organization was reluctant to pay for the service and was looking for the Mobile Operator to provide the service in-kind. Such an arrangement requires an enormous effort of weaving the wave through the Government bureaucracy. Myanmar Post and Telecommunications (MPT), now falls under the same Ministry as DMH; i.e. the Ministry of Transportation and Communication. However, it took over six months for DMH to get MPT to agree to provide a SMS Gateway free of charge. The next challenge was that MPT had never offered such a service to an external entity it was a news service. Commercial providers such as Clickatell and Text Magic do not service Myanmar. PAGASA was reluctant to undergo the procedures for getting one of the local mobile operators: Globe or Smart to provide a bulk SMS package. Instead the project had to purchase the service from Clickatell. Going across the ocean add more uncertainties and delays to the SMS alert dissemination. PAGASA could leverage the "free mobile disaster alerts law" [19].

The project facilitated for the Communications Authority of Maldives (CAM) to Mobile Operators to provide an SMS gateway. CAM negotiate a discounted rate for alerting first-responders. In the event the entire Nation needs to be notified of a Tsunami, for example, the SMS would be free. However, the deal did not come through. Instead, NDMC worked out a public private partnership with a local Bank to purchase the SMS service.

4.4.2. Email

In Myanmar we realized that many First-Responders did not have an Email account. Therefore, they are unable to receive email alerts. Email also serves as the means for verifying and activating a new user's registration and requesting for resetting the password. In the Myanmar case, the project had to create dummy email accounts such as somename@example.com. However, this account would not provide the aforementioned features related to a user's login.

4.4.3. Mobile App

During the silent-tests we realized some of the Smartphone to block the audible siren. These were caused by Smartphone applications that kill applications that idle for a long period of time. Also certain Smartphones had not provided the mobile SAMBRO app with permissions to forward notifications.

The first mobile SAMBRO app was developed for Android Smartphones. In Myanmar we observe nearly everyone to use Smartphones. Some were still using Android versions below 4.4. GCM and other SAMBRO feature do not function well on Android phones with an operating system version below 4.4. The app was also migrated to the Apple iOS platform. This decision was made when CAM presented that sixty percent of the phones were Smartphones and of them there was a fifty-fifty market split between Android and Apple phones. As a result the project made investments in adapting to the Apple market as well.

Following the CAP standard 1.2 which states the scope of the alert. The 'Public' alerts are disseminated to the public. In SAMBRO, the implementer can create different groups responsible for different activities during the disaster and issue Restricted or Private alerts for this purpose. Similarly, the previous alert can be updated, clear, cancel or error easily according to the CAP standard 1.2

4.4.4. Predefined Alerting Areas

The project realized that there is a need for developing predefined alerting area polygons to enhance warning efficiencies. To address this need SAMBRO has introduced a mapping tool that allows Risk-Analysts and Warning Practitioners to develop a set of predefined polygons. Identifying the level of risk by geographical area allows for defining impact-based alerting. Integrating risk maps, with SAMBRO, allows differentiating community that might be at a greater risk to a hazard event over another. In order to save the lives and livelihoods, alerts can be issued to higher impacting communities first for the responders to attend that community's needs first. Thus, removing the burden of optimizing the response resources.

Naturally, it is difficult to predefine alert areas for a forest fire a tropical cyclone but can be defined for volcanic, tsunami, and floods. The National Stakeholders, in the three countries, faced difficulties acquiring any kind of risk map as Vector or Rasta GIS data. Some cases they had very limited risk maps, confined to a few targeted regions or townships, but as still images; of no use to SAMBRO to offer interactive analysis and mapping capabilities.

A dilemma with Island nations (or Archipelagos) was including or excluding Islands that are not visible on a map. For example, Maldives wanting to develop predefined alert areas for each of the Atolls, when zooming in to an Atoll could not see some of tiny Islands to realize, when they were drawing a polygon, was including or excluding those unseen Islands.

Geocodes presented themselves as an innovating solution for overcoming the dilemma of differentiating Islands that belong various jurisdictions. Philippines had implemented geocodes to define their administrative areas. CAP provides means for defining an alerting area associated with the respective geocodes. The lesson learned from the Philippines was valuable for requesting Maldives to follow the same, seeking assistance from the Maldives Land and Survey Authority.

5. CONCLUSION

EWSs, in the region, are gradually evolving to their required potential. However, the concepts of moving beyond a top-down approach to a peer-to-peer approach using software services is yet to mature. SAMBRO has realized those gaps and has presented itself to server in this capacity. National policies and strategies must be put into practice to further strengthen these concepts. A growing challenge faced by National initiatives is integrating the early warning dissemination and coordination with all relevant stakeholders. The authors have realized the intricacies of implementing cross-agency situational-awareness platforms in the Region. Lessons learned from the current experience provides inputs to shaping SAMBRO strategies for operationalizing such systems for improving institutional responsiveness to all-hazards.

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