Stewarding Situational Awareness Technology for Safety of People with Disabilities

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EXECUTIVE SUMMARY

People with Disabilities (PWDs) are a marginalized lot who are five times more likely to be impacted than a person without a disability in disasters. Many wonder, whether the disaster and resilience practitioners have considered inclusive disaster communication practices in support of PWDs. In the context of PWDs and “independent living” - looking after their own safety in emergency situations – one must have a good understanding of the environment and a comprehension of the risks. It is equally important to know yourself and realize your “adaptive capacity” to face those peculiar but frequent crises affecting the individual and catastrophic events affecting the community or society as a whole. Information and Communication Technology (ICT) supported “assistive technology” is transforming the future of PWDs and independent living (Alexander, 2008). ICT tool and platforms are also aiding the management of those day to day crises and larger-scale disastrous events.

Figure 1: Why disability matters - one billion people are disabled (infographic source World Health Organization - 2016)

There is growing evidence that Disaster Risk Reduction (DRR) is a cost-effective investment in preventing casualties, physical damage, and economic losses. This process includes the provision of universal accessibility for PWDs and involving them in emergency response and DRR. Thus, instead of stigmatizing them, it is important to consider them as another variation of humans and then to reframe the problem as Disability inclusive DRR (DiDRR) (Craig et al., 2019).

National and local government entities, private-sector and public-sector actors and individuals have found that including PWDs has enhanced their capacities in DRR tasks in many places (European Agency, 2013; Samant Raja et al., 2013). Otherwise, the impact of disaster on PWDs’ health is significant, including the number of PWD deaths, injuries, diseases, disabilities, psychosocial problems and other indirect effects with damage to facilities and disruption to the delivery of services over extended periods of time.

In managing crisis situations arising from all scales of risk events, Dr. Mica Endsely’s “situational awareness” model is useful in perceiving the environment, comprehending the situation, and projecting the consequences to decide on the appropriate action upon the crisis situation. Situational awareness has been proven to improve the adaptive capacity of people in crisis situations especially, supporting emergency services and first responders in the field (Lundberg, 2015). To explore the state of situational awareness practices in emergencies involving PWDs, of particular interest was realizing whether ICT-enabled assistive technology for PWDs are in fact considering the role of enhancing the

PWD adaptive capacity when facing crises in the changing world (Craig et al., 2019; Ramli et al., 2019).

Situational awareness system developers should consider universal design strategies. From the perspective of inclusive crisis communication and similar to the universal set of road signs, pictographs that are action oriented, culturally appropriate, and comprehensible were field tested with a group of deaf for crisis communication (Frommberger & Waidyanatha, 2017). In the context of crisis communication, PWDs need to be involved in all phases of technology development. This begins with designing the technology by communicating their stories, needs, and technology acceptance.

Deaf women fear rape and may not trust strangers to reach out for any assistance in a crisis (Gartrell et al., 2017). For such, trust protocols can be established by exercising “team” situational awareness, “shared” situational awareness, and “task” situational awareness (Gjøsæter et al., 2019; Lundberg, 2015), Thereby, family member are informed of situational updates and also including a family member in the situational awareness communication to give the PWD a sense of assurance; i.e. sharing a video facilitated between the PWD and a trusted family member while an unfamiliar individual or team is responding to the PWD’s crisis situation.

In the presence and surrounding of disabled persons and their community, first responders and other crisis response services are functionally illiterate. Therefore, shared situational awareness can involve caregivers and family members as interpreters. Emergency data exchange standards can support shared situational awareness (Bhandari et al., 2017). There is an observed lack in uptake of interoperability policy and standards for emergency data exchange by many nations.

The problem with predicting future risks is that it works until it fails. In the context of risky situations the intent is to be safe. However, if we can empower PWDs to go into a risk situation armed with more knowledge and experience, we can improve their behaviour, if it might be perceived as a dangerous or a move that will incur losses or be unsafe. To that end, we introduce the concept of Safety-II of building adaptive capacity through enhanced situational awareness to aid PWDs in a crisis.

Safety-II encourages building on and strengthening what works instead practising the typical approach of trying to fix granular risks and what went wrong because it can be a costly endeavour. An important consideration in the design of situational awareness applications is to adopt an inclusive crisis communication approach that fosters interoperability. The advantage is that situational-awareness systems offer adaptive capacity for dealing with small and large risks (Lundberg, 2015).

A key assumption that limits the suggested situational awareness for improved adaptive capacity, is that the PWDs can create mental models of situations. On the contrary a person who is unable to create any kind of mental model cannot benefit from situational awareness. The more one is aware of the risk one can derive more choices to overcome those risks with confidence. However, the perception and analysis of risk, is always, based on incomplete information.

Stakeholders designing ICT for Emergencies should consider situational awareness and the holistic approach of providing Safety-II to PWDs. Safety of PWD through effective situational awareness is

one of the unexplored areas with respect to the ICT for crisis management design and can be considered as the main contribution of this report. It serves as a resource for designers and developers of crisis (including emergency and disaster) communication ICT systems. In lieu of putting it into practice, there are three primary recommendations:

> *Recommendation I: Disabled Persons Organization to take the lead in sponsoring a community of practice for learning together, and promoting, stewarding, and sustaining situational awareness technology.*
>
> *Recommendation II: Technology Stewards who emerge from the community of practice to lead with establishing the digital habitat for innovating with and supporting the community in adapting a situational awareness platforms and tools.*
>
> *Recommendation III: Agents of Change to use evidence-based research to advocate government and the public safety community in setting interoperability policies and procedures that foster team and shared situational awareness across all platforms.*

Implementing these recommendations are expected to promote peer learning. Integration of disabled persons means a process of incorporation in which individual diversity is metabolised. It will allow for technology stewards and agents of change to emerge from the community of practice to lead with establishing the digital habitat for innovating with and supporting the community in adapting situational awareness platforms.

In thinking about the policy and material response to crises, it is important to understand heightened risks and vulnerabilities that arise out of social disparities and environmental conditions. This will allow public safety officials and emergency responders to tailor preparedness and response services to be inclusive. Instrumental to the process of ICT-enhanced assistive technology for situational awareness is the integration of daily use applications in addressing all risks; thus, emphasising that a Safety-II approach to addressing crises is required.

Technology Steward – Raja Acharya, an IT student, was brainstorming ICT solutions for PWD and remembered his deaf neighbour: Ram Adhikhari from when he was a child. He looked up Adhikhari on Facebook, to find that he was the Principal of Swabalambi Primary School for Deaf Children. “I was determined to create something that could help deaf people and the students from this school” he said. Acharya’s team, from New Summit College, developed the product Bahasa Buddy App – supports those with hearing disability, in the process of learning to read and write Nepali.

Agent of Change – Dinesh Kaushal is a leader of non-visual desktop access development in India. He himself was rendered completely blind due to glaucoma at the age of eight. With sheer determination he solved his own problem by developing Screen Access for All, the first open source screen-reader in the world. “Anyone can come up with far-fetched ideas for solutions. … the process of a hackathon, to have seemingly crazy ideas,” Kaushal explained. “But most of the time we lack the tools of structured thinking that help us turn these crazy ideas into practical, user-friendly solutions.”

Box 1: Example of a Technology Steward and Agents of Change – excerpts were taken from LIRNEasia blog https://lirneasia.net/2018/08/let-the-deaf-be-heard-accessible-and-inclusive-icts-for-persons-with-disabilities/

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KEY TERMS AND CONCEPTS

Crisis – is largely perceptual and the logic here is that a crisis harms someone or something. There are some 20+ definitions and contextual use of the word 'crisis' in the manifestation of risk, hazard event, calamity, catastrophe, emergency, and disaster (Coombs & Holladay, 2010). A crisis can be viewed as the perception of a distinct yet unexpected and non-routine event (or series of events) that threatens the important expectations of stakeholders, such as their lives, livelihoods, and the viability, thereby creating spheres of uncertainty and unknown outcomes (Calgaro et al., 2013) .

Crisis Management – has a focus on control with a more positivist and rationalist approach to crisis prevention and response – whether the stakeholder or system knew, appreciated, planned, and appropriately enacted sufficient control over operations to prevent, mitigate, respond, and learn from a crisis. While emergency and disaster have a perception of being beyond the risk imposed on an individual and managing them would constitute a coordinated response, a crisis could be smaller and individualistic as well as large, collective, and resource-intensive. To that end, crisis management is a set of factors designed to combat crises and to lessen the actual damages inflicted; whereby, crisis management "seeks to prevent or lessen the negative outcomes of a crisis and thereby protect the stakeholders" (Coombs & Holladay, 2010).

Adaptive capacity – the capacity to cope with unforeseen and unanticipated events can be extended to considering *proactive* adaptation capacity of people affected by adverse circumstances. Adaptive capacity, in the face of crises, is a measure of the capacity of a system to respond to a given environmental risk (or hazard) through mitigation, coping, survival, adjustment, or adaptation (Hollnagel et al., 2015b; Saleh Safi et al., 2012). Essentially, it determines 'how well the system can adjust to a disturbance or moderate damage, take advantage of opportunities and cope with the consequences of a transformation (Combaz, 2014; UNESCAP & UNISDR, 2012).

Situational Awareness (SA) – a critical component of crisis management is communication and the role of communication in the crisis management process (Coombs & Holladay, 2010). In crisis situations attaining situational awareness is an important part of taking appropriate action (Gjøsæter et al., 2019) and It should suggest the best protective action to take— for example, when to shelter in place, when to evacuate, and where to evacuate. Situational awareness has its roots in the everyday common-sense observation that a loss of "the picture", a loss of orientation towards ongoing events, sometimes causes accidents or other undesirable events. Therefore, central to the notion of situational awareness is that humans need to be aware of

certain aspects of the world – at specific moments in time, to make critical decisions (Lundberg, 2015). Situational awareness is essential in a crisis situation, for the general public affected by the emergency as well as for first responders and decision-makers. Elements of situational awareness is developed on an individual level and on a team level to comprehend a crisis situation. We adopt Endsley's proposed three-level model to *define situational awareness; whereby, L1 - the perception of the elements in the environment within a volume of time and space, L2 - the comprehension of their meaning, and L3 - the projection of their status in the near future* (Gjøsæter et al., 2019).

Safety (in the traditional sense, defined as Safety–I by (Hollnagel, 2015), is defined as 'a condition where the number of adverse outcomes is as low as possible' is recognized in accident investigation but also in risk analysis and risk management. Since risk analysis looks to possible future events – to something that could happen but has not happened yet, it could be argued that Safety–I in this respect is proactive (Hollnagel, 2015; Hollnagel et al., 2015a, 2015b). Safety–I embody a number of assumptions and myths and thereby indirectly endorses them. Since these are important determinants of how we perceive adverse outcomes, how we try to understand them and how we respond to them – and, thereby, how we manage safety. Since Safety–I require that a cause can be found and that something can be done about it, the inability to find a root cause, or set of root causes was a serious setback (Hollnagel, 2015; Hollnagel et al., 2015b).

Safety-II - is the system's ability to succeed under varying conditions. The framework includes concepts from resilience engineering, reflecting an increased focus in research and practice on managing the unexpected/unplanned-for-situations; namely, Safety-II, complements antifragility in high risk domains (Lundberg, 2015). Safety-II introduces frames and implications in a step towards being useful in the analysis of situational awareness. Thereby, the situational awareness states emerge from processes of exploring situations through situational awareness systems. Reflecting research on Safety-II, in describing situational awareness states the framework distinguishes frames (what situations are considered) from implications (regarding the situations) of objects on and of an event horizon (Hollnagel et al., 2015b; Lundberg, 2015). It is recommended that safety management should, therefore, move from ensuring that 'as few things as possible go wrong' to ensuring that 'as many things as possible go right' (Hollnagel, 2015).

People with Disabilities (PWD) - The term 'people with disabilities' is widely used within the social model and places people as individuals first; whereas, the term 'disabled' that champions 'identity-first' is a personal preference that a person or a group wishes to associate themselves (Craig et al., 2019). It can be perceived as inherently offensive as it indicates a lack or absence of ability (Sagramola et al., 2016). The United Nations (UN) Convention on the Rights of PWDs defines a person with a disability as: those who have long-term physical, mental, intellectual or sensory impairments which in interaction with various barriers may hinder their full and effective participation in society on an equal basis with others (European Agency, 2013). Disability is a part of the human condition – almost everyone will be temporarily or permanently impaired at

some point in life, and those who survive to old age will experience increasing difficulties in functioning (WHO & WB, 2011).

Disabled Persons Organization (DPO) – is a representative organization or group of PWDs, where PWDs constitute a majority of the overall membership, staff, board members, and volunteers in all levels of the organization. They play a larger role in responding to the needs and life expectations of PWDs. As a representative organisation, they establish the necessary recognition, support and resources for playing a major role. Disabled Persons' Organizations go beyond their boundaries of just focusing on PWDs (Alexander, 2008).

Vulnerability – is a socially construct and it can be addressed through associated contextual parameters that include the elements of poverty, capacity of early warning, knowledge of emergency action or crisis management, the existence of appropriate evacuation plans or presence of shelters, or the appropriate design of buildings, among other protective or mitigating practices (UNESCAP & UNISDR, 2012). The degree to which an exposure unit (human groups, ecosystems and communities) is susceptible to harm due to exposure to a perturbation or stress, and the ability (or lack thereof) of the exposure unit to cope or recover (Calgaro et al., 2013).

Disaster Risk Reduction (DRR) – is acknowledged and structured to the guidelines and indicators declared in the Sendai Framework for DRR 2015-2030 agenda (Craig et al., 2019; Llewellyn et al., 2015; Villeneuve, 2019). The 2015 World Conference on Disaster, during which the Sendai Framework for DRR was adopted, incorporated explicit recommendations toward a disability-accessible and inclusive environment not evident in previous DRR conferences (Stough & Kang, 2015).

Disability inclusive DRR (DiDRR[1]) - is placing PWDs at the centre of DRR by considering a systems approach because systems approaches provide a holistic theoretical lens through which to identify and engage with the multiple contextualised factors and processes that collectively influence differential vulnerability and resilience patterns (Calgaro et al., 2020; Craig et al., 2019). It ensures the needs and voices of people with disability are included in disaster risk management.

Community of Practice – with a context in emergency communication, is a group of people who come together to learn from each other by sharing knowledge and experiences about the activities in which they are engaged (Gimenez et al., 2014). The interactions that take place within the communities of practice, members are capable of sharing first-hand knowledge acquired through experiences and practice with the rest of the community, which otherwise would hardly be possible (Lesser & Prusak, 2009). The explicit and the tacit includes what is said and what is left unsaid; what is represented and what is assumed. It includes language, tools, documents, images, symbols, well-defined roles, specified criteria, codified procedures,

1 DiDRR Network promotes meaningful contribution of ALL in developing resilience towards disaster: https://www.didrrn.net/

regulations, and contracts that various practices make explicit for a variety of purposes (Wenger et al., 2009b).

Digital Habitat – provides a place for the community to learn together. It is a dynamic, mutually-defined, relationship between the community and the place. It is analogous to the ecological sense of a 'habitat' being is a place with environmental and biological features for a species (or community) to survive and reproduce. Increasingly the habitats, forming communities of practice, include digital technology-based connections and interactions to take place in a virtual world, in addition to the physical ones (Wenger et al., 2009b).

Agents of Change – is a role whereby PWDs emerge in playing the role of a researcher in bringing about the needed change for their members (Craig et al., 2019). They identify the change needs for a disability DiDRR (Handicap International, 2015). Agents of Change are instrumental to formulating evidence in support of policy advocacy and planning of DiDRR initiatives.

Technology Steward (or Tech steward) – is a new role emerging from the convergence of technology and community. Tech stewards are central to such an implementation strategy and have enough experience with the workings of a community to understand its technology needs, and enough experience with or interest in technology to take leadership in addressing those needs. They are the group of people, often members of the community they serve, who will be paying attention to this process and influencing it. The distinct function attending to this interplay between technology and community is termed as 'technology stewardship' or 'stewarding technology' whereby these individuals take responsibility for the community's technology resources for a time. Technology stewarding is both a perspective and a practice that distinguishes between technology stewardship and IT Support (Wenger et al., 2009b).

GLOSSARY OF TERMS AND ABBREVIATIONS

Table 1: Glossary of Terms and Abbreviations

Term	***Definition***
CAP	Common Alerting Protocol
DiDRR	Disability inclusive Disaster Risk Reduction
DPO	Disabled Persons Organization
EDXL	Emergency Data Exchange Language
EWS	Early Warning System
HAVE	Hospital Availability
HDX	Humanitarian Data eXchange
ICS	Incident Command System
ITU	International Telecommunication Union
NDMO	National Disaster Management Organizations
NIEM	National Information Exchange Model
NIEM	National Information Emergency Model
PWD	People With Disability
RM	Resource Messaging
SA	Situational Awareness
SITREP	Situational Reporting
TEC	Tracking Emergency Clients
TEP	Tracking Emergency Patients
UN	United Nations
WHO	World Health Organization
SDG	Sustainable Development Goal

Stewarding Situational Awareness Technology for Safety of People with Disabilities

INTRODUCTION

Disasters wreak havoc and destroy full-scale infrastructures, homes, schools, hospitals, communication systems, and disrupt access to food, clean water, electricity, and transportation. In the past 10 years, disasters have continued to inflict a heavy toll with, according the United Nations Environment Program, “over 700,000 people dead, over 1.4 million injured, and around 23 million made homeless as a result of disasters .” Overall, more than 1.5 billion people were affected by disasters in various ways during this period (Sagramola et al., 2016).

In the event of a crisis, a complex range of social and economic factors affect the ability of individuals to respond – socio-economic inequalities determine the level of risk different individuals face, and thus their vulnerability during crises (Samant Raja et al., 2013). What this means is that different populations may face similar exposure to the negative effects of any crises, but their actual vulnerability is dependent on their socio-economic conditions, civic and social empowerment, and access to mitigation and relief resources.

Individuals with disabilities are disproportionately affected in disaster, emergency, and conflict situations due to inaccessible evacuation, response (including shelters, camps, and food distribution), and recovery efforts (Robinson, 2020; Samant Raja et al., 2013; Stough & Kang, 2015; Wolbring, 2009). An indirect impact of major crises is the heightened risk of abuse and violence against disadvantaged communities. In addition, the pathways for long-term recovery and restoration may remain murky, slow, and obstacle driven (Samant Raja et al., 2013).

A crisis has a focus on some turning event and is risk manifested. The "handbook of crisis communication", by (Coombs & Holladay, 2010), explores the literature addressing the definition of 'crisis'. They also argue that one of the central themes of crisis is 'accountability'; thus, the willingness of the public safety officials, emergency services, community and stakeholders to meet key expectations on the matter. In the context of this report it means exercising the willingness to including disabled people and making crisis communication systems accountable with meeting inclusive crisis communication criteria. The claim is that crisis communications should focus on practices, policies, and ethics that prevent or staunch the harm of this crisis. It is normative to risk management and is the life blood of crisis management aiming to prevent harm to others and to be accountable (Coombs, 2010).

With extreme weather events and disasters set to increase in a warming climate, more needs to be done to plan for and protect the most vulnerable in our societies. The International Day of PWDs reminds us of the importance of thinking outside the box while we work towards building more just, inclusive societies (Villeneuve, 2019). PWDs are a marginalized and neglected group that is five times

more likely to die in a disaster. Therefore, the consequences of disasters apply by large to PWDs and the entire system that supports their day to day living (Calgaro et al., 2020; Craig et al., 2019).

Factors contributing to vulnerability included personal factors (e.g., female gender, uncoupled or living alone, nonwhite ethnicity, and low income), environmental factors (commonly, limited practical support from government agencies and disability organizations), bodily impairments (cognitive impairments, hearing impairments, progression of impairments, relapse/exacerbation of symptoms, and thermo regulation difficulties), and activity limitations and participation restrictions (limited preparedness, difficulties with evacuation, and difficulties reassembling individual accommodations and repairing or replacing adaptive equipment) (Gaskin et al., 2017; Villeneuve, 2019).

A “toolkit for good practice” for PWDs identifies and categorizes some of the common difficulties the PWD community face during disaster and, most importantly, emergency situations. The challenges of evacuation are obvious from the high percentages of respondents who had a degree of difficulty hearing (39%), seeing (54%), walking or climbing steps (68%), and communicating (45%). The 22-question survey also highlighted that 71% of respondents had no personal preparedness plan for disasters. PWDs are especially at risk, resulting in a mortality rate two to four times higher than that of the non-disabled population in many disaster situations (Sagramola et al., 2016).

“It is a fundamental principle in the modern world that PWDs be given the opportunity to participate in modern society with as few impediments as possible” (Alexander, 2008). World Health Organisation (WHO) defines disability as context dependent, and no longer consider it just a health problem, but a complex interaction between features of person’s body and features on the society where he or she lives, covering wider context: 1) Impairments: a problem in a body structure; 2) Activity limitations: a difficulty encountered by an individual in executing task or action; 3) Participation restrictions: a problem experienced by an individual in involvement in life situations. World Report on Disabilities states that the prevalence of disability is 15% and is increasing due to a global increase in chronic health in overall ageing population. Asia Pacific region continues to be characterized by growth on one hand, but widening inequalities across PWDs (Stough, 2015; WHO & WB, 2011).

OBJECTIVES, METHOD AND APPROACH

Aims and Objectives

In general, Information and Communication Technology (ICT) is taking a bigger role in emergency management and are becoming increasingly important. The International Telecommunication Union (ITU, 2013) emphasized the need for inclusive emergency warning and disaster management systems using technology based on open, non-proprietary, global standards. It must be possible to inform the deaf, blind and illiterate and it should be possible to obtain information in one’s own language. For example, text-to-speech, text-to-sign language and talking books may be used. ICT enables content creation and delivery in multiple formats through multiple media. Public and private service providers

use multiple communication channels simultaneously to connect with consumers including SMS, voice, web service with multimedia, social media, and mobile apps (Deepti Samant Raja, 2016).

Crisis information services should be suitable for all, including the very young, aged and PWDs, visitors, foreigners and roamers (ITU, 2013). Digital technologies enable PWDs to receive information and content in the format that they can perceive and prefer. Moreover, digital technology presents an important opportunity to break the traditional barriers of communication and interaction that PWDs face and which hinder their full participation in society (Deepti Samant Raja, 2016). According to Mordini et al., (2018) assistive technology can be also categorized according to the two models integration and inclusion, which describe two different mechanisms of social assimilation.

To that end, the aim of the research is to identify the ICT best practices in crisis communication that will facilitate capacity for PWDs to effectively respond to crisis situations. Disability is not only a cause for safety in a crisis but also a disadvantage in post crisis (Stough & Kang, 2015). Within the confines of crisis communication, of particular interest to this study is assessing the organizational arrangements, content standards and interoperability, applications, and communications in support of preparedness, early warning, incident reporting, and relief and rehabilitation components of a typical disaster management cycle. These elements are instrumental to the early identification of the risk, initiating protocols for evading the risk, and riding out the displaced period until it is all clear to return to the regular routines.

Considering an inclusive crisis communication approach that would empower PWDs to prepare and respond, the objectives of the study are to:

1. Identify the necessary organizational arrangements and the required practices for facilitating robustness, self-organizing, and learning capacity of the end-to-end inclusive crisis communication elements, specifically for resilient building, early warning, incident reporting, and relief and rehabilitation.
2. Ascertain the necessary ICT best practices that are addressing the content standards and interoperability challenges specific to early warning, incident reporting, and relief and rehabilitation in support of inclusive disaster communication during crises
3. Define the necessary design parameters of ICT as assistive technology for informing researchers and practitioners by offering a comprehensive and inclusive approach to early warning, incident reporting, and relief and rehabilitation for managing crises of all forms and impact levels

Scope of the Study

The primary focus of the study was reviewing literature on PWD and DiDRR specifically involving Asian countries to find gaps in inclusive crisis communication. It is because the Asia Pacific region is facing complex disaster risks clustered around hotspots where fragile environments are converging with critical socio-economic vulnerabilities – hot spots are the trans-boundary river basins of South

and South-East Asia, Pacific Ring of Fire, and Pacific Small Islands Developing States (UNESCAP, 2019). In the Asian context 60% of the world's 650 Million PWDs live in South East Asia alone. Realizing this challenge, Craig et al., (2017) set out to redress the issue by strengthening the voices of PWDs in Southeast Asia, focusing on Thailand, Cambodia and the Philippines, and provide them with the institutional and social support needed to respond effectively to hazards and disasters and to be champions of resilience and change (Gartrell et al., 2017).

LIRNEasia & the Ford Foundation (2020) carried out research with PWDs and their use of assistive technologies in Myanmar. Lessons learned about accessibility challenges of ICT use by PWDs were transformed to policy and practical solutions to these problems – particular solutions enabled by Myanmar's rapid take-up of smartphones. LIRNEasia & Ford (2020) have conducted research, built capacity, and provided regulatory and policy recommendations in Nepal – including a nationally representative (quantitative) survey on PWDs explored their experiences and quantified PWDs by type of disability, barriers and other variables related to education, transport and livelihood.

The study learned from a qualitative research, carried out by VIHARA (2019), that assessed how ICT can enable independent living for PWDs in India. Included in the research conducted were speech and hearing impaired, visually impaired and mobility impaired segments. A complementary ICT and PWD study was the After Access research that revealed important findings from a stratified sample of PWDs in Sri Lanka (Hurulle et al., 2018; LIRNEasia & Ford, 2020).

Method and Approach

In the efforts in attaining the objectives, the method involved studying the reports from the Cambodia, India, Myanmar, Nepal, Philippines, Sri Lanka, and Thailand, to make the connection as to

- how PWDs perceive risk?
- how does that risk map to crisis situations arising from those risks?
- how information needs would map to their risk priorities?
- how adaptive capacity can lead to their safety in crisis situations?
- how ICTs would fulfill the PWD safety and foster adaptive capacity?

Additionally, the study explored other relevant literature all of which is discussed in the literature review. Thereafter, the method involved synthesizing the findings to **propose a conceptual architecture for ICT-enabled assistive technology in support PWDs facing crisis situations**.

LITERATURE REVIEW

Independent and Assistive Living

From the PWDs movement came “independent living”. The concept of “assisted living” applies to PWDs but it is mostly associated with catering to the elderly living in community-dwellings. There are no risk management related studies on independent living but a substantial number in assisted living; especially, with respect to elderly with mental and physical impairments. Independent living for PWD does not mean the same as living alone. Instead it means being empowered to take control over their day to day life activities – it means being able to live the way they chose and with people they chose and making choice about who helps you and the way they help. It is also a movement and an ideology for the political and social equal rights (VIHARA, 2019).

It is not possible to assess the risks to disabled persons or PWDs living independently without first knowing what resources are available to the person. For example, the temporary inability to prepare a meal may be compensated for by a resource such as a restaurant delivery service. The assessment of persons with disability and independent living skills and resources evaluates both personal skill and resource levels and defines risk as "the likelihood that an individual will be unable to accomplish a task given current levels of skill and resource". Gender is also linked to the perception of risk related to independent living among PWDs around crime rates (Craig et al., 2017; VIHARA, 2019).

PWDs who are extremely vulnerable are seen as weak, open to attack, or damage. Therefore, the idea of "vulnerability" undercuts the idea of independent living. Allowing a vulnerable person to control their own destiny is seen as risky. By that definition, anyone with home care or the assistance of a care giver is vulnerable. Their choices and participation are limited by other people's assessment of their capacity (Craig et al., 2017; Gartrell et al., 2017).

United Nations on Disabilities

The United Nations Disability Inclusion Strategy provides the foundation for sustainable and transformative progress on disability inclusion through all pillars of the work of the United Nations: peace and security, human rights, and development. The strategy enables the UN system to support the implementation of the Convention on the Rights of PWDs (CRPD) and other international human rights instruments, as well as the achievement of the Sustainable Development Goals, the Agenda for Humanity and the Sendai Framework for Disaster Risk Reduction.

CRPD Article 11[2] by its optional protocol resolution A/RES/61/106 was adopted on 13 December 2006 at the United Nations Headquarters in New York, and was opened for signature on 30 March 2007. The Convention’s stand-alone article on “situations of risk and humanitarian emergencies” - Article 11 – requires States Parties to take, in accordance with their obligations under international law, including

2 United Nations Treaty Collection CRPD New York, USA 13 December 2006 https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=IV-15&chapter=4&clang=_en

international humanitarian law and international human rights law, “all necessary measures to ensure the protection and safety of PWDs in situations of risk, including situations of armed conflict, humanitarian emergencies and the occurrence of natural disasters”. Among the set of countries that is discussed in this report: India, Cambodia, Nepal, Myanmar, Philippines, Sri Lanka, and Thailand; all but Myanmar (only ratified) have signed and ratified CRPD Article 11 – Australia too given that the report learned from some of the literature from Australian collaborators.

Sendai Framework for DRR

The Sendai Framework targets and indicators contribute to measuring disaster-related goals. Since the release of the Sendai Framework in 2015, recognition of DiDRR and action on the ground has expanded in South East Asia (Craig et al., 2019). Of particular interest is that the Sendai Framework, along with the Convention on the Rights of PWDs, recognize that inclusion and DiDRR is a human right and demands full integration; whereby it can no longer be treated as an “add on” to existing DRR approaches. The rationale of the DiDRR toolkit and best-practices, discussed by Sagramola et al. (2016) was to respond to the lack of data and rigorous research into disability and disasters and to build the capacity of DPOs to contribute to DRR practice and policy in line with the targets and indicators of the Sendai Framework for DRR.

The infusion of disability-related terms and concepts such as accessibility, inclusion, and universal design throughout the Sendai Framework for DRR document was significant. These concepts, which have their origin in disability studies, are used in the Sendai Framework for DRR document to refer to the needs of all in disaster, not only to PWDs. These disability-related concepts will now serve the field of DRR as important overarching disaster-related principles. One may safely conclude that the Sendai Framework for DRR has firmly established PWDs and their advocacy organizations as legitimate stakeholders and actors in the design and implementation of international DRR policies (Stough & Kang, 2015).

Sustainable Development Goals

In general, sustainable development discipline has a distinct focus for risk concept perspective of physical events and socio-economic factors that influence the vulnerability of humans (UNESCAP & UNISDR, 2012). Therefore, it was realized that there is an urgency to manage disaster risk with the overarching sustainable development framework. To that end, the 2015-2030 agenda for Sustainable Development Goals builds on the amalgamation of the predecessor Millennium Development Goals and the Hugo Framework of Action to establish the seventeen (17) priority areas of the 2015-2030 Sustainable Development Goals (SDGs).

Derived from the Rio+20 – “The Future We Want” – calls for “DRR and the building of resilience to disasters to be addressed with a renewed sense of urgency in the context of sustainable development and poverty eradication, and as appropriate, to be integrated into policies, plans, programmes and budgets at all levels and considered within relevant future frameworks” (UNESCAP & UNISDR, 2012). The Rio+20 also calls for the improvement of risk governance in the context of sustainable

development and the need to promote more integrated approaches to environmental, economic and social aspects of development for reducing disaster risks.

PWDs are included in SDG 4 – equitable and quality education, SDG 8 – good jobs and economic growth, SDG 10 – reduce inequality, SDG 11 – inclusive, safe, resilient, and sustainable cities and human settlements, and SDG 17 – strengthen and revitalize global partnerships. Reflecting on what is discussed in the SDG advocacy Toolkit: Disability Indicators (IDDC et al., 2015) of particular relevance and interest to DiDRR are also: SDG 1 – no poverty in all its forms everywhere, SDG 3 – good health and wellbeing, SDG 5 – gender equality, SDG 13 – take urgent action to combat climate issues, and SDG 16 – peace justice and strong institutions.

Disability is currently only included in indicators 1.3 poverty reduction -- 1.3.1 social protection and 11.2 accessible transport. SDG 1.5 - by 2030 build the resilience of the poor and those in vulnerable situations, and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters.

SDG 11 – make cities and human settlements inclusive, safe, resilient, and sustainable - Target 11.2 states that by 2030, nations should provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, PWDs and older persons.

Environmental dangers and natural disasters can lead to the onset of many types of disabilities, and inaccessible environments prevent PWD from taking part in economic and social activities. Human and environmental recovery is vital for the achievement of “ensuring environmental sustainability”. Embodied in other overarching strategies such as environmental protection and management or sustainable development cannot be achieved without the inclusion of all persons in society, including PWD.

Figure 2: UN Infographic on disability inclusive sustainable development goals (infographic source: Department of Economics and Social Welfare - 2017)

Target 11.5: By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations.

Climate Change

UN Environment Programme is working around the world to respond to and prepare for disasters and human-induced crises. UNEP emphasises on knowledge sharing to help communities find ways to mitigate environmental risks and address existing challenges. Despite existing evidence of their particular vulnerability, disabled populations are still largely neglected in climate and environmental change research. The disabled population needs to be considered and taken into this conversation around climate change and climate change risks (Kosanic et al., 2020).

In addition, according to the global survey conducted by the UN published on 10 October 2013 (Sagramola et al., 2016), the top five hazards or disaster risks faced by survey respondents were floods, 54%; extreme weather, 40%; tornados, 39%; drought, 37%; and earthquakes, 27%. Climate change-related beliefs, and risk perceptions, political orientations, and socio-economic characteristics. For marginalized populations such as PWDs, the climate discourses around adaptation, mitigation, vulnerability and resilience are of particular importance. Mordini et al., (2018) structure considers the silence around disabled people in these discourses.

Gaskin et al., (2017) conducted systematic review and identified factors associated with climate change vulnerability and adaptive capacity of people with disability – people with disability are vulnerable to climate change largely due to inequalities and their exclusion from adaptation and mitigation efforts. The adaptive capacity of people with disability can be gained through considering how they have fared during the types of events associated with climate change, such as droughts, floods, heat waves, hurricanes, and wildfires (Gaskin et al., 2017).

Factors relating to the adaptive capacity of PWDs included personal factors (e.g., formal education), environmental factors (practical support from mainstream organizations, disability organizations, family, and friends), and activities and participation (emergency planning, keeping an emergency pack, and seeking information).The background will introduce the reader to the concepts of risk assessment and the complexities that are inherent in that process, largely due to the cost of carrying out risk assessments, the multiple variations of risk perception and ways in managing each of those risks.

What is Risk?

Schneiderbauer and Ehrlich (2004) argue that the term ‘risk’ and ‘hazard’ are used interchangeably without realizing the actual definition and distinctions. Similarly, the distinction between risk and hazard are not evident in sign language; especially, when people adopt their own home sign languages that are different from the dominant spoken language (Calgaro et al., 2020; Calgaro &

Dominey-howes, 2012). There are people who are physically deaf but do not identify themselves with the Deaf Community (Craig et al., 2019). Linguistic problems may amplify confusion since there is no direct translation from the English word ‘hazard’ into for example French, German, Dutch or Italian, where the idea of hazard has to be circumscribed with expressions such as ‘risque’, ‘péril’, ‘Risiko’, ‘risico’ or ‘pericolo’. In technical definitions the terms ‘risk’ and ‘hazard’ are linked to each other but should be clearly distinguished.

The review of the disaster risk index, Ramli et al., (2019) describe ‘risk’ to be the probability of harmful consequence or expected losses arising from a hazard to a given element at danger. They describe a ‘hazard’ as a potential damaging physical or monetary event, which may cause loss of life, damage to property, social and economical disruptions or environmental degradation. EM-DAT[3] classifies hazards into two disaster groups termed as natural and technological disasters. Natural disasters arise from meteorological, hydrological, geophysical, biological, and climatological hazard events. Industrial, transportation, and miscellaneous accidents are grouped into Technological disasters; where a chemical hazard event would be considered a technological disaster. Saleh Safi et al., (2012) introduce Anthropogenic disasters that arise from human negligence of addressing climate change and their consequences; as well as terrorism and civil unrest attributed to human instigated hazard events.

The research carried out within the scope of the International Decade of Natural Disaster Reduction was the emphasis of the dependence of risk on three elements of hazard, vulnerability and exposure (Schneiderbauer & Ehrlich, 2004). As a critical vulnerability Alexander (2008) argue that disabled are likely to be poor and live in low-quality houses increasing their ‘exposure’ to hazards. Deaf girls, who are alone and unprotected by family are vulnerable and exposed to rape, physical abuse, and sexual assault (Handicap International, 2015; Villeneuve, 2019).

Economist associate a cost to monetize the risk, making risk be an augmentation of hazard, vulnerability, exposure, and cost. The cost are further emphasised into categories of human capital costs, ecological costs, disaster costs, socio-economic costs, consequential costs, damage costs, and so on (UNESCAP & UNISDR, 2012).

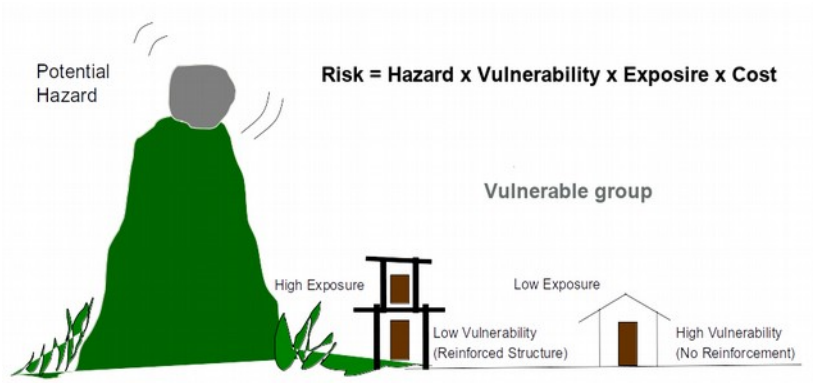

Figure 3: A perception of the relationship between risk, hazard, vulnerability, exposure, and cost

As shown in Figure 3, the appropriate way to consider risk is as a product of the compound factors involving hazard, vulnerability, exposure, and cost. When we calculate the overall risk, the rationale way to approach is

3 Centre for Research on Epidemiology of Disaster managed EM-DAT has documented approximately 63% of the global disasters: https://www.emdat.be/classification

to think through all possibilities and weigh them by how probable they are. If the odds add up to something worthwhile to us then it is a risk worth considering. It’s not always based on numbers, there is some emotional thinking that also helps with prioritizing the risk (Schrager, 2019).

Risk Perception

Vulnerability is not a significant determinant of risk perception (Saleh Safi et al., 2012). Furthermore, the orientation of political (conservative, liberal, marxists, or other), gender, and beliefs influences an individual's risk perception. Saleh Safi et al., (2012) also argue that those who acknowledge the anthropogenic causes of climate change perceive its risk as personally and socially more threatening than others. It is similar to how a blind person would perceive the risk illustrated in Figure 3; i.e. what does exposure mean to them. Personal experience of a natural hazard and trust—or lack of trust—in authorities and experts have the most substantial impact on risk perception (Wachinger et al., 2013).

Cultural and individual factors such as media coverage, age, gender, education, income, social status, and others do not play such an important role but act as mediators or amplifiers of the main causal connections between experience, trust, perception, and preparedness to take protective actions. From Wachinger et al., (2013) literature tells us that a risk perception paradox exists in that it is assumed that high risk perception will lead to personal preparedness and, in the next step, to risk mitigation behaviour. However, this is not necessarily true. In fact, the opposite can occur if individuals with high risk perception still choose not to personally prepare themselves in the face of a crisis situation.

Wachinger et al. (2013), in their research, identifies three findings that have implications for future risk governance and communication as well as for the willingness of individuals to invest in risk preparedness or risk mitigation actions. The three reasons related to the intervening variables are: (1) experience and motivation, (2) trust and responsibility, and (3) personal ability (economic and personal conditions); where the later two emphasising trust and personal ability are of utmost relevance to disabled people (Craig et al., 2019; VIHARA, 2019).

Risk Management

Inclusive Humanitarian Response

To better identify the changes needed for a disability- inclusive humanitarian response , a survey among PWDs, DPOs, and humanitarian actors contributed to the World Humanitarian Summit (Handicap International, 2015) – Half (54%) of the PWDs responded with that they experienced a new physical impact in a crisis. A similar proportion of them, 46%, required specific support services, such as social workers, interpreters, and nurses, who should be part of the rehabilitation or social protection staff in the response. A quarter (27%) were psychologically, physically, or sexually abused. Three quarter, 75%, of them fell through the crack during a crisis to receive basic assistance such as water, food, shelter, and health. For example, hearing-impaired people are not always able to access

emergency services, and hence, they do not have equal access to social support and infrastructure (Constantinou et al., 2017).

Handicap International (2015) reported main barriers preventing PWDs from obtaining aid in crisis contexts are linked to the lack of accessible information on those services and the difficulty in accessing the services themselves: lack of physical or financial access, lack of staff trained in disability, or distance from the services. As a result, 56% of humanitarian actors consider that improved coordination between mainstream actors, specialised actors, and DPOs should be a priority (Handicap International, 2015). For example, after Hurricane Katrina in 2005, Independent Living Centers and other disability organizations played a key role in rescue and evacuation efforts because they knew of PWDs in their communities and were able to provide that information to first responders (Samant Raja et al., 2013).

In a disaster disabled people may be more vulnerable to contracting infectious diseases because of underlying conditions, which often do not allow them to move and to independently access water and sanitation. For example, Hurricane Katrina was found to disproportionately impact 155,000 PWDs ranging from visual and physical impairments to learning disabilities. In devastating events like hurricanes, floods and cyclones, disabled people, because of limited mobility or impaired senses, might have difficulty evacuating.

Pathways for DiDRR

Disaggregation is important for the inclusion of excluded populations (Calgaro et al., 2020) . For example, an indicator that analyses the entire population can not monitor the progress of subpopulations. Consequently, subpopulations, such as PWDs, will be excluded from monitoring purposes and targets will not be realised for them. Disaggregation solves this problem and requires only a small additional reporting burden for Member States (UNESCAP, 2019).

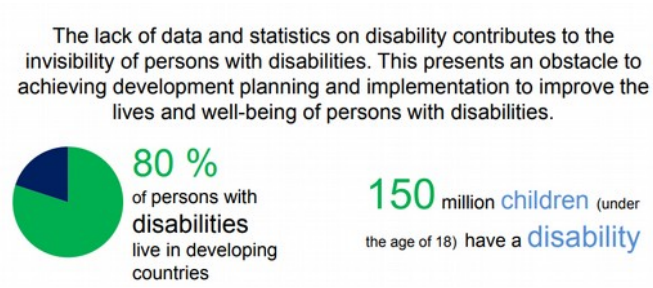

Figure 4: The invisibility of disability
(infographic source World Health Organization - 2015)

The “SDG Advocacy Toolkit” (IDDC et al., 2015) aligns SDG-17 that is indicative of the global commitment to DiDRR; thus, by realizing the percentage of countries with data for all disability related indicators and disability disaggregation of the SDG framework, in the last 5 years. Disaster planning related to people with intellectual disability needs to consider that (1) they experience disproportionate risk in disaster situations, (2) they are often excluded from relief processes and are disadvantaged in disaster support situations, (3) they may need specialized disability-related supports, (4) they often have needs for assistive technology and special rehabilitative services, (5) family and community networks are important supports in disaster situations, and (6) during recovery, rebuilding should be inclusive and include disability needs (Stough, 2015).

Calgaro et al., (2020) describe pathways for disability inclusion and greater disaster justice for PWDs in overcoming some of the barriers. They introduce seven pillars of action to improve DiDRR. From a systems approach, the seven pillars recommended are: 1) improve data and knowledge of PWDs; 2) stigmatization, discrimination, and marginalization, 3) improve access to infrastructure, and early warning; 4) increase access to social and human resources; 5) build capacity and increase awareness for disability support organizations and services, PWDs, and DRR actors, 6) support inclusive governance, and 7) promote shared learning around DiDRR via global and local stakeholders.

The Council of Europe released the toolkit 'Major Hazards and People with Disabilities' (Sagramola et al., 2016). The Toolkit presents a collection of good practices for public protection services with a twofold aim: involving PWDs in the disaster preparedness process and assisting them during disasters.

Risk Communication

A whole range of ICT exists to carry out risk communication – television, radio, fixed phones, mobile phones, text messaging and SMS, internet-based resources (email, instant messaging, video conferencing, image sharing), and satellite technology (Raja & Narasimhan, 2013; UNDSPD & UNDESA, n.d.; UNGA , 2013). However, disabled persons are excluded from the design and delivery of such emergency communication systems which is the fundamental issue forming the information asymmetries and accessibility issues (Calgaro et al., 2020; Craig et al., 2019; Gartrell et al., 2017; Stough, 2015; VIHARA, 2019).

Information Asymmetry

Asymmetry of information, in economics, is when one party in a transaction is better informed than the other. It is also understood as the participants do not have complete information about the situation (Vanek & Josef Botlik, 2013). Information barriers are the main reason for information asymmetry among PWDs – architectural (spatial) barriers (e.g. a person in a wheelchair reaching up to a touch screen bulletin board), economic barriers (e.g. cost of obtaining information), language when a user communicates in sign language, providing outdated information, knowledge caused by lack of information, communication for people with speech disorders, cultural (religious) difference in the perception. As a solution to overcoming the barriers Vanek & Josef Botlik (2013) suggest increasing the competency of market participants.

The report issued for the high level meeting on Disability and Development held by the UN ranks the importance of ICTs for inclusion of PWDs. The use of ICTs allow the removal of many of the remaining barriers faced by PWDs. With ICTs increasingly integrated into every aspect of the modern world, these ubiquitous technologies have become a positive force of transformation and a crucial element of any personal development/empowerment and institutional framework for inclusive development (UNGA, 2013).

ICT Accessibility

The ICT and disability report for Africa describes ways for making national information infrastructure inclusive of PWDs (UNDSPD & UNDESA, 2016). The basic principles of accessible interfaces are a disabled person must perceive it, understand it, and be able to operate it. The report further discusses key intervention areas with respect to mobile phones, television, internet, and e-publishing. Furthermore, there is potential for intervention areas in handset, software, services, and content accessibility for mobile phones. Television already employees tele-tex, sign language windows, caption subtitles, and audio descriptions.

The UNGA (2013) expert assessment of the contribution of ICTs (websites, mobile phones, television, radio, and other emerging technology) to improve PWDs' access to social and economic activities show that it helps to 'some extent'. The extent of the ICT impact is on healthcare, education, employment, independent living, government services, and participation in political and public life. The services and content are made accessible through mobile phone, computer-based and web-based accessibility applications such as screen readers, speech recognition, video communication (for sign language communication and video relay interpretation), voice to text services (open and closed captioning, both real-time and embedded) and visual assistance.

Owning a mobile phone increases independent living (UNGA, 2013). Mobile phones have proven the ability and trend for creating customized assistive technologies - "It appears relatively easy to develop such an app[4]". The survey conducted by (Galpaya, 2018) in Sri Lanka, shows only 37% of the households with PWDs to own a mobile phone and only 15% of the PWDs to have used a public phone in the past 3 months. Lack of digital skills, unawareness of the internet and low uptake of assistive technology features are also emphasised in the report by Galpaya (2018). Nevertheless, of those who use smartphones, social media applications are the most popular; especially, those that offer a multitude of modes like instant messaging and video conferencing.

Mainstream and older radio and television services enable social inclusion of PWDs. Digital television amplifies the range of features and functions for the disabled. The world wide web consortium emphasises on making it accessible[5] by adhering to the 'web content accessibility guidelines' because it is critical for PWDs. Digital accessible information system (Daisy), International Digital Publishing Forum allows publishers use EPUB (or e-Publication) an extension of XML format, and the Portable Document Format (PDF) with Adobe Acrobat 9 pro saves fully accessible documents (UNDSPD & UNDESA, 2016). In this context ensuring accessible ICTs for PWDs and expanding access to these technologies, as well as to assistive technologies, should become a key element of global, regional and national strategies to remove the remaining barriers faced by PWDs (UNGA, 2013).

4 LIRNEasia Nepal workshop report: https://lirneasia.net/2018/03/reflections-disability-workshop-kathmandu/
5 Web content accessibility guidelines: https://www.w3.org/WAI/

SYNTHESIS OF LITERATURE

Three Key Problems

Synthesis of the literature identifies three key problems that are relevant to the scope of crisis, disaster, emergencies, and inclusiveness of PWDs for leaving no one behind:

1) Stigmatization and being excluded from DiDRR planning and services
2) Limited or no access to DiDRR knowledge and learning togetherness
3) Gap in DiDRR tools and interoperable platforms to foster situational awareness

Problem 1: Stigmatization and exclusion from DiDRR services

Natural disasters and environmental shocks can have substantial impact on health, including deaths, injuries, diseases, disabilities, psychosocial problems and other indirect effects with damage to facilities and disruption to the delivery of services over extended periods of time. Vulnerabilities arising from stigmatization and being marginalized from access to DiDRR services is a friction that must be first overcome.

The goal of integration is uniformity. Inclusion means a process in which individual diversity is protected and preserved. The goal of inclusion is parity. In the last decades, most representatives of PWDs have advocated an approach to disability based on the notion of “disabled identity”, which means considering disabilities as biological variations not to be treated but to be socially included. This is mirrored by a corresponding trend towards inclusive technology, which emerges from the study by Mordini et al., (2018).

Since the release of the Sendai Framework in 2015, recognition of DiDRR and action on the ground has expanded in South East Asia. However, the lack of data and limited research on disability and disasters, including DiDRR needs, challenges, and existing best practices continues to hinder inclusionary DRR (Craig et al., 2019).

Problem 2: Limited access to DiDRR knowledge

Disasters and emergencies disproportionally affect disabled people because of their inherent vulnerabilities and limited access to knowledge and lack DiDRR knowledge for emergency services to assist PWDs in crises. Therefore, it is to assume that PWD will need to assist themselves or need to be assisted by a trusted party such as family member or trusted non-family member (e.g. neighbour or emergency services).

The UN flagship report on disability and development shows that disabled people, and in particular disabled youth, are lagging behind the normal in access to undergraduate education. When you have more knowledge you more easily make decisions. And in such extreme events, if you have good knowledge you have a better chance to survive. Many of the problems faced by the disabled involve

functioning outside the familiar surroundings of the home. For example, persons who are blind have difficulty in finding out the destination or route of a particular bus stop.

Problem 3: Absence of *DiDRR situational awareness platforms and tools*

There is a substantial gap in DiDRR platforms and tools (application services) for PWD, DPO, and Emergency Services in managing crises that are of high frequency but low impacting (regular events that effect the daily living), let alone managing low frequency high impacting crises (e.g. fire emergency or earthquake disasters) in life.

Crisis situations have direct and indirect impacts on the people they affect, ranging from small inconveniences and disruptions to daily life to life threatening conditions, loss of life, death or displacement of loved ones, damage to property, loss of livelihoods, migration and displacement, and large scale destruction of entire communities. The whole question of how to assist PWDs in emergencies, let alone how they might help themselves, each other, and assist planners, has been roundly overlooked.

A WAY FORWARD

Crises (or shocks) are experienced at the individual level but they can encompass the whole household (Craig et al., 2017; Gallipoli & Turner, 2011). Some crises arise from those risks with peculiar unexpected shocks or incidents. On the other extreme are catastrophic crises that pose a risk to many people, the build environment, and functional systems, which feels like the entire world around you is collapsing. Risks that effect everything and everyone, such as a cyclone, are dangerous because it can bring injury and death to individuals and cripple the entire community's lifelines such as their agriculture systems (farm land, irrigation systems, and transportation systems).

Derived from the theory and practices in the finance sector, insurance schemes are one of the oldest and simplest strategies but it is often neglected (Daniell et al., 2018; Schrager, 2019). Financial insurance schemes can safeguard against and remove individualist and peculiar risk, such as removing the financial burden of repairing a car after an accident. However, it does not help with removing risks to safeguarding one's life or evading a life threatening situation that might be posed by small or large scale crises situations.

Insurance does not necessarily have to be interpreted in the form of a financial insurance plan. An ICT instrument, such as a mobile phone, serving as an assistive technology in the time of a crisis is also offering a form of insurance. Insuring one's risks with a mobile phone is complementing and ensuring modes of communication during crises to ask for assistance. To that end, the solution discussed anchors on an important crisis communication theory; namely, "situational awareness". The reason to consider this concept around situational awareness is because it is important to:

1) foster adaptive capacity for all the PWDs and their variants of disabilities, as well as including the dependent DPOs, caregivers, and community, to be safe in crisis situations

2) enhance daily use ICT-enabled assistive technology that are always on and ready to use, such as mobile phone, to be also useful in the time of crises imposing varied situations
3) customize in ways which PWDs perceive the world, comprehend the situation relating to the risk, projecting the consequences and making appropriate decisions to exercise actions (or inactions) to adapt to the shock

Safety-II, a holistic approach

A white paper by Professors Erik Hollnagel, Robert L Wears and Jeffrey Braithwaite redefined the way we see safety (Hollnagel et al., 2015b). Most people think of safety as the absence of accidents and incidents (or as an acceptable level of risk). In this perspective, Safety-I is defined as the state where as few things go wrong. 'Safety-I' runs *risk assessments* to identifiable failures or potential malfunctions of specific components: technology, procedures, the human workers and the organisations in which they are interlinked. The complexities and multitude of variations arising from how PWDs perceive risk. Moreover, risk assessments can be laborious and incomplete in covering every possible risk factor.

The contrasting 'Safety-II' concept argues that we should stop focusing only on how to stop things from going wrong but emphasize on why things go right instead. Safety-II complements "antifragitlity" by addressing the volatility in the risk and learning to bounce forward. Thus, Safety-II relates to the system's ability to succeed under varying conditions of the environment and the conditions. Safety-II approach assumes that everyday performance variability provides the adaptations that are needed to respond to varying conditions, and hence is the reason why things go right (Hollnagel, 2015). With this kind of thinking, the 'Safety-II' perspective acts as an evolutionary complement of the conventional Safety-I thinking.

In the perspective of Safety-II, humans—acting alone or collectively—are therefore viewed predominantly as a liability or hazard, principally because they are the most variable of these components (Lundberg, 2015). Humans are consequently seen as a resource necessary for system flexibility and resilience. In this respect, a starting point for DiDRR actors interested in Safety-II is to emphasize on enhancing their adaptive capacity, as the ability to monitor things and handle situations.

Safety-II resonates the Philippine, Governor Joey Sarte Salceda of Albay Province, adopted a pragmatic approach to championing disaster resilience for reducing risks of disasters for his community. The governor noted that "people have the basic right to the capacity to adapt; relief, recovery and rehabilitation are essentially compensation [penalty] of the State for failing to reduce exposure and to increase capacity (UNESCAP & UNISDR, 2012).

Designers and Implementers of systems in support of the safety of PWD in every aspect, whether be a small shock to a large crisis, are encouraged to consider the Safety-II perspective as it supports improving adaptive capacity. If we can introduce this characteristic into PWDs by enriching their situational awareness capacity then society will see them as a resource as well. Therefore, public

safety and crisis response management should move from ensuring that 'as few things as possible go wrong' to ensuring that 'as many things as possible go right'. An important way of achieving Safety-II for improving adaptive capacity is through enriched situational awareness. The general safety management principle is to facilitate everyday work, to anticipate developments and events, and to maintain the adaptive capacity to respond effectively to the inevitable surprises (Hollnagel, 2015). Threse principles also apply to public safety principles of monitoring and comprehending the situations and being informed to make appropriate decisions to effectively respond to crises.

Situational Awareness

Situational awareness is important in our day to day life activities and also in crises such as emergencies and disasters. Situational awareness is essential in a crisis situation, for the general public affected by the emergency as well as for first responders and crisis response managers. Having been successful in being applied to other high dynamic systems as well as its ability to separate the process of situational awareness from the product, Endsley's three-level framework of situational awareness (Figure 5) is best suited for applications designed for crisis communication – including perception of the elements in the environment and comprehension of how those elements relate to each other and then being able to make decision on the appropriate action or inaction (Hunter et al., 2020).

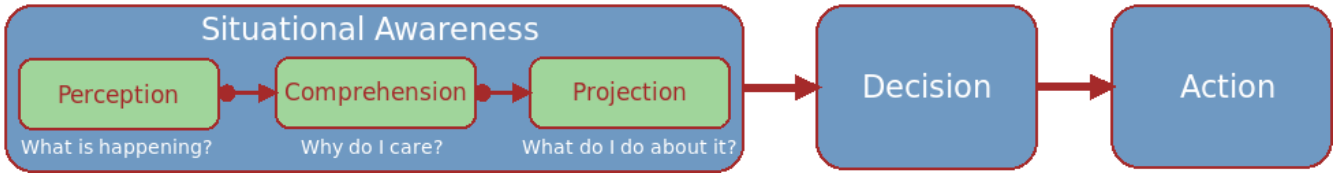

Figure 5: Endsley's three-level framework of situational awareness

What is situational awareness?

Situational awareness is the state of understanding the "big picture" in time- and safety-critical situations. It is time-dependent and gives an aggregate understanding, recommended action and immediacy of an underlying crisis scenario (Landgren, 2007). The more situational awareness people have, the better equipped they are to make informed decisions - it is a state of knowing what is happening in your immediate environment and understanding what that information means for a particular situation. Situational awareness is developed on an individual level and on a team level to comprehend a crisis situation. Poor situational awareness has been considered as important factor that lead into poor individual and team situational awareness (Hunter et al., 2020) such as failure to detect critical cues regarding the state of the crisis; or failure to interpret the meaning of information from monitoring technology; and ultimately making the wrong decision based on incomplete or distorted information.

The situational awareness theoretical framework adopts the holistic approach to situational awareness described by Lundberg (2015); whereby, he argues that situational awareness state, system, and process descriptions of situational awareness are interdependent. The states emerge from processes of exploring or analysing the situations situational awareness systems. Reflecting research on Safety-II, in describing situational awareness states, the framework distinguishes frames that situations are considered from implications regarding the situations of objects on and of a crisis event horizon (awareness of plans and events in time and space).

Making sense of a Situation

The transient nature of situational awareness emphasises processes of awareness of how the moment-to-moment perception and comprehension of the crisis situation is achieved and refreshed. It is indicative of particular crisis situation that is about to occur, it is ongoing, or the situation is all clear. Central to situational awareness is gaining deep insights of what crisis situation has occurred and how to make sense of it; also referred to as the 'mental model'. The idea of a "situation" presents the contents of situational awareness states, focuses on situational awareness as the set of information pieces that satisfy decision-making in the midst of ongoing dynamic uncertain processes. Decision-making is based on the interpretation of the implications with a reference to specific actions in time and space within a crisis event horizon (i.e. awareness of events, plans and actions relative to time and space).

Sensemaking is one way that situations are recognised and constructed; namely, the process of fitting information into a frame, and fitting a frame around the information" (Klein et al., 2010; Villeneuve, 2019). Three activities are central for making sense of a crisis situation: 1) comparing the different ideas about what is going on or about creating new ideas to address the crisis situation, 2) filling them in and gathering more details and following up information that becomes relevant to this current frame of the crisis situation (it is also about rejecting information that do not fit in), and 3) raising doubt about the current understanding through anomalies, inconsistencies, and issues related to the crisis situation (Villeneuve, 2019; Weick et al., 2005).

It is necessary to frame the situation as a story or script which is dependent on the perspective taken by the person with disabilities. For a person with disabilities, focusing on situational awareness, the environment may be seen as everything outside of the individual. Taking a systems view (e.g. a system consisting a team of humans and collection of assistive technologies), the environment is instead what is outside of that system. When framing a situation there is a problem of requisite imagination (i.e. ability to imagine key aspects of the future) that must be consider before it has occurred at all. More connected to sensemaking of immediate events is the problem of requisite interpretation (i.e. take in that an on-going situation is actually occurring despite it being inconvenient or unusual).

People can perform well with low situational awareness. However, as uncertainty increases, so does the requirement to generate and maintain situational awareness. Sometimes, people evaluate situations based on recognition of similarities to previous situations, and that people evaluate ideas

serially, using the first idea that suffices. Typicality of situations is matched based on four main facets: cues (used to recognize situations), expectancies (temporal dimension of what to expect of an event), goals and typical actions (Klein et al., 2010).

Team, Shared, and Task Situational Awareness

A *team* , with respect to PWDs in crisis management will be all of them: caregiver, family members, community, DPO, and emergency services, who interact dynamically, interdependently and adaptively toward a common and valued goal, objective, and mission in managing a crisis situation. They all have assigned specific roles or functions to perform. *Team situational awareness* is the degree to which every team member must possesses the situational awareness required for his or her responsibilities (Hunter et al., 2020). The success or failure of a team depends on the success or failure of each of its team members. If any one of the team members has poor situational awareness, it can lead to a critical error in performance that can undermine the success of the entire team. By this definition, each team member needs to have a high level of situational awareness on those factors that are relevant for his or her activities. It is not sufficient for one member of the team to be aware of critical information if the team member who needs that information is not aware (Landgren, 2007).

Both, Kurapati et al. (2013) and Lundberg (2015) emphasise that situation awareness of the team as a whole, therefore, is dependent upon both (1) a high level of situational awareness among individual team members for the aspects of the situation necessary for their crisis response operations; and (2) a high level of shared situational awareness between team members, providing an accurate common operating picture of those aspects of the situation common to the needs of each member. They also describe a model of team situation awareness as a means of conceptualizing how teams develop high levels of *shared situational awareness* across members. For such requirements, devices, mechanisms and processes act to help build team and shared situational awareness. *Task situational awareness* is associated with the information relating to the tasks different members of the team must have to perform for managing the crisis (Matheus et al., 2003).

Design considerations

Situational awareness is important because it informs about the relations among the objects in a frame that is relevant to the current crisis situation and the crisis management operation (Matheus et al., 2003; Vieweg, 2012). The consequence of not paying attention to situational awareness means that when we lose insights and we increase the potential for human error and mishaps. Finding the best combination of situational awareness applications is the holy grail for emergency services. If we pick situational awareness applications that complement each other, risk would be reduced, and, on average, we would get the same, or better safety outcomes.

Sigmund Freud divided human consciousness into three levels of awareness; namely, preconsciousness, consciousness, and unconsciousness. Further to in crises, it is perceived that people typically operate on five distinct levels of awareness: turn out (or ignore), relaxed awareness (irrelevant but be vigilant), focused awareness (pay attention), high alert (give utmost attention), and

severely disillusioned (in a state of shock). This is an important consideration when developing the transient frames of situational awareness and presenting their states as to neither overwhelm nor be ill-informed and to offer appropriate amounts of insights and instructions to avoid potential errors but, yet, achieve the desired safety outcomes.

It is important that situational awareness platforms integrate daily use technologies that PWDs are comfortable and familiar using; most of which are discussed by Deepti Samant Raja (2016) in their article on “bridging the disability divide through digital technologies”. *There is a visible disconnect between what we know ICT can achieve for PWDs and real life examples of widespread adoption and delivery of accessible ICT*. Therefore, the daily use technologies must be identified through the community of practice mobilized technology development processes. Thereafter, develop a platform for integrating those tools that form their digital habitat, situational awareness tools, and the learning together basing inclusive crisis communication as the practice and domain. Subsequently, extend that platform for providing situational awareness information for all shapes and forms of crisis situations.

The everyday common-sense observation that a loss of “the picture”, a loss of orientation toward ongoing events, sometimes causes accidents or other undesirable events (Lundberg, 2015). Central to the notion of situational awareness is that humans need to be aware of certain aspects of the world – at specific moments in time, to make critical decisions. Situational awareness becomes important when it is critical that this awareness contains the right aspects, at the right time, to cope with real-time systems. It is thus anchored in the present, when decisions and actions can be made, but can be oriented toward the past or the future.

To prepare for shocks, PWDs must assume to be surprised. Given this reality, one must assess the main assets necessary protect oneself, their dependents (caregiver, DPOs, community, and emergency services), and their lifelines. It is situational awareness technology designed for visibility or cognition that will help understand the surprises, shocks, and the changing situation of the environment, so the technology can be employed to quickly and effectively protect oneself, the dependents, and lifelines. Intuitively, when a person with disabilities is more aware of the situation and gain higher visibility for an enhanced perspective, then they are offered equally or more enhanced comprehension, which can transform into protective actions. The technology must enhance visibility that can help the person block more threats, accelerate detection, mitigate impact, and remediate (or get back on the feet) faster.

The situational awareness tools and platforms must suggest the best protective action to take—i.e. who to call, what to prepare, when to shelter in place, when to evacuate, and where to evacuate. Important challenges faced by people who are disabled during everyday dyadic and group social interactions and correlate them to the challenges faced by participants in remote interactions. A case study of visually impaired individuals, demonstrated how assistive technologies developed for social assistance of people who are disabled can help with increasing the social situational awareness, and hence social presence, of remote interaction partners (Krishna et al., 2010).

There are concerns on how to describe the contents of situational awareness and what contents to describe, in specific domains; it is particularly lacking in DiDRR. In the context of crises, PWDs need to be involved in all phases of situational awareness technology development. This begins with designing the technology by communicating their stories, needs, and technology acceptance. The UN-sponsored response to the Japanese earthquake identified three core indicators of whether disability perspectives were integrated into designs, such as: Were PWDs involved in the risk-reduction plans? Does training for service personnel incorporate disability considerations? What proportion of emergency shelters and sites are accessible?

Universal Design concerns the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design. A prerequisite for Universal Design is accessibility. According to WAI/W3C, for the web, accessibility means that PWDs can perceive, understand, navigate, and interact with websites and tools, and that they can contribute equally without barriers (European Agency, 2013; UNDSPD & UNDESA, 2016). Since disaster and emergency management is a “public good”, E-Gov has a duty to provide fair and usable information access for those with disabilities. However, the delineation between where this responsibility lies becomes blurred when third party platforms like social media are utilized in E-Gov services – extent to which social media pervades government sites and causes accessibility issues is one that is not well understood (Sonnenberg, 2020). Organization for the Advancement of Structure Information Standards is working towards ensure that OpenDocument schema allows to store the information that is required by applications aimed at allowing people with disabilities to access properly the content of OpenDocument documents[6].

In other words, the design considerations must ensure accessibility and usability for the broadest possible diversity of users. Universal Design is said to be “Necessary for Some and Good for Everyone”. Gjøsæter et al. (2019) explain universally designed solutions that are absolutely necessary for some people, can also be very useful for others in certain situations or contexts. For example, subtitles on video is not only useful for people with a hearing impairment or an ear infection, but also for commuters watching the video on the bus with lots of traffic noise and other auditory disturbances. Such situations can be thought of as temporary or Situational Disabilities (Gjøsæter et al., 2019). In crises situational disability can be seen among anyone who is disillusioned, including those who are low-illiterate or functionally illiterate refugees in a foreign land. In such cases pictographs for sharing risks and crisis situations with situationally disabled persons and also providing pictograph-enabled tools for the situationally disabled to communicate with crisis response agencies have been shown to be effective (Frommberger & Waidyanatha, 2017; Hurulle et al., 2018)

6 OASIS Technical Subcommittee of open document accessibility is discovering potential accessibility issues and to improve the usability and functionality of creating, reading, and editing office documents for people with disabilities. https://www.oasis-open.org/committees/tc_home.php?wg_abbrev=office-accessibility

Community of Practice

Why a Community of Practice approach?

“Technology has enabled communities to form and to interact in new ways, it’s just as much the case that communities have played a critical role” (Wenger et al., 2009a). The Cathedral and the Bazaar, Eric Raymond observes that, “The best hacks start out as personal solutions to the author’s every day problems and spreads because the problem turns out to be typical for a large class of users.” The PWD and DPOs are encouraged to consider a Bazaar and Community of Practice approach to innovating situational awareness applications in support of DiDRR.

Several studies show us that including the needs and voices of PWDs at all stages of the disaster management process, and especially during planning and preparedness, can significantly reduce their vulnerability and increase the effectiveness of Government response and recovery efforts. However, despite an increasing worldwide focus on DRR as opposed to mere crisis response, most city and related Government agencies fail to adequately plan for – or include – PWDs in their disaster management activities. This causes severe inequities in access to immediate response, as well as long-term recovery resources for people who have disabilities prior to the disaster and those who acquire a disability as a result of the disaster (e.g. a bomb blast that makes you deaf).

There is growing evidence that reducing disaster risk is a cost-effective investment in preventing casualties, physical damage, and economic losses. This process includes the necessity of providing universal accessibility for PWDs and involving them in emergency response and DiDRR (Sagramola et al., 2016). National and local government entities, private and public sectors and individuals have found that including PWDs has enhanced their capacities in these tasks in many places, with immense pay-offs. However, DiDRR and disability actors tend to work in silos, creating a critical gap in knowledge and skills between the two communities – PWDs and their support DPOs on one side and DRR specialists and government on the other further stagnates progress.

Such barriers of silos can be broken to support an inclusive approach by exercising technology stewardship and a community of practice method that includes all DiDRR stakeholders in learning together to harmonize on the inclusive crisis management and situational awareness communication policies and procedures. Implementation of such socio-technical challenges can only be approached through a community of practice. Experience tells us that peer learning works; especially, when it crosses either geographical or subject boundaries, it can become even more stimulating and engaging. Therefore, for national stakeholders, the best venues for inspirational and impactful learning are regional (UNESCAP & UNISDR, 2012).

The fundamental problem is there is no opportunity for “learning together” in the disaster management planning, implementation, evaluation, and re-planning process. Communities of practice offer a useful perspective on technology because they are not defined by place or by personal characteristics, but by people’s potential to learn together and also the integral part of a community of practice. Since

2001, technology inclusive communities of practice have proliferated and has rapidly spread in digital habitats – where community and technology intersect.

Learning together

Learning together forms a valuable perspective on the communal aspects of technology and implies that technology will foster engagement with the learning partners in a meaningful way; thus forming a "learning friendship" and participation in the community of practice. Learning can be formal or informal. A formal activity might involve a survey of a proportionate sample of d/Deaf[7] people to understand their preferred modes of communication for being informed of a flash flood warning to immediately evacuate (Frommberger & Waidyanatha, 2017). Informal learning can be day-to-day experiences, where the community would learn from each other through question and answer or discussion of current events and hot topics. These can be peer-to-peer, group discussions, and open forums.

PWD and DPO community members are scattered and live all over an area. They are of different ages and come from different walks of live. Therefore, disagreements will crop up but keep in mind disagreements are an essential ingredient of collective learning. There are three fundamental dimensions of a community of practice; namely, the crisis management domain, situational awareness practice, and DiDRR community. The learning connection is just as salient as a process of community building. The first step is opening a space for exploring a specific DiDRR of inquiry. If necessary the community may choose to split the DiDRR and its identity to remove controversies as well as giving it an insider or outsider perspective.

The practice includes all the activities and techniques to avail situational awareness for coping with risks. In the presence of life-threatening – not just physical but also economical – instances the PWD must have a crisis coping mechanism. Therefore, PWDs can be truly called practitioners in the sense of sharing a practice because they see things directly as through a practitioners eye.

Tech stewards and Agents of Change

It is necessary to finds a balance between the stakeholders who bring the community and the practice together through contribution of resources, community members who will be the primary beneficiaries, the technology the community members will and, most important, the Technology Stewards (tech stewards) who are integrated into the community but not necessarily is a PWD. Agents of Change, on the other hand, are community members who inherit a disability themselves. The distinction is that they are proactive in carrying out relevant research, development, and policy advocacy to facilitate technology adoption (Craig et al., 2019). Their status as a researcher may disrupt the peer-to-peer dynamics of the community. However, their integration into the community in exercising the pivotal sociotechnical role is in enhancing "accessibility" to technology for PWDs.

7 The difference between 'deaf' and 'Deaf' – deaf (lower case) refers to an audiological impairment: someone who cannot hear is deaf; but someone who is Deaf (upper case) is a member of the deaf community and an active participant in deaf culture such as those who have been deaf their entire life and sign language is the first language they learn.

Stewarding technology, in support of situational awareness for DiDRR and PWD inclusive crisis management, should be treated as a team sport for two reasons: first, it helps to have a group within a community share the work – or at least share in the understanding of the role, and second, it helps to connect with other tech stewards and agents of change (from whatever community) who can provide a larger context, offer support, share ideas, tips, and innovation, and help in pressuring a tool developer to address the community needs. Generally, a person would take on the tech steward or agent of change role for different reasons that go from personal interest to curiosity to generosity or because they were pushed into it as a result of their previous experience with technology.

The tech steward or agent of change attend to what happens spontaneously and what can happen purposefully, by plan and cultivation of insights into what actually works. “Stewarding becomes a very creative practice that evolves along with the community and reflects the community’s self-design – the process by which a *community design* itself as a vehicle for learning with the use of technology” (Wenger et al., 2009a). What distinguishes a community tech steward from other technologists is placing the community perspective at the core of technology-related challenges. Similarly, what distinguishes an agent of change from another researcher, developer, or policy steward is paying attention to how technology is used to achieve community ends. The role of stewarding, in both roles, typically includes selecting and configuring technology, in this case for DiDRR and PWD inclusive situational awareness.

“SAHANA” SITUATIONAL AWARENESS PLATFORM

We present the Sahana risk and emergency management (or DRR) platform as a use case for what is considered as a community of practice and a community that offers tools with a focus on crisis management. The Sahana community engage in learning together and developing software whereby the crisis management researchers and practitioner along with software engineers offer an innovation platform for operationalizing resilience, humanitarian, and emergency management solutions. Sahana has positioned itself as the *premier innovation platform and enabler for comprehensive risk emergency management software* because it inherits many unique and useful domain characteristics.

Following the practice of a Bazaar model, the Sahana innovation platform creates environments for code and content producers to develop applications and software to their own specific needs and wants. The know-how and software libraries are freely and publicly available. Particularly the software libraries are protected under the MIT License to ensure that no one can take ownership to refuse access to the free and open source software. The Sahana movement is a globally scattered volunteer community of academics, students, public safety officials, researchers, policy entrepreneurs, commercial service providers, a membership, and set of board members.

In the emerging ICT ecosystem, Sahana falls strictly within software applications services; while the entire emergency communication ecosystem comprises of communications networks, Internet of Things (IoT), cloud computing, big data analytics, Unmanned Arial Vehicles (UAV or Drones) and Artificial Intelligence (AI). Sahana platform, as a software application and service, integrates with all

other technologies influencing the ICT ecosystem. For example, the ability to provide structured and unstructured data in support of AI for Good. Connecting with 3GPP networks for complementing “cell broadcast” one-to-many warnings, managing drone image streams, providing analytics on climate sensor data and so on. Inevitably improving productivity Sahana encourages growing data into digital intelligence because that is an important key to effective crisis response and management.

Sahana Community of Practice

The digital habitat that has emerged within the community adopts email as the main mode of communication. Email is where users, developers, technology stewards, domain experts, and lurkers interact in discussing and exchanging ideas about various crisis management solutions. The asynchronous mode allows everyone from different time zones to participate in the email conversations. Slack is used for instant messaging, document sharing, and task management. Loomio offers participation in consensus and decision-making with voting and re-voting processes in achieving the desired outcomes. A community managed Wiki offers insights of the Sahana platform features and functions, instructions for installing and experimentation, forking one’s own Github instance to modify and customize the code, guidelines for contributing code to the greater good of all. The Sahana website serves as a gateway to access all of the afore mentioned resources in the digital habitat; including access to the Sahana Software Foundation by-laws and norms that govern the community.

Among the community are Sahana Service Providers who offer commercial services to assist organizations and users to cost-effectively customize and implement Sahana solutions. Although Tech stewards or other associates of the users may choose to manage and maintain their Sahana implementations, the Service Providers are able to provide the same sometimes termed as Software as a Service (SaaS) or simply assisting with coding and customization. This removes the burden on the users from managing the human resources and data centre infrastructure for hosting their Sahana software services. The IFRC regional office in Malaysia has been working with AidIQ, one of the Sahana Service Providers, since 2010 on the IFRC Resource Management System (RMS) system. What began in Asia has scaled into Red Cross societies in the African continent as well. Essentially, AidIQ supports IFRC with the national society customizations, training, and support services. There are regional RMS hubs established in Malaysia, Nigeria, and there is work being done in establishing a regional RMS hub in Fiji. Spot On Solutions, a counterpart commercial service provider has lead the design, research, development, implementation, and evaluation of the Sahana Alerting and Messaging Broker (SAMBRO), with implementations in India, Malaysia, Maldives, Myanmar, Nepal, Sri Lanka, and Philippines .

The implementation model of volunteer assisted self implementations and service provider assisted commercial implementation build on the concept of “if you have the time and no resources to invest, then simply follow the Wiki instructions ask the for guidance over email from volunteers to do it yourself; but if you don’t have the time and patience, then hire a service provider to do the job for you at a fee”. The advantage of encouraging service providers is that in this model where by Sahana volunteers can also serve as service providers, play a key role in sustaining the community with

driving the open source software initiative. For example, the service providers actively maintain the code-base on Github and also reviewing code contributions to ensure they meet the Sahana coding standards. Noticeably the members belonging to the service provider outfits are incentivized to offer free assistance over the email and slack channels to those who require a little bit of a nudge to overcome their Sahana platform implementation and customization requirements. The analogy is the Linux Foundation offers free and open source operating systems where as Red Hat Linux is a commercial service provider that assists users with the adoption and upkeep of the free to use software.

Heterogeneous groups with varied expectations and capacities to invest in crisis management approach the Sahana community for assistance. Most common are in the form of emergency deployments that typically follow immediately after a major disaster. Most recently there were several groups who made use of the public health crisis management modules, such as disease tracking, logistics, and request management, were deployed to assist COVID-19[8] outbreak in several parts of the world. Academics introduce the Sahana software to their students and use it to generate various projects with contributions that are relevant to the Sahana platform – simple as modifying a piece of code with enhanced functionality, to testing and critiquing a module or feature, or adding and editing the wiki knowledge-based. International organizations have teamed up with Governments and Non-governmental organizations to supply solution they desire to meet their risk and emergency management information needs.

Universal Design of Situational Awareness Platform

The universal design, in this case, takes a technology neutral and open source approach to offering a free to use and integrated situational awareness platform. For example, Sahana solutions can run on Windows and Linux operating systems. It works on a stand-alone laptop or a cloud server, depending on what the user wants to achieve and how the system is shared among user groups. The Sahana Mobile platform is optimized to work with browsers, which again does not restrict the user to whether their mobile device is Android or Apple (iOS). The technology independent platform extends to all crisis

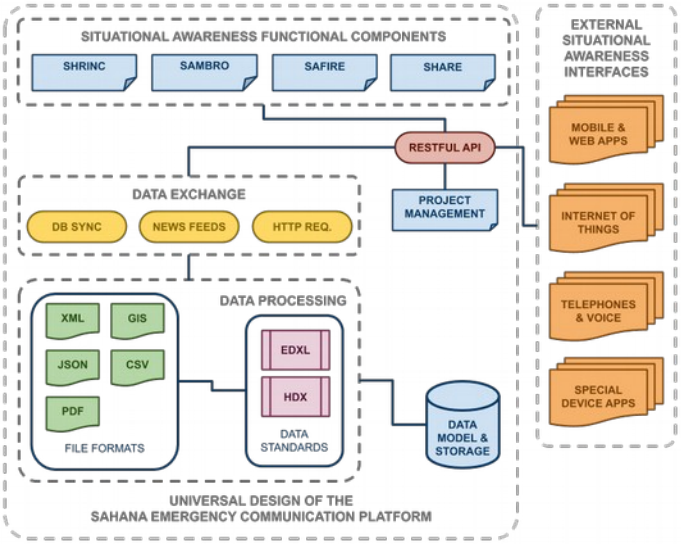

Figure 6: Components of a Sahana Situational Awareness Platform Universal Design

8 Cumbria County, UK and Government of Pakistan are known users - like many rapid onset disasters, Corona Virus (COVID-19) presents governments with familiar coordination and resource management problems that Sahana EDEN helping mitigate: https://sahanafoundation.org/sahana-eden-used-for-covid-19-responses/

management stakeholders including public safety and emergency services, in-line agencies, community-based organizations, and the public.

In Figure 6 we illustrate the software component of a Sahana-enabled situational awareness platform that follows a Model View Controller software architecture. User access control, data privacy, and data security are inherent properties of the Sahana software modules and are not discussed but information is available on the Sahana Wiki. The Sahana platform offers adoption of best practices and standards. For example, the controls and access to the functions, features, and data are through the REpresentational State Transfer (REST) Application Programming Interface (API) that is commonly referred to as RESTful API. It is the heart of the platform that makes it easy for integrating disparate applications and scaling the functionality to meet the user expectations.

The Sahana Resilience In Community (SHRINC), Sahana Alerting and Messaging Broker (SAMBRO), Sahana First Response (SAFIRE), and Sahana Relief and Rehabilitation (SHARE) situational awareness tools are discussed in detail in the subsequent sections. The important design component is that they offer standard and common crisis management operations that cover pre-crisis, crisis, and post-crisis processes. Moreover, each one of them is a stand alone system that offers situational awareness frames and internal states that aggregate to the three crisis management operational states. Essentially, the four situational awareness functional components are for risk mapping (identifying the hazard specific vulnerabilities, exposure, and potential impact), early warning (alerting of threatening hazard events), incident management (first response and emergency services coordination), and resource management (logistics, demand, and supply of response resource) are standard crisis response functional information clusters. The data processing makes use of crisis semantics and data exchange standards and popular file formats. Thereby, solution providers may interact with the platform to develop user interfaces customized to be useful and ease to use and mostly importantly customized to the needs of the narrow hetrogenic user groups.

Central to the community's engagement, sense of belongingness, and accountability is the Project Management solution. The project management module is introduced into Figure 6 for the community of practice to record, analyse, and share the activities and outcomes of their DiDRR initiatives that transpire their DiDRR objectives. The Project Management functional component engages the community in DiDRR planning, monitoring, and execution. If the community so desires, they may choose to make use of any other project management tool because it is independent of the situational awareness functionality but is essential for implementing and operationalizing their DiDRR practices. Then disparate crisis management groups can engage in a multitude of DiDRR initiatives towards a common goal. The World Bank and the Asia Disaster Preparedness Centre hosted a DRR Portal was essentially the Sahana project management tool that managed various statistics for monitoring DRR projects in Asia and the Pacific. It presented various project statistics to measure their achievements.

The crisis management functionality is activated and the data exchange, information processing, and knowledge sharing happens through the APIs. The Sahana community, through various collaborations, have developed modules that provide the useful data processing and information sharing features that are instrumental to effective crisis management. By interfacing with those modules for gaining the

desired situational awareness functionality, Tech stewards, Angels of Change, DPOs, PWDs, and emergency services, with the support of technology developers, can deliver useful situational awareness applications for their PWD community. Details of each of the essential data processing, data exchange standards, API, and situational awareness functional components, with an emphasis 'building on what works', is elaborated in the subsequent sections.

Data processing and interoperability

The Sahana platform adopts standards[9] to foster interoperability, whenever it is necessary. The experience is that people prefer the simple and durable file formats such as Comma Separated Value File (CSV files can be generated from spreadsheets such as XL for import and export of data), Portable Document Format (PDF typically used in sharing situational reports), eXtensible Markup Language (XML, the basis for interoperability of data and defined data semantics), JavaScript Object Notation (JSON is a low-weight version of XML) and Geographic Information Systems (GIS, specifically openGIS standards developed for sharing maps and map information). Having adopted these common data standards and semantics, Sahana modules can import and export files in those file formats making it easy for users to adopt their preferred and commonly used file formats and data exchange modes to interface with the Sahana modules.

Of particular interest to humanitarian and crisis management are two key standards; namely, the Emergency Data Exchange Language[10] (EDXL) and Humanitarian Data eXchange (HDX) Language. All of the data standards related to the situational awareness functional components can be tailored to EDXL and HDX; with an exception that HDX only addresses crisis and post crisis information exchange but not alerting. Whereas EDXL, managed by the Organization for the Advancement of Structured Information Standards covers the entire crisis management cycle. HDX has integrated a free to access repository to offers "humdata" comprising a multitude of country-wise risk data and emergency management near real time data[11].

To give a little bit of an overview of how standards evolved from Sahana and contribute to the greater good of all – Sahana People Finder Registry was one of the first modules to emerge as a response to the 2004 Indian Ocean Tsunami when Sahana was the first to provide a web solution for displaced families and loved ones to find each other and reunite. The US National Library of Medicine expanded on the people finder module to also offer facial recognition software to assist with matching and identifying missing persons. Google Crisis Response adopted the concept to offer the Google Person Finder

Figure 7: People Finder Registry hosted by the National Library of Medicine

9 A comprehensive account of the standards adoption are discussed in the Sahana Wiki with an emphasis on humanitarian data standards: http://wiki.sahanafoundation.org/standards/wiki
10 EDXL product directory: http://www.oasis-emergency.org/products
11 HDX 'humdata' repository: https://data.humdata.org/

tool, which they no longer offer as a service but the software is available for use by anyone who chooses to host their own instance. Thereon the People Finder Information Platform (PFIF) version 1.4 became a standard with the OASIS (Organization for the Advancement of Structured Information Standards) Emergency Management Technical Committee and the EDXL suit of emergency communication standards.

LIRNEasia, in 2005, was an early adopter and first to research the International Telecommunication Union recommended ITU-T X.1303 EDXL Common Alerting Protocol (CAP) international warning standard. The EDXL-CAP standard was implemented in software and has now evolved into SAMBRO. 2010 Haiti earthquake was the first instance when the EDXL Hospital Availability (HAVE) data standard, for sharing information with response organizations seeking information on various medical facilities and equipment. It was also the first instance when Sahana served as an interoperable platform where various cleansed and categorized datasets were made available by Sahana and other volunteers for humanitarian response agencies to utilize. This model of brokering information and contributing humanitarian and crisis response data is what the HDX platform offers with a data repository to access risk and response information through the HDX Language.

Other important crisis information exchange standards, of the EDXL suit, are Tracking Emergency Patients (TEP), Tracking Emergency Clients (TEC), Situational Reporting (SITREP), and Resource Messaging (RM). Tracking information from the point of patient encounter through definitive care admission or field release – TEP supports patient tracking across the Emergency Medical Services (EMS) care continuum, as well as hospital evacuations and patient transfers, providing real-time information to responders, Emergency Management, coordinating organizations and care facilities in the chain of care and transport. Similar to TEP, the purpose of TEC is to provide a standard messaging format for the creation and exchange of client records in and among publicly-accessible registries to assist in tracking and repatriation of displaced individuals during emergencies, disasters, and routine day-to-day crises.

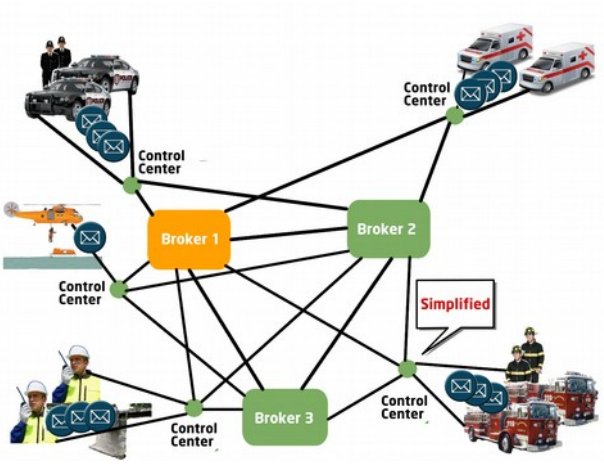

Figure 8: Sahana platform and message brokers support interconnects disparate information communication systems

SITREP describes a set of standard reports and elements that can be used for data sharing among emergency information systems, and that provide incident information for situation awareness on which incident command can base decisions. Specific to SITREP are field-observation (circumstance), casualty-illness (counts and case details), detailed situation information (including location and environment information), dispatch of response resources (personnel and equipment), and management summary reports for the media and institutional heads. RM complements all of the response efforts that deals in requesting and providing emergency equipment, supplies, people and

teams. The data standards offers a standard format to cast messages with required resources (needs) for suppliers to commit to them (e.g. asking for boats to shuttle flood victims).

Interfacing with Sahana data, functions, and features

RESTful API is the common practice for software systems to communicate with the Sahana platform. It is a widely used architectural style for distributed hypermedia systems. Since Sahana platform is RESTful, it exposes information about itself in the form of resources; i.e. information about its accessibility, crisis information, data structures, module functionality, and software features. The advantage is that it enables third-party client software applications to take actions on those resources, such as create new resources (i.e. create a new user) or change existing resources through their own software system (i.e. edit a record pertaining to a module in the database using your own mobile app).

Alternatively, the Sahana platform offers two other modes of data interchange. Different Sahana database instances, distributed across the internet, can directly exchange data between each to synchronize the selected information elements of two or more Sahana databases. A backup SAMBRO instance is hosted at the business continuity and disaster recovery data centre, which uses the ‘database synchronization’ technique for users to switch to it if the primary SAMBRO server and database was to fail. Publisher Subscriber models (or commonly known as a “pubsub”) is a very common approach to exchanging information; especially, to encourage many-to-many data exchange platforms. Real Simple Syndication (commonly referred to as RSS feeds) and a similar file format: Atom feeds are popular for exchanging news; hence, they are also often termed as news feeds.

Here is an example of the capabilities the APIs present through one of the Sahana implementation involving the SAMBRO situational awareness tool. The Myanmar Department of Meteorology and Hydrology used SAMBRO to publish EDXL-CAP warnings about flood, cyclone, earthquake, landslide, and other hydro-met and seismic alerts. The World Meteorological Organization subscribes to the Myanmar CAP feed through SAMBRO RSS feed generator to receive the XML files of each EDXL-CAP warning message. It is then processed by the World Meteorological Organization hosted Alerthub and made available for other software systems to consume.

The International Federation of Red Cross and Crescent (IFRC) Preparedness Centre supplied Hazard App also reads the RSS/Atom feed to process the hazard, intensity, and area specific alerts to provide useful impact-based risk estimates and evacuation instructions. SAMBRO Android and iOS mobile apps use the RESTful APIs to send and receive data between the centralized database and the mobile apps. A local alerting authority in a small village community would use the SAMBRO mobile app to issue warning of about a local hazard (e.g. a industrial fire). The SAMBRO mobile app is simplified for the local need but it maintains the data semantics and consistency to comply with the EDXL-CAP standard. This demonstrates that the Sahana situational awareness platform interoperability EDXL-CAP cabilities opens up and becomes a highly accessible platform for inclusive end-user specific application development and, in this case, for situational awareness applications for PWDs.

In the purview of PWDs, the Sahana Software Foundation interacted with a group of Deaf community members of the Deaf Disaster Assistance Team – DRR in Cebu, Philippines. The research involved realizing the capacity of pictographs and mobile applications for receiving warnings and also for Deaf people to report incidents and ask for help. The reason to use pictographs was to accommodate for linguistically challenged people. They can be low-literate and functionally illiterate people. For example, researcher has found that Refugees in distress and fleeing from conflict situations are in capable of reading lengthy text.

Four Essential Tools

These section discusses a few relevant Sahana projects that cut across the standard operations of the disaster management cycle. Error: Reference source not found shows them clustered into ‘mitigation-reconstruction’, preparedness-response, and ‘relief-rehabilitation’. The Sahana deployments page offers a descriptive tabulation of all Sahana projects. The Nepal Climate Data Portal - capturing and modelling weather data, New York City Emergency Management – an all hazard sheltering plan, Give2LA - City of Los Angeles information on volunteers and donation opportunities, and Timor-Leste Disaster Information Management System - reporting and sharing incident information are a few others from the of 67 Sahana deployments.

2015 is the first time in history that Europe had to process so many immigrants seeking refuge from conflicts in different parts of the world. The German Red Cross was challenged with processing 10,000 persons per day develop a Client Management system using the Sahana EDEN platform. Various national and international agencies were demanding statistics to prepare and respond to the masses of displaced people. It was also the first time Sahana EDEN had to implement protocols that were governed by the General Data Protection Regulation of the European Union. The Client Management tool builds on the 2014 Sahana EDEN customizations implemented by the Italian EVASS for Shelter and Evacuees Management and the Philippines Department of Social Welfare and Disaster.

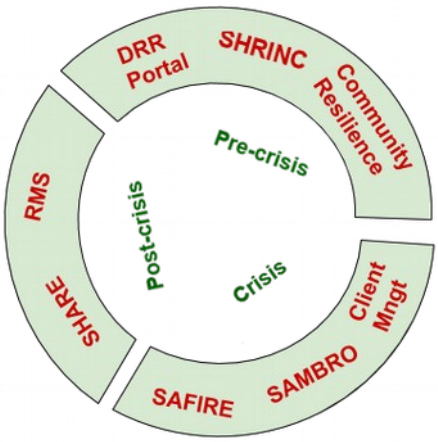

Figure 9: Relevant Sahana software tools that apply to the three crisis operations

Central to situational awareness are the four key Sahana tools: SHRINC, SAMBRO, SAFIRE, and SHARE. They are situational awareness tools that provide individual, team, and shared situational awareness. Given the interoperability and data sharing aspects, PWDs, DPOs, care takers, family members, the community, and emergency services have access to a common operating picture. Moreover, the messaging module that cuts across all four tools offers ways for integrating social media platforms (twitter, facebook), instant messaging tools (e.g. WhatsApp through Twilio service provider), SMS gateways (Clickatell, local Mobile Service Operator, or connect your own modem with a SIM card), email exchanges, and RSS/Atom feeds.

SHRINC

Sahana Resilience In Communities (SHRINC) harmonizes with ‘shrink-ing’ the risk in a communities and building resilience against those risks. SHRINC shares the risk situation and the risk mitigation plans, procedure, and projects. SHRINC also informs SAMBRO of the risk and impact for alerting authorities to define impact-based alerting strategies. Community resilience mapping was a RAND Corporation conducted pilot project sponsored by the Los Angeles Country Public Department of Health.

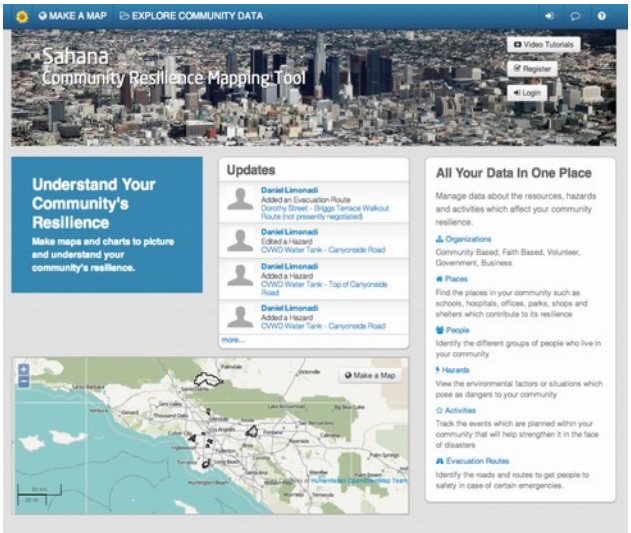

Figure 10: Sahana Resilience In Communities (SHRINC) tool for collating layers of maps for communities to identify risk and take action to mitigate them

The tool integrates all GIS layers to offer a tool for coalitions of community members to investigate the hazard, vulnerability, exposure and points of interest on maps. Thereafter, the tool allowed the community to manage the interventions for that risk area using the same tool. As an example, the coalition might identify a mental health institute to be located in a highly vulnerable landslide risk area. The community may intervene by asking the nearby fire station to help the institute build and test the mental health institute’s emergency response plans.

ESCAP 2019 Disaster Report also highlights that investments in resilience deliver important social co-benefits. SHRINC for more inclusive and empowered societies, can ensure that PWDs and vulnerable groups are not excluded from the benefits of community resilience investments due to barriers risk assessment tools, reliable early warning systems, decision-making structures, and social capital to finance the community resilience projects. SHRINC can be an innovative risk-informed social policy and DiDRR measures that can be replicated across all disability groups. The approaches advocated by SHRINC may also deliver co-benefits through better collaboration among emergency services and community resilience.

SAMBRO

LIRNEasia field tested the EDXL-CAP interoperable warning standard in thirty-two tsunami effected villages in Sri Lanka – with the assistance of the International Development Research Centre (IDRC) of Canada. SAMBRO began as a simple tool for disseminating alert through Short Message Service (SMS) and Email to selected groups of emergency services. SAMBRO adopted the EDXL-CAP standard and was field tested in syndromic surveillance and notification project in India and Sri Lanka (funded by IDRC in 2008) and voice-enabled alerting and incident reporting project in Sri Lanka (funded by the Humanitarian Innovation Fund and Kubatana Foundation in 2012). The well tested SAMBRO, with the assistance of the UN ESCAP Tsunami, was deployed for the use by the Governments of Myanmar, Maldives, and the Philippines (2016).

With SAMBRO everyone has shared access to the common picture of all alerts and the situation of all on going and past events. SAMBRO is a tool designed to inform before disasters strike and also leverage open, transparent and human-centred processes to identify areas where access to data can convert shared risks into better-informed coordinated action. The SAMBRO Alerthub is a one-stop-shop for national and closed user group (e.g. Community Emergency Response Teams) alerts. It can subscribe to a multitude of News Feeds and official EDXL-CAP messages to offer an aggregation, ranking, and filtering of hazard event specific data for emergency services and the community to be better informed. For example, an ambulatory service knowing about a culvert underwater is unmotorable better prepares them with alternate routes for accessing a life critical patient. Along with the EDXL-CAP standard, SAMBRO is a hybrid tool with rules that also provides a trust framework for sharing authenticated warnings. It enhance resilience and trust to drive positive shared outcomes.

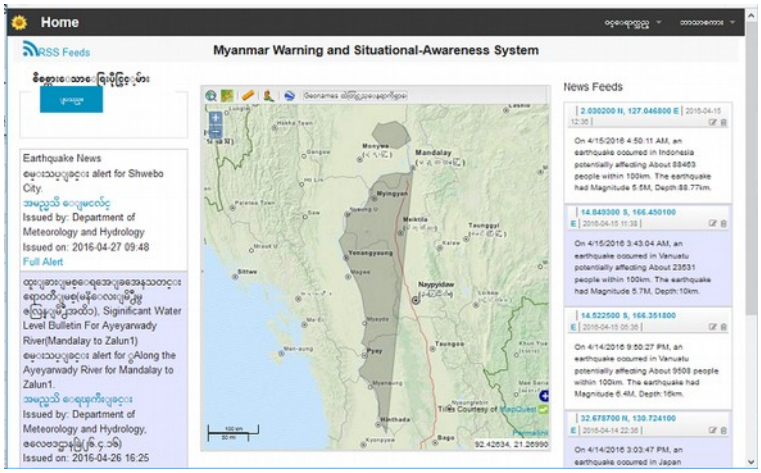

Figure 11: Multi-language Myanmar Department of Meteorology and Hydrology Sahana Alerting and Messaging Broker (SAMBRO) dashboard with alerting areas, description and relevant news feeds

SAFIRE

Sahana First Response (SAFIRE) is a strong counterpart of SAMBRO. It complements early warning with incident management; i.e. coordinating the information for responding to the aftermath of or during an incident. SAFIRE was designed as a simple tool for Emergency Operation Centres (EOCs) who typically manage emergency call centres (e.g. 119) and manage the incident information. The functions include logging incidents, dispatching resources and managing the situational reporting cycles. It follows the principles of the United States Federal Emergency Management Agency's Incident Command System (ICS) standards and processes. The Seychelles National EOC , along with their Local Government, Fire, Police, Coast Guard, and Stakeholders evaluated SAFIRE and at the time of writing this report, they were in the process of customizing it for their ICS needs. SAFIRE is also being used, now, by "Urgences- Santé" in Quebec, Canada. Part of SAFIRE, which involved only logging incidents is being used by the Timore-Leste Red Cross as a platform for keeping all administrative layers of the emergency services (fire, ambulance, policy, military, local leaders, and so on) informed.

SAFIRE is designed for coordinating crisis response teams such as public safety and emergency first responders for managing incidents arising from an event. The incident situational information is shared with the response teams, emergency operation centres, in-line agencies; and depending on the severity of the incident various summarized reports are shared with the government ministries and sometimes the president or prime minister's office. Although there is value in adopting relevant aspects of the EDXL-SITREP standard, the opportunity has not presented itself to implement the standard in SAFIRE but SAFIRE to can easily conform to EDXL-SITREP to offer field-observation, casualty-illness, situational information, response resource planning, and management summary reports. Moreover, SAFIRE can adopt the EDXL-RM to manage the demand and supply of required response resources. For example, location-based Over The Top (OTP) services integration of smarter Resource Messaging for matching demand with the right suppliers offers a decentralized approach to managing response resources.

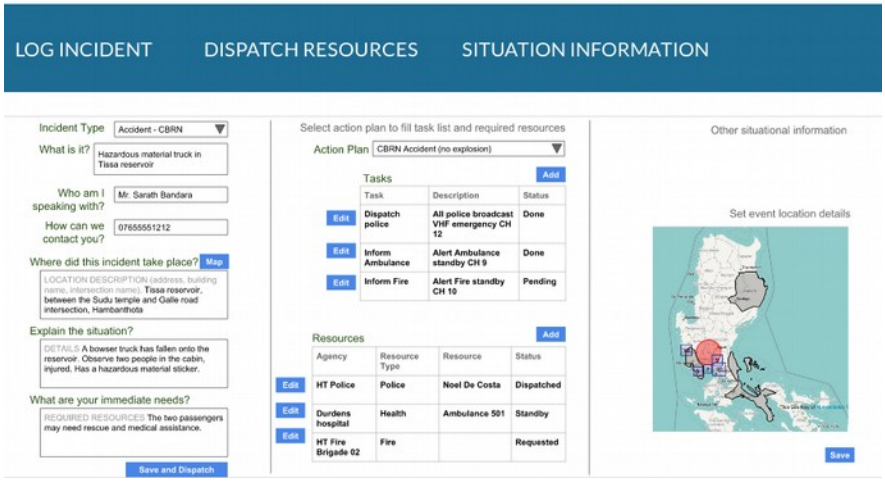

Figure 12: Sahana First Response (SAFIRE) Incident Command System (ICS) for any emergency operation centre's of all classes to coordinate response to any magnitude of incident and any type of organization

SHARE

Essentially the Sahana Relief and Rehabilitation (SHARE) hub builds on the Occupy Sandy experience. The SAHRE hub offers a common operating picture of who is doing what where and when (i.e. 4W) with non-emergency crisis response efforts. UN Resident Coordinator in Sri Lanka has operationalized a SHARE hub. The UN requires Humanitarian Country Teams; namely, the non-governmental organizations and civil society, to use the UN 4W reporting standard. SHARE hub offers a feature for Country Humanitarian Teams, such as Oxfam, Red Cross, World Vision, and so on, to manage the data with their own software but upload a CSV file (i.e. a spreadsheet) with the 4W data. Typically, the data they upload informs UN of the relief supplies and the demographic distribution of the relief items. SHARE hub, then offers a set of analytical and

Figure 13: Sahana Relief and Rehabilitation (SHARE) Hub for managing needs, commitments, and 4W

reporting tools for UN to offer real-time and planned situational updates of the non-emergency response.

The IFRC developed an integrated platform for each national society to manage their assets, logistics, volunteers, staffing, and response (2011). It integrates need requests with commitments to supply and deliver those requests. Each national society is siloed with restrictions on simply managing their own society information but IFRC could see the information across all societies. Thereby, IFRC plays a pivotal role for coordinating the logistics of assets, volunteers, and staff in aiding the response of a society by neighbouring societies.

“The system uses Sahana Eden to register national societies’ resources and includes geographical data such as hazard risks, population density, rainfall frequency and topography to allow for a more informed planning of humanitarian relief. The main purpose of the system is to support the Red Cross and Red Crescent national societies to manage their material and human resources, to inform longer-term development planning and help in more effective crisis response operations”. The Department of Social Welfare Development and Rehabilitation of the Government of Philippines operationalized the warehouse and logistics components of the RMS. The Sahana Eden instance was used during the 2013 typhoon Yoland response in the Philippines.

Impact on Global DRR Targets & SDG Priorities

Sahana tools and their data are well positioned to support “innovative risk-informed social policy and pro-poor DRR measures that can be replicated throughout the region”. Also it will “foster regional cooperation to reinforce national efforts”. It can also be positioned as the technology that “addresses new risks” because it is vital that vulnerable, marginalized groups are protected from these risks, so that everybody can benefit from this rich, new source of information and knowledge.

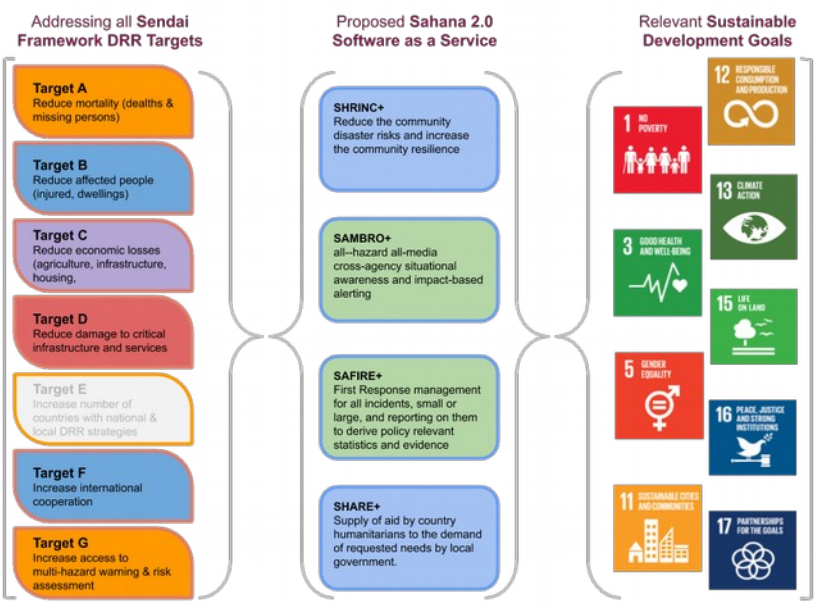

Figure 14: Mapping between Sahana solutions, SDGs priorities, and global DRR targets

Sahana also offers the advantage in the data driven digital economy for offering data and services that would complement national development targets; especially SDG 1, 3, 5, 11, 12, 13, 15, 16, and 17. The Sahana platform, comprising a free and open source software and the community identifies itself with

contributing to more SDGs than the PWD focus UN has that is illustrated in Figure 2. The Sahana platform has its objectives directly implanted into the Sendai Framework for DRR. Figure 14 shows the mapping between the four essential situational awareness tools, the Sendai Framework for DRR targets and the SDG priority areas.

RECOMMENDATIONS

In developing the element of situational awareness tools for DiDRR, there are three elements that form the base stack necessary for fostering the fourth element to avail daily use of assistive technologies for situational awareness applications. The purpose of the four elements of the stack, illustrated in Figure 2, are achieved by:

Figure 15: Building blocks for forging situational awareness tools for PWD

1) Applying a participatory and learning together community of practice approach to realize the necessary and sufficient elements for harnessing a Safety-II concepts; because It will allow for DiDRR stakeholders, including PWDs, DPOs, and emergency services face in realising the strengths, weaknesses, opportunities, and threats of the Safety-II approach.

2) Encouraging synchronous and asynchronous interactions between the DiDRR stakeholders through a digital habitat allowing for wide scale and range of interdisciplinary participation – begin to identify Tech stewards and Agents of Change who will champion in leading the community with identifying the technology to bring the community together, and also nurture those tech stewards in taking on the role of stewarding the situational awareness platforms and tools.

3) Integrating the situational awareness platforms and tools through cohesive interoperable emergency communication data standards that are tested and proven for their effectiveness by the national public safety and crisis management community – evidence for adaptability can be evaluated by the Agents of Change and implemented with the assistance of Tech stewards.

4) Re-purpose tools that cover a coherent set of daily use applications for dealing with frequent risks affecting individuals and, then extending the same as situational awareness tools for supporting the essence of adaptive capacity to act on larger risks affecting everyone – typical exercise for Tech stewards.

The aforementioned procedures must be propelled by emergency communication policies to make it all happen and come together; especially around interoperability to integrate the PWD situational awareness tools and platforms with the national and local emergency communication systems.

Practitioners should pay close attention to the necessary policies and procedures supporting the four perspectives in the technology involved supporting the digital habitat and situational awareness applications: the tools that support community activities, the platforms in which vendors and developers bundled them, the features that make them usable and liveable, and the overall configuration in which they are integrated for sustaining the situational awareness platforms. To methodically achieve them, there are three types of role driven activities that need to be addressed in a planned and coherent way.

> ***Recommendation (I)***: Disabled Persons Organization to take the lead in sponsoring a community of practice for learning together, and promoting, stewarding, and sustaining situational awareness technology.
>
> ***Recommendation (II)***: Tech stewards who emerge from the community of practice to lead with establishing the digital habitat for innovating with and supporting the community in adapting a situational awareness platforms and tools.
>
> ***Recommendation (III)***: Agents of Change to use evidence-based research to advocate government and the public safety community in setting interoperability policies and procedures that foster team and shared situational awareness across all platforms.

The three recommendations are discussed in detail below. The discussion offers and explanation of the roles and responsibilities of each of the actors in achieving the specific recommendation. A check list that is derived from (Wenger et al., 2009a) described community orientation, activities, tools, and action notebook. Finally, a set of expected outcomes are listed for each recommendation for deriving the objectives for achieving them. Anyone who intends to further analyse of put these recommendations in to practice is encouraged to refer to the “digital habitat” literature, by (Wenger et al., 2009b), that discusses aspects of the checklist in detail.

Recommendation I: Sponsor a Community of Practice

There are cultural and social variations to how people perceive risk and react to shocks. Therefore, risk and response is contextual and very localized to the extent the community of practice can be very narrow and specific to a set of PWDs and limited set of Stakeholders. Communities learn together in different ways: some meet regularly, some converse online, some work together, some share documents, some develop deep bonds, and some are driven by a mission they serve. They have a different orientation of typical pattern of activities and connections through which members experience being a community towards learning together. The DPOs are well integrated into the PWD community and also linked to national and local institutions. This makes them an ideal candidate for determining the most appropriate course for engagement, communication, and learning together.

Role of DPOs

Generally DPOs assist one type of disability group or a small community of persons with varied disabilities. Therefore, the DPOs are ideal for advocating and sponsoring a community of practice to offer a platform for PWDs, public safety officials, emergency services, emergency communication advocates and other relevant stakeholders to explore, define, and express common identity through the landscape of issues to address, and then negotiate a learning agenda worth pursuing. In the best interest of exploring situational awareness tools and practices that are best for the PWD community of interest, the DPOs should:

- Nurture the sustained mutual engagement around the practice of DiDRR and disability inclusive situational awareness and over time until the community overcomes the challenges posed by time and space – the things that are of physical, social, and political nature, but not the technology
- Lead in maintain the technology that creates the digital habitat for supporting the togetherness and making the community a social container for learning together in designing, developing, and deploying the necessary disability inclusive situational awareness technology and the supporting policies and procedures

Check list

1. Understand the challenges the community faces in learning together by considering the three challenges of rhythms (togetherness and separation), interactions (participation and reification), and identity (individuals and groups) that should become part of the “literacy” of technology stewardship.
2. Assess the range of relationships interplay between the poles – from complementarity to uncomplimentary, from harmony to conflict, and from mutual reinforcement to tension – that affect each other but captures the distinct dimension of the challenge of learning together
3. Apply enough continuity and intensity of engagement and weaving of the community to define the domain and development of the practice that eventually becomes a shared resource.

Expected outcomes

- Making sense of the extremes whereby members positively participating or negatively distancing (or reifying) that is a fundamental to the underlying concept of a community of practice and learning together or not learning together.
- Members will engage in activities, conversations, reflections and other forms of participation in the learning of the community – members will produce physical and conceptual artefacts of definitions, tools, concepts, methods, stories, documents, links to resources, and other forms of knowledge representation (i.e. conforming objects) that reflect their shared experience.

Recommendation II: Build the Digital Habitat

Typically there are nine orientations that have implication for the selection of the technology. The orientations are meetings, Open-ended conversations, projects, content, access to expertise, relationships, individual participation, community cultivation, and serving a context. Meetings that are synchronous, like face to face meetings, are nowadays achieved through online. Platform such as email can be asynchronous but can also be used in a similar way as a chat room or instant messenger for exchanging near-synchronous conversations and exchanging of content (documents).

Role of the Tech stewards

Distinct from traditional community leadership, stewarding a digital habitat in support of situational awareness technology, must consider taking on some leadership functions otherwise the technologies will be poorly developed; especially, since none or very few of PWDs are doing it. Therefore, the Tech steward:

- Should be largely motivated and have a sense of satisfaction in contributing to the community and eventually to the world – has to assemble without organizational support by considering open source and freely available solutions.
- Play a crucial role in bringing the community together and focusing on learning in community to yield a specific community-oriented perspective on technology – use the lens of the three polarities of synchronous and asynchronous, participation and exclusion, individuals and groups from a community perspective
- Work directly with the technology service providers (telcos, vendors, software developers) to ensure the situational awareness needs of the community are achieved – skills includes not only computer science but also communication systems, expert decision-making processes, group work (or team work), and ways of looking at communities and networks.
- An attitude to take on the responsibilities of the practice, including all the conversations, decisions, and learning that address the design and management of community's situational awareness platform infrastructure
- Embrace the opportunity to learn and grow by stretching the technical skills and learning – organize hackathons, mashups, and other technology development and scoping activities through a universal design approach.

Check list

1. Community understanding – the first and foremost activity of tech stewards is to understand their community and its evolution well enough to be able to respond to its expressed and unexpressed needs with respect to technology.

2. Technology awareness – with the community in mind, the technology stewards need to have enough understanding of technology developments to have a sense of what is available and possible.
3. Selection and installation – combination of community understanding and technology awareness should enable tech stewards to help their communities make informed choices about technology.
4. Adoption and transition – shepherd their community through the process of adopting (or rejecting) the new technology). Planning and facilitating the non-technological aspects of a transition process is a substantial task.
5. Every day use – tech stewards need to integrate the use of technology into everyday practices of the community as it evolves – the nine orientations with a focus on specific implications for technology starting with a brief definition of the orientation and list the main variants, indicators that the orientation is alive and well, list success factors that are considered critical to communities, question to warrant important configurations of a set of tools, paragraph on the technology implications, list of typical activities with examples of tools, with brief practice notes, to support the given orientation.

Expected Outcomes

- The technology induced digital habitat will drastically change the rhythms of togetherness and separation by creating new “community times” that are unconstrained by schedules and time zones and “communal spaces” that do not depend on physical location.
- It will shift away from the traditional focus of organization on decision-making and towards the processes that constitute the meaning of the decisions that are enacted with pragmatism.
- Flexibility of participation, leaving no one behind, allowing for personal integration capabilities by which they can coordinate and connect their various memberships, chose what to track, and decide how to participate

Recommendation III: Interoperability Policies and Protocols

Electronic Information Exchange Systems are explicitly designed to support online group work. Standards and interoperability sets the basis for public safety communication. That requires setting public safety policies and procedures in support of interoperability through standards. Those familiar with User Centred Design will understand the importance of putting the user at the core of a solution. If you’re trying to solve challenges faced by individuals with disabilities, you need to involve those individuals so you understand what the challenges are, and whether a proposed solution actually helps.

Role of Agents of Change

Leadership is an essential ingredient in a community of practice; whether it be formal or informal, concentrated in a few people or broadly distributed. PWDs acting as agents of change in DiDRR has the benefits of increasing awareness of risk, create cultural awareness among people without disabilities, and facilitate a supportive environment for DiDRR (Sonnenberg, 2020). Therefore, the role of Agents of Change are to:

- Understand the culture of the community members and their interactions to improve reduce the limited understanding hazard risks and the roles and responsibilities of the public safety officials, and emergency services.
- Bring to the attention of the aid agencies, international and local non-governmental organizations the need to build the skills and capacity of local and national government and in-line agencies and the need to include PWDs in all components of the crisis management and crisis communication cycle.
- Interpret the needs of the PWDs, developing community-based resources and partnerships, and strengthening the capacity of PWDs to participate in evidence-based emergency communication policy advocacy
- Immerse into the emergency communication domain to learn about emergency communication interoperability and data standards that can be integrated into national and local situational platforms, if any, to foster cohesive situational awareness platforms that can better serve the diverse groups of PWDs.
- Collaborate with all Stakeholders in formulating situational awareness capacity building, action research, and pilot projects that provide evidence for taking the lessons learned in to policy and advocating policy reforms that facilitate DiDRR and PWD inclusive situational awareness platforms.

Check list

1. Construct a mapping between the range of activities the community would engage in and the types of activities that will need to be supported by situational awareness tools (or design parameters) – define the number of activities a given tool supports (not necessarily a one-to-one mapping), take an inventory of the community's existing technology.
2. Determine how well one or more platforms would package and integrates a number of tools available in the marketplace (purchase or free) – also considering how well it provides additional features like security and data privacy, simplicity and intuitiveness for removing human computer interaction complexities, limits such as the volume of members it can handle and the options of supporting multiple communities, the cost implications for hosting, maintenance, and support, and the relationships and organizational arrangements between the community and vendors.

3. Understand the “habitability” as to how a community conducts its activities and how they get involved to realise the required balance in the set of features for making the platform and tools usable and at the same time enhance the functionality, flexible, and security – evaluate whether a feature supports how a community conducts activities, adds or removes complexity, offers consistency for ease-of-use, and is appealing to all community member skill levels from beginners to more experienced users.
4. Evaluate the configurability of the platforms and tools to serve as substrate to the digital habitat that meets the needs and desire of the community of practice – deciding whether the a) tools belong to single or multiple platforms, b) important missing functions and features affecting the specific activities, c) tolerance of the community in adapting a wider variety of tools and crossing technology boundaries, and resource limits constrain the acquisition and adoption of new tools or the use of existing ones.
5. Challenges of integrating the tools and platforms into a coherent situational awareness platform (i.e. do different tools appear to be located together) – configurations that offer one sign on to various tools, ability to pass data from different times of history between tools, and the ease of navigation from one state to another.
6. Ensure reliability through complementary redundancy of situational awareness tools and platforms such that PWDs require both ICT-enabled and non-ICT-enabled tools and platforms – in this day in age of Internet of Things considering both online and offline techniques – consider privacy and security of the emergency communication channels with opt-in or opt-out of situational awareness services.
7. Consider the adaptability of emergency communication interoperable emergency data exchange platforms and data standards – eXtensible Markup Language (XML), Javascript Object Notation (JSON), compatible Application Programming Interfaces (APIs), features such as RSS feeds, Health Level 7, Emergency Data Exchange Language (EDXL), Humanitarian Data eXchange (HDX), and National Information Exchange Model (NIEM) such that tools adopting these interoperable emergency communication data standards can talk to each other and can be plugged together. Of particular interest are the:
    a. Common Alerting Protocol (CAP) designed for all-hazard all-media in support for inclusive early warnings. The warning standard allows for addressing a range of devices including IoT-devices (e.g. firs alarms and sprinklers) or the use of pictograms and animations to communication the state of the situation as to what is about to happen. Given that warnings are the responsibility of the government, these official privileges are offered to “alerting authorities” with the government organizational and administrative structures.
    b. Situational Reporting (SITREP) offers a series of periodic reports updating the situational information of incidents in a crisis, the allocation of response resources to those incidents, and the management summary reports essential for emergency services in their tactical

response planning and execution. The SITREPs updates are compilations of the communication between crisis response teams and emergency operation centres.

c. Resource Messaging (RM) is a protocol designed for integrating emergency responders and equipment suppliers with the demand for crisis response resources. The United Nations 'who is doing what where and when' (4W) reporting standard is designed for country humanitarian organizations to exchange resource needs and supplier commitments to those individual or community needs. Hospital Availability (HAVE) is special standard complementing Resource Messaging with sharing information of hospital resources – being informed of where hospitals with resources with specific need for PWDs

d. Tracking Emergency Clients (TEC) and Tracking Emergency Patients (TEP) is how emergency services track the movement of victims during a triage operation. It can serve as means for shared situational awareness of where a person with disability or their family member is. The two standards integrate with the People Finder Information Format (PFIF 1.4) for resolve missing persons inquiries.

Expected Outcomes

- Integration of tools into platforms is the aspiration that the best community platform will accommodate all of a community's activities in a self-contained package; whereby, community members do not have to move back and forth between platforms and tools, feeling them close at hand and accessible because they are designed to work together.
- From a community development point of view a centrally integrated situational awareness platform, with its most important tools, gives the community a home and asserts its existence and identity in DiDRR.
- Elements of the situational awareness design of technology configuration would have considered interoperability features with quality, consistency, portability, and security across bridging of tools and platforms.

CONCLUSION

Evidence points to disability of itself is not the barrier but it is society that creates the divide and stigmatization. It has created a significant knowledge gap between the DiDRR communities and the crisis response and management communities. A community of practice, therefore, is a stepping stone to changing those bad practices and attitudes that currently is prevalent in the public safety, crisis response, and crisis management domain. While community or practice has been beneficial in many disciplines and domains, it is a method that should be encouraged in future DiDRR initiatives.

Risk analysis is a costly and laborious process, one that cannot ensure that all microscopic, peculiar, and frequent risks affecting individuals and risks arising from catastrophic events that affects everyone can be mitigated. Therefore, a proactive approach that the DiDRR community has not considered is

the Safety-II paradigm, which has a focus to build on best practices that work and is effective. Most importantly Safety-II foster will introduce ways for enhancing adaptive capacity for PWDs to safeguard against and appropriately respond to crises. Situational awareness does exactly that because situational awareness informs the big picture of a crisis allowing PWDs and crisis response and management community to perceive, comprehend, and project their decisions and action.

Situational awareness platforms are an integral part of offering situational awareness tools. When introducing situational awareness platforms and tools it is important that they adopt interoperability best practices, which allows application to be developed covering the variations of the heterogeneous groups. This presents a challenge for the Agents of Change who are taking on the roles to foster DiDRR and who are paving the ways for the situational awareness tools and platforms to harmonize with the necessary policies and protocols for DiDRR and PWD inclusive situational awareness. There are significant shortcomings of nations adopting emergency and humanitarian data exchange standards, in general; let alone neglecting DiDRR.

Another important consideration is that Tech stewards, who intend to enhance technologies for situational awareness, strongly consider technologies that are integrated into the PWDs daily lives. Thereby, you are also applying concepts of the Safety-II paradigm of using technologies and practices that work rather than trying to introduce specialized new technology that is usually short lived. The experience of realizing the daily use technologies that can be enhanced to serve situational awareness in crisis can be achieved through building of a digital habitat that nurtures the community of practice. It will be apparent that ICTs that are part of the digital habitat can be re-purposed for situational awareness and crisis communication. The national public safety community and crisis response managers should consider developing all these capacities to engage in an all inclusive manner to leave no one behind.

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