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i. Acronym List

AADMER - ASEAN Agreement on Disaster Management and Emergency Response

ACDM - ASEAN Committee on Disaster Management

ADMM – ASEAN Defense Ministers Meeting

AHA Centre – ASEAN Coordinating Center for Humanitarian Assistance

AMRG – ASEAN Military Ready Group

APAN – All Purpose Access Network

ASEAN - Association of Southeast Asian Nations

CFE-DM – Center for Excellence in Disaster Management and Humanitarian Assistance

COORES - Coordinated Response

COP - Common Operating Picture

CC&CC - Changi Command and Control Center

DoD – Department of Defense (U.S.)

EWG – Expert Working Group

GDACS - Global Disaster Alert and Coordination System

HADR – Humanitarian Assistance and Disaster Relief

ISMP – Information Sharing and Management Platform

MNMCC - Nepal Army's Multinational Military Coordination Centre

OPERA - Command and Control Information System web-portal (utilized by RHCC)

PDC - Pacific Disaster Center

RCMC – Regional Civil Military Coordination Branch

RDT&E - Research Development Test and Evaluation

RHCC – Regional HADR Coordination Center (Government of Singapore)

SIPA - School of International and Public Affairs (Columbia University)

SOP - Standard Operating Procedure

UN OCHA - United Nations Office for the Coordination of Humanitarian Affairs

VOSOCC – Virtual On-Site Operations Coordination Center

WebEOC - Web Emergency Operations Center

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I. Executive Summary

Collection, sharing, and dissemination of information are critical components of a successful international disaster response operation. However, information sharing and management platforms (ISMPs) currently in use by the Association of Southeast Asian Nations (ASEAN) use different technologies, are not mutually accessible, and are not interoperable. Given the severity of recent disasters in the region such as Typhoon Haiyan, a common, interoperable information sharing and management platform that is easily accessible to civilian and military responders is a critical element necessary for effective and efficient collaboration during natural disaster response. As stated in ASEAN's Plan of Action and Milestones for 2017, the lack of interoperability is compounded by the fact that there is "no single, agreed-upon command and control system" to direct ASEAN member states' militaries during a natural disaster.[1]

As part of an ongoing collaboration with Columbia University, School of International and Public Affairs (SIPA), the Center for Excellence in Disaster Management and Humanitarian Assistance (CFE-DM) requested the SIPA team to compare and contrast the four main ISMPs used in the region and to provide recommendations for the development of an effective and efficient ISMP to increase interoperability among disaster response partners. This report presents and discusses the following ISMPs:

1. Web Emergency Operations Center (WebEOC, by AHA Centre)
2. OPERA Command and Control Information System (OPERA, by RHCC)
3. Virtual On-Site Operations Coordination Center (VOSOCC, by UN OCHA)
4. All Partners Access Network (APAN, by DoD)

Through extensive literature research, seven metrics - cost, interoperability, ease of access, mobile application, portability, bandwidth and technology requirements - were identified and selected to evaluate the current level of performance of the different ISMPs. Quantitative

[1] "Information Sharing in One ASEAN, One Response." *DRAFT: Plan of Action and Milestones*, 17 Nov., 2017.

and qualitative questionnaires and interviews with key stakeholders in Jakarta and Singapore provided further in-depth information regarding interoperability elements of ISMPs.

Conclusive data analysis conducted by the team suggest that, although there is agreement amongst stakeholders that a single ISMP is the optimal course of action, there are significant challenges hindering such development. To advance the goal of interoperability in the region, the team recommends development of a mobile application, increased unity of effort in the region, expanded collaboration efforts among relevant stakeholders, and dissemination of lessons learned and shared strengths.

II. Background Information

A. Existing Conditions

1. Association of Southeast Asian Nations (ASEAN)

The Association of Southeast Asian Nations (ASEAN), founded in 1967, is a regional intergovernmental organization comprised of ten Southeast Asian member states including Singapore, the Philippines, Brunei Darussalam, Cambodia, Indonesia, Malaysia, Myanmar, Lao PDR, Thailand and Vietnam. ASEAN is one of the most natural disaster-prone regions in the world, at high risk of earthquakes, floods, disease outbreaks, tsunamis, droughts and volcanic eruptions. The Southeast Asia region experienced more than 50% of total natural disasters worldwide, in addition to 354,000 out of 700,000 related deaths. Resulting total economic losses were about US$91 billion during 2004 and 2013.[2] In 2003, ASEAN formed the ASEAN Committee on Disaster Management (ACDM) as its core disaster management policy-making body, and signed the ASEAN Agreement on Disaster Management and Emergency Response (AADMER) in 2004 to create a unified regional disaster management body.[3] In this capacity,

[2] "ASEAN VISION 2025 DISASTER MANAGEMENT." *THE ASEAN SECRETARIAT JAKARTA*. http://asean.org/storage/2018/01/45.-December-2017-ASEAN-Vision-2025-on-Disaster-Management.pdf accessed 13 Apr. 2018

[3] "ASEAN Agreement on Disaster Management and Emergency Response." *The ASEAN Secretariat*. May 2010. http://www.asean.org/storage/images/resources/ASEAN%20Publication/2013%20(12.%20Dec)%20-%20AADMER%20Work%20Programme%20(4th%20Reprint).pdf accessed on 8 Apr. 2018

AADMER serves as the regional policy backbone for disaster management in the Southeast Asian region and has helped streamline the process of multilateral disaster response.

2. Center For Excellence in Disaster Management and Humanitarian Assistance (CFE-DM)

The Center For Excellence in Disaster Management and Humanitarian Assistance (CFE-DM) is a unit that directly reports to U.S. Pacific Command (USPACOM). Its mission is to enhance U.S. and international civil-military preparedness for disaster management and humanitarian assistance. CFE-DM advises USPACOM leaders and key stakeholders and partners in the Southeast Asia region, including the AHA Centre and the RHCC. Additionally, CFE-DM enables focused engagements, training and education, increases knowledge of best practices and shares information.[4] Furthermore, CFE-DM, by way of its Regional Civil-Military Coordination (RCMC) Branch, brings together the civil and military actors in the region and provides "unique expertise, partnerships, and resources to play a constructive role within the regional civil-military network" for humanitarian assistance and disaster relief (HADR) operations.[5]

3. Objectives

From 2017 to 2019, the U.S. and Malaysia will co-chair the ASEAN Defense Ministers Meeting Plus (ADMM-Plus) Humanitarian Assistance and Disaster Relief (HADR) Expert Working Group (EWG). The primary goal is to further the vision of "one ASEAN, one response",[6] but this cannot be done without effective communication among stakeholders. ASEAN's Vision for 2025 in disaster management recognizes "it is important that the overarching strategy identifies a central focal point for information management and sharing."[7]

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[4] "CFE-DM Initiatives." *CFE-DM*. www.cfe-dmha.org/About-CFE-DM/CFE-DM-Initiatives accessed on 8 Apr. 2018.

[5] "Civ-Mil Coordination." *CFE-DM*. https://www.cfe-dmha.org/RCMC accessed on 8 Apr. 2018.

[6] Interview at AHA Centre 12 March 2018

[7] "ASEAN VISION 2025 DISASTER MANAGEMENT." THE ASEAN SECRETARIAT JAKARTA. http://asean.org/storage/2018/01/45.-December-2017-ASEAN-Vision-2025-on-Disaster-Management.pdf accessed 13 Apr. 2018

In order to assist in this mission and within an ongoing cooperative arrangement between CFE-DM and Columbia University's School of International and Public Affairs (SIPA),[8] CFE-DM commissioned a team of graduate students to explore current ISMPs used within this space in an effort to determine the best possible way forward for collaboration, preparedness and response for disaster relief in Southeast Asia.[9] CFE-DM works with other stakeholders in the region such as the AHA Centre, the RHCC and UN OCHA, in supporting the U.S. Under Secretary of Defense for Policy in managing the EWG. These stakeholders represent four organizations that are significant actors in the ASEAN region – AHA Centre, RHCC, UN OCHA, and U.S. DoD – each one housing a different ISMP: WebEOC, OPERA, VOSOCC, and APAN, respectively.

Interoperability among systems, as well as effective and efficient sharing of information via a common operational platform, is crucial in both military and civilian operations to assure the success of relief efforts during disaster response. As stated in ASEAN's Plan of Action and Milestones for 2017, the lack of interoperability is compounded by the fact that there is "no single, agreed-upon command and control system" to direct ASEAN member states' militaries during a natural disaster.[10]

The challenge for ASEAN is to identify a common ISMP and operationalize it among ASEAN's member states and disaster response partners. Many of the functions of these systems are overlapping and may result in a duplication of effort throughout the region.[11] This can impair effective information sharing and resource allocation among disaster response partners.

To address the aforementioned inefficiencies, the following represent this project's key objectives:

1. Explore available ISMPs in an effort to determine the best possible candidate (or candidates) for a collaborative ISMP for disaster preparedness and response for Southeast Asia.

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[8] There are two separate research projects, published in 2016 and 2017, that focused on civil-military coordination for ASEAN programs and initiatives.
https://sipa.columbia.edu/academics/capstone-projects/enhancing-us-and-international-civil-military-preparedness-disaster (SIPA Capstone project 2016)
https://sipa.columbia.edu/academics/capstone-projects/multilateral-deployment-asean-militaries-during-disaster-indo-asia (SIPA Capstone project 2017)

[9] Terms of Reference

[10] "Information Sharing in One ASEAN, One Response." *DRAFT: Plan of Action and Milestones*, 17 Nov, 2017.

[11] "Information Sharing in One ASEAN, One Response." *DRAFT: Plan of Action and Milestones*, 17 Nov, 2017.

2. Identify information sharing requirements (needs, sources, sharing processes) and data issues (trust, metadata, standards) that an effective disaster management (preparation and response) ISMP should possess.
3. Illustrate the interoperability challenge existing between the various current ISMPs.
4. Recommend and indicate the minimum capabilities necessary for improved regional coordination in respect to interoperable ISMPs.[12]

B. Hosting Organizations

1. ASEAN Coordinating Center for Humanitarian Assistance (AHA Centre)

In 2011, the ASEAN Committee on Disaster Management officially launched the AHA Centre with the mission to facilitate cooperation and coordination of disaster management amongst ASEAN member states.[13] The AHA Centre has three main functions: disaster monitoring, preparedness and response, and capacity building.[14] The AHA Centre's office houses the Web Emergency Operations Center (WebEOC), which serves as the central platform to monitor and coordinate ASEAN's collective response to disasters.[15]

2. Changi Regional HADR Coordination Center (RHCC)

Located in the Changi Command and Control Center (CC&CC) in Singapore, the RHCC was launched in 2014.[16] The RHCC leverages available in-country facilities for multinational exercises and operations and supports international military coordination in HADR operations for affected states through the use of the OPERA Command and Control Information System.

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[12] Terms of Reference

[13] "ASEAN Agreement on Disaster Management and Emergency Response." *The ASEAN Secretariat*. May 2010. http://www.asean.org/storage/images/resources/ASEAN%20Publication/2013%20(12.%20Dec)%20-%20AADMER%20Work%20Programme%20(4th%20Reprint).pdf accessed on 8 Apr. 2018

[14] "What We Do". *AHA Centre*. https://ahacentre.org/what-we-do/ accessed on 8 Apr. 2018.

[15] "What We Do". *AHA Centre*. https://ahacentre.org/what-we-do/ accessed on 8 Apr. 2018.

[16] "About RHCC." *Changi RHCC Singapore*. https://www.changirhcc.org/App_Pages/Main/AboutUs.html accessed on 8 Apr. 2018

The RHCC aids the existing mechanisms within the UN and ASEAN when coordinating military assets from foreign countries.[17]

3. The United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA)

As the part of the United Nations Secretariat, UN OCHA is responsible for connecting humanitarian actors to assure a coherent response to emergencies.[18] Their mission is to "coordinate the global emergency response to save lives and protect people in humanitarian crises."[19] UN OCHA first developed the Virtual On-Site Operations Coordination Centre (VOSOCC) concept with the International Search and Rescue Advisory Group[20] in support of "international search-and-rescue efforts"[21] to the affected member state's government. UN OCHA also uses VOSOCC to carry out its mandate of coordination and information sharing in emergency response, particularly at the field level.[22]

4. U.S. Department of Defense

As one of the six geographic Unified Combatant Commands[23] under the United States Department of Defense, U.S. Pacific Command (USPACOM) is responsible for stability and development in the Indo-Asia-Pacific region by facilitating security cooperation during

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[17] "Fact Sheet:Changi Regional HADR Coordination Centre (RHCC)." *Ministry of Defense of Singapore.* https://www.mindef.gov.sg accessed on 8 Apr. 2018.

[18] "Our Work " *The United Nations Office for the coordination of Humanitarian Affairs* *https://www.unocha.org/our-work* accessed on 18 Apr. 2018

[19] "Our Work " *The United Nations Office for the coordination of Humanitarian Affairs* *https://www.unocha.org/our-work* accessed on 18 Apr. 2018

[20] "On-Site Operations Coordination Centre (OSOCC) Guidelines." *United Nations Office for the Coordination Humanitarian Affairs Field Coordination Support Section*. Dec. 2014. http://www.unocha.org/sites/dms/Documents/2014%20OSOCC%20Guidelines_FINAL.pdf

[21] "On-Site Operations Coordination Centre (OSOCC)." *The United Nations Office for the coordination of Humanitarian Affair* www.unocha.org/our-work/coordination/site-operations-coordination-centre-osocc accessed on 18 Apr. 2018

[22] "On-Site Operations Coordination Centre (OSOCC) Guidelines." *United Nations Office for the Coordination Humanitarian Affairs Field Coordination Support Section*. Dec. 2014. http://www.unocha.org/sites/dms/Documents/2014%20OSOCC%20Guidelines_FINAL.pdf

[23] "Home: About USPACOM." *U.S. Pacific Command*. www.pacom.mil/About-USPACOM/ accessed on 20 Apr. 2018

emergency and aggression.[24] USPACOM leverages CFE-DM to enhance disaster management and provide humanitarian assistance throughout the Indo-Asia-Pacific region.[25] To facilitate its mission regarding disaster response and to fulfill its key obligations, the Department of Defense, USPACOM and CFE-DM utilize APAN to share information with partner agencies and entities during stability and disaster response operations.[26]

C. Information Sharing and Management Platforms

WebEOC and OPERA were selected because they are used by the AHA Centre and the RHCC, respectively. Virtual OSOCC, managed by UN OCHA was selected due to its prominent use by the international humanitarian community. APAN was analyzed as it is the DoD's unclassified system to share information with other militaries, governments, and civilian partner organizations.

1. Web Emergency Operations Centre (WebEOC)

WebEOC is an online, map-based platform used by ASEAN member states to serve as the central location in support of sharing real-time information.[27] Member states can monitor the live situation on the ground based on the information provided by the National Disaster Management Office (NDMO) of the affected country as well as the AHA Centre field teams, including the Emergency Response and Assessment Team (ERAT).[28] WebEOC also allows ASEAN member states to post offerings of assistance to the affected country and vice-versa.[29] WebEOC is not a pre-deployment or pre-disaster tool and will only be activated when a disaster occurs. In addition, as one of the most widely utilized ISMPs for the ASEAN region, WebEOC

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[24] "COMMANDER, U.S. PACIFIC COMMAND (USPACOM)." *USPACOM*. 12 Aug 2016. *http://www.pacom.mil/Portals/55/Documents/pdf/guidance_12_august_2016.pdf?ver=2016-08-16-140701-960* accessed on 20 Apr. 2018

[25] "Strategy to Task Analysis." *CFE-DMHA*. www.cfe-dmha.org/About-CFE-DMHA/Hierarchy-of-Strategies-Plans-and-Doctrine-for-DMHA acessed on 8 Apr. 2018

[26] "Deputy Assistant Secretary of Defense for Stability and Humanitarian Affairs." http://policy.defense.gov/OUSDP-Offices/ASD-for-Special-Operations-Low-Intensity-Conflict/Stability-and-Humanitarian-Affairs/DoD-Capabilities/ acessed on 23 Apr. 2018

[27] *CFE review of HADR Information Sharing/Collaboration Platforms*. CFE-DM. Published October 2017.

[28] "What We Do." *AHA Centre*. https://ahacentre.org/what-we-do/ accessed on 8 Apr. 2018.

[29] "What We Do." *AHA Centre*. https://ahacentre.org/what-we-do/ accessed on 8 Apr. 2018.

facilitates increased cooperation and resource coordination in support of the ASEAN Militaries Ready Group (AMRG).[30]

2. OPERA Command and Control Information System web-portal[31] (OPERA)

OPERA is a map-based software that gives decision-makers an accurate picture of what is occurring on the ground and what assets are available to address the situation as it evolves.[32] Differing from other ISMPs, OPERA is specifically utilized to coordinate military assets through a network of international liaison officers from different militaries in disaster zones.[33] However, it is not a pre-deployment tool and is offered by the RHCC to the affected state in the event of a disaster.

3. Virtual On-Site Operations Coordination Center (VOSOCC)

VOSOCC is a web-based and password-restricted system, primarily used for real-time operational information exchange during disasters and complex emergencies.[34] This system is also a rapid response tool to coordinate international response management before and after a disaster.[35] VOSOCC allows users to access information on disasters, training events, meetings, and to participate in HADR online discussion by providing disaster situation reports, HADR documents, and an online simulator for users to practice.[36] iGDACS allows for a live feed and updates through mobile devices, but is only intended to improve the overall situational picture and does not process any individual responses to requests for help.[37]

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[30] The activation and deployment of the AMRG will help ASEAN develop "deeper cross-sectoral collaboration" that enhances strategic thinking on HADR operations and supports the vision of ASEAN as a global leader in disaster management by 2025.

[31] "Fact Sheet:Changi Regional HADR Coordination Centre (RHCC)." *Ministry of Defense of Singapore.* https://www.mindef.gov.sg accessed on 8 Apr. 2018.

[32] "Fact Sheet:Changi Regional HADR Coordination Centre (RHCC)." *Ministry of Defense of Singapore.* https://www.mindef.gov.sg accessed on 8 Apr. 2018.

[33] Interview at RHCC 14 March 2018

[34] *CFE review of HADR Information Sharing/Collaboration Platforms*. CFE-DM. Published October 2017.

[35] "On-Site Operations Coordination Center (OSOCC) Guidelines." *United Nations Office for the Coordination Humanitarian Affairs Field Coordination Support Section*. Dec. 2014. http://www.unocha.org/sites/dms/Documents/2014%20OSOCC%20Guidelines_FINAL.pdf

[36] *CFE review of HADR Information Sharing/Collaboration Platforms*. CFE-DM. Published October 2017.

[37] " iGDACS - Mobile Application for Disaster Information and Response." *GDACS*. http://portal.gdacs.org/Expert-working-groups/Mobile-technology/iGDACS accessed on 18 Apr. 2018

4. All Partners Access Network (APAN)

APAN is the United States Department of Defense's "premier unclassified information sharing" platform.[38] It is an online site developed to allow individuals, organizations and other DoD partners outside their system to effectively use and share available information[39] and thus coordinate a response to common objectives. According to user interviews, APAN's information sharing interface is not map based but is similar to Google Drive.[40] This system has a mobile application that can be used on a smartphone, but the features are limited in functionality.[41]

Information Sharing Platform Comparison[42]

The following tables are compiled from a combination of user interviews, literature review, and team research.

WebEOC (by AHA Centre)	
STRENGTHS	● All ASEAN Member States have access to WebEOC (used region wide) ● Backed by same developer that supports DisasterAWARE ● WebEOC has been utilized during emergencies (successful during Myanmar Floods of 2015)
CHALLENGES	● Lack of full understanding of functionalities by current users ● Non-ASEAN States might have limited or no access ("plus" countries, UN, NGO and military of Assisting States) ● "Closed System"; interoperability limited ● Web-based only; no mobile application
VOSOCC (by UN OCHA)	
STRENGTHS	● Preferred pre-deployment communication tool for UN Disaster Assessment and Coordination teams organizing and readying for deployment-the standard for initial communications between international first responder teams

[38] "About Us", *APAN*. https://www.apan.org/pages/about accessed on 8 Apr. 2018.
[39] "About Us", *APAN*. https://www.apan.org/pages/about accessed on 8 Apr. 2018.
[40] Interview at RHCC 13 March 2018
[41] "About Us", *APAN*. https://www.apan.org/pages/about accessed on 8 Apr. 2018.
[42] *CFE review of HADR Information Sharing/Collaboration Platforms*. CFE-DM. Published October 2017.

	• Supported by the United Nations and European Commission • Works well during pre-response phase as a planning tool for responding organizations • Shown to be an effective and stable information sharing tool during emergencies including the 2010 Haiti earthquake[43] • Relatively open and easy web-based access • Present form since 2003 with well-established user base of responders and disaster managers • An integral part of GDACS, a larger well-known and used information portal also managed by OCHA
CHALLENGES	• May not be used as frequently as an operational information platform during the actual deployment (vs. pre-deployment) as other communication and coordination mechanisms with improved functionalities are stood up • Technology outdated (e.g. bulletin board tool for communications) • Situation reports and other documents are likely better suited to be posted to other information portals such as Humanitarian Response and ReliefWeb • Other humanitarian workers and military responders may prefer to use regionally accepted ISMPs for response due to specific functionalities and interoperability among stakeholders
OPERA (by RHCC)	
STRENGTHS	• Has been used successfully as an operational information platform during a real-time emergency (2015 Nepal earthquake) • Used as an exercise tool for ASEAN HADR exercises (COORES) • Has been used successfully to coordinate and track disaster response units on the ground in Nepal[44] • Consistent upgrades improve functionalities over time • Useful during all phases of disaster management • Seeks to provide a common operational picture (COP) for HADR
CHALLENGES	• Current version of OPERA is based on 2007 software and contains bandwidth constraints along with aging servers[45] • Access limited to a subsection (specialized) of responders • Web-only access; No mobile app • May not be the preferred platform of the UN and international humanitarian organizations due to its use by the Singaporean

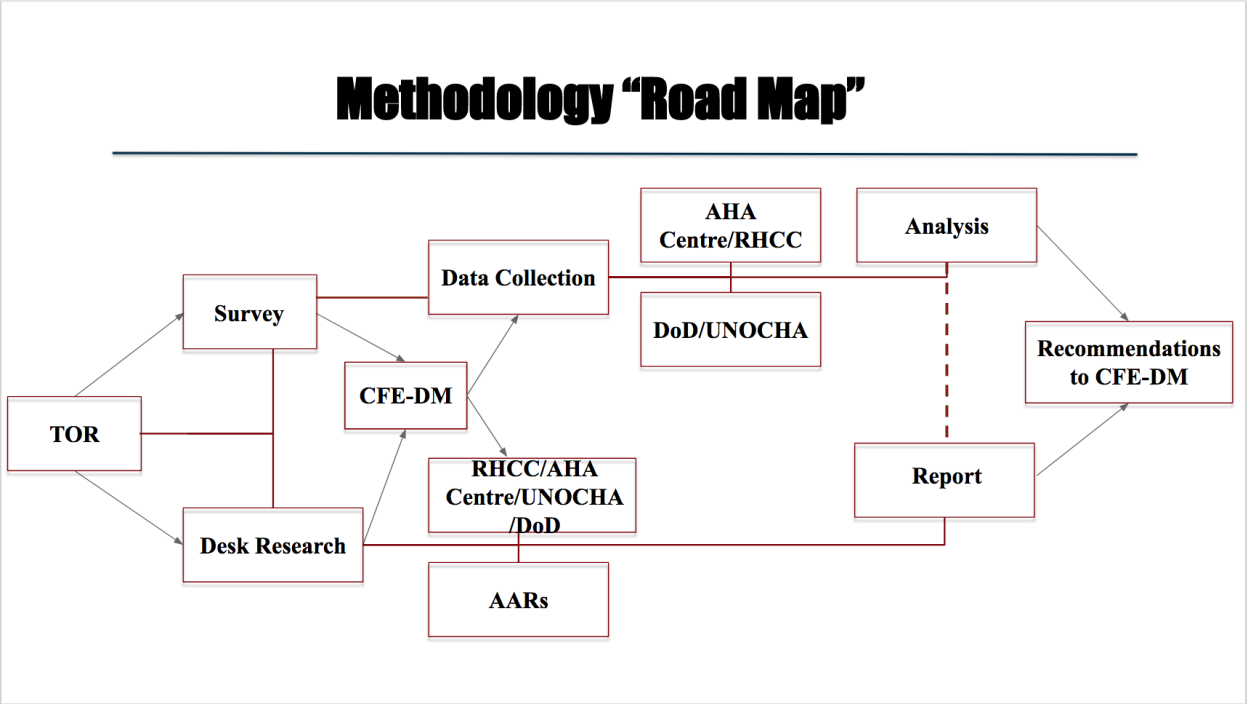
[43] Retrieved from https://reliefweb.int/sites/reliefweb.int/files/resources/4FCA4AC874331CFE85257768005AF32F-Full_Report.pdf
[44] Interview at RHCC 14 March 2018
[45] Interview at RHCC 14 March 2018

	military and government ● Because it is a "closed system" interoperability may be limited
APAN (by U.S DoD)	
STRENGTHS	● Access granted for foreign militaries, and international humanitarian organizations that would not normally have access to a U.S. "military" information portal website ● A ".org" v. ".mil" U.S. military website (May be more attractive to humanitarian workers) ● Used routinely for HADR-focused exercises ● Used for bilateral and multilateral exercises and engagements ● Widespread recognition for information sharing role played in 2010 Haiti earthquake response ● Sharing "communities" stood up quickly for a disaster response ● Mobile collaboration tools available through mobile application
CHALLENGES	● May not be the preferred ISMP for the international humanitarian community due to the perception of coordinating with the U.S. DoD ● The United Nations has its own ISMPs it relies upon (Humanitarian Response, VOSOCC, ReliefWeb, etc.) and international humanitarian organizations widely use these systems ● Sharing "communities" for disaster response may need to be requested by users to be created(system administration burden) ● Mainly web-based access; Not all functionality available for mobile app

III. Methodology

A. Project Methodology

Developing a clear methodology roadmap was key in defining a successful approach for research, data collection and reporting. The plan of action displayed below has been the guiding principle surrounding fieldwork and research.



As shown in the image, the project's methodology was based upon objectives developed in consultation with CFE-DM. This involved two arms of effort allowing for further comprehension of disaster response issues present in Southeast Asia while also hearing directly from the local stakeholders.

An in-depth familiarity with the HADR environment and architecture in Southeast Asia was obtained through extensive desk research and literature reviews. In particular, this process of familiarization included a combination of after-action reports gathered from the AHA Centre/RHCC's responses to natural disasters in the region, CFE-DM reports, and academic pieces describing the disaster management picture in Southeast Asia.

Furthermore, the development of the interview structure involved creating qualitative and quantitative questionnaires for each ISMP. Interview questionnaires reflected differences based

on the organization's past deployments. However, all the surveys utilized the same metrics, which as a result, strengthened the findings. The metrics portion was divided into two pieces: current performance and future desirability in a new or updated system. The future metrics were critical in shaping the recommendations.

The fieldwork portion of the project was conducted at the RHCC in Singapore and the AHA Centre in Indonesia. Five interviews were conducted at the RHCC and eight were conducted at the AHA Centre. Interviews were also conducted with Dr. Alistair D. B. Cook, Research Fellow at the Center for Non-Traditional Security (NTS) Studies and Coordinator of the Humanitarian and Disaster Relief Program in Singapore and the Indonesian National Board for Disaster Management (BNPB) in Jakarta. Finally, the data was collected, analyzed, and used to produce usable recommendations for CFE-DM.

B. Limits and Constraints

One major challenge was low participation at the RHCC and AHA Centre since many staff members were either on field deployments or leave. Additionally, conducting in-person interviews with APAN and VOSOCC users was not possible due to financial limitations and time constraints. To overcome this shortcoming, CFE-DM provided surveys to users of APAN and VOSOCC, who then completed the interviews and metrics measurements via email. These results were returned to the SIPA team for analysis to obtain the inputs and suggestions necessary for future recommendations.

IV. Metrics

Cost, interoperability, bandwidth capacity, portability, technology requirements, mobile application, and ease of access were the seven metrics used to evaluate each of the ISMPs. These metrics were identified and selected based on desk research, and relevant readings[46] prior to engaging in interviews and survey data analysis.

Metrics data collected in response to surveys and interviews were separated based on the duty position of the interviewee. Analysis of the data showed a clear delineation between end users and system administrators. Metrics that are not commonly evaluated by end users (such as overall cost of the system), did not receive the same amount of feedback compared to other more commonly understood metrics (such as interoperability). Additionally, responses to certain metrics such as ease of access differed based on the category of the individual's role in using an ISMP (operator or system administrator).

Survey responders in organizations such as the AHA Centre served in multiple capacities and allowed for a comprehensive assessment of the ISMP. These individuals acted as both members of the Emergency Response and Assessment Team (end user) along with being system administrators during steady state operations.

A. Cost

Total cost consists of research, development, test and evaluation (RDT&E), procurement, maintenance, troubleshooting, upgrading, contractual fees, and the necessary hardware and infrastructure requirements to utilize each ISMP.

RDT&E is often under the purview and responsibility of third party software developers. For example, WebEOC is developed by Intermedix and is licensed by the AHA Centre and ASEAN member states. However, this cost is transferred to the end user via licensing fees, contractual fees, support fees, and other charges. Software and systems are constantly

[46] CFE review of HADR Information Sharing/Collaboration Platforms, Civil-Military Coordination in HA/DR Missions: Best Practices for Affected and Assisting States, Rand Corporation: How Do We Know What Information Sharing is Really Worth, ALNAP: Nepal Earthquake Response and Lessons for Operational Agencies, ASEAN Disaster Response Management Handbook 2015

undergoing upgrades and this increases the burden on users who may be required to purchase or license the new versions.[47]

Procurement costs are separate from RDT&E and involve obtaining the hardware, software, networks, and user rights to access the ISMP. Examples of procurement costs are infrastructure and system requirements (network access, storage space, operating system, etc.), hardware (tablets, laptops, mobile devices), and accessories needed for connectivity.

Maintenance and troubleshooting costs are often overlooked[48] by users and system administrators when calculating the total costs for each system. Included in this category are fees and costs related to server upkeep, connectivity troubleshooting, and emergency deployment redundancy systems.

The metric of cost and expenses accrued is an indicator of how vested each stakeholder in is to their own ISMP (there is an inverse relationship between amount spent on current ISMP and the willingness to upgrade or change platforms). Both the RHCC and the AHA Centre have invested significant financial resources into their primary ISMPs (OPERA and WebEOC, respectively).[49]

The cost performance metric ranked fifth out of seven for OPERA, last for WebEOC, and was undetermined for VOSOCC and APAN due to interviewees being end users and not familiar with the cost structure of these two ISMPs. AHA Centre and RHCC respondents were sufficiently familiar with the cost structure of their ISMPs to give feedback on the metric. The importance of cost placed on future design for each ISMP was ranked sixth for OPERA, fifth for WebEOC, and last for both APAN and VOSOCC. This shows that cost is not as crucial to stakeholders in the region as other metrics such as interoperability.

B. Interoperability

The interoperability of each system is defined as how well it interfaces or shares data with other ISMPs. By definition, a closed system cannot interact with the database, storage, or information contained on a different system. Of the ISMPs researched during the project, all of

[47] Interview conducted at AHA Centre 12 March 2018
[48] Interview conducted at AHA Centre 12 March 2018
[49] Interviews conducted at AHA Centre and RHCC 12-16 March 2018

them are currently closed. WebEOC and OPERA completely lack interoperability and cannot share data of any kind with each other nor with VOSOCC and APAN.

Interoperability is a key metric in ensuring that the region addresses one of the lessons learned from the EWG 2016 HADR exercise, the need to improve on joint communications between participating members.[50] Interoperability has multiple levels which can range from simply allowing the transfer of files to full database editing and access.

The level of interoperability can also affect how closely two organizations work together during a disaster response scenario. By simply being able to forward data and files to another system, responders during an emergency can greatly decrease the time and effort necessary to coordinate and execute rescue or disaster response operations.

The most commonly requested interoperability function, as identified by both the AHA Centre and RHCC, is the ability to forward location and resource data to other stakeholders in the response area.[51] This allows for more proactive coordination between different response organizations and prevents bottlenecks at the strategic level (e.g. AHA Centre manually entering data they receive from OPERA users who are responding to the same disaster). Several survey respondents have identified the strategic level where all information is compiled as the bottleneck for information sharing.[52]

Due to these shortcomings, the performance metric ranked near the bottom (sixth out of seven) for both OPERA and WebEOC, while also scoring poorly on VOSOCC and APAN surveys. This shows a clear lack of interoperability in the ISMPs of all organizations. Additionally, all organizations ranked interoperability as a crucial functionality for future upgrades, with WebEOC users ranking it number one in importance, OPERA users ranking it as number two, VOSOCC users ranking it third, and APAN users ranking it as number one.

C. Bandwidth Capacity

For the purposes of this research, bandwidth capacity is measured as the ability to simultaneously send pictures, descriptions, data packets, and video conferencing over the ISMP.

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[50] ADMM EWG Workplan 2017-2020 retrieved from https://prezi.com/jepp6xqycehl/experts-working-groups-on-humanitarian-assistance-and-disast/

[51] Interviews conducted at AHA Centre and RHCC 12-16 March 2018

[52] Interviews conducted at AHA Centre and RHCC 12-16 March 2018

In each of the current systems used by stakeholders in the ASEAN region, the amount of bandwidth capacity met or exceeded needs with the exception of OPERA. RHCC invested in upgrades to its ISMP, due to bandwidth capacity constraints which caused a system freeze during a 2016 exercise in Thailand.[53] Furthermore, by keeping bandwidth requirements low, such as limiting or removing video conferencing functionality, stakeholders can rapidly deploy their emergency response teams to austere environments without the need for extra hardware requirements necessary to increase connection speed.[54]

A review of survey data shows that overall bandwidth capacity performance ranks fourth for OPERA users, first for WebEOC users, last for APAN users, and sixth for VOSOCC users. For importance in future system design, bandwidth capacity ranked fourth for the RHCC, third for the AHA Centre, fifth for VOSOCC, and second for APAN users. Stakeholders interviewed mentioned that bottlenecks in the flow of information did not stem from a lack of capacity. Rather, speed of information sharing was hindered due to interoperability constraints along with administrative and reporting requirements dictated in standard operating procedures (SOPs).[55]

D. Portability

The metric of portability is defined as how much equipment, personnel, or time is required to set up access to an ISMP. In the most basic of measurements, this metric is obtained by recording the effort in which emergency ground assessment teams spend in gaining connectivity to the ISMP.

Highly portable systems require less hardware transportation, less set up personnel, and decreased accessibility times. The current performance of this metric ranked first for the RHCC and second for the AHA Centre. This shows that the ISMPs used by both organizations are highly portable and easy to transport into disaster response operations areas where conditions may be extremely austere.

For importance in future systems or upgrades, portability is ranked second for RHCC, AHA Centre, and VOSOCC users. APAN users ranked the importance of portability fifth for

[53] Interview conducted at RHCC 14 March 2018
[54] Interviews conducted at AHA Centre and RHCC 12-16 March 2018
[55] Interviews conducted at AHA Centre and RHCC 12-16 March 2018

future development. As expected for organizations that must deploy rapidly during disaster response scenarios, portability continues to be a crucial characteristic in ISMPs.

E. Technology Requirements

Technology requirements for ISMPs measure whether the current hardware, infrastructure, or accessories are sufficient in supporting proposed upgrades and functionality updates. A low score for this metric could mean that one or more of the legacy system components should be replaced. A high score indicates that current technology and capability exceeds functionality requirements, or that any upgrades to the ISMP can be completed with off-the-shelf (already commercially available) components instead of having to research or develop a new technology.

The RHCC ranked the technology requirement current performance second while the AHA Centre ranked it third. This indicates that both organizations utilize technology efficiently in their ISMPs and can acquire functionality upgrades without investing heavily in hardware or components.

Alternatively, the RHCC ranked technology requirement fifth in importance for future consideration, the AHA Centre ranked it last out of seven metrics, and both VOSOCC and APAN users ranked it sixth out of seven. Since surveyed organizations believe that technology is not a hindrance to future upgrades, the importance placed on this metric ranked very low.

F. Ease of Access

This metric measures how easily a stakeholder gains access to the information made available by each ISMP (experiences vary between end users and system administrators). On the end user side, key performance indicators are the speed with which the user can gain access, how quickly a new user can learn to navigate all the functionalities, language barriers, and the amount of mandatory inputs required before the user is allowed to share or post information. From the system administrator side, key performance indicators are how quickly a new account can be created, how much time is required to customize user information, and the amount of effort spent updating information for the common operating picture.

Both OPERA and WebEOC are web-based and require a username and password for access. For current performance of ease of access, OPERA users ranked the system's performance second out of seven, while WebEOC users ranked WebEOC fourth out of seven. This relatively lower score for WebEOC was due to both end user and system administrator issues regarding process flow, SOP requirements, and user knowledge of system functionalities.

End user survey respondents cited the need to fill out cumbersome mandatory information requirements, language issues, and the lack of knowledge precluding 100% usage of WebEOC functionalities.[56] Requiring end users to completely input all the required (possibly extraneous) information before sharing data may slow down how responsive emergency response personnel are to the situation on the ground.[57] In regards to the language barrier, survey respondents have suggested translation software (possibly a variant of Google translate) be incorporated into the platform.[58] The ISMP is English-based and could benefit from translating data automatically into a variety of regional languages. Finally, some survey respondents mentioned that the lack of in-depth training prevents users from utilizing 100% of functionalities. One respondent mentioned that only "40-60% of functionalities are being used".[59]

System administrators cited the lack of automation and the extensive amount of time it takes to customize user data as a strain on the metric. In regards to automation, the COP is manually updated at the headquarters and administrator level. The lack of automatic information updates places a significant burden on the headquarters staff to ensure the accuracy of the information being shared.[60] Additionally, the ability to change or customize user data is withheld at the administrator level while preset user access must be given before an incident, as per current SOPs.[61] If users were granted certain rights to edit their own information in the ISMP, the burden on system administrators would decrease substantially.[62] Any improvements to these identified shortcomings would address a lesson learned from the EWG 2016 HADR exercise, i.e. improve general administration and management in the standard operating procedures.[63]

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[56] Interviews conducted at AHA Centre and RHCC 12-16 March 2018
[57] Interviews conducted at AHA Centre and RHCC 12-16 March 2018
[58] Interviews conducted at AHA Centre and RHCC 12-16 March 2018
[59] Interviews conducted at AHA Centre and RHCC 12-16 March 2018
[60] Interviews conducted at AHA Centre and RHCC 12-16 March 2018
[61] Interviews conducted at AHA Centre 13 March 2018
[62] Interviews conducted at AHA Centre and RHCC 12-16 March 2018
[63] ADMM EWG Workplan 2017-2020 retrieved from https://prezi.com/jepp6xqycehl/experts-working-groups-on-humanitarian-assistance-and-disast/

The importance of the metric for future system development varied between the entities. RHCC ranked it the most important functionality, the AHA Centre ranked it fourth out of seven, VOSOCC users ranked it the most important, and APAN users ranked it third.

G. Mobile Application

Although many of the ISMPs are browser based, the user interface is often not optimal for access on a phone or tablet device. This metric measures the efficiency, user friendliness, and functionality of accessing the ISMP on a mobile device. A low score corresponds to reduced functionality, degradation of user experience, or a hindrance to sharing information quickly and effectively with a hand held device. A high score indicates that the ISMP is highly accessible when utilizing a phone or tablet.

Due to the lack of a specific mobile application for their ISMPs, both the RHCC and AHA Centre ranked the current mobile performance low. OPERA users ranked mobile performance last while WebEOC users ranked it fifth out of seven. The most common complaint was having to consistently zoom in and out to access functionalities on a hand-held device (two survey interviewees specifically mention this as a shortcoming of using WebEOC on a tablet).[64] Additionally, survey respondents mentioned difficulty attaching files along with general glitches and random shutdowns while accessing from a mobile device.[65] This indicates a poor transfer of functionalities from computer browser to mobile device.

Surprisingly, a mobile application's importance in future development was ranked low by both the RHCC and AHA Centre. The RHCC ranked mobile application as the least important future metric while the AHA Centre ranked it sixth out of seven. However, this measurement of importance for future system design does not convey some of the qualitative answers that survey respondents gave when asked about mobile applications. Some suggestions for future improvement for a mobile application included a QR code for information storage and transmission, automatic geotagging of mobile users, offline storage of information that is automatically uploaded once connectivity is achieved, and better user interfaces.[66] Some of the

[64] Interviews conducted at AHA Centre and RHCC 12-16 March 2018
[65] Interviews conducted at AHA Centre and RHCC 12-16 March 2018
[66] Interviews conducted at AHA Centre and RHCC 12-16 March 2018

commonly mentioned answers regarding what survey respondents from the AHA Centre requested in a future system is the advent of a true mobile application.[67]

RHCC's OPERA Metrics Current Performance Evaluation					
Interviews	1	2	3	4	Average (out of 10)
Cost	**3**	**-**	**9**	**5**	**5.67**
Interoperability	**0**	**10**	**5**	**2**	**4.25**
Bandwidth Capacity	**5**	**10**	**6**	**4**	**6.25**
Portability	**5**	**10**	**9**	**7**	**7.75**
Technology Requirements	**4**	**8**	**9**	**7**	**7**
Mobile Application	**0**	**8**	**2**	**5**	**3.75**
Ease of Access	**8**	**8**	**5**	**7**	**7**

RHCC's OPERA Metrics Metrics for Future System Design					
Interviews	**1**	**2**	**3**	**4**	**Average (out of 7)**
Cost	**1**	**1**	**2**	**3**	**1.75**
Interoperability	**3**	**6**	**5**	**7**	**5.25**
Bandwidth Capacity	**6**	**4**	**4**	**5**	**4.75**
Portability	**5**	**7**	**3**	**6**	**5.25**
Technology Requirements	**4**	**3**	**6**	**2**	**3.75**
Mobile Application	**2**	**2**	**1**	**1**	**1.5**
Ease of Access	**7**	**5**	**7**	**4**	**5.75**

[67] Interviews conducted at AHA Centre and RHCC 12-16 March 2018

AHA Centre's WebEOC Metrics Current Performance Evaluation									
Interviews	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Average (out of 10)**
Cost	**4**	**-**	**-**	**8**	**4**	**6**	**5**	**2**	**4.8**
Interoperability	**4**	**10**	**2**	**3**	**1**	**7**	**8**	**5**	**5.0**
Bandwidth Capacity	**8**	**8**	**7**	**8**	**6**	**7**	**8**	**8**	**7.5**
Portability	**3**	**9**	**6**	**7**	**8**	**7**	**9**	**8**	**7.1**
Technology Requirements	**8**	**9**	**5**	**8**	**3**	**8**	**9**	**4**	**6.8**
Mobile Application	**4**	**9**	**7**	**1**	**5**	**6**	**5**	**5**	**5.3**
Ease of Access	**5**	**5**	**8**	**4**	**4**	**7**	**9**	**4**	**5.8**

AHA Centre's WebEOC Metrics Metrics for Future System Design									
Interviews	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Average (out of 7)**
Cost	**3**	**4**	**4**	**1**	**6**	**1**	**1**	**7**	**3.4**
Interoperability	**7**	**7**	**7**	**2**	**1**	**7**	**7**	**3**	**5.1**
Bandwidth Capacity	**1**	**6**	**6**	**4**	**5**	**4**	**6**	**6**	**4.8**
Portability	**5**	**5**	**5**	**6**	**3**	**5**	**5**	**5**	**4.9**
Technology Requirements	**2**	**2**	**2**	**3**	**4**	**3**	**3**	**1**	**2.5**
Mobile Application	**4**	**1**	**1**	**7**	**7**	**2**	**2**	**2**	**3.25**
Ease of Access	**6**	**3**	**3**	**5**	**2**	**6**	**4**	**4**	**4.13**

UN OCHA's VOSOCC Metrics				
Current Performance Evaluation				
Interviews	**1**	**2**	**3**	**Average (out of 10)**
Cost	**N/A**	**10**	**N/A**	**10**
Interoperability	**8**	**1**	**7**	**5.3**
Bandwidth Capacity	**8**	**3**	**5**	**5.3**
Portability	**8**	**10**	**10**	**9.3**
Technology Requirements	**7**	**10**	**7**	**8.0**
Mobile Application	**7**	**10**	**7**	**8.0**
Ease of Access	**7**	**10**	**10**	**9.0**

UN OCHA's VOSOCC Metrics				
Metrics for Future System Design				
Interviews	**1**	**2**	**3**	**Average (out of 7)**
Cost	**1**	**2**	**1**	**1.3**
Interoperability	**7**	**3**	**4**	**4.7**
Bandwidth Capacity	**4**	**5**	**3**	**4.0**
Portability	**5**	**4**	**6**	**5.0**
Technology Requirements	**3**	**1**	**2**	**2.0**
Mobile Application	**2**	**7**	**5**	**4.7**
Ease of Access	**6**	**6**	**7**	**6.3**

U.S. DoD's APAN Metrics			
Current Performance Evaluation			
Interviews	**1**	**2**	**Average (out of 10)**
Cost	**N/A**	**N/A**	**N/A**
Interoperability	**6**	**3**	**4.5**
Bandwidth Capacity	**4**	**N/A**	**4.0**
Portability	**10**	**N/A**	**10.0**
Technology Requirements	**5**	**6**	**5.5**
Mobile Application	**N/A**	**N/A**	**N/A**
Ease of Access	**7**	**8**	**7.5**

U.S. DoD's APAN Metrics			
Metrics for Future System Design			
Interviews	**1**	**2**	**Average (out of 7)**
Cost	**1**	**2**	**1.5**
Interoperability	**7**	**7**	**7.0**
Bandwidth Capacity	**5**	**6**	**5.5**
Portability	**2**	**3**	**2.5**
Technology Requirements	**3**	**1**	**2.0**
Mobile Application	**4**	**5**	**4.5**
Ease of Access	**6**	**4**	**5.0**

V. Challenges to Implementation

While the majority of respondents agree that a single ISMP is optimal, they also acknowledge there are significant challenges hindering the development of such a platform in the current ASEAN area of operations. Interoperability among ISMPs and organizations, for example, was mentioned as desirable. However, all parties agreed that given the nature of their work and the focused nature of their missions within the disaster management space, this is difficult to accomplish. The RHCC focuses on military-to-military coordination while the AHA Centre and UN OCHA focus on primarily coordinating civilian responders for humanitarian relief. At the same time, two of the stakeholders in question, the AHA Centre and the RHCC, have made significant investments in their individual platforms,[68] and thus are unwilling to shelve their systems in favor of another.

Regarding a mobile application, one respondent expressed interest but was apprehensive due to potential technology requirements. This was driven by differences in mobile operating systems, such as the iPhone iOS or Google's Android, and worries about how frequent updates could affect long term compatibility across devices. While the cost of each system was not necessarily an issue, there were concerns about the additional burden and high investment an application would entail.

According to a study conducted by the Institute for Computing, Information and Cognitive Systems at the University of British Columbia, differences among operating systems is one of the biggest challenges faced by app developers today.[69] Getting the same app to work on multiple operating systems translates to developing a separate one for each. Developers must then manually check its "functionality" and make sure features are preserved across operating systems. Even replicating the user interface among systems is a challenge and was cited as a "trade-off between consistency and adhering to each system's standards."[70]

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[68] Interviews conducted at AHA Centre and RHCC 12-16 March 2018

[69] Joorabchi, Mona Erfani, et al. "Real Challenges in Mobile App Development." *2013 ACM / IEEE International Symposium on Empirical Software Engineering and Measurement*, 2013, www.ece.ubc.ca/~amesbah/docs/mona-esem13.pdf. Accessed on Apr. 18. 2018

[70] Joorabchi, Mona Erfani, et al. "Real Challenges in Mobile App Development." *2013 ACM / IEEE International Symposium on Empirical Software Engineering and Measurement*, 2013, www.ece.ubc.ca/~amesbah/docs/mona-esem13.pdf. Accessed on Apr. 18. 2018

Lastly, while there were a few individuals who have worked on multiple ISMPs, most expressed preference for their home organization's system. The most compelling reason for this was the lack of familiarity with the user interface of different platforms and the perception that each organization's system aligns most with their individual missions.

VI. Conclusions and Recommendations

ASEAN member states have developed essential core competencies regarding international disaster management. Their capabilities and contributions to regional cooperation have improved dramatically since the creation of the AHA Centre in 2011. To further expand on the benefits of coordination and resource optimization, there is a need to overcome the lack of interoperability between systems and stovepiping (the isolated operating nature) of individual responses and contributions.

The findings of survey and interview data analysis reveal a lack of overall interoperability and information sharing among the different systems in use. This shortcoming continues even with the acknowledged need from a majority of interviewees. There is no functionality that allows for data transfer between the various ISMPs analyzed in this report. For responders and stakeholders to better coordinate their efforts and resources, steps must be taken to increase efficient exchange and use of information.

Furthermore, users and system administrators in the region have indicated through qualitative survey data the need for improvement in user interfaces of the ISMPs and to make them more streamlined and accessible to mobile devices. By overcoming the difficulties of accessing the ISMP on a mobile device, information sharing becomes faster and less cumbersome. This increases the accuracy and timeliness of data required to portray an updated COP for stakeholders responding to a disaster.

The following steps and recommendations are encouraged to resolve the aforementioned challenges. By applying key lessons learned from previous EWG exercises such as improving joint communications between participating members and streamlining general administration

and management in the standard operating procedures,[71] ISMP hosting organizations in the region can improve information sharing capabilities during disaster response operations.

The first step is to gain consensus from relevant stakeholders on what information should be shared and how to share it. This sets the tone for required hardware and software development to gain interoperability by identifying the required functionality upgrades or changes for current systems in use.

The second step is to ensure that organizations who are participating in disaster response do not focus the entirety of their efforts on the mission at hand and lose sight of the importance of regional cooperation. Coordination and understanding of each other's missions are essential to building a strong multilateral response to disasters.

The third step is to improve the functionalities and interfaces of current systems in use such as sharing documents or accessing from a mobile device. Increasing the speed at which users can input and retrieve information from ISMPs while simultaneously reducing the burden placed on system administrators can have a positive effect on disaster response.

Interoperability Requirement and Unity of Effort

Recommendation One: Conduct a meeting of relevant ISMP hosting organizations and stakeholders to gain consensus on how to better share information between the different entities. As the survey data indicates, there is strong acceptance among different organizations that interoperability is a crucial functionality that is lacking in the current communications structure. What is not agreed upon is the way ahead or method of addressing this shortcoming in the different ISMPs. By conducting a meeting with interoperability on the agenda, regional leaders can work towards creating acceptable courses of action in overcoming the myriad of interoperability challenges identified. An ideal date to hold this meeting would be during the EWG Exercise Mid Planning Conference to be held in Malaysia in the fourth quarter of 2018.

[71] ADMM EWG Workplan 2017-2020 retrieved from https://prezi.com/jepp6xqycehl/experts-working-groups-on-humanitarian-assistance-and-disast/

Expediting Information Sharing Through Improved System Administration and Access

Recommendation Two: Refine standard operating procedures for both the end users and system administrators of current ISMPs. Current procedures place a heavy burden on the headquarters and administration staff in creating, maintaining, and editing user accounts. The result of withholding certain edit or change rights at the administrator level is the reduced capacity of end users to input data in a rapid manner while also reducing the resources available at headquarters to process and share data with decision makers.

Furthermore, although the functionalities of each ISMP is vast, end users conveyed a lack of complete understanding of what their ISMP could accomplish, with one estimate stating that only "40-60% of functionalities are being used".[72] This indicates that there may be faster or more effective methods of sharing data currently available than what is being utilized.

By ensuring that standard operating procedures address both procedural and administrative shortcomings in current ISMPs, hosting organizations can streamline their information sharing process.

Recommendation Three: Develop a mobile application for stakeholders to access their ISMP. This allows for emergency response teams of each organization to quickly and efficiently share necessary information and is much more user friendly than current browser-based access on mobile devices.

While the challenges of developing a mobile application are significant (including, but not limited to, cost and challenges of developing for multiple operating systems) the rewards of creating a versatile and user friendly application may outweigh the drawbacks. The ASEAN region is one of the most mobile driven in the world, with significant revenue and application development being forecasted in the next five years.[73] By harnessing this growth and reliance on mobile devices, hosting organizations can facilitate rapid information sharing and dissemination that would not have been otherwise possible over traditional methods.

The creation of an application can further be used to update COPs and provide real time information to decision makers through crowdsourcing. Utilizing filters and other selective

[72] Interviews conducted at AHA Centre and RHCC 12-16 March 2018

[73] Mobile Apps in APAC: 2016 Report retrieved from https://www.thinkwithgoogle.com/intl/en-apac/trends-and-insights/mobile-apps-in-apac-2016-report/

methods to the avoid information overflow at the strategic level, mobile applications can give leaders the data, statistics, and facts needed to make decisions regarding resource allocation and disaster response operations.

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